

CHEMISTRY

REVISION KIT

S.1,S.2,S.3 & S.4

Multiple Choice Questions

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CHEMISTRY PRACTICAL GUIDE

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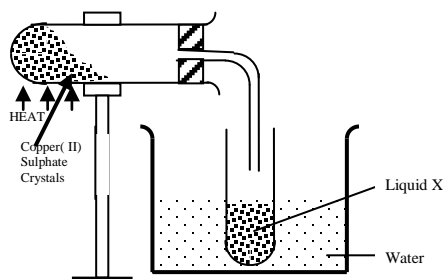
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TEST NUMBER ONE:

1. Choose the best answer. Soot is most likely to be formed in a Bunsen burner flame when:
 - A. a test tube is held in a flame.
 - B. the gas supply is turned as low as possible.
 - C. the airhole is closed.
 - D. the airhole is fully open and the gas supply fully on.
2. When the air hole on a Bunsen burner is opened
 - A. the flame is hot and smoky
 - B. air is correctly mixed with afrigas.
 - C. the afrigas comes out through the air hole.
 - D. the Bunsen burner uses more afrigas .
3. The term aqueous solution means
 - A. a solution with little solute per litre of solution.
 - B. a solution which can provide hydrogen ions.
 - C. a solution in which water is the solvent.
 - D. a solution in which more solute can dissolve.
4. A hydrate is a compound with
 - A. shape and size
 - B. a colour
 - C. molecules of water of crystallization.
 - D. shape, colour and size and no water of crystallization.
5. Which of the following is a property of a suspension?
 - A. it is a homogeneous mixture.
 - B. it is an aqueous solution.
 - C. it contains solid particles which can be seen.
 - D. No solid settles at the bottom on standing.
6. The process of separating alcohol (ethanol) from a mixture of water and alcohol depends upon the fact that
 - A. water is denser than alcohol
 - B. the boiling point of alcohol is lower than that of water.
 - C. water is inorganic liquid and alcohol is organic liquid.
 - D. the freezing point of alcohol is lower.
7. A saturated solution is a solution
 - A. which will not dissolve more solid at higher temperature
 - B. which can dissolve more solute at that temperature.
 - C. in which no more solid will dissolve at that temperature.
 - D. which contains no solid.
8. X and Y are miscible liquids the best method of separating these liquids is:
 - A. filtering
 - B. distillation
 - C. fractional distillation
 - D. fractional crystallization.

9. Which of the following substances will sublime heated strongly ?
- A. Phosphorus
 - B. Iodine
 - C. copper (ii) sulphate
 - D. sodium Chloride.
10. Copper sulphate crystals change in weight when heated because:
- A. water is gained
 - B. some of the copper sulphate is lost
 - C. steam is given off.
 - D. the crystals become hot.
11. The solution of sugar in water was fermented in yeast for a week the mixture was then carefully distilled , which statement about the first few drops of the liquid is not correct.
- A. drops had a higher boiling point than water
 - B. drops mixed easily with water
 - C. drops burned in air
 - D. drops were colourless.
12. What is a crystal ?
- A. a solid
 - B. different solids with same shape
 - C. solid with repetitive particles
 - D. a salt.
13. Which of the following is miscible with water?
- A. alcohol
 - B. salt
 - C. copper
 - D. petrol
14. Naphthalene is soluble in ethanol but insoluble in water. Pure naphthalene may be obtained from its mixture with sand by
- A. melting the mixture, filtering and cooling
 - B. heating the mixture so that it sublimes.
 - C. passing the mixture in water that it floats.
 - D. dissolving the mixture in ethanol, filtering and crystallizing.
15. Which of the following statement is not correct?
- A. crystallization is the formation of a solid from a solution or molten substance
 - B. a liquid changes to vapour during evaporation.
 - C. condensation is the formation of a liquid from gas when the gas is cooled.
 - D. vaporization occurs when gas changes to a liquid.

Questions 16 -18 refer to the diagram .



16. The crystals in the diagram are heated as shown at the end of the experiment the crystals will turn from to
- blue to white
 - white to blue
 - colourless to blue
 - blue to colourless.
17. Liquid X is:
- liquid nitrogen
 - alcohol
 - liquid oxygen
 - water.
18. How would one test for the presence of X.
- by looking at the colour
 - by heating
 - by adding it to hydrated copper (ii) sulphate
 - by adding it to anhydrous copper (ii) sulphate.
19. What is the difference between evaporation and boiling:
- both do occur at all temperatures.
 - evaporation and boiling take place at a fixed temperature.
 - boiling changes a liquid to a gaseous state.
 - boiling takes place at a fixed temperature.
20. Sodium hydroxide crystals are deliquescent; This means that the crystals
- change to vapour directly on heating .
 - form aqueous solution on standing
 - absorb a lot of moisture from air and dissolve in it to form a solution.
 - absorb carbondioxide gas from air and form a white solid.
21. Which of the following represents the correct way of lighting a Bunsen burner
- close the air holes turn on the gas full on, close the air hole a few seconds later light the gas.
 - turn on the gas full on, close the airhole a few seconds later light the gas.
 - close the airhole, light the gas.
 - close the airhole, turn on the gas full on a few seconds later light the gas.

22. Heating of solid substances should take place in the apparatus called
 A. boiling tube
 B. test tube
 C. ignition tube
 D. beaker.
23. Which of the following best describe a non -luminous flame
 A. is obtained when the airhole is fully opened.
 B. is obtained when the airhole is closed .
 C. is one when soot forms
 D. is one that forms a purple flame.
24. A flame can be described as:
 A. burning gases
 B. burning gases which gives off heat and light
 C. one with a blue flame.
 D. one that forms a lot of soot.
25. 10cm^3 of hydrogen chloride gas were dissolved in 200cm^3 of water to give an aqueous solution. Which of the following is true about the solution which is formed?
 A. water is a solute.
 B. hydrogen chloride is a solute.
 C. the solution formed is basic.
 D. a gas is given off when the solution is formed.
26. Which of the following is not true?
 A. sugar is an ionic compound.
 B. a filtrate is a solution which is obtained after filtration process has been carried out .
 C. a volatile solvent boils at very low temperature.
 D. benzene is a solvent for rubber.
27. The term ‘amorphous’ in chemistry refers to
 A. a crystalline solid
 B. a solid with molecules of water of crystallization.
 C. shapeless solid
 D. a liquid which is coloured.
28. The solubility of a substance is
 A. is the grams of solute required to saturate 100gm of solvent at a given temperature.
 B. is the grams of solvent required to saturate 100gm of water at a given temperature.
 C. is the amount of solute soluble in 100gm of water at a given temperature.
 D. 1 mole of solute in 1000cm^3 of solution.
29. The solubility of potassium nitrate and sodium chloride is given below.

	Temper ature	potassium nitrate	sodium chloride
Solubilit y	70°C	140	37
$\text{g}/100\text{cm}^3$	20°C	32	35

If a mixture of 130gm potassium nitrate and 30gm of sodium chloride are mixed and dissolved in 100gm of water at 70°C and then cooled to 20 °C.

Which of the following observations will be made?

- A. 98gm of potassium would separate out as crystals.
- B. 5gm of sodium chloride will separate out as crystals.
- C. 7gm of sodium chloride will separate out as crystals.
- D. 108g of potassium nitrate would separate out as crystals.

30. The process employed in the above example (question 29) is best described as

- A. filtration process
- B. crystallization process.
- C. fractional crystallization
- D. fractional distillation.

31. Which of the following is true?

- A. impure substances have a definite melting point.
- B. impurities usually lower the melting point.
- C. impurities usually lower the boiling point.
- D. pure water freezes at - 0.8 °C.

32. Which of the following is a compound?

- A. Copper
- B. Nitrogen
- C. Sodium chloride
- D. Mercury.

33. Which of the following is a mixture?

- A. Ink
- B. Iron sulphide
- C. Copper sulphate
- D. Ethanol.

34. A mixture of water and alcohol can best be separated by

- A. heating under reflux.
- B. fractional distillation.
- C. steam distillation
- D. steam bath.

35. Which of the following is NOT true?

- A. the percentage of carbon dioxide in air is 21%
- B. nitrogen is a diatomic molecule.
- C. the atomicity of sulphur is 8, the number of molecules is 2.
- D. carbon monoxide is a poisonous gas.

36. When mercury (II) oxide is strongly heated:

Which of the following is formed

- A. Mercury chloride
- B. Nitrogen dioxide
- C. Mercury (I) oxide
- D. Oxygen gas.

37. Which of the following elements does not react with steam?

- A. magnesium
- B. copper
- C. calcium

D. sodium

38. Consider the reaction:-



Which of the following is true about the reaction given above ?

- A. Iron (ii) oxide is formed
- B. The reaction is exothermic
- C. It is a reversible reaction
- D. It represents rusting of iron.

39. Which of the following is formed when white - hot coke reacts with steam?

- A. Producer gas
- B. Water gas
- C. Carbon dioxide gas
- D. Carbonic acid.

40. The smallest electrically neutral indivisible particle of an element that can take part in a chemical change is a definition of

- A. Molecule
- B. Proton
- C. Electron
- D. A tom.

TEST NUMBER TWO

1. Which of the following pH best describes a strong acid?

- A. pH = 1
- B. pH = 4
- C. pH = 7
- D. pH = 12.

2. Which of the statements below is not true about atoms?

- A. they are made up of neutrons , protons and electrons.
- B. they combine in small whole numbers
- C. the nucleus takes up the largest volume of the atom.
- D. they are exactly alike for a given element.

3. Which of the following methods is best for separating a mixture of ethanol and water.

- A. chromatography
- B. evaporation
- C. filtration
- D. fractional distillation.

4. Which one of the following carbonates does not give off carbondioxide when heated?

- A. calcium carbonate
- B. sodium carbonate
- C. copper carbonate
- D. ammonium carbonate.

5. A separating funnel can be used to separate a mixture of water and petrol because the two liquids

- A. are miscible liquids
B. are immiscible
C. have different densities
D. have different boiling points.
6. Which of the following substances has a giant ionic structure?
A. iodine
B. graphite
C. sodium chloride
D. hydrogen chloride
7. The process in which water vapour changes to dew is called
A. efflorescence
B. distillation
C. evaporation
D. condensation
8. A metal when reacts with a mineral acid usually forms:
A. an oxide of metal and hydrogen gas
B. a salt of the metal and water.
C. a salt of the metal and hydrogen.
D. a hydroxide of the metal and hydrogen.
9. Which of the following series of elements are arranged in their correct order of reactivity beginning with the least reactive?
A. magnesium, hydrogen, copper
B. hydrogen, magnesium, copper.
C. copper, hydrogen, magnesium.
D. hydrogen, copper, magnesium.
10. A student carried out an experiment on activity series and obtained the following results on metals, W, X, Y, Z. W displaced Y from its salt solution. Z displaced W from its salt solution, Y displaced X from its salts solution. The order of reactivity of these metals starting with the most reactive is:
A. ZWYX
B. WYXZ
C. XYWZ
D. YZWX.
11. The electron configuration for an atom with atomic number 20 is:
A. 2: 8: 10
B. 2: 18
C. 2:8: 8: 12
D. 2:8:18.
12. The process by which crystals lose their water of crystallization to the atmosphere is:
A. dehydration
B. efflorescence
C. hygroscopy
D. deliquescence.

13. Which of the following sets contains metals that can react with cold water?
- A. sodium, copper, silver
 - B. potassium, magnesium, silver
 - C. magnesium, potassium, sodium
 - D. calcium, sodium, lead.
14. A mixture of sand and salt can be separated by:
- A. distillation
 - B. evaporation to dryness.
 - C. adding water, filter and evaporate.
 - D. adding water, filter and evaporate the filtrate.
15. A piece of iron will rust in the presence of:
- A. water from air
 - B. dry air
 - C. air free water
 - D. moist air.
16. Sodium metal is stored in oil because:
- A. it sinks in oil but floats on water.
 - B. it reacts very easily with air.
 - C. sodium is very alkaline.
 - D. it forms a protective coating of oxide with the oil.
17. The chemical term, 'reduce' means:
- A. remove oxygen
 - B. lose weight
 - C. gain oxygen.
 - D. remove hydrogen.
18. Y is an element which combines with calcium to form a compound of formula CaY . The compound of Y with aluminium has the formula:
- A. AlY
 - B. AlY_2
 - C. Al_2Y_3
 - D. Al_3Y_2 .
19. Which of the following is immiscible with water.
- A. ethanol
 - B. petrol
 - C. salt
 - D. copper (ii) sulphate.
20. Cobalt chloride paper is used for proving the presence of:
- A. acids
 - B. gases
 - C. water
 - D. air.
21. An element has atomic number 13 and atomic mass 27. The particles in the atoms are likely to be:
- A. 13P 13E, 14N

- B. 12E 14P, 13N
- C. 14E 13P, 13N
- D. 13P 13E, 13N

22. Which of the following is true?

- A. air is a compound
- B. melting of ice is a chemical change.
- C. the luminous flame gives off soot.
- D. iodine melts when heated.

23. Which of the following is not true about hydrogen

- A. it burns in air to form water gas.
- B. it is less dense than air.
- C. pure hydrogen burns with a 'pop' sound.
- D. hydrogen is a reducing agent.

24. When sugar is added to water:

- A. it dissolves to give a mixture.
- B. it dissolves to give a solution.
- C. it melts to give a solution.
- D. a suspension is formed.

25. Which of the following electronic configurations represents a metallic atom

- A. 2.8.8.4
- B. 2.8.18.7
- C. 2.8.8.1
- D. 2.8.8.5.

26. When an atom gains two electrons it becomes

- A. negatively charged particle with a charge of -2
- B. positively charged particle with a charge of +2
- C. an ion with no charge
- D. an ion with a charge of +2.

27. In a periodic table, elements are arranged according to increasing

- A. atomic mass
- B. atomic number
- C. atomic symbol
- D. atomic shells.

28. Potassium has a valency of 1. That of sulphate is 2. The formula for potassium sulphate is:

- A. KSO_4
- B. $\text{K}(\text{SO}_4)_2$
- C. K_2SO_4
- D. $(\text{KSO}_4)_2$

29. Which of the following acids cannot form acid salt?

- A. H_2SO_4 , sulphuric acid
- B. H_3PO_4 , phosphoric acid
- C. H_2CO_3 , carbonic acid
- D. HCl , hydrochloric acid.

30. Which of the following is a weak acid?

- A. hydrochloric
- B. nitric
- C. phosphoric.

D. ethanoic.

31. Which of the following represents a normal oxide?

A. MgO

B. Na_2O_2

C. BaO_2

D. NaO_2 .

32. Which of the following substance will allow an electric current to go through it?

A. diamond

B. phosphorus

C. sulphur

D. lead.

33. When molten lead (II) bromine is electrolysed using carbon electrodes:

A. lead and carbon are formed

B. lead is deposited at cathode.

C. bromine is deposited at cathode.

D. oxygen gas is formed at anode.

34. The term nucleon refers to:

A. protons and neutrons.

B. protons and electrons.

C. neutrons and electrons.

D. atomic number.

35. The three elements belong to the same group in the periodic table.

A. hydrogen, helium and beryllium.

B. hydrogen, lithium, sodium.

C. hydrogen, fluorine, oxygen.

D. helium, fluorine and chlorine.

36. Selenium, Se is an element of relative atomic mass 79. Its oxide contains 71.2% of selenium. What is the simplest formula of the oxide?

(O = 16)

A. SeO

B. SeO_2

C. Se_2O

D. Se_2O_3

37. A colourless gas was brought close to the bottle containing concentrated ammonia solution. White fumes formed. The colourless gas has been.

A. sulphur dioxide

B. hydrogen chloride

C. Carbon dioxide

D. nitrogen dioxide.

38. A compound of nitrogen and oxygen contains 74.1% oxygen, its vapour density is 54. Its simplest formula is:

(N = 14, O = 16)

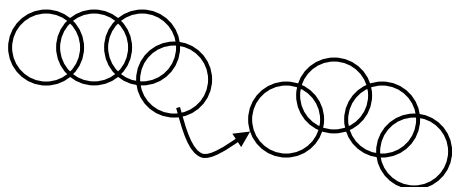
A. N_2O_4

B. N_5O_2

C. N_2O_5

D. NO_2

39.



The atomicity of sulphur in the sulphur molecules shown in the diagram is:

- A. 2
- B. 4
- C. 8
- D. 1

40. The number of moles of phosphorous atom in 62gm of P_4 molecules $\text{P} = 31$

- A. 0.5
- B. 2.0
- C. 8.0
- D. 4.0.

TEST NUMBER THREE

1. Aluminium flame:

- A. has 3 zones
- B. forms soot
- C. can be noisy
- D. has a steady flame.

2. Chalk is added to sugar and water and the resulting mixture is stirred continuously and filtered: The filtrate is of:

- A. chalk solution
- B. chalk suspension
- C. sugar solution
- D. chalk and sugar solution.

3. When iodine is heated gently in a test tube.

- A. it sublimes
- B. a new substance is formed
- C. melts into a purple liquid
- D. it burns brightly with a yellow flame.

4. Which of the following is true?

- A. melting of ice forms a new substance
- B. in a physical change a new substance is formed
- C. mercury (II) oxide gives off hydrogen when heated strongly
- D. heating sulphur in iron forms a compound.

5. Pure water boils at 100°C . Two grams of salt is added. The best temperature at which this solution is likely to boil is:

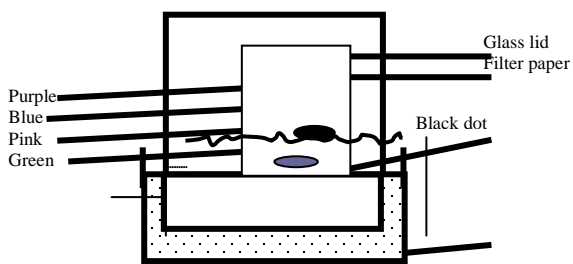
- A. 100°C
- B. 100.8°C

12

C. 90 °C

D. 98 °C

The diagram below shows one method of separating mixtures (dyes)



6. Which of the following dyes is most soluble in water?

A. purple

B. pink

C. blue

D. green.

7. The method employed above is called

A. fractional distillation

B. fractional crystallization

C. chromatography

D. filtration.

8. The mixture in b contains

A. a single substance

B. five single substances

C. four single substances

D. three single substances.

9. Air is a mixture and NOT a compound because.

A. its composition is uniform.

B. nitrogen has a highest percentage composition.

C. components of air can be separated by physical means.

D. it is composed of nitrogen , oxygen and water vapour.

10. Which of the following ions is a radical?

A. copper ion

B. chloride ion

C. sulphate ion

D. lead ion.

11. The action of an acid and a carbonate produces:

A. hydrogen gas

B. neutralization

C. bases

D. carbondioxide.

12. Hydrogen gas is collected over water because:

A. it is denser than air

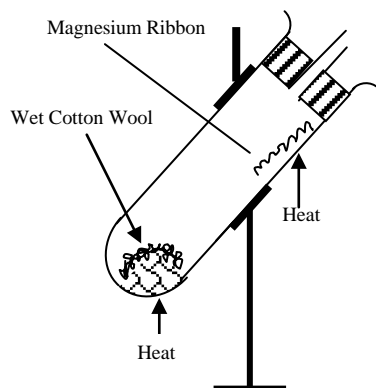
B. it is denser than water

C. it is less dense than water

D. it dissolves in water.

13. The term 'synthesis' in preparation of compounds means:

- A. preparation of a gas
 B. preparation of water and a gas
 C. preparation of a compound from another compound
 D. preparation of a compound from its elements.
14. Which of the following is true about hydrogen?
 A. petrol contains hydrogen in it.
 B. the gas reacts with oxygen to form producer gas .
 C. the percentage composition of hydrogen in water is 21 percent .
 D. the hydrogen gas burns with a squeak sound when ignited.
- 15.



The diagram represents

- A. a reaction between magnesium and cotton wool
 B. a reaction between magnesium and water
 C. a reaction between magnesium and steam
 D. effect of heat on magnesium ribbon.
16. Choose the best equation which represents the reaction between magnesium with steam.
- A. $\text{Mg} + 2\text{H}_2\text{O} \rightarrow \text{Mg}(\text{OH})_2 + \text{H}_2$
 (s) (g) (s) (g)
- B. $\text{Mg} + \text{H}_2\text{O} \rightarrow \text{MgO} + \text{H}_2\text{O}$
 (s) (l) (s) (l)
- C. $\text{Mg} + \text{H}_2\text{O} \rightarrow \text{MgO} + \text{H}_2$
 (s) (g) (s) (g)
- D. $\text{Mg} + \text{H}_2\text{O} \rightarrow \text{Mg}(\text{OH})_2 + \text{H}_2$
 (s) (g) (s) (g)
17. Carbon reacts with steam to produce:
 A. producer gas
 B. no reaction
 C. carbon monoxide
 D. water gas.
18. Fluorine is an element found in group VIIB and period 2 in the periodic table. The valency of shells in a fluorine atom respectively are:-
 A. 2 and 2
 B. 7 and 2
 C. 7 and 1

14

D.. 1 and 2

19 The element in the periodic table are represented as shown below in the diagram



The values of x and y respectively are:

- A. x = 12 and y = 2
- B. x = 24 and y = 12
- C. x = 24 and y = 12
- D. x = 23 and y = 11

20. Phosphorus combine with oxygen to form a compound P_2O_5 . The formula between phosphorus and chlorine is:

- A. P_2Cl_5
- B. P_5Cl_2
- C. PCl_5
- D. P_5Cl_3 .

21. The percentage composition of water in hydrated copper (II) sulphate crystal is $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ is: (Cu = 64, S = 32, O = 16, H = 1)

- A. 36%
- B. $17\frac{1}{5}\%$
- C. 4%
- D. 20%

22. A gaseous compound of nitrogen and oxygen only contains 30.5% nitrogen. The vapour density of this gas is 46. The empirical and molecular formula respectively of this compound is:

(N = 14, O = 16)

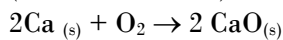
- A. NO_2 and N_2O_4
- B. NO_2 and NO_4
- C. NO and N_2O_4
- D. NO and N_2O_4 .

23. The ionic equation between zinc and dilute sulphuric acid is

- A. $\text{Zn (s)} + \text{H}_2\text{SO}_4 \rightarrow \text{ZnSO}_4 + \text{H}_2$
(aq) (aq) (g)
- B. $\text{Zn (s)} + \text{SO}_4^{2-} \rightarrow \text{ZnSO}_4$
(aq) (aq)
- C. $\text{Zn (s)} + 2\text{H}^+ \rightarrow \text{Zn}^{2+} + \text{H}_2$ (g)
(aq) (aq)
- D. $\text{Zn}^{2+} + 2\text{H}^+ \rightarrow \text{Zn}^{2+} + \text{H}_2$
(aq) (aq) (s) (g)

24. Calculate the gain in mass when 0.5gm of calcium is completely burned in excess oxygen according to the equation .

(Ca = 40, O = 16)



- A. 0.2gm
- B. 0.7gm
- C. 0.5gm
- D. 2.0gm

25. The volume of a given mass of 300cm^3 at 48°C and 800mmHg pressure.

Saturated vapour pressure at 48°C is 15mmHg pressure. What is the volume of this gas at s.t.p?

- A. $\frac{800}{760} \times \frac{273}{321} \times 300$
- C. $\frac{785}{760} \times \frac{273}{321} \times 300$
- C. $\frac{760}{785} \times \frac{273}{321} \times 300$
- D. $\frac{800}{760} \times \frac{321}{273} \times 300$

26. The atomicity of a sulphur molecule, S_4 is:

- A. 2
- B. 1
- C. 4
- D. 8

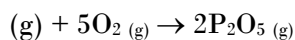
27. The number of moles of sodium hydroxide NaOH in 4gm of the compound is
(Na = 23 O = 16 H = 1)

- A. 0.5
- B. 0.2
- C. 1.0
- D. 0.1

28. The atomic number of calcium is 20, its atomic mass is 40.
The electronic configuration (arrangement) of a calcium ions is:

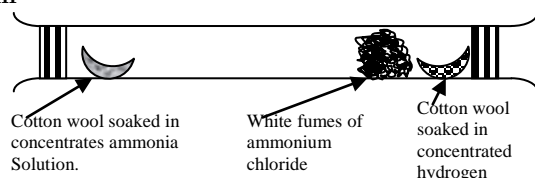
- A. 2: 8: 8: 3
- B. 2: 8: 8: 1
- C. 2: 8: 8
- D. 2: 8: 8: 2

29. 50cm^3 of phosphorus vapour, P_4 is mixed with 30cm^3 of oxygen gas to form phosphorus (V) oxide according to the equation below:



What is the volume of P_2O_5 that will be produced if the experiment is carried out at S.T.P ? ($p = 31$, $O = 16$)

- A. 12 cm^3
- B. 6 cm^3
- C. 20 cm^3
- D. 80 cm^3



30.

The above experiment shows that:

- A. hydrogen chloride gas diffuses faster than ammonia.
- B. ammonia chloride is white.
- C. gravity has great effect on rates of diffusion of gases.
- D. ammonia gas diffuses faster than hydrogen chloride gas.

31. Which of the following gases is acidic:

- A. ammonia
- B. carbondioxide
- C. carbonmonoxide

D. nitric oxide

32. Potassium chlorate decomposes on heating as follows:

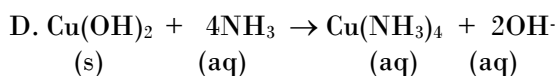
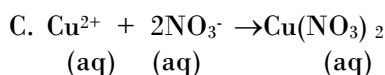
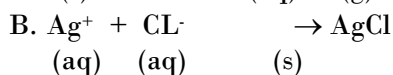
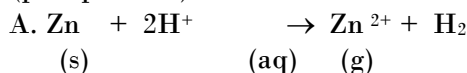


Calculate the volume of oxygen gas produced at S.T.P when 2.45gm of the compound is heated to constant mass.

(K = 39, Cl = 35.5, O = 16 molar volume at S.T.P is 22400cm³).

- A. 224 cm³
- B. 672 cm³
- C. 2016 cm³
- D. 336 cm³

33. Which of the following reaction represent a salt which can be prepared by double decomposition (precipitation)



MULTIPLE COMPLETION QUESTION:

There are 4 number responses, one or more of which may be correct. Decide whether each possible answer is correct and then choose

- A. if only 1, 2 and 3 are correct
- B. if only 1 and 3 are correct
- C. if only 2 and 4 are correct
- E. if only 4 is correct.

A	B	C	D
1, 2 and 3 only.	1 and 3 only	2 and 4 only	4 only

34. Element x has atomic number 7. The element:

- 1. is a non - metal
- 2. has relative atomic mass 7
- 3. reacts by gain of electrons
- 4. has two electrons in the outmost shell.

35. Which of the following will evolve hydrogen from a solution of hydrochloric acids ?

- 1. magnesium
- 2. iron
- 3. zinc
- 4. lead

36. Carbonmonoxide resembles hydrogen in that both of them are:

- 1. reducing agents
- 2. poisonous
- 3. colourless
- 4. soluble in sodium hydroxide.

37. When magnesium loses two electrons the particle formed:

- 1. is an inert gas

2. is an allotrope of magnesium
 3. carries a double negative charge
 4. carries a double positive charge.
-
38. Which of the following form a “similar pair”?
 1. iron, nitrogen
 2. chlorine, bromine
 3. neon, potassium
 4. lithium, sodium.
-
39. Which of the following is true about ammonia gas.
 1. it is an alkaline gas
 2. it is a colourless gas
 3. it reduces oxides of copper and lead when heated
 4. it has no smell.
-
40. Hardness of water is caused by presence of:
 1. sulphate of magnesium
 2. carbonate of calcium
 3. hydrogen carbonate of calcium
 4. sulphate of sodium.

TEST NUMBER FOUR:

1. Which of the following elements reacts with nitrogen when heated ?
 - A. copper
 - B. sulphur
 - C. magnesium
 - D. zinc .

2. Element x belongs to group (II) in the periodic table. The formula of the oxide of x is:
 - A. X_2O
 - B. X_2O_3
 - C. XO_2
 - D. XO

3. Carbon monoxide reacts with nitrogen to produce:
 - A. carbonmonoxide
 - B. producer gas
 - C. carbondioxide and nitrogen
 - D. water gas.

4. In the periodic table the element is represented as $^{27}_{13}Al$
What is the formula of aluminium sulphate ?
 - A. $AlSO_4$
 - B. $Al_2(SO_4)_3$
 - C. Al_2SO_4
 - D. $Al(SO_4)_3$.

5. The percentage of sulphur in hydrated aluminium sulphate is:

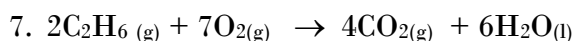
(Al = 27, O = 16, H = 1)

- A. 15.8
- B. 56
- C. 28
- D. 9.3

6. A student weighed 5.6 grams of potassium hydroxide pellets. How many moles of compound are contained in this mass?

(K = 39, O = 16, H = 1)

- A. 1
- B. 0.5
- C. 0.1
- D. 56



if 50cm^3 of ethene, C_2H_6 were burned in excess oxygen. What volume of carbondioxide would be produced at the same conditions of experiment.

- A. 100 cm^3
- B. 75 cm^3
- C. 25 cm^3
- D. 50 cm^3

8. Which of the following properties is shown by carbon monoxide?

- A. it is very soluble in water
- B. It turns blue litmus paper red
- C. it burns with blue flame
- D. it turns lime water milky.

9. What would be observed when copper turnings were added to zinc sulphate solution?

- A. solution turns blue
- B. copper is coated with zinc
- C. a white precipitate is formed.
- D. solution remains colourless.

10. When element x and z are heated together they form a compound with the formula X_3Z_2 . Element X and Z have the following electronic structure respectively.

- A. 2,8,1 and 2,6
- B. 1,8,2 and 2,5
- C. 2,8,2 and 2,4
- D. 2,8,1 and 2,5

11. The atomic number of an element Y is 21. Its electronic arrangement in the structure is:

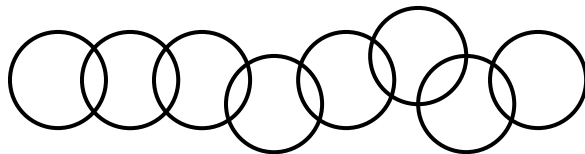
- A. 2.8.3
- B. 2.18,3
- C. 2.8.8.2
- D. 2.8.8.3

12. Neon forms very few chemical compounds because:

- A. its standard electrode potential is zero.
- B. it has a full outermost electron structure.

- C. it is above argon in the same group.
E. it has a greater tendency to lose electrons.

13. Consider the molecules of sulphur



What is its atomicity ?

- A. 4
B. 8
C. 2
D. 12
14. The volume of a given gas is 480cm³ at 48°C and 8 atmospheres and pressure. What is the volume of the gas at s. t. p.?
- A. $\frac{8}{1} \times \frac{273}{321} \times 480$
B. $\frac{7.5}{1} \times \frac{321}{273} \times 480$
B. $\frac{7.5}{1} \times \frac{273}{321} \times 480$
D. $\frac{8}{1} \times \frac{321}{2731} \times 480\text{cm}^3$.
15. The number of particles in the nuclei of atoms Q,R,S and T are shown in the table below:

	Number of particles	
Atom	Proton + Neutrons	Neutrons
T	40	20
R	45	25
S	40	22
Q	45	24

Which of the atoms are isotopes?

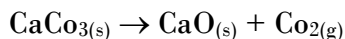
- A. T and R
B. S and Q
C. Q and R
D. T and S.
16. Element K lies in group V and element M in group II. The formula of the compound between K and M would be
- A. M₂K₃
B. M₃K₂
C. MK
C. MK₃.

17. Calculate the loss in mass when 5gm of calcium carbonate is heated to constant mass. (Ca = 40, C = 12 O = 16).



- A. 7.5 B. 2.2 C. 7.2 D. 2.8

18.

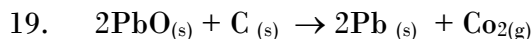


A. 7.5

B. 2.2

C. 7.2

D. 2.8.



In the reaction, carbon behaves as:

A. dehydrating agent

B. oxidizing agent

C. a reducing agent

D. hydrolyzing agent

19. In the exothermic reaction

A. heat energy is absorbed by reacting substance.

B. heat energy is supplied to the reacting substance.

C. heat energy is given off to the surroundings.

D. a colourless gas is usually given off.

20. Hardness in water is caused by the presence of:

A. calcium carbonate.

B. magnesium hydrogen carbonate.

C. sulphates of the calcium and aluminium.

D. nitrates of magnesium and calcium.

21. The chemical name for soap is

A. calcium hydroxide

B. glycerin

C. sodium stearate

D. saponification.

22. When calcium hydrogen carbonate is heated strongly the clear solution turns cloudy. This is due:

A. formation of insoluble calcium hydroxide.

B. calcium hydroxide reacts with carbon dioxide.

C. calcium hydrogen carbonate which is insoluble.

D. formation of insoluble calcium carbonate.

23. Two gases which are evolved on heating lead (II) nitrate are:

A. oxygen and nitrogen dioxide

B. nitrogen dioxide and ammonia

C. ammonia and oxygen

D. nitrogen and oxygen.

24. Which one of the following pairs of substances will react to form hydrogen?

A. copper and dilute sulphuric acid

B. copper carbonate and dilute sulphuric acid

C. magnesium and dilute hydrochloric acid

D. sodium sulphite and dilute hydrochloric acid.

25. Which of the following is true about nitrogen dioxide gas?

A. it is neutral to litmus

- B. it is colourless
 C. it is very soluble in water
 D. it relights a glowing splint

26. A brown ring test is used to identify.....radical.

- A. chloride
 B. carbonate
 C. nitrate
 D. sulphate

27. Molar volume of a gas refers to:

- A. a volume occupied by one molecule of gas at S.T.P
 B. volume occupied by any gas at S.T.P
 C. volume of all gases at S.T.P
 D. volume occupied by one mole of gas at S.T.P

28. A solid was added to a colourless solution of hydrochloric acid a gas which turned lime water milky was given off. From this observation only, we can conclude that.

- A. the solid was a hydroxide.
 B. the solid contained carbon
 C. the solid was of calcium carbonate
 D. the solid contained a carbonate radical.

Each of the questions 29 - 35 consists of an assertion (statement) on the hand side and a reason on the right hand side.

Select:

- A. if both assertion and reason are true statement and the reason is a correct explanation of the assertion.
 B. if both assertion and reason are true statements but the reason is **not** is correct explanation of the assertion.
 C. if the assertion is **true** but the reason is an **incorrect** statement.
 D. if the assertion is incorrect but the reason is a true statement.

Summary:

	Assertion	Reason
A	True	True (reasons is a correct explanation)
B	True	True (reasons is not a correct explanation)
C	True	Incorrect explanation)
D	Incorrect	True statement

Assertion

Reason

29. When liquid air is distilled,
 off before **because**

Nitrogen boils at a lower oxygen comes
 temperature than oxygen.

30. When hydrogen is passed over
 copper(II) oxide there
 is no chemical reaction.

because Hydrogen is higher than heated
 copper in the activity series.

31. Solid lead (ii) bromine **because**
 lead(ii) bromine are not able
 to move.

The ions of the solid conducts electricity

32. Sodium atom reacts by losing one electron *because* Sodium atom is a metal with one electron in the outermost shell.
33. Diamond, graphite are carbon. *because* One gram of each gives the crystalline form of dioxide when burnt in oxygen. same amount of carbon
34. Ammonia gas is the only alkaline gas. *because* Other gases are acidic.
35. Hard water forms scum with mixed together *because* Scum is a soluble part of soap when soap that forms lather.

In each of the questions 36 to 40 one or more of the answers given may be correct. Read each question carefully and then indicate on your answer sheet according to the following:

- A. if only 1,2 and 3 are correct
 B. if only 1 and 3 are correct
 C. if only 2 and 4 are correct
 D. if only 4 is correct.

Instructions summarised.

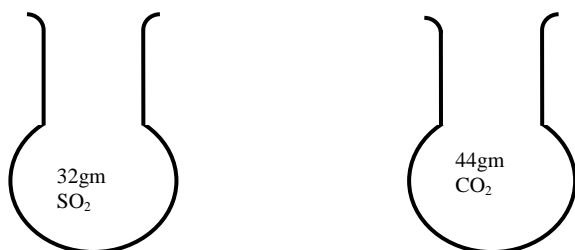
A	B	C	D
1, 2 and 3 only correct	1 and 3 only correct	2 and 4 only correct	4 only correct.

36. Which of the following substances will sublime when heated?
1. Ammonium chloride
 2. Iron(III) chloride
 3. Iodine
 4. sulphur.
37. Which of the following form similar pair?
1. carbon, sulphur
 2. iron, zinc
 3. bromine, chloride
 4. neon, sodium.
38. Which of the following substances would undergo permanent changes when strongly heated?
1. Iodine.
 2. sugar.
 3. potassium carbonate.
 4. potassium chlorate.
39. Identify a gas which is neutral to litmus.
1. nitrogen dioxide
 2. carbon monoxide
 3. sulphur dioxide
 4. Hydrogen.
40. Which of the following gases re-lights a glowing splint similar to oxygen?
1. Nitrogen dioxide
 2. nitric oxide

3. sulphur
4. nitrogen oxide.

TEST NUMBER FIVE:

1. A student was asked to use 0.2 moles of magnesium in an experiment. The mass in grams of this quantity of magnesium is:
(Mg = 24)
 - A. 48
 - B. 4.8
 - C. 0.048
 - D. 0.48.
2. Which one of the following contains the same number of molecules as 1gm of hydrogen molecule?
 - A. 14gm of nitrogen molecules.
 - B. 28gm of nitrogen molecules.
 - C. 32gm of oxygen molecules
 - D. 8gm of oxygen molecules.
3. Two flasks A and B are filled with two gases as shown in the diagram.



