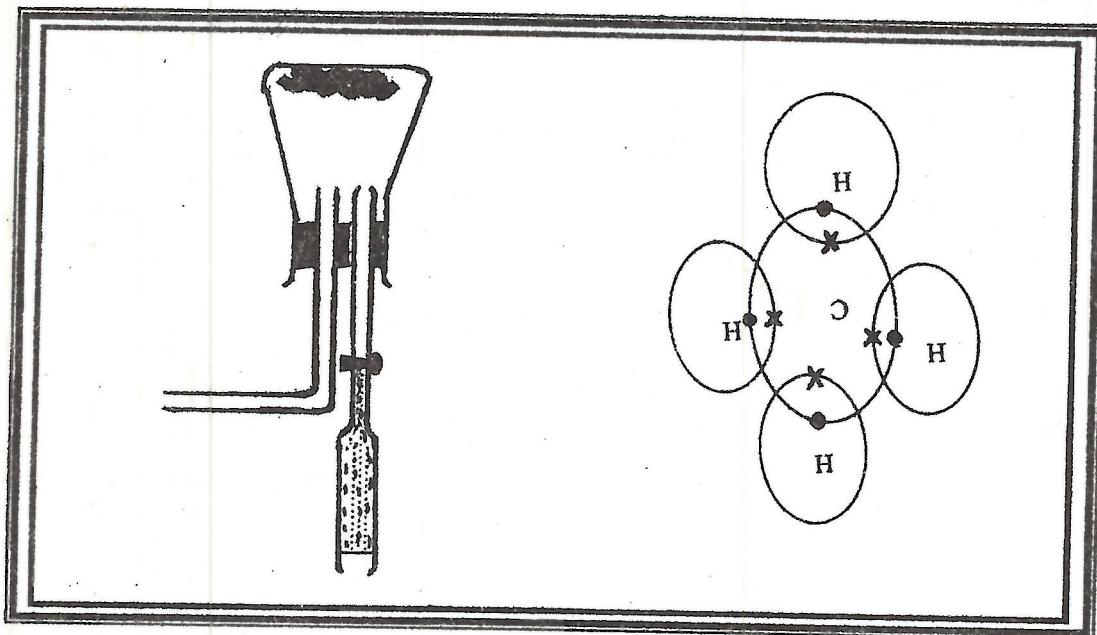


Fraser Kumwenda

COMPLETE SYLLABUS COVERAGE

QUESTIONS AND ANSWERS



CHEMISTRY

Senior Secondary School

PREFACE

This book provides a varied selection of questions and answers. The questions, which include some MANEB past paper questions, have been carefully selected to cover all the chemistry topics at MSCB level.

The questions cover the fundamentals which appear most frequently in MANEB questions in line with the current Physical Science Syllabus.

This book serves as a quick revision aid and a self-assessment resource for Chemistry questions selected to answer for exams. It is also an illustration of how students as they prepare for exams. It is also an illustration of how in some cases, the method or solution to a problem given is not the only one. It would prove a useful experience for the student to find alternative method or solution to such problems.

The questions selected are expected to familiarise students with the type of questions set for MSCB examinations.

I hope you find this book a very useful resource as you prepare for your examinations. I wish you all the best.

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I thank the almighty God for giving me the wisdom, courage and enthusiasm to compile this book. To him be the honour and the glory.

Many thanks are due to *Willy Ntholola* of St John's Catholic Secondary School, *Joshua Nkhatia* of Likuni Girls Secondary School and *Chiyoka Ng'ambi* of Chipasula Secondary School for checking the relevance of the questions to the current syllabus and the correctness of the answers provided.

I also wish to thank St John's Secondary school management, teaching staff, support staff and the entire student body for their support and encouragement which helped me work positively while writing this book.

Chapter 1:	Elements And Chemical bonding	1
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- The following list of books is not exhaustive.
1. Keith Wallis, Chancro Physical Science for Malawi, Book 2 (3rd edition), pages 15-33, 39-62.
 2. Samuel Kaleda, MSC Physical Science (New edition), pages 22-41
 3. Juliet Napwora et al, K.C.S.E Golden Tips Chemistry, pages 41-45, 48-53, 56-62, 77-83, 101-104.
 4. Rose Gallagher & Paul Ingram, Complete Chemistry, pages 26-39, 42-53, 62-73.

After reading the chapter, test your understanding by answering the 58 questions in this chapter. Cross check your answers with the answers provided.

Before attempting the following questions, you are STRONGLY ADVISED to read the chapter in your notes or one of the books listed below.

To the student.

58 QUESTIONS WITH ANSWERS

ELEMENTS AND CHEMICAL BONDING

CHAPTER 1

Sodium chloride is used as a preservative for meat and fish signs.

Sodium vapour produces a yellow glow and is used in street lights and advertising Answers

Q4. Mention two uses of sodium metal

particles	Mass number	Number of protons	Number of neutrons	Electron configuration	
Z		20	10	10	2.8
Y		23	11	12	2.8.1
X		19	9	10	2.7

Answers

particles	Mass number	Number of protons	Number of neutrons	Electron configuration	
Z		20		10	
Y				12	
X		19		10	2.8.1

Q3. Copy and complete the following table.

c. It belongs to group 2 of the periodic table.
The atom has 12 protons.

$$= 12$$

$$= 24 - 12$$

b. Number of neutrons = mass number - atomic number.

a. 2.8.2

Answers

c. To which group of the periodic table does element K belong?

b. How many neutrons are there in one atom of K?

a. Write the electronic configuration of K.

Q2. An atom of element K can be represented as follows: $^{24}_{12} \text{K}$

particles	symbols	charges	mass	proton	p	+1	1
neutrons	n	0	1				
electrons	e	-1	0				

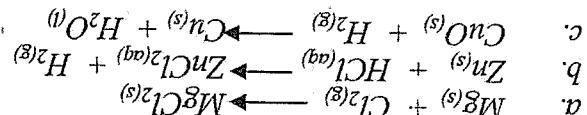
Answers

particles	symbols	charges	mass	neutrons	n	+1	1
electrons		-1					

Q1. Copy and complete the table below.

Answer
Molten form.

Q7. Sodium chloride conducts electricity in one form. Name it.



Answers

e. Copper (II) oxide reacts with hydrogen.

b. Zinc reacts with hydrochloric acid.

a. Magnesium reacts with chlorine

Q6. Write the chemical equations of the following reactions:

- b. R has more valence electrons than E therefore it experiences stronger forces of attraction between the positively charged nucleus and the valence electrons which make the atomic radius smaller.
- c. The halogens.
- d. Element C
- e. Element R.
- f. BE

						X	
						W	
					E	R	
			V	U			
		II	III	IV	V	VI	VII

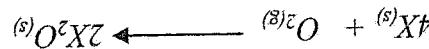
Answers

- a. An element V has an atomic number of 7. Indicate the position of V on the grid.
- b. Explain why the atomic radius of E is bigger than that of R.
- c. What name is given to the family of elements to which R, W and X belong?
- d. Which element has the highest tendency to lose electron?
- e. Select the most reactive non-metal.
- f. Write the formula of the compound formed when B reacts with E.

						X	
						W	
					E	R	
			V	U			
		II	III	IV	V	VI	VII

I

- Q5. The grid below represents part of the periodic table. Study it and answer the questions that follow. The letters are not the actual symbols of the elements.



Answer

for the reaction.

Q11. A student got element X which she suspected to be a group I element. She inserted burning metal X in a gas jar full of oxygen. Write a balanced equation

air while hydrogen is explosive.

Answer
Helium is preferred because it is generally inert and does not react with oxygen in the

preferred to hydrogen?

Q10. Hydrogen and helium are used in weather balloons. Explain why helium is

lost or gained electrons in order to attain stability.

e. Oxidation number is the charge obtained after an atom or group of atoms has

stability/Is the combining power of an atom.

d. Valency is the number of electrons an atom loses or gains in order to attain shells of an atom.

c. Electron configuration is the systematic arrangement of electrons in the energy levels of an atom/Is the number and arrangement of electrons in the electron

b. Mass number is the sum of the number of protons and neutrons in an atom.

a. Atomic number is the number of protons in an atom.

Answer

Q9. Define the following terms:
 a. atomic number b. mass number c. electron configuration
 d. valency e. oxidation number

	protons	neutrons	CI-37	17	18
			CI-35	17	18

c. valence electrons.

b. They have the same chemical properties because they have the same number of different mass numbers.

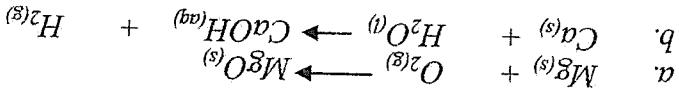
a. Isotopes are atoms of the same element with the same atomic number but different mass numbers.

Answers.

c. What is the number of protons and neutrons in the nucleus of each isotope?
 b. Would you expect the two isotopes of chlorine to have the same chemical properties or not? Explain.
 a. What are isotopes



Q8. The following symbols refer to isotopes of chlorine.



Answers

b. Reaction of calcium with air

a. Reaction of magnesium with water.

in each equation.

Q14. Write balanced equations for each of the following reactions. Show state symbol in each equation.

Elements	Carbonates (CO_3^{2-})	Nitrates (NO_3^-)	Oxides (O_2^-)	K ₂ O	K_2CO_3	KNO_3	K ₂ O
lithium	Li_2CO_3	$LiNO_3$	Li_2O			Na_2CO_3	Na_2O
sodium						$NaNO_3$	
potassium							

Answer

Elements	Carbonates (CO_3^{2-})	Nitrates (NO_3^-)	Oxides (O_2^-)	K ₂ O	K_2CO_3	KNO_3	K ₂ O
lithium							
sodium							
potassium							

Q13. Complete the table below given that the valency of group I elements is one.

a. Li: 2.1 Na: 2.8.1 K: 2.8.8.1							
b. The atomic radius increases from lithium to potassium because the number of energy levels occupied by electrons increases from lithium to potassium.							
c. From lithium to potassium, atomic radius increases and this reduces the forces of attraction between the atoms. Less forces of attraction between the atoms result in less melting and boiling points.							
d. Metals have delocalised valence electrons which are responsible for electrical conductivity.							

Answers

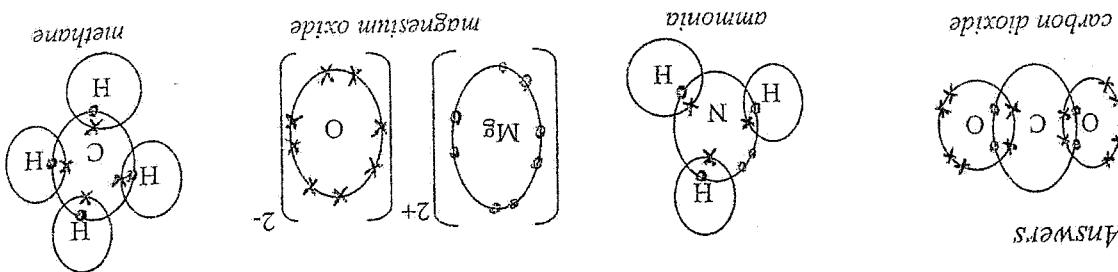
Element	Symbol	Atomic number	M.pt (°C)	B.pt (°C)	Electrical conductivity	Potassium	K	19	63	759	good
sodium	Na	11	98	883	good						
lithium	Li	3	181	134	good						

Answers

Element	Symbol	Atomic number	M.pt (°C)	B.pt (°C)	Electrical conductivity	Potassium	K	19	63	759	good
sodium	Na	11	98	883	good						
lithium	Li	3	181	134	good						
potassium											

Answer the questions that follow.

Q12. The table below shows some properties of group I elements. Study the table and answer the questions that follow.



Answers

d. methane

a. carbon dioxide b. ammonia c. magnesium oxide

Q17. Draw electron-shell diagrams to illustrate the bonding in the following substances.

Answer
Increase in temperature increases the kinetic energy of the vibrating atoms as a result they vibrate faster. This increases resistance to the flow of electrons, reducing electrical conductivity of the metal.

Q16. Explain why the electrical conductivity of a metal decreases with increasing temperature.

- a. Which elements have similar chemical properties. Explain.
b. Which element is a non-metal. Explain.
c. Write the chemical formula for oxide of E.
d. Name the elements that belong to the same group. Explain.
e. Identify the most reactive metal from the table.
f. What is the valency of elements F and H
g. F is non-metal. It has seven electrons in the outer shell therefore belongs to the same group.
h. EO
i. Halogens (non-metals)
j. E and H. They have same number of electrons in the outer shell hence belongs to the same group.
k. G is the most reactive metal.
l. Valency of F is 1
m. Valency of H is 2
n. Answers

- a. Which elements have similar chemical properties. Explain.
b. Which element is a non-metal. Explain.
c. Write the chemical formula for oxide of E.
d. Name the elements that belong to the same group. Explain.
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i. Halogens (non-metals)
j. E and H. They have same number of electrons in the outer shell hence belongs to the same group.
k. G is the most reactive metal.
l. Valency of F is 1
m. Valency of H is 2
n. Answers

Elements	Electron arrangement
H	2,8,2
G	2,8,1
F	2,7
E	2,2

Q15. Use the table below to answer the following questions.

- a. Have high melting and boiling points, Poor conductors of electricity.
 b. Have low melting and boiling points, Poor conductors of electricity.

Answers

- b. Simple molecular compounds.

- a. Giant covalent structures

Q21. State one property of each of the following:

- a. Rhombic sulphur is more stable because of the interlocking arrangement of the sulphur rings.
 b. Vulcanisation of rubber, Making of drugs and skin ointments, Manufacture of gun powder, manufacture of sulphuric acid, sterilizing agent, manufacture of matches.

Answers

- b. Mention any two uses of sulphur.

Q20. a. Explain why rhombic sulphur is more stable than monoclinic sulphur.

- a. E will be good for making a cooking pan because it has high melting point and is a poor conductor of electricity.
 b. H can be used as an electrolyte.
 c. F has a giant covalent structure.
 d. H has metallic bonds.

Answers

- (i) Giant covalent structure (ii) Metallic bond

b. Name the substance that can be used in the laboratory as an electrolyte.

a. Which substance would you recommend for making a cooking pan?

Substance	Mp (°C)	Bt (°C)	Electrical conductivity (solid)	Electrical conductivity (liquid)
H	1083	2567	good	good
G	-183	-164	poor	poor
F	993	1695	poor	poor
E	1723	2230	poor	good

the questions that follow.

Q19. The following table gives some properties of four substances. Study it and answer

a. Allotropes of sulphur are rhombic sulphur and monoclinic sulphur.

b. Allotropes of carbon are diamond and graphite.

a. Allotropes are the different forms of an element in the same physical state.

Answers

- (i) Carbon (ii) Sulphur

b. Mention two allotropes of the following:

Q18. a. What are allotropes?

b. Lithium atom has smaller atomic radius compared to sodium atom. As a result of the small atomic radius, lithium atoms experience strong forces of attraction between the atoms making it harder to cut than sodium.

a. Lithium has a small atomic radius compared to potassium. Its valence electrons experience stronger forces of attraction from the positively charged nucleus. The valence electrons are not easily lost hence slow reaction.

Answers.

- b. Lithium is harder to cut than sodium.
- a. Lithium reacts slowly in water than does potassium.
- Q26. Explain the following:

b. They have low melting and boiling points due to weak intermolecular forces.

a. Do not conduct electricity in any physical state.

Answers

Q25. Mention two physical properties of covalent compounds.

- c. Ionic bonding is common between a metal and non metal in which case the metal loses electrons to the non metal. The metal forms positive ions while the non metal forms negative ions. Bonding occurs because the two ions with opposite charges attract each other to form compounds.
- b. Metallic bonding is the type of bonding which occurs in metals due to the forces of attraction between the free electrons and stationary positive metal ions in the metallic lattice.
- a. Covalent bonding occurs when two or more non metal atoms share electrons to attain stability.
- Answers.

- c. Ionic bonding.
- b. Metallic bonding.
- a. Covalent bonding.
- Q24. Briefly describe the following types of bonding.

Answer: Ionic compound

Q23. Element M and N have electron configurations 2.8.1 and 2.6 respectively. Name the type of compound formed when M and N combine.

Answer: Ionic bond is formed because the sodium loses electrons to the chlorine. The sodium forms positive ion while the chlorine forms negative ion. Bonding occurs because of the forces of attraction between the two ions with opposite charges.

Q22. Sodium reacts with chlorine to form sodium chloride salt. What type of bond is formed? Explain.

Chemical properties: React with halogens to form metal halides, react with oxygen in the air to form a metal oxide.

Physical properties: Are soft and can be cut with a knife, they are ductile, they are malleable, have low density and float on water, have silvery colour when just cut.

a. *Physical properties:* Are soft and can be cut with a knife, they are ductile, they are malleable, have low density and float on water, have silvery colour when just cut.

Answers.

- Q29. a. Mention any two physical properties and any two chemical properties of the group I elements.
- b. Explain why sodium metal floats on water.
- c. Briefly describe an experiment that can be done to show that when sodium reacts with water a balanced chemical equation for the reaction between water and sodium metal.
- d. Write down a balanced chemical equation for the reaction between water reacts with a basic solution is formed.

Q30. a. Mention any two physical properties and any two chemical properties of the

b. Diamond does not conduct electricity while graphite conducts electricity.

c. Diamond is very hard compared to graphite.

d. Graphite has valence electrons which are delocalised while diamond has no free valence electrons.

Answers.

- Q29. a. Graphite and diamond are allotropes of carbon. Explain why graphite is a good conductor of electricity while diamond is a poor conductor of electricity.
- b. Explain the difference between graphite and diamond in terms of their physical properties.
- c. Graphite has valence electrons which are delocalised while diamond has no free valence electrons.

- Q28. a. Cesium is expected to conduct electricity because group I elements are metals (except hydrogen) and metals are good conductors of electricity.
- b. Cesium would react more faster than lithium.
- c. Cesium would be softer than lithium.
- d. Cesium oxide

Answers.

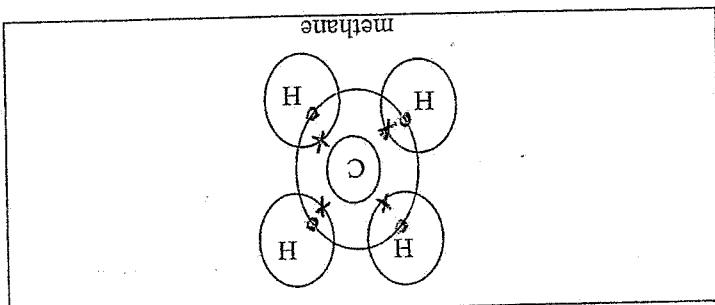
- Q27. a. Would you expect cesium to conduct electricity? Explain
- b. Describe two ways how cesium would be different from lithium.
- c. If cesium reacted with air, name the product.

- Q28. Cesium is in group I.
- a. Have the same number of valence electrons except for the group 8 elements all of which have filled outer shells.
- b. It is a non metal.
- c. It forms covalent bonds while the group I elements form metallic or ionic bonds.

- Q27. a. What is common in the electron arrangement of elements in the same group?
- b. Hydrogen is an unusual element. Describe two ways in which it is different to other typical elements of group I.

- Answers.
- Six electrons.
 - Four valence electrons.
 - Five atoms.
 - Eight electrons.
 - Four covalent bonds

- How many valence electrons does an atom of carbon have?
- How many atoms are there in one methane molecule?
- How many electrons are being shared in methane?
- How many covalent bonds are formed in methane?
- e. How many valence electrons does carbon have?



Q32. The following diagram shows a methane molecule.

- A and C.
 - B^{-2} ; 2.8 C^{+3} ; 2.8 E^{+} : forms an ion with no electrons.
 - D needs one electron to form an ion.
 - C has a valency of 3.
- Answers.

- Write down the letters of metal atoms
- Write down the electron configurations of the following ions: B^{-2} , C^{+3} , E^{+} .
- How many electrons does D need in order to form an ion?
- What is the valency of element C?

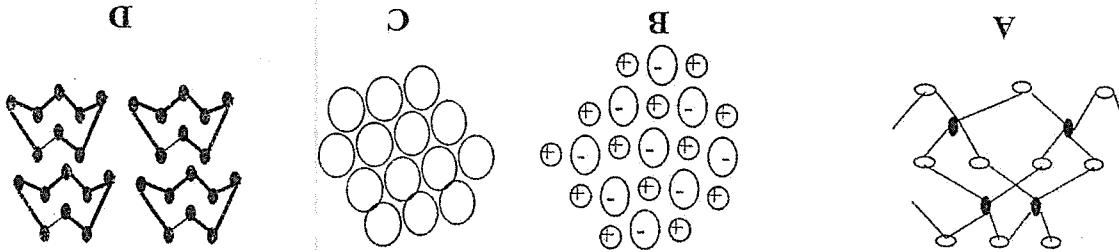
element	electron configuration
E	I
D	2.8.7
C	2.8.3
B	2.6
A	2.1

Q31. Use the following table to answer the questions that follow.

- b. The density of sodium is lower than that of water.
- c. Pour about 100ml of water into a beaker. Cut a tiny piece of sodium metal and drop it in the beaker. Wait for a few seconds for the reaction to come into completion. Add three drops of phenolphthalein indicator to the beaker and observe the colour change. Pink colour indicates a basic solution.
- d. $H_2O^{(l)} + Na^{(s)} \longrightarrow NaOH^{(aq)} + H_2^{(g)}$

- a. Substance A ii. Substance D
- b. D has the lowest melting point because it is a simple molecular compound
- c. Therefore has weak intermolecular forces.
- d. Conducts electricity in molten form only. This is because in solid form, the ions are held in fixed positions by the strong ionic bonds and can not conduct electricity while in liquid form the ions are free to move and conduct electricity.
- e. Could be sodium chloride.
- Answers.

- a. Identify one substance which is: i. a giant structure
- b. Which substance has the lowest melting point? Explain.
- c. Which substance conducts electricity only in molten form? Explain.
- d. Which substance conducts electricity in solid form?
- e. Which substance could be sodium chloride (NaCl)?
- f. Which structure would represent silica (SiO_4)?
- g. Which structure could be copper metal?



Q34. Use the following structures to answer the questions that follow.

- a. Choose two elements that will form an ionic compound when reacted together.
- b. Give two elements that will form a compound, the elements being in a ratio of 1:1
- c. Which element will not react with others?
- d. Which elements will react in a ratio of 4:1
- e. Element A will not react with others.
- f. Element D is liquid at s.t.p.
- Answers.

- a. Which element is liquid at s.t.p?
- b. Which elements will react in a ratio of atoms 4:1?
- c. Which element will not react with the others?
- d. Which element will react in a ratio of 1:1
- e. Element A will react with others.
- f. Element D is liquid at s.t.p.
- Answers.

element	electron configuration
A	2
B	2.7
C	2.4
D	2.8.7
E	2.8.1

Q33. Use the following table to answer the questions that follow.

Further decrease in the boiling points of the elements from group five to group five elements, there is a sharp decrease in the boiling point. There is a further decrease in the boiling points of the elements from group four elements to points of the elements up to group four elements. From group four elements to period two and period three, there is a significant increase in the boiling points of the elements.

as the atomic number increases.

For period one, there is no significant change in the boiling point of the elements boiling point of the metals increases as the atomic number increases.

Ca is expected to have a higher boiling point than K. From the graph, the

- a. It is 800°C.
- b. The atomic number is 6.
- c. P belongs to group 5.
- d. Mg is in the same group as Be.
- e. H, He and Ne.
- f. They are all non-metals.
- g. Answers.

Study the graph and describe in general terms how the boiling points of the elements in a given period change as the atomic number increases.

Ca is an element whose atomic number is 20. would you expect it to have higher or lower melting point than K.

Give a common property of the elements mentioned in part (f) above.

Which three elements have the lowest boiling points?

Which element is in the same group as Be?

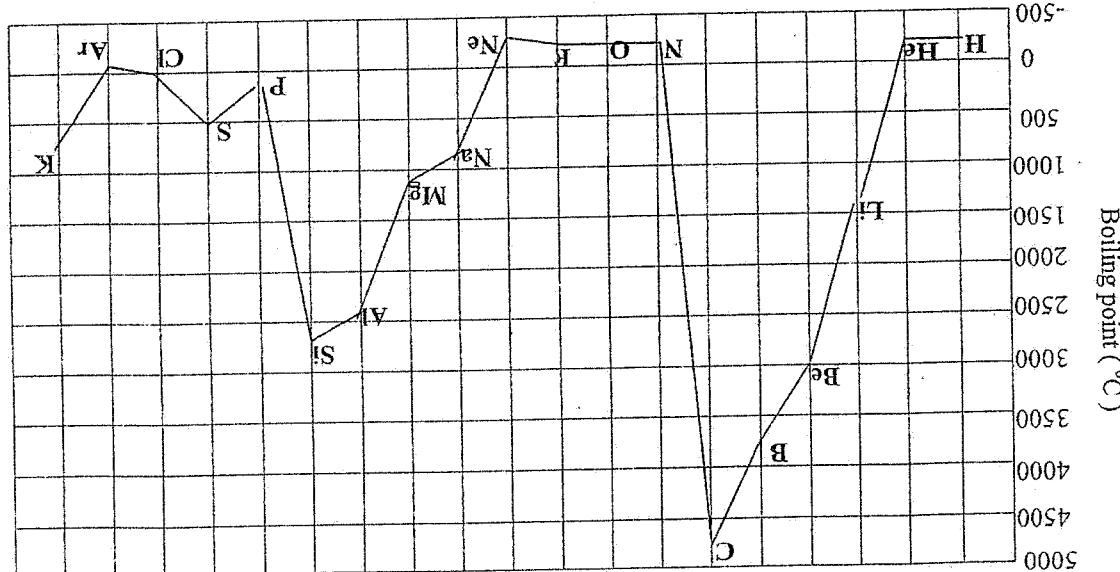
In which group of the periodic table does element P belong?

Write down the atomic number of the element with the highest boiling point.

Estimate the boiling point of Na.

Atomic number

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

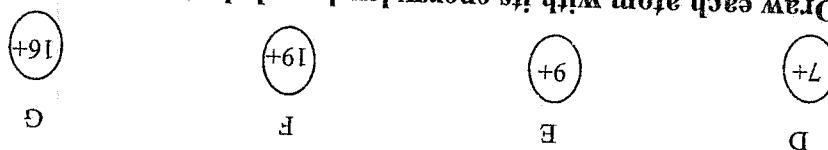


19 elements. Use it to answer the questions that follow.

Q35. The diagram below is a graph of boiling points against atomic number of the first

- f. D would be silica
- g. C could be copper metal.

- Q38. The following figure shows nuclear diagrams of four atoms.
- a. Draw each atom with its energy levels and electrons in each energy level.
- b. What are the valencies of E and F?
- c. To which group of the periodic table does element G belong? Explain.
- d. Which of the two elements E and G is more reactive? Give reason.
- e. What type of bonding occurs when E and F combine?



Q38. The following figure shows nuclear diagrams of four atoms.

- a. Answers.
- b. Letter E.
- c. Chloride E.
- d. Ionic: A, B and D.
- e. Covalent: C, E and F.
- f. Generally, ionic compounds have higher boiling points than covalent compounds because the particles (ions) in ionic compounds are held together by very strong ionic bonds while molecules in covalent compounds are held together by intermolecular forces which are not as strong as ionic bonds.
- g. The valence shell of helium is completely filled with electrons making helium chemically stable (unreactive).

- a. b. c. d.
- Hydrogen chloride has the lowest boiling point?
- Hydrogen chloride is a gas at room temperature. Which letter could represent hydrogen chloride?
- Divide the chlorides into those which are likely to be ionic and those which are likely to be covalent. Explain your reasoning.
- Helium does not form a chloride. Explain.
- Generally, ionic compounds have higher boiling points than covalent compounds because the particles (ions) in ionic compounds are held together by very strong ionic bonds while molecules in covalent compounds are held together by intermolecular forces which are not as strong as ionic bonds.

Chlorides	Boiling point (°C)
F	60
E	-85
D	1330
C	180
B	1410
A	1460

- Q37. The following table shows the boiling points of some chlorides which are represented by letters A, B, C, D and E.

- a. Answers.
- b. CH_3OH and SO_2
- c. CuCl_2 is expected to have a higher melting point because its particles (ions) are held together by strong ionic bonds while the molecules of CH_3OH are held together by intermolecular forces which are not as strong as ionic bonds.
- d. CH_3OH substance would you expect to have a higher melting point, CH_3OH or CuCl_2 ? Explain your answer.

- Q36. a. In which of the following substances are the atoms covalently bonded?
- b. CH_3OH , CuCl_2 , SO_2 , and BeF_2
- c. Which substance would you expect to have a higher melting point, CH_3OH or CuCl_2 ? Explain your answer.

$$\text{Average atomic mass of chlorine} = \frac{4}{142 \text{ amu}} = 35.5 \text{ amu}$$

Combined mass of Cl-35 and Cl-37 = 142 amu

Mass of Cl-37 in ordinary chlorine = $1 \times 37 = 37$ amu

Mass of Cl-35 in ordinary chlorine = $3 \times 35 = 105$ amu

Answer.

chlorine.

Q40. Given that two isotopes of chlorine are present in ordinary chlorine in the ratio of three atoms of Cl-35 to one atom of Cl-37, calculate the average atomic mass of chlorine.

The compound conducts electricity in liquid form.

The compound has high melting point and boiling point.

d. The compound is soluble in water.



c.

filled with electrons making X unreactive.

a. The atomic mass = $(19 + 18)$ amu = 37 amu.

Answers.

reacts with sodium.

d. State three physical properties of the compound formed when chlorine reacts with sodium.

chlorine, ^{35}Cl , reacts with potassium, ^{39}K .

b.

c. Draw an electron dot and cross diagram of the compound formed when your answer.

c.

b. What could happen if element X were mixed with sodium metal? Explain.

b.

a. If the element has 19 neutrons, what is its mass number?

a.

Q39. An element X has atomic number 18.

While G needs two electrons to attain stability.

e.

d. E is more reactive than G because E needs only one electron to attain stability.

d.

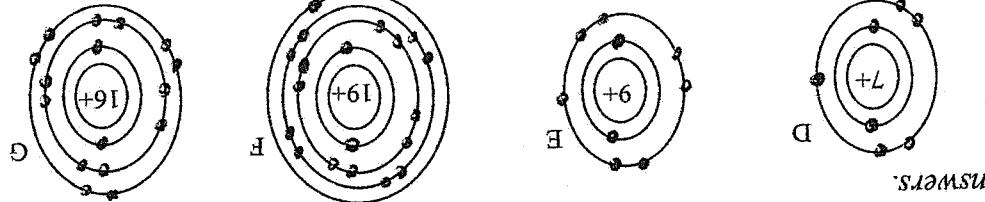
c. G belongs to group six of the periodic table because it has six valence electrons.

c.

b. Ionic bonding occurs.

b.

a. Valency of E is 1. Valency of F is 1.



Answers.

- a. Which element is liquid at 25°C ?
 b. Why does iodine have the biggest atomic radius?
 c. Work out the effective nuclear charge for fluorine.
 d. Mention any two physical properties and any two chemical properties of the halogens.

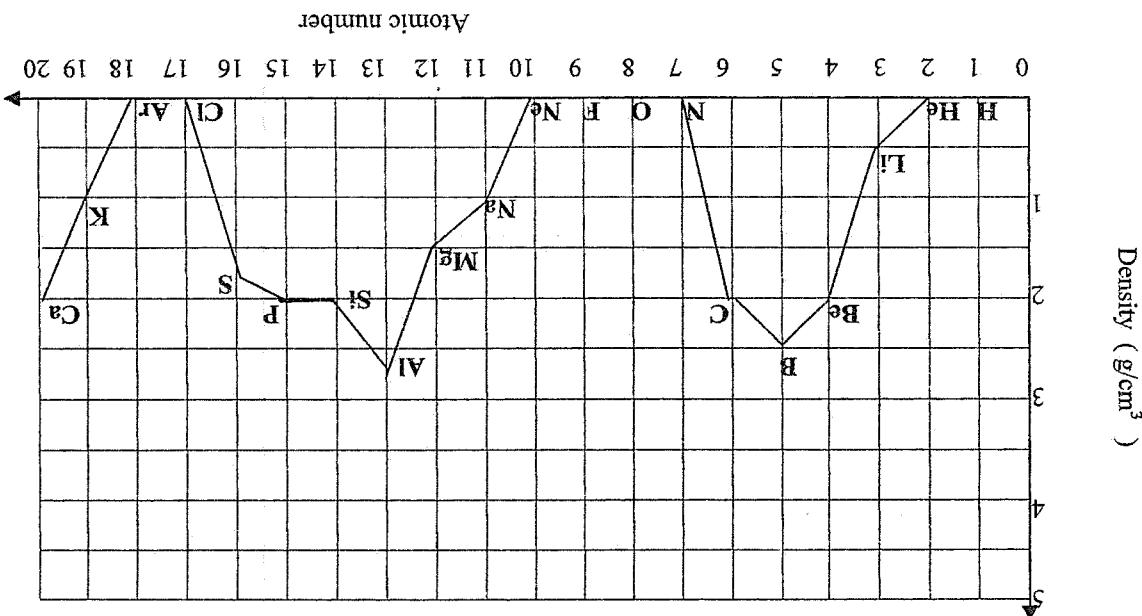
Name of element	Atomic number	Melting point ($^{\circ}\text{C}$)	Boiling point ($^{\circ}\text{C}$)	Atomic radius (nm)
iodine	53	-114	184	0.133
bromine	35	-7	59	0.114
chlorine	17	-101	-34	0.099
fluorine	9	-220	-188	0.071

Q42. The following table shows atomic numbers, melting points, boiling points and atomic radii of some of the halogens.

- a. It is $2\text{g}/\text{cm}^3$
 b. Period 2 shows that as the atomic number increases, density of the elements increases significantly for the metals (from group 1 to group 3), it then decreases to zero across the remaining groups. The same trend repeats itself across period 3 showing that density is a periodic property of the elements.
 c. It is element Al.
 d. Three complete periods.

Answers

- a. What is the density of Be?
 b. How does the graph show that density is a periodic property of the elements?
 c. Which element has the greatest density?
 d. How many complete periods are represented by the graph?



Q41. The diagram below is a graph of density against atomic number of the first 20 elements of the periodic table. Use it to answer the questions that follow.

- a. They have the same number of electrons in the outer shell.
- b. They are called isotopes.
- c. They both belong to group seven of the periodic table because both of them have seven valence electrons.
- Answers.**

- a. To which period of the periodic table could each belong? Explain your answer.
- b. What are atoms of this type called?
- c. Explain why the two atoms react in the same way?



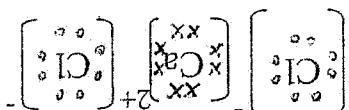
Q45. The following diagram shows nuclei of two atoms.

- Answers:** a. It is chlorine. b. It is iodine.

- Q44.** Name the halogen used for: (a). Sterilizing drinking water. (b). Photography

- a. It is CaCl_2 .
- b. It means calcium has two more protons than electrons giving it a net positive charge of 2^+ .
- c. Has high melting point and boiling point.
- d. Is soluble in water.
- Answers.**

- a. Write the chemical formula of calcium chloride.
- b. What is the meaning of the sign 2^+ on calcium?
- c. Mention two properties of calcium chloride.



Q43. The diagram below shows a dot and cross diagram of calcium chloride.

- Answers.**
- a. It is brownish.
- b. It has the greatest number of electrons which occupy more energy levels.
- c. It is -1 .
- d. Physical properties:
- Have low melting and boiling points
- Poor conductors of electricity.
- Chemical properties:
- React with metals to form metal chlorides
- React with organic compounds such as alkenes to form haloalkanes.

answer

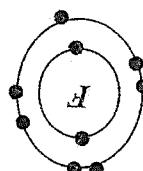
- a. How many protons are in the atom?
 b. What would happen if element X was mixed with water? Explain your answer
 Q48. Element X has mass of 39 amu and atomic number 19.

It would be solid because the particles are held together by strong ionic bonds which require a lot of energy to break.
 It is LiCl.
 The bonding in lithium forms a giant structure with atoms held together by covalent bonds while the bonding in chlorine forms simple molecules which are held together by intermolecular forces.
 Valence electrons and the fixed positive lithium ions while the bonding in chlorine is due to the forces of attraction between the positive nuclei and shared valence electrons.
 a. The bonding in lithium metal is due to forces of attraction between the free valence electrons and the positive lithium ions while the bonding in chlorine is due to the forces of attraction between the positive nuclei and shared valence electrons.
 Answers.

- c. Would you expect the compound in part (c) to be liquid or solid at room temperature. Explain.
 b. Write down the chemical formula of the compound formed when lithium and chlorine react.
 a. Give two differences in the type of bonding between lithium metal (Li) and chlorine gas (Cl_2).
 Q47. a.

For group seven elements, the bigger the atomic radius, the less the forces of attraction between the nucleus and valence electrons hence the lower the reactivity. Iodine has the biggest atomic radius therefore is the least reactive. Chlorine has the smallest atomic radius and is the most reactive. The atomic radius of bromine is greater than that of chlorine but less than that of iodine so its reactivity is greater than that of iodine but less than that of chlorine.

Iodine, bromine, chlorine.



- b.
 c.
 d.
 a. Bromine can be prepared from lithium bromide
 chlorine can be prepared from lithium chloride
 iodine can be prepared from lithium iodide
 Answers.

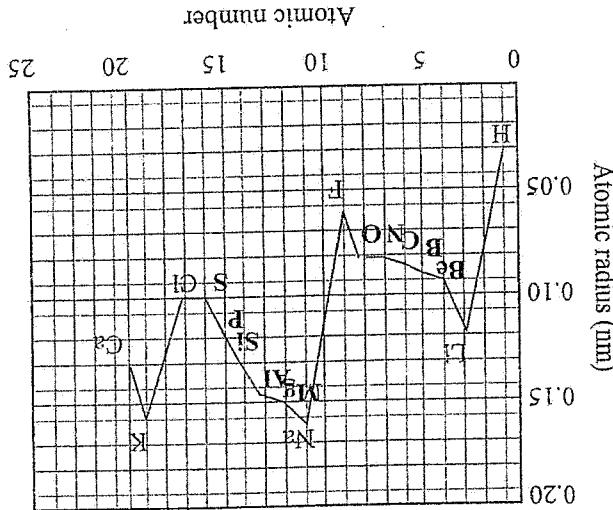
- d. Explain the difference in reactivity of the elements in part (c) above.
 c. Arrange the elements iodine chlorine and bromine in order of increasing reactivity.
 b.

- a. Halogens such as bromine, chlorine and iodine can be prepared by reacting an alkali metal salt with concentrated sulphuric acid in the presence of a catalyst. Name any salt from which each of the following can be prepared.
 i. Bromine ii. Chlorine iii. Iodine
 Draw an electron shell diagram of a fluorine atom, ${}_{19}^{\text{F}}$.

- a. By losing three electrons.
- b. As you go down the group, atomic radius increases. The bigger the atomic radius, the less the forces of attraction between the nucleus and valence electrons. So, as you go down group I elements, the elements tend to lose electrons more easily.
- Answers.

- Q50. a. Explain why the reactivity of group I elements increases as you go down the group.
- b. How can aluminium, a group 3 element, attain an inert gas configuration?
- c. Fluorine reacts faster than chlorine because it has a smaller atomic radius. The extra energy level increases the atomic radius significantly.
- d. As atomic number increases across a period, the atomic radius decreases.
- Answers.

- a. It belongs to group six of the periodic table because it has six electrons in the outer shell.
- b. This is because Na is in the next period after F with an extra energy level. The outer shell.
- c. In terms of atomic radius, explain the difference in reactivity between F and Cl.
- d. Briefly, describe the general trend in the atomic radius of elements as the atomic number increases across a period.
- To which group of the periodic table does element O belong? Give reason.
- Answers.



- Q49. The following figure is a graph of atomic radius across a period against atomic number of some elements. Use it to answer the questions that follow.

- a. The atom has 19 protons.
- b. X would react with water to form hydrogen gas and a basic solution because it belongs to group one of the periodic table.
- Answers.

Lithium attains stability by losing an electron as a result the number of protons in the ion formed is greater than the number of electrons by one. The lithium ion therefore attains a positive charge.