- Which one of the following statements about the gases in the flask is correct?
- A. flask A contains more molecules than flask B.
 - B. flask A contains the same number of molecules as B.
 - C. flask A contains fewer molecules than B.
 - D. flask A contains the same number of atoms.
4. 20cm³ of hydrogen was reacted with 15cm³ of oxygen the volume of gas that remained when the reaction was completed was
 - A. 5cm³ of oxygen
 - B. 5cm³ of hydrogen
 - C. 20cm³ of hydrogen
 - D. 10cm³ of oxygen.
 5. A compound contains 92.3% carbon and 7.7% hydrogen by mass. What is the empirical formula of the compound?
 - A. C₂H
 - B. C₂H₂
 - C. CH₂
 - D. CH.
 6. Which one of the following is likely to be untrue for a substance with a giant ionic structure?
 - A. it is hard

- B. it is volatile
 - C. it has a high melting point
 - D. it does contain molecules.
7. The atoms of the same element may differ from one another in:
- A. Number of neutrons in their nuclei
 - B. the number of protons in their nuclei.
 - C. the chemical reactions they may undergo.
 - D. the number of orbital electrons in their electron cloud.
8. Which of the following is true for the ions N^{3-} .
- A. it has a mass number of 14, 7 protons, 7 neutrons and 2 electrons.
 - B. it has a mass number of 14, 7 protons, 7 neutrons and 10 electrons.
 - C. it has a mass number of 14, 7 protons, 7 neutrons and 10 elements.
 - D. it has a mass number of 14, 7 protons, 7 neutrons and 5 electrons.
9. Argon forms no chemical compounds because
- A. it is above Xenon in the same group.
 - B. it is a non metal.
 - C. it tends to lose electrons.
 - D. it has a full outmost electron shell.
10. The electron arrangement of some elements are given below.
 $\text{P} = 2, 8, 2$ $\text{Q} = 2, 8, 7$ $\text{S} = 2, 8, 4$ which pair will form an ionic bond?
- A. Q and R
 - B. P and Q
 - C. P and S.
 - D. R and S.
11. Decomposition of hydrogen peroxide is accelerated by:
- A. adding manganese (IV) oxide.
 - B. lowering the temperature.
 - C. adding sulphuric acid.
 - D. adding vanadium (V) oxide.
12. Which reaction is normally used to prepare hydrogen in the laboratory.
- A. reacting calcium with dilute sulphuric acid.
 - B. reacting zinc with dilute hydrochloric acid.
 - C. reacting sodium with water.
 - D. reacting hydrogen chloride with ammonia.
13. Liquid oxygen is obtained by allowing nitrogen to boil out of liquid air?
 This is because:
- A. nitrogen is lighter than oxygen.
 - B. nitrogen has a higher boiling point than oxygen.
 - C. nitrogen has a lower boiling point than oxygen.
 - D. there is more nitrogen than oxygen in air.
14. The separation of a mixture of liquids by distillation is improved by:
- A. distilling at a higher temperature.
 - B. distilling a larger amount of the mixture.
 - C. distilling in a larger distillation flask.
 - D. distilling using a column.
15. Astatine, At, is an element below iodine in group VII B of the periodic table, which of the following is **not** correct?
- A. it is a diatomic molecule.
 - B. it is a solid at room temperature.

- C. it is a liquid at room temperature.
 D. it is less reactive towards potassium than iodine.
16. A compound can sometimes be separated into its different elements by:
 A. electrolysis.
 B. chromatography.
 C. fractional distillation.
 D. filtration.
17. Which of the metals forms a soluble carbonate?
 A. lead
 B. zinc
 C. sodium
 D. barium
18. Which one of the following is an acid salt?
 A. sodium hydrogen sulphate
 B. sodium carbonate
 C. sodium chloride
 D. sodium nitrate
19. Which of the following is **not** prepared by double decomposition (precipitation)
 A. lead (II) bromine.
 B. lead (II) nitrate.
 C. lead (II) chloride.
 D. lead (II) sulphate.
20. Which of the following reactions demonstrate hydrogen as a reducing agent?
 A. heating zinc in a stream of hydrogen.
 B. adding magnesium to dilute hydrochloric acid.
 C. exposing a mixture of hydrogen gas and chlorine to sunlight.
 D. heating copper (II) oxide in a stream of hydrogen gas.
21. When a gas Y with a pungent smell was passed over hot platinum foil a colourless gas x was formed. Gas x turned brown on mixing with air. Gas Y is most likely to be:
 A. ammonia
 B. sulphur dioxide
 C. hydrogen sulphide.
 D. nitrogen monoxide.
22. An atom ${}_{41}^M$ forms a chloride of the type MCl_2 which one of the following

20

forms a chloride with similar formula as M?

- A.
 B. ${}_{13}^{25}T$
 C. ${}_{12}^{25}R$
 D. ${}_{11}^{22}Z$
23. The loss in mass in grams, when two moles of potassium chlorate are thermally decomposed is:

$$2KClO_{3(s)} \rightarrow 2KCl_{(s)} + 3O_{2(s)}$$

 A. 32
 B. 46

26

C. 68

D. 96.

(K = 39, Cl = 35.5, O = 16)

24. Which one of the following is **not** true about sodium nitrate when strongly heated?

A. it melts

B. it liberates oxygen

C. it loses mass.

D. it liberates nitrogen dioxide.

25. Water gas is used in the manufacture of:

A. hydrogen

B. methane

C. butane

D. carbon dioxide .

26. 25cm³ of 0.1m KOH were used by a student; how many moles of the salt are contained in this volume?

A. 0.1

B. 0.25

C. 0.0025

D. 0.025.

27. Astatine, At, is an element below iodine in group VII B of the periodic table, but its chemistry differs from other members of the group because:

A. it is more reactive towards metals

B. it is a non-metal

C. it is a radioactive element, others are not.

D. it is a gas at room temperature.

28. Which of the following ions can cause hardness in water?

A. Fe²⁺

B. Pb²⁺

C. Na⁺

D. Ca⁺⁺

29. Carbon monoxide resembles ammonia in that both of them are:

A. poisonous and soluble in sodium hydroxide.

B. colourless and reducing agents.

C. coloured and reducing agents.

D. gases and poisonous.

30. Which of the following form a similar pair?

A. lithium and sodium.

B. nitrogen and aluminium.

C. neon and potassium.

D. chlorine and sulphur.

31. Which one of the following is normally used to catalyse the oxidation of ammonia during the manufacture of nitric acid?

A. finely divided Iron

B. Iron (III) oxide

C. vanadium(V) oxide

D. platinised asbestos.

32. The atomic number of element Y is 19. The formula of its chloride is:
 A. Y_2Cl_2
 B. Y_2Cl
 C. YCl
 D. YCl_2
33. Suppose you wanted to make an electrical connection between wires lying side by side, which of the following could be put between them?
 A. molten lead.
 B. molten sulphur.
 C. pure water.
 D. powdered sulphur.
34. When sodium hydroxide solution on a watch glass is exposed to air a white crust is formed. This crust is formed due to:
 A. the solution evaporated to leave solid sodium hydroxide.
 B. carbon dioxide reacting with sodium hydroxide.
 C. sodium hydroxide solution dissolving glass.
 D. oxygen in air reacting with sodium hydroxide solution.
35. Each of the questions 35 to 40 consists of an assertion (statement) on the left hand side and a reason on the right hand side.
 Select:
 A. if both assertion and reason are true statement and the reason is a correct explanation of the assertion.
 B. if both assertion and reason are true statements but the reason is **not** a correct explanation of the assertion.
 C. if the assertion is true but the reason is incorrect statement .
 D. if the assertion is incorrect but the reason is a true statement.

Assertion**Reason.**

- | | | |
|---|-----------------------|--|
| 36. Equal volumes of gases under the conditions of temperature and Pressure contain the same number of atoms. | <i>because</i> | Gases are composed same of tiny, fast moving particles . |
| 37. When hydrogen is passed over heated copper (II) oxide there is no chemical change. | <i>because</i> | Hydrogen is higher than copper in the activity series. |
| 38. Graphite conducts electricity but diamond does not electrons which are free to move while diamond does not have them. | <i>because</i> | Graphite structure contains delocalised |
| 39. Ammonia gas cannot be dried with concentrated sulphuric acid. strongly dehydrating agent. | <i>because</i> | concentrated sulphuric acid is |
| 40. Carbon reacts with nitric acid oxidising agent. | <i>because</i> | carbon is an |

41. Element of group I in the periodic table are very electropositive. *because* Their outermost electron are not Shall electrons shell strongly attached by the nucleus.

TEST NUMBER SIX :

- Which of the following mixture is best separated by chromatography?
 - water and oil
 - water and ethanol
 - crude petroleum
 - ink.
- The PH of a neutral solution is:
 - 0.0
 - greater than 0.
 - 7
 - between 5 and 9.
- Carbondisulphide, CS_2 is a very inflammable liquid and when it catches fire in air, chocking fumes are formed. The choking gas is most likely to be:
 - carbondioxide
 - water vapour
 - sulphurdioxide
 - hydrogen sulphide.
- Which one of the following is normally used to catalyse the reaction between sulphurdioxide and oxygen to manufacture sulphur trioxide?
 - Vanadium (v) oxide
 - finely divided iron
 - Iron (III) oxide
 - manganese (IV) oxide.
- Which one of the following substances would form an aqueous solution which is acidic to litmus?
 - sodium ethanoate
 - ammonium chloride
 - calcium oxide
 - sodium carbonate.
- Ammonia solution was added to dropwise to a solution of Fe^{2+} ions until the reagent is in excess. What was observed?
 - a green precipitate soluble in excess ammonia.
 - a green precipitate.
 - a reddish brown precipitate.
 - a reddish brown precipitate soluble in excess ammonia.
- Which one of the following properties is not shown by group VII element: They:
 - all form diatomic molecules.

- B. all form ionic compounds with group 1 elements.
C. are all non metals.
D. are all gases at room temperature.
8. Which one of the following substances has a giant atomic structure?
A. sulphur
B. iodine
C. phosphorus
D. diamond.
9. Sulphur dioxide is prepared in the laboratory by:
A. heating a mixture of dilute sulphuric acid and sodium sulphite.
B. reacting sodium sulphite with dilute sulphuric acid in the cold.
C. reacting sodium sulphite with concentrated sulphuric acid in the cold.
D. heating a mixture of concentrated sulphuric acid and sodium sulphite.
10. Atoms of elements in the same group in the periodic table have the same number of:
A. outermost electrons.
B. electrons outside the nucleus.
C. Protons in the nucleus.
D. Neutrons in the nucleus.
11. The mass of nitric acid (HNO_3) required to make 200cm^3 of a 3M solution is: ($\text{H} = 1$, $\text{N} = 14$, $\text{O} = 16$)
A. 31.5gm
B. 3.78gm
C. 37.8gm
D. 12.6gm.
11. Which one of the following is an electronic configuration of an atom of an inert gas?
A. 2:8:3
B. 2:8:8
C. 2:8:7
D. 2:8:81.
13. When heated, calcium carbonate decomposes according to the equation.
 $\text{CaCO}_{3(s)} \rightarrow \text{CaO}_{(s)} + \text{CO}_{2(g)}$
- The loss in mass of calcium carbonate when 25gm of the carbonate is heated to constant mass is:
($\text{Ca} = 40$, $\text{O} = 16$, $\text{C} = 12$)
- A.
B. $\frac{100 - 44}{1000}$
C. $\frac{100 - 44}{40}$

D. $\frac{100 - 40}{44}$

14. A metal normally reacts with dilute mineral acids to give:-

- A. a salt of the metal and hydrogen.
- B. the oxide of the metal and hydrogen.
- C. a salt of the metal and water.
- D. the hydroxide of the metal and hydrogen.

15. Which one of the following carbonates is soluble in water?

- A. lead (II) carbonate.
- B. zinc carbonate.
- C. magnesium carbonate.
- D. ammonium carbonate.

16. Which one of the following sets of elements are arranged in their correct order of reactivity, beginning with the most reactive.

- A. magnesium, calcium, Iron
- B. magnesium, Iron, calcium
- C. calcium, magnesium, Iron
- D. calcium, Iron, magnesium.

17. During the preparation of hydrogen from zinc and hydrochloric acid, the rate of reaction is increased by:

- A. heat the mixture strongly
- B. adding copper(II) oxide to the mixture .
- C. adding copper(II) sulphite to the mixture .
- D. adding manganese (IV) oxide to the mixture .

18. Barium carbonate reacts with dilute acids according to the equation .



The maximum volume of carbondioxide that would be evolved on reacting 2.0gm of the salt with excess acid at s.t.p is: ($\text{BaCO}_3 = 197$; molar volume at s.t.p is 22.4dm^3).

- A. 448cm^3
- B. 227cm^3
- C. $.224\text{cm}^3$
- D. 112cm^3 .

19. Sodium hydrogen carbonate and sodium carbonate occur in solution in lake Magadi. The two salts are separated by a method known as:

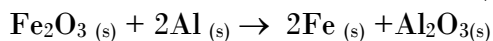
- A. fractional distillation
- B. fractional crystallisation
- C. evaporation
- D. chromatography.

20. The ion formed by the element Z of atomic number 15 is:

- A. Z^{3+}
- B. Z^{2-}
- C. Z^{2+}

D. Z^{3-}

21. Aluminium reacts with Iron (III) oxide according to the following equation.



What mass of Iron (III) oxide would be required to produce 11gm of Iron?

A.. $\frac{160 \times 112}{11}$

B. $\frac{160 \times 11}{112}$

D. $\frac{160 \times 11}{112}$

D. $\frac{160 \times 11}{102}$

22. A. metal x when heated in air forms a yellow powder which remained yellow on cooling X is

A. Aluminium.

B. **Lead**

C. Zinc

D. Iron

23. Which one of the following is a neutral oxide?

A. aluminium oxide

B. magnesium oxide

C. sulphur trioxide

E. nitrogen monoxide

24. Which one of the following nitrates does not give off brown fumes when heated.

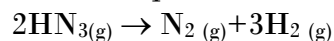
A. sodium nitrate.

B. magnesium nitrate.

C. calcium nitrate.

E. barium nitrate.

25. The equation below shows the reaction that took place when ammonia is decomposed.



What is the total volume of the gaseous product formed when 600cm³ of ammonia is decomposed at s.t.p?

A. 900 cm³

B. 1200 cm³

C. 3000 cm³

D. 1800 cm³

26. The element Y shows the following reaction .

i. it forms a strongly acidic oxide

ii. it forms a compound H₂Y

iii. it shows allotropy

Which group of the periodic table will Y most likely be in?

A. VII

B. VI

C. IV

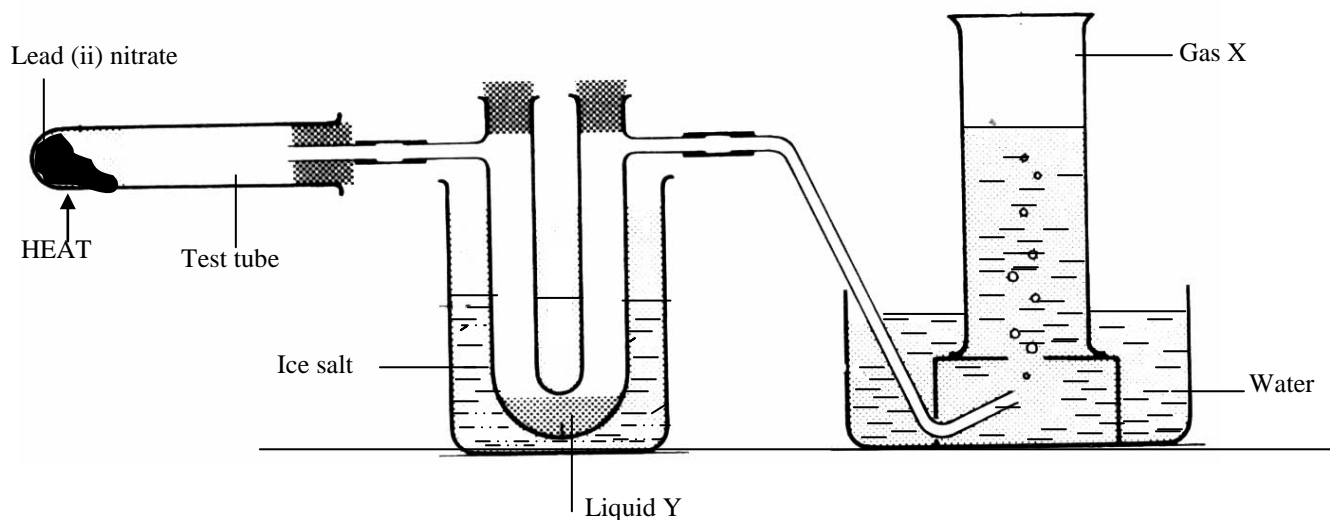
D. I

27. Consider 1gm of each of the following gases at S.T.P, which one occupies the greatest volume?.

(Ne = 20, N = 14 C = 12 H = 1)

- A. nitrogen
- B. ethene
- C. ammonia
- E. neon.

28.



The crystals of lead (II) nitrate are heated in the apparatus shown above.

Liquid Y should be:

- A. nitrogen dioxide.
- B. nitric acid.
- C. nitrogen tetraoxide.
- D. water.

29. Gas x should be (seen diagram)

- A. dinitrogen tetraoxide
- B. water vapour
- C. oxygen
- D. nitrogen dioxide.

30. An element X forms an oxide that contains 4 gm of X and 6gm of oxygen. What is the simplest formula of the oxide?

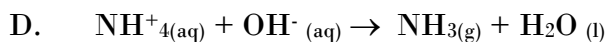
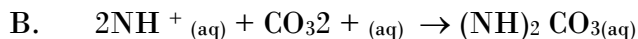
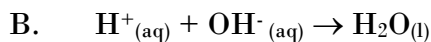
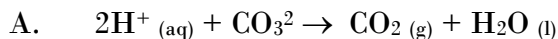
(x = 32, O = 16).

- A. XO_3
- B. X_3O
- C. X_2O_3
- D. XO_2 .

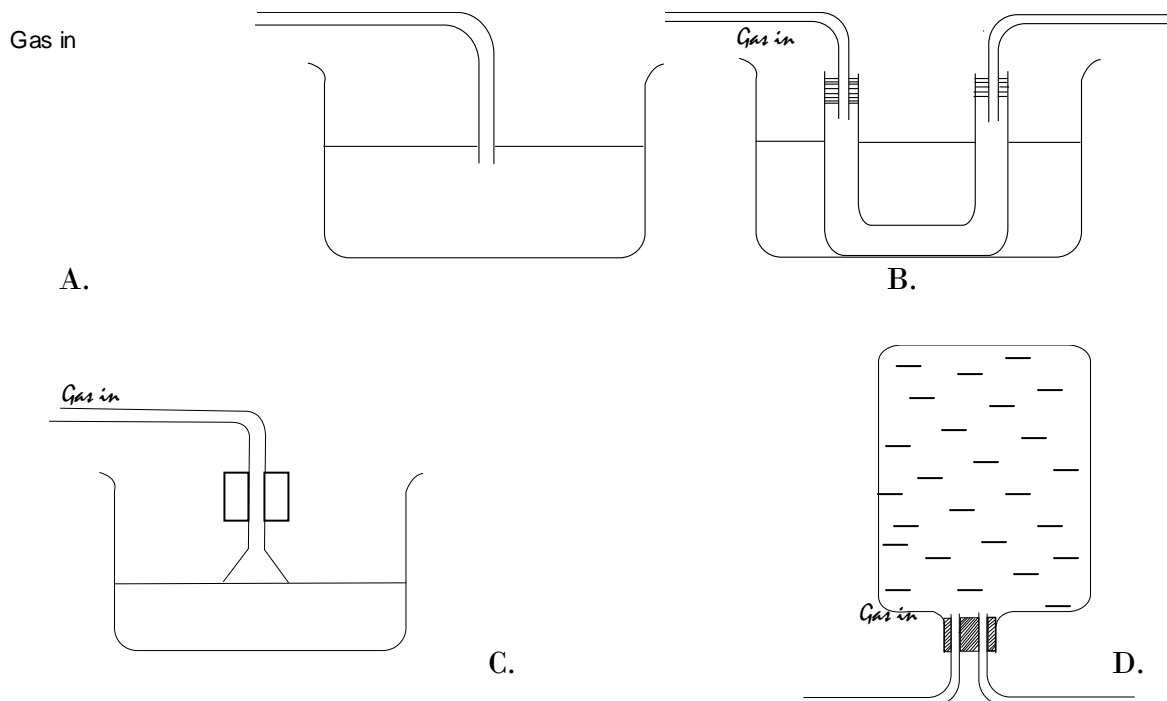
31. When pollen grains are placed in water in a trough and observed under a microscope, the grains particles will be seen to:

- A.. all remain stationary.
- B. stick together in a cluster
- C. all move randomly.
- D. all move in one direction.

32. Which one of the following equations represents a neutralization reaction.



33. Which one of the following set up of apparatus can be used for the preparation of ammonia solution.



34. An oxide of metal Z reacts with magnesium when heated but does not react with copper. The order reactivity of Z, magnesium and copper starting with the most reactive is

A. Mg, Z, Cu.

B. Mg, Cu, Z

C. Z, Mg, Cu

D. Cu, Z, Mg.

Each of the questions 35-37 contains an assertion (statement) on the left hand side and a reason on the right hand side. Using the given information, choose a correct pair from the following:

	Assertion	Reason
A	True	True (reason is a correct explanation)
B	True	True (reason is not a correct explanation)
C	True	Incorrect
D	incorrect	True statement

35. Chlorine, bromine and fluorine because They are all non-metals and have similar chemical properties. they are halogen.

36. Crude petroleum is refined by fractional distillation. because Crude petroleum is a mixture of substances with the same densities.

37. Sulphurdioxide turns red litmus paper blue. because It is an acidic gas.

In each of the questions 38 to 40 one or more of the answers given may be correct. Read each question carefully and then indicate your answer in the box according to the following.

- A. if only 1, 2 and 3 are correct
- B. if only 1 and 3 are correct
- C. if only 2 and 4 are correct
- F. if only 4 is correct.

38. When copper (II) nitrate crystals are heated strongly the following substances are produced

- 1. copper metal
- 2. oxygen
- 3. water vapour
- 4. nitrogen dioxide gas .

39. The following are (is) characteristics of metals

- 1. conduct electricity
- 2. conduct heat
- 3. their atoms form cations
- 4. their atoms form anions

40. The atom of the same element have the

- 1. same number of protons as $^{12}_6\text{C}$
- 2. same number of electrons as $^{12}_6\text{C}$
- 3. same number of neutrons
- 4. same number of protons.

TEST NUMBER SEVEN:

12

1. The number of neutrons in the nucleus of an atom, Y is:

17

- A. 54
- B. 37
- C. 20
- D. 17.

2. Which one of the following salts can be prepared by neutralization?

- A. ammonium sulphate.
- B. zinc sulphate.
- C. lead(II) sulphate.
- D. calcium sulphate.

3. Which of the following substances has against molecular structure?

- A. silicon dioxide
- B. sodium chloride

- C. hydrogen chloride
D. Iodine

4. An atom of an element has the structure $\begin{matrix} 20x \\ 10 \end{matrix}$

The element

- A. forms covalent bonds readily with non metals.
B. forms ionic bond with non-metals.
C. belongs to group II of the periodic table.
D. has full shells of electrons.
5. The percentage of oxygen in baking powder NaHCO_3 is
(Na = 23, H = 1, C = 12, O = 16)

- A. $\frac{48 \times 100}{84}$
B. $\frac{16 \times 100}{102}$
C. $\frac{16 \times 100}{84}$
D. $\frac{48 \times 100}{102}$

6. Which one of the following oxides can be reduced by carbon monoxide?

- A. magnesium oxide
B. calcium oxide
C. copper(II) oxide
D. potassium oxide.

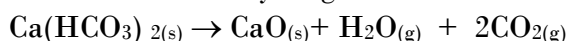
7. Beginning with the least reactive, the order of reactivity of the following metals with dilute hydrochloric acid is:

- A. lead, iron, aluminium
B. aluminium, zinc, Iron, lead
C. zinc, lead, aluminium, iron
D. iron, aluminium, lead, zinc .

8. The number of moles of nitrogen molecules in 42gm of nitrogen is (N = 14).

- A. 0.33
B. 0.67
C. 3.00
D. 1.50

9. When calcium hydrogen carbonate is heated, it decomposes according to the equation



27.0gm of calcium hydrogen carbonate was decomposed. The volume in litres of carbon dioxide evolved at s.t.p was: (H = 1, C = 12, O = 16, Ca = 40, 1 mole of gas occupies 22.4l at s.t.p).

- A. $\frac{27 \times 22.4}{162}$
B. $\frac{2 \times 27 \times 22.4}{162}$
C. $\frac{162}{27 \times 22.4}$
D. $\frac{162}{2 \times 27 \times 22.4}$

10. Which of the following properties is NOT true about carbonmonoxide?
 - A. its colourless
 - B. its poisonous
 - C. its acidic
 - D. it is a reducing agent.
11. Which of the following statements is NOT true about acids.
 - A. they react with all metals producing a salt and water.
 - B. they all have PH below 7.
 - C. they react with carbonates producing carbon dioxide.
 - D. they contain hydrogen ions which can be replaced by metals.
12. The valencies of sodium and oxygen respectively are:
 - A. 1 and 2
 - B. 3 and 2
 - C. 2 and 1
 - D. 2 and 2
13. A compound Z when strongly heated leaves a residue which is yellow when hot and white when cold. Z contains
 - A. Zn^{2+}
 - B. Cu^{++}
 - C. Pb^{++}
 - C. Fe^{++}
14. A reaction in which soap is manufactured from oils called
 - A. fermentation.
 - B. saponification.
 - C. polymerization.
 - D. hydrogenation.
15. The red brown coating formed when iron nails are left in moist air for a long time is:
 - A. anhydrous iron (III) oxide
 - B. anhydrous iron (II) oxide
 - C. hydrated iron (III) oxide
 - D. hydrated iron (II) oxide.
16. An oxide of an element N is made up of 50%N. The simplest formula of the oxide is: (N = 14 O = 16)
 - A. NO
 - B. N_2O
 - C. NO_2
 - D. N_2O_3 .
17. Which of the following statement is true about diamond and graphite.
 - A. carbon exhibits covalency of four in graphite and two in diamond.
 - B. the carbon atoms are arranged differently in the two substances.
 - C. the carbon atoms in graphite are larger than those in diamond.
 - D. the arrangement of electrons in the atoms are different in the two substances.
18. The temporary hardness of water is caused by the presence of:
 - A. carbonates of calcium and magnesium.
 - B. sulphates and chlorides of calcium and magnesium.
 - C. irons of magnesium and calcium.
 - D. hydrogen carbonates of calcium and magnesium.

19. Which of the following aqueous solutions is most likely to liberate hydrogen by the action of magnesium powder.
A solution of PH.
- A. 13
 - B. 2
 - C. 12
 - D. 6.5
20. Air contains mainly
- A. carbondioxide and nitrogen
 - B. nitrogen and water vapour
 - C. nitrogen and oxygen.
 - D. oxygen and hydrogen.
21. The difference between the composition of producer gas and water gas is that:
- A. water gas is a better fuel than producer gas.
 - B. water gas contains carbon monoxide and producer gas contains hydrogen.
 - C. producer gas contains nitrogen while water gas contains hydrogen.
 - D. producer gas produce more heat than water gas when heated.
22. The method that can be used to determine whether blue ink is not a single substances is:
- A. distillation
 - B. chromatography
 - C. filtration
 - D. fractional crystallisation.
23. A blue solid X was strongly heated in test tube to leave a white residue and drops of a colourless liquid in the mouth of the test tube which turned an hydrous cobalt chloride paper pink X is likely to be:
- A. lead (II) carbonate
 - B. copper (II) sulphate
 - C. iron (III)sulphate
 - D. copper (II) carbonate.
24. Which of the following is used in both in rusting and burning:
- A. oil
 - B. hydrogen
 - C. carbon
 - D. oxygen.
24. A carbonate of an element Y has the formula $Y_2(CO_3)_3$ to which group in the periodic table does Y belong?
- A. 1
 - B. 2
 - C. 3
 - D. 4
26. Which one of the following metal can burn both in oxygen and carbondioxide?
- A. magnesium
 - B. calcium
 - C. iron
 - D. alminium.

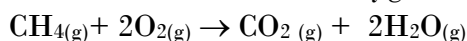
27. Which of the following reagents is used for softening hardness in water ?

- A. calcium carbonate
- B. calcium sulphate
- C. sodium sulphate
- D. sodium carbonate .

28. When a stream of air is passed through sodium hydroxide solution and then over heated copper, the residual gas is mainly.

- A. neon
- B. nitrogen'
- C. hydrogen
- D. oxygen

29. Methane burns in oxygen according to the equation.



If 10cm³ of methane and 20cm³ of oxygen are mixed and exploded, and the final products cooled to room temperature, the final gaseous volume is:

- A. 15cm³
- B. 30cm³
- C. 25cm³
- D. 10 cm³

29. Which one of the following reactions does not require a catalyst?

- A. production of chloride from magnesium(IV) oxide and concentrated hydrochloric acid.
- B. synthesis of sulphur trioxide from sulphur dioxide and oxygen .
- C. synthesis of ammonia from nitrogen and hydrogen.
- D. production of oxygen from hydrogen peroxide.

30. Copper (II) carbonate when heated in air decomposes according to the equation.



31. What volume of carbondioxide is produced at s.t.p when 0.4 mole s of copper (II) oxide is formed?

(Cu = 64, O = 16, 1 mole of gas at STP occupies 22.4m³)

- A. 11.2dm³
- B. 89.6dm³
- C. 8.96dm³
- D. 0.896dm³.

32. Which one of the following substances sublimes when heated?

- A. P
- B. NH₄Cl
- C. CaCl₂
- D. ZnO.

33. The atomic numbers of elements Q, R, S, T are 8, 9, 13 and 17 respectively. Which one of the following pairs of elements belong to the same group in the periodic table?

- A. R and T

- B. S and T
C. Q and S
D. R and Q

34. Which one of the following gases turns a solution of potassium dichromate (VI) green?

- A. SO_2
B. CO_2
C. NO_2
D. Cl_2

35. Two gases which are evolved on heating copper (II) nitrate are:

- A. oxygen and nitrogen
B. ammonia and nitrogen dioxide
C. oxygen and ammonia
D. oxygen and nitrogen dioxide .

A	B	C	D
If 1, 2, 3 only correct.	If 1, 3 only correct.	If 2, 4 only correct.	If 4 only correct.

36. Which of the following would be formed when anhydrous copper (II) nitrate is heated strongly?

- a black solid.
- oxygen.
- nitrogen dioxide.
- a white solid.

37. Hydrogen gas:

- is neutral to litmus solution.
- is a reducing agent.
- burns in air.
- is soluble in water.

38. Which of the following are mixtures?

- brass
- diamond
- steel
- aluminium

39. Element X burns with a yellow flame and reacts vigorously with water producing an alkaline solution and gas which gives a pop sound with a lighted splint.

Which of the following is/ are correct?

- x burns in air forming basic oxide.
- x will most likely form a covalent chloride.
- the gas given off is hydrogen.
- x could be a group four element.

40. When magnesium is burnt in air.

- there is a decrease in mass.
- a black solid is formed.
- it burns with a red flame.

40

4. there is an increase in mass.

41. Ionic compounds are generally.
 1. conductors of electricity when in molten state only.
 2. soluble in water.
 3. soluble in all solvents.
 4. have high melting points.

42. Which of the following substances can be displaced by chlorine in a chemical reaction?
 1. fluorine
 2. hydrogen
 3. nitrogen
 4. bromine.

43. Graphite:
 1. is an isotope of carbon.
 2. is an allotrope of carbon.
 3. consists of atoms arranged in a tetrahedral shape.
 4. conducts electricity in the solid state.

44. Which of the following metals is /are normally used for making cables?
 1. copper
 2. zinc
 3. aluminium
 4. magnesium.

45. Which of the following compound(s) is /are usually used as drying agent(s)?
 1. calcium oxide
 2. silicon dioxide
 3. calcium chloride
 4. ammonium chloride.

Each of the questions 46 to 50 consists of an assertion (statement) on the left hand side and a reason on the right hand side.

Select:

- A. if both assertion and reason are true reason are true statement and the reason is a correct explanation of the assertion.
- B. if both assertion and reason are true statement but the reason is **not** a correct explanation of the assertion.
- C. if the assertion is true but the reason is not correct statement .
- D. if the assertion is incorrect but the reason is a true statement.

Assertion

46. Hydrogen is used in filling balloons
but its use is now extremely limited because

Reason.

Hydrogen is the least
dense gas known.

47. Copper, silver and gold are elements
suitable for monetary purposes. because

They are good
oxidising agents and
therefore do not react

with oxygen.

48. Distillation is a thorough method of because It is very costly.

removing hardness in water but is rarely used.

49. Diamond conducts electricity because Diamond has a giant atomic structure.

50. Solid lead(II) bromide conducts electricity because The ions of solid lead (II) bromide are not able to move.

TEST NUMBER EIGHT:

- The PH of dilute sodium hydroxide is likely to be:
 - equal to 7
 - less than 7
 - more than 7
 - equal to 0.
- Which of the gases below is acidic
 - carbonmonoxide
 - ammonia
 - carbondioxide.
 - nitric oxide
- The volume of a given gas is 300cm^3 at 51°C and 745mmHg of pressure. What would be the pressure of this gas if its volume is increased to 420cm^3 when the temperature is increased to 75°C ?
 - $\frac{324}{348} \times \frac{300}{420} \times 745$
 - $\frac{348}{324} \times \frac{300}{420} \times 745$
 - $\frac{348}{324} \times \frac{420}{300} \times 745$
 - $\frac{348}{300} \times \frac{324}{420} \times 745$
- Sodium dichromate has the formula $\text{Na}_2\text{Cr}_2\text{O}_7$. When dissolved in water it forms Na^+ and $\text{Cr}_2\text{O}_7^{y-}$ ions. The value of y in $\text{Cr}_2\text{O}_7^{y-}$ is:
 - 2+
 - 1-
 - 2-
 - 1+
- Y forms a sulphide of the formula Y_2S_3 . The value of its chloride is:
 - YCl_3
 - Y_2Cl_3
 - YCl_2
 - YCl
- Which one of the following methods is usually used to prepare hydrogen in the laboratory?
 - action of steam on zinc.
 - action of dilute hydrochloric acid on iron.
 - action of water on magnesium.

D. electrolysis of water.

7. 1.27gm of an element Y combines with chlorine to give 4.11gm of a chloride. The simplest formula of the chloride is.

(Cl = 35.5, Y = 63.5)

A. Y_2Cl_2

B. YCl_3

C. YCl_4

D. Y_2Cl_3

8. Ammonia solution was added drop wise to a solution of Fe^{3+} ions until the solution was in excess. What was observed?

A. a green precipitate soluble in excess ammonia.

B. a reddish brown precipitate.

C. a green precipitate.

D. a reddish brown precipitate soluble in excess ammonia.

9. A carbonate of metal x when heated forms a black powder and a colourless gas was given off, x could be:

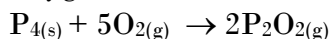
A. zinc

B. lead

C. aluminium

D. copper

10. The equation below shows the reaction that takes place when phosphorus reacts with oxygen:



What is the total volume of gaseous products formed at s.t.p when $30cm^3$ of P_4 reacts completely in excess oxygen ?

A. $360cm^3$

B. $30cm^3$

C. $60cm^3$

D. $180cm^3$.

11. The element M shows the following reactions.

i. it forms a weakly acidic oxide

ii. it forms a compound NH_4 .

iii. it shows allotropy.

Which group of the periodic table will M most likely be in.

A. I

B. IV

C. VI

D. VII

12. Which one of the following elements reacts with nitrogen when heated?

A. magnesium

B. sulphur

C. copper

D. aluminium

13. The number of particles in the nuclei of atoms Q, R and T are shown in the table below.

Atom	Number of particles	
	protons and neutrons	electrons
Q	40	20
R	40	18

S	46	23
T	45	20

Which of the atoms are isotopes ?

- A. S and T
- B. R and S
- C. Q and R
- D. Q and S.

14. Which one of the following properties is shown by carbon monoxide?

- A. it burns with a blue flame.
- B. it turns lime water milky.
- C. it turns blue litmus red.
- D. it is very soluble in water.

15. Covalent compounds:

- A. are strong electrolytes.
- B. have low melting points and are formed by sharing electrons.
- C. are formed by transfer of electrons.
- D. conduct electricity in molten state.

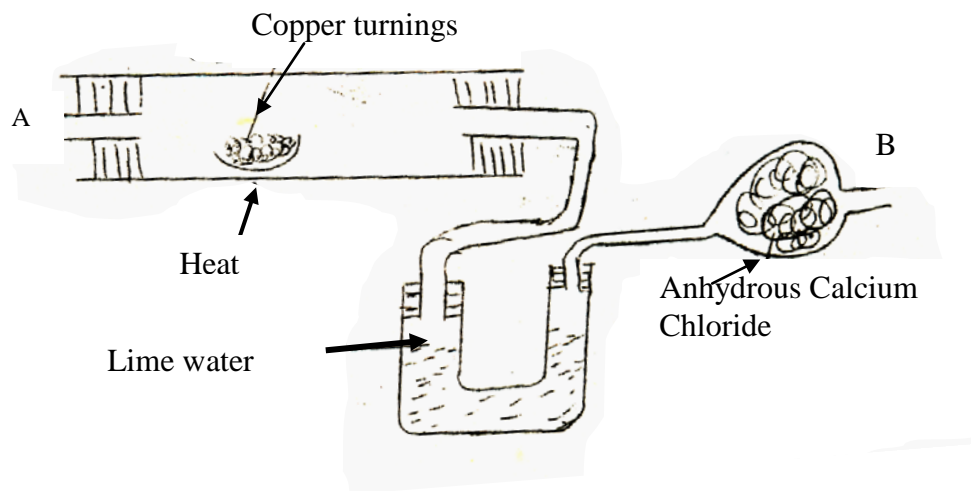
16. The formula of an oxide ion O^{2-} . This shows that:

- A. the number of protons exceeds the number of electrons by two
- B. the oxide ion has two electrons in its outmost orbital
- C. oxygen atom loses two electrons to form the ion.
- D. the number of electrons exceeds the number of protons by two.

17. Which of the equation given below shows an oxidation, reduction reaction.

- A. $PbO_2 + 4HCl_{(aq)} \rightarrow PbCl_{2(s)} + Cl_{2(s)} + 2H_2O_{(l)}$
- B. $Na_2O_{(s)} + H_2O_{(i)} \rightarrow 2NaOH_{(aq)}$
- C. $SO_{3(g)} + H_2O_{(l)} \rightarrow H_2SO_{4(aq)}$
- D. $Fe_2O_{3(s)} + 6HCl_{(aq)} \rightarrow 2FeCl_{3(aq)} + 3H_2O_{(l)}$.

18. Air was passed through the apparatus below from A to B. Which one of the gasses below will come out at B ?



A. Nitrogen

B. Water Vapour

C. Carbondioxide

D. Oxygen

19. What would be observed if zinc granules were added to copper (II) sulphate solution.

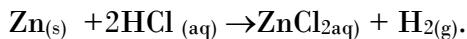
A. a white precipitate is formed.

B. the blue solution turns colourless.

C. copper is coated with zinc.

D. the solution turns blue.

20. Excess hydrochloric acid was reacted with 1.95 gm of zinc powder. The reaction proceeded according to the equation.



The maximum volume of hydrogen in cm^3 which was evolved at S.T.P was

$\text{Zn} = 65$ molar volume = 22400cm^3 at s.t.p.

A. 892

B. 448

C. 224

D. 672.

21. When element X and Y are heated together they form a compound with the formula X_3Y_2 . element X and Y have the following electronic structure respectively.