Answer:

Q53. Explain why the charge of lithium ion is +1.

- a. W and X are isotopes because they have the same number of protons but different numbers of neutrons.
- b. Z is an electron because it has more protons than electrons.
- c. It has a negative charge (-).
- d. Lithium attains stability by losing an electron as a result the number of protons in the ion formed is greater than the number of electrons by one. The lithium ion therefore attains a positive charge.

Answers:

- a. Which two particles are isotopes of an element. Explain.
- b. Which particle is an ion? Explain.
- c. What is the charge on the particle identified in part (c) above?

particles	protons	neutrons	electrons	Z
W	1	1	1	10
X	1	2	1	9
Y	9	10	9	1
Z	9	10	10	10

Q52. The following diagram shows some information about four particles labelled W, X, Y and Z. Use it to answer the questions that follow.

- a. Write the formula of a charged atom of R.
- b. Which letter represents an element that belongs to the halogen family?
- c. Name two elements which are likely to be solid at room temperature.
- d. In what ratio would element Q react with element W.
- e. Element Z because its outer shell is filled with electrons making it inert.
- f. Ratio of Q to W is 2 : 1.
- g. They are W and Z.
- h. It is element M.

Answers:

- a. It is R^{2+} .
- b. It is letter Y.
- c. From the table, identify an element whose valency is 4.
- d. Name two elements which are likely to be solid at room temperature.
- e. In what ratio will not react with another element?
- f. Which letter represents an element that belongs to the halogen family?
- g. Which elements will not react with another element?
- h. Write the formula of a charged atom of R.

Group	I	II	III	IV	V	VI	VII	VIII	Z
Element	Q	R	L	M	X	W	Y		Z

the same period of the periodic table.

Q51. The table below shows elements represented by letters Q, R, L, M, X, W, Y and Z in

- c. i. Y is ductile ii. Y is a good conductor of heat.
- b. Element Z is an ionic compound.
- a. Element Y is a metal.
- Answers.**

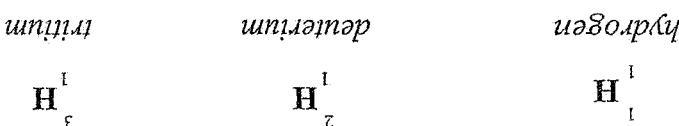
electricity?

- f. How does element Y differ from element Z in the way it conducts electricity?
- e. Briefly, describe the bonding in element Z .
- d. Which element is likely to be a simple molecular substance?
- c. Mention two other physical properties of element Y .
- b. Which element is an ionic compound?
- a. Which element is a metal?

Element	Physical property
Z	Is a white solid that conducts electricity only in liquid form.
Y	Is a shiny solid with high density and conducts electricity.
X	Is a colourless gas at room temperature
W	Is a grey solid that does not conduct electricity in any form

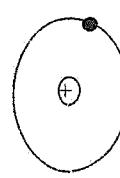
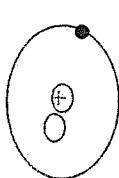
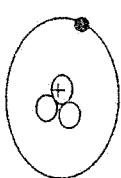
Q55. The following table gives some information about three elements.

- d. The number of neutrons are different in the three isotopes making them have different atomic masses.
- c. i. \oplus Represents a proton. ii. \ominus Represents a neutron iii. \bullet Represents electron.
- b. The three isotopes would react in the same way because they all have one valence electron.



Answers.

- d. How are the isotopes different?
- i. \oplus ii. \ominus iii. \bullet
- c. What does each of the following symbols in the isotopes represent?
- b. Would you expect the three isotopes to react in the same way? Explain your answer.
- a. Write the chemical symbol of each of the isotopes.



Q54. Three isotopes of hydrogen are shown in the diagram below.

- Answers.
- a. On going down the group, atomic radius increases. As the atomic radius increases, forces of attraction between the valence electrons and the positive nuclei decrease because it has the biggest atomic radius. As the valence electrons get weaker and atoms tend to lose their valence electrons quite easily.
- b. Rubidium is the most reactive because it has the biggest atomic radius. As the atomic radius increases, the forces of attraction between the valence electrons of the atoms and the positive nuclei decreases reducing the melting point and boiling point.
- c. In its chemical reaction with cold water,
- d. Describe how sodium is similar to lithium and how it is different to lithium in its chemical reaction with cold water.

	melting point (°C)	boiling point (°C)
A	34	700
B	64	774
C	83	1007
D	120	817

- a. Explain why the melting point and boiling point of the elements decrease as you go down the group.
- b. Identify the most react metal from the table. Give reason for your choice.
- c. Which of A, B, C and D is most likely to be potassium?
- d. Describe how sodium is similar to lithium and how it is different to lithium in its chemical reaction with cold water.

Element	Melting Point (°C)	Boiling Point (°C)
lithium	180	1330
sodium	98	890
potassium		
rubidium	39	688

- Q57. Lithium, sodium, potassium and rubidium appear in this order in group I of the periodic table. The following table contains data about three of the elements.

- Answers: a. High melting point
b. Reaction with dilute acid

- a. What two properties from the table show that silicon is not a metal?

Property	Description	Melting Point	Appearance	Electrical conductivity	Reaction with dilute acid
	Conducts electricity using its free ions.	1410°C	Black solid	Medium	No reaction

- Q56. The table below lists some of the properties of the element silicon.

- f. Elements X conducts electricity using its free ions.
- e. Element Z has ionic bonding which occurs because of the forces of attraction between the positively charged ions and the negatively charged ions which make up the compound.
- d. Element X

Answer
 The ions which make up sodium chloride are held together by very strong ionic bonds while the molecules of C_7H_{14} are held together by intermolecular forces which are relatively weaker compared to ionic bonds.

Q58. Explain why sodium chloride has a higher melting point than C_7H_{14} .

Difference:
 Sodium reacts more quickly with water compared to lithium.

d. Similarity:
 Both potassium and lithium react with water to form a basic solution and hydrogen gas.

c. It is B.

- The following list of books is not exhaustive.
1. Keith Wallis, Chancos Physical Science for Malawi, Book 1 (3rd edition), pages 67-95, 102-120, 126-136, 143-185, 196-218, 223-236.
 2. Samuel Kaleda, MSCS Physical Science (New edition), pages 62-86.
 3. Juliet Napwora et al, KCSE Golden Tips Chemistry, pages 30, 33-34, 71-74, 77-82, 101-102, 104, 115-116, 126-132, 138-139.
 4. Lawrie Ryan, Chemistry for You: Revised edition for GCSE, pages 80-85, 92-95, 100-107, 110-116, 122-123, 124, 142-156, 190-192, 194, 199-210, 232-238, 352-364.
 5. Gallagher & Ingaram, Complete Chemistry, pages 62-73, 76-82, 90-99, 106-113, 118-127, 132-135, 138-145, 150-151, 192-197, 210-211, 228-231.

After reading the chapter, test your understanding by answering the 110 questions in this chapter. Cross check your answers with the answers provided.

Before attempting the following questions, you are **STRONGLY ADVISED** to read the chapter in your notes or one of the books listed below.

To the student:

110 QUESTIONS WITH ANSWERS

CHEMICAL REACTIONS

CHAPTER 2

- Q1.** Balance the following chemical equation.
- a. $\text{Fe}^{(s)} + \text{O}^{2(g)} \longleftrightarrow \text{Fe}_2\text{O}^{3(s)}$
- b. Name the type of reaction in part (a) above.
- Q2.** Aluminum burns in oxygen according to the following equation.
- a. $4\text{Fe}^{(s)} + 3\text{O}^{2(g)} \longleftrightarrow 2\text{Fe}_2\text{O}^{3(s)}$
- b. It is a reduction-oxidation reaction
- Answers**
- a. $4\text{Al}^{(s)} + 3\text{O}^{2(g)} \longleftrightarrow 2\text{Al}_2\text{O}^{3(s)}$
- b. What mass of aluminum oxide is formed from the complete combustion of 5.4 g of aluminum metal? (R.A.M: Al = 27, O = 16)
- a. Balance the chemical equation.
- Q3.** a. Write down a balanced chemical equation for the reaction between magnesium metal and oxygen gas.
- b. Calculate the mass of oxygen gas that reacts with exactly 3.6 g of magnesium metal and oxygen gas.
- Answers**
- a. $2\text{Mg}^{(s)} + \text{O}^{2(g)} \longleftrightarrow 2\text{MgO}^{(s)}$
- b. Number of moles of Mg in 3.6 g = $\frac{\text{Mass of Mg}}{\text{R.A.M of Mg}} = \frac{3.6}{24} = 0.15 \text{ moles}$
- From the balanced equation, 2 moles of Mg reacts with 1 mole of O₂.
- Moles of O₂ that will react with 0.15 moles of Mg metal = $\frac{2}{2} = 0.15 \times 1$
- Relative molecular mass for oxygen = $2 \times 16.0 = 32.0$
- Therefore, mass of O₂ that reacts = number of moles \times R.F.M = $0.075 \times 32.0 = 2.4 \text{ g}$
- 2.4 g of oxygen reacts with the magnesium.
- Answers**
- a. $10.2 \text{ g of Al}_2\text{O}_3 \text{ is produced from the reaction.}$
- b. Moles of Al₂O₃ produced from 0.2 moles of Al metal = $\frac{0.2 \times 2}{4} = 0.1 \text{ moles.}$
- From the balanced equation, 4 moles of Al produces 2 moles of Al₂O₃.
- Therefore, mass of Al₂O₃ produced = number of moles \times R.F.M = $0.1 \times 102 = 10.2 \text{ g}$
- 10.2 g of Al₂O₃ is produced from the reaction.
- Answers**
- a. $5.4 \text{ g of aluminum metal? (R.A.M: Al = 27, O = 16)}$
- b. What mass of aluminum oxide is formed from the complete combustion of 5.4 g of aluminum metal? (R.A.M: Al = 27, O = 16)
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- Therefore, mass of O₂ that reacts = number of moles \times R.F.M = $0.075 \times 32.0 = 2.4 \text{ g}$
- 2.4 g of oxygen reacts with the magnesium.

- c. Surface area if one of the reactants is a solid
 b. Concentration
 a. Temperature.

Answers

Q5. Mention any three factors which affect the rate of a chemical reaction. Unit

245 g of potassium chlorate will produce 18.00×10^{23} molecules of oxygen
 $= 18.00 \times 10^{23}$ molecules

Number of oxygen molecules in 2.99 moles = $2.99 \times 6.02 \times 10^{23}$
 Number of oxygen molecules in one mole = 6.02×10^{23} molecules

71.76 dm^3 of oxygen gas is produced

Therefore, volume occupied by 2.99 moles of oxygen at rtp = $2.99 \times 24 \text{ dm}^3$
 Volume occupied by 1 mole of any gas at rtp = 24 dm^3
 $= 2.99 \text{ moles}$

Moles of oxygen gas produced from 1.99 moles of KClO_3 = $1.99 \times \frac{2}{3}$

From the equation, 2 moles of KClO_3 produces 3 moles of oxygen gas.
 149 g of KCl is produced from the reaction.

$= 149 \text{ g}$

$= 1.99 \times 75$

Mass of KCl produced = number of moles \times R.F.M.
 Therefore, 1.99 moles of KClO_3 will produce 1.99 moles of KCl .
 From the balanced equation, 2 moles of KClO_3 produce 2 moles of KCl .
 Relative formula mass of KCl = $39 + 36 = 75$.

d. Moles of KClO_3 = $\frac{\text{Mass of } \text{KClO}_3}{\text{R.F.M of } \text{KClO}_3}$ = $\frac{245}{123} = 1.99 \text{ moles.}$

c. Relative Formula mass of KClO_3 = $39 + 36 + 3(16) = 123$.

b. $2\text{KClO}_3(s) \longrightarrow 2\text{KCl}(s) + 3\text{O}_2(g)$

remains chemically unchanged itself.

a. A catalyst is a substance that changes the rate of a chemical reaction but
 Answers

(Relative atomic masses: K = 39, Cl = 36, O = 16)

Potassium chloride?

f. How many molecules of oxygen gas would be produced from 245 g of potassium chlorate?

e. What volume of oxygen gas is produced from 245 g of potassium chlorate?

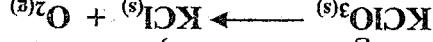
d. What mass of potassium chloride would be produced from 245 g of potassium chlorate?

c. How many moles of KClO_3 are there in 245 g of the substance?

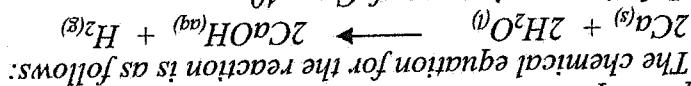
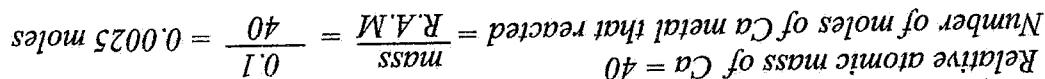
b. Balance the chemical equation.

a. What is a catalyst?

Q4. When potassium chlorate (KClO_3) is heated strongly in the presence of a catalyst manganese dioxide, the following chemical change takes place:



From the equation, 2 moles of calcium produce 1 mole of hydrogen gas.



The chemical equation for the reaction is as follows:

d. Pink colour because the solution formed is basic and changes colour of

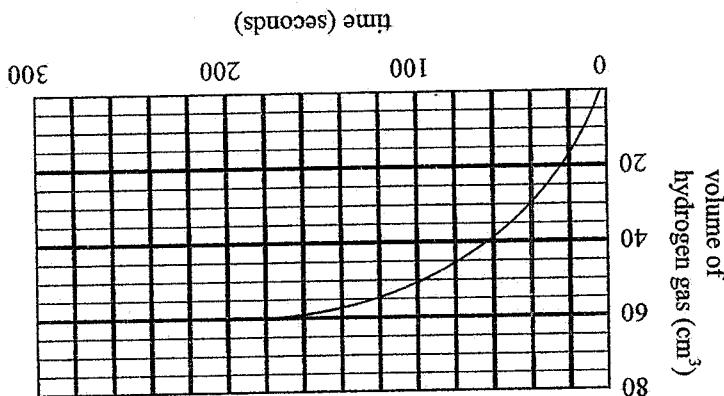
$$\text{Rate of reaction by volume} = \frac{\text{Total volume}}{\text{Total time}} = \frac{60 \text{ cm}^3}{180 \text{ s}} = 0.33 \text{ cm}^3/\text{second}$$

a. 180 cm^3
Answers b. 60 seconds.

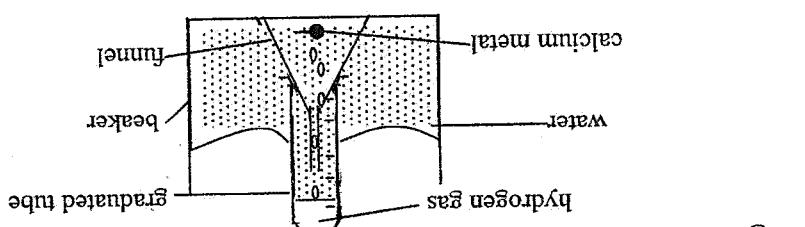
After how many minutes was half of the calcium used up?
(Relative atomic masses: Ca = 40, H = 1.0.)

At the end of the experiment, a few drops of phenolphthalein indicator were added to the solution. What colour would you expect to show. Explain your

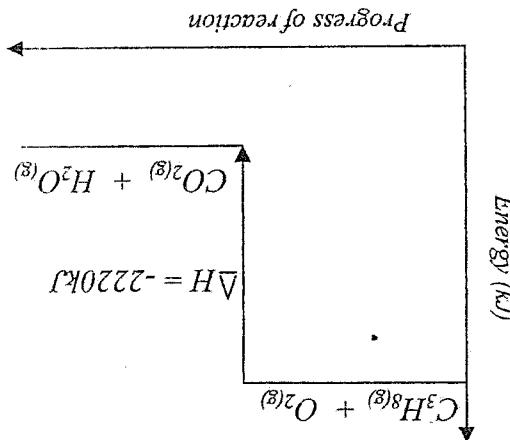
What was the total volume of the hydrogen gas produced in the reaction?



The volume of the collected gas was measured using the graduated tube and the values were read off at intervals and recorded. A graph of the results was then drawn as shown below.



Q6. Calcium turnings of mass 0.1g were made to react with water at room temperature, 25°C. Hydrogen gas was given off and collected as shown in the diagram below.



- Q9. Propane gas, C_3H_8 , is used as a fuel. Like other alkanes, it produces CO_2 gas and water when burned in plentiful supply of oxygen. Its heat of combustion, $\Delta H = -2220 \text{ kJ}$.
- a. Write a balanced chemical equation for the reaction including the heat of reaction.
- b. An endothermic reaction is a reaction which takes in heat from the surroundings.
- c. An exothermic reaction is a reaction which gives out heat to the surroundings.
- d. The reaction is endothermic because it gives out heat to the surrounding shown by the negative heat of combustion.
- e. The reaction is exothermic because it gives out heat to the surrounding shown by the negative heat of combustion.
- Answers**
- a. $C_3H_8(g) + 5O_2(g) \longrightarrow 3CO_2(g) + 4H_2O(g) + 2220 \text{ kJ}$
- c. Draw a well labelled energy level diagram for the reaction.
- b. Is the reaction endothermic or exothermic. Give reason for your answer.
- a. Write a balanced chemical equation for the reaction including the heat of reaction.
- b. An exothermic reaction is a reaction which gives out heat to the surroundings.
- c. An endothermic reaction is a reaction which takes in heat from the surroundings.
- d. The reaction is exothermic because it gives out heat to the surroundings.
- e. The reaction is endothermic because it gives out heat to the surrounding shown by the negative heat of combustion.
- Answers**

- Q8. Define the following:
- a. Endothermic reaction.
- b. Exothermic reaction.

The aqueous solution of ammonia turned pink because it is a basic solution. Basic chloride was added and the solution turned colourless. Explain this observation.

Phenolphthalein indicator were added to it. A concentrated solution of ammonia solutions turn pink if phenolphthalein indicator is added. A concentrated solution of ammonium chloride is acidic and it neutralised the base causing the pink colour to disappear.

Answer

- Q7. An aqueous solution of ammonia turned pink when a few drops of *amunt* were produced.
- From the graph, half of the C_a was used up after 19 seconds.
- Therefore, half of the calcium was used up after 15 cm³ of H_2 gas was produced.
- Volume occupied by 0.000625 moles of hydrogen = $0.000625 \times 24000 \text{ cm}^3 = 15 \text{ cm}^3$
- Volume occupied by 1 mole of any gas at rtp = $24 \text{ dm}^3 = 24000 \text{ cm}^3$
- Half of the C_a was used after 0.000625 moles of H_2 were produced.
- Answer**

- a. An oxidising agent is a substance which accepts electrons
 b. A reducing agent is a substance which donates electrons
 Answers

Q13. a. In terms of electron movement, define the following:
 i. Oxidising agent. ii. Reducing agent.

The required volume of copper sulphate is 50 cm^3

$$V_1 = \frac{C_2 \times V_2}{C_1} = \frac{50}{25 \times 0.1} = 0.05 \text{ dm}^3 = 50 \text{ cm}^3$$

Using the dilution equation, $C_1 \times V_1 = C_2 \times V_2$

Let the required volume be V_1

Initial concentration (C_1) = 50 g/dm^3

Final concentration (C_2) = 25 g/dm^3

Final volume (V_2) = $100 \text{ cm}^3 = 0.1 \text{ dm}^3$ ($1000 \text{ cm}^3 = 1 \text{ dm}^3$)

Answer

50 g/dm^3

Q12. Calculate the volume required to make 100 cm^3 of hydrochloric acid solution with a concentration of 25 g/dm^3 from a stock solution of with a concentration of

$$\text{Mass of NaOH} = \text{number of moles} \times \text{R.F.M} = 0.01 \times 40 = 0.4 \text{ g}$$

$$\text{Number of moles in } 20 \text{ cm}^3 \text{ of the solution} = \frac{1000}{0.5 \times 20} = 0.01 \text{ moles.}$$

$$\text{Number of moles in 1 litre (1000 cm³) of the solution} = 0.5 \text{ moles}$$

$$\text{Molarity of the solution} = \frac{\text{Number of moles}}{\text{Volume in litres}} = \frac{0.5 \text{ moles}}{1 \text{ litre}} = 0.5 \text{ M}$$

$$\text{Moles of NaOH in } 20 \text{ g} = \frac{\text{mass}}{\text{R.F.M}} = \frac{20}{40} = 0.5 \text{ moles}$$

$$\text{a. Relative formula mass of NaOH} = 23 + 16 + 1 = 40$$

Answers

in part (a) above.

b. How much NaOH, in grams, is contained in 20 cm^3 of the solution prepared

Q11. a. A student dissolved 20 g of NaOH flakes in water to make 1 litre of solution.
 b. Calculate the molarity of the solution. (R.F.M: Na = 23, O = 16, H = 1.0)

Graphite conducts electricity using its free valence electrons while molten sodium chloride conducts electricity using the sodium ions and chloride ions which are free to move in molten form.

Q10. Molten sodium chloride and graphite both conduct electricity. State their difference in electrical conductivity.

The molarity of the sodium hydroxide is = 0.5M

$$= 0.5M$$

$$C_{NaOH} = \frac{C_{HCl} \times V_{HCl} \times \text{moles of NaOH}}{\text{moles of HCl} \times V_{HCl}} = \frac{1.0M \times 25 \text{ cm}^3 \times 1 \text{ mole}}{1 \text{ mole} \times 50 \text{ cm}^3}$$

$$C_{NaOH} \times V_{NaOH} = \frac{\text{moles of NaOH}}{C_{HCl} \times V_{HCl}}$$

From the equation, 1 mole of HCl reacts with 1 mole of NaOH.

$$\text{Volume of NaOH} (V_{NaOH}) = 50 \text{ cm}^3$$

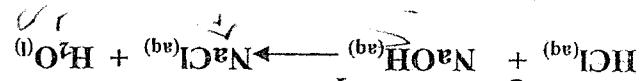
Let the concentration of NaOH be C_{NaOH}

$$C_{NaOH} = \frac{\text{Concentration of HCl} (C_{HCl})}{\text{Volume of HCl} (V_{HCl})} = 1.0M \quad \text{Volume of HCl} (V_{HCl}) = 25 \text{ cm}^3$$

a. Neutralisation reaction b. Sodium chloride and water

Answers

- c. If 25 cm³ of 1.0M hydrochloric acid neutralised 50 cm³ of the sodium hydroxide solution, calculate the molarity of the sodium hydroxide.
- b. Name the products of this reaction.
- a. What name is given to the reaction between HCl and NaOH?



Following chemical equation.

Q17. Hydrochloric acid (HCl) and sodium hydroxide (NaOH) react according to the

- ii. Is an acid which ionises completely in water. An example is sulphuric acid.
- i. Is an acid which does not ionise completely in water. An example is ethanoic acid.
- a. i. Is an acid which ionises completely in water. An example is

Answers

ii. Strong acid

i. Weak acid

Q16. a. Define the following and give an example of each.

b. The hydroxide ions (OH^-).

a. Hydrogen ions (H^+).

Answers

2 Un

2 Un

Q15. Mention the ions which are responsible for the following:

- b. Spectator ions are the ions which do not take part in a chemical reaction.
- a. aqueous solutions.
- a precipitate is an insoluble solid formed from the reaction of two or more

Answers

b. Spectator ions.

a. Precipitate

3 Un

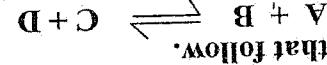
Q14. Define the following terms:

- Answers
- Equilibrium means rate of forward reaction is equal to rate of backward reaction.
 - i. Adding B shifts the equilibrium to the right.
 - ii. Removing D shifts the equilibrium to the right.

Answer

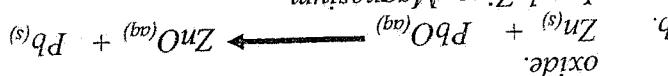
- Adding B to the equilibrium mixture?
- Removing D from the equilibrium mixture?

- What is the meaning of equilibrium?
- What is the effect of:

*that follow.*

Q21. Study the following chemical process at equilibrium and answer the questions

- Lead, Zinc, Magnesium,

*oxide.*

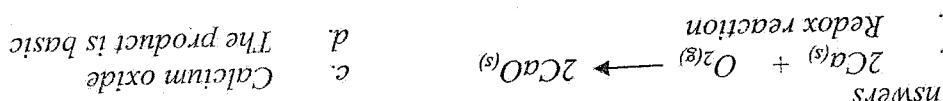
- Zinc metal is more reactive than lead and less reactive than magnesium so, it displaces oxygen from lead oxide but can not displace oxygen from magnesium.

Answers

- Oxygen from a compound: Zinc, Lead and magnesium.

- Arrange the following metals in order of increasing ability to take away oxygen from a metal oxide. Explain this observation.

- Q20. a. Zinc metal displaces oxygen from lead oxide however it does not displace oxygen from magnesium oxide. Explain this observation.

*Answers*

- nature of the product?

- The product turns litmus paper red. What does that tell you about the nature of the product(s) of the reaction.

- Name the type of reaction which takes place.

- Write the equation for the reaction that takes place.

Q19. When calcium burns in air, a white solid is formed.

- Galvanising the iron

- Painting the iron

- Cover the iron with grease.

- Rust is an oxide of iron formed when iron metal reacts with oxygen in the presence of water.

Answers

- Mention three ways which can be used to prevent rust.
- State the conditions necessary for rusting.
- What is rust?

Answer

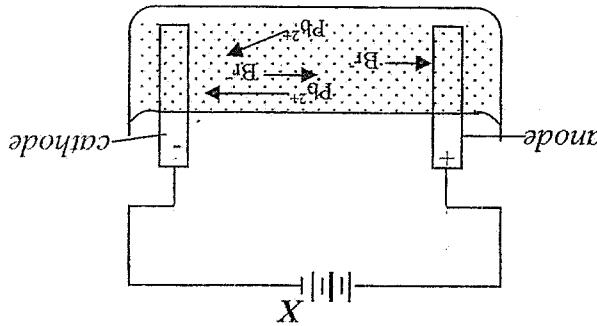
c. The anode is a positive electrode therefore, it attracts the bromide ions which are negative ions. The cathode is a negative electrode therefore, it attracts the lead ions which are positive ions.

d. At the cathode, lead ions gain electrons to form lead metal which coats the electrode according to the following half equation: $Pb^{2+} + 2e \rightarrow Pb(s)$

e. At the anode, bromide ions lose electrons to form bromine gas which bubbles off according to the following half equation: $Br^{(aq)} - 2e \rightarrow Br_{2(g)}$

f. The electrons move in the circuit from the negative terminal of the battery to the positive terminal of the battery however, they do not pass through the electrolyte as free electrons. At the cathode, each lead ion accepts 2 electrons to form lead metal simultaneously, 2 bromide ions lose 2 electrons to the anode which flow through the conductor. The net effect is a continuous flow of electrons in the circuit aided by the ions.

g. The ions in solid lead bromide are not free to move making solid lead bromide a poor conductor of electricity.



a/b.

- The arrows show the general direction of the ions.

a. Complete the circuit by drawing three cells in gap X.

b. On the diagram, show the cathode and anode.

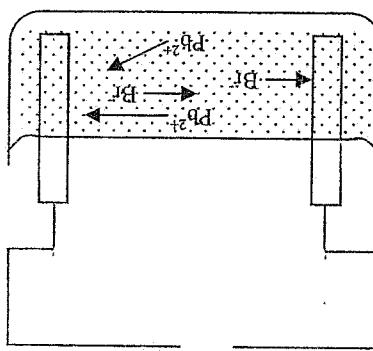
c. Describe the direction of motion of the ions.

d. Using relevant half equations, describe what happens at the cathode and anode.

e. Explain how the electrons move during the electrolysis.

f. When solid lead bromide was used, no any form of chemical reaction took place. Explain.

4 Unit



Q22. The following experimental set up was used to study what happens to certain ions during electrolysis of a molten compound.

Physical properties: Acids conduct electricity.
Acids have a sour taste.

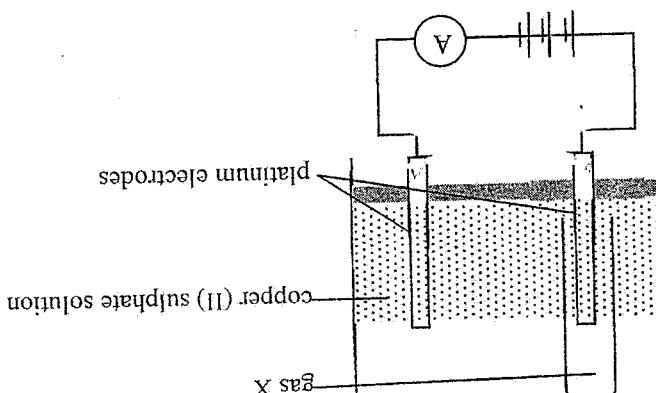
Chemical properties: Acids react with metals to produce a salt and water.
Acids react with bases to produce a salt and hydrogen gas.

Answers

- a. Name two chemical properties and two physical properties of acids.
- b. Gas X is oxygen
- c. Name gas X.
- d. Explain what happens at the cathode and anode using relevant half equations.
- e. During the electrolysis, the pH of the solution gradually becomes less than 7.
- f. What happens to the colour of the electrolyte during the electrolysis?
- g. Describe using relevant half equation what would happen at the anode if the platinum anode is replaced by a copper metal rod.
- h. How would the change in part (e) above affect the colour of the electrolyte as the reaction progresses.
- i. Oxygen is preferentially discharged at the anode because hydroxide ions move to the anode where they lose electrons to form oxygen gas and water according to the following half equation: $4OH^{(aq)} \rightarrow O^{2-} + 2H_2O^{(l)} + 4e^-$
- j. The solution becomes acidic due to the increase in the concentration of hydrogen ions.
- k. The colour fades away.
- l. The copper anode will be dissolving in its aqueous solution according to the following half equation: $Cu^{(s)} - 2e^- \rightarrow Cu^{2+}_{(aq)}$. This mass reduces as the reaction proceeds.
- m. The colour does not fade away because concentration of copper ions is being maintained by the dissolving copper rod.

Answers

- a. Copper ions move to the cathode where they gain electrons to form copper metal according to the following half equation: $Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu^{(s)}$. Copper metal coats the cathode.
- b. Oxygen is preferentially discharged at the anode because hydroxide ions move to the anode where they lose electrons to form oxygen gas and water according to the following half equation: $4OH^{(aq)} \rightarrow O^{2-} + 2H_2O^{(l)} + 4e^-$
- c. The solution becomes acidic due to the increase in the concentration of hydrogen ions.
- d. The colour of the electrolyte changes from blue to colourless.
- e. The colour of the electrolyte changes from blue to colourless.
- f. The colour of the electrolyte changes from blue to colourless.
- g. The colour of the electrolyte changes from blue to colourless.
- h. The colour of the electrolyte changes from blue to colourless.
- i. The colour of the electrolyte changes from blue to colourless.
- j. The colour of the electrolyte changes from blue to colourless.
- k. The colour of the electrolyte changes from blue to colourless.
- l. The colour of the electrolyte changes from blue to colourless.
- m. The colour of the electrolyte changes from blue to colourless.



- Q23. Aqueous copper (II) sulphate was electrolysed using the set up shown in the diagram below.

Powdered metal has a large total surface area which increases the rate of reaction.

Answer

A 3 a u t

metal lamps.

Q29. Explain why powdered metal reacts faster with hydrochloric acid than solid

They conduct electricity in aqueous or molten form.

Chemical properties: They react with acids to form a salt and water.

Physical properties: i. Have a bitter taste. ii. They feel soapy

Answers

Q28. Mention two physical properties and two chemical properties of bases. *C u n t*

d. A salt and water.

c. Neutralisation reaction.

b. The pH value increases.

a. ii. V is the most acidic.

i. Y is the most alkaline.

Answers

d. What are the likely products of the reaction in part (c) above?

c. What type of reaction occurs between U and X?

b. What happens to the pH value of V if X is gradually added to V?

iii. Neutral?

ii. The most acidic?

i. The most alkaline?

a. Which solution is:

solution	T	U	V	W	X	Y	Z	pH
	4	5	2	7	10	14	8	

Q27. The following table shows the pH of solutions T-Z.

b. An indicator is a substance which shows one colour in acidic solutions and a

a. An alkali is a soluble base.

Answers

b. An indicator.

a. An alkali

Q26. Define the following terms: *C u n t*

The compound sodium chloride is used as a preservative for meat and fish.

Used in nuclear reactors to transfer heat from the reactor to steam generators.

b. Used in street lamps to produce a yellow glow.

a. Paraffin is chemically inert and prevents the sodium from reacting with the air.

Answers

b. Mention any three uses of sodium metal.

Q25. a. Explain why sodium metal is kept under liquid paraffin.

H_2O and OH^- is a conjugate acid base pair

b. NH_4^+ and NH_3 is a conjugate acid base pair

iv. A conjugate base is an acid which has lost a proton

iii. A conjugate acid is a base which has accepted a proton

ii. A base is a substance which accepts a proton.

i. An acid is a proton donor.

Answers

Write the conjugate acid base pairs from the above equation.



b. Ammonia gas in solution dissociates according to the following equation:

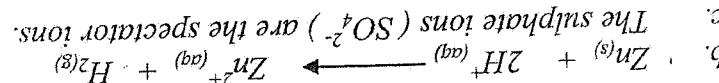
iv. conjugate base.

iii. conjugate acid

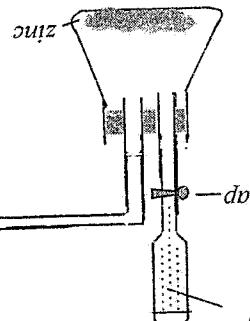
ii. a base.

i. an acid.

Q31. a. According to Lowry Brønsted theory, define the following:



c. The sulphate ions (SO_4^{2-}) are the spectator ions.



a. dilute sulphuric acid

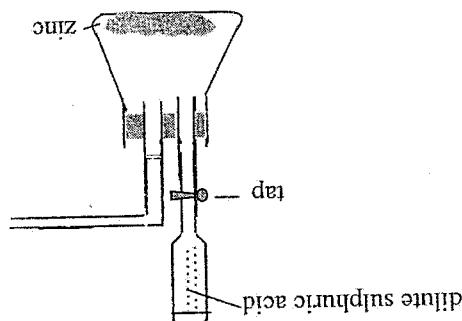
Answers

c. Identify the spectator ions.

b. Write an ionic equation for the reaction which takes place.

c. collected.

a. Complete the diagram to show how a sample of hydrogen gas can be



Q30. The following set up was used to prepare hydrogen gas.

A solution that can dissolve no more solute at that temperature.

Answer

Q36. What is meant by the term saturated solution?

Bond breaking requires a supply of energy whereas bond making releases energy.

Answer

Q35. Explain why bond breaking is endothermic and bond making is exothermic.

Both acids and bases change the colour of indicators such as litmus solution or litmus paper.
Both acids and bases do conduct electricity.

Answers

Q34. Mention two ways how acids are similar to bases.

Therefore, 1 mole of carbon dioxide is produced

$$\text{Number of moles in } 32 \text{ g of methanol} = \frac{\text{mass of methanol}}{\text{R.F.M of methanol}} = \frac{32}{32} = 1.0 \text{ mole}$$

a. From the equation, 2 moles of methanol produce 2 moles of carbon dioxide.
The number of moles is in the ratio of 1 : 1.
 $2\text{CH}_3\text{OH}^{(g)} + 3\text{O}_2^{(g)} \longrightarrow 2\text{CO}^{(g)} + 4\text{H}_2\text{O}^{(g)}$

Answers

(Relative molecular mass of ethanol = 32.0)

b. How many moles of carbon dioxide gas are produced from the complete combustion of 32 g of methanol.

Q33. a. Write a balanced chemical equation for the complete combustion of methanol (CH_3OH)

The concentration of the acid is 0.05 M

$$C_{acid} = \frac{C_{KOH} \times V_{acid} \times \text{moles of acid}}{2 \text{ moles} \times 30 \text{ cm}^3 \times 1 \text{ mole}} = \frac{0.12M \times 25 \text{ cm}^3 \times 1 \text{ mole}}{2 \text{ moles} \times 30 \text{ cm}^3} = 0.05M$$

$C_{acid} \times V_{acid} = \frac{\text{moles of KOH}}{C_{KOH} \times V_{acid}}$
Let the concentration of acid be C_{acid} Volume of the acid (V_{acid}) = 30 cm³
Concentration of KOH (C_{KOH}) = 0.12M Volume of KOH (V_{KOH}) = 25 cm³
From the equation, 2 moles of KOH reacts with 1 mole of H_2SO_4

$2\text{KOH}^{(aq)} + \text{H}_2\text{SO}_4^{(aq)} \longrightarrow \text{K}_2\text{SO}_4^{(aq)} + 2\text{H}_2\text{O}^{(l)}$
Potassium hydroxide reacts with sulphuric acid according to the following equation:

Answers

Q32. 25 cm³ of 0.12M potassium hydroxide was neutralised by 30 cm³ of sulphuric acid solution. Calculate the concentration of the acid.

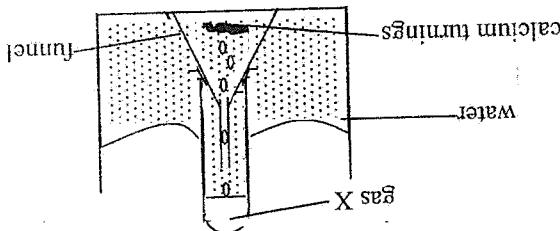
- b. Increasing concentration of the reactants increases rate of reaction unit time.
- a. Rate of reaction is the change in the concentration of reactants or products per Answers

b. How is the rate of reaction affected by an increase in the concentration of reactants?

Q39. a. Define the term *rate of reaction*.

- c. $\text{Ca(s)} + \text{H}_2\text{O(l)} \rightleftharpoons \text{Ca(OH)}_{2(aq)} + \text{H}_{2(g)}$
water and forms a suspension
- b. It turns cloudy because calcium hydroxide is formed which is slightly soluble in Gas X is hydrogen gas.
- a. Answers

- c. Write an equation for the reaction of calcium and water.
- b. As calcium reacts with water, it turns cloudy. Explain this observation.
- a. Name gas X.



Q38. The diagram below shows an experimental set up which was used to study the reaction between calcium turnings and water.

- e. A pop sound confirms that the gas is indeed hydrogen.
- d. Collect the gas in a test tube and bring a burning splint to the mouth of the tube. observe the colour change. If the solution turns pink, then it is indeed basic.
- c. Add three drops of phenolphthalein indicator to the resulting solution and Water is the oxidising agent. Potassium metal is the reducing agent.
- b. The products are potassium hydroxide and hydrogen gas.
- a. It is a reduction-oxidation reaction.
- Answers

- c. How would you test for the gas produced in the reaction.
- d. basic.
- c. Identify the reducing agent and the oxidising agent.
- b. Name the products formed.
- a. Name the type of reaction.



Q37. The reaction between sodium metal and water is represented by the chemical

It is fractional distillation
Answer

Q41. Name a method which can be used to separate a mixture of ethanol and water.
The concentration of the acid is 0.2M

$$= 0.2M$$

$$C_{acid} = \frac{C_{base} \times V_{base} \times \text{moles of acid}}{\text{moles of base} \times V_{acid}} = \frac{0.1M \times 40 \text{ cm}^3 \times 1 \text{ mole}}{1 \text{ mole} \times 20 \text{ cm}^3}$$

$$\frac{C_{acid} \times V_{acid}}{\text{moles of acid}} = \frac{\text{moles of base} \times V_{base}}{C_{base}}$$

$$\text{Volume of } H_2SO_4 \text{ used } (V_{acid}) = 20 \text{ cm}^3$$

$$\text{Let the concentration of } H_2SO_4 \text{ be } C_{acid}$$

$$\text{Volume of } Ba(OH)_2 (V_{base}) = 40 \text{ cm}^3$$

$$\text{Concentration of } Ba(OH)_2 (C_{base}) = 0.1M$$

From the equation, 1 mole of $Ba(OH)_2$ reacts with 1 mole of H_2SO_4

c. Barium hydroxide and sulphuric acid react according to the following chemical equation: $Ba(OH)_{2(aq)} + H_2SO_{4(aq)} \longrightarrow BaSO_{4(s)} + 2H_2O_{(l)}$

The hydroxide ions have been neutralised and addition of the acid increases the concentration of hydrogen ions which conduct electricity.