A. 2,8,2 and 2,5

B. 2,8,1 and 2,6

C. 2,8,1 and 2,4

D. 2,8,1 and 2,5

22. The alloy solder consists of

A. zinc and lead

B. copper and aluminium

C. tin and lead

D. copper and lead.

23. The percentage of water of crystallisation in $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ is:

A. $\frac{(18 \times 100)\%}{160}$

B. $\frac{(18 \times 100)\%}{160}$

- C. $\frac{(18 \times 100)\%}{250}$
- D. $\frac{(90 \times 100)\%}{250}$
24. Which of the following metals will **NOT** displace lead from its salt in solution?
- A. zinc
- B. calcium
- C. silver
- D. aluminium
25. The gas produced when steam is passed over heated iron fillings
- A. oxygen
- B. nitrogen dioxide
- B. hydrogen
- E. nitrogen.
26. The electronic configurations of the atoms of elements X and Y are 2, 8, 3 and 2, 5 respectively. The formula of the compound formed between X and Y is :
- A. X_2Y_5
- B. X_3Y_2
- C. X_2Y_3
- D. XY
27. Which one of the following gases does not react with water ?
- A. sulphur dioxide
- B. carbonmonoxide
- C. chloride
- D. ammonia
28. The molarity of a solution containing 40gm of sodium hydroxide in 500cm³ of the solution is:
- A. 2.0M
- B. 1.0M
- C. 0.5M
- D. 0.2M
29. Which one of the following elements is not a constituent of fertilizers
- A. iodine
- B. calcium
- C. Nitrogen
- D. phosphorus
30. Which one of the following hydroxides is **not** an alkaline?
- A. KOH
- B. NaOH.
- C. Cu(OH)₂
- D. Ca(OH)₂.
31. Carbon monoxide burns in oxygen according to the equation:



20cm³ of carbon monoxide was mixed with 20cm³ of oxygen and exploded. If all volumes were measured at the same temperature and pressure, what was the final gaseous volume ?

- A. 40 cm³
- B. 50 cm³
- C. 30 cm³
- D. 20 cm³

32. An oxide of a metal X contains 78% of X and 22% of oxygen, the empirical formula of the oxide is: (X = 56, O = 16)
- X_3O_4
 - X_2O_4
 - XO_2
 - XO
33. Nitric acid can be prepared in the laboratory by the reaction between
- potassium nitrate and concentrated sulphuric acid
 - potassium nitrate and concentrated hydrochloric acid
 - potassium nitrite and concentrated sulphuric acid
 - potassium nitrite and concentrated hydrochloric acid
34. Which one of the following substances undergoes a chemical reaction when heated?
- sulphur
 - hydrogen
 - argon
 - ice
35. Which one of the following oxides can be reduced by dry ammonia
- iron (III) oxide
 - copper (II) oxide
 - calcium oxides
 - zinc oxide.

Questions 36-44 consist of an assertion (statement) on the hand side and a reason on the right hand side select.

- If both assertion and reason are true statement and the reason is a correct explanation of the assertion.
- if both assertion and reason are true statements but the reason is not a correct explanation of the assertion.
- if the assertion is true but the reason is an incorrect statement.
- If the assertion is incorrect but the reason is a true statement.

	Assertion	Reason
A	True	The (Reason is a correct explanation)
B	True	True (Reason is not a correct explanation)
C	True	Incorrect
D	incorrect	True statement

Assertion

Reason

36. Hard water requires a lot of soap to form a lather magnesium ions. because Soap is initially used in removing calcium and magnesium ions.
37. When liquid air is distilled, oxygen comes off, before because Nitrogen boils at a lower temperature than oxygen. nitrogen.
38. Crystals of silver can be obtained by adding zinc to silver nitrate solution. because silver is above zinc in the activity series.
39. The volume of 1gm of gaseous 1gm of gaseous carbon

carbon dioxide is greater than the because
volume of 1 gm of solid carbon
dioxide.

dioxide contains more
molecules than 1 gm of
solid carbondioxide.

40. Carbon monoxide diffuses more
Rapidly than carbon dioxide. because
than that of carbon dioxide.

The molecules mass of
carbon monoxide is less

41. 2M nitric acid is as strong an acid
as 2M ethanoic acid because

The acids have the same
molarity.

42. Sulphur dioxide turns moist
dichromate paper green. because

It is an acidic gas.

43. When hydrogen is passed over
over heated copper(II) oxide because
there is no chemical change

Hydrogen is higher than
copper in activity series.

44. Ammonium chloride and sodium
chloride are separated by
sublimation. because

Sodium chloride has a
lower melting point than
ammonium chloride.

In each of the questions 45-50 one or more of the answers given may be correct. Read each question carefully and then indicate on your answer sheet according to the following:

A	B	C	D
If 1, 2, 3 only correct	If 1, 3 only correct	If 2, 4 only correct	If 4 only correct.

45. Which of the following gases will bleach moist litmus paper?

1. chlorine
2. oxygen
3. sulphur dioxide
4. carbondioxide.

46. Which one of the following when in aqueous solution can be reduced by aluminium metal?

1. calcium ions.
2. iron(II) ions.
3. magnesium ions
4. copper(II) ions.

47. Which of the following substances would undergo permanent changes when strongly heated?

1. iodine.
2. sodium nitrate.
3. potassium carbonate.
4. potassium chlorate.

48. The carbon atoms in graphite

1. form a layer structure
2. are held together by double bonds.
3. are linked through single covalent bonds.
4. form a three dimensional net work.

49. Which of the following compounds is / are in the purification of water?

1. calcium chloride.
2. calcium hypochlorite.
3. carbondioxide gas.
4. chlorine gas.

50. Which of the following salts when in solution will form a white precipitate with dilute hydrochloric acid?

1. silver nitrate.
2. calcium nitrate.
3. lead nitrate.
4. zinc nitrate.

TEST NUMBER NINE

1. A mixture of sodium chloride and ammonium chloride is best separated by:

- A. sublimation
- B. chromatography
- C. distillation
- D. crystallization.

2. Which one of the following processes below involves a physical change.

- A. rusting of iron.
- B. melting of wax.
- C. burning of wood.
- D. burning of magnesium.

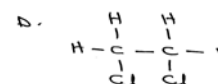
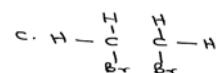
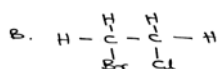
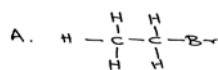
3. The number of moles of sodium ions in 200cm^3 of a 1.5M solution of sodium carbonate is:

- A. 3.0
- B. 6.0
- C. 0.6
- D. 0.3

4. Which of the following has a giant ionic structure?

- A. aluminium chloride.
- B. graphite.
- C. sodium chloride.
- D. silicon oxide.

5. **Ethane** was bubbled through a solution of bromine in tetra chloromethane. The structure of the compound formed



6. Which one of the following oxides is soluble in excess sodium hydroxide solution and in excess ammonia.
- A. iron (III) oxide.
 - B. aluminium oxide.
 - C. lead(II)oxide.
 - D. Zinc oxide.
7. When an electric current was successfully passed through a solution of a metal M, 4.32gm of silver and 2.24gm of M were formed. The charge on the ion of M is: ($\text{Ag} = 108$, $\text{M} = 112$)
- A. +4
 - B. +1
 - C. +2
 - D. +3.
8. The percentage, by mass of phosphorous in calcium phosphate $\text{Ca}_3(\text{PO}_4)_2$ is ($\text{Ca} = 40$, $\text{P} = 31$, $\text{O} = 16$)
- A. 20%
 - B. 10%
 - C. 17%
 - D. 8%
9. Which of the following is formed on the anode when an aqueous solution of copper(II) sulphate is electrolysed between two carbon electrodes?
- A. oxygen.
 - B. copper.
 - C. sulphur dioxide.
 - D. hydrogen.
10. Which of the following is **NOT** a large scale use of chlorine?
- A. manufacture of plastics.
 - B. purification of drinking water.
 - C. electrolysis of sodium chloride.
 - D. manufacture of bleaching powder.
11. Sodium sulphite reacts with hydrochloric acid according to the equation.
- $$\text{SO}_3^{2-}(\text{aq}) + 2\text{H}(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l}) + \text{SO}_2(\text{g})$$
- 20.0cm³ of sodium sulphite was neutralized exactly by 25.0cm³ of 0.05M hydrochloric acid. The molarity of the sulphite was:
- A. 0.08
 - B. 0.125
 - C. 0.04
 - D. 0.03

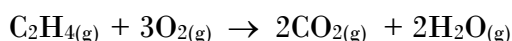
Question 12 and 13 concerns the following salts:

- A. copper (II) carbonate.
- B. lead(II) nitrate.
- C. magnesium sulphate.
- D. potassium chloride.

Select, from A to D the salt which can be prepared by:

12. The reaction of an acid with a metal:
13. precipitation:
14. When a solution X was reacted with aqueous sodium iodine a yellow precipitate was formed, with ammonium hydroxide, solution X formed a white precipitate insoluble in excess alkali x contained
- Ca^{++}
 - Fe^{2+}
 - Pb^{2+}
 - Zn^{2+}
15. An organic compound contains 66.7% carbon, 11.1% hydrogen, the rest being oxygen. Calculate its empirical formula.
(C = 12, O = 16, H = 1)
- $\text{C}_4\text{H}\text{O}_2$
 - $\text{C}_3\text{H}_6\text{O}$
 - $\text{C}_4\text{H}_8\text{O}$.
 - CHO
16. Which one of the following equations does **NOT** represent oxidation of the first substance?
- $\text{Fe}_2\text{O}_{3(s)} + 3\text{CO}_{(g)} \rightarrow 2\text{Fe}_{(s)} + 3\text{CO}_{2(g)}$
 - $\text{Zn}_{(s)} + \text{Cu}^{2+}_{(aq)} \rightarrow \text{Zn}^{2+}_{(aq)} + \text{Cu}_{(s)}$
 - $\text{S}_{(s)} + \text{O}_{2(g)} \rightarrow \text{SO}_{2(g)}$
 - $2\text{H}_2\text{S}_{(aq)} + \text{O}_{2(g)} \rightarrow 2\text{S}_{(s)} + 2\text{H}_2\text{O}_{(l)}$.
17. A solution of salt Y formed a white precipitate when dilute nitric acid was added to followed by barium nitrate solution.
Y contained
- carbon
 - nitrate
 - sulphate
 - chloride.
18. What is the percentage of nitrogen in ammonium sulphate
(N = 14, H = 1, S = 32, O = 16)
- $\frac{14}{132} \times 100$
 - $\frac{36}{132} \times 100$
 - $\frac{28}{132} \times 100$
 - $\frac{124}{132} \times 100$

19. The volume of 0.01M sodium hydroxide solution which is required to react exactly with 25.0cm³ of 0.04M hydrochloric acid is:
- A. 75 cm³
 - B. 100 cm³
 - C. 50 cm³
 - D. 25 cm³
20. Which of the following is observed when an aqueous solution of barium chloride is added to iron(III) sulphate solution?
- A. a green precipitate
 - B. a blue precipitate
 - C. a white precipitate
 - D. a brown precipitate
21. Ethane burns in oxygen according to the equation:



The volume of gases produced when 20cm³ of ethane burns completely in oxygen; (All volumes measured at constant temperature and pressure) is:

- A. 40 cm³
 - B. 100 cm³
 - C. 80 cm³
 - D. 60 cm³
22. Element X belongs to group II in the periodic table. The formula of the oxide of X is:
- A. XO
 - B. X₂O₃
 - C. X₂O
 - D. XO₂
23. Element Y has atomic number 20. The number of shells contained in an atom Y are /is:
- A. 3
 - B. 4
 - C. 2
 - D. 1

24. Calcium carbonate reacts with dilute acids according to the equation:



The maximum volume of carbon dioxide that would be evolved on reacting 2.0gm of calcium carbonate with excess dilute hydrochloric acid at S.T.P is:

(Ca = 40, O = 16, H = 1, C = 12, molar volume at s.t.p = 22.4dm³)

- A. 0.112 cm³
 - B. 0.0224 cm³
 - C. 0.227 cm³
 - D. 0.448 cm³
25. Sodium hydrogen carbonate and sodium carbonate occur in solution in lake Magadi. The two salts are separated by a method known as:
- A. fractional distillation
 - B. evaporation
 - C. fractional crystallisation
 - D. chromatography.

26. The mass of potassium hydroxide, KOH, contained in 250cm³ of 0.02M of potassium hydroxide solution is:
(K = 39, H = 1, O = 16)
- 0.280gm
 - 0.112gm'
 - 0.560gm
 - 1.12gm
27. Solution Z forms a white precipitate with silver nitrate solution. The precipitate is soluble in ammonia solution, Z is likely to contain
- CL⁻
 - SO₄²⁻
 - CO₃²⁻
 - NO₃⁻
28. Which of the following formulae represents an alkene?
- C₄H₁₀
 - C₃H₆
 - C₃H₈
 - C₃H₁₀
29. Which of the following represent a reduction oxidation reaction?
- $2\text{NaOH}_{(\text{aq})} + \text{CuCl}_{(\text{aq})} \rightarrow \text{Cu}(\text{OH})_{2(\text{s})} + \text{NaCl}_{(\text{aq})}$
 - $2\text{FeCl}_{2(\text{aq})} + 3\text{Cl}_{2(\text{g})} \rightarrow 2\text{FeCl}_{3(\text{aq})}$
 - $2\text{NaOH}_{(\text{aq})} + \text{H}_2\text{SO}_{4(\text{aq})} \rightarrow \text{Na}_2\text{SO}_{4(\text{aq})} + 2\text{H}_2\text{O}_{(\text{l})}$
 - $\text{ZnCO}_{3(\text{s})} + 2\text{HNO}_{3(\text{aq})} \rightarrow \text{Zn}(\text{NO}_3)_{2(\text{aq})} + \text{H}_2\text{O}_{(\text{l})} + \text{CO}_{2(\text{g})}$
30. Which of the following is NOT shown by group VII element?
- they are all non- metals.
 - are all gases at room temperature.
 - all form ionic compounds with group 1 elements.
 - all form diatomic molecules.
- Choose according to the summary.

A	B	C	D
If 1, 2, 3 only correct	If 1, 3 only correct	If 2, 4 only correct	If 4 only correct.

31. Which of the following may be observed if copper sulphate crystals are heated strongly?
- water vapour
 - a black residue
 - white crystals
 - brown fumes.
32. Which of the following gases cannot be dried using concentrated sulphuric acid.
- ammonia
 - hydrogen chloride
 - hydrogen sulphide
 - sulphur dioxide
33. Which of the following can affect the rate of reaction of gases?
- size of molecules
 - temperature

3. surface area
4. pressure.
34. Covalent substances (compounds)
 1. are usually solids at room temperature.
 2. are formed by sharing electrons.
 3. conduct electricity when molten.
 4. generally have low melting points.
35. Which of the following solutions contain the same number of Na^+ ions?
 1. 1dm^3 of $1\text{M Na}_2\text{SO}_4$
 2. 2dm^3 of 1M NaCl
 3. 1dm^3 of 2M NaCl
 4. 1dm^3 of $2\text{M Na}_2\text{SO}_4$
36. Which of the following ions will form a white precipitate with barium chloride solution?
 1. sulphate
 2. sulphite
 3. carbonate
 4. zinc
37. Which of the following is (are) true about a solution of sodium carbonate in water ?
 1. it produces carbondioxide gas when heated.
 2. it reacts with acids with effervescence.
 3. it can be used in purification of water.
 4. it turns red litmus paper blue.
38. When a solution of copper(II) sulphate is electrolysed using copper electrodes:
 1. the anode loses weight.
 2. the colour of the solution remains the same.
 3. the cathode gains weight.
 4. the solution turns colourless gradually.
39. When iron filings is added to copper(II)sulphate solution.
 1. a brown solid is formed.
 2. bubbles of gas are formed.
 3. heat is produced.
 4. the solution becomes colourless.
40. Which of the following solids would not show any change in mass when heated strongly in air?
 1. wax
 2. copper
 3. sodium hydroxide
 4. potassium manganate (VII)

Each of the questions 41-50 consists of an assertion (statement) on the left hand side and a reason on the right hand side.

Select:

- A. if both the assertion and reason are true statements and the reason is a correct explanation of the assertion .
- B. if both the assertion and the reason are true statements but the reason is not a correct explanation of the assertion.

- C. if the assertion is true but the reason is an incorrect statement.
 D. if the assertion is incorrect but the reason is a true statement.

	Assertion	Reason
A	True	True (reason is a correct explanation)
B	True	True (reason is not a correct explanation)
C	True	Incorrect
D	Incorrect	True statement

Assertion

Reason

41. Carbohydrates are hydrocarbons because Carbohydrates react with concentrated sulphuric acid to form carbon.
42. The PH of an aqueous solution of ammonia is less than 7 because Ammonia reacts with water form ammonium hydroxide.
43. Sodium and potassium belong to group I in the periodic table. because Sodium and potassium are both reactive metals.
44. Carbondioxide can be collected by down ward delivery because Carbondioxide is denser than air.
45. Sulphur dioxide is an acid anhydride. because It dissolves in water
46. Complete combustion and fermentation of glucose are similar processes. because In both cases a gas that lime water milky is produced
47. During fermation of chlorine atom attains the electronic configuration of a noble gas. because Noble gases have stable configuration.
48. During the electrolysis of brine by using carbon electrodes , chlorine is liberated at the anode. because chlorine ions are higher in the electro chemical series than hydroxide ions.
49. Manganese(IV) oxide reacts with concentrated hydrochloric acid to produce chlorine because Manganese(IV) oxide is a basic oxide.
50. Hydrogen chloride can be used in the fountain experiment. because Hydrogen chloride is very soluble in water.

TEST NUMBER TEN:

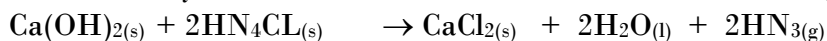
1. Which of the following combinations would produce carbon dioxide at the fastest rate?

- A. 100cm³ of 2M HCl and marble chips heated to 30°C
- B. 100cm³ of 2M H₂SO₄ and marble chips at room temperature .
- C. 100cm³ of 2M HCl and marble powder to 30°C
- D. 100cm³ of 2M HCl and marble powder at 30°C

2. Which of the following is not a property of aqueous hydrogen chloride solution?

- A. gives a white precipitate with aqueous silver ions.
- B. liberates HCl gas on heating.
- C. has a PH less than 7.
- D. it is a proton donor .

3. Calcium hydroxide reacts with ammonia chloride according to the equation:



If 114.8 gm of the calcium hydroxide was reacted completely with ammonium chloride, what mass of ammonia gas was evolved?

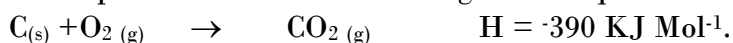
Ca = 40 H = 1 O = 16 N = 14 Cl = 35.5

- A. 6.8gm
- B. 9.0gm
- C. 3.4gm
- D. 1.7gm

4. Which of the following makes carbonmonoxide more dangerous compared to other poisonous gases

- A. it's neither acidic nor alkaline
- B. combines with haemoglobin in blood to form carboxy haemoglobin.
- C. it's colourless and has no smell.
- D. It is tasteless.

5. Graphite burns in air according to the equation.



When 48 gm of graphite is burnt in excess oxygen the heat produced is:

(C = 12, O = 16.)

- A. -97.5KJ
- B. -195KJ
- C. -180KJ
- D. -1560KJ

6. Which of the following can be used to confirm the presence of Iron (III) ions in solution .

- A. aqueous ammonia.
- B. sodium hydroxide.
- C. potassium thiocyanate.
- D. potassium cyanide.

7. Which one of the following pairs of substances is used for the laboratory preparation of chlorine?

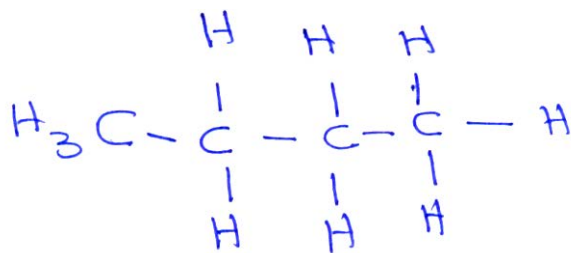
- A. diluted hydrochloric acid and potassium manganate (VII).
- B. concentrated sulphuric acid and sodium chloride.
- C. dilute hydrochloric acid and sodium sulphate.
- D. concentrated hydrochloric acid and potassium manganate (VII).

8. Which one of the following ions forms a green precipitate when reacted with sodium hydroxide solution?

- A. Cu²⁺
- B. Fe²⁺
- C. Al³⁺

D. Fe^{3+}

9. A compound with the structural formula



Is called

A. pentane

B. propane

C. butane

D. methyl propane .

10. A compound M decolourises a solution of bromine in trichloromethane. M, could be

A.. ethanol

B. ethene

C. ethane

D. ethanoic acid .

11. Which one of the following substances would form solution in water with PH less than 7:

A. NH_4Cl B. NaCl C. Na_2CO_3 D. CH_3COONa .

12. The anion which can be confirmed by a brown ring test is:

A. Cl^- B. SO_3^{2-} C. NO_3^- D. CO_3^{2-} .

13. Which of the following gases decouries aqueous potassium permanganate?

A. NO_2 B. NH_3 C. SO_2 D. HCl

14. Which of the following is formed when hydrogen sulphide is bubbled through hydrogen peroxide?

A. SO_4^{2-} B. SO_2^{2-} C. $\text{S}_2\text{O}_3^{2-}$

D. S

15. Which one of the following chlorides can be prepared by precipitation.

A. PbCl_2 B. CuCl_2 C. Cl_2 D. MgCl_2 .

16. The pair of compounds that can be used in the laboratory to prepare sulphur dioxide is:

A. copper metal and dilute sulphuric acid.

B. iron (II) sulphide and dilute nitric acid.

- C. sodium sulphite and dilute nitric acid.
- D. carbon and dilute sulphuric acid .

Each group of questions below consists of four letters headings followed by a list of numbered questions 17 to 21: For each numbered question select the one heading which is most closely related to it. Each heading may be used one, more than once, or not at all.

Questions 17 - 21 are concerned with the following processes which are used industrially .

- A. electrolysis of aqueous solution.
- B. electrolysis of a molten material.
- C. reduction using carbon.
- D. formation of a complex compound.

17. Pure copper from impure copper

18. Iron from iron oxide

19. Sodium from sodium hydroxide

20. Sodium hydroxide from sodium chloride

21. Aluminium from aluminium oxide.

22. You have a powdered mixture of copper(II) sulphate and calcium carbonate. The best sequence of operations to obtain a sample of pure calcium carbonate is:

- A. warm with water, filter, evaporate the filtrate.
- B. warm with water, filter, wash the residue with water.
- C. warm with water, partly evaporate, cool, filter.
- D. warm with water, filter, dry.

23. An element which burns to form an oxide which is a gaseous at room temperature is:

- A. sulphur.
- B. hydrogen.
- C. helium.
- D. calcium.

24. Equal volumes of 0.2M sodium hydroxide and 0.4M hydrochloric acid were reacted, which of the following statements is correct about the reaction?

- A. a white precipitate is formed.
- B. sodium chloride and water are formed.
- C. there is a drop in temperature.
- D. the PH of the final solution is seven.

25. 5.3KJ of heat energy are required to vapourize 13gm of a liquid of relative molecular mass 78.

The heat of vapourisation of the liquid in KJ mol⁻¹ is:

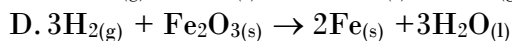
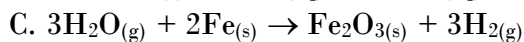
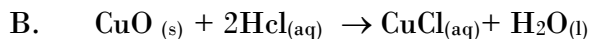
- A. 11.3
- B. 31.8
- C. 68.9
- D. 78.0

26. Hot excess concentrated sulphuric acid reacts with ethanol to give a gas which decolourises bromine, water. The gas is:

- A. ethane
- B. ethyne
- C. ethene
- D. methane.

27. In which of the following reactions has the substance underlined been reduced.

- A. $\text{CO}_{(g)} + \text{CuO}_{(s)} \rightarrow \text{Cu}_{(s)} + \text{CO}_{2(g)}$



28. A salt reacted with concentrated sulphuric acid to give a colourless gas which fumed in moist air.

The anion in P is likely to be a

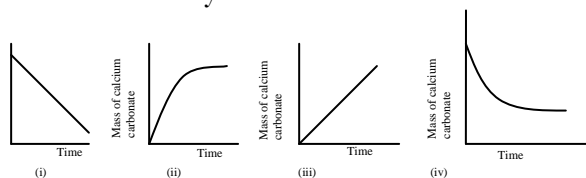
A. carbonate

B. sulphite

C. chloride

D. nitrate

29. Which of the graphs shows the change in mass of calcium carbonate with time when it is reacted with hydrochloric acid?



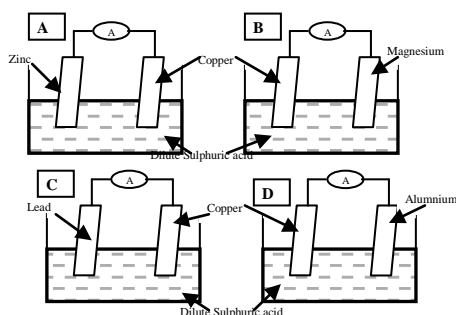
A. (i)

B. (ii)

C. (iii)

D. (iv).

30. Various pairs of metals were placed in aqueous solution and in each case the metals were connected to an ammeter which of the following arrangements would produce the greatest deflection on the ammeter?



31. Which of the following would contain the same number of atoms as 12gm of magnesium? (Mg = 24, C = 12, Ca = 40).

A. 40gm of calcium.

B. 24 gm of carbon.

C. 12gm of carbon.

D. 20gm of calcium.

32. The reaction in which ethanol is changed to ethene when ethanol is reacted with excess concentrated sulphuric acid is called.

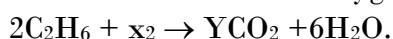
A. hydrogenation.

B. dehydration.

C. hydration.

D. dehydrohalogenation.

33. Ethane burns in oxygen according to the following equation.



The values of X and Y in the equation are?

A. x = 4 and y = 6

B. x = 7 and y = 4

C. x = 2 and y = 2

D. x = 7 and y = 6

34. 7gm of an element combine with 8gm of oxygen. Which of the following statements is correct? ($O = 16$)

- A. the element could have a relative atomic mass of 7 and its oxide the formula AO
- B. the element could have a relative atomic mass of 14 and its oxide the formula AO .
- C. the element could have a relative atomic mass of 7 and the oxide formula A_2O
- D. the element could have a relative atomic mass of 14 and its oxide the formula AO_2 .

Question 35- 40.

Each of the questions 35-40 consists of an assertion (statement) on the hand side and a reason on the right hand side select .

- A. If both assertion and reason are true statement and the reason is a correct explanation of the assertion .
- B. if both assertion and reason are true statements but the reason is not a correct explanation of the assertion .
- C. if the assertion is true but the reason is an incorrect statement .
- D. If the assertion is incorrect but the reason is a true statement .

	Assertion	reason
A	True	True reason is correct explanation
B	True	True (reason is not a correct explanation)
C	True	Incorrect
D	Incorrect	True statement

Assertion		Reason
35. The energy required to break bonds during a chemical reaction supplied more rapidly when the temperature of reaction raised.	<i>because</i>	When carrying a reaction at a higher temperature the number of collisions between the reacting particles is increased.
36. When a liquid boils, more particles escape from the surface of the liquid per unit time than are returning to it per unit time.	<i>because</i>	Only when a liquid boils is sufficient energy being supplied to the particles to enable them to escape from the surface of the liquid.
37. When burnt in excess oxygen, equal masses of graphite and diamond react to give the same volume of carbondioxide.	<i>because</i>	Graphite and diamond are both pure forms of the element carbon.
38. Pure water is not a good conductor of electricity. $OH^-_{(aq)}$ ions.	<i>because</i>	Pure water is highly ionized into $H^+_{(aq)}$ and $OH^-_{(aq)}$ ions.
39. Ethane, ethene and ethyne belong to the same homologous series.	<i>because</i>	Ethane, ethene and ethyne each contain two carbon atoms per molecule.
40. When sulphur dioxide reacts with iron (III) sulphate, the solution turns from brown to green.	<i>because</i>	Sulphur dioxide is oxidized with iron (III) by iron (III) ions.

Questions 41 to 50

Directions: For each of the questions below one or more of the responses given is/are correct.

Decide which of the responses is / are. The choose :

- A. if only 1, 2 and 3 are correct
- B. if only 1 and 3 are correct
- C. if only 2 and 4 are correct
- D. if only 4 is correct.

A	B	C	D
1,2 and 3 only.	1 and 3 only	2 and 4 only	4 only

41. Beryllium, Be, is the element immediately above magnesium in the periodic table, we would expect it to:

- 1. react slowly with cold water, with the evolution of hydrogen .
- 2. dissolve in dilute hydrochloric acid forming beryllium chloride .
- 3. form an oxide with the formula BeO.
- 4. react with nitrogen to form the nitride BeN.

42. When a sodium atom loses an electron the particle formed is

- 1. an atom of an inert gas
- 2. an isotope of sodium
- 3. an allotrope of sodium
- 4. a positive ion.

43. A white precipitate is formed when barium chloride solution is added to a solution of:

- 1. sodium sulphate
- 2. sodium nitrate
- 3. sodium carbonate
- 4. sodium chloride.

44. When copper (II) sulphate solution is electrolysed using platinum electrodes.

- 1. copper is formed at the anode
- 2. the colour of the solution remains unchanged
- 3. oxygen is produced at the cathode
- 4. the final solution is acidic.

45. When ethanol burns in excess oxygen carbon dioxide and water, only are formed. This shows that ethanol contains

- 1. hydrogen
- 2. oxygen
- 3. carbon
- 4. nitrogen.

46. Graphite has a structure made up of layers of atoms. In each layer the atoms are arranged in hexagonal rings. The distance between successive layers is very much greater than the distance between the atom within a given layer. Thus, we can say that:

- 1. graphite has a high boiling point
- 2. a crystal of graphite will be easier to break in some directions than others.
- 3. graphite will act as a good lubricant.
- 4. the forces between the atoms are likely to be less strong than those between the atoms in a layer.

47. Which of the following conditions does **not** affect the rate of reaction between lumps of calcium carbonate and dilute hydrochloric acid?

1. grinding the calcium carbonate.
2. adding iron powder to the mixture.
3. warming the reaction mixture.
4. exposing the reaction mixture to light.
48. During electrolysis of copper(II) sulphate solution using copper electrodes.
 1. copper is deposited at the cathode
 2. oxygen is evolved at the anode.
 3. the anode dissolves.
 4. the cathode dissolves.
49. Which of the following substances will dissolve in water to give a solution that will change blue litmus paper red?
 1. ammonium chloride
 2. magnesium oxide
 3. sodium ethanoate
 4. carbondioxide.
50. The slag formed in the blast furnace during the extraction of iron is used for:
 1. surfacing roads
 2. making steel
 3. manufacture of cement
 4. electroplating.

TEST NUMBER ELEVEN :

1. Three moles of electrons were required to deposit one mole of atoms of a metallic element, Y from an aqueous solution of one of its salts. The empirical formula of the bromide of Y is.
 - A. Y_3Br
 - B. Y_3Br_2
 - C. Y_2Br_3**
 - D. YBr_3 .
2. The element astatine, At belongs to the same group as chlorine. Which statement is most likely to describe the chemistry of astatine ?
 - A. it is diatomic and forms ions of the formula At^+
 - B. it is monatomic and forms ions of the formula At^-
 - C. *it is diatomic and forms ions of the formula At^-***
 - D. it is diatomic and form ions of the formula At^{2-}
3. The following four reactions were each started at the same time and same temperature. The greatest volume of hydrogen would be produced in the first ten seconds by:
 - A. adding 1gm of magnesium ribbon to 10cm³ of 0.5M sulphuric acid.
 - B. adding 1gm of magnesium ribbon to 40cm³ of 0.5M sulphuric acid.
 - C. adding 1gm of magnesium powder to 20cm³ of 0.5M. sulphuric acid.
 - D. adding 1gm of magnesium powder to 10cm³ of 1M sulphuric acid.
4. The most accurate description of what happens when lead nitrate crystals are heated in a test tube is
 - A. melting occurs and a pale yellow liquid distils over .
 - B. the crystals break up with a cracking sound and brown gas is evolved .
 - C. the crystals break up with a cracking sound and melting occurs. A colourless gas is evolved which turns brown in air.
 - D. the crystals break up with a cracking sound and melting occurs. A brown gas is evolved.

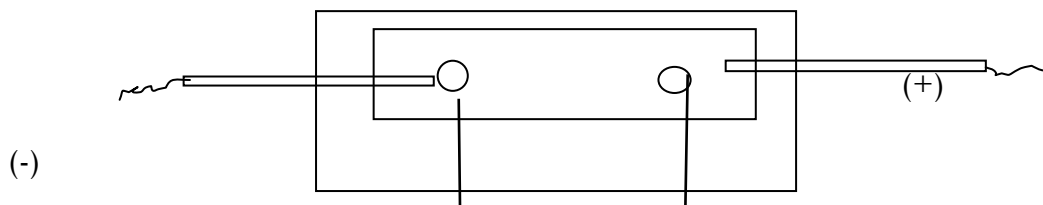
5. A certain hydrocarbonate has 82.3% mass of carbon, its molecular mass is 58. Its formula is: (C = 12, H = 1).
 - A. C_4H_{10}
 - B. C_2H_5
 - C. C_4H_8
 - D. C_2H_2 .
6. An essential part of the softening of water made hard by the presence of calcium compounds is:
 - A. converting the calcium to a form which is soluble in water.
 - B. converting the aqueous calcium ions to a compound which is soluble in water.
 - C. reducing the aqueous calcium ions.
 - D. precipitating off the calcium compound.
7. Which of the following is conclusive evidence that the bonding in a solid is predominantly ionic?
 - A. it is crystalline.
 - B. its aqueous solution has a high electrical conductivity.
 - C. it is soluble in water.
 - D. it has a high melting point.
8. When a colourless aqueous solution was electrolysed between carbon electrodes, a brown colour developed around one electrode and a metallic deposit formed on the other. The colourless solution could contain
 - A. lead iodine.
 - B. sodium bromide.
 - C. zinc bromide.
 - D. potassium iodine.
9. An aqueous solution of a chloride of metal was electrolysed. It was found that 0.103gm of M was deposited at the cathode during the flow of 0.002 faradays of electricity. If the atomic mass of M is 103 what is the charge of the ions of M ?
 - A. M^{4+}
 - B. M^{3+}
 - C. M^{2+}
 - D. M_+
10. Which of the following is **not** a property of chlorine?
 - A. it is yellowish - greenish in colour.
 - B. it extinguishes a glowing splint.
 - C. it fumes in moist air
 - D. it gives an acidic response to universal indicator.
11. When "salt gas" is passed over heated iron, a gas is formed and the iron.
 - A. rusts
 - B. reacts to form crystals
 - C. melts
 - D. vapourises.
12. Rubidium is an element in the same group of the periodic table as sodium and potassium. It is likely to be metal which is:
 - A. soft with a low melting point, which reacts very vigorously with water.
 - B. soft, with high melting point, which reacts very vigorously with water.
 - C. hard, with a low melting point, which reacts vigorously with water.

D. hard, with high melting point, which reacts very vigorously with water.

13. A red powder is known to be an oxide of a metal. It dissolves in dilute nitric acid to form a pale-blue solution. Which of the following could it be?

- A. iron (III) oxide.
- B. mercury (II) oxide.
- C. trilead tetraoxide.
- D. copper(I) oxide.

14. A strip of damp filter was placed on a microscope slide, and held to it by means of crocodile clips connected to a battery. A spot of lead nitrate solution and potassium iodine solution are placed in the position shown.



Potassium lead nitrate solution.

Iodine solution

What would you expect to see first ?

- A. streak of iodine near the negative end
- B. a streak of iodine near the positive end
- C. a streak of iodine near the centre
- D. a streak of iodine(yellow) near the centre

15. A solution that contains zinc ions will form

- A. a reddish brown precipitate with magnesium.
- B. a white precipitate soluble in excess sodium hydroxide solution.
- C. a white precipitate with dilute sulphuric acid.
- D. a green precipitate insoluble in excess ammonia.

16. Which one of the following acid react with a base to produce an acid salt?

- A. ethanoic acids
- B. hydrochloric acid
- C. sulphurous acid
- D. nitric acid .

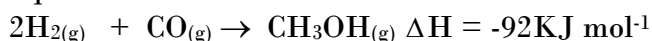
17. A gas has the following properties .

- (i) turns blue litmus paper red.
- (ii) forms white fumes with ammonia.
- (iii) forms a white precipitate with aqueous silver nitrate.

The gas is

- A. hydrogen chloride
- B. hydrogen sulphide
- C. sulphur dioxide
- D. carbon dioxide.

18. The formation of methanol from hydrogen and carbondioxide is represented by the equation



What would be the energy released, in KJ, when 3.2gm of methanol is formed? (C = 12, H = 1, O = 16)

- A. 2.9
- B. 3.6
- C. 10.2
- D. 9.2

19. Potassium chlorate is heated until it just starts to produce oxygen. It is then allowed to cool a little until all traces of oxygen evolution ceases. What happens if manganese (IV) oxide is then added?

- A. nothing
- B. chemical reaction occurs with the formation of a new compound
- C. oxygen is produced when the mixture is reheated
- D. the oxygen is liberated from manganese (IV) oxide.

20. It is found that when 50cm³ of a solution of barium hydroxide Ba(OH)₂ is added to 25cm³ of a solution of nitric acid, HNO₃ a neutral solution is formed. Thus,

- A. the nitric acid is four times the same concentration as the barium hydroxide
- B. the nitric acid has the same concentration as the barium hydroxide solution.
- C. the barium hydroxide solution is twice as concentrated as the nitric acid solution.
- D. the barium hydroxide solution is four times as concentrated as the nitric acid.