Between R and S, the electrical conductivity increases. This is because at point R, all hydroxide ions decrease.

Because the acid neutralises the barium hydroxide. Concentration of the

b. Between Q, the electrical conductivity decreases as the acid is being added because the acid neutralises the barium hydroxide. Concentration of the

a. A point when the acid and the base have completely neutralised each other.

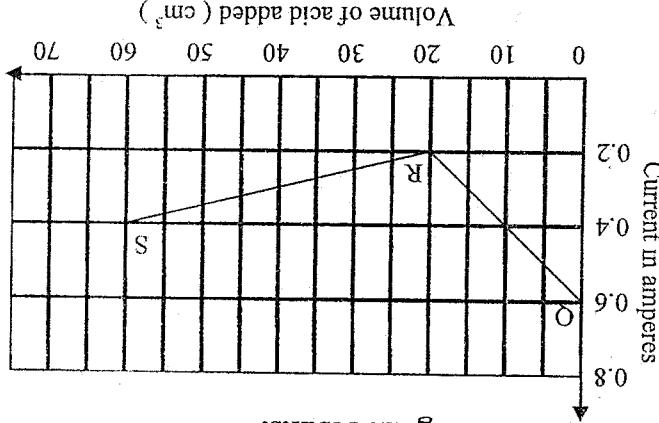
Answers

c. $Ba(OH)_2$ was used in the experiment.

c. Calculate the concentration of the acid if 40 cm³ of 0.1M barium hydroxide

b. Which letter represents the end point of the reaction. Explain your answer.

a. Explain what happens between Q and R.



Q40. a. What is meant by the term end point in an acid base reaction.
b. The electrical conductivity of barium hydroxide was measured after each addition of 1.0 cm³ of dilute sulphuric acid from a burette. The graph below was obtained using the results.

Q42. 50 ml of sodium hydroxide solution with a concentration of 20g/ml is diluted by adding distilled water to a volume of 250 ml. Calculate the concentration of the new solution.

Answer

The new solution has a concentration of 4.0 g/ml

Using the dilution equation, $C_1 \times V_1 = C_2 \times V_2$

Initial volume (V_1) = 50 ml

Initial concentration (C_1) = 20 g/ml

Final volume (V_2) = 250 ml

Let the required concentration be C_2

Let the required volume be V_1

Final concentration (C_2) = 20 g/ml

Final volume (V_2) = 250 ml

Calculate the required volume to be diluted

Concentration of the volume to be diluted (C_1) = 2.0 M

Let the volume to be diluted be V_1

Using the dilution equation, $C_1 \times V_1 = C_2 \times V_2$

$V_1 = \frac{C_2 \times V_2}{C_1} = \frac{0.1M \times 250 \text{ ml}}{2.0 \text{ M}} = 12.5 \text{ ml}$

Q43. A student dissolved 50 g of copper sulphate (CuSO_4) into 100 ml of water.

Answers

a. Relative formula mass for $\text{CuSO}_4 = 64 + 32 + 4(16) = 144$

b. Grams per litre

Moles per litre

Calculate the concentration of the copper sulphate in:

Relative atomic masses: Cu = 64, S = 32, O = 16

Number of moles in 50 g = $\frac{\text{Mass}}{\text{R.F.M.}} = \frac{50}{144} = 0.35 \text{ moles}$

Volume of the water used = 100 ml = 0.1 litres

Therefore, concentration = $\frac{\text{amount in moles}}{\text{volume in litres}} = \frac{0.35}{0.1} = 3.5 \text{ moles/litre}$

Concentration = $\frac{\text{mass in grams}}{\text{volume in litres}} = \frac{50}{0.1} = 500 \text{ g/litre}$

2.0M sodium hydroxide stock solution.

The solution can be prepared by diluting a certain volume taken from the stock Answer

Q44. Describe how you can prepare 250 ml of 0.1M sodium hydroxide solution from 2.0M sodium hydroxide stock solution.

Answers

a. Relative formula mass for $\text{CuSO}_4 = 64 + 32 + 4(16) = 144$

b. Grams per litre

Moles per litre

Calculate the concentration of the copper sulphate in:

Relative atomic masses: Cu = 64, S = 32, O = 16

Number of moles in 50 g = $\frac{\text{Mass}}{\text{R.F.M.}} = \frac{50}{144} = 0.35 \text{ moles}$

Volume of the water used = 100 ml = 0.1 litres

Therefore, concentration = $\frac{\text{amount in moles}}{\text{volume in litres}} = \frac{0.35}{0.1} = 3.5 \text{ moles/litre}$

Concentration = $\frac{\text{mass in grams}}{\text{volume in litres}} = \frac{50}{0.1} = 500 \text{ g/litre}$

2.0M sodium hydroxide stock solution.

The solution can be prepared by diluting a certain volume taken from the stock Answer

Q42. 50 ml of sodium hydroxide solution with a concentration of 20g/ml is diluted by adding distilled water to a volume of 250 ml. Calculate the concentration of the new solution.

Answer

The new solution has a concentration of 4.0 g/ml

Using the dilution equation, $C_1 \times V_1 = C_2 \times V_2$

Initial volume (V_1) = 50 ml

Initial concentration (C_1) = 20 g/ml

Final volume (V_2) = 250 ml

Let the required concentration be C_2

Let the required volume be V_1

Final concentration (C_2) = 0.1M

Final volume (V_2) = 250 ml

Calculate the required volume to be diluted

Concentration of the volume to be diluted (C_1) = 2.0 M

Let the volume to be diluted be V_1

Using the dilution equation, $C_1 \times V_1 = C_2 \times V_2$

$V_1 = \frac{C_2 \times V_2}{C_1} = \frac{0.1M \times 250 \text{ ml}}{2.0 \text{ M}} = 12.5 \text{ ml}$

Acids have a sour taste while bases have a bitter taste.

Acids have a pH less than 7 while bases have a pH greater than 7.

Answers

Q46. Mention any two differences between acids and bases. *Answers*

- b. (nickel spoon) increases as silver metal coats its surface.
- i. To make the metal shiny and attractive.
- ii. Prevent corrosion of the metal.

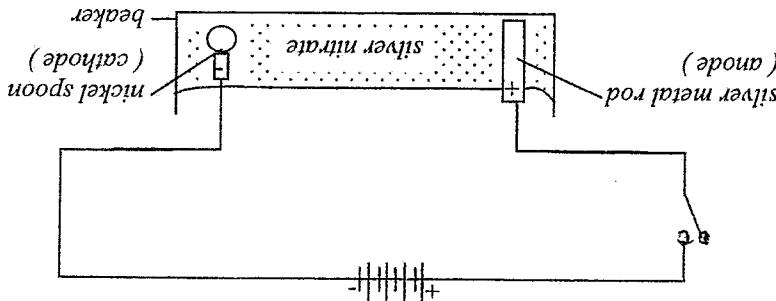
As the reaction proceeds, mass of anode decreases while mass of the cathode silver.

The silver metal rod dissolves and generates silver ions according to the following half equation: $\text{Ag}^{(aq)} + e \rightarrow \text{Ag}^{(s)}$. This reaction ensures continuous supply of silver ions in solution until the spoon is well coated with silver.

When the switch is closed, current flows in the circuit. The silver ions in solution move towards the cathode where they gain electrons to form silver ions in solution according to the following half equation: $\text{Ag}^{(aq)} + e \rightarrow \text{Ag}^{(s)}$. Silver metal coats the cathode.

A silver metal connected to the positive terminal of the battery is dipped in the aqueous solution of silver nitrate. It forms the anode.

The nickel spoon to be electroplated is connected to the negative terminal of the battery by connecting wires and submerged in an aqueous solution of silver nitrate. It forms the cathode. The silver nitrate is used as the electrolyte.



- a. To electroplate a nickel spoon with silver, the experiment is set up as shown below.
- Answers

Q45. a. With the aid of a well labelled diagram, describe how you can electroplate a nickel spoon with silver. *Answers*

Using a measuring cylinder, measure exactly 12.5 ml of the stock solution and transfer into a 250 ml volumetric flask. Add distilled water up to the 250 ml mark and shake gently. The solution has a concentration of 0.1 M.

Procedure

The hydronium ion is positively charged while the hydroxyl ion is negatively charged.

A hydronium ion is formed when a water molecule gains a hydrogen ion to form H_3O^+ while a hydroxyl ion is formed when a water molecule has lost a hydronium ion to form OH^- .

Answer:

Q49. Using a suitable example explain the difference between hydronium and hydroxyl ions.

The discharge reaction is as follows: $2\text{Cl}^-(aq) \rightarrow \text{Cl}_{2(g)} + 2\text{e}^-$.

- e. The element is chlorine.
 - d. The element is potassium because it is a reactive metal and hydrogen is preferentially discharged at the cathode.
 - c. The elements are: silver, hydrogen, zinc, copper, potassium and lead.
 - b. An element is a substance made up of only one type of atoms.
 - a. In aqueous form or molten state, the ions are free to move and conduct electricity.
- Answers**

anode and give the equation to represent the discharge reaction for this ion.

From the list, select one element whose ions would be discharged at the cathode in this case.

- d. One of the elements in the list can only be made from the electrolysis of a molten substance. Name the substance and explain why an aqueous solution would not be suitable in this case.
- c. From the list, pick out all elements whose ions were in molten state?
- b. Why must substances be in molten form or aqueous solution for electrolysis to take place?
- a. In the statement above, what is meant by the term element?

molten substances or aqueous solutions.

Q48. Below is a list of some elements which may be prepared by electrolysis of suitable

Copper is the oxidising agent.

- b. Zinc is the reducing agent.
 - a. $\text{Zn}(s) + \text{Cu}^{2+}(aq) \rightarrow \text{Zn}^{2+}(aq) + \text{Cu}(s)$
- Answers**

- i. Reducing agent
- ii. Oxidising agent
- b. From the equation identify the following:
 - a. Write a net ionic equation for the reaction which takes place.
- Q47. Zinc metal displaces copper from copper sulphate solution.

a. Suggest two reasons for adding water to the reacting mixture.

Volume of sodium thiosulfate (cm^3)	Volume of distilled water (cm^3)	Volume of hydrochloric acid (cm^3)	Time for the sulphur precipitate to appear (s)	1/time (s ⁻¹)
40	0	40	8	0.125
30	10	40	11	0.091
20	20	40	14	0.071
15	25	40	21	0.048
10	30	40	32	0.031

the table to answer the questions that follow.
 Q51. When sodium thiosulfate is mixed with dilute hydrochloric acid, sulphur precipitate is formed. To study the speed of this reaction different volumes of sodium thiosulfate and water were added to a constant volume of hydrochloric acid. In each case, time taken for the appearance of sulphur precipitate 1/time recorded. The table below shows the results of the experiment. Use value 1/time recorded to answer the questions that follow.

d. $\text{C}_{(s)} + \text{D}_{2+}^{(aq)} \longleftrightarrow \text{no reaction}$
 e. Reaction (ii) is expected to be most vigorous because it is between the most reactive metal and the least reactive metal.

f. $\text{A}_{(s)} - \text{2e} \longleftrightarrow \text{A}_{2+}^{(aq)}$
 b. $\text{B}_{2+}^{(aq)} + \text{2e} \longleftrightarrow \text{B}_{(s)}$
 c. $\text{C}_{(s)} \longleftrightarrow \text{increasing reactivity}$
 a. They are all metals because they all form positive ions and none of their reactions produce a gas.

Answers
 d. Write an equation to represent what you would expect to happen if solid C reacted.
 e. Which reaction would you expect to be most vigorous if concentrations and temperature were the same? Give reason for your answer.

b. Write half reactions to represent the changes which occur in equation (i).
 c. Arrange the four elements in order of reactivity starting with the least reactive.
 d. Write an equation to represent what you would expect to happen if solid C and D are all metals, all non-metals or a combination of them two? Give reason for your answer.

Q50. The equations below represent displacement reactions involving four elements. The elements are represented by the letters A, B, C and D. Study the equations and answer the questions that follow.

i. $\text{A}_{(s)} + \text{B}_{2+}^{(aq)} \longleftrightarrow \text{A}_{2+}^{(aq)} + \text{B}_{(s)}$
 ii. $\text{B}_{(s)} + \text{2C}_{(aq)} \longleftrightarrow \text{B}_{2+}^{(aq)} + \text{2C}_{(s)}$
 iii. $\text{B}_{(s)} + \text{2C}_{(aq)} \longleftrightarrow \text{A}_{2+}^{(aq)} + \text{2C}_{(s)}$
 iv. $\text{D}_{(s)} + \text{B}_{2+}^{(aq)} \longleftrightarrow \text{D}_{2+}^{(aq)} + \text{B}_{(s)}$
 v. $\text{D}_{(s)} + \text{A}_{2+}^{(aq)} \longleftrightarrow \text{no reaction}$

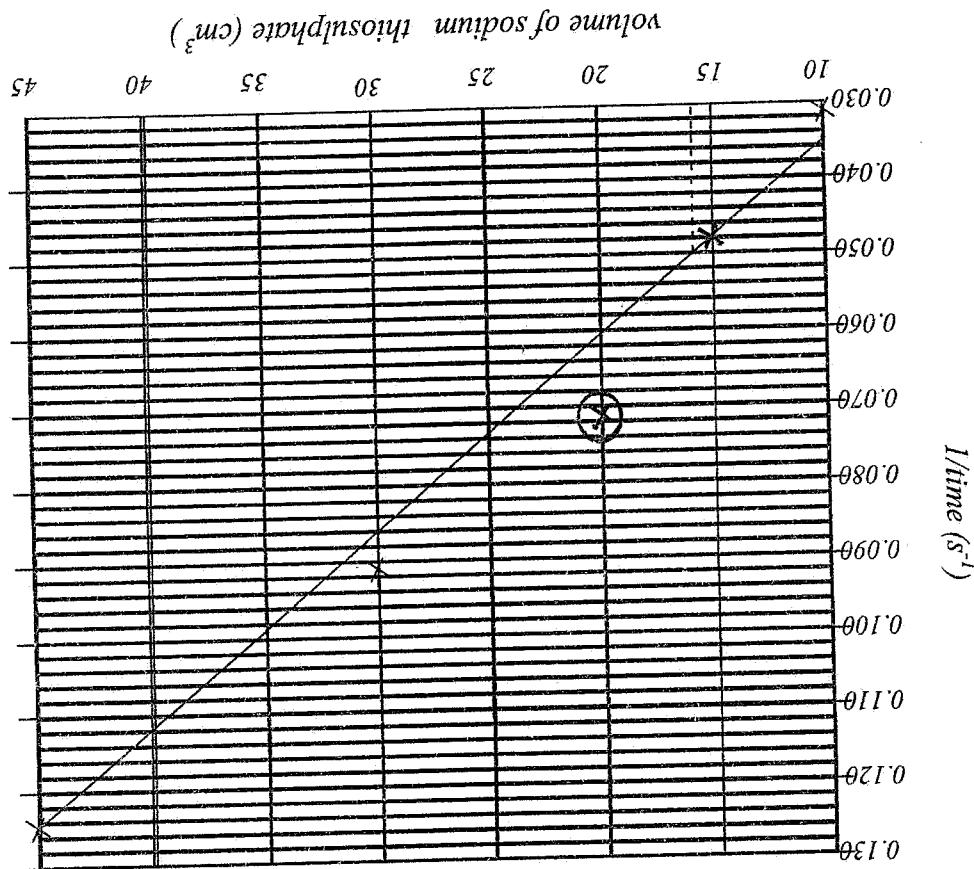
16 cm^3 . The volume of water to be used is 24 cm^3 .

$$\frac{1}{20 \text{ s}} = 0.05 \text{ s}^{-1}$$

From the graph, volume of sodium thiosulfate to be used is

compared to the other points.

The point in a circle is wrong because it is far away from the best fit line

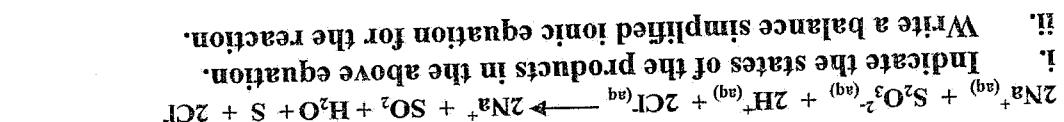


b. Graph of $1/\text{time}$ against volume of sodium thiosulfate.

To vary the concentration of the sodium thiosulfate.

a. To maintain a constant volume of the reactant sodium thiosulfate.

Answers



e. The balanced full ionic equation for the reaction between sodium thiosulfate and dilute hydrochloric acid is as follows:

f. State the factor that is being investigated in this experiment and the conclusion that could be drawn from the results shown.

g. What volume of sodium thiosulfate and water should be used for the sulphur precipitate to appear in a time of 20 seconds.

h. One of the readings is probably wrong. Put a circle round it on your graph thiosulfate on the horizontal axis.

i. Plot a graph of $1/\text{time}$ on the vertical axis and the volume of sodium

b.

c.

d.

e.

f.

g.

$$= 0.083M$$

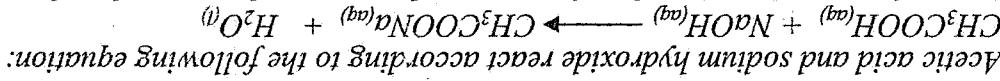
$$C_{acid} = \frac{C_{base} \times V_{base} \times \text{moles of acid}}{\text{moles of base} \times V_{acid}} = \frac{0.1M \times 25 \text{ cm}^3 \times 1 \text{ mole}}{1 \text{ mole} \times 30 \text{ cm}^3}$$

$$C_{acid} \times V_{acid} = \frac{\text{moles of acid}}{\text{moles of base}}$$

Let the concentration of the acid be C_{acid}

$$\text{Volume of acid used } (V_{acid}) = 30 \text{ cm}^3, \quad \text{Concentration of base } (C_{base}) = 0.1M$$

$$\text{Volume of base used } (V_{base}) = 25 \text{ cm}^3, \quad \text{From the equation, 1 mole of acidic acid reacts with one mole of sodium hydroxide.}$$



$$= 40 \text{ cm}^3 - 10 \text{ cm}^3 = 30 \text{ cm}^3$$

volume added = final volume - initial volume

b. The indicator is phenolphthalein solution and its colour is pink.

X is conical flask

a. X is burette

Answers

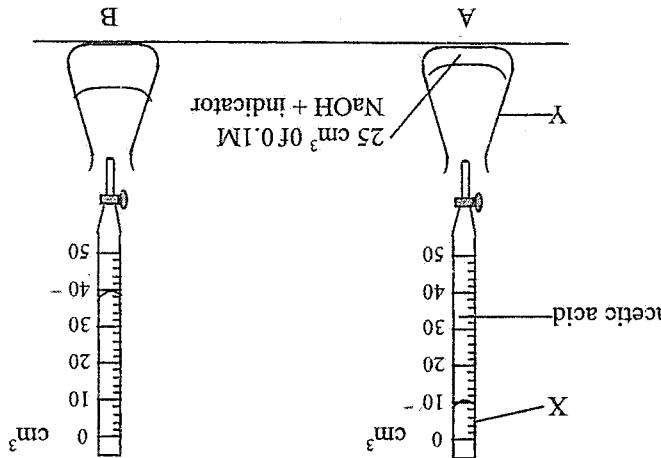
d. Calculate the concentration of the acetic acid in moles per litre.

hydroxide?

c. What volume of acetic acid was added to the 25cm³ of 0.1M sodium

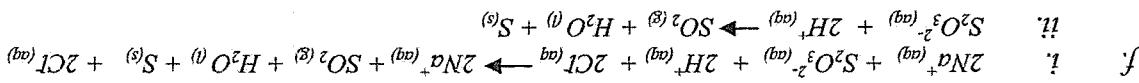
b. Name the indicator and its colour in A.

a. Give names of the pieces of apparatus labelled X and Y.



of the acetic acid at the end point.

Q52. The arrangement shown in the following diagram was used to carry out a titration of acetic acid against 0.1M sodium hydroxide solution. Diagram A shows the volume of acetic acid before the reaction and diagram B shows the volume of the acetic acid at the end point.