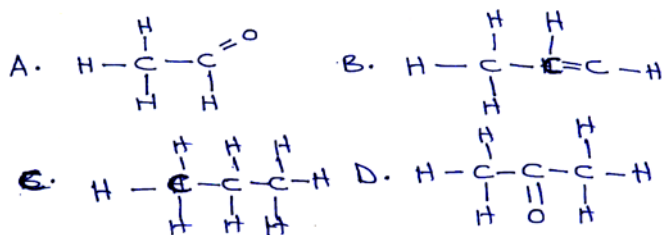
21. 0.16gm of copper displaced 0.54gm of silver from excess silver nitrate solution. Which of the following equations best represents the reaction of copper atoms and silver ions? (Cu = 64, Ag = 108)

- A. $\text{Cu}^{2+}_{(\text{aq})} + 2\text{Ag}_{(\text{s})} \rightarrow \text{Cu}_{(\text{s})} + 2\text{Ag}^{+}_{(\text{aq})}$
- B. $2\text{Ag}^{+}_{(\text{aq})} + \text{Cu}_{(\text{s})} \rightarrow \text{Cu}^{2+}_{(\text{aq})} + 2\text{Ag}_{(\text{s})}$
- C. $\text{Ag}^{+}_{(\text{aq})} + \text{Cu}_{(\text{s})} \rightarrow \text{Cu}^{+}_{(\text{aq})} + \text{Ag}_{(\text{s})}$
- D. $\text{Cu}^{+}_{(\text{aq})} + 2\text{Ag}_{(\text{s})} \rightarrow \text{Cu}_{(\text{s})} + 2\text{Ag}_{(\text{aq})}$

22. When carbon dioxide is prepared by the action of acid on marble chips, hydrochloric acid is used rather than sulphuric acid because:

- A. hydrochloric acid is more volatile
- B. sulphuric acid reacts as an oxidising agent.
- C. calcium sulphate is insoluble in water
- D. carbon dioxide is less soluble in hydrochloric acid.

23. Which of the following is unsaturated hydrocarbon.



24. 20cm³ of hydrochloric acid of unknown molarity reacted with 25cm³ of 0.05M sodium carbonate. The molarity of the acid is:

- A. 0.125 M
- B. 0.031 M
- C. 0.040 M

D. 0.02 M

25. The number of moles of hydrogen ions in 500cm³ of 2M sulphuric acid is:

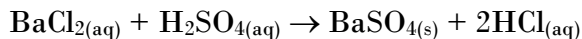
A. 0.50

B. 1.00

C. 2.00

D. 4.00

26. Barium chloride reacts with sulphuric acid according to the following equation.



The mass of barium sulphate precipitated when 1.2 gm of barium chloride is treated with excess sulphuric acid is:

(Ba = 134.34, Cl = 35.5, S = 32, O = 16, H = 1)

A. $\frac{230.34 \times 1.2}{205.34}$

B. $\frac{230.34 \times 205.34}{1.2}$

C. $\frac{205.34 \times 1.2}{230.34}$

D. $\frac{230.34}{230.34} \times 1.2$

27. 100cm³ of carbon monoxide are mixed with 20cm³ of oxygen, ignited and allowed to cool back to the original temperature and pressure. The total volume in cm³ of gas after the reaction is:

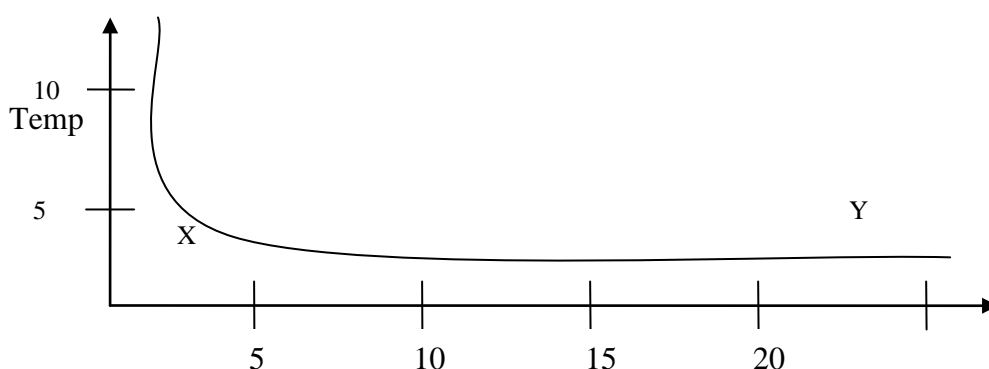
A. 5

B. 10

C. 25

D. 20

28. Benzene, C₆H₆ was cooled in a freezing mixture. The temperature changes with time as shown in the graph below:



Which of the following explains the shape of the graph between X and Y?

A. the benzene has reached room temperature

B. the freezing mixture is not cold enough.

C. the benzene has frozen.

D. Benzene cannot be cooled below 5°C.

29. Some dilute hydrochloric acid was electrolysed using carbon electrodes. Within five minutes 10cm³ of hydrogen had been collected, but at the anode only about 1cm³ of chloride was collected. This was because:

A. chlorine is much more dense than hydrogen.

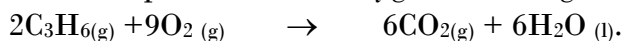
B. chlorine is very soluble in water.

- C. oxygen rather than chlorine was being discharged at the anode
- D. chlorine was being absorbed into the carbon anode.

30. 10gm of powdered chalk was mixed with 50cm³ of 2M hydrochloric acid and the rate of reaction was followed by measuring the volume of carbondioxide evolved at half minute intervals. The rate of reaction would be:

- A. very rapid throughout.
- B. slow but steady throughout.
- C. rapid at first, gradually becoming slower.
- D. slow at first, gradually becoming faster.

31. Propane burns in oxygen according to the equation.



When 2.1gm of propane is completely burned in oxygen, the volume of carbondioxide produced at room temperature is:

(C = 12, H = 1, mole of gas occupies 24 dm³ at room temperature)

- A. 2.4dm³
 - B. 1.2 dm³
 - C. 4.8 dm³
 - D. 3.6 dm³
32. Which of the following gases is least soluble in water?
- A. ammonia.
 - B. sulphurdioxide.
 - C. hydrogen chloride.
 - D. chlorine.

33. An element burns readily in oxygen to form a solid. The solid dissolves in water producing an alkaline solution and a gas which re-lights a glowing splint. The element is:

- A. phosphorus
- B. magnesium
- C. sodium
- D. sulphur

34. Which one of the following anions will react with silver nitrate solution to give white precipitate soluble in excess aqueous ammonia?

- A. Cl⁻
- B. NO₃⁻
- C. SO₄²⁻
- D. CO₃²⁻

35. Which one of the following hydroxides can be prepared by reacting a soluble salt of the metal with excess sodium hydroxide solution?

- A. lead(II) hydroxide
- B. iron (III) hydroxide
- C. aluminium hydroxide
- D. zinc hydroxide.

In each of the questions 36 - 44 one or more of the answers given may be correct. Read each question carefully and then indicate on your answer sheet according to the following.

- A. if only 1,2 and 3 are correct
- B. if only 1 and 3 are correct
- C. if only 2 and 4 are correct
- C. if only 4 is correct.

36. Which of the following when in aqueous solution can be reduced by aluminium metal?

1. Fe^{2+}
2. Ca^{2+}
3. Cu^{2+}
4. Mg^{2+}

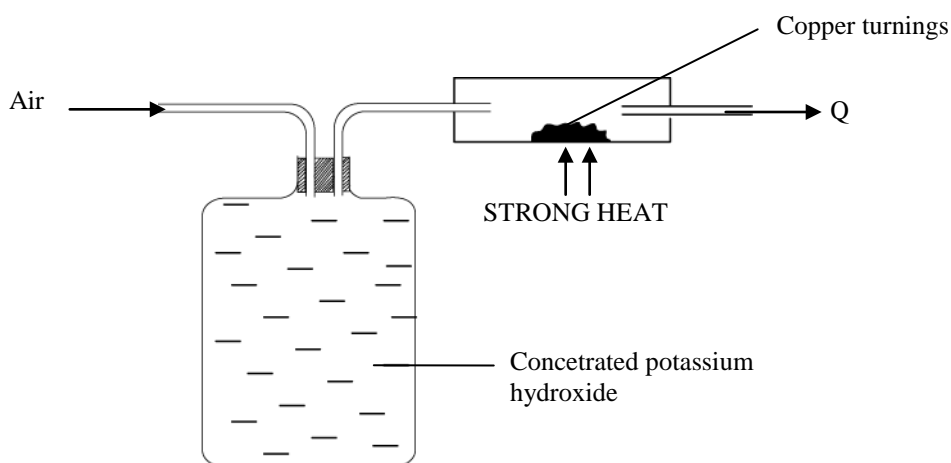
37. Which of the following substances is /are decomposed by an electric current?

1. solution of urea
2. aqueous sodium chloride
3. molten wax
4. molten lead (II) iodine

38. Which of the following sulphates when heated strongly, give(s) off a gas that turns potassium dichromate (VI) solution green?

1. FeSO_4
2. CuSO_4
3. ZnSO_4
4. CaSO_4

39.



Air was passed through an apparatus as shown in the diagram above. The gas that comes out at Q consists of:

1. oxygen
2. neon
3. carbondioxide
4. nitrogen

40. Which of the following pairs of reactants would be suitable for preparing magnesium sulphate?

1. $\text{Mg}(\text{NO}_3)_2(\text{aq})$ and $\text{H}_2\text{SO}_4(\text{aq})$
2. $\text{MgCO}_3(\text{s})$ and $\text{H}_2\text{SO}_4(\text{aq})$
3. $\text{MgCl}_2(\text{aq})$ and $\text{H}_2\text{SO}_4(\text{aq})$
4. $\text{Mg}(\text{s})$ and $\text{H}_2\text{SO}_4(\text{aq})$

41. Which of the following compound(s) have a multiple bond

1. C_2H_2
2. C_4H_{10}
3. C_2H_4
4. C_2H_6

42. When fuming nitric acid was heated, the gas that was evolved was collected over water. The gas was.

1. hydrogen
2. nitrogen dioxide
3. nitrogen monoxide

4. oxygen

43. When a burning piece of magnesium is plunged into a jar of carbondioxide, the following observation(s) is / are made:

1. the magnesium continues to burn brightly
2. a white ash is formed.
3. black particles are formed.
4. the burning magnesium is extinguished.

44. Which of the following is / are formed when sodium hydrogen carbonate is strongly heated

1. carbon dioxide
2. sodium metal
3. sodium carbonate
4. sodium oxide.

Each of the questions 45-50 consists of an assertion (statement) on the left hand side and a reason on the right hand side.

Select.

- A. If both assertion and reason are true statement and the reason is a correct explanation of the assertion.
- B. if both assertion and reason are true statements but the reason is not a correct explanation of the assertion.
- C. if the assertion is true but the reason is an incorrect statement.
- D. If the assertion is incorrect but the reason is a true statement.

Assertion

Reason

45. Isotopes of an element show similar chemical reactions.

because Isotopes of an element contain the same number of neutrons.

46. The PH of an aqueous solution of carbon dioxide is greater than 7.

because Carbon dioxide reacts with water form carbonic acid.

47. When sodium hydroxide solution on a watch glass is exposed to air, a white crust is formed .

because The solution absorbs carbon dioxide gas and forms sodium carbonate which is white.

48. When chlorine is bubbled through iron (II) chloride solution, the colour changes from yellow to green.

because Chlorine is an oxidizing agent

49. Diamond is used in tools to drill into rocks.

because It forms one of the hardest substances known.

50. Although hydrogen sulphide is very poisonous, it is not as dangerous, as carbon monoxide.

because hydrogen sulphide is sparingly soluble in water.

10. A compound Z contains Fe, = 72.4% and O, 27.6% (Fe = 56, O = 16). The empirical formula of Z is given by the ratio;

Fe: O as;

A. 1: 0.38 B. 0.77: 0.58

C. 1.29: 1.73

E. 40.5: 4.4

11. Which one of the following hydroxides when exposed to air turns brown?

A. magnesium hydroxide

B. zinc hydroxide

C. iron (II) hydroxide

D. lead (II) hydroxide

12. A few drops of concentrated sulphuric acid was added to a compound P, on warming the mixture, a colourless gas which fumes with ammonia was given off. P could be a:

A. sulphite

B. nitrate

C. carbonate

D. chloride

13. When testing for a sulphate, dilute nitric acid is added before barium nitrate in order to:

A. eliminate any sulphite or carbonate present

B. change the sulphate to a sulphite.

C. acidify the medium for reaction

D. catalyse the reaction.

14. Spring water decomposes on boiling to produce white solid particles. The solid particles are:

A. calcium sulphate.

B. calcium carbonate.

C. calcium hydrogen sulphate.

D. calcium hydrogen carbonate.

15. Which one of the following equations does **not** represent reduction reaction?

A. $\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Cu}(\text{s})$

B. $\text{Cl}_{2(\text{g})} + 2\text{e}^- \rightarrow 2\text{Cl}^{-}(\text{aq})$

C. $\text{N}_{2(\text{g})} + 3\text{H}_{2(\text{g})} \rightarrow 2\text{NH}_{3(\text{g})}$

D. $\text{Fe}(\text{s}) \rightarrow \text{Fe}^{3+}(\text{aq}) + 3\text{e}^-$

The volume of a 0.25M hydrochloric acid required to exactly react with 20.0cm³ of a 0.1M sodium carbonate solution is given by:

A. $\frac{2 \times 20 \times 0.1}{0.25}$

B. $\frac{2 \times 20 \times 0.25}{0.1}$

C. $\frac{20 \times 0.25}{2 \times 0.1}$

D. $\frac{20 \times 0.1}{2 \times 25}$

17. When 6.4gm of an oxide of element X was heated and hydrogen passed over it; 3.2gm of X was formed. The empirical formula of the oxide is:

(X = 32, O=16)

A. XO

B. X₂O₃

C. XO₂

D. X₂O.

18. Excess lead powder was shaken with an aqueous solution containing a mixture of copper (II) nitrate and magnesium nitrate. The cations present in the solution after the reaction were.

A. Pb²⁺ and Mg²⁺ only

B. Mg²⁺ and Cu⁺⁺ only

C. Pb²⁺ and Cu²⁺ only

D. Pb²⁺, Cu²⁺ and Mg²⁺

19. The reaction between dilute hydrochloric acid and magnesium ribbon is fast at the beginning and gradually slows down there after. The decrease in the rate is due to:

A. increase in pressure above the reaction vessel brought about by the hydrogen gas being produced.

B. endothermic reaction between magnesium ions and chloride ions.

C. insolubility of the magnesium chloride being produced.

D. gradual decrease in the number of hydrogen ions during the reaction.

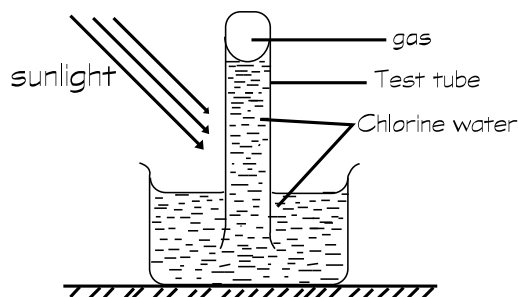
20. When a dilute solution of sodium chloride is electrolysed using carbon electrodes, the substance formed at the cathode is:

- A. oxygen
B. hydrogen
C. sodium
D. chlorine

21. What mass in grams, of sodium carbonate 10- water, $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$, is contained in 50cm^3 of a 0.1M solution? (Na =23, C = 12, O =16, H = 1)

- A. 1.43gm
B. 572gm
C. 0.53gm
D. 212gm.

22.

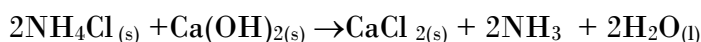


Chlorine water was exposed to sunlight as shown in the diagram below.

The gas collected in the test tube was

- A. chlorine
B. oxygen
C. hydrogen
D. hydrogen chloride

23. Ammonia chloride reacts with calcium chloride according to the equation.



Calculate the volume of ammonia at room temperature, produced when 2.14 gm of ammonia chloride is reacted with the hydroxide.

(N =14, H = 1, Cl =35.5, Ca = 16 and 1 mole of gas occupies 24 dm^3 at room temperature)

- A. 1.92 dm^3
B. 4.80 dm^3
C. 0.96 dm^3
D. 0.48 dm^3

24 Ethene can react to form a solid whose molecular mass is more 10,000 The reaction is called.

- A. vulcanisation of ethane
B. hydrogenation of ethene
C. cracking of ethane
D. polymerisation of ethene.

25. In the laboratory preparation of chlorine, concentrated hydrochloric acid is heated with;

- A. lead (II) oxide
D. sodium chloride crystals
E. copper (II) chloride crystals
D. manganese (IV)oxide solid.

26. Which one of the following oxides does not react with dilute sodium hydroxide solution?

- A. lead(II) oxide
B. iron (III) oxide
C. aluminium oxide
D. zinc oxide.

27. When carbondioxide is bubbled through water, the lime water turns milky and finally a clear solution is obtained. From the observation one can conclude that:

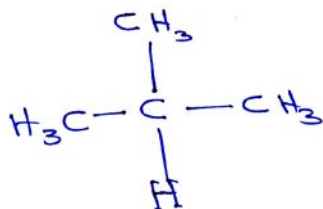
- A. the reaction between carbondioxide and lime water is reversible
B. carbondioxide eventually dissolves in lime water to form carbonic acid
C. lime water is a good solvent for the milky substance.

D. the milky substance reacts to form a soluble compound.

28. Which of the following is not a property of ethene?

- A. it turns potassium permanganate colourless.
- B. it has a double bond between carbon atoms
- C. it undergoes addition with bromine
- D. it dissolves in water to form a basic solution .

29. The compound shown here is called:

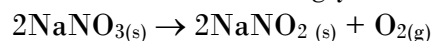


- A. 2 - methyl propane
- B. 2 - methyl butane
- C. propane
- D. butane.

30. Fertilizer L was treated with calcium hydroxide and a gas which turned red litmus blue was evolved . L contained

- A. ammonium nitrate
- B. potassium sulphate
- C. potassium phosphate
- D. sodium nitrate.

31. When heated strongly, sodium nitrate decomposes according to the following equation.



The volume of oxygen at STP that can be obtained by heating 5gm of the salt is?

- A. $\frac{22 \times 5}{170} \text{ dm}^3$
- B. $\frac{5 \times 170}{22.4} \text{ dm}^3$
- C. $\frac{22.4 \times 5}{85} \text{ dm}^3$
- D. $\frac{85 \times 5}{22.4} \text{ dm}^3$

32. The electronic configurations of elements W, X, Y, and Z are:

W : 2, 8, 6 X : 2, 8, 7 Y : 2, 8, 3 Z : 2, 8, 2.

Which of the following pairs are non-metals?

- A. Y and X
- B. Z and W
- C. W and X
- D. Z and Y

33. Which one of the following compounds is used as a catalyst in the manufacture of sulphur trioxide from air and sulphur dioxide?

- A. vanadium (V) oxide
- B. manganese(IV) oxide
- C. iron powder
- D. alumina.

34. Which one of the following cations would form a yellow precipitate when reacted with aqueous potassium chromate?

- A. Zn^{2+}
- B. Pb^{2+}
- C. Fe^{2+}
- D. Ca^{++}

35. Carbon burns in oxygen according to the following equation. $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$

The heat energy obtained when 480 gm of carbon is burnt completely is (the molar heat of combustion of carbon is $2.2 \times 10^{-7} \text{ KJ mol}^{-1}$ C = 12)

- A. $8.8 \times 10^7 \text{ KJ}$
- B. $4.4 \times 10^{-6} \text{ KJ}$
- C. $8.8 \times 10^{-6} \text{ KJ}$
- D. $8.8 \times 10^{-5} \text{ KJ}$

36. To test for a chloride in solution

- A. nitric acid is added followed by silver nitrate solution .

- B. sodium hydroxide is added drop wise until in excess
 C. aqueous ammonia is added drop wise until in excess
 D. iron (II) sulphate solution is added followed by concentrated sulphuric acid .

37. Which one of the following compounds does **not** cause hardness in water?

- A. calcium hydrogen carbonate B. magnesium sulphate
 C. sodium carbonate D. calcium sulphate

38. Metal M was dissolved in dilute nitric acid and the solution was evaporated to dryness and then strongly heated until there was no further change. The residue was yellow when hot and white when cold. M is:

- A. iron B. aluminium
 C. lead D. zinc.

39. When concentrated hydrochloric acid is reacted with potassium permanganate, the given off is:

- A. oxygen B. hydrogen
 C. hydrogen chloride D. chloride.

40. Which one of the following solutions would give the maximum volume of carbon dioxide within the shortest time when reacted with 10gm of calcium carbonate at room temperature ?

- A. 40cm³ of 2M HCl B. 50cm³ of 1M HCl
 C. 60cm³ of 1M HCl D. 30cm³ of 2M HCl

41. Which one of the following gases is a major sewerage product?

- A. N₂ B. C₂H₆
 C. CH₄ D. SO₂

In each of the questions 42-46 one or more of the answers given may be correct. Read each question carefully and then indicate on your sheet according to the following .

- A. if only 1,2 and 3 are correct
 B. if only 1 and 3 are correct
 C. if only 2 and 4 are correct
 D. if only 4 is correct.

42. Which of the following substances are efflorescent ?

1. MgSO₄. 7H₂O
2. Na₂B₄O₇. 10H₂O
3. NaCO₃. 10H₂O
4. CaCl₂. 2H₂O

43. A solution of potassium hydroxide was added to a solution of copper(II) sulphate and the mixture heated strongly . The final product(s for)med was /were

1. potassium sulphate
2. potassium oxide
3. copper(II) oxide
4. copper (II) hydroxide

44. An element T, belong to group II in the periodic table, but below calcium. The element is likely to:

1. from an ionic chloride of formula TCl₂
2. react with cold water and liberate hydrogen
3. be a solid at room temperature.
4. form an oxide which reacts with both acids and alkalis.

45. An aqueous sodium hydroxide solution was added to a solution of salt X and a white precipitate insoluble in excess alkali was formed.

1. zinc ions.
2. aluminium ions.
3. lead ions.
4. magnesium ions.

46. Hydrogen bromide in solution.

1. reacts with magnesium hydrogen and a salt.
2. reacts with a base to form a salt and water only.
3. liberates carbondioxide from carbonates.
4. bleaches litmus paper.

47. Each of the questions 47-50 consists of an assertion (statement) on the left hand side and a reason on the right hand side.

Select:

A. if both assertion and reason are true statement and the reason is a correct explanation of the assertion.

B. if both assertion and reason are true statements but the reason is **not** a correct explanation of the assertion.

C. if the assertion is true but the reason is an incorrect statement.

D. if the assertion is incorrect but the reason is a true statement.

	Assertion	Reason
A	True	True (reason is a correct explanation)
B	True	True (reason is not a correct explanation)
C	True	Incorrect
D	incorrect	True statement

Assertion

Reason

47. When chlorine is bubbled into potassium iodide solution, iodine is liberated

because Iodine atom is larger than chlorine atom.

48. Rubber is more elastic than polyethene.

because Rubber is a natural polymer.

49. Aqueous lead(II)bromide conducts an electric current

because The ions in the aqueous salt are free to move about.

50. Hard water forms scum with soap solution. insoluble salt scum.

because Soap reacts with the hard water to produce an

TEST NUMBER THIRTEEN :

1. Which one of the following is obtained when a solution of copper (II) sulphate is evaporated to dryness?

- | | |
|-----------------------|------------------------------------|
| A. copper (II) oxide | B. copper (II) sulphate crystals |
| C. copper(I) sulphate | D. anhydrous copper (II) sulphate. |

2. What volume of nitrogen will be found in 500cm³ of air?

- | | |
|------------------------|------------------------|
| A. 390 cm ³ | B. 100 cm ³ |
|------------------------|------------------------|

- C. 40 cm^3 D. 450 cm^3
3. Which of the following is not considered a pollutant to air or water?
- A. synthetic detergents B. nitrogen
- C. fertilizers D. carbon monoxide
4. Which one of the following does **not** undergo a chemical change when heated?
- A. sulphur B. ice
- C. magnesium D. sodium
5. Temporary hardness is due to dissolved
- A. calcium sulphate B. scum
- C. magnesium sulphate D. magnesium hydrogen carbonate.
6. Equal volumes of all gases at the same temperature and pressure?
- A. have the same molecular mass B. have the same density
- C. contain the same number of molecules D. dissolve equal volumes of air.
7. The gas produced when hydrogen gas is passed over heated iron (III) oxide is:
- A. H_2O B. H_2
- C. N_2 D. NO .
8. The same, quantity of electricity is passed through solutions containing different cations. The greatest number of moles is deposited in one containing:
- A. zinc B. aluminium
- C. copper D. sodium
9. When compound X is burnt completely in oxygen, the products are water and carbondioxide only. X must contain:
- A. carbon and oxygen B. carbon and hydrogen
- C. hydrogen and oxygen D. carbon, hydrogen and oxygen
10. What mass of sulphur contains the same number of atoms as there are molecules in 22gm of carbon dioxide? (S = 32, C = 12, O = 16)
- A. 8 B. 32
- C. 16 D. 44.
11. An atom R has 3 outermost electrons while S has 7 electrons in its outermost shell. The formula from the compound of R and S is:
- A. RS_3 B. R_3S
- C. R_2SD D. RS_2
12. Which of the following metal ions will colour the Bunsen flame red?
- A. K^+ B. Ca^{2+}
- C. Na^{2+} D. Cu^{2+}
13. Which of the following salts are always soluble in water?
- A. chloride B. nitrate
- C. carbonate D. sulphate.
14. A solution of an alkali.
- A. will not conduct an electric current. B. turns blue litmus red.
- C. contains more OH^- than H^+ ions. D. reacts with carbonate to give off carbondioxide gas.
15. An alcohol was heated with concentrated sulphuric acid to dehydrate it. The product was an:
- A. alkane B. ester
- C. alkene D. acid
16. Sulphuric acid was added to a black substance Z forming only a blue solution and no gas was evolved. The black substance could be:
- A. carbon B. graphite
- C. copper (II) oxide D. iron (II) sulphide

17. Which of the following is used to confirm lead (II) ions in solution?
 A. chromate ions B. nitrate ions
 C. hydroxyl ions D. ammonia solution.
18. 10cm³ of hydrogen was burnt in 10cm³ of oxygen. Find the volume of gas in cm³ after cooling to room temperature?
 A. 5B. 10
 C. 15D. 20
19. What volume of carbondioxide is obtained by dissolving 5.0gm of calcium carbonate in excess hydrochloric acid ?
 A. 4800 cm³B. 2400 cm³
 C. 3600 cm³D. 1200 cm³
20. A current of 9.65 amperes flowed for 1000 seconds in a solution of a molten chloride. How many moles of chlorine gas are liberated? IF = 96500C.)
 A. 0.05B. 0.10
 C. 0.20D. 0.30.
21. What is the percentage of zinc in ZnSO₄ .7H₂O.
 (Zn = 65, S = 32, O = 16, H = 1)
 A $\frac{65}{287} \times 100$ B $\frac{126}{287} \times 100$
 C $\frac{64}{287} \times 100$ D. $\frac{136}{287} \times 100$
22. Which of the following solutions contains the greatest mass of sodium hydroxide?
 A. 500cm³ of 0.1M NaOH . B. 200cm³ of 0.5M NaOH
 C. 150cm³ of 0.4M NaOH D. 100cm³ of 0.8M NaOH
23. Iron rusts according to the equation given below. What mass of iron would just use up 4.8gm of oxygen to rust? [Fe = 56, O = 16]
- $$4\text{Fe}_{(s)} + 3\text{O}_{2(g)} \rightleftharpoons 2\text{Fe}_2\text{O}_{3(s)}$$
- A. 96gm B. 224gm
 C. 11.2gm D. 22.4gm
24. The mass of 280cm³ of a gas measured at S.T.P is 0.55gm, The relative molecular mass of the gas is? [molar volume at S.T.P is 24000cm³]
 A. 36.4 B. 509
 C. 44 D. 154.
25. Which of the following substances will not conduct electricity?
 A. mercury B. carbon
 C. sulphur D. lead .
26. Which of the following is an electronic configuration of an atom of a metal?
 A. 2.8.8 B. 2.8.7
 C. 2.8.4 D. 2.8.8.1
27. Which one of the following is dried using calcium oxide ?
 A. sulphurdioxide B. hydrogen
 C. ammonia D. hydrogem chloride.
28. Which of these acids is not used to prepare hydrogen with metals
 A. hydrochloric B. nitric
 C. sulphuric D. ethanoic.
29. The anhydride of sulphuric acid is:
 A. SO₃ B. S
 C. H₂S D. SO₂.

30. Which of these nitrates decomposes to the metal when heated:

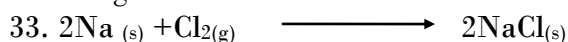
- A. lead nitrate B. zinc nitrate
C. Silver nitrate D. sodium nitrate

31. Steel is an alloy of iron and

- A. carbon B. zinc
C. sulphur D. bras.

32. Element X reacts in air when heated to give a compound Z reacts with water to give an alkaline solution and a gas which turns red litmus paper to blue, X reacted in air with

- A. hydrogen B. oxygen
C. nitrogen D. carbon dioxide



In the above equation:

Chlorine:

- A. is reduced B. is oxidised
C. is the reducing agent D. donates electrons to sodium.

34. Aluminium oxide is

- A. basic oxide B. acidic oxide
C. amphoteric oxide D. neutral oxide

35. Concentrated nitric acid was added to iron (II) sulphate and boiled. After cooling the mixture, sodium hydroxide solution was added, what was observed ?

- A. a green precipitate B. a white precipitate
C. a blue precipitate D. a brown precipitate.

36. 2.8gm of potassium hydroxide was dissolved in water to make 500cm³ of solution. The molarity of the solution is

[K = 39, O = 16, H = 1]

- A. 2MB. 0.1M
C. 0.5MD. 0.5M

37. A white solid when heated sublimed. It was most likely to have been

- A. iodine B. ammonium nitrate
C. ammonium nitrite D. ammonium chloride

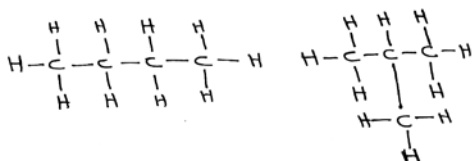
38. Hydrogen sulphide is passed into a solution of lead (II) nitrate, what was observed ?

- A. hydrogen gas is evolved B. sulphur is deposited
C. a black substance is formed D. a white precipitate is formed.

39. The process of making soap is called.

- A. esterification B. decrepitation
C. saponification D. precipitation.

40. The compound below are



- A. isotopes B. allotropes
C. isomers D. polymorphic

41. $^{20}_{\text{Ne}}$ and $^{22}_{\text{Ne}}$ are isotopes of neon

The isotopes

- A. have the same relative atomic mass

- B. have different atomic number
- C. contain equal number of electrons in their outermost shell
- D. contain equal numbers of neutrons in their atoms .



The above thermochemical equation indicate that the change is

- A. endothermic B exothermic
- C. isobaric D. isotonic

Each of the questions 42-47 consists of an assertion (statement) on the hand side and a reason on the right hand side select .

- A. If both assertion and reason are true statement and the reason is a correct explanation of the assertion .
- B. if both assertion and reason are true statements but the reason is not a correct explanation of the assertion .
- C. if the assertion is true but the reason is an incorrect statement .
- D. If the assertion is incorrect but the reason is a true statement.

	Assertio n	Reason
A	True	True (reason is a correct explanation)
B	True	True (reason is not a correct explanation)
C	True	Incorrect
D	in correc t	True statement

Assertion

Reason

- | | | |
|---|---------|----------------------------|
| 43. Hydrogen sulphide decolourised potassium permanganate solution. | because | it is an acidic gas |
| 44. Chlorine gas changes iron (II) chloride solution from brown to pale green | because | it is an oxidising agent. |
| 45. Propanen decourlises bromine water. | because | it is unsaturated compound |
| 46. Diamond is used to make tools which can drill into rocks | because | it is the hardest metal . |

In each of the questions 47-50 one or more of the answers given may be correct. Read each question carefully and then indicate on your sheet according to the following.

- A. if only 1,2 and 3 are correct
- B. if only 1 and 3 are correct
- C. if only 2 and 4 are correct
- D. if only 4 is correct.

instructions summarised.

A	B	C	D
1, 2 and 3 only.	1 and 3 only	2 and 4 only	4 only

47. Nitrogen dioxide

- 1. dissolves in water to form two acids
- 2. is an impurity in the preparation of nitric acid
- 3. is a poisonous gas

4. is a colourless gas and turns brown on exposure to air

48. Chlorine:

1. can bleach when dissolved in water

2. dissolves in water to form an acidic solution

3. is a poisonous gas.

4. reduces turpentine to hydrogen chloride.

49. When nitrates of Mg, Zn and Ca are heated

1. nitrogen gas is evolved

2. the residual solid is white in colour

3. oxygen gas is given off

4. the residual solid is a pure metal.

50. Which of the following is NOT a property of hydrogen chloride gas?

1. it is a covalently bonded molecule.

2. it does not burn in air.

3. it has a choking smell.

4. it is greenish -yellow gas.

TEST NUMBER FOURTEEN:

1. The term aqueous solution means:

A. a solution containing one mole of solute per dm^3 of solution

B. a solution which can provide hydrogen ions

C. a solution in which the solvent is water

D. a solution in which more solute can still dissolve .

2. Sodium hydroxide is produced on a large scale by electrolysis of an aqueous solution of:

A. sodium chloride

B. sodium carbonate

C. sodium chlorate

D. sodium hypochlorate

3. A bottle is labelled 2M KOH. This means.

A. 2moles of KOH are contained in 2 litres of solution

B. 2moles of KOH are contained in 1 litre of solution

C. 2moles of KOH are contained in 200cm^3 of solution

D. 2moles of KOH are contained 500cm^3 of solution

4. 25cm^3 of 0.1M sodium hydroxide were reacted with 25cm^3 of 0.1M sulphuric acid . Which of the following statements is correct about the reaction ?

A. sodium sulphate and hydrogen are produced

B. there is a drop in temperature

C. the PH of the final solution is less than 7

D. a white precipitate is formed .

5. When hydrogen sulphide was bubbled through Iron (III) chloride the colour changed from yellow to green. From this observation it can be concluded that

A. hydrogen sulphide is an oxidising agent

B. hydrogen sulphide is a reducing agent

C. Iron (III) sulphide was produced

D. chlorine gas was formed

6. Which of the following substance will change an aqueous solution of Iron (II) to Iron (III) ions?
- A. sulphur trioxide. B. ammonia.
C. carbondioxide. D. chlorine.
7. The discharge of ion at an electrode does not depend on:
- A. position of the ion in the activity series.
B. magnitude of the charge on the ion.
C. the concentration of the ion.
D. the nature of the electrode.
8. During electrolysis, which one of the following will require the greatest number of faradays to liberate one mole of the substance?
- A. aluminium B. oxygen gas
C. potassium D. copper
9. The electronic configurations of four elements W, X, Y and Z are given
W: 2, 8, 2, X: 2, 8, 6, Y: 2, 8, 8, 1 and Z: 2, 8, 3. Which of these elements do(es) not belong to period 3 in the periodic table?
- A. W and X B. W and Y
C. Z and Y D. Y
10. Sodium hydroxide solution was added to three different test tubes, each of which contained a solution of a different metallic ion, blue, green and reddish brown precipitates were formed. The ions present respectively were:
- A. Cu^{2+} , Fe^{3+} and Fe^{2+} B. Cu^{2+} , Zn^{2+} and Fe^{3+}
C. Cu^{2+} , Pb^{2+} and Fe^{2+} D. Cu^{2+} , Fe^{2+} and Fe^{3+}
11. A sample of a given compound was placed on a spatula and heated in Bunsen flame. The flame changed from blue to lilac.
The compound contained:
- A. sodium B. calcium
C. potassium D. barium
12. Which of the statements below is **not** true about atoms?
- A. they combine in small whole numbers.
B. they are made up of neutrons, protons and electrons.
C. the nucleus takes up the largest volume of the atom.
D. they are all exactly alike for a given element.
13. To test for a carbonate ion in solution, the following is done.
- A. sodium nitrate is added followed by ammonia.
B. add dilute nitric acid.
C. add nitric acid followed by barium nitrate.
D. add dilute hydrochloric acid and pass the gas through calcium hydroxide.
14. Nitrogen reacts with hydrogen according to the following equation:
- $$\text{N}_{2(g)} + 3\text{H}_{2(g)} \longrightarrow \text{NH}_{3(g)}$$
- 100cm³ of N₂ were mixed with 180cm³ of H₂ and exploded together. What volume of NH₃ would be produced at STP if the yield of ammonia is only 10%?
- A. 200cm³ B. 120cm³
C. 20cm³ D. 12 cm³

15. The electronic structure of elements Q is 2, 8, 3. Which of the following statements is not true about Q?
- Q is in group III of the period.
 - the oxide of Q is acidic in nature.
 - Q ionises by loss of three electrons.
 - the chloride of Q is a solid with a high melting point.

16. The electronic arrangements of some elements are given below.

- | | |
|----------|----------|
| A. 2.8.2 | B. 2.8.5 |
| C. 2.8.3 | D. 2.8.4 |

Which of these elements form covalent compounds?

- | | |
|------------|-------------|
| A. W and X | B. W and Y |
| C. X and Z | D. Y and Z. |

17. Magnesium is a group II element and it is immediately above calcium we expect magnesium oxide to have.

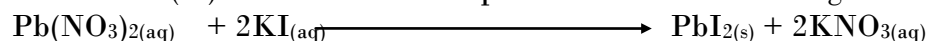
- a molecular structure
- a lower melting point
- an ionic structure
- a higher solubility in water.

18. The percentage of oxygen in magnesium sulphate is:

(O = 16, Mg = 24, S = 32)

- | | |
|-------|--------|
| A. 36 | B. 46 |
| C. 53 | D. 64. |

19. Lead (II) nitrate reacts with potassium iodide according to the equation :

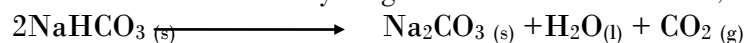


The mass of lead (II) iodide that will be formed when 33.2gm of potassium iodide react with excess lead (II) nitrate is:

[K = 39, I = 127, Pb = 207]

- | | |
|-----------|-----------|
| A. 16.9gm | B. 46.1gm |
| C. 66.4gm | D. 92.2gm |

20. When sodium hydrogen carbonate is heated, it decomposes according to the equation:



21.0 gm of the hydrogen carbonate were completely decomposed. The volume in dm³ of the carbondioxide evolved at STP was

[H = 11, Na = 23, O = 16, C = 12] 1 mole of gas at STP.

- | | |
|--|--|
| A. $\frac{21}{168} \times \frac{1}{2} \times 22.4$ | B. $\frac{168}{21} \times 2 \times \frac{1}{22.4}$ |
| C. $\frac{21}{84} \times \frac{1}{2} \times 22.4$ | D. $\frac{84}{21} \times 2 \times \frac{1}{22.4}$ |

21. To silver plate an article:

- the article is made the cathode using aqueous silver solution as an electrolyte.
- the article is made the anode using aqueous silver solution as an electrolyte.
- the silver metal dissolves into solution.
- the silver layer deposits on the article on the anode.

22. A weak electrolyte is one which

- A. furnishes many ions in solution.
 B. furnishes few ions in solution.
 C. does not allow electricity to go through it.
 D. allows ions to move in one direction.
23. Bauxite is one of:
 A. iron B. aluminum
 C. calcium D. copper
24. When 2.0gm substance X were burnt, the heat produced raised the temperature of 1000gm of water by 15.6° C. The molar heat of combustion of X is:
 (Molar mass of X is 60; 4.2KJ of energy raises the temperature of 1kg of ware by 1°C)
 A. $\frac{4.2 \times 15.6 \times 2}{60}$ KJ B. $\frac{15.6 \times 60 \times 100}{2 \times 4.2}$ KJ
 C. $\frac{15.6 \times 2 \times 100}{60 \times 4.2}$ KJ D. $\frac{15.6 \times 4.2 \times 60}{2}$ KJ
25. Solution X forms a white precipitate with dilute sulphuric acid. It also forms a white precipitate with aqueous sodium hydroxide which is soluble in excess. The solution contain ions of:
 A aluminium B. zinc
 C. lead D. calcium.
26. When 40gms of an oxide of an element x were reduced using excess carbon monoxide, 32gms of x were obtained. The simplest formula of the oxide is:
 [X = 64, O=16]
 A. X₂O B. XO
 C. XO₂ D. X₂O₃.
27. If the molecular mass of the oxide in question 26 is 400. What is the molecular formula of the oxide?
 A. X₅O₅ B. X₆O₃
 C. X₄O₈ D. X₄O₆.
28. Which of the following substances are formed when ammonia is oxidised by air in the presence of catalyst?
 A. nitrogen and water.
 B nitrogen and nitrogen dioxide.
 C. nitrogen monoxide and steam .
 D. nitrogen and hydrogen.
29. Decomposition of hydrogen peroxide produces
 A.. water and hydrogen B. water and oxygen
 C. oxygen and hydrogen. D. oxygen and nitrogen.
30. Which one of the following would give the fastest reaction rate?
 A. 2gm of zinc granules with 100cm³ of 2M HCL at 25°C
 B. 2gm of zinc powder with 100cm³ of 0.5M HCL at 25°C
 C. 2gm of zinc powder with 100cm³ of 2 M HCL at 35°C
 D. 2gm of zinc powder with 100cm³ of 2 M HCL at 10°C
31. Which one of the following is **NOT** true about potassium nitrate when strongly heated?
 A. It melts B. it liberated nitrogen dioxide
 C. it losses weight D. it liberates oxygen.

32. Which one of the following reactions does not take place in the extraction of iron blast furnace?
- A. carbon monoxide reduces iron(II) oxide to iron.
 - B. limestone decomposes to calcium oxide.
 - C. coke burns in air forming carbon dioxide.
 - D. limestone reduces iron (II) oxide to iron.
33. Which of the elements below combines directly with nitrogen when heated?
- A. sodium
 - B. copper
 - C. calcium
 - D. zinc.
34. Element Y is a metal which is one of the metals high up in activity series and exists naturally as an oxide. Which of the following methods can be used to extract X from its oxide?
- A. decomposing the oxide to red hot
 - B. dissolve the oxide in hydrochloric acid and electrolysis the chloride.
 - C. reducing the oxide using carbon monoxide.
 - D. heating the oxide with carbon at high temperature.
35. Which of the following solutions could contain Zn ions.
- A. a solution that forms a black precipitate with hydrogen sulphide.
 - B. a solution that forms a green precipitate with aqueous ammonia.
 - C. a solution which forms a white precipitate soluble in excess sodium hydroxide solution.
 - D. a solution that forms a white precipitate with dilute sulphuric acid.
36. To find out if a sample of a substance is pure, one would:
- A. dissolve the substance in water and then filter the solution.
 - B. determine the melting point of the substance
 - C. add litmus solution to it to determine its acidity.
 - D. heat it and identify all the products formed.
37. Which of the following gases are produced when ammonia carbonate is heated strongly?
- A. ammonia and carbon dioxide.
 - B. ammonia, steam and carbon dioxide
 - C. ammonia, steam and carbon monoxide
 - D. nitrogen steam and carbon dioxide.
38. To test for ammonium ion, NH_4^+ one has to:
- A. add sodium hydroxide solution followed by heating.
 - B. add sodium hydroxide solution and test with litmus.
 - C. add ammonia solution and heat.
 - D. add red litmus paper which turns blue.
39. When phosphorus reacts with concentrated nitric acid on heating, which of the following is a correct observation.
- A. reddish brown gas is given off and a colourless solution of phosphoric acid is formed.
 - B. a colourless gas of nitric oxide is given off and a clear solution results.
 - C. a colourless gas of nitric oxide is given off and a yellow solution is formed.
 - D. a reddish brown gas is given off and a yellow solution is formed.

40. Which of the following compounds reacts with the same homologous series?

- A. CH_3CH_3 and CH_3CHCH_2
- B. CH_2CH_2 and CH_3CHCH_2
- C. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$ and $\text{CH}_3\text{CHCHCH}_3$
- D. C_2H_2 and CH_2CH_2

In each of the questions 41-46 at least one or more of the four given responses is / are correct.

Choose your answer as follows:

- A. if only 1, 2 and 3 are correct
- B. if only 1 and 3 are correct
- C. if only 2 and 4 are correct
- D. if only 4 is correct.

instructions summarised.

A	B	C	D
1, 2 and 3 only.	1 and 3 only	2 and 4 only	4 only

41. Which of the following statement(s) is /are true about the atoms of the
35 37

Cl and Cl

17 17

- 1. they have same mass number.
- 2. they have different numbers of neutrons.
- 3. they are known as allotropes.
- 4. they have the same oxidation state.

42. Which of the following statements on group I and II hydroxide is /are correct

- 1. the group I and II hydroxide are crystalline ionic solids.
- 2. the group I hydroxides are more soluble in water than those of group of II.
- 3. the group I and II hydroxides give alkaline solutions.
- 4. the group I hydroxides are more easily decomposed by heat than those of group II.

43. Methane, ethane, propane and butane all are hydrocarbons which

- 1. have high boiling point.
- 2. are obtained by dehydration of alcohol.
- 3. have high solubility in water.
- 4. burn producing a lot of heat energy.

44. Which of the following compounds whose formulae are given has / have a double bond?

- 1. C_2H_2
- 2. C_4H_{10}
- 3. C_2H_6
- 4. C_4H_8

45. Which of the following properties belong (s) to ethanol?

- 1. it is soluble in water
- 2. it boils at higher temperature than water
- 3. it burns in air to produce carbondioxide and water.
- 4. it is oxidised to give first ethanoic acid and then ethanol.

46. Which of the following ions will form a yellow precipitate with lead ethanoate solution.

- 1. SO_4^{2-}
- 2. CrO_4^{2-}
- 3. CO_3^{2-}
- 4. I^- .

Each of the questions 47-50 consists of an assertion (statement) on the left hand side and a reason on the right hand side.

Select:

- A. If both assertion and reason are true statement and the reason is a correct explanation of the assertion .
 B. if both assertion and reason are true statements but the reason is not a correct explanation of the assertion .
 C. if the assertion is true but the reason is an incorrect statement.
 D. If the assertion is incorrect but the reason is a true statement.

	Assertion	Reason
A	True	True (reason is a correct explanation)
B	True	True (reason is not a correct explanation)
C	True	Incorrect
D	incorrect	True statement

Assertion

Reason

47. The giant structure of ions is a closely and regularly packed structure because There is strong electrostatic force of attraction between the ions in a giant structure.
48. Ammonia gas can be dried with concentrated sulphuric acid because Concentrated sulphuric acid is a strong dehydrating agent .
49. In the extraction of copper, there ore can be reduced using carbon monoxide because Carbon monoxide easily reduces oxides of Cu, Zn and Pb which are below carbon in the activity series.
50. Copper can be used for ornamental work. because It is not easily attacked by air.

TEST NUMBER FIFTEEN:

1. The pH of dilute Nitric acid is:

- A. 6.0 B. 1.0
 C. 10.0 D. 14.0

2. The valencies of copper and iron respectively are:

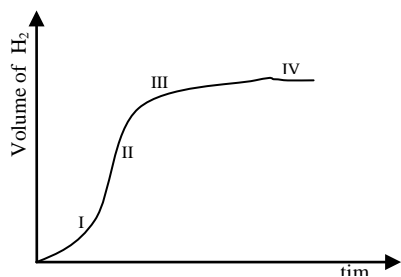
- A. 1 and 1 B. 2 and 6
 C. 2 and 3 D. 1 and 4.

3. Total number of electrons and protons in the sulphide ion S^{2-} are:

(atomic number of S = 16)

- A. 16 electrons, 16 protons
 B. 16 electrons, 18 protons
 C. 18 electrons, 16 protons
 D. 18 electrons, 18 protons.

4. The graph below shows the relationship between hydrogen produced with the time in the reaction between dilute hydrochloric acid and magnesium.



Which part of the graph shows the greatest rate of reaction?

- A. I
- B. II
- C. III
- D. IV.

5. In the laboratory preparation of nitric acid from KNO_3 and concentrated H_2SO_4 both potassium hydrogen sulphate and nitric acid are formed as products but nitric acids distills over because:

- A. it is in excess
- B. it is more volatile
- C. it is more concentrated.
- D. it is a weak acid.

6. 1.27gm of an element X combines with chlorine to give 4.11 gm of chloride . The simplest formula of the chloride is: ($\text{Cl} = 35.5$, $\text{X} = 63.5$)

- A. X_2Cl
- B. XCl_4
- C. XCl_3
- D. X_2Cl_3 .

7. The reaction $\text{OH}^-_{(\text{aq})} + \text{H}^+_{(\text{aq})} \rightarrow \text{H}_2\text{O}_{(\text{l})}$ can best be described as:

- A. dehydration
- B. polymerisation
- C. neutralisation
- D. precipitation.

8. What mass of zinc will be produced by electrolysis of molten zinc chloride when 0.6 amps of electricity pass through the solution for 3 minutes.

($\text{Zn} = 65$, $f = 96500 \text{ c}$).

- A. 0.0727gm
- B. 0.03638
- C. 39gm
- D. 0.001007

9. How many moles of oxygen atoms are present in one mole of $\text{K}_2\text{Cr}_2\text{O}_7$.

- A. 3.5
- B. 2
- C. 7
- D. 11.

10. Which one of the following organic compounds is not an alkane?

- A. C_2H_6
- B. C_3H_6
- C. CH_4
- D. C_4H_{10} .

11. Which of the following substances below can be prepared by the action of an acid on an insoluble carbonate?

- A. zinc sulphate
- B. calcium sulphate
- C. lead sulphate
- D. barium sulphate

12. 20cm^3 of 0.2M hydrochloric acid were mixed with 40cm^3 of 0.1M sodium hydroxide solution. The PH of the resultant solution will be:

- A. less than 7
- B. greater than 7
- C. equal to 7
- D. cannot be determined.

13. Which one of the following gases is contained in both producer and water gases?

- A. nitrogen
- B. hydrogen
- C. carbonmonoxide
- D. oxygen

14. Which one of the following mixtures can be separated by shaking with cold water and filtering?
- calcium nitrate and calcium chloride
 - barium nitrate and barium chloride
 - zinc nitrate and zinc chloride
 - silver nitrate and silver chloride
15. 0.07 moles of calcium hydroxide was required to neutralise 0.035 moles of an acid. The formula of an acid is:
- H_4X
 - HX
 - H_2X
 - H_2X
16. Which one of the following hydroxides is soluble in both aqueous ammonia and sodium hydroxide solution?
- $Pb(OH)_2$
 - $Zn(OH)_2$
 - $Cu(OH)_2$
 - $Al(OH)_3$
17. The number of positive particles in an atom is equal to its
- valency.
 - atomic number.
 - Mass number.
 - neutrons.
18. Which of the following properties is NOT true about chlorine gas ?
- it turns moist red litmus blue.
 - it is a bleaching agent.
 - it extinguishes a flame.
 - it is acidic.
19. Which one of the following substances is used in both burning and rusting?
- oil
 - hydrogen
 - carbon
 - oxygen.
20. The equation below shows the reaction between copper and concentrated sulphuric acid.
- $$Cu_{(s)} + 2H_2SO_{4(aq)} \rightarrow CuSO_{4(aq)} + SO_{2(g)} + 2H_2O_{(l)}$$
- What is the volume of SO_2 gas produced at S.T.P when 0.67gm copper is reacted with excess acid? (C= 63.5, 1 mole of gas occupies $22.4dm^3$ at S.T.P)
- $\frac{63.5 \times 22.4}{22.4}$
 - $\frac{63.5 \times 0.067}{22.4}$
 - $\frac{22.4 \times 0.067}{63.5}$
 - $\frac{0.67 \times 22.4}{63.5}$
21. Which one of the following is NOT true about boiling point of a substances.
- the boiling point depends on pressure.
 - the boiling point is constant for a pure substance at a given pressure.
 - the boiling point increases slightly with impurities.
 - the boiling point decreases slightly with impurities.
22. In the reaction.
- $$Zn_{(s)} + 2Fe^{3+}_{(aq)} \rightarrow Zn^{2+}_{(aq)} + 2Fe^{2+}_{(aq)}$$
- the oxidising agent is
- Zn
 - Zn^{2+}
 - Fe^{3+}
 - Fe^{2+}
23. A gas has the following properties
- it gives a black precipitate with lead (II) nitrate
 - it burns in air (oxygen) with a blue flame
 - it decolorises potassium permanganate solution.
- The gas is:
- hydrogen chloride
 - hydrogen sulphide
 - sulphur dioxide
 - chloride
24. Air contains mainly

- A. carbon dioxide and nitrogen
 C. nitrogen
- B. nitrogen and oxygen
 D. nitrogen and noble gases .

25. Magnesium has atomic number 12 and forms Mg^{2+} . The total number of electrons in the magnesium ions is:

- A. 10
 C. 6
- B. 12
 D. 14

26. Sodium chlorate has the formula Na_2CrO_4 when dissolved in water, it forms Na^+ and CrO_4^{x-} ions. The value of x is:

- A. 2+
 C. 2-
- B. 1-
 D. 1+

27. Solubility of a gas in water will be greatest at:

- A. low pressure and high temperatures.
 B. high pressure and low temperature.
 C. low pressure and low temperature.
 D. high pressure and low temperature.

28. Which one of the following is NOT a reduction oxidation process?

- A. $\text{CuO}_{(s)} + \text{H}_{2(g)} \rightarrow \text{Cu}_{(s)} + \text{H}_2\text{O}_{(l)}$
 B. $\text{Fe}_{(s)} + \text{CuSO}_{4(aq)} \rightarrow \text{FeSO}_{4(aq)} + \text{Cu}_{(s)}$
 C. $\text{C}_2\text{H}_{4(g)} + \text{H}_{2(g)} \rightarrow \text{C}_2\text{H}_{6(g)}$
 D. $\text{Fe}_{(s)} + \text{Cl}_{2(g)} \rightarrow \text{FeCl}_{3(s)}$

29. Y forms a sulphide of the formula Y_2S_3 . The formula of its oxide is:

- A. YO
 C. YO_3
- B. Y_2O
 D. Y_2O_3 .

30. Calcium carbonate reacts with hydrochloric acid according to the equation :



if 20gm of calcium carbonate reacts with hydrochloric acid; what mass of carbondioxide gas would be evolved?

[H = 1 ,O = 16 Ca = 40 C = 12]

- A. 2.8
 C. 3.6
- B. 8.8
 D. 4.4

31. Which of the properties below is not a result of ionic combination

- A. electrostatic force
 B. transfer of electrons
 C. Formation of ions
 D. formation of molecules.

32. Calcium chloride is applied on dusty road surfaces because:

- A. it is deliquescent.
 B. it is a strong electrolyte.
 C. it is an ionic compound.
 D. it is a combination of an alkaline earth metal and a halogen.

33. Which of the following statement is **NOT** true about acids:

- A. They contain halogen which can be replaced by a metal.
 B. They react with carbonates producing carbondioxide.
 C. They react with all metals producing a salt and water.

D. They all have a PH below 7.

34. When calcium dicarbide reacts with water, which of the following gases is produced:

- A. ethene
- B. ethyne
- C. ethane
- D. butane

Each of the questions 35 to 43 consists of an assertion (statement) on the left hand side and a reason on the right hand side.

Select:

- A. if both assertion and reason are true statement and the reason is a correct explanation of the assertion.
- B. if both assertion and reason are true statements but the reason is not a correct explanation of the assertion.
- C. if the assertion is true but the reason is an incorrect statement.
- D. if the assertion is incorrect but the reason is a true statement.

	Assertion	Reason
A	True	True (reason is a correct explanation)
B	True	True (reason is not a correct explanation)
C	True	Incorrect
D	incorrect	True statement

Assertion

Reason

35. Lead (II) sulphate can be prepared by precipitation. *because* Lead (II) sulphate is insoluble in water.

36. Chlorides of metals are very suitable for flame test application. *because* The chlorides are very volatile.

37. Ethane decolourises a solution of bromine. *because* Ethane is saturated.

38. Dalton's theory that atoms of a given element are all exactly alike holds true. *because* Some elements exhibit isotopy.

39. Distillation is a good method of removing hardness in water but is rarely used. *because* It is very expensive.

40. Bromine water can be used to detect unsaturatedness in organic molecules. *because* Bromine is reddish brown in colour.

41. Esters have a sweet smell that of fruits. *because* Esters are prepared from fruit like juice.

42. Carbon can reduce the oxide of lead *because* Carbon is above lead in the activity series.

43. Iron (III) chloride is formed **because** Iron is a reducing agent .
when Iron reacts with
hydrogen chloride gas.

In each of the questions 44-50 one or more of the answers given may be correct. Read each question carefully and then write the correct answer according to the following: Choose:

- A. if only 1, 2 and 3 are correct
B. if only 1 and 3 are correct
C. if only 2 and 4 are correct
D. if only 4 is correct.

Instructions Summarised.

A	B	C	D
1, 2 and 3 only.	1 and 3 only	2 and 4 only	4 only

44. In the laboratory bottles containing sodium hydroxide solution are not covered with glass stoppers because

1. glass is not durable, it can easily break.
2. sodium hydroxide is a strong alkaline solution which can easily lose its alkalinity with a glass stopper.
3. sodium hydroxide is very volatile and easily evaporated through glass.
4. sodium hydroxide absorbs carbondioxide from the atmosphere forming a hydrogen carbonate which forms as a hard crust on the glass stopper making it difficult to open the bottle.

45. Ammonia, potassium and sodium salts are all soluble in water. However ammonium salts can easily be distinguished from the other salts because

1. all ammonium salts have a characteristic smell of ammonia gas.
2. all ammonium salts when heated with any alkali and water yield ammonia gas.
3. all ammonium salts give alkaline solution.
4. ammonium salts easily decompose on heating and most of them produce NH_3 gas.

46. A mixture of Iron and sulphur can be separated by:

1. dissolving the sulphur in carbon disulphide and then filtering.
2. distillation
3. magnetism
4. heating with water.

47. Monoclinic and rhombic sulphur:

1. are crystalline forms of sulphur.
2. allotropes of sulphur.
3. co-exist at a transition temperature.
4. have the same density.

48. Lime stone is added to a blast furnace for the extraction of iron from iron ore in order to:

1. lower the melting point of iron.
2. produce additional carbondioxide.
3. ensure that all the iron ore is used up.
4. remove silicondioxide impurities from the furnace.

49. Nitrogen forms three common oxides, dinitrogen oxide, nitrogen oxide and nitrogen dioxide.

1. their respective formula are N_2O , NO , and NO_2 .

2. they are all colourless, odourless and neutral gases with no poisonous effect.
 3. one of the oxides supports combustion.
 4. dinitrogen oxide reacts with air producing nitrogen dioxide.
50. Iron (III) oxide and tri-iron tetraoxide
1. both are reduced to metallic iron if heated in stream of hydrogen gas or carbonmonoxide
 2. tri-iron tetra oxide is magnetic while iron (III) oxide is non magnetic
 3. their respective formulae are Fe_2O_3 , and Fe_3O_4 .
 4. the oxide of iron (III) oxide appears in an impure state as haematite.

TEST NUMBER SIXTEEN:

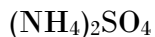
1. The mass of potassium hydroxide KOH contained in 250cm^3 of 0.1M of potassium hydroxide solution is [K = 39 , H = 1 , O = 16]
 - A. 0.56gm
 - B. 1.40gm
 - C. 2.80gm
 - D. 5.60.
2. 2.3KJ of heat energy are required to vaporise 13gm of a liquid of relative molecular mass 78 . The heat of vaporisation of the liquid in KJ mol^{-1} is
 - A. 78
 - B. 68.9
 - C. 31.8
 - D. 11.3
3. The mass of copper deposited when 240 coulombs of electricity is used in the electrolysis of copper (II) sulphate is
 - A. $\frac{240 \times 64}{2 \times 96,500} \text{ gm}$
 - B. $\frac{64 \times 96,500}{2 \times 240} \text{ gm}$
 - C. $\frac{64 \times 2 \times 240}{96,5000} \text{ gm}$
 - D. $\frac{2 \times 96,500}{64 \times 240} \text{ gm}$
4. An oxide of a metal M contains 78% of M and 22 % of oxygen , the simplest formula of the oxide is [M= 56 , O = 16]
 - A. MO
 - B. MO_2
 - C. M_2O_3
 - D. M_3O_4
5. Which of the following processes below involves a physical change ?
 - A. burning of magnesium
 - B. burning of wood

- C. rusting of iron
- D. melting of wax

6. The number of moles of sodium ions contained in 100cm^3 of a 2M solution of sodium carbonate is

- A. 0.2
- B. 0.4
- C. 2.0
- D. 4.0

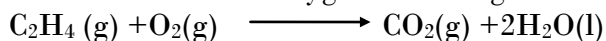
7. What is the % of nitrogen in ammonium sulphate



[N = 14, O = 16, S = 32, H = 1]

- A. $\frac{14 \times 100}{132}$
- B. $\frac{36 \times 100}{132}$
- C. $\frac{28 \times 100}{132}$
- D. $\frac{124 \times 100}{132}$

8. Ethene burns in oxygen according to the equation



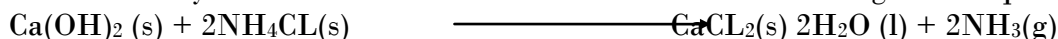
The volume of gases produced when 20cm^3 of ethene burns completely in oxygen. [all volumes at constant temperature and pressure] is

- B. 80cm^3
- C. 40cm^3
- D. 100cm^3

9. Which of the following combinations would produce carbon dioxide at the fastest rate?

- A. 100cm^3 of 2M HCL and marble chips heated at 30°C .
- B. 100cm^3 of 2M H_2SO_4 and marble chips at room temperature.
- C. 100cm^3 of 1M HCL and marble powder at 30°C
- D. 100cm^3 of 2M HCL marble powder at 30°C .

10. Calcium hydroxide reacts with ammonium chloride according to the equation



If 14.8gm of calcium hydroxide was reacted completely with ammonium chloride, what was the mass of ammonia evolved?

[Ca = 40, H = 1, O = 16, Cl = 35.5, N = 14]

- A. 1.7gm
- B. 3.4gm
- C. 6.8gm
- D. 9.0gm

11. Which one of the following substances would form a solution in water with pH less than 7?

- A. NH_4Cl
- B. NaCl
- C. Na_2CO_3
- D. CH_3COONa

12. The relative formula mass of $\text{Ca}(\text{NO}_3)_2$ is

- A. 204
- B. 150
- C. 164
- D. 98

13. Boyle's law of gases can be written mathematically as

- A. $\frac{V}{P} = \text{CONSTANT}$
- B. $P \propto \frac{1}{V}$
- C. $V \propto P$
- D. $V \propto T$

14. Arrange the following in order of increasing reactivity

- A. magnesium ,zinc, aluminium , iron , lead
- B. magnesium , aluminium , zinc iron , lead
- C. lead , iron , aluminium ,, zinc , manesium
- D. lead, iron , zinc , aluminium , magnesium

15. When zinc carbonate is heated

- A. zinc , oxygen and carbondioxide are formed
- B. it sublimes
- C. zinc oxides and carbondioxide are formed.
- D. zinc oxide carbondioxide and water are formed

16. The formula of the chloride of an element X is XCl_3 ,its oxide has a formula?

- A. XO
- B. XO_2
- C. X_2O_3
- D. X_2O

17. The atomic number of an element is

- A. the number of protons and electrons
- B. the number of neutrons
- C. the number of protons
- D. the number of protons and neutrons

18. Which of the following is not true about hydrogen ?

- A. it burns in air to form water
- B. it is a reducing agent
- C. pure hydrogen burns with a pop sound
- D. it forms a diatomic molecules .

19. A certain mass of gas occupies 14cm^3 at 18°C and 738mmHg pressure . its volume at stp is

- A. $\frac{738 \times 273}{18 \times 760}$
- B. $\frac{738 \times 18 \times 146}{273 \times 760}$
- C. $\frac{738 \times 146 \times 273}{291 \times 760}$

D. $\frac{291 \times 760}{738 \times 146 \times 237}$

20. Which of the following oxides is reduced by hydrogen ?

- A. MgO
- B. CaO
- C. ZnO
- D. PbO.

21. The mass of lead (II) iodide that will be formed when 16.60gm of potassium iodide is reacted with excess lead nitrate is

[Pb = 207 , I = 127 , K = 39 , N = 14 O = 16]

- A. 33.40
- B. 23.05
- C. 16.60
- D. 46.10

22. Oxygen is prepared in the laboratory by heating

- A. magnesium (IV) oxide and hydrochloric acid
- B. potassium chlorate and magnesium (IV) oxide
- C. potassium chlorate and hydrochloric acid
- D. hydrogen peroxide and magnesium (IV) oxide

23. The % of oxygen in baking powder

NaHCO_3 is [Na = 23, H = 1 , O = 16 C = 12]

- A. $\frac{16 \times 100}{102}$
- B. $\frac{48 \times 100}{102}$
- C. $\frac{16 \times 100}{84}$
- D. $\frac{48 \times 100}{84}$

24. Which of the following statements is true about diamond and graphite .

- A. carbon exhibits a covalency of four in graphite and two in diamond
- B. in carbon atoms in diamond are larger than those in graphite
- C. the electrons in the atoms in the two substances are arranged differently
- D. the carbon atoms in the two substances are arranged differently .

25. The number of nitrogen molecules in 21gm of nitrogen is

N = 14

- A. 0.33
- B. 0.75
- C. 0.50
- D. 3.00

26. When a solid was heated , it changed to gaseous state without passing through the liquid state .

Thus the transition is called ?

- A. vaporisation
- B. evaporation
- C. sublimation
- D. condensation .

27. The atomic number of a divalent non metal X is 16 which of the following is true about X.

- A. it belongs to period two of the periodic table
- B. It has a full outermost shell
- C. It has two electrons in the outermost shell
- D. It belongs to group six of the periodic table

207

28. The number of neutrons in the atoms Z is

82

- A. 207
- B. 82
- C. 125
- D. 189

29. The basicity of an acid is

- A. The tendency of acid to exhibit basic properties
- B. The number of hydrogen ions produced by one molecule of the acid.
- C. The amount of water required to dilute the acid
- D. An acid with pH greater than seven

30. Carbondioxide reacts with lime water forming

- A. carbonate
- B. Carbonic acid
- C. Carbon
- D. Carbondioxide

Each of the questions 31 to 40 consists of an assertion (statement) on the hand side and a reason on the right hand side select .

A. If both assertion and reason are true statement and the reason is a correct explanation of the assertion .

B. If both assertion and reason are true statements but the reason is not a correct explanation of the assertion .

C. If the assertion is true but the reason is an incorrect statement .

D. If the assertion is incorrect but the reason is a true statement .

	Assertion	Reason
A	True	
B	True	True (reasons not a correct explanation)
C	True	Incorrect
D	incorrect	True statement

Assertion

Reason

31. Carbohydrates are _____ because _____ carbohydrates react with sulphuric acid to form carbon hydrocarbons.

32. The pH of an aqueous _____ because ammonia reacts with water to form ammonium ammonia is less than _____ hydroxide seven. .

33. Sulphuric acid is not suitable because it absorbs the gas.
for preparation of carbondioxide
using marble chips.
34. Graphite conducts electricity because graphite is made up of a giant two dimensional
while diamond does not molecules while diamond has a giant three
dimensional structure.
35. When 30cm^3 of 2M HCL are because phenolphthalein is pink in basic media.
added to 30cm^3 of 2M NaOH and
phenolphthalein indicator added.
The indicator turns pink.
36. Carbon reacts with nitric acid because carbon is an oxidising agent
- 37 Elements of group one because their outermost shell electrons are
of the periodic table are strongly attracted by nucleus.
very electro positive
- 38 Ammonia gas can be dried with because concentrated acid reacts with ammonia gas.
concentrated sulphuric acid
39. Hard water forms a lather with because soap forms scum with hard water.
soap easily
40. Sulphurdioxide is an acid dehydride because it reacts with water to form an acidic
solution

In each of the questions 41-50 one or more of the answers given may be correct. Read each question carefully and then indicate on your sheet according to the following .

- A. if only 1,2 and 3 are correct
B. if only 1 and 3 are correct
C. if only 2 and 4 are correct
D. if only 4 is correct.

instructions summarised.

A	B	C	D
1,2 and 3 only	1 and 3	2 and 4	4only
.	only	only	

41. Which of the following can be dried using concentrated sulphuric acid?
1. Nitric oxide
 2. Hydrogen sulphide
 3. Ammonia
 4. Sulphurdioxide
42. Which of the following solutions contain the same number of sodium ions?
1. 1dm^3 of 1M Na_2SO_4
 2. 2dm^3 of 1M NaCl
 3. 1dm^3 of 2M NaCl
 4. 1dm^3 of 2M Na_2SO_4
43. Which of the following is/are true about a solution of sodium carbonate in water?
1. It produces carbondioxide when heated
 2. It reacts with acids with effervescence
 3. It can be used in purification of water
 4. It turns red litmus blue

44. Metals conduct electricity because they

1. Are malleable and ductile
2. Have high melting points
3. Gain electrons to form positively charged ions.
4. Possess loosely bound outermost electrons which can conduct electricity

45. Isotopes

1. Are atoms of the same element
2. Have different mass number
3. Have different number of neutrons
4. have different number of protons

46. Which of the following gasses will bleach moist litmus paper?

1. Oxygen
2. Chlorine
3. Carbondioxide
4. Sulphurdioxide

47. Which of the following when in aqueous solution can be reduced by aluminum metal?

1. Iron(II) ions
2. Calcium ions
3. Copper(II) ions
4. Magnesium ions

48. The carbon atoms in graphite

1. Form a layer structure
2. Are held together by double bonds
3. Are linked through single covalent bonds
4. Form a three dimensional network

49. Which of the following are mixtures?

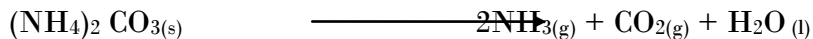
1. Diamond
2. Brass
3. Aluminium
4. Steel

50. Haematite ore contains

1. Zinc
2. Copper
3. Aluminium
4. Iron .

TEST NUMBER SEVENTEEN :

1. Ammonium carbonate when heated in air decomposes according to the following equation .



What volume of carbon is produced at STP. when 0.5 mole of the carbonate is heated?

N = 14, H = 1 O = 16, C = 12 molar volume at S.T.P is 22.4dm³.

A. 112. dm³

B. 44 dm³

C. 22.4 dm³

D. 11.2 dm³

2. The percentage of iron in iron (III) oxide: Fe₂O₃ is:

A. $\frac{56 \times 100}{160}$

B. $\frac{160 \times 100}{112}$

C. $\frac{56 \times 100}{160 \times 2}$

D. $\frac{112 \times 100}{160}$

3. During the manufacture of nitric acid from ammonia:

A. a great deal of heat is observed.

B. ammonia is oxidised to nitrogen dioxide.

C. nitrogen monoxide is observed in concentrated nitric acid.

D. a mixture of air and ammonia is passed through platinum gauze.

4. Which of the nitrates given does not give off oxygen when heated?

A. zinc nitrate

B. sodium nitrate

C. ammonium nitrate

D. calcium nitrate

5. If the formula of the chloride of element x is XCl₃ its corresponding sulphide is:

A. XS

B. X₂S

C. XS₂

D. X₂S₃.

6. 8gm of metal Q completely reacts with 1gm of oxygen to form an oxide of Q. This shows that Q reacts with oxygen in the ratio; [Q=64]

A. 2:1

B. 1:2

C. 1:1

D. 2:3

7. Which of the following contains the highest number of moles of atoms?

[H = 1, O = 16, N = 14, S = 32]

A. 16gm of oxygen

B. 28gm of nitrogen

C. 32gm of sulphur

D. 1gm of hydrogen

8. Ammonia is oxidised by copper(II) oxide according to the following equation: $2NH_3(g) + 3CuO(s) \longrightarrow 3Cu(s) + 3H_2O(l) + N_2(g)$

What volume of ammonia gas will be oxidised by 6.0gm of copper(II) oxide at S.T.P?.

[N=14, O =16, H = 1, Cu =64 molar volume is 22.4dm³ at S.T.P]

- A. 2240cm³
- B. 560cm³
- C. 1120cm³
- D. 120cm³

9. The table below shows the distribution of nuclear particles and electrons in atoms A, B, C and D.

Atom	number of protons	number of neutrons	number of electrons
A	1	0	1
B	17	37	17
C	13	13	13
D	17	38	17

Which atoms are isotopes of the element?

- A. Band D
- B. D and C
- C. A and D
- D. A and B

10. Atomic number of element Z is 7. The electronic structure of the ion is:

- A. 2, 7
- B. 2, 8
- C. 2, 8, 1
- D. 2, 9.

11. The percentage composition of A is 75% carbon and 25% hydrogen.

What is the empirical formula of A?

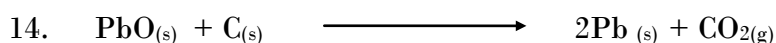
- A. CH₂
- B. CH₄
- C. C₂H₈
- D. C₆H₄

12. Element K lies in group V and element L in group II. The formula of the compound between K and L will be:

- A. L₂K₃
- B. L₃K₂
- C. LK
- D. LK₃

13. A compound of nitrogen and oxygen contains 30.5% nitrogen. Its vapor density is 46. The empirical and molecular formula of the compound respectively are:

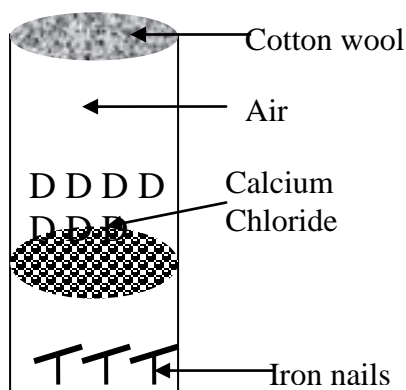
- A. NO and NO₂
- B. NO₂ and N₂O₄
- C. N₂O and N₄O₂
- D. NO₂ and N₂O



In this reaction carbon behaves as

- A. areducing agent
 - B. oxidising agent
 - C. dehydrating agent
 - D. hydrolysing agent
15. The exothermic reaction.
- A. heat energy is absorbed by reacting substances
 - B. no observable change is made.
 - C. a colourless gas is usually given off.
 - D. heat energy is evolved.
16. The chemical name for soap is:
- A.. calcium hydroxide.
 - B. glycerine
 - C. lead
 - D. sodium stearate
17. When calcium hydrogen carbonate is strongly heated, the clear solution turns cloudy. This is due to:
- A. formation of insoluble calcium hydroxide
 - B. formation of insoluble calcium carbonate
 - C. calcium hydrogen carbonate which is insoluble
 - D. calcium hydroxide reacts with carbonate ions.
18. Which of the following is true about nitrogen dioxide gas?
- A. it is a colourless gas
 - B. it is neutral to litmus
 - C. it re-lights a glowing splint
 - D. it is very soluble in water
19. Molar volume of a gas refers to:
- A. volume occupied by one molecule of gas at STP
 - B. volume occupied by one mole of a gas at STP
 - C. volume occupied by any gas at STP
 - D. volume of all gasses at STP
20. Which of the following elements exhibits allotropy?
- A. carbon.
 - B. Neon.
 - C. Magnesium.
 - D. Zinc.
21. A gaseous hydrocarbon X contains 20% hydrogen by mass. 7.5gm f X occupied 5.6dm³ at STP
- [C =12, H=1] The empirical and molecular formula of X respectively are:
- A. CH₂ and C₂H₄
 - B. CH₃ and C₂H₆
 - C. CH₄ and C₂H₈
 - D. CH₃ and C₂ H₈
22. A polymer
- A. is formed from repetitive units to give a large giant molecule with boiling point.
 - B. contains repetitive units to give a large molecule with long chains and high boiling point.
 - C. a large molecule from two molecules.
 - D. a large molecule with similar single molecules and forms a solid mass.

23. In the manufacture of soap, saturated solution of sodium chloride is added. This is to:
- make soap float on top of solution.
 - make soap sink to the bottom of solution.
 - make soap boil faster.
 - catalyze the reaction.
24. Which of the compounds below is prepared by synthesis
- lead (II) iodide
 - Copper (II) oxide
 - sulphur dioxide
 - sulphur trioxide
25. Which of the following best describes a solute ?
- sodium chloride
 - uniform mixture
 - dissolve substance
 - aqueous solution
26. Air is a mixture because:
- nitrogen and oxygen form the basic composition
 - nitrogen comprises 78% of air
 - proportions of nitrogen and air are not definite.
 - when air is formed heat is generated.
- 27.



Which of the following is true about the above experiment.

- iron nails will rust.
 - iron nails will not rust in air free water.
 - calcium chloride stops rusting of iron.
 - iron nails will not rust in dry air.
28. Which of the following substances is deliquescent?
- copper (II) sulphate
 - sodium carbonate
 - iron (III) chloride
 - calcium oxide
29. $\text{H}_2 + \text{Cl}_2 \longrightarrow 2\text{HCl}$
- Which of the following is true in the above reaction?
- the product is green-yellow in colour.
 - the reaction takes place only in sun light.
 - the reaction requires iron as a catalyst.
 - the product burns in air with a blue flame.
30. Atomic masses of various elements are usually not integers (whole numbers) because:

- A. atoms of different elements are not the same.
- B. atoms of the same element differ in masses.
- C. isotopes exists in elements and have different percentage compositions.
- D. atoms of different elements have different number of electrons.

31. Atom Z is represented as $^{24}_{12}\text{Z}$

Which of the following is true about Z:

- A. it lies in period 3 and group II in the periodic table.
 - B. it lies in period 2 and group III in the periodic table.
 - C. Z forms ions of the type Z^{3+} .
 - D. Z reacts vigorously with water.
32. When sodium peroxide reacts with water:
- A. an alkaline solution is formed and hydrogen gas is evolved.
 - B. an acidic solution is formed and oxygen gas is evolved.
 - C. an alkaline solution is formed and oxygen gas is evolved.
 - D. an acidic solution is formed and hydrogen gas is evolved.