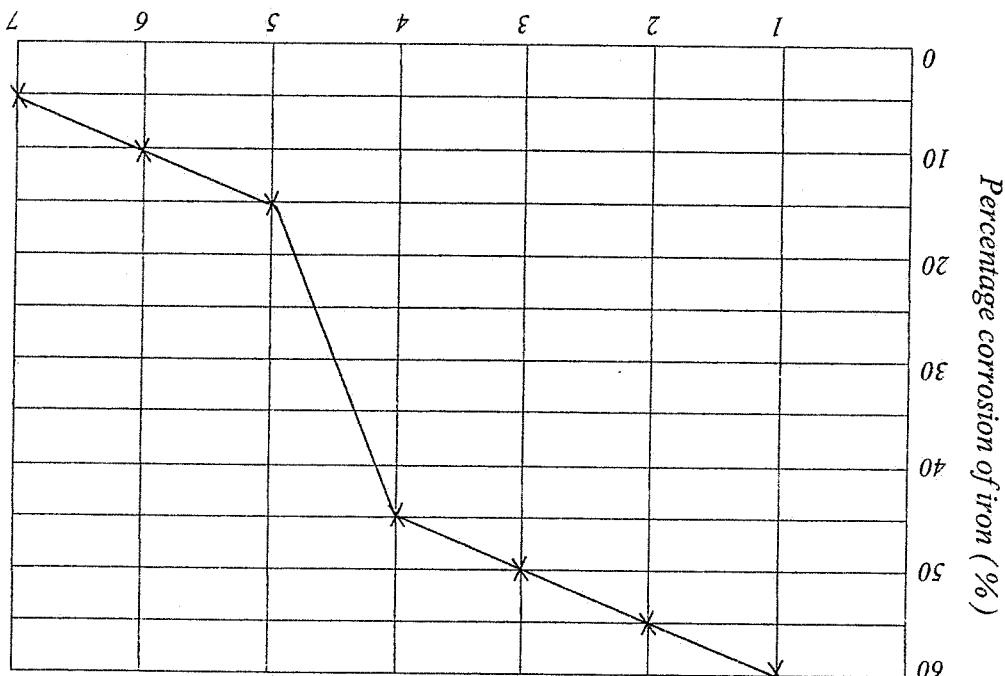
e. Effect of concentration on rate of reaction is being investigated. The conclusion is that rate of reaction increases with increasing concentration and decreases with decreasing concentration.

- a. Neutralisation reaction
 $\text{CH}_3\text{CO}_2\text{H}^{(aq)} + \text{K}^{(aq)} + \text{OH}^{-} \rightleftharpoons \text{CH}_3\text{CO}_2\text{K}^{(aq)} + \text{H}_2\text{O}^{(l)}$
- b. The spectator ions are: CH_3CO_2^- ions and K^+ ions.
- c. $\text{CH}_3\text{CO}_2\text{H}^{(aq)} + \text{H}^{(aq)} + \text{K}^{(aq)} \rightleftharpoons \text{CH}_3\text{CO}_2^- + \text{H}_2\text{O}^{(l)} + \text{K}^{(aq)}$

Answers

- a. Name the type of reaction.
 b. Write the full ionic equation for the reaction.
 c. Identify the spectator ions.
- 3 Unit*
- $\text{CH}_3\text{CO}_2\text{H}^{(aq)} + \text{KOH}^{(aq)} \rightleftharpoons \text{CH}_3\text{CO}_2\text{K}^{(aq)} + \text{H}_2\text{O}^{(l)}$
- Q56. The reaction between ethanoic acid and potassium hydroxide can be represented by the following equation:

- a. The higher the concentration of hydrogen ions in a solution, the higher the rate of corrosion.
- b. As the pH increases, percentage of corrosion decreases.
- c. The higher the concentration of hydrogen ions in a solution, the higher the rate of corrosion.

pH

Graph of percentage of corrosion against pH.

Answers

- a. Plot a graph of percentage of corrosion against pH.
- b. How does percentage corrosion vary as the pH increases from 1 to 7?
- c. What conclusion can be drawn from the results?

- 3 Unit*
- Q55. A teacher performed an experiment to find out the effect of pH on corrosion of iron. The following results were obtained.
- | pH | Percentage corrosion of iron (%) |
|----|----------------------------------|
| 1 | 1 |
| 2 | 2 |
| 3 | 3 |
| 4 | 4 |
| 5 | 5 |
| 6 | 6 |
| 7 | 7 |
| 10 | 10 |
| 15 | 15 |
| 45 | 45 |
| 50 | 50 |
| 55 | 55 |
| 60 | 60 |

increasing concentration of CH_3COOH shifts the equilibrium to the right so that more heat is given out.

Decreasing the temperature of the beaker shifts the equilibrium to the right. This is because decreasing the temperature favours the backward reaction, the system opposes the change by shifting the equilibrium to the right.

- i. Reversible reactions than CH_3COO^- and H_3O^+ .
- ii. The statement means there is more of the CH_3COOH and H_2O produced in the H_3O^+ and H_2O .
- iii. CH_3COOH and CH_3COO^- .

Answers

- a. What effect would the following have on the equilibrium position of the equation? Give reason in each case.
- b. In the equation above, the equilibrium lies to the left. What do you understand by this statement?
- c. Write the conjugate acid-base pairs in the equation.
- i. Decreasing the temperature of the contents of the beaker.
- ii. Increasing the concentration of CH_3COOH .



can be represented by the following equation:

Q58. Acetic acid (CH_3COOH) ionises slightly in water. The ionisation is reversible and

19.2 g of NaOH will react completely with 24 g of H_2SO_4 .

$$\text{Therefore, mass of NaOH} = \text{number of moles of NaOH} \times \text{R.F.M of NaOH}$$

Number of moles of NaOH to react with 0.24 moles of $\text{H}_2\text{SO}_4 = 2 \times 0.24$ moles
From the equation, 2 moles of NaOH react with 1 mole of H_2SO_4

$$\text{Moles of } \text{H}_2\text{SO}_4 \text{ in 24 g of the acid} = \frac{\text{Mass}}{\text{R.F.M}} = \frac{98}{24} = 0.24 \text{ moles}$$

$$\text{Relative formula mass for } \text{H}_2\text{SO}_4 = 2(1) + 32 + 4(16) = 98.$$

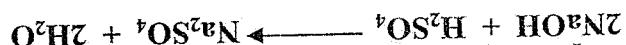
$$\text{Relative formula mass for NaOH} = 23 + 16 + 1 = 40.$$

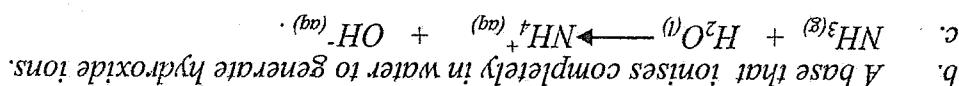
a. 2 moles of sulphuric acid

Answers

- a. How many moles of sulphuric acid are required to form 4 moles of water?
- b. How many grams of sodium hydroxide will react completely with 24 g of sulphuric acid. (Relative atomic masses: O = 16, S = 32, H = 1, Na = 23)

Q57. Sulphuric acid (H_2SO_4) reacts with sodium hydroxide (NaOH) to form sodium sulphate (Na_2SO_4) and water according to the following equation:





- a. i. A salt and hydrogen gas
ii. A salt and water
iii. A salt, carbon dioxide and water.

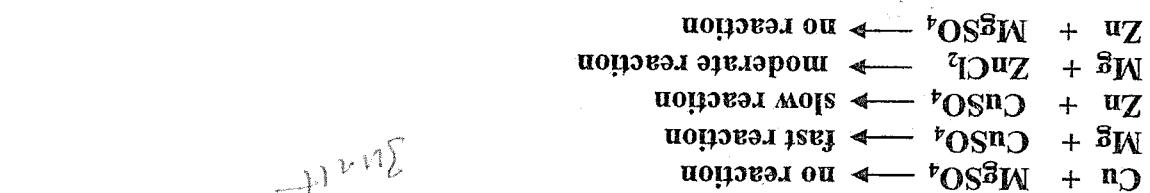
Answers

- Q61 a. Name the products of the reaction between an acid and the following:
Dunif
- b. Ammonia (NH_3) is an example of a strong base. What is a strong base?
- c. Write an equation to show the ionisation of ammonia in water.

- d. Mg and Cu because it involves the most reactive and the least reactive metal.
 e. Mg, Zn, Cu.
 f. Magnesium is the reducing agent.
- a. $Mg^{(s)} + CuSO_4^{(aq)} \rightarrow Cu^{(s)} + MgSO_4^{(aq)}$
 b. Copper is the oxidising agent.

Answers

- Q62 a. Write a balanced chemical equation for the reaction between magnesium and (Mg) and copper sulphate ($CuSO_4$) solution.
 b. Name the oxidising agent and the reducing agent in the reaction written in part (a) above.
- c. Arrange the metals in order of reactivity starting with the most reactive.
- d. Which combination of metals would react fastest. Give reason.



Answer the questions that follow.

- Q60. Below are results of a set of experiments carried out by a pupil. Study them and

- a. Rate of a reaction increases with increasing concentration of the reactants.
 b. Rate of reaction increases with increasing temperature and decreases with decreasing temperature.
 c. Rate of reaction increases with increasing surface area of a solid reactant.
- 31/14*

Answers

- a. Concentration
 b. Temperature
 c. Surface area of a solid reactant.

- Q59. Explain how the following affect the rate of a reaction.
A 1/14

Q62. a. What is a standard solution?
 b. A laboratory technician has 1 litre of 2M hydrochloric acid solution. Describe how she could prepare 250 cm³ volume of 0.2M hydrochloric acid solution.
 c. The diluted hydrochloric acid solution was used to determine concentration of sodium hydroxide solution. Describe how she could have carried out the experiment.

The procedure can be prepared by diluting a certain volume taken from the 2M hydrochloric acid solution to 250 cm³.
 A solution with known concentration.

Using a measuring cylinder, measure exactly 25 cm³ of the 2M hydrochloric acid solution and transfer into a 250 cm³ volumetric flask. Add distilled water up to the 250 cm³ mark and shake gently. The solution has a concentration of 0.2 M.

Using a measuring cylinder, measure exactly 25 cm³ of the 2M hydrochloric acid solution. Initial volume (V_1) of the hydrochloric acid was recorded. By subtracting V_1 from V_2 , the volume of hydrochloric acid (V_1 cm³) that reacted with the base was calculated from the three results. The procedure was repeated two times and an average volume of the acid (V_2 cm³) that reacted with the base was then calculated using the following formula:

$$\text{Concentration of NaOH} = \frac{C_{HCl} \times V_{HCl}}{C_{NaOH} \times V_{NaOH}} = \frac{0.2M \times V_2 \text{ cm}^3}{x \text{ cm}^3}$$

The final volume (V_2) of the hydrochloric acid was recorded. By subtracting V_1 from V_2 , the volume of hydrochloric acid (V_1 cm³) that reacted with the base was found. The contents of the conical flask changed colour from pink to colourless. A burette was clamped onto a stand and filled with the hydrochloric acid solution. Initial volume (V_1) of the hydrochloric acid solution was recorded. The contents of the conical flask turned pink as soon as the acid was gradually added to the base while shaking the conical flask gently. Addition of the acid to the base sodium hydroxide was stopped as soon as the conical flask turned pink. Three drops of phenolphthalein indicator solution were added into the conical flask and the solution turned pink. Using a measuring cylinder, a known volume (x cm³) of the sodium hydroxide solution was transferred into a conical flask. Three drops of phenolphthalein indicator solution were added into the conical flask and the solution turned pink.

The concentration of the sodium hydroxide could have been determined by the method of titration.

Using a measuring cylinder, a known volume (x cm³) of the sodium hydroxide solution was transferred into a conical flask. Three drops of phenolphthalein indicator solution were added into the conical flask and the solution turned pink.

Initial volume (V_1) = $C_2 \times V_2 = \frac{C_1 \times V_1}{2.0M} = 25 \text{ cm}^3$

Final concentration (C_2) = 0.2M
 Let the volume to be diluted be V_1
 Concentration of the solution to be diluted (C_1) = 2.0M
 Using the dilution equation, $C_1 \times V_1 = C_2 \times V_2$
 Final concentration (C_2) = 0.2M
 Let the volume to be diluted be V_1
 Concentration of the solution to be diluted (C_1) = 2.0M
 Using the dilution equation, $C_1 \times V_1 = C_2 \times V_2$
 Final volume (V_2) = 250 cm³.
 Calculation of the required volume to be diluted

b. The solution can be prepared by diluting a certain volume taken from the 2M hydrochloric acid solution to 250 cm³.
 a. A solution with known concentration.

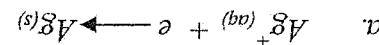
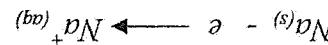
Answers

Q62. a. What is a standard solution?
 b. A laboratory technician has 1 litre of 2M hydrochloric acid solution. Describe how she could prepare 250 cm³ volume of 0.2M hydrochloric acid solution from the 2M hydrochloric acid solution.
 c. The diluted hydrochloric acid solution was used to determine concentration of sodium hydroxide solution. Describe how she could have carried out the experiment.

iii. Nitrate ions (NO_3^-) are the spectator ions.

ii. Silver is the oxidising agent.

i. Sodium metal is the reducing agent.



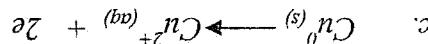
Answers

i. Reducing agent ii. Oxidising agent iii. Spectator ions

b. Identify the following from the reaction in part (a):

Sodium metal.

Q65. a. Write half equations for the reaction between silver nitrate ($AgNO_3$) and



b. Reduction-oxidation reaction.

a. It means the element is neutral.

Answers

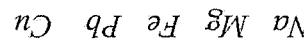
c. Write the oxidation half reaction.

b. Name the type of reaction.

a. What is the meaning of the zero sign (0) in $Cu_0(s)$



Q64. Copper metal reacts with silver ions according to the following equation:



b. *Decreasing reactivity* \longleftarrow

a. Redox reaction

Answers

b. List down the metals in order of decreasing reactivity.

a. Name the type of reaction that took place during the deposition of the

metals.

Metal	Ions	Z	X
Mg	Mg^{2+}	12	No change
Na	Na^+	11	Magnesium (Mg) deposited
Pb	Pb^{2+}	82	Copper (Cu) deposited
Fe	Fe^{2+}	26	Lead (Pb) deposited
	Results		

Column X into solutions containing ions in column Z.

Q63. A pupil carried out a series of experiments to find out positions of metals in a displacement series. The following results were obtained after dipping metals in

Preparation.

Measure exactly 62.5g of the hydrated copper sulphate using a triple beam balance and transfer into a beaker. Add approximately 100 cm³ of distilled water, stir gently until the compound dissolves. Quantitatively, transfer into a 250 cm³ volumetric flask and dilute to the mark using distilled water. Shake gently. The 250 solution has a concentration of 1.0M

$$= 62.5\text{g}$$

$$\text{Mass of the hydrated compound to contain 40g of copper sulphate} = \frac{40 \times 100}{64} = 62.5\text{g}$$

$$\text{Percentage of copper sulphate in the hydrated compound} = \frac{160 \times 100\%}{250} = 64\%$$

$$\text{Mass of water in the hydrated compound} = 18 \times 5\text{g} = 90\text{g}$$

$$= 0.25 \times 160\text{g} = 40\text{g}$$

$$\text{Mass of copper sulphate to be dissolved} = \text{number of moles} \times \text{relative formula mass}$$

$$= 0.25 \times 1\text{ mole} = 0.25 \text{ moles}$$

$$\text{Concentration of the solution} = 1\text{M}$$

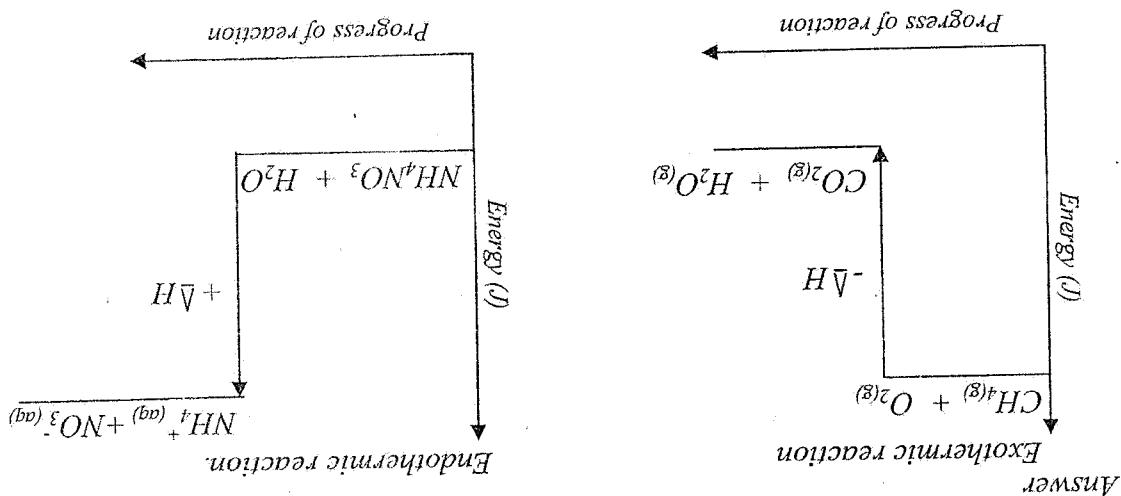
$$\text{Volume of solution to be prepared} = 250 \text{cm}^3 = 0.25 \text{ litres}$$

$$\text{Calculation of the required mass.}$$

The solution can be prepared by dissolving a certain amount of the hydrated copper sulphate in distilled water and diluting the solution to 250 cm³.

Answer is 250 g.

Q67. Describe how 250 cm³ of 1.0M copper sulphate solution could be prepared using hydrated copper sulphate crystals (CuSO₄.5H₂O). Molar mass of CuSO₄.5H₂O



Answer

Q66. Given that the reaction between methane (CH₄) and oxygen (O₂) to produce ammonia nitrate (NH₄NO₃) is endothermic, draw energy level diagrams for carbon dioxide gas (CO₂) and water (H₂O) is exothermic and the dissociating ammonia nitrate (NH₄NO₃) is endothermic, draw energy level diagrams for the two types of reactions.

$$\text{Mass of the salt in grams} = m_1 - m_2$$

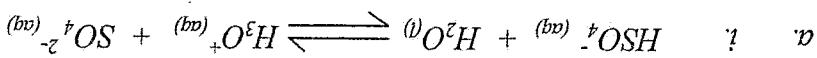
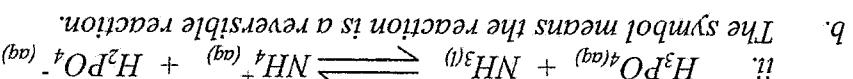
Pour the 20 cm^3 of the salt solution on the evaporation basin, place the basin on a tripod stand and heat the solution using a bunsen burner until all the water has evaporated. Leave the evaporation basin and the salt to cool down. Measure the mass of the evaporating basin and salt (m_2) using a triple beam balance and record the mass in grams.

Measure the mass (m_1) of a clean and dry evaporation basin using a triple beam balance and record the mass in grams.

- a. The concentration can be determined as follows:
- Answers

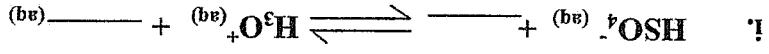
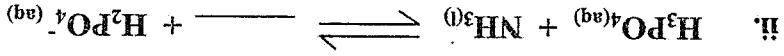
Q70. a. Describe how the concentration of 20 cm^3 of sodium chloride can be determined by the evaporation method. ($\text{R.F.M. of NaCl} = 59$)

b. Suggest two sources of error in the experiment in part (a) above.



Answers

b. What does the symbol \rightleftharpoons , mean in the equation?