33. Phosphoric acid ionises in aqueous solution as follows:



The acid is said to be:

- A. monobasic
 - B. dibasic
 - C. tribasic
 - D. polybasic.
34. The term effervescence in a chemical reaction means.
- A. a solid is formed from soluble salts.
 - B. a gas is evolved from reaction mixture.
 - C. a precipitate has been formed.
 - D. a vigorous reaction which evolves a gas from liquids / aqueous mixture.

35. 20cm^3 of 0.1M of sodium hydroxide reacted completely with 25cm^3 of Phosphoric acid H_3PO_4 . The molarity of the acid is:

- A. $\frac{0.1 \times 20}{3 \times 25}$
- B. $\frac{0.1 \times 25}{3 \times 20}$
- C. $\frac{0.1 \times 20 \times 3}{25}$
- D. $\frac{0.1 \times 25 \times 3}{20}$

36. A known volume of silicon hydride diffuses in 27.8 seconds. The same volume of oxygen diffuses through the same opening in 20 seconds. The relative molecular mass of silicon hydride is:

- A. 17
- B. 62
- C. 44.48
- D. 23

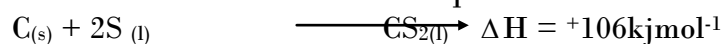
37. The compound of nitrogen and oxygen contains 74.1% oxygen. Its vapour density is 54. The molecular formula of the compound is:

- A. N_2O
- B. NO_2
- C. N_2O_5
- D. N_2O_4

38. When sodium methanoate, HCOONa reacts with concentrated sulphuric acid; which of the following gases is produced?

- A. CO_2
- B. CO
- C. HCOOH
- D. CH_4

39. In the thermo chemical equation



Which of the following is true?

- A. 1 mole of CS_2 is formed by absorbing 106KJ of heat energy by the surroundings.
 - B. when carbon reacts with sulphur the reaction takes place when heat is supplied to the mixture.
 - C. the reaction is exothermic.
 - D. the reaction is photochemical
40. Respiration differs from burning in that:
- A. respiration process takes place slowly.
 - B. burning involves combination with oxygen.
 - C. respiration is a physical process.
 - D. respiration takes place at low temperature.

In each of the questions 41-46 one or more of the answers given may be correct. Read each question carefully and then indicate on your answer sheet according to the following.

- A. if only 1, 2 and 3 are correct
- B. if only 1 and 3 are correct
- C. if only 2 and 4 are correct
- A. if only 4 is correct.

Instructions Summarized.

A	B	C	D
1, 2 and 3 only .	1 and 3 only	2 and 4 only	4 only

41. The following best describes amphoteric compounds

- 1. it is an alkaline
- 2. it has both acid and basic properties
- 3. it is an acid
- 4. it is neither a base nor an acid.

42. The following are properties of carbon monoxide.

- 1. it is less dense than air.
- 2. it is acidic to litmus.
- 3. it is highly poisonous.
- 4. it turns lime water milky.

43. Which of the following forms a similar pair?

- 1. iron, oxygen.
- 2. chlorine, bromine.
- 3. argon, lithium.
- 4. lithium, sodium.

44. When lithium loses one electron, the particle formed:
1. is an inert gas.
 2. allotrope of lithium.
 3. carries a single negative charge.
 4. carries a single positive charge.
45. Which of the following gases re-lights a glowing splint?
1. nitrogen
 2. oxygen
 3. nitric oxide
 4. dinitrogen oxide
46. Which of the following is true?
1. carbondioxide gas is responsible for hardness of water.
 2. hydrogen gas reduces the oxide of zinc.
 3. hydrogen peroxide decomposes to give oxygen gas.
 4. diamond is metal.

Each of the questions 47 to 50 consists of an assertion (statement) on the left hand side and a reason on the right hand side select.

- A. if both assertion and reason are true statement and the reason is a correct explanation of the assertion.
- B. if both assertion and reason are true statements but the reason is not a correct explanation of the assertion.
- C. if the assertion is true but the reason is an incorrect statement.
- D. if the assertion is incorrect but the reason is a true statement.
- E.

	Assertion	Reason
A	True	True (reason is a correct explanation)
B	True	True (reason is not a correct explanation)
C	True	Incorrect
D	Incorrect	True statement

Assertion

Reason

47. Solid lead (II) bromide conducts electricity. *because* The ions of solid lead (II) bromide are not free to move.
48. Diamond and graphite are crystalline forms of carbon. *because* One gm of each gives the same amount of carbon dioxide when burn in excess oxygen.
49. Crystals of silver can be obtained by adding zinc to silver nitrate solution. *because* Silver is above zinc in the displacement (activity) series.
50. Elements of group 1 react easily with water. *because* They are all metal.

TEST NUMBER ONE :

- | | | | |
|-----|------|------|------|
| 1.C | 11.A | 21.D | 31.B |
| 2.B | 12.C | 22.C | 32.C |
| 3.C | 13.B | 23.A | 33.A |
| 4.C | 14.D | 24.B | 34.B |

4.A	14.D	24.D	34.B	44.D
5.D	15.C	25.B	35.D	45.A
6.B	16.C	26.C	36.C	46.C
7.C	17.C	27.D	37.C	47.B
8.B	18.A	28.C	38.D	48.B
9.D	19. C	29.B	39.D	49.C
10.C	20.D	30.A	40.A	50.D

TEST NUMBER SIXTEEN:

1.B	11.D	21.B	31.D	41.D
2.C	12.C	22.B	32.D	42.A
3.A	13.C	23.D	33.C	43.C
4.A	14.D	24.D	34.B	44.D
5.D	15.C	25.B	35.C	45.A
6.B	16.C	26.C	36.C	46.C
7.C	17.C	27.D	37.C	47.B
8.B	18.A	28.C	38.D	48.B
9.D	19.C	29.B	39.D	49.C
10.C	20.D	30.A	40.A	50.D

TEST NUMBER SEVENTEEN:

1.D	11.B	21.B	31.A	41.A
2.D	12.B	22.B	32.C	42.B
3.D	13.B	23.A	33.C	43.C
4.C	14.A	24.C	34.D	44.D
5.D	15.D	25.C	35.A	45.C
6.A	16.D	26.C	36.B	46.B
7.B	17.B	27.D	37.C	47.D
8.C	18.D	28.C	38.B	48.B
9.A	19.B	29.B	39.B	49.C
10.B	20.A	30.C	40.A	50.B

VOLUMETRIC ANALYSIS :

Volumetric analysis deals with the determination of amount of a substance in sample of solid or solution. This amount may be in terms of moles, mass or volume.

Two aqueous solutions are used, one of which must be standard, i.e is of known concentration.

The second may or may not be standard. The concentration of a solution is measured in moles per litre, or in grammes per litre of solution.

Volumetric analysis requires speed and accuracy, in both manipulation recording.

Recording of the titration results :

Volume of pipette used :

Sometimes candidates lose marks for omitting to record the volume of the pipette used. Pipettes are different capacities (volumes) and so it is necessary to indicate the volume used. This is always indicated on the pipette.

Volume of initial and final burette readings:

Should be recorded to two places of decimal, to the nearest 0.05 .Candidates lose marks by omitting decimal points or writing to one place of decimal only . The second decimal place should be 0. If the bottom of the meniscus sits on a line, or ' 5 ' if the meniscus is between two lines.

Volume used in titration:

The difference between the final and initial burette readings gives the volume required with the pipetted volume. It should be recorded to two places of decimal also. This volume is sometimes called a **titre**, while that measured by the pipette is called **aliquot**.

Titre to be averaged:

These are any accurate titers which must exclude the first (or trial) titre and any titre that differs from others by more than 0.1cm^3 .

Getting accurate results:

Precautions taken :

(1) Fill the burette to a level above the zero mark, then open the tap or clip to ensure filling of the jet so that no air bubble is left. The level of the solution need not to be at the zero mark, but must not be above it.

Note that the burette should be filled with the relevant solution after washing it with water then rinse twice with about 10cm^3 of the relevant solution to ensure that the inner walls are completely wetted with that solution.

2. The correct reading position of the pipette is that one where the bottom of the meniscus horizontally level to the eye. Do not take burette readings (or pipette readings) from below or above the eye level as this increases or lowers the actual reading respectively. The burette reading should be to two places of decimal, to the nearest 0.05.

3. Titration must stop immediately the indicator color changes. This indicates the end - point or quantity required to react completely with the aliquot.

The common indicators used in acid - base titration are methyl orange and phenolphthalein.

Methyl orange is red in acid medium but yellow in alkali medium. It is orange in neutral medium and this should be the change at end point. When this orange color is obtained, no more addition should be done as this would give more titre than required.

Phenolphthalein is colorless in neutral or acid medium, but pink alkali medium. The end point is reached when the indicator color just change from pink to colorless or from colorless to pale pink. The pale (faint) pink color should persist for at least five seconds. Never go further than this to obtain the shouting pink color.

How to acquire speed and accuracy in titration:

(i) Suck into the pipette one of the solutions as required just above the mark, then carefully allow some solution to drop out slowly till the meniscus just sits on the mark. It is then allowed to run freely into a clean conical flask. The solution should not be forced out by blowing, as this adds in CO_2 .

(ii) Add 2 -3 drops of appropriate indicator .

(iii) Fill the burette to appropriate reading (as described earlier) then fully open the tap to allow continuous flow of the solution as you shake the flask. Stop the addition immediately the indicator color changes as described above. Record both the final and titre obtained. (the initial reading must be recorded before titrating).

(iv). Wash the flask with water, and then pipette into it the appropriate solution once again.

Add the indicator then titrate once again very fast till 1cm^3 less than the previous titre , i.e. if the first titre was 15cm^3 , the second quick addition should be 14cm^3 . At this stage, add the solution drop wise (drop by drop) till the indicator just changes color, record the final reading and titre .

(v). Wash the flask once again , add the required aliquot followed by the drop of indicator and a quick titration once again till $0.\text{cm}^3$ than the previous titre , e.g. if the previous titre is 14.05 , add up 13. 85 then add drop till the indicator color just changes within five drops.

The last two titres should agree within 0.10cm^3 , if not a four titration should be carried out.

Note that no burette refilling is required unless the remaining burette solution is less than that required, in which case more solution is added to appropriate level before commencing the next titration.

Example of titrating the result:

Titration number	Trial	First	Second
Final reading	0.58	37.60	46.70
Initial reading	4.00	0.85	30.00
Titre obtained	16.8 5	16.85	16.70

Note that

(i) The initial reading need not start from zero, nor always end in point zero - zero (oo).

(ii) When enough solution is available in the burette , no refilling is required as this only wastes time (see readings for the trial and first titrations) , but if the volume left in the burette is not enough , more has to be added to the burette , a little more than the rough (trial) titre obtained . Again this sane time spent on adding to the burette which could be saved for the titration it's self.

Calculation abilities expected in exams:

The volumetric analysis examination demands varied mathematical abilities, which includes the determination of

(a) Relative atomic mass. R.A.M

(b) Relative formula mass. R.F.M

- (c) Concentration of a solution in
 - (i) Moles per litre (molarity) M.
 - (ii) Grammes per litre g^{-1} .
- (d) Moles of water of hydration (crystallization)
- (e) Stoichiometry of a reaction and formulae .
- (f) Basicity of an acid, and volume
- (g) Reacting volumes of solution
- (h) Relative - atomic mass (R.A.M) and gram formula (molecules) mass RFM.

Examples:

In calculation involving the above quantities, a balanced equation or ratio is reactant must be known in some of them.

Solution:

Determination of:

1. Relative and gram atomic mass
2. Relative and gram formula mass
3. Concentration of a solution.

Note:

1. The concentration of a solution in a measure of the quantity of a solute in a given volume. This quantity may be in moles or grams.
2. The molarity of a solution is the number of moles of a solute presenting one litre (or dm^3 or 100cm^3) of a solution. If the concentration of the solution is not per litre, it should be converted to concentration per litre before the molarity can be obtained.

$$\text{Molarity} = \text{moles per litre} \cdot \frac{\text{Concentration in } \text{g}^{-1}}{\text{mass of one mole of solution}}$$

(Expressed in grams).

3. Gram formula of a substance is the mass in grams of one mole of the substance, it may be abbreviated to R.F.M if the formular mass of the substance is not expressed in grams, it becomes relative formula mass. R.F.M.

Example 1:

20cm^3 of nitric acid solution containing 6.30g l^{-1} of solution required 25cm^3 of a normal carbonate N_2CO_3 , solution containing 5.5 of

Solution: For neutralization, calculate the relative

(i) Formula mass of the carbonate, N_2CO_3

(ii) Atomic mass of metal m.

(H = 1 N = 14, O = 16, C = 12)

The equation for the reaction is



Ratio = 1 mole to 2 moles.

Solution :

Step (1): Mass of one 1 mole of nitric acid

$$= (14 + 1 + 48)$$

$$= 63 \text{ g mol}^{-1}.$$

Step (2). Molarity of the acid

$$\frac{6.3 \text{ g}^{-1}}{63 \text{ g mol}^{-1}} = 0.1 \text{ mol}^{-1}$$

Step (3). Moles of acid in 20cm^3 of acid.

$$\frac{0.1 \text{ mol}}{1000 \text{ cm}^3} \times 20 \text{ cm}^3 = 0.002 \text{ mols}$$

$$\text{Step (4) moles of Na}_2\text{CO}_3 \text{ in } 25\text{cm}^3 = \frac{1}{2} \text{ moles of acid } 20\text{cm}^3 \text{ of acid.}$$

$$\frac{1}{2} \times 0.002 \text{ moles} = 0.001 \text{ mol}$$

$$\begin{aligned} \text{Step (5). Molarity of Na}_2\text{CO}_3 &= \frac{0.001 \text{ moles} \times 1000 \text{cm}^3}{25} \\ &= 0.04 \text{ moles per litre.} \end{aligned}$$

$$\text{Step (vi) Molarity of Na}_2\text{CO}_3 = \frac{\text{Conc in g l}^{-1}}{\text{R.F.M}} = \frac{5.52 \text{ g l}^{-1}}{\text{R.F.M}}$$

$$\therefore 0.04 \text{ mol l}^{-1} = \frac{5.52 \text{ g l}^{-1}}{\text{R.F.M}}$$

$$\therefore \text{RFM} = \frac{5.52 \text{ g l}^{-1}}{0.04 \text{ mol l}^{-1}}$$

$$\begin{aligned} \text{Relative formula mass of Na}_2\text{CO}_3 &= 138 \text{ g l}^{-1} \\ \text{Relative formula, mass of Na}_2\text{CO}_3 &= \underline{\underline{138}} \end{aligned}$$

(ii) Let the relative atomic mass of M = 39.

$$2 + 12 + 48 = 138$$

$$2x + 60 = 138$$

$$2x = 138 - 60$$

$$= 78$$

$$x = \frac{78}{2} = 39$$

Relative atomic mass = 39.

Example 2.

32.5 cm³ of a solution containing 6.10 g l⁻¹ of an acid HXO₃ required 25 cm³ of a solution containing 5.00 g l⁻¹ of sodium hydroxide solution, calculate the

(i) the molarity of the acid.

(ii) relative atomic mass of element x in the acid HXO₃.

(H = 1 O = 16 Na = 23)

Equation: HXO₃ (aq) NaOH (aq) → NaXO₃ (aq) + H₂O (l)

Ratio: 1 mole: 1 mole.

Solution:

$$\begin{aligned} \text{Step 1. R.F.M of NaOH} &= (23 + 16 + 16) \\ &= 40 \text{ g l}^{-1}. \end{aligned}$$

$$\begin{aligned} \text{Step 2. . Molarity of the alkali} &= \frac{5.00 \text{ g l}^{-1}}{40 \text{ g l}^{-1}} \\ &= 0.125 \text{ M.} \end{aligned}$$

$$\text{Step 3. Moles of alkali in } 25\text{cm}^3 = \frac{0.125 \text{ moles} \times 25\text{cm}^3}{1000\text{cm}^3}$$

$$= 0.003 \text{ moles.}$$

$$\text{Step 4. Moles of acid in } 32.5\text{cm}^3 = \text{moles of alkali} = 0.003 \text{ moles}$$

$$\text{Step 5. Molarity of acid} = \frac{0.003 \text{ moles}}{32.5} \times 1000\text{cm}^3$$

$$\begin{aligned}
 &= \underline{\underline{0.092 \text{ M.}}} \\
 \text{Since molarity} &= \frac{\text{concg l}^{-1}}{\text{R FM}} \\
 \therefore 0.092 \text{ moles per litre} &= \frac{6.10 \text{ g l}^{-1}}{\text{R.FM}} \\
 &= \frac{6.10 \text{ g l}^{-1}}{0.092 \text{ mols}^{-1}} \\
 &= 66.3 \text{ g mol}^{-1} \\
 \text{Relative formula mass of HXO}_3 &= 66.3 \\
 \text{But RFM of HXO}_3 = 1 + x + 48 &= x + 49 \\
 [\text{assuming that the relative atomic mass of X} = x] \\
 x + 49 &= 66.3 \\
 x &= 66.3 - 49 \\
 &= \underline{\underline{17.3}}
 \end{aligned}$$

Relative atomic mass of x = 17.3 .

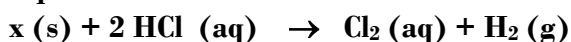
Note : If a calculator had been used [not a three figure mathematical table] the moles of alkali in step 3 would have been 0.003125 and the molarity of the solution would have been consequently 0.096 M.

This would lead to the relative atomic mass of x being 14.5.

Example 3 .

1.44 g of metal x is found to react completely with exactly 50cm³ of 2.4 M hydrochloric acid. Calculate the relative atomic mass of metal x.

Equation for the reaction:



Mole ratio: 1 mole: 2 moles

Solution :

Step 1: Moles of acid used

$$\frac{2.4 \text{ moles}}{1000} \times 50 \text{ cm}^3 = 0.12 \text{ moles.}$$

Step 2. Moles of metal reacting:

$$\frac{1}{2} \times 0.12 \text{ moles} = 0.006 \text{ moles.}$$

(Moles of metal = Half moles of acid as given by the equation)

$$3 \text{ moles of metal atoms : } \frac{\text{mass of metal}}{\text{R.F.M}}$$

$$0.06 \text{ MOLES} = \frac{1.44 \text{ g}}{\text{R.F.M}}$$

$$\text{R.F.M} = \frac{1.44 \text{ g}}{0.06 \text{ moles}}$$

$$= \underline{\underline{24 \text{ g mol}^{-1}}}$$

Relative atomic mass of X = 24.

Note that relative atomic mass is the same as gramme atomic mass with no units. Gramm atomic mass is the mass in grams of one mole of atom whereas relative atomic mass is the mass of one atom of an element compared to the mass of $\frac{1}{12}$ the mass of one atom of carbon -12.

Example 4 :

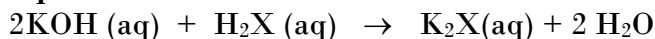
20 cm³ of 0.012M of potassium hydroxide required 24 cm³ of a solution containing a dibasic acid of an acid H₂X, containing 1.58g per 250cm³ of solution.

Calculate

(i) the molarity of the acid .

(ii) relative formula mass of the acid.

Equation.



Ratio:

2moles: 1 mole.

Solution :

Step 1: Moles of alkali in 20 cm³

$$\begin{aligned} &= \frac{0.12\text{moles}}{1000\text{cm}^3} \times 20\text{cm}^3 \\ &= 2.4 \times 10^{-3} \text{ mols} \end{aligned}$$

Step 2:

Moles of acid is 24 cm³

$$\begin{aligned} &= \frac{1}{2} \times \text{moles of alkali (ratio)} \\ &= \frac{1}{2} \times 2.4 \times 10^{-3} \text{ moles} = 1.2 \times 10^{-3} \text{ mols.} \end{aligned}$$

Step 3:

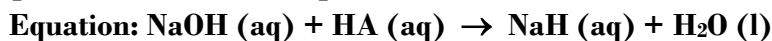
$$\begin{aligned} \text{Molarity of acid} &= \frac{1.2 \times 10^{-3} \text{ mols}}{24\text{cm}^3} \times 1000\text{cm} \\ &= 0.05 \text{ mols l}^{-1} \\ &= 0.05\text{M.} \end{aligned}$$

$$\begin{aligned} \text{(ii)} \quad \text{Molarity} &= \frac{\text{conc in gl}^{-1}}{\text{R.F.M}} \\ \text{But conc in gl}^{-1} &= \frac{1.58\text{gm}}{250\text{cm}^3} \times 1000\text{cm}^3 \\ &= 6.32 \text{ gl}^{-1} \\ 0.05\text{M} &= \frac{6.32\text{gl}^{-1}}{\text{R.F.M}} \\ \therefore \text{R.F.M} &= \frac{6.32\text{gl}^{-1}}{0.05\text{moles l}^{-1}} = 126.4\text{gmol}^{-1} \\ \text{Relative formula mass} &= \mathbf{126.4.} \end{aligned}$$

Example five:

25cm³ of a solution containing 12.0g of sodium hydroxide per litre required 15cm³ of a solution containing 18.25gl⁻¹ of acid. HA. Calculate the gram - formula mass of the acid, HA.

[H = 1 O = 16, Na = 23]



Ratio : 1 mole: 2 moles.

Solution:

Step 1.

Mass of one mole (R.F.M)of NaOH

$$= [23 + 16 + 1] \text{ g} = 40 \text{ g}$$

Step 2. No of moles of the alkali per litre (molarity of alkali)

$$\begin{aligned} &= \frac{12\text{gl}^{-1}}{40\text{gmol}^{-1}} = 0.3\text{mol}^{-1} \\ &= 0.3\text{mol}^{-1} \end{aligned}$$

$$= \quad \underline{\underline{0.3 \text{ M.}}}$$

Step 3: No of moles of alkali in 25cm³.

$$\frac{0.3\text{mols}}{1000\text{cm}^3} \times 25\text{cm}^3 = 7.5 \times 10^{-3} \text{ mols}$$

No of moles of alkali in 15cm³

No of moles of alkali 25cm³ (ratio)

7.5 x 10⁻³ moles

No of moles of acid in 1000cm³.

$$\begin{aligned} \text{(i.e. Molarity of acid)} &= \frac{7.5 \times 10^{-3} \text{ mols} \times 10^3 \text{ cm}^3}{15\text{cm}^3} \\ &= 0.5 \text{ mols per litre:} \end{aligned}$$

$$\text{Since molarity} = \frac{\text{concg l}^{-1}}{\text{R.F.M}}$$

$$\begin{aligned} 0.5\text{mols l}^{-1} &= \frac{18.25\text{gl}^{-1}}{\text{R.F.M}} \\ &= \frac{18.25\text{gl}^{-1}}{0.5\text{mol l}^{-1}} \\ &= \underline{\underline{36.5\text{gmol}^{-1}}} \end{aligned}$$

Example 6:

20cm³ of a solution containing sodium hydroxide carbonate required 19cm³ of a solution containing 7.84g of sulphuric acid per litre. Calculate the number of grammes of sodium hydrogen carbonate per litre of solution.

(H = 1, C = 12, O = 16, Na = 23, S = 32)

Equation: $2\text{NaHCO}_3 (\text{aq}) + \text{H}_2 \text{SO}_4 (\text{aq}) \rightarrow \text{Na}_2\text{SO}_4 (\text{aq}) + 2 \text{CO}_2 (\text{g}) + 2\text{H}_2\text{O} (\text{l})$

Ratio: 2 moles: 1 mole.

$$\begin{aligned} \text{Solution: Step 1. Mass of one mole (R.F.M) of H}_2 \text{SO}_4 &= \frac{7.84\text{gl}^{-1}}{98\text{mol}^{-1}} \\ &= 0.08 \text{ mols per litre} \\ &= 0.08 \text{ M.} \end{aligned}$$

Step 3:

$$\begin{aligned} \text{Moles of H}_2 \text{SO}_4 \text{ in } 19\text{cm}^3. &= \frac{0.08\text{moles}}{1000\text{cm}^3} \times 19\text{cm}^3 \\ &= \underline{\underline{1.52 \times 10^{-3}}} \end{aligned}$$

$$\text{STEP 4 : Moles of alkali} = 2 \times \text{moles of acid (ratio)}$$

Moles of alkali in 20cm³.

STEP 5 : Moles of the alkali in 1000cm³.

(i.e. Molarity of alkali)

$$\begin{aligned} &= \frac{2 \times 1.52 \times 10^{-3} \times 1000}{20\text{cm}^3} \\ &= \underline{\underline{0.152 \text{ moles l}^{-1}}}. \end{aligned}$$

STEP6: Mass of one mole (R.F.M)of NaHCO₃.

$$\begin{aligned} &= (23 + 1 + 12 + 48) \text{ g} \\ &= 84\text{gmol}^{-1}. \end{aligned}$$

STEP 7: mass of 0.152 moles per litre (no of grams in 0.152 moles)

$$\begin{aligned} \text{NaHCO}_3 &= 84 \text{ g mol}^{-1} \times 0.152 \text{ mols l}^{-1} \\ &= \underline{\underline{12.77\text{g l}^{-1}}}. \end{aligned}$$

Example seven .

25cm³ of sodium carbonate required 27.25cm³ of a solution containing 4.00g of hydrochloric acid per litre. Calculate the

(i) Molarity of the base

(ii) Concentration of sodium carbonate per litre of solution.

[H = 1 Na = 23, C = 12, O = 16, Cl.35.5)

Equation:



Ratio:

2 moles: 1 mole.

Solution :

STEP 1: Mass of 1 mole (R.F.M) of HCl.

$$(1 + 35.5)\text{g} = 36.5\text{g}.$$

$$\text{Molarity (moles per litre) of HCl.} = \frac{4.00\text{g l}^{-1}}{1000\text{cm}^3} = 0.11\text{M}$$

STEP 3 : Moles of HCl in 27. 25cm³.

$$= \frac{0.11\text{moles}}{1000\text{cm}^3} = 27.25\text{cm}^3$$

$$= 3.00 \times 10^{-3} \text{ moles.}$$

$$\text{Moles of Na}_2\text{HCO}_3 \text{ in } 25\text{cm}^3 = \frac{1}{2} \text{ moles}$$

$$\text{Hcl in } 27.5\text{cm}^3 = \frac{1}{2} \times 3 \times 10^{-3} \text{ mols.}$$

$$= \underline{\underline{1.5 \times 10^{-3} \text{ mols.}}}$$

Moles of Na₂HCO₃ in 1000cm³.

$$\text{Molarity Na}_2\text{HCO}_3 \text{ of} = \frac{1.5 \times 10^{-3} \text{ mols} \times 10^3 \text{ cm}^3}{25\text{cm}^3}$$

$$= 6.0 \times 10^{-2} \text{ M.}$$

Molarity of the base = 0.06M.

$$\text{Mass of 1 mole (R.F.M) of Na}_2\text{HCO}_3 = (46 + 12 + 48) \text{ g}$$

$$= 6.06\text{g.}$$

$$\text{Mass of 0.06 moles of Na}_2\text{HCO}_3 = 106 \text{ g} \times 0.06$$

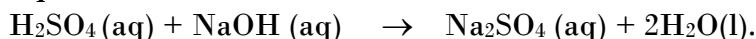
$$= \underline{\underline{6.36 \text{ g.}}}$$

$$\text{Concentration of in g l}^{-1} = 6.36\text{g l}^{-1}.$$

Example eight :

16.0 cm³ of 0.2M sodium hydroxide solution required 20cm³ of sulphuric acid for neutralization. Calculate the concentration of the acid in g dm⁻³. (H = 1, O = 16, S = 32).

Equation :



Ratio:

1 mole: 2 moles.

Solution:

Step1: Moles of NaOH in 16.0cm³.

$$= \frac{0.2\text{moles}}{1000\text{cm}^3} \times 16\text{cm}^3 = 3.2 \times 10^{-3} \text{ mols}$$

$$\text{Step2: Moles of H}_2\text{SO}_4 \text{ in } 20\text{cm}^3 = \frac{1}{2} \text{ moles of NaOH in } 16.0 \text{ cm}^3 \text{ (ratio)}$$

$$= \frac{1}{2} \times 3.2 \times 10^{-3} \text{ mols}$$

$$= 1.6 \times 10^{-3}.$$

Step 3: Moles of H_2SO_4 in 1000cm^3

$$\begin{aligned}\text{Molarity.} &= \frac{1.6 \times 10^{-3} \text{ mols}}{20\text{cm}^3} \times 1000\text{cm}^3 \\ &= 0.08\text{M} \\ &= 0.08\text{mol dm}^{-3}.\end{aligned}$$

Step 4: Mass of 1 mole of H_2SO_4

$$= (2 + 32 + 64) \text{ g} = 98\text{g}.$$

Step 5: concentration (mass of 0.08 mols dm^3)
of the acid in g dm^3

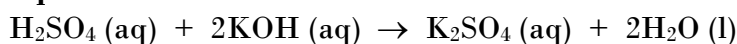
$$\begin{aligned}&= 98 \text{ g mol}^{-1} \times 0.08\text{mols dm}^3 \\ &= \underline{\underline{7.84\text{g dm}^3}}\end{aligned}$$

Example nine.

25cm^3 of 0.1M sulphuric acid neutralized 24.5cm^3 of potassium hydroxide solution. What was the concentration of the base in terms of molar concentration?

($\text{H} = 1$, $\text{O} = 16$, $\text{K} = 39$).

Equation :



Solution:

$$\begin{aligned}\text{Step 1: Moles of } \text{H}_2\text{SO}_4 \text{ in } 25\text{cm}^3 . &= \frac{0.1\text{mole}}{1000\text{cm}^3} \times 25\text{cm}^3 \\ &= 2.5 \times 10^{-3} \text{ mols} \\ \text{Moles of KOH in } 24.5 \text{ cm}^3 &= 2 \times \text{moles of } \text{H}_2\text{SO}_4 \text{ in } 25\text{cm}^3 \\ &= 2 \times 2.5 \times 10^{-3} \text{ moles} \\ \text{Ratio} &= 5.0 \times 10^{-3} \text{ moles.} \\ \text{Moles of KOH in } 1000\text{cm}^3 \text{ (Molarity)} &= \frac{5 \times 10^{-3} \text{ moles}}{24.5\text{cm}^3} \times 1000\text{cm}^3 \\ &= 0.0204 \text{ moles per litre.}\end{aligned}$$

Molar concentration of the base

$$= \underline{\underline{0.204 \text{ M}}}.$$

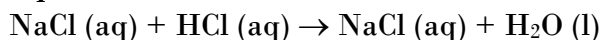
Example 10 :

20cm^3 of sodium hydroxide containing 12gdm^{-3} required 24cm^3 of dilute hydrochloric acid for neutralization.

Calculate the molar concentration of the acid, and its concentration in g dm^{-3} .

($\text{H} = 1$, $\text{Cl} = 35.5$, $\text{Na} = 23$, $\text{O} = 16$)

Equation:



Ratio:

1mole: 1 mole.

Solution:

Step1: Molar mass (mass of one mole) of NaOH ($23 + 16 + 1$) $\text{g} = 40 \text{ g}$.

Step2: Molarity (moles of NaOH per litre) of NaOH .

$$= \frac{12\text{gdm}^{-3}}{40\text{mol}^{-1}} = 0.3\text{M}$$

Step 3: Moles of NaOH in 20cm^3

$$\begin{aligned}&= 0.3\text{moles} \times 20 \\ &= 6.0 \times 10^{-3} \text{ moles.}\end{aligned}$$

Step 4:

$$\begin{aligned}\text{Moles of HCl in } 24\text{cm}^3 &= \text{moles of NaOH in } 20\text{cm}^3 \text{ (ratio)} \\ &= 6 \times 10^{-3} \text{ mols}\end{aligned}$$

Step 5. Moles of Hcl in 1000cm^3 (molarity)

$$= \frac{6 \times 10^{-3} \text{ moles}}{24 \text{ cm}^3} \times 20 \text{ cm}^3$$

$$= 0.25 \text{ moles per litre.}$$

Molar concentration of the acid.

$$= 0.25 \text{ M.}$$

Step 6: Molar mass of HCl (mass of one mole)

$$= (1 + 35.5) \text{ g}$$

$$= 36.5 \text{ g.}$$

Mass of 0.25 moles of HCl per dm^3 .

$$9.125 \text{ g mol}^{-1} \times 0.25 \text{ mols dm}^{-3}.$$

$$= 9.125 \text{ g dm}^{-3}.$$

Concentration of the acid per dm^3 .

$$= \underline{\underline{9.125 \text{ g dm}^{-3}}}.$$

Note: In some cases the molarity of a solution containing a given amount of a substance in less than one litre of solution can also be determined by computing the amount that would be present in 1 litre of the same concentrate.

Example.

What is the molarity of a solution containing 20g of NaOH in 250 cm^3 solution?

(Na = 23, O = 16, H = 1)

Solution:

Mass of NaOH in 1000 cm^3 of solution.

$$= \frac{20 \text{ g}}{250 \text{ cm}^3} \times 1000 \text{ cm}^3 = 40 \text{ g}$$

Mass of one mole (R.F.M) of NaOH

$$= 40 \text{ g.}$$

$$\text{Molarity of NaOH} = \frac{80 \text{ g l}^{-1}}{40 \text{ g mol}^{-1}}$$

$$= 2 \text{ M.}$$

TOPIC 2

Determination of

(i) percentage purity

(ii) Solubility

(iii) Moles of water of hydration.

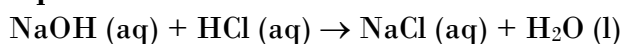
In this section, part of the amount supplied for investigation takes part in the reaction, while the other part does not. The part that reacts (physically or chemically) is determined by titration while the unreacting part is determined by difference.

Example one :

5g of impure sodium hydroxide was dissolved in water to make 100cm³ of solution. 20cm³ of the solution required 24cm³ of molar hydrochloric acid neutralization. Calculate the percentage purity of the sodium hydroxide.

(Na = 23, O = 16, H = 1).

Equation for the reaction.



Ratio : 1 mole : 1 mole.

Solution.

$$\begin{aligned} \text{Step 1 : Moles of HCl in 24cm}^3 &= \frac{1\text{mole}}{1000\text{cm}^3} \times 24\text{cm}^3 \\ &= 2.4 \times 10^{-2} \text{ moles.} \end{aligned}$$

step 2:

$$\begin{aligned} \text{Moles of NaOH in 20cm}^3 &= \text{moles of HCl in 24 cm}^3 \text{ (ratio)} \\ &= 2.4 \times 10^{-2} \text{ moles.} \end{aligned}$$

$$\begin{aligned} \text{Moles of NaOH in 100cm}^3 &= \frac{2.4 \times 10^{-2} \text{ moles} \times 100\text{cm}^3}{20\text{cm}^3} \\ &= 0.12 \text{ moles.} \end{aligned}$$

$$\text{step 3 : Molar mass of NaOH} = 40\text{g}$$

$$\begin{aligned} \text{Mass of 0.12moles of NaOH} &= 0.12\text{mols} \times 40\text{g mol}^{-1}. \\ &= 4.8\text{g.} \end{aligned}$$

Mass of NaOH dissolved in 100cm³ of solution.

$$= 4.8\text{g.}$$

$$\text{step 4: Percentage purity of NaOH} = \frac{4.8\text{g} \times 100}{5\text{g}} = 96\%$$

$$(\text{Note mass of impurity} = 5\text{g} - 4.8\text{g} = 0.2 \text{ g.})$$

$$\text{Its Percentage} = \frac{0.2\text{g}}{5\text{g}} \times 100 = 4\%$$

Example two.

1.00g of a mixture of calcium and sodium carbonate was carefully shaken with 200cm³ of distilled water, then filtered.

20cm³ of the filtrate required 8cm³ of 0.125M hydrochloric acid for neutralization.

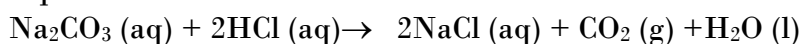
Calculate the

(i) Mass of calcium carbonate in the sample (i.e. the 1.00g).

(ii) Percentage purity of sodium carbonate in the mixture.

(Na = 23, C = 12, O = 16)

Equation:



Solution

$$\begin{aligned}
 \text{Moles of HCl in } 8\text{cm}^3 &= \frac{0.125\text{moles}}{1000\text{cm}^3} \times 8\text{cm}^3 \\
 &= 1.00 \times 10^{-3} \text{ moles} \\
 \text{Moles of Na}_2\text{CO}_3 \text{ in } 20\text{cm}^3 &= \frac{1}{2} \text{ moles} \\
 \text{of HCl in } 8\text{cm}^3 &= \frac{1}{2} \times 1.00 \times 10^{-3} \text{ moles} \\
 &= 5.0 \times 10^{-4} \text{ moles.}
 \end{aligned}$$

Remember CaCO_3 is insoluble in water.

Step 3:

$$\begin{aligned}
 \text{Moles of in Na}_2\text{CO}_3 \text{ in } 200\text{cm}^3 &= \frac{5 \times 10^{-4} \text{ moles} \times 200\text{cm}^3}{20\text{cm}^3} \\
 &= 5 \times 10^{-3}
 \end{aligned}$$

$$\begin{aligned}
 \text{Step 4: Mass of 1 moles of Na}_2\text{CO}_3 &= (46 + 12 + 48) \text{ g} \\
 &= 0.530\text{g.}
 \end{aligned}$$

$$\begin{aligned}
 \text{Step 5: Mass of CaCO}_3 \text{ in the mixture} &= (1.00 - 0.55) \text{ g} \\
 &= 0.47\text{g}
 \end{aligned}$$

$$\begin{aligned}
 \text{(ii) \% Purity of the Na}_2\text{CO}_3 &= \frac{0.53\text{g}}{1.00\text{g}} \times 100 \\
 &= \underline{\underline{53\%}}
 \end{aligned}$$

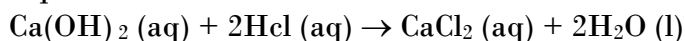
Example three.

0.5 g of calcium hydroxide was shaken well with 50cm^3 of distilled water then filtered. 25cm^3 of filtrate required 21.3cm^3 of 0.005M hydrochloric acid for neutralization:

Calculate the solubility of calcium hydroxide in 100cm^3 of water.

(Ca = 32, O = 16, H = 1)

Equation :



Ratio:

1mole: 2moles.