Answers

Q69. a. Complete the following chemical equations:

$$C_{acid} = \frac{C_{NaOH} \times V_{NaOH}}{V_{acid}} = \frac{0.2M \times 25cm^3}{20cm^3} = 0.25M$$

NaOH and HCl react in a 1:1 mole ratio.

d. Hydrogen chloride solution reacts with sodium hydroxide according to the following chemical equation: $\text{HCl}^{(aq)} + \text{NaOH}^{(aq)} \rightarrow \text{NaCl}^{(aq)} + \text{H}_2\text{O}^{(l)}$

c. Sodium hydroxide solution because its concentration is known.

b. Phenolphthalein is used as an indicator.

a. Titration is the gradual addition of a solution to another solution and the exact volume added can be measured.

Answers

d. Calculate the concentration of the acid.

c. Identify the standard solution in the titration. Give reason.

b. Explain the function of the phenolphthalein in the titration.

a. What is the meaning of the word 'titration'.

Q68. In a titration, 20cm^3 of hydrogen chloride solution reacted completely with 25cm^3 of $0.2M$ sodium hydroxide solution mixed with phenolphthalein solution.

- a. A substance which can remove oxygen atoms and hydrogen atoms as water from a compound.
- b. Carbon and water.
- Answers

- a. What is a dehydrating agent?
- b. Name the products in the dehydration of sucrose ($C_{12}H_{22}O_{11}$).

Q73. Sulfuric acid (H_2SO_4) can be used as a dehydrating agent.

$$C_2 = \frac{C_1 \times V_1}{V_2} = \frac{20 \text{ g/l} \times 0.1 \text{ l}}{0.25 \text{ l}} = 8 \text{ g/l}$$

Using the dilution equation, $C_1 \times V_1 = C_2 \times V_2$

Initial volume (V_1) = 100 cm³ = 0.1 litres.

Initial concentration (C_1) = 20 g/l

Let the final concentration be C_2

Final volume (V_2) = 250 cm³ = 0.25 l (1000 cm³ = 1 litre)

Answer

work out the concentration of the new solution.

Q72. 100cm³ solution of concentration 20g/l is diluted with distilled water to 250 cm³.

electrons.

b. Sodium is the most electropositive because it has the greatest tendency of losing solution.

a. Copper will not react with magnesium sulphate because copper is a less reactive metal than magnesium and can not displace the magnesium from its aqueous

Answers

your answer.

- b. Which metal is the most electropositive in the reactivity series? Explain ($MgSO_4$). Explain your answer.
- a. State whether copper will react with a solution of magnesium sulphate

Copper

Hydrogen

Lithium

Magnesium

Sodium

Lithium

Magnesium

The oxidation number of sulphur is +6.
Therefore, $-2 = -8 + x$, so $x = 8 - 2 = 6$.

Sum of oxidation numbers of the 4 oxygen atoms = 4 $(-2) = -8$
Oxidation number of one oxygen atom = -2
Oxidation number of the sulphate ion = -2
Let the oxidation number of sulphur be x
Answer

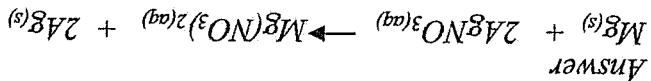
Q78. Calculate the oxidation number of sulphur in a sulphate ion (SO_4^{2-})

Both ethanol and water have the hydroxyl group ($-\text{OH}$) which acts as the reactive centre.
Answer

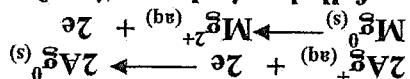
Q77. Explain why sodium metal reacts with ethanol in the same way as it does with water.

- a. It undergoes partial ionisation in water as a result, less hydrogen ions are generated to conduct electricity, so its electrical conductivity is relatively small.
- b. $\text{CH}_3\text{COOH}_{(aq)} + \text{H}_2\text{O}_{(l)} \rightleftharpoons \text{CH}_3\text{COO}^{-}_{(aq)} + \text{H}_3\text{O}^{+}_{(aq)}$
- c. CH_3COOH and $\text{CH}_3\text{COO}^{-}$
- Answers

- a. Write an equation for the ionisation of ethanoic acid in water.
- b. Identify one conjugate-acid base pair from the equation in part (b) above.
- c. Why is ethanoic acid regarded as a weak electrolyte?



Write a full chemical equation for the reaction.



Q75. The following are half equations for the reaction between magnesium and silver nitrate.

$$\text{Concentration of } \text{C}_6\text{H}_5\text{O}_4^{-} = \frac{0.0017}{0.01} = 0.17 \text{ moles/litre}$$

$$\text{Moles of } \text{C}_6\text{H}_5\text{O}_4^{-} \text{ in } 0.01 \text{ litres of water} = \frac{\text{R.F.M}}{\text{mass}} = \frac{180}{0.3} = 0.0017 \text{ moles.}$$

$$\text{Relative molecular mass of } \text{C}_6\text{H}_5\text{O}_4^{-} = 9(12) + 8(1) + 4(16) = 180$$

$$\text{Volume of water} = 10 \text{ ml} = 0.01 \text{ litres}$$

$$\text{Mass of the tablet} = 300 \text{ mg} = 0.3 \text{ g}$$

Answer

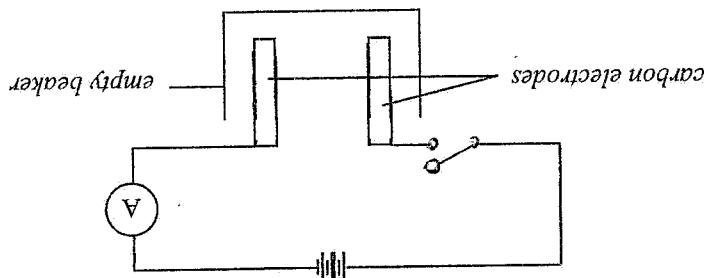
Q74. A 300 mg tablet of a drug was completely dissolved in 10ml of water. The molecular formula of the drug is $\text{C}_6\text{H}_5\text{O}_4^{-}$. Calculate the concentration of the solution in moles per litre. (Relative atomic masses: C = 12, H = 1.0, O = 16).

Ammeter reading A_1 is compared to ammeter reading A_2 . If $A_1 > A_2$, then potassium nitrate has a higher electrical conductivity than potassium nitrate. If $A_1 = A_2$, then the two solutions have the same electrical conductivity.

The empty beaker is filled with potassium chloride solution. The switch is closed and current flowing in the circuit is measured using the ammeter. The ammeter reading (A_2) is then recorded on paper.

The switch is opened, the beaker and carbon electrodes are removed. The electrodes are thoroughly washed with distilled water, wiped dry with a clean cloth, connected back into the circuit and placed in a clean dry beaker.

The empty beaker is filled with potassium nitrate solution. The switch is closed and current flowing in the circuit is measured using the ammeter connected in series. The ammeter reading (A_1) is then recorded on paper.



To compare the electrical conductivity of potassium nitrate solution and potassium chloride solution, the experiment is set up as shown in the diagram below.

Answer

Q80. With the aid of a well labelled diagram, describe an experiment that can be carried out to compare the electrical conductivity of potassium nitrate solution and potassium chloride solution.

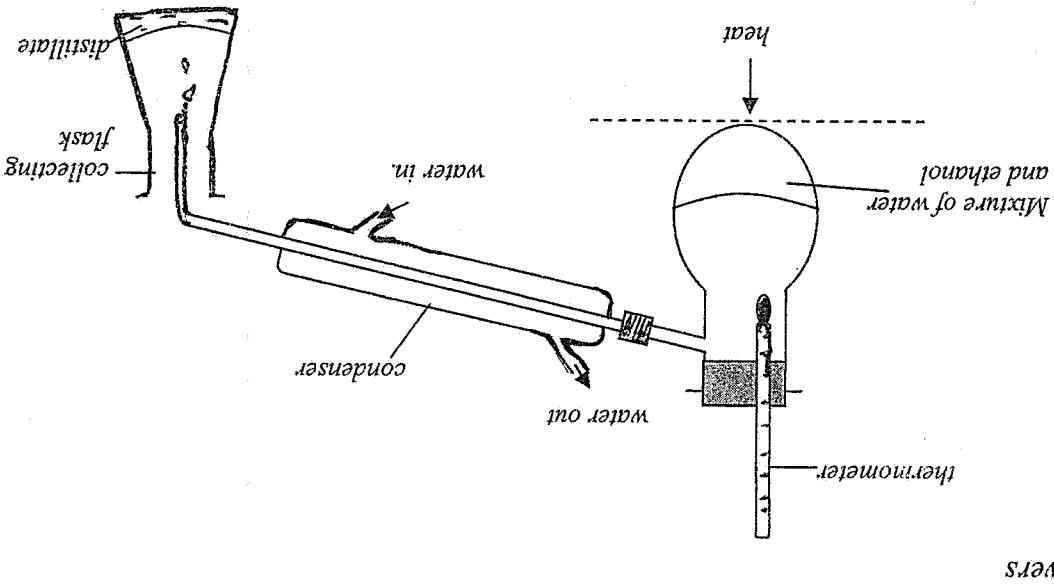
Answer

a. Let the oxidation number of nitrogen be x .
Oxidation number of one oxygen atom = +1
Sum of oxidation numbers of the 3 oxygen atoms = $3(-2) = -6$.
Therefore, $-I = -6 + x$, so $x = 6 - I = 5$.
The oxidation number of nitrogen is +5.
Therefore, $-I = -6 + x$, so $x = 6 - I = 5$.
Oxidation number of one oxygen atom = -2
Sum of oxidation numbers of the 3 oxygen atoms = $3(-2) = -6$.
Oxidation number of the nitrate ion = -1
Let the oxidation number of nitrogen be x .
Oxidation number of one sodium atom = 0
Oxidation number of the Na_2CO_3 = 0
Let the oxidation number of oxygen be y .
 $2(+1) + 3(-2) + x = 0$
 $2 + 3 - 6 + x = 0$
 $x = 2$.

Answers
Q79. a. Calculate the oxidation number of nitrogen in a nitrate ion (NO_3^-) in

b. Calculate the oxidation number, x , of the carbonate ion (CO_3^{2-}) in (Na_2CO_3) .

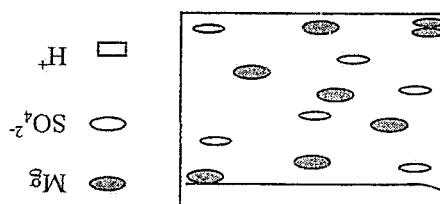
b. Some of the water evaporates together with the ethanol.



a. Answers

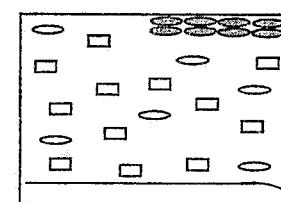
- Q82. a. Draw a labelled diagram of the set up of apparatus that can be used to separate a mixture of ethanol and water.
b. Explain why the distillate is not pure.

b. I expect the mass to decrease because the hydrogen gas which is produced escapes into the surrounding air.



a. Answers

- a. Use the symbols given to show the contents of the beaker after the reaction has gone to completion.
b. Suppose the beaker and its contents were weighed before and after the reaction, would you expect the mass to increase, decrease or remain the same? Explain your answer.



- Q81. The diagram below represents a mixture of magnesium metal and sulphuric acid solution before the reaction starts.

- Q83. a. Define molarity.**
- b. Calculate the molarity of a solution prepared by dissolving 5g of sodium chloride (NaCl) in water to make 1 litre of solution.
- c. If 10 cm³ of the solution prepared in part (d) was vaporised, how much NaCl would be left on the evaporating basin.
- a. Molarity is the concentration of a substance in moles per litre.
- b. Moles of NaCl in 5 g = $\frac{5}{58.5} = 0.085$ moles.
- c. Concentration = $\frac{\text{Number of moles}}{\text{Volume in litres}} = \frac{0.085}{1.0} = 0.085\text{ M}$
- Answers
- Q84. Describe how a hydronium (H_3O^+) ion is formed.**
- c. Number of moles in 1 litre of the NaCl = 0.085×0.01 litres = 0.00085 moles.
- Therefore, number of moles in 0.01 litres of the NaCl = 0.085×0.01 moles.
- Mass of NaCl left on the basin = number of moles \times R.F.M = $0.00085 \times 58.5 = 0.00085 \times 58.5 = 0.00085 \times 58.5 = 0.050\text{ g} = 50\text{ mg}$.
- 50 mg of NaCl would be left on the evaporating basin.
- Q85. Explain why aluminium is a better conductor of electricity than magnesium.**
- Answer
- Aluminium has more valence electrons which are delocalised compared to magnesium.
- Q86. Define the term concentration.**
- Answer
- Concentration refers to the amount of a solute dissolved in a unit volume of a solvent.
- Q87. What is the mass (in grams) of 0.1 moles of sodium metal?**
- Relative atomic mass of sodium metal = 23
- Mass in grams = number of moles \times relative atomic mass = 0.1×23 g = 2.3 g
- = 2.3 g
- Answer
- (relative atomic mass for sodium = 23).

Therefore, simplest formula of the compound is Fe_2O_3

Ratio of moles of iron to moles of oxygen = 1 : 1.5 = 2 : 3

Moles of oxygen = $\frac{\text{relative atomic mass}}{\text{mass}} = \frac{16}{6} = 0.375 \text{ moles}$

Moles of iron = $\frac{\text{relative atomic mass}}{\text{mass}} = \frac{56}{14} = 0.25 \text{ moles}$

Mass of iron = 14g Mass of oxygen = 20g - 14g = 6g

Answer

Q91. 20g of a compound of iron contains 14g iron and the rest oxygen. Find its simplest formula. (relative atomic masses: Fe = 56, O = 16).

Relative atomic mass of metal X = $\frac{2}{112} = 56$.

Mass of metal X (28%) = $\frac{288 \times 28\%}{72\%} = 112$

If 72% is equivalent to 288
combined mass of sulphur and oxygen = $3(32) + 12(16) = 96 + 192 = 288$
combined mass of sulphur and oxygen as a percentage = 72%
mass of metal X as a percentage = 28%
Answer

Q90. A metal $\text{X}_2(\text{SO}_4)_3$ contains 28% by mass of metal X. What is the relative atomic mass of metal X? (relative atomic masses: S = 32, O = 16).

36g of water contain 2.0 moles of water molecules.

Number of moles = $\frac{\text{relative molecular mass}}{\text{mass}} = \frac{18}{36} = 2.0 \text{ moles}$

Relative molecular mass of water = 18

Answer

Q89. How many moles of water molecules will have a mass of 36g? (relative atomic masses: H = 1, O = 16).

0.018 moles of oxygen gas will occupy a volume of 400 cm^3 at s.t.p.

Therefore, number of moles to occupy $0.4 \text{ dm}^3 = \frac{1 \text{ mole} \times 0.4 \text{ dm}^3}{22.4 \text{ dm}^3} = 0.018 \text{ moles}$

Volume occupied by 1 mole of any gas at s.t.p. = 22.4 dm^3

$400 \text{ cm}^3 = 0.4 \text{ dm}^3$

Answer

Q88. How many moles of oxygen gas will occupy a volume of 400 cm^3 at s.t.p.

Therefore, molarity = $0.094 \text{ moles/l or } 0.094M$

$$= 0.094 \text{ moles}$$

Moles of sodium carbonate dissolved in $1 \text{ dm}^3 = \frac{\text{F.F.M}}{\text{mass}} = \frac{10}{106} \text{ moles}$

Answer.

1 dm^3 of water? (relative formula mass of sodium carbonate = 106).

Q95. What is the molarity of sodium carbonate when 10g of the solid is dissolved in

5.6 dm^3 of carbon dioxide gas will be produced

Therefore, volume occupied by 0.25 moles of $\text{CO}_2 = 0.25 \times 22.4 \text{ dm}^3 = 5.6 \text{ dm}^3$.

Volume occupied by 1 mole of any gas at s.t.p = 22.4 dm^3

Therefore, 0.25 moles of CaCO_3 will produce 0.25 moles of CO_2

From the chemical equation given, 1 mole of CaCO_3 produces 1 mole of CO_2 .

Number of moles of $\text{CaCO}_3 = \frac{\text{relative formula mass}}{\text{mass}} = \frac{100}{25} = 0.25 \text{ moles}$

Relative formula mass of $\text{CaCO}_3 = 40 + 12 + 3(16) = 52 + 48 = 100$

Answer



is heated at r.t.p. (relative atomic masses: Ca = 40, C = 12, O = 16)

Q94. Calculate the volume of carbon dioxide produced when 25g of calcium carbonate

0.25 moles of carbon dioxide will occupy 5.6 dm^3 at s.t.p

Volume occupied by 0.25 moles of carbon dioxide gas = $0.25 \times 22.4 \text{ dm}^3 = 5.6 \text{ dm}^3$

Volume occupied by 1 mole of any gas at s.t.p = 22.4 dm^3

Answer

Q93. What is the volume occupied by 0.25 moles of carbon dioxide at s.t.p?

The molecular formula of the hydrocarbon is C_4H_8

Therefore, number of moles of hydrogen = $\frac{\text{relative atomic mass}}{\text{mass}} = \frac{1.0}{7.84} = 8 \text{ moles}$

Mass of hydrogen (14%) = $\frac{14 \times 56}{100} = 7.84$

Therefore, number of moles of carbon = $\frac{\text{relative atomic mass}}{\text{mass}} = \frac{12}{48.16} = 4.0 \text{ moles}$

Mass of carbon (86%) = $\frac{86 \times 56}{100} = 48.16$

Molecular mass of the hydrocarbon = 56

Answer

hydrocarbon. (relative atomic masses: C = 12, H = 1.0).

Q92. A hydrocarbon has a percentage composition by mass of 86% of carbon and 14% of hydrogen. Its molecular mass is 56. Determine the molecular formula of the

- b. Determine the simplest formula of magnesium oxide.
- iii. Oxygen
 - ii. Magnesium oxide
 - i. Magnesium ribbon
- a. Calculate the mass of

$$\text{Mass of crucible, lid and magnesium oxide} = 24.7\text{g}$$

$$\text{Mass of crucible, lid and magnesium ribbon} = 23.3\text{g}$$

$$\text{Mass of crucible and lid} = 21.2\text{g}$$

Q99. A student performed an experiment to determine the formula of magnesium oxide. Use the following information to answer the questions that follow.

$$\text{Mass of sodium carbonate} = \text{number of moles} \times \text{relative formula mass}$$

$$= 0.025 \times 106\text{g}$$

$$= 2.65\text{g}$$

$$\text{Number of moles of sodium carbonate} = \text{concentration} \times \text{volume}$$

$$= 0.1\text{M} \times 0.25\text{litres}$$

$$\text{Volume of sodium carbonate} = 250\text{cm}^3 = 0.25\text{litres} \quad (1000\text{cm}^3 = 1\text{litrer})$$

Answer.

Q98. What mass of anhydrous sodium carbonate is needed to make 250 cm^3 of 0.1M solution? (RFM of sodium carbonate = 106)

$$\text{Mass in grams} = \text{number of moles} \times \text{relative formula mass} = 0.1 \times 40\text{g} = 4.0\text{g}$$

$$\text{The mass of sodium hydroxide is } 4.0\text{g.}$$

$$\text{Number of moles of sodium hydroxide} = \text{concentration} \times \text{volume}$$

$$= 0.2\text{M} \times 0.5\text{litres}$$

$$\text{Volume of the sodium hydroxide} = 500\text{ cm}^3 = 0.5\text{ litres.} \quad (1000\text{cm}^3 = 1\text{litrer})$$

Answer.

Q97. Calculate the mass of sodium hydroxide in 500cm^3 of a solution whose concentration is 0.2M . (RFM for sodium hydroxide = 40).

$$\text{Concentration} = \frac{\text{number of moles}}{\text{volume}} = \frac{0.10 \text{ moles}}{0.25\text{l}} = 0.4 \text{ moles/litre.}$$

$$= 0.10 \text{ moles}$$

$$\text{Number of moles of magnesium chloride} = \frac{\text{mass}}{\text{relative formula mass}} = \frac{9.5}{94} \text{ moles}$$

$$250\text{ cm}^3 = \frac{1\text{ litre} \times 250\text{cm}^3}{1000\text{ cm}^3} = \frac{250\text{l}}{1000} = 0.25\text{l}$$

$$1000\text{ cm}^3 = 1\text{litrer}$$

Answer.

Q96. Calculate the concentration of a solution, in moles per litre, made by dissolving 9.5g of magnesium chloride in 250cm^3 of water. (relative formula mass of magnesium chloride = 94).