Solution:

$$\begin{aligned}
 \text{Step 1: Moles of HCl in } 21.2\text{cm}^3 &= \frac{0.05\text{moles}}{1000\text{cm}^3} \times 21.3\text{cm}^3 \\
 &= 1.06 \times 10^{-3} \text{ moles.}
 \end{aligned}$$

Moles of Ca(OH)_2 in 25cm^3 (Ca(OH)_2 is Sparingly soluble in water).

$$\begin{aligned}
 \text{in } 21.2\text{cm}^3 \text{ (ratio)} &= \frac{1}{2} \times 1.06 \times 10^{-3} \text{ mols} \\
 &= 5.3 \times 10^{-4} \text{ moles.}
 \end{aligned}$$

$$\begin{aligned}
 \text{Step 2: Moles of Ca (OH)}_2 \text{ in } 1000\text{cm}^3 &= \frac{5.3 \times 10^{-4} \text{ mols}}{25\text{cm}^3} \times 1000^3 \\
 &= \underline{\underline{0.0212 \text{ mols.}}}
 \end{aligned}$$

Step 3:

$$\begin{aligned}
 \text{Mass of 1 mole of Ca (OH)}_2 &= (40 + 32 + 2)\text{g} \\
 &= 74\text{g}
 \end{aligned}$$

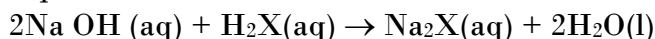
$$\begin{aligned}
 \text{Mass of 0.0212 moles} &= 74\text{gmol}^{-1} \times 0.0212 \text{ mol.} \\
 &= \underline{\underline{1.569\text{g}}}
 \end{aligned}$$

Example four:

20cm³ of a solution containing 25.2g l⁻¹ a dibasic hydrated acid, H₂Xn . nH₂O was found to neutralize 10cm³ of 0.8 M sodium hydroxide solution, if the relative formula mass of H₂X 90, determine the value of n.

(H = 1, O = 16)

Equation:



Solution:

Step 1:

Moles of alkali in 10cm³.

$$= \frac{0.8\text{moles}}{1000\text{cm}^3} \times 10\text{cm}^3 = 8.0 \times 10^{-3} \text{ moles}$$

$$\begin{aligned} \text{Step 2: Moles of acid in 20cm}^3 \text{ of acid} &= \frac{1}{2} \text{ moles of alkali in } 10\text{cm}^3 \\ &= \frac{1}{2} \times 8 \times 10^{-3} \text{ moles} \\ &= 4 \times 10^{-3} \text{ moles} \end{aligned}$$

Moles of acid in 1000cm³ of the acid

$$\begin{aligned} &= \frac{4 \times 10^{-3} \text{ moles} \times 1000\text{cm}^3}{20\text{cm}^3} \\ &= \underline{\underline{0.2 \text{ moles per litre.}}} \end{aligned}$$

Step 3: Mass of 1 mole of H₂X. nH₂O

Mass of 0.2 moles of acid per litre.

$$\begin{aligned} &= (90 + 18n) \text{ g l}^{-1} \times 0.2 \text{ moles l}^{-1}. \\ &= (18 + 3.6n) \text{ g l}^{-1}. \\ \frac{18 + 3.6n}{3.6n} &= \frac{25.2}{25.2 - 18} \\ &= 7.2. \end{aligned}$$

Multiplying each side by 10 to get rid of the decimal point.

$$\begin{aligned} \frac{3.6 \times 10}{36n} &= \frac{7.2 \times 10}{72} \\ n &= \frac{72}{36} \\ &= 2. \\ n &= \underline{\underline{2.}} \end{aligned}$$

$$(\text{Note R.F.M of H}_2\text{X. nH}_2\text{O} = \underline{\underline{90 + 36 = 126}}).$$

Example five:

20cm³ of a solution containing 28.6gl⁻¹ of hydrated sodium carbonate Na₂CO₃ .xH₂O neutralized 13.35cm³ of a solution containing 14.7gl⁻¹ of sulphuric acid.

Calculate the value of x in Na₂CO₃ .xH₂O.

Equation:



Ratio: 1 mole: 1 mole.

Note that water of hydration has no effect on the acid.

Solution.

Step 1:

$$\text{R.F.M of H}_2\text{SO}_4 = 98\text{g}$$

$$\text{Molarity} = \frac{14.7\text{gl}^{-1}}{98\text{gmol}^{-1}} \times 0.15\text{M}$$

step 2. Moles of acid in 13.35 cm^3 .

$$= \frac{0.15\text{moles}}{1000\text{cm}^3} \times 13.35\text{cm}^3 = 2 \times 10^{-3} \text{ moles}$$

$$\text{Moles of Na}_2\text{CO}_3 \text{ in } 20\text{cm}^3 = 2 \times 10^{-3}.$$

Moles according to equation ratio.

Step 3 moles $\text{Na}_2\text{CO}_3 \cdot x\text{H}_2\text{O}$ in 1000cm^3

$$= \frac{2 \times 10^{-3} \text{ moles}}{20\text{cm}^3} \times 1000\text{cm}^3 = 0.2\text{mol l}^{-1}$$

$$\begin{aligned} \text{step 4 .R.F.M of Na}_2\text{CO}_3 \cdot x\text{H}_2\text{O} &= (106 + 18x)\text{g} \\ &= \frac{28.6\text{gl}^{-1}}{(106 + 18x)\text{gmol}^{-1}} \end{aligned}$$

$$\begin{aligned} 1.8x &= 28.6 - 10.6 \\ &= 18 \end{aligned}$$

$$\text{Multiplying both sides by } 10, 18x = 180$$

$$\therefore x = \frac{180}{18} = 10.$$

N.B Compare ex.4 with ex.5 choose the easier method.

SECTION C :

Determination of

1. Stoichiometry

2. Basicity of an acid

3. Formulae of compounds.

4. Valency of an element or radical.

The common feature of this section is that it deals with ratios, in one way or another.

(i) **Stoichiometry** : Of a reaction is the mole ratio in which the reactants combine , together with the mole ratio in which the products are formed , once the ratio of reactants and products are determined experimentally , a stoichiometric equation , i.e. a fully balanced chemical equation , can be written. Note that an equation can only be written if the formulae of the reactants and products are known , though some can be inferred from the law of mass action , i.e. conservation of matter .

(ii) The basicity of an acid is the number of replaceable (by metal) hydrogen atoms in one molecule of an acid . In acid base titrations , used up from a given number of moles of acid reacting , since neutralization reaction takes the form $\text{H}^+ (\text{aq}) + \text{OH}^- (\text{aq}) \rightarrow \text{H}_2\text{O} (\text{l})$.

Examples .

Acid	Basically
HCl	1
H ₂ SO ₄	2
CH ₃ COOH	1

The number of moles of hydroxyl ions combining with one mole of acid equals the basicity of the acid.

Since an acid reacts with a base to form a salt and water only , using the valency values and balancing number add kind of atoms involved the formula of the salt formed can be determined , whether normal or acid salt

(iii) A formula of a compound or element represents one molecule of a substance by means of symbols and numbers. The symbols indicate the kind of atom in the molecule, whereas the number indicate how many atoms of a particular kind are present in one molecule represented by the formulas e.g. $\text{Ca}(\text{H}_2\text{PO}_4)_2$.

phosphate. One molecule contains one atom of calcium, four atoms of hydrogen, two atoms of phosphorous and eight atoms of oxygen.

Suppose two moles of phosphoric acid react with one mole of calcium hydroxide :

$2\text{H}_3\text{PO}_4(\text{aq}) + \text{Ca}(\text{OH})_2(\text{aq})$, the product must be salt and water, since it is neutralization reaction, but one mole of $\text{Ca}(\text{OH})_2$ contains two moles of hydroxyl ions. Two moles of hydrogen ions have been removed from the two moles of acid, leaving $2\text{H}_3\text{PO}_4$ - which combines with the Ca^{2+} ions to form $\text{Ca}(\text{H}_2\text{PO}_4)_2$. It is therefore possible to determine formulae experimentally. The valency reactions, the valency of an element or radical determined from titration values of acids concerned.

Examples :

20cm³ of 0.1M hydrochloric acid neutralized 18cm³ of 0.11M alkali ,X,Y .

Determine the

(i) Stoichiometry of the reaction

(ii) Valency of X.

Step 1 : 1moles of HCl in 20cm³.

$$= \frac{0.11\text{mole}}{1000\text{cm}^3} \times 20 \times 10^{-3} \text{ mols}$$

Step 2 : Moles of XY in 18 cm³

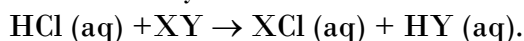
$$\begin{aligned} &= \frac{0.11\text{mole}}{1000\text{cm}^3} \times 18\text{cm}^3 \\ &= 1.98 \times 10^{-3} \text{ moles.} \end{aligned}$$

Step 3 :

Molar ratio of acid to alkali

$$\begin{aligned} &= 2 \times 10^{-3} : 1.98 \times 10^{-3} \text{ moles.} \\ &= 1:1 \end{aligned}$$

Stoichiometry of the reaction is



(ii) Valency of X = 1, since it displaces one atom of hydrogen.

Example two:

5.00cm³ of 0.2M solution of an acid H_nX was completely neutralized by 15cm³ of 0.2M sodium hydroxide solution:

Determine the

(i) basicity of the acid.

(ii) valency of X.

Solution :

$$\begin{aligned} \text{Step 1: Moles of acid} &= \frac{0.2\text{moles}}{1000\text{cm}^3} \times 5\text{cm}^3 \\ &= 1 \times 10^{-3} \text{ moles} \end{aligned}$$

Step 2: Moles of the alkali

$$\begin{aligned} &= \frac{0.2\text{moles}}{1000\text{cm}^3} \times 15\text{cm}^3 \\ &= \underline{\underline{3 \times 10^{-3}}} \end{aligned}$$

$$\begin{aligned} \text{Step 3: Moles of alkali reacting with 1mols of acid.} &= 3 \times 10^{-3} \text{ mole} \times 1 \text{ mole} \\ &= 3 \text{ moles.} \end{aligned}$$

But 3 moles of NaOH contains 3 moles of OH ions.

$$\text{Basically of the acid} = 3.$$

(ii) Since the basicity of $H_nX = 3 \therefore 3$.

Valency of X = 3.

Example three.

10cm³ of 0.1M phosphoric acid H_2PO_4 required 20cm³ of 0.1M sodium hydroxide solution for neutralization using a suitable indicator.

Determine the

(i) Formula of salt formed

(ii) Stoichiometry of the reaction.

Solution

$$\begin{aligned} \text{STEP 1: Moles of } H_2PO_4 \text{ in } 10 \text{ cm}^3. &= \frac{0.1 \text{ mole} \times 10 \text{ cm}^3}{1000 \text{ cm}^3} \\ &= 1 \times 10^{-3} \text{ moles.} \end{aligned}$$

Step 2:

$$\begin{aligned} \text{Moles of NaOH in } 20 \text{ cm}^3. &= \frac{0.1 \text{ mole}}{1000 \text{ cm}^3} \times 20 \text{ cm}^3 \\ &= 2 \times 10^{-3} \end{aligned}$$

Step 3:

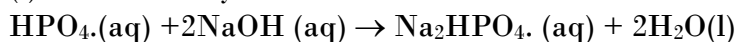
$$\text{Ratio of acid to alkali.} = \frac{1 \times 10^{-3}}{2 \times 10^{-3}} = 1:2$$

1 mole of acid reacts with 2 moles of alkali. 2 moles of hydrogen ions have been displaced by sodium metal, leaving one hydrogen

Formula of salt is Na_2HPO_4 .

$2H_2O$

(i) Stoichiometry of reaction.



The moles of water are determined by equalizing number of atoms.



Example 4:

25cm³ of 0.2M hydrochloric acid react completely with 24.95cm³ of 0.2M sodium carbonate solution Na_2CO_3 . Determine the number of moles of alkali reacting with one mole of acid.

Solution:

$$\text{Moles of acid in } 25 \text{ cm}^3. = \frac{0.2 \text{ moles} \times 25 \text{ cm}^3}{1000 \text{ cm}^3} = 5 \times 10^{-3} \text{ moles.}$$

$$\begin{aligned} \text{Moles of alkali used} &= \frac{0.2 \text{ moles} \times 24.95 \text{ cm}^3}{1000 \text{ cm}^3} \\ &= \underline{\underline{4.99 \times 10^{-3} \text{ moles.}}} \end{aligned}$$

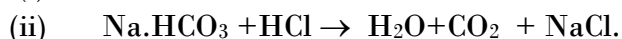
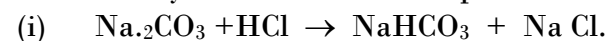
Moles of alkali reacting with one mole of acid.

$$\begin{aligned} 4.99 \times 10^{-3} : 5 \times 10^{-3} &= 0.998 \\ &\cong 1. \end{aligned}$$

Note One mole of HCl reacts with one mole of Na_2CO_3 .

One mole of Na^+ displaces one mole of H^+ from HCl, leaving $NaCO_3$ -

Products are NaCl and $Na.HCO_3$ Further displacement gives another NaCl and H_2CO_3 which is very unstable and decomposes to CO_2 and water .



SECTION D:

Determination of reacting volumes of solutions.

In chemical reactions involving solutions, it is the moles of a substance contained in the given volume of solution that actually react. It is therefore important to know how to convert volumes of standard solution into moles of reacting species.

Suppose a litre of solution A contains M moles of substance A, we can write its molarity as M. If out of one litre of this solution we take $V \text{ cm}^3$ of solution A, we write its volume $V_A \text{ cm}^3$.

Therefore the number of moles of A in $V_A \text{ cm}^3 = \frac{M_A}{1000 \text{ cm}^3} \times V_A \text{ cm}^3 = \frac{M_A V_A}{1000 \text{ cm}^3}$ moles.

Similarly the volume containing one mole of substance A = $\frac{1000 \text{ cm}^3}{M_A \text{ moles}}$: (e.g. if the molarity of acid

A = 2M, then the volume containing one mole = $\frac{1000 \text{ cm}^3}{2 \text{ moles}} = 500 \text{ cm}^3 \text{ mol}^{-1}$)

and the volume of this solution containing X moles

$$\frac{1000 \text{ cm}^3}{M_A \text{ moles}} \times X \text{ moles} = \frac{1000 X \text{ cm}^3}{M_A \text{ moles}}$$

Example one:

What volume of 0.15M hydrochloric acid will react completely with 25 cm^3 of 0.1M sodium carbonate solution?

Step 1:

Equation for reaction:



Ratio: 1 mole: 2 moles.

Step 2:

Moles of Na_2CO_3 in 25 cm^3 .

$$= \frac{0.1 \text{ moles}}{1000 \text{ cm}^3} \times 25 \text{ cm}^3 = 2.5 \times 10^{-3} \text{ moles}$$

$$\text{Moles of HCl} = 2.5 \times 10^{-3} \text{ moles}$$

(according to equation).

Step 3:

$$0.15 \text{ moles of HCl are in } 1000 \text{ cm}^3 = 2 \times 2.5 \times 10^{-3} \text{ moles are in } \frac{1000 \text{ cm}^3}{0.15 \text{ moles}} \times 2.5 \times 10^{-3} \text{ moles}$$

$$= 33.30 \text{ cm}^3$$

Volume required

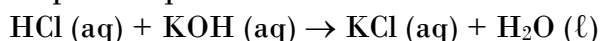
$$= 33.30 \text{ cm}^3$$

Example two :

20 cm^3 of 1M HCl are mixed with 1.25 cm^3 of 2M KOH solution. What volume of 0.1M HCl will neutralize the excess alkali ?

Solution .

Step 1: . Equation.



Ratio 1 mole: 1 mole.

Step 2:

$$\text{Moles of HCl in } 20 \text{ cm}^3 = \frac{1 \text{ mole}}{1000 \text{ cm}^3} \times 20 \text{ cm}^3 = 2 \times 10^{-2} \text{ moles}$$

Moles of KOH in 1.25 cm^3 of 2M KOH

$$= \frac{2 \text{ moles}}{1000 \text{ cm}^3} \times 1.25 \text{ cm}^3 = 2.5 \times 10^{-2} \text{ moles}$$

$$\text{Moles of excess alkali} = 10^{-2} (2.5, -2) \text{ moles } 5 \times 10^{-3}.$$

Moles of acid reacting with the excess alkali = 5×10^{-3} moles.

Step 4:

Volume of 0.1M acid containing of 5×10^{-3} moles.

$$= \frac{1000\text{cm}^3}{0.1\text{mole}} \times 5 \times 10^{-3} \text{ moles}$$

$$= \underline{\underline{50 \text{ cm}^3.}}$$

Example three .

What volume of molar nitric would exactly neutralize 20cm^3 of sodium hydroxide solution containing 50 g dm^{-3} of the alkali?

(Na = 23, O = 16 H = 1)

Solution :

Step 1:

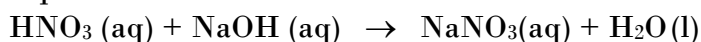
$$\text{Mass of 1 mole of NaOH} = 40\text{g}$$

Step 2:

$$\text{Molarity of Na OH} = \frac{50\text{gdm}^{-3}}{40\text{gmol}^{-1}} = 1.25\text{M}$$

Step 3:

Equation for reaction:



Ration 1mole: 1 mole

Step 4:

Moles of NaOH in 20cm^3

$$= \frac{1.25\text{moles}}{1000\text{cm}^3} \times 20\text{cm}^3 = 2.5 \times 10^{-2} \text{ moles (ratio)}$$

Moles of M HNO₃ containing 2.5×10^{-2}

$$= \frac{1000\text{cm}^3}{1\text{mole}} \times 2.5 \times 10^{-2} \text{ moles} = 25\text{cm}^3$$

$$= \underline{\underline{25 \text{ cm}^3.}}$$

$$\text{Volume required} = \underline{\underline{25\text{cm}^3.}}$$

Example four :

What volume of 0.2M sodium 20cm^3 of a solution containing 4.9g sulphuric acid per 250cm^3 of solution ? (H = 1 , S = 32, O = 16) .

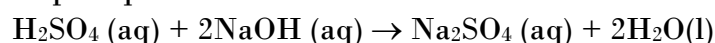
Solution :

$$\text{Step 1: R.F.Mof H}_2\text{SO}_4 = 90\text{g.}$$

$$\text{Molarity of acid} = \frac{4.9\text{g} \times 1000\text{cm}^3}{250\text{cm}^3 \times 98\text{gmol}^{-1}}$$

$$= \underline{\underline{0.2\text{M}.}}$$

Step2: equation of reaction:



Ratio: 1 mole: 2 moles.

$$\text{Step 3 : Moles of NaOH in } 20\text{cm}^3. = \frac{0.2\text{moles}}{1000\text{cm}^3} \times 20\text{cm}^3 = 4 \times 10^{-3} \text{ mols}$$

$$\text{Moles of acid reacting} = \frac{1}{2} \times 4 \times 10^{-3} \text{ mols}$$

$$= \underline{\underline{2 \times 10^{-3} \text{ mols.}}}$$

(according to equation ratio).

step 4 : Volume of H₂SO₄ containing 2×10^{-3} mols

$$= \frac{1000\text{cm}^3}{0.2\text{mols}} \times 2 \times 10^{-3} \text{ mols} = 10\text{cm}^3$$

Example 5.

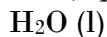
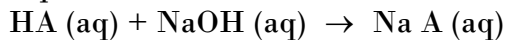
20cm³ of sodium hydroxide solution required 12cm³ of 0.5M of HA acid solution for neutralization. Calculate the volume of acid that would neutralize one gram formula mass of the alkali.

(Na = 23, O = 16, H = 1)

Solution :

Step 1:

Equation for reaction:



Step 2:

$$\text{Moles of acid in 12cm}^3 = \frac{0.5\text{moles}}{1000\text{cm}^3} \times 12\text{cm}^3 = 6 \times 10^{-3} \text{ mols}$$

$$\text{Moles of NaOH in 20cm}^3 = \mathbf{6 \times 10^{-3} \text{ mols}}$$

Step 3:

$$\text{R.F.M of Na OH} = (23 + 16 + 1)\text{g}$$

$$= 40\text{g}.$$

$$\text{Mass of } \mathbf{6 \times 10^{-3} \text{ mols}} = 40\text{g mol}^{-1} \times$$

$$= 6 \times 10^{-3} \text{ mols} = 0.24\text{g}.$$

12cm³ of acid react with 0.24g of alkali.

Volume of acid reacting with 40g of

$$= \frac{12\text{cm}^3 \times 40\text{g}}{0.24\text{g}}$$

$$= 2000\text{cm}^3$$

$$= \mathbf{2 \text{ dm}^3}.$$

SECTION E :

BACK TITRATION

Certain substances are insoluble in water and therefore cannot give standard solution. e.g. CaCO_3 , MgO e.t.c. Such substances may be added to excess solutions with which react to form solutions. The amount of the un reacted standard solution is determined by titration against a second solution and therefore enabling one to determine the quantity of the first standard solution that reacted with the insoluble substance. This process is called **BACK TITRATION**.

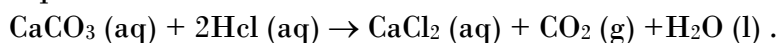
Back titration experiments are not common in 'O' level practical examinations, but calculations concerning this method occasionally appear in the theoretical papers and therefore important to know.

Example :

1. 1.60 g of pure calcium carbonate CaCO_3 , was dissolved in 50 cm^3 of hydrochloric acid, and the resulting solution made up to 250 cm^3 by diluting with distilled water. 25 cm^3 of those solution required 8 cm^3 of dilute sodium hydroxide solution for neutralization. Calculate the molarity of sodium hydroxide **Solution.**

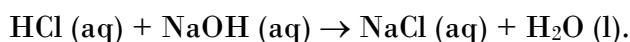
(Ca = 40, C = 12, O = 16).

Equations :



Ratio:

1mole: 2 moles.



Ratio

1mole: 1mole

$$\begin{aligned} \text{Mass of 1 mole of CaCO}_3 &= (40 + 12 + 48) \text{ g} \\ &= 100\text{g} \end{aligned}$$

100g CaCO_3 react with 2 moles of HCl.

$$\begin{aligned} 1.60\text{g CaCO}_3 \text{ react with } \frac{2\text{moles}}{100\text{g}} \times 1.60\text{g} \\ = 3.20 \times 10^{-2} \text{ mols of HCl.} \end{aligned}$$

Moles of HCl originally present in 50 cm^3 .

$$= \frac{1.2\text{moles}}{1000\text{cm}^3} \times 50\text{cm}^3 (6 - 3.)$$

$$\begin{aligned} \text{Moles of unreacted HCl} &= 10^{-2} (6 - 3.2) \text{ mols.} \\ &= \underline{\underline{2.8 \times 10^{-2}}}. \end{aligned}$$

$$\text{Moles of HCl in 25cm}^3 \text{ of the dilute acid.} = \frac{2.8 \times 10^{-2} \text{ moles}}{250\text{cm}^3} \times 25\text{cm}^3 = 2.8 \times 10^{-3}$$

$$\text{Moles of alkali in 28cm}^3 = \underline{\underline{2.8 \times 10^{-3}}}$$

Moles (according to molar ratio in eq. (ii))

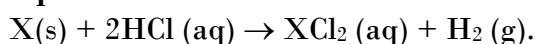
$$\begin{aligned} \text{Molarity of the NaOH} &= \frac{2.8 \times 10^{-3} \text{ mols} \times 1000\text{cm}^3}{28\text{cm}^3} \\ &= \underline{\underline{0.1\text{M}}}. \end{aligned}$$

0.36 g of a pure metal x was dissolved in 50 cm^3 of molar hydrochloric acid. The resulting solution required 20 cm^3 of molar sodium hydroxide solution for neutralization.

Calculate the relative atomic mass of X, given that x is a divalent metal.

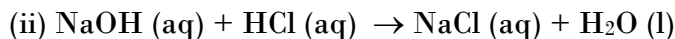
Solution:

Equation:



Ratio:

1mole: 2 moles.



1mole: 1 mole

$$\text{Moles of HCl reacting with NaCl} = \frac{1\text{mole}}{1000\text{cm}^3} \times 20\text{cm}^3$$

2×10^{-3} moles (according to eq (ii))

$$\text{Moles of HCl originally in } 50\text{cm}^3 = \frac{1\text{mole} \times 50\text{cm}^3}{1000}$$

5×10^{-3} moles

$$\begin{aligned} \text{Moles of HCl reacting with x} &= 10^{-2} (5 - 2) \text{ moles.} \\ &= 3 \times 10^{-2} \text{ moles} \end{aligned}$$

$$\begin{aligned} \text{Moles of the metal reacting} &= \frac{1}{2} \times 3 \times 10^{-2} \text{ moles} \\ &= 1.5 \times 10^{-2} \text{ moles (according to equation)} \end{aligned}$$

$$\text{Moles of} = \frac{\text{Mass of x}}{\text{G.F.M of x}} = \frac{0.36\text{g}}{\text{R.A.M}}$$

$$1.5 \times 10^{-2} \text{ mole} = \frac{0.36\text{g}}{\text{R.A.M}}$$

$$\text{G.A.M} = \frac{0.36\text{g}}{1.5 \times 10^{-2} \text{ moles}} = \frac{360\text{g}}{15\text{mole}} = 24\text{gmol}^{-1}$$

$$\text{Relative atomic mass} = \underline{\underline{24.}}$$

0.28g of metal oxide, MO was dissolved completely in 40 cm^3 of 0.5M of nitric acid. The excess acid remaining after reaction required 10cm^3 of molar sodium hydroxide solution for complete neutralization.

(a) Write an equation for the reaction between the acid and

(i) MO (ii) NaOH.

(ii) Calculate the number of moles of nitric acid

(i) In 40cm^3 of the original acid

(ii) Remaining after the reaction with MO.

(iii) reacting with 0.28g of MO.

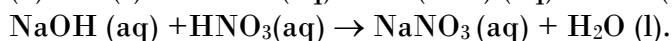
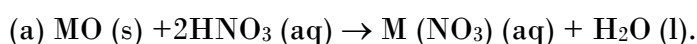
Calculate the

(i) the number of moles of MO that reacted with the acid.

(ii) relative formula mass of MO.

(iii) relative atomic mass of M, given O = 16.

Answers :



$$(b) \frac{0.5\text{moles} \times 40\text{cm}^3}{1000\text{cm}^3} = 2 \times 10^{-2} \text{ moles}$$

$$(ii) \frac{1\text{mole} \times 10\text{cm}^3}{1000\text{cm}^3} = 1 \times 10^{-2} \text{ moles}$$

(iii) Moles of original acid - moles of excess acid

$$= 10^{-2} (2 - 1) \text{ moles}$$

$$= 1 \times 10^{-2} \text{ moles.}$$

$$(c) \frac{1}{2} \times 1 \times 10^{-2} \text{ moles} = 0.005\text{moles}$$

$$(ii) \text{Moles of Mc} = \frac{\text{Mass}}{\text{R.F.M}} = 56\text{mol}^{-1}$$

$$\text{R.F.M of Mc} = 56.$$

(iii) Let the relative atomic mass of M be x

$$\begin{array}{rcl} x & + & 16 \\ & & x \end{array} = \begin{array}{rcl} 56 \\ 56 - 16 \end{array}$$

$$= 40$$

Relative atomic mass of M = 40.

SECTION F

Use of formula in volumetric analysis deriving formulae concerning solutions.

Suppose solution A has molarity M_A , then a volume of solution of A of $V_A \text{ cm}^3$ will contain

$$\frac{M_A \text{ moles}}{1000 \text{ cm}^3} \times V_A \text{ cm}^3 = \frac{M_A V_A}{1000} \text{ moles}$$

Similarly $V_B \text{ cm}^3$ of M_B contains

$$\frac{M_B \text{ moles}}{1000 \text{ cm}^3} \times V_B \text{ cm}^3 = \frac{M_B V_B}{1000} \text{ moles}$$

Then the ratio of moles A to moles of B

$$= \frac{M_A V_A}{1000} = \frac{M_B V_B}{1000} = \frac{M_A V_A}{M_B V_B}$$

Therefore in a given reaction between an acid A and base B, the ratio given by the moles of the acid to moles of base in the equation for that reaction equals to the ratio above i.e.

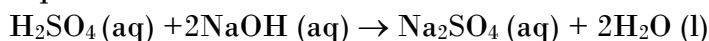
$$\frac{M_A V_A}{M_B V_B} = \frac{\text{molsA}}{\text{molsB}} \text{ in equation.}$$

Once all but one entities in the above formula are known, the unknown entity is easy to determine.

EXAMPLE :

20cm³ of H₂SO₄ required 25cm³ of 2M NaOH solution calculate the molarity of the acid.
solution:

Equation of reaction.



Ration of acid to base in equation = 1 : 2

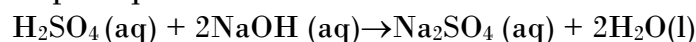
Using the formula $\frac{M_A V_A}{M_B V_B} = \frac{\text{molsA}}{\text{molsB}}$ in equation. $\frac{M_A V_A}{M_B V_B} \times \frac{\text{molsA}}{\text{molsB}}$

$$\begin{aligned} \text{Molarity of acid} &= \frac{2M \times 25 \text{ cm}^3}{20 \text{ cm}^3} \times \frac{1}{2} \\ &= \underline{\underline{1.25M.}} \end{aligned}$$

2. What volume of 2 M NaOH solutions will be required to neutralize 1.25M H₂SO₄ ?

Solution :

Step 1: equation of reaction



Step 2: ratio of acid to base = 1mole : 2 moles .

Step 3: Using the formula $\frac{M_A V_A}{M_B V_B} \times \frac{\text{molsA}}{\text{molsB}}$

$$V_B = \frac{M_A V_A}{M_B V_B} \times \frac{\text{molsA}}{\text{molsB}}$$

$$\text{Volume of the base required} = \frac{1.25M \times 20 \text{ cm}^3}{2M} \times \frac{2}{1} = 25 \text{ cm}^3$$

Calculations using formula are much shorter than those reasoning. BUT use of formula in calculations is highly discouraged. Do not use it in exams. Simply because in case you substitute

wrongly, the answer will be wrong and you lose all marks. Stop wise calculations do not lead to total loss of marks if method of work is required.

Suppose $V_c \text{ cm}^3$ of a concentrated solution of molarity M_c is diluted with water to volume V_d , the new molarity of the dilute solution will be M_d .

Now, the number of moles of solute in $V_c \text{ cm}^3$ of M_c solution

$$= \frac{M_c \text{ moles} \times V_c \text{ cm}^3}{1000 \text{ cm}^3}$$

$$= \frac{M_c V_c}{1000} \text{ mols}$$

This no. of moles is still the same in , since only water was added V_c to make it V_d .

$$= \frac{M_d \text{ moles} \times V_d \text{ cm}^3}{1000 \text{ cm}^3}$$

$$= \frac{M_d V_d}{1000} \text{ moles}$$

$$= \frac{M_c V_c}{1000} \text{ mols} = \frac{M_d V_d}{1000} \text{ moles}$$

Where M_c and M_d are molarities of the concentrated and dilute solutions respectively while V_c and V_d are volumes of conc and dilute solutions respectively. It is based on the fact that the number of moles of a solute in a given volume remains unchanged on adding more water to that volume. Only the molarity changes. This is why it does not matter washing down with water a drop of solution from a burette onto the walls of the conical flask . But washing a burette or pipette with water first before adding appropriate solution to it is wrong because this will decrease its molarity .

The formula can be manipulated to make the desired entity the subject of the formula, assuming other entities to be known e.g.

$$M_c = \frac{M_d V_d}{V_c}$$

$$\text{Or } V_d = \frac{M_c V_c}{M_d}$$

Example:

To what volume of 30 cm^3 of 2 M of NaOH solution be diluted to make it 1.5 M ?

Solution from the formula.

$$M_c V_c = M_d V_d = \frac{M_c V_c}{M_d}$$

Volume of dilute solution:

$$= \frac{2 \text{ M} \times 30 \text{ cm}^3}{1.5 \text{ M}}$$

$$= \underline{\underline{40 \text{ cm}^3}}.$$

Notice that the new molarity of the dilute solution is lower than that of original (conc) solution, therefore the new volume will be more than due to more water added .

2. What will be the molarity of the solution formed by diluting 30 cm^3 of Na OH to 50 cm^3 .

$$\text{Solution : } M_c V_c = M_d V_d$$

From the equation

$$V_d = \frac{M_c V_c}{M_d}$$

Molarity of dilute solution

$$= \frac{2M \times 30\text{cm}^3}{50\text{cm}^3}$$

$$= \mathbf{1.2M}.$$

Notice that the number of moles in 30cm^3 are the same as those in 50cm^3 therefore the concentration (molarity) of the new solution will be less.

3. What volume of water must be added to 20cm^3 of 3M of HCl to make it 1.5M ?

Solution :

Using the formula: $M_c V_c = M_d V_d$

$$V_d = \frac{M_c V_c}{M_d}$$

$$\begin{aligned} \text{Final volume of the dilute acid} &= \frac{3M \times 20\text{cm}^3}{1.5M} \\ &= \mathbf{40\text{cm}^3}. \end{aligned}$$

Volume of water added $(40 - 20) \text{cm}^3$.

$$= \mathbf{20\text{cm}^3}.$$

Short as the method may be the use of formulae in those calculations encouraged. Step wise calculations is much recommended instead. The above three questions are worked out below from first principles, without repeating the questions:

1. Step 1: Volume of 2M NaOH containing

$$\begin{aligned} 1.5\text{Moles} &= \frac{1000\text{cm}^3}{2\text{moles}} \times 1.5\text{moles} \\ &= \mathbf{750\text{cm}^3}. \end{aligned}$$

But the same numbers of moles are present in 1000cm^3 of the dilute solution

Step 2 :

If the 750cm^3 are diluted to 1000cm^3
then 30cm^3 are diluted to

$$= \frac{1000\text{cm}^3}{750\text{cm}^3} \times 30 = 40$$

30cm^3 of 2M are diluted to 40cm^3 .

Step 2 :

Moles of NaOH in 30cm^3 of

$$\begin{aligned} 2M \text{ NaOH} &= \frac{2\text{moles} \times 30\text{cm}^3}{1000\text{cm}^3} \\ &= \mathbf{0.06 \text{ moles.}} \end{aligned}$$

Step3 :

Moles of NaOH in 30cm^3 .

Moles of NaOH in 50cm^3 on diluting

0.06moles of NaOH are present in 50cm^3 .

Moles of NaOH in 1000cm^3 .

$$\begin{aligned} &= \frac{0.06\text{moles}}{50\text{cm}^3} \times 1000\text{cm}^3 \\ &= \mathbf{1.2 \text{ moles} .} \end{aligned}$$

Molarity of the diluted solution = $\mathbf{1.2M}$.

$$\begin{aligned} \text{Volume of 3M containing 1.5moles} &= \frac{1000\text{cm}^3 \times 1.5\text{moles}}{3\text{moles}} \\ &= \mathbf{500\text{cm}^3}. \end{aligned}$$

But the same no of moles are present in 1000cm^3 of the dilute solution.

$(1000 - 500\text{cm}^3)$ 500cm^3 of water has been added to 500cm^3 of 3M NaOH if 500cm^3 of water are added to 500cm^3 of 5M NaOH, then

$$= \frac{500\text{cm}^3}{500\text{cm}^3} \times 20\text{cm}^3$$

$$= 20\text{cm}^3 \text{ are added to } 20\text{cm}^3.$$

1. You are provided with solution BA1 and BA2. BA1 is a solution containing 0.25 moles of an acid, H_nX , per litre BA2 in a 0.6M sodium hydroxide. You are required to determine the basicity, n of the acid.

Procedure :

Pipette 25cm^3 of BA_2 into a conical flask. Add 2-3 drops of methyl orange as indicator.

Titrate the solution with BA_1 from a burette. The end point is then when the color of methyl orange . Repeat the titration until you get consistent results.

Results:

Volume of pipette use =

Titration	1	2	3	4
Final reading(cm^3)				
Initial reading (cm^3)				
Volume of $\text{BA}_1(\text{cm}^3)$				

Volumes of BA_1 used for calculating the average values

.....

Average volume of BA_1 used cm^3

Questions :

(a) Calculate the values of n

.....

(b) Write ionic equation for the reaction between the acid and sodium hydroxide.....

.....

2. BA 20 is a solution containing 3.65g of HCl per litre of solution. BA 21 is a solution containing 6.30 g of impure sodium carbonate per litre of solution.

But the acid in the titrate 25cm^3 (or 20cm^3) portions of solution BA21 using methyl orange (or screened methyl orange) as the indicator.

Record you results in the table below.

Results:

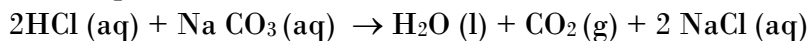
The volume of the pipette used was cm^3 .

Burette Readings:

Titration	1	2	3	4
Final reading(cm^3)				
first reading (cm^3)				
Volume of $\text{BA}_1(\text{cm}^3)$				

Summary :

.....cm³ of BA2l neededcm³ of BA 20 for complete reaction.



Or $2\text{H}^+\text{(aq)} + \text{CO}_3^{2-}\text{(aq)} \rightarrow \text{H}_2\text{O (l)} + \text{CO}_2\text{(g)}$

Calculate:

- the concentration of BA 2 in mole of HCl per litre.
- the mass in grams of sodium carbonate, $\text{Na}_2 \text{CO}_3$, in one litre of BA 2l .
- the % by mass of sodium carbonate in the impure solid dissolved in BA 2l.

2. (contd.....)

1.....

2. The concentration of BA 20 ismols /l.

3. The mass of sodium carbonate in one litre of BA 2l is.....g.

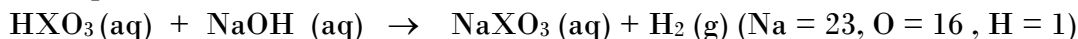
The percentage by mass of sodium carbonate in the impure solid dissolved in BA 2l is %.

3. BA 10 is a solution containing 6×10^{-1} of an acid HXO_3 .

BA 1^l is a solution containing 5.00g l^{-1} of sodium hydroxide. You are required to determine the

- Molarity of solution BA 10.
- Atomic mass of the element X present in the acid.

The equation for the reaction is



Procedure :

Put the acid into the burette and titrate 25 cm^3 or 20cm^3 portion of BA 11 using the indicator provided.

Record your result in the table below.

Results :

Volume of pipette usedcm³.

Titration	1	2	3	4
Final reading(cm ³)				
Initial reading (cm ³)				
Volume of BA1(cm ³)				

Volumes of BA 10 used for calculating the average value

.....

.....

.....

Calculations :

Calculate the molarity of BA

10.....

.....

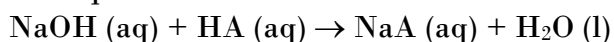
.....

B20 is a solution containing 17.0g of an acid per litre B21 per litre is a solution containing 12.0g of sodium hydroxide.

You are required to calculate

- (i) the volume of BA 20 that would neutralize one mole of the alkali
- (ii) the volume of BA 20 that would neutralize one mole of the alkali
- (iii) the gram formula mass of the acid , HA,

The equation for the reaction is



(Na = 23, O = 16, H = 1)

Procedure .

Put the acid into the burette and titrate 20cm³ or 25cm³ portion of the alkali to get two agreeable titres . Use the indicator given.

Results

Volume of pipette usedcm³.

Burette readings (cm³)

Titration	1	2	3	4
Final reading(cm ³)				
Initial reading (cm ³)				
Volume used				

Calculations.

Volumes of B20 used for calculating the average value

.....

.....

.....

.....

Calculate the

- (a) The volume of solution B20 which would neutralize one molar mass (R.F.M).
-
-
-

The gram formula mass of the acid , HA.

.....

.....

.....

5. B11 is a solution of hydrochloric acid containing 3.50g of HCl litre B12 is a solution of an alkali containing 4.20g of the alkali per litre of solution.

You are required to determine the

(i) the molarity of the alkali

(ii) relative formula mass of the alkali one mole of the acid reacts with one mole of the alkali for complete neutralization.

(H = 1; Cl = 35.5).

Procedure :

Put B 11 into the burette and titrate 25cm³ or 20cm³ portions of B 12 in a conical flask. Add 2-3 drops of phenolphthalein provide. The end point is when the solution just turns from pink to colorless. Repeat the titration until you get consistent consecutive results. Record your results in the table below.

Results:

Volume of pipette usedcm³.

Titration	1	2	3	4
Final reading(cm ³)				
Initial reading (cm ³)				
Volume B 11				

Volumes of B11 used for calculating the average value

.....

Average volume of B11 used

.....

..... **Calculations** . Calculate the

(i) Molarity of the alkali B12.

.....

The relative formula mass of the alkali, B12.

.....

6. B10 is a solution containing 6.30g of nitric acid per litre. B11 is a solution of a normal carbonate M₂CO₃ containing 5.30g per litre. You are required to determine the

(i) the relative formula mass of carbonate, N₂CO₃.

(ii) relative atomic mass of the metal M.

(H = 1, N = 14, O = 16, C = 12).

Procedure :

Fill the burette with the carbonate, B11, pipette 20cm³ or 15cm³ of the acid, B 10 into the conical flask. Add 2-3 drops of methyl orange indicator; titrate till the indicator color just changes from

red to orange. Repeat the procedure till you get consistent. Record your results in the table below.

Results:

Volumes of pipette usedcm³.

Burette readings (cm³)

Titration	1	2	3	4
Final reading(cm ³)				
Initial reading (cm ³)				
Titre of B 11				

Titre values used to get average

.....

Average volume of B11 used

.....

Write the equation for the reaction

.....

(i) Calculate the relative formula mass of M₂CO₃:

.....

(ii) Relative atomic mass of the metal M.

.....

7. Solid X is 2.0g of a metallic oxide, MO.

Very carefully slide down X into a conical flask containing 100cm³ of molar hydrochloric acid, cork the flask and shake carefully to completely label this MO.

Label solution BA 1.

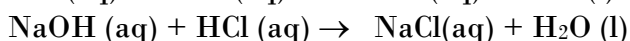
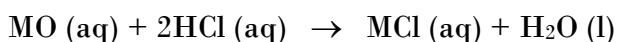
Solution BA2 is 0.5M sodium hydroxide solution ‘

You are required to determine the

(i) the relative mass of MO.

(ii) relative atomic mass of metal M.

Equation for the reaction :



(O = 16)

procedure:

Put solution BA₂ into the burette , then pipette 20cm³ of solution BA₁ into a conical flask . Add 2-3 drops of phenolphthalein indicator titrate till indicator colour just turns to permanent pale pink (lasting for at least five seconds) . Repeat the procedure till you get constant titres.

Record your result in the table below.

Results

volume of the pipette used.....cm³.

Burette readings cm³.

Titration	1	2	3	4
Final reading(cm ³)				
Initial reading (cm ³)				
Titre of B A2				

Titre values used to get average volume (titre)

.....

Average volume of BA2.

..... cm³.

Calculate the number of moles o the BA 1 in the 20 cm³ used .

.....

Calculate the number of moles of BA1 in the 100 cm³.

.....

Calculate the number of moles of the molar hydrochloric acid in the of 100 cm³ the acid supplied.

.....

.....Calculate the number of moles of the acid reacting with the solid x (metallic oxide , MO).

.....

Calculate the number of moles of MO, reacting with the acid supplied .

.....

Calculate the relative formula mass of MO.

.....

(ii) relative atomic mass of he M in the metallic oxide MO.

.....

8. Solution B3 contains 14.30g per litre of hydrated sodium carbonate , Na₂CO₃ . xH₂O.

solution B4 contains 4.9 g of sulphuric acid per litre of solution .

You are required to determine the

(i) Molarity of the base B3

(ii)relative formula mass of the base B3.

(iii) the number of moles of water of crystalisation x per mole of the base.

Equation for reaction :



Procedure :

Put the acid B4 into the burette .

Pipette 20cm³ or 25cm³ of the base ,B3 into a conical flask .

Add 2-3 drops of methyl orange indicator . Titrate against B4 from the burette.

Repeat the titration two or three times. Record your results in the table below.

Results .

Volume of pipette used (cm³)

Burette readings

	1	2	3	4
Final reading				
Initial reading				
Volume of B4				

Volumes of B4 to be averaged (cm³)

Average volume of B4

.....

(H = 1 O =16 C = 12 , S = 32 Na =23)

Calculate the

(i) Molarity of the base

B3.....

(ii) relative formula mass of the base B3

.....

.....(iii) number of moles of water of crystallization , X per moles of base .

.....

You are provided with BA 10 which is a sparingly soluble base and BA 12 which is a 0.05M hydrochloric acid .

You are required to determine the solubility of BA10 in grams per litre of solution.

BA10 reacts with BA2 in the ratio 1: 2 . The relative formula mass of BA 10 is 74 .

Procedure :

Place all BA 10 provided into flask . Add 100cm³ of water , then stopper the flask and shake vigorously for 10 minutes .

Filter rapidly . Titrate 25cm³ of this saturated solution with BA 12 . Use methyl orange indicator .

Repeat the titration until you obtain consistent results . Enter your results in the table below.

Volume of pipette used (cm³)

Burette readings

	1	2	3	4
Final reading				
Initial reading				
Volume of				

B4				
----	--	--	--	--

Volumes of BA 12 to be averaged

.....Averaged volume of BA 12 used

(a) Calculate the number of

(i) moles of hydrochloric acid that reacted .

..... (ii)
moles of the base that reacted .

(b) Calculate the conc. of the HCl per litre .

10. You are supplied with BA 1 which is a solution containing 4.9g of phosphoric acid , H_3PO_4 per litre of solution and BA2 which is a 0.04M sodium hydroxide solution:

You are required to determine the

(i) ratio of acid to base reacting

(ii) stoichiometric equation for the reaction.

(iii) charge of the anion of the salt formed formula of the salt formed .

Procedure :

Titrate 20cm^3 of BA2 with solution BA1 using the indicator supplied. Repeat the titration to get consistent results . Enter your results in the table below . Burette readings (cm^3) .

Volume of pipette used (cm^3)

Burette readings

	1	2	3	4
Final reading				
Initial reading				
Volume of B4				

Average of BA1 used

(H = 1 O = 16, P = 31)

(i) Calculate the molarity of the acid.

(ii) the number of moles of the
(a) acid that reacted

(b) the alkali that reacted.

Determine the

(a) ratio of moles of acid to alkali reacting

.....

 (b) Stoichiometric equation for the reaction between the acid and alkali .

(c) formula of the salt produced .

(d) charge on the anion of the salt

Give a reason for your answer in (d) .

Follow up exercises.

STOICHIOMETRY :

1.00g of manganese metal (Mn) was added to 100cm³ of molar hydrochloric acid. The metal completely dissolved , producing 436cm³ of hydrogen, measured at room temperature and pressure. The excess acid required 64cm³ of molar sodium hydroxide solution for neutralization . (1 mole of gas at room temperature and pressure occupied 24dm³ , Mn = 55) .

(a) write an equation for the reaction between Hcl and NaOH solutions.

(b) calculate the number of acid that

(i) were in 100cm³ added to the metal

(ii) reacted with 64cm³ of molar sodium hydroxide solution.

(iii) reacted with the metal.

(c) Calculate the number of moles of

(i) manganese in 1.00g of the metal

(ii) hydrogen molecules in 436cm³ of hydrogen at room temperature and pressure .

Determine the molar ratio of manganese : acid .

hydrogen gas using your answers in questions (b) (iii) (c) above .

(e) with reasons , determine the formula of the other product not named , and state the charge on the manganese ion.

(f) Using your answers in (d) and (e) write the stoichiometric equation for the reaction between manganese and hydrochloric acid .

2. A certain compound was investigated and the following results obtained in various experiments .

experiment .

100g of a compound was composed 3.7g hydrogen , 37.8 phosphorous and 58.5g oxygen.
 experiment.

relative formula mass of the compound was formed to be 82.'

Experiment three .

100cm³ of 2M potassium hydroxide neutralised 100cm³ of a molar solution of the compound .
 Experiment four.

The compound showed acidic properties .

(c) What do you understand by the following terms

(i) a compound

(i) an acid ?

- (b) Other than neutralization of bases, state four other properties of the compound related to its acidic nature.
- (c) Use the results of experiment one and two to determine the molecular formula of the compound ($H = 1$ $O = 16$ $P = 31$)
- (d) Use the results of experiment three to determine the stoichiometric equation for the reaction between potassium hydroxide. All working should be shown.
1. Student A was supplied with solution BA1 contained 0.2 moles per litre and BA 2 which contained 14.4g per litre of $Na_2CO_3 \cdot xH_2O$. He pipetted 20cm^3 portions of BA 2 into 3 conical flasks added 3 drops of methyl orange indicator then titrated to get the following burette readings (cm^3).

Titration	1	2	3
Final readings	9.3	18.5	27.6
Initial readings	0	9.3	18.5
Titre used	9.3	9.2	9.1

- (a) what was the colour of the solution in the conical flask
- (i) before
- (ii) after titration.
- (b) What is wrong with the student's method of recording the results?
- (c) which titres should be averaged?
- (d) what was the average titre?
- (e) calculate the (i) molarity of BA2 to 2 places of decimal.
- (ii) relative formula mass of $Na_2CO_3 \cdot xH_2O$.
- (iii) value of x in $Na_2CO_3 \cdot xH_2O$.
- ($Na = 23$, $O = 16$, $H = 1$, $C = 12$).
- (iv) % of anhydrous Na_2CO_3 in $Na_2CO_3 \cdot xH_2O$.

2. Student B was given solution BA3 which was 0.05M acid H_nX and BA 4 which was a 0.1M NaOH, he pipetted 25cm^3 of BA 3 into each of three conical flasks added to each two drops of phenolphthalein indicator, then titrated against BA4, he tabulated the following.

Titration no	1	2	3
Final reading(cm^3)	13	25.5	38
Initial reading(cm^3)	0	13	25.5

- (a) Correct the mistakes made by the student in recording the above results.
- (b) Include the information not given by the student in the table above.
- (c) What was the colour of the solution in the flask just
- (i) before titration?
- (ii) after titration?
- (d) Calculate the
- (i) molar ratio of the acid to base reacting
- (ii) value of n in H_nX (basicity)
- (e) Write the stoichiometric equation between the acid and the alkali.
- (f) Name the two mineral acids that H_nX could be

Student C was given solution BA5 which was 0.1M XOM alkali, and BA 6 which was an acid $H_2Y \cdot nHO$ containing $6.30g\ l^{-1}$ of solution. He pipetted $20cm^3$ of BA6 into each of 3 conical flasks, added a suitable indicator, then titrated. He partially recorded the following results (cm^3)

Titration no	1	2	3
Final readings	19.95		
Initial readings	0.00		
Volumes of BA used		20.000	20.00

- Complete the table giving most suitable readings that would save time where appropriate.
- Name three acid - base indicators that could be used.
- What is the basicity of BA6?
- Calculate the molarity of the acid, BA6?
- Determine the relative formula mass of the acid, BA6.
- If $Y = 86$, determine the value of n .

4. A student pipetted $25cm^3$ of 0.02M acid .R into a conical flask, he added a suitable indicator, he titrated once, obtaining a very accurate titre. The diagrams below indicate his final and initial burette readings.

- showing your working, determine the volume of base added
- calculate the
 - ratio of acid to base reacting
 - basicity of the acid R.
- Reacting volumes of solution and their concn,
 - What volume of 2M KOH contains
 - 0.05moles of KOH?
 - $K = 39, O = 16, H = 1$.

2. What volume of 0.1M H_2SO_4 will neutralize $400cm^3$ of NaCl solution containing $16g\ l^{-1}$ of solution?

($Na = 23, O = 16, H = 1$)

3. What volume of water must be added to $500cm^3$ of M of HCl to make it 0.1MHCl?

4. 10g of sodium hydroxide was dissolved in water to make $100cm^3$ of solution. $10cm^3$ was diluted to $50cm^3$ by adding $40cm^3$ of water. What was the concentration of the diluted solution.

(i) in $g\ l^{-1}$

(ii) moles per litre ($Na = 23, O = 16, H = 1$)

5. If $20cm^3$ of 2M NaOH was mixed with $20cm^3$ of 2M H_2SO_4 , what volume of 0.2M Na_2CO_3 would be required to neutralise the excess acid?

QUALITATIVE ANALYSIS.

It deals with identification of various cations and anions present in the salts of inorganic substances. Qualitative analysis at this level mainly deals with the chemistry of a few selected non-transition metal cations, transition metal cations and some anions.

a) Non- transition metal cations:

Salts of non-transition metals are usually white or colorless and they generally dissolve in water or dilute acids to form colorless solutions. The cations considered in this case include:

Zinc ion, Zn^{2+}

Lead (ii) ion, Pb^{2+}

Aluminium ion, Al^{3+}

Ammonium ion, NH_4^+

Others may include:

Calcium ion, Ca^{2+}

Barium ion, Ba^{2+}

Magnesium ion, Mg^{2+}

b) Transition metal cautions.

Salts of transition metal exhibit characteristic colors and they usually dissolve in water or dilute acids to form colored solutions. The cautions considered in this case include:

Copper (ii) ion, Cu^{2+}

Iron (ii) ion, Fe^{2+}

Iron(iii)ion, Fe^{3+}

c) The anions (negative ions) considered at these level include:

Carbonate ion, CO_3^{2-}

Sulphate ion, SO_4^{2-}

Chloride ion, Cl^-

Nitrate ion, NO_3^-

Sulphite ion, SO_3^{2-}

Others may include:

Bromide ion, Br^-

Iodide ion, I^-

Nitrate ion, NO_2^-

Preliminary tests of substances:

When carrying out preliminary test on the unknown substance, a student is expected to carefully note the appearance, color and smell of the solid substance provided. The table below may be used as a guide.

Observation	Deduction
a) Substance is blue in color	Cu^{2+} possibly present
b) Substance is black in color	An oxide (O^{2-}) or Sulphide (S^{2-}) probably present
c) Substance is green	Fe^{2+} or Cu^{2+} could be present
d) Substance has a yellow color	Fe^{3+} or PbO probably present
e) Substance has smell of ammonia gas (punget chocking smell 'smell of urine')	NH_4^+ present
f) Substance has smell of sulphur dioxide(sharp chocking smell of burning sulphur)	SO_3^{2-} probably present
g) Substance has smell of hydrogen sulphide gas (punget rotten egg smell)	S^{2-} possibly present
h) Substance has smell of chlorine	Bleaching powder, CaOCl_2 ; Ca^{2+} probably present
i) Substance is deliquescent i.e. absorbs water vapor from air thus forming a solution.	Cl^- or NO_3^- could be present.

NOTE:

If the unknown substance is:

- (i) Crystalline in nature then it may be hydrated or possibly contain SO_4^{2-} , NO_3^- , SO_3^{2-} , Cl^- .
- (ii) Powdery in nature then it may be anhydrous or probably contain CO_3^{2-} , O^{2-} .

Solubility of unknown substances in water.

- i) All nitrates are soluble
- ii) All K^+ Na^+ and NH_4^+ salts are soluble.
- iii) All carbonates are insoluble except Na_2CO_3 , K_2CO_3 and $(\text{NH}_4)_2\text{CO}_3$.
- iv) All sulphates are soluble except CaSO_4 and Ag_2SO_4 , which are moderately soluble; PbSO_4 and BaSO_4 are insoluble.
- v) All Chlorides are soluble except PbCl_2 which is sparingly soluble in hot water and AgCl is insoluble.
- vi) All sulphites are soluble except CaSO_3 , BaSO_3 and PbSO_3 .
- vii) All hydroxides are insoluble except NaOH , KOH , NH_4OH ; $\text{Ca}(\text{OH})_2$ is sparingly soluble in cold water.

CARRYING OUT TESTS IN AQUEOUS SOLUTION.

In this case a solution of the original solid substance should first be prepared as follow:

Place a spatula end-full of the unknown solid substance into a clean test-tube then add about 5cm^3 of distilled water. Vigorously shake the mixture, incase the degree of solubility is low, warm gently and carefully note the color of the resultant solution and any heat changes that may occur.

The table below may be used as a guide.

Observation (colors)	Deduction(caution)
a) Solution is colorless	Zn^{2+} , Pb^{2+} , Al^{3+} , NH_4^+ , Ca^{2+} , Ba^{2+} , or Mg^{2+} may be present.
b) Solution is blue	Cu^{2+} could be present.
c) Solution is green	Fe^{2+} may be present.
d) Solution is pale blue- green	Cu^{2+} or Fe^{2+} suspected.
e) Yellow or yellow-brown solution that turns blue litmus red.	Fe^{3+} present.

ACTION OF HEAT ON UNKNOWN SOLID SUBSTANCE.

In these test, heat a spatula end full of unknown solid substance in a hard dry test-tube or in an ignition tube until no further change occurs.

During heating a student should note;

- i) Appearance of the substance (residue) when hot then on cooling.
- ii) The color of the sublimate, if any.
- iii) Identify any gases or vapors evolved. Gases or vapors given off by action of heat on solid substance may be identified by:

Noting the color and smell of the gas.

- Bubbling the gas into limewater.
- Bringing the gas into contact with Conc. Hydrochloric acid and conc. Ammonia solution.
- Using anhydrous copper (ii) sulphate or Cobalt chloride paper.
- Using acidified solutions of potassium permanganate or potassium dichromate.

The table below may be used as a guide on the nature of the residue during or after heating.

Observation	Deduction
a) Yellow when hot white on cooling	ZnO formed Zn^{2+} present
b) Reddish-brown (when hot)	PbO formed Pb^{2+} suspected
c) White sublimate formed on the walls of the middle part of the test-tube.	Ammonium salt NH_4^+ present
d) Blue solid turns black	CuO formed Cu^{2+} present
e) Yellow solid turns red-black	Fe_2O_3 formed Fe^{3+} present
f) Blue solid turns white (when hot or on cooling.	Hydrated Cu^{2+} changes to anhydrous Cu^{2+}
g) Green solid turns black.	CuO or FeO formed Cu^{2+} or Fe^{2+} possibly present
h) Green solid turns red-brown	Fe_2O_3 formed Fe^{2+} oxidized to Fe^{3+}
i) The solid does not change color on heating. (No apparent Observable color change on heating)	SO_4^{2-} or O^{2-} present The solid may be thermally stable.

The table below may be used as a guide on gases or vapors given off during heating.

Observation	Deduction
a) Colorless, steamy vapor condenses into a colorless liquid in the upper test tube. The liquid is neutral to litmus but turns white anhydrous copper(ii) sulphate to blue cobalt chloride paper pink.	Water of crystallization. Hydrated salt or HCO_3^{2-} , HSO_4^- , OH^- probably present.
b) Colorless, odourless gas that turns blue litmus to pale red and lime water milky.	Carbon dioxide gas, CO_2 evolved CO_3^{2-} or HCO_3^- present.
c) Colorless gas with characteristic. Chocking smell. The gas turns red litmus blue and forms dense white fumes with Conc. Hydrochloric acid.	Ammonia gas, NH_3 given off. NH_4^+ present.
d) Colorless gas with irritating smell of burning sulphur turns blue litmus red then bleaches it. The gas decolorizes acidified potassium permanganate solution from Orange to green.	Sulphurdioxide gas, SO_2 evolved. SO_3^{2-} or SO_4^{2-} from heavy metals present.
e) Reddish-brown gas with characteristics irritating smell, turns blue litmus red but does not bleach.	Nitrogen dioxide gas, NO_2 evolved. NO_3^- present

f) White fumes with irritating smell turns blue litmus red and barium nitrate milky	Sulphurdioxide, SO_3 evolved. SO_4^{2-} , HSO_4^- suspected.
g) Colorless, colorless gas neutral to litmus and relights a glowing splint.	Oxygen, O_2 evolved. NO_3^- present.
h) Colorless gas with irritating smell forms misty fumes in damp air and turns blue litmus red. The gas forms dense white fumes with Conc. Ammonia solution and a white acidified solution of silver nitrate.	Hydrogen Chloride gas, HCl evolved. Cl^- present.
i) Colorless gas with rotten egg smell, turns blue litmus pale red and burns with blue flame, depositing a yellow solid (sulphur) on the cold surface.	Hydrogen sulphide, H_2S gas evolved.
j) Greenish yellow gas with characteristic irritating smell, turns blue litmus red then bleaches it.	Chlorine gas Cl_2 evolved.

Detection of Cations and Anions.

1. Action of sodium hydroxide solution.

Test: To the solution of unknown, add dilute sodium hydroxide solution drop wise until in excess. If no precipitate is formed, warm gently and then test for ammonia gas.

Observation

Deduction

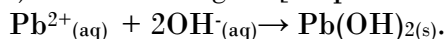
a) White ppt. insoluble in excess reagent.	Ca^{2+} , Ba^{2+} , Mg^{2+} probably present (NB: Solutions of Ba^{2+} and Ca^{2+} must be concentrated)
b) White ppt soluble in excess reagent forming a colorless solution.	Pb^{2+} , Zn^{2+} , Al^{3+} possibly present
c) No observation color change but a colorless choking gas that turns red litmus blue and forms dense white fumes with Conc. HCl evolved on warming	NH_3 (g) evolved NH_4^+ present
d) Blue ppt insoluble in excess reagent. Black solid formed on heating	Cu^{2+} present CuO formed
e) Green ppt insoluble in excess but slowly turns brown on the surface	Fe^{2+} present Fe^{2+} oxidized to Fe^{3+}
f) Reddish-brown ppt insoluble in excess	Fe^{3+} suspected.

Note:

$\text{Pb}(\text{OH})_2$, $\text{Zn}(\text{OH})_2$ and $\text{Al}(\text{OH})_3$ are amphoteric thus they dissolve in excess sodium hydroxide solution to form colorless solutions (complexes) i.e.

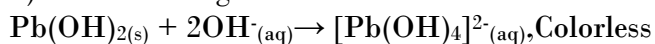
a) Consider Pb^{2+} ions.

i) In a little reagent [drop wise addition of NaOH (aq)]



White ppt

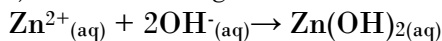
ii) In excess reagent:



Tetrahydroxyplumbate (ii) ion

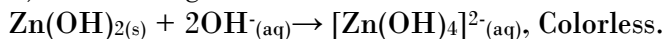
b) Consider Zn^{2+} ions.

i) In a little reagent:



White ppt.

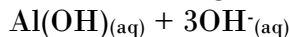
ii) Excess reagent;



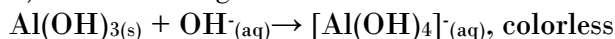
Tetrahydroxyzincate ion.

c) Consider Al^{3+}

i) In a little reagent:



ii) In excess reagent:



Tetrahydroxyaluminate ion.

2. Action of aqueous ammonia solution.

Test: To the solution of the unknown, add dilute ammonia solution drop wise till in excess.

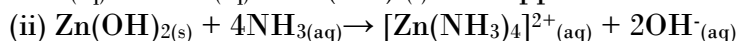
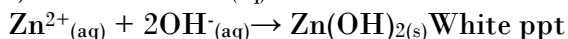
Observation	Deduction
a) White ppt insoluble in excess	Pb^{2+} , Al^{3+} present
b) white ppt soluble in excess forming a colorless solution.	Zn^{2+} present $[\text{Zn}(\text{NH}_3)_4]^{2+}$ formed in excess.
c) Pale blue ppt soluble in excess forming a deep blue solution.	Cu^{2+} present $[\text{Cu}(\text{NH}_3)_4]^{2+}$ formed in excess
d) Green ppt insoluble in excess turns yellowish-brown on shaking/ standing	Fe^{2+} present Fe^{2+} oxidized to Fe^{3+}
e) Reddish- brown ppt insoluble in excess.	Fe^{3+} present

Note:

Zinc hydroxide, $\text{Zn}(\text{OH})_2$ and copper (ii) hydroxide, $\text{Cu}(\text{OH})_2$ dissolve in excess aqueous ammonia solution to form soluble complexes. i.e.

(a) Consider Zn^{2+} ion.

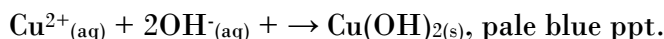
i) In a little $\text{NH}_3(\text{aq})$.



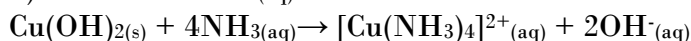
Tetra amine zinc (ii) ion, colorless.

(b) Consider Cu^{2+} ion.

i) In a little $\text{NH}_3(\text{aq})$



ii) In excess $\text{NH}_3(\text{aq})$



Tetra ammine copper(ii) ion, deep blue

3. Action of dilute hydrochloric acid on solid substances.

Test; To the unknown solid substance in a clean test-tube, add about 2cm³ of dilute hydrochloric acid. If no reaction occurs warm gently.

Observation	Deduction
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a) Effervescence of a colorless, odourless gas, turns blue litmus pale red (pink) and lime water milky.	$\text{CO}_{2(g)}$ evolved CO_3^{2-} present $\text{CO}_3^{2-} + 2\text{H}^+_{(aq)} \rightarrow \text{CO}_{2(g)} + \text{H}_2\text{O}_{(l)}$
b) No reaction in cold. Bubbles of a colorless, choking gas, turns blue litmus red and dichromate paper green.	$\text{SO}_{2(g)}$ given off. SO_3^{2-} present $\text{SO}_3^{2-} + 2\text{H}^+_{(aq)} \rightarrow \text{SO}_{2(g)} + \text{H}_2\text{O}_{(g)}$
c) No visible reaction even on warming.	SO_4^{2-} or NO_3^- present
d) With solution of the unknown, white ppt formed dissolve on heating and reprecipitates on cooling	Pb^{2+} present $\text{Pb}^{2+}_{(aq)} + 2\text{Cl}^-_{(aq)} \rightarrow \text{PbCl}_{2(s)}$

4. Action of concentrated sulphuric acid on solid substances.

Test: Add a few drops of Conc. Sulphuric acid to the unknown solid substance in a clean test-tube. If no reaction occurs in the cold warm gently. [Care! Do not boil, the reaction may be explosive or violent]

Observation

Deduction

a) Rapid effervescence of a colorless gas that turns blue litmus red and lime water milky occurs.	Carbon dioxide evolved. CO_3^{2-} present.
b) Effervescence of a colorless, choking gas, turns blue litmus red then bleaches it and decolorizes acidified potassium permanganate solution.	$\text{SO}_{2(g)}$ evolved. SO_3^{2-} present
c) Effervescence of a colorless irritating gas that turns blue litmus red, forms misty fumes in damp air and dense white fumes with conc. NH_3 solution.	$\text{HCl}_{(g)}$ given off. Cl^- present. $\text{Cl}^-_{(s)} + \text{H}^+_{(aq)} \rightarrow \text{HCl}_{(g)}$
d) pale yellow irritating fumes condense to a colorless liquid. Further reddish-brown, irritating gas evolved turned blue litmus red and a glowing splint re-lit.	NO_3^- present Nitric acid vapor, $\text{HNO}_{3(g)}$, $\text{O}_{2(g)}$ and $\text{NO}_{2(g)}$ evolved. $\text{NO}_3^-_{(g)} + \text{H}^+_{(aq)} \rightarrow \text{HNO}_{3(g)}$ $4\text{HNO}_{3(g)} \rightarrow 4\text{NO}_{2(g)} + 2\text{O}_{2(g)} + 2\text{H}_2\text{O}_{(l)}$
e) Blue solid turned white.	Cu^{2+} present Hydrated Cu^{2+} salt turned to anhydrous Cu^{2+}

5. Action of dilute sulphuric acid on solid substance or aqueous solution.

When dilute sulphuric acid is used, observation and deduction similar to those of dilute hydrochloric acid are made.

If a white ppt is formed, then Pb^{2+} , Ba^{2+} , or Ca^{2+} is possibly present due to precipitation of PbSO_4 , BaSO_4 , and CaSO_4 respectively.

6. Action of lead (ii) nitrate solution.

Test: To 1cm³ of the solution unknown, add 1-2 drops of lead nitrate solution. If necessary heat then cool after wards.

Observation

Deduction

a) White ppt, dissolves on boiling and crystallizes on cooling to white crystals.	Cl^- present
b) White ppt, insoluble on heating or in dilute nitric acid.	SO_4^{2-} present.
c) White ppt insoluble on heating but soluble in dilute nitric acid with effervescence of a colorless gas that turns blue litmus pink and lime water milky.	CO_3^{2-} present. $\text{CO}_2(\text{g})$ present.

7. Action of potassium iodide solution.

Test: To the solution of unknown substance, add 2-3 drops of potassium iodide solution.

Observation**Deduction**

a) Colorless solution forms a yellow ppt	Pb^{2+} present
b) Yellow solution turns to reddish-brown solution.	Fe^{3+} present $\text{I}_2(\text{aq})$ is liberated. Fe^{3+} is reduced to Fe^{2+}
c) Cream ppt (or nearly yellow ppt stained white) in a red-brown solution.	Cu^{2+} present. I_2 liberated.

8. Action of potassium chromate solution.

Test: Add 2-3 drops of potassium chromate solution to the solution of the unknown observe then heat.

Observation**Deduction**

a) Yellow ppt turns orange on heating and soluble in excess $\text{NaOH}_{(\text{aq})}$ forming a colorless solution.	Pb^{2+} present
b) Pale yellow ppt, insoluble in $\text{NaOH}_{(\text{aq})}$	Ba^{2+} present.

Confirmatory tests for Cations.**Cation****Test****Observation**

a) Pb^{2+}	To a solution containing Pb^{2+} add: i) 1-2 drops of potassium Iodide solution, heat then cool under a tap of running water. ii) 1-2 drops of potassium chromate solution then heat. iii) 2-3) drops of dilute hydrochloric acid, heat then cool, under a tap of running water.	Yellow ppt, soluble on heating, re-crystallizes on cooling as golden yellow crystals. Yellow ppt turns orange on heating. White ppt, dissolves on boiling, crystallizes on cooling to form white crystals.
b) NH_4^+	To a solution containing NH_4^+ , add excess sodium hydroxide solution then boil.	A colorless gas with punget chocking smell is evolved; the gas turns red

		litmus blue and forms dense white fumes with conc. Hydrochloric acid NH_3 evolved.
c) Zn^{2+}	To a solution containing Zn^{2+} , add aqueous ammonia solution drop wise till in excess.	White ppt dissolves in excess reagent forming a colorless solution.
d) Ba^{2+}	To a solution containing Ba^{2+} add 1-2 drops of potassium chromate.	Pale yellow ppt.
e) Al^{3+}	To a solution containing Al^{3+} add 1-2 drops of litmus solution, followed by dilute hydrochloric acid, then finally add a few drops of $\text{NH}_3(\text{aq})$ until just alkaline.	Blue lake observed.
f) Cu^{2+}	To a solution containing Cu^{2+} add: i) Ammonia solution drop wise till in excess. ii) 2-3 drops of potassium hexacyanoferrate (ii) solution iii) 3-4 drops of potassium iodide solution	Pale blue ppt dissolves in excess to form a deep blue solution A reddish-brown ppt. Green ppt, insoluble in excess, turns yellow-brown on standing.
g) Fe^{2+}	To a solution containing Fe^{2+} add; i) 3-4 drops of potassium hexacyanoferrate(iii) solution. ii) Ammonia solution drop wise until in excess.	Dark blue ppt. Green ppt, insoluble in excess, turns yellow-brown on standing.
h) Fe^{3+}	To a solution containing Fe^{3+} add; i) 3-4 drops of potassium thiocyanate. ii) 3-4 drops of potassium hexacyanoferrate (ii) solution.	Deep red solution Dark blue ppt.

Confirmatory tests for Anions.

Anion	Test	Observation
a) Cl^-	i) To the test solution add a few drops of dilute nitric acid, then 2-3 drops of silver nitrate solution. ii) To unknown solid add a few drops of conc. H_2SO_4 and warm. iii) To unknown solid add a little manganese (iv) oxide followed by a few drops of conc. H_2SO_4 then warm.	White ppt insoluble in the acid turns violet on exposure to light. The white ppt is soluble in excess ammonia solution. Colorless pungent fumes evolved, turn blue litmus red. NH_3 solution . $\text{HCl}(\text{g})$ given off. Evolution of greenish yellow gas that turns blue litmus red then bleaches

		it. Cl_2 evolved.
b) SO_4^{2-}	i) To the solution of the unknown add a few drops of nitric acid then 2-3 drops of Barium nitrate solution. ii) To a solution of unknown add drops of hydrochloric acid followed by 2-3 drops of Barium chloride solution.	White ppt insoluble in the acid. White ppt insoluble in the acid.
c) CO_3^{2-}	To the unknown solid add dilute nitric or hydrochloric acid or strongly heat the solid.	Effervescence of a colorless, odorless gas that turns blue litmus pale red and lime water milky (i.e. CO_2 evolved) confirms CO_3^{2-}
d) NO_3^-	i) To unknown solid add a few pieces of copper turnings, then about 2cm^3 of H_2SO_4 heat gently. ii) Brown ring test. Add cold freshly prepared iron (ii) sulphate solution to conc. H_2SO_4 down the sides of the test-tube to form lower layer. iii) To the solid or solution of the unknown add a few drops of $\text{NaOH}_{(\text{aq})}$ then a little Zinc or Aluminium or Devard's alloy and heat the mixture.	Evolution of a reddish-brown gas that turns blue litmus red (NO_2 gas) and formation of a blue solution of Cu^{2+} confirms NO_3^- Formation of brown ring at the aqueous layer-acid junction confirms NO_3^- Evolution of a colorless pungent gas that turns red litmus blue and fumes heavily with conc. (NH_3 evolved) confirms NO_3^-
e) SO_3^{2-}	i) To test solution add a few drops of iodide solution. ii) To test solution add 2-3 drops of Barium nitrate solution followed by dilute nitric acid.	The brown color is immediately decolorized $\text{I}_2 + 2\text{SO}_3^{2-} + \text{H}_2\text{O} \rightarrow 2\text{I}^- + \text{SO}_4^{2-} + 2\text{H}^+$ White ppt, soluble in dil. Nitric acid. $\text{Ba}^{2+} + \text{SO}_3^{2-} \rightarrow \text{BaSO}_3(\text{s})$ $\text{BaSO}_3(\text{s}) + 2\text{H}^+ \rightarrow \text{SO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) + \text{Ba}^{2+}$

Worked examples**Example 1.**

You are provided with the substance X that contains one cation and one anion. Carry out the following tests to identify the cation and the anion in X. Identify any gases that may be evolved. Record your observation and deduction in the table below.

Test	Observation	Deduction
a) Appearance of X	X is a green crystalline substance.	Transition metal ion probably present.
b) Place a spatula end-full of X in a dry test tube	X forms a black residue. A colorless vapor that	CuO possibly formed. Cu^{2+} probably present.

then heat strongly till no further change occurs.	condenses to a colorless liquid is given off. The liquid turns white anhydrous copper (ii) sulphate blue. A colorless gas with an irritating smell is evolved. The gas turns blue litmus red and forms misty fumes in air and dense white fumes with conc. Ammonia solution on a glass rod.	Water of crystallization possibly from hydrated substance or OH^- Hydrogen chloride gas evolved. Cl^- probably present.
c) To a spatula end-full of X in a test tube add about 5cm^3 of water and shake. Divide the solution into 4 portions. i) To the first portion add sodium hydroxide solution drop wise till in excess.	X completely dissolves in water forming a pale blue solution. Pale blue ppt insoluble in excess reagent.	Cu^{2+} suspected. Cu^{2+} present.
ii) To the second portion add ammonia solution drop wise till in excess.	Blue ppt, which dissolves in excess reagent forming a deep blue solution.	Cu^{2+} confirmed.
iii) To the third portion add a few drops of lead(ii) nitrate solution.	White ppt observed.	SO_4^{2-} or Cl^- present.
iv) Use the forth portion to carry out a test of your own choice to confirm the anion in X. test: To the forth portion add 2-3 drops of silver nitrate solution followed by dilute nitric acid.	Intense white ppt insoluble in nitric acid.	Cl^- confirmed.

Identify the:Cation in X Cu^{2+} Anion in X Cl^- **Example 2.**

You are provided with substance Y that contains two cations and two anions. Carry out the following tests to identify the cations and the anions in Y. Identify any gases that may be evolved. Record your observations and deductions in the table below.

a) Place 2 spatula of Y in a test tube. Add 5cm^3 of water, shake vigorously and filter. Keep both filtrate and residue.	White crystalline-powdery substance Y partially dissolves forming a colorless filtrate and white residue.	Non-transition metal ions such Pb^{2+} , Zn^{2+} , NH_4^+ , Al^{3+} possibly present.
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Divide the filtrate into 3 parts. i) To the first part add excess sodium hydroxide solution then heat and smell.	No observable color change. But a colorless gas with an irritating punget smell is evolved. The gas turns red litmus blue and forms dense white fumes with conc. Hydrochloric acid on a glass rod.	Ammonia gas evolved. NH_4^+ confirmed.
ii) To the second part 2-3 drops of lead nitrate solution and heat.	White ppt. insoluble on heating.	Cl^- absent. SO_4^{2-} probably present.
iii) use the third part to carry out a test of your choice to confirm the anion in Y. test To the third part add 2-3 drops of barium chloride solution followed by dilute hydrochloric acid.	White ppt insoluble in the acid.	SO_4^{2-} confirmed.
b) Wash the residue with little distilled water then divide it into parts. i) strongly heat the first part till no further change occurs.	White residue turns yellow when hot white on cooling. A colorless gas that turns blue litmus pink and limewater milky is evolved.	ZnO formed. Zn^{2+} present Carbon dioxide gas is evolved. CO_3^{2-} present.
c) To the second part of the residue add 3cm^3 of dilute hydrochloric acid. Divide the mixture into 2 parts. i) To the first part of the mixture add sodium drop wise till in excess.	The residue dissolves with rapid effervescence of a colorless gas that turns limewater milky. A colorless solution is formed. White ppt soluble in excess reagent forming a colorless solution is observed.	Carbon dioxide gas is evolved. CO_3^{2-} confirmed. $\text{Zn}^{2+}, \text{Pb}^{2+}, \text{Al}^{3+}$ present.
ii) To the second part add ammonia solution drop wise till in excess.	White ppt that dissolve in excess reagent forming a colorless solution is observed.	Zn^{2+} confirmed.

Identify the:

Cation in Y NH_4^+ and Zn^{2+}

Anion in Y SO_4^{2-} and CO_3^{2-}