- Answers.**
- a. i. Mass of magnesium ribbon = $23.3g - 21.2g = 2.1g$
ii. Mass of magnesium oxide = $24.7g - 21.2g = 3.5g$
iii. Mass of oxygen = $3.5g - 2.1g = 1.4g$
- b. Moles of magnesium = $\frac{\text{mass}}{\text{relative atomic mass}} = \frac{2.1}{24} = 0.0875 \text{ moles}$
Moles of oxygen = $\frac{\text{mass}}{\text{relative atomic mass}} = \frac{1.4}{16} = 0.0875 \text{ moles}$
- c. Therefore, formula of magnesium oxide is MgO .
Ratio of moles of magnesium to moles of oxygen = $1 : 1$
- d. Q100. The formula of hydrated sodium carbonate is $Na_2CO_3 \cdot XH_2O$ where X represents the number of molecules of water of crystallization. To determine the value of X , a sample of hydrated sodium carbonate crystals was heated to a constant mass as follows:
- a. Calculate the decrease in mass.
b. How many moles of water were lost in the experiment?
c. How many moles of water were formed at the end of the experiment?
d. Work out the value of X in the formula $(RAM: H = 1, O = 16, Na = 23, C = 12)$.
- Answers.**
- a. Decrease in mass = $7.15g - 2.65g = 4.50g$
Relative molecular mass of water = 18
Mass of water in the hydrated sodium carbonate = $4.50g$
- b. Relative molecular mass of anhydrous sodium carbonate = 106
Relative formula mass of anhydrous sodium carbonate = 106
Number of moles of water = $\frac{\text{mass}}{\text{relative formula mass}} = \frac{4.50}{18} = 0.25 \text{ moles}$
- c. Relative formula mass of anhydrous sodium carbonate = 2.65g
Mass of anhydrous sodium carbonate = 2.65g
- d. Ratio of moles of sodium carbonate to moles of water = $0.025 : 0.25 = 1 : 10$.
Therefore, the value of X is 10.



- d. Bromine would be discharged at the anode according to the following equation:
- $$Br^{2(g)} + 2e \longrightarrow 2Br^{(aq)}$$
- c. Instantly reacts with water therefore can not be discharged in aqueous form.
- b. Silver, hydrogen, zinc, copper, potassium and lead.
- a. The ions are free to move in aqueous or molten form.

Answers

- and give the equation to represent the discharge reaction of this element
- d. From the list, select an element whose ions would be discharged at the anode not be suitable in this case.
- c. One of the elements in the list can only be made from electrolysis of molten substance. Name the element and explain why the aqueous solution would not be suitable.
- b. From the above list, pick out all elements whose ions would be discharged at the cathode during electrolysis if the elements were in molten state.
- a. Why must substances be in molten or aqueous form for electrolysis to take place?
- Hydrogen Bromine Lead
 Silver Copper Chlorine
 Oxygen Zinc Potassium
- Hydrogen*
- Q103. Below is a list of some elements which may be prepared by electrolysis of suitable molten substances or aqueous solutions.

- a. Is a chemical process in which a compound in solution or aqueous form is broken down by the use of electricity.
- b. Used in electrolyzing.
- c. Used in purification of metals.
- Answers.
- b. Define the term electrolysis.
- Electrolysis*
- Q102.a. Give two practical uses of electrolysis.
- Alumina*
- The molarity of the solution is $2M$.

$$\text{Molarity of the sodium hydroxide} = \frac{\text{number of moles}}{\text{volume in litres}} = \frac{0.2 \text{ moles}}{0.1 \text{ litres}} = 2.0M$$

$$\text{Number of moles of sodium hydroxide} = \frac{\text{relative formula}}{\text{mass}} = \frac{40}{8} = 0.2 \text{ moles}$$

$$\text{Relative formula mass of sodium hydroxide} = 40$$

$$\text{Volume of water used} = 100 \text{ ml} = 0.1 \text{ litres. } (1000 \text{ ml} = 1.0 \text{ l})$$

$$\text{Mass of sodium hydroxide used} = 8 \text{ g.}$$

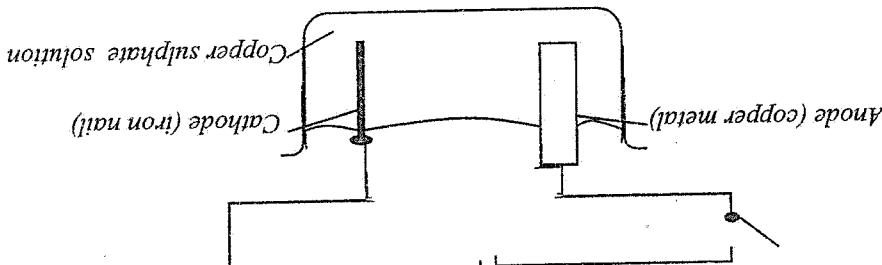
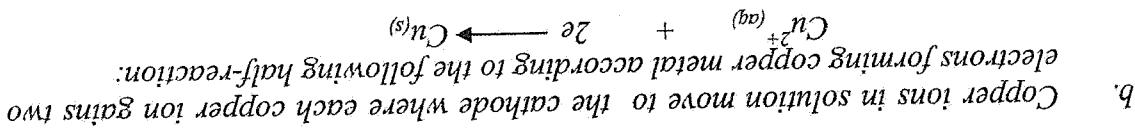
- a. The mole of any substance is the amount of the substance that contains the same number of particles as there are in exactly $12 \text{ g of carbon-12}$ which is 6.023×10^{23}
- Answers.

$$(\text{RAM: Na} = 23, \text{O} = 16, \text{H} = 1).$$

water. Calculate the molarity of the solution.

- b. A solution was made by dissolving 8g of sodium hydroxide in 100ml of water.
- Q101. a. What is a "mole"?

The copper metal formed coats the cathode which is the iron nail. The copper anode is an active electrode. It dissociates in its aqueous solution generating copper ions according to the following half-reaction:



Answers. The apparatus is set up as shown in the diagram below.

Q105.a. Draw a labelled diagram of the apparatus that would be used to electroplate an iron nail with copper.
b. Explain what happens in the process of electropatinng iron nail with copper.
Support your explanation with relevant chemical equations.

a. Answers.
Anode is the impure copper because it is the electrode which dissolves into the copper sulphate solution thereby generating copper ions which move to the cathode where they are reduced to pure copper metal.

b. Cathode dissolves while cathode is coated with pure copper metal.
Anode is coated with copper metal and some impurities drop just below the cathode is coated with copper metal and some impurities drop just below the anode.

c. d.

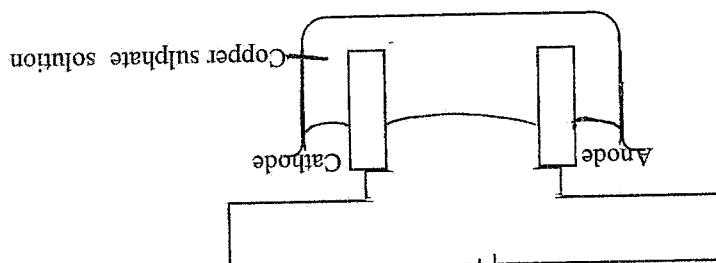
d. Copper ions which move to the cathode and get reduced to copper metal are continuously being replenished by the anode as it dissolves in the solution.

a. Which of the electrodes is impure copper. Give reason for your choice.

b. What happens to the electrodes if the experiment is left for a few hours?

c. What evidence will be there to show that purification process was taking place?

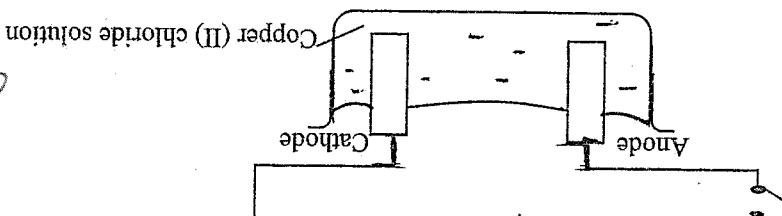
d. Why does the colour of copper sulphate remain the same as the purification process is taking place?



Q104. The following diagram shows an apparatus used in the purification process of copper metal where one electrode is impure copper and the other pure copper.

- The chloride ions move to the anode where they lose electrons to form chlorine gas according to the following half-reaction:
- $$2Cl^{(aq)} \longrightarrow Cl_{(g)} + 2e.$$
- metal according to the following half-reaction:
- $$Cu^{2+}_{(aq)} + 2e \longrightarrow Cu^{(s)}$$
- b. The ions present in solution are copper ions and chloride ions. Copper ions move to the cathode where each copper ion gains two electrons to form copper metal according to the following half-reaction:
- $$Cu^{2+}_{(aq)} + 2e \longrightarrow Cu^{(s)}$$
- a. Pure copper is used as the cathode
- Answers.

- b. Using relevant chemical reactions, explain what happens during the extraction of copper from its ionic salt.
- a. Name the metal which is used as the cathode.



Q107. Copper can be extracted as shown in the diagram below.

- e. Electrolysis is used in the extraction of metals from their ores.

- d. $2Al_2O_3(s) \longrightarrow 4Al^{(s)} + 3O^{2(g)}$
- Anode reaction: $2O^{2-}_{(s)} - 4e \longrightarrow O^{2(g)}$
- Cathode reaction: $Al^{3+}_{(l)} + 3e \longrightarrow Al^{(s)}$
- b. i. aluminium metal is produced at the cathode in fixed positions. The free ions are responsible for electrical conductivity. The ions are free to move because the ionic bonds are too weak to hold the ions in fixed positions. The ions are therefore not free to move whereas in molten form the ions are held by strong ionic bonds.
- a. In solid aluminium oxide, the ionic bonds are very strong and hold the ions in fixed positions.
- Answers.

- c. Write balanced chemical equations to describe the reactions taking place at the cathode and anode.
- b. During the electrolysis of aluminium oxide, what substance is produced at the cathode? i. Cathode ii. Anode.
- e. Mention one use of electrolysis in everyday life.
- d. Write a balanced overall chemical equation for the electrolysis of aluminium oxide.
- c. Write balanced chemical equations to describe the reactions taking place at the cathode and anode.
- a. Molten aluminium oxide is a poor conductor of electricity.
- Q106a. Explain why solid aluminium oxide is a poor conductor of electricity while molten aluminium oxide is a good conductor of electricity.

The anode reaction ensures that there is continuous supply of copper ions in solution then reduced at the cathode where it coats the iron nail. So that the process keeps going. Overall, the copper metal is dissolved in its aqueous solution which then reduces the copper ions in solution.

- Q109 a. Explain why copper can be extracted by electrolysis from aqueous copper chloride while aluminium can not be extracted from its aqueous chloride salt by the same method.
- b. i. Molten form. Magnesium is a reactive metal therefore can not be extracted in solution form. ii. By evaporation iii. Molten form. Magnesium is a reactive metal therefore can not be extracted in solution form but in molten form.
- c. Anode: chlorine gas is formed
Cathode: magnesium metal is formed

Substance electrolysed	Cathode product	Anode product	Sodium iodide solution	Hydrogen	Iodine
Molten aluminium oxide	Aluminium	Oxygen			
Copper chloride solution	Copper	Chlorine			
Calcium nitrate solution	Hydrogen	Oxygen			
Molten potassium chloride	Potassium	Chlorine			
Molten lead bromide	Lead	Bromine			

Answers.

- a. i. In the electrolysis of magnesium chloride, what substance is formed at the cathode and anode.
ii. How is solid magnesium chloride recovered from sea water?
iii. What is the state of magnesium chloride in sea water?
iv. What is the state of magnesium chloride in sea water?
- b. Magnesium metal is obtained from the salt magnesium chloride. Magnesium chloride is obtained from sea water.

Substance electrolysed	Cathode product	Anode product	Sodium iodide solution	?	?
Molten lead bromide	?	?	?	Aluminium	Oxygen
Calcium nitrate solution	?	?	?	?	?
Copper chloride solution	?	?	?	?	?
	Potassium	Chlorine			

Q108 a. Copy and complete the following table.

Overall, copper ions are being converted to copper metal which coats the cathode therefore copper is being extracted from its salt according to the following overall reaction: $\text{CuSO}_4^{(aq)} \rightleftharpoons \text{Cu}^{(s)} + \text{Cl}^{2(g)}$.

The chlorine gas bubbles off at the anode.

- a. Sodium chloride solution has sodium ions and chloride ions which are free to move. When the solution is part of a complete circuit, the ions move in particular direction. This movement of ions in a particular direction is responsible for electrical conductivity.
- b. Electrolysis is the chemical decomposition of a substance by passage of current through it when in molten or solution form.
- c. Electrolyte is a compound which conducts electricity in molten or solution form.
- i. Cathode is the electrode connected to the negative terminal of the cell or battery.
- ii. Anode is the electrode connected to the positive terminal of the cell or battery.
- iii. Cations are positively charged ions and tend to move towards the anode.
- iv. Anions are negatively charged ions and tend to move towards the cathode.
- Answers.

- Q110a.** Explain how sodium chloride solution conducts electricity.
- a. Hydrogen is discharaged in preference to aluminium because aluminium is higher than hydrogen in the reactivity series while copper is lower than hydrogen therefore it is discharged.
- b. The blue colour of copper sulphate fades away because copper ions which are responsible for the blue colour are being removed from the electrolyte.
- c. Electropolluting is the covering of a metal with another metal by using electricity.
- Q110b.** Define the following terms:
- i. electrolysis ii. electrolyte
- i. cathode ii. anode iii. cation iv. anion.
- c. What is the meaning of the following words:
- Answers.

- c.** What is the meaning of the word 'electropolluting'?
- b. If platinum electrodes are used in the electrolysis of aqueous copper sulphate, what happens to the colour of the electrolyte during the electrolysis process? Explain your answer.
- c. What is the meaning of the word 'electropolluting'?
- Answers.

1. Keith Wallis, Chancos Physical Science for Malawi, Book 2 (3rd edition), pages 277-294.
2. Samuel Kalea, MSCB Physical Science (New edition), pages 88-102
3. Juliet Napwora et al, KCSE Golden Tips Chemistry, pages 156-165 (alkanes and alkenes), 167-173 (alkanols and alkanolic acids), 175-177 (polymers)
4. Rose Gallagher & Paul Ingaram, Complete Chemistry, pages 224-249 (sources of organic compounds and plastics), pages 252-260.

The following list of books is not exhaustive.

After reading the chapter, test your understanding by answering the 50 questions in this chapter. Cross check your answers with the answers provided.

Before attempting the following questions, you are **STRONGLY ADVISED** to read the chapter in your notes or one of the books listed below.

To the student:

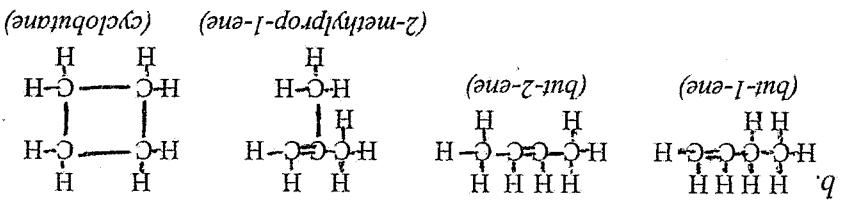
50 QUESTIONS WITH ANSWERS

ORGANIC CHEMISTRY

CHAPTER 3.

- a. Heptane has a higher boiling temperature than butane because it is a bigger molecule. The bigger the molecule, the stronger the intermolecular forces.
- Answers

- b. 2-methylbutane and pentane
a. Butane and heptane
temperatures? Explain.
- Q6. Which member of the following pairs of alkanes has a higher boiling



- a. Isomerism is the existence of two or more compounds with the same molecular formula but different structural formulae.
- Answers

- b. Draw and name all isomers of the compound having the molecular formula C₄H₈.
- Q5. a. Define the term 'isomerism'.

Heating breaks the chemical bonds of a thermosetting polymer as a result, the polymer decomposes and forms completely a new substance.

Answers

- Q4. Explain why thermosetting plastics can be heated and moulded only once.

Reduces environmental pollution
Reduces cheap raw materials for production of other materials.

Answers

- Q3. State any two advantages of recycling organic compounds.

They have no cross linkages between polymer molecules.
They soften when heated
Are easy to recycle.

Answers

- Q2. State any three characteristics of thermoplastics.

Plastics do not corrode while metals do.
Plastics are easier to recycle than metals.
Plastic materials are light, easy to carry than metallic materials.

Answers

- Q1. Mention three advantages of plastic materials over metallic materials.

Ethanol is soluble in water because Ethanol and water molecules are both polar and tend to associate with each other by hydrogen bonding. Ethane molecules are not polar. Like dissolves like.

Answer: Ethanol is very soluble in water while ethane is not. Explain.

Q9. Ethanol is very soluble in water while ethane is not. Explain.

c. STEP IV is substitution reaction.

b. STEP III is addition reaction.

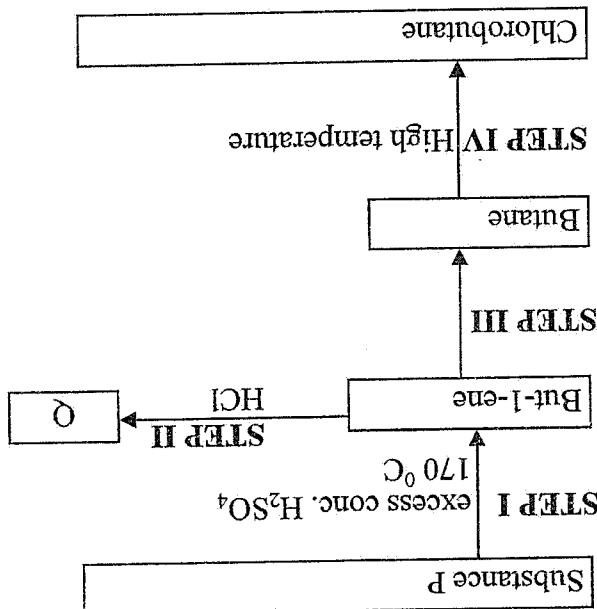
a. STEP I is dehydrogenation.

. The reagent is hydrogen gas.

a. P is butanol.

Answers:

- a. Identify substance P and Q
- b. Name the reagent and conditions necessary for step (III) to occur.
- c. Name the types of reactions taking place in step (I), step (III) and step (IV).



Q8. Study the flow chart below and use it to answer the questions that follow.

Answer: Natural gas.

Q7. State the natural source of methane.

b. Pentane has a higher boiling temperature than 2-methyl butane because the latter is a branched chain alkane. Branched chain alkanes have weaker intermolecular forces than straight chain alkanes of comparable mass.

b. Pentane has a higher boiling temperature than 2-methyl butane because the latter is a branched chain alkane. Branched chain alkanes have weaker intermolecular forces than straight chain alkanes of comparable mass.

Thermoplastic polymers are easy to recycle while thermosetting polymer are not easy to recycle.

Thermosetting polymers have cross-links between the polymer chains while thermoplastic polymers have no cross-links.

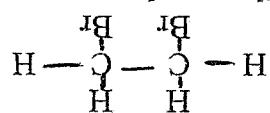
Thermosetting polymers decompose when heated while thermoplastic polymers soften when heated.

Answers

Q12. Name three differences between thermosetting and thermoplastic polymers.

*Used in the manufacture of alkanols
industry.*

c. *Used in the manufacture of halothanes which are important raw materials in industry.*

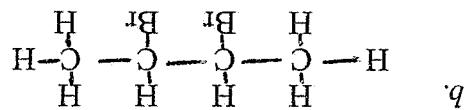


Answers

- c. Give two reasons why addition reactions are important in industries.
 b. Name the product of the reaction.
 a. Draw the structure of the product formed.
- Q11. Ethene (C_2H_4) reacts with bromine (Br_2) in an addition reaction.**

d. Bromine water changes colour from red brown to colourless.

c. But-2-ene (C_4H_8)



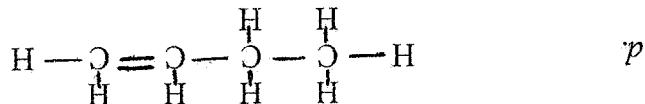
a. 2,3-dibromobutane.
Answers

- d. State the observation made during this reaction.
 c. Write the name and molecular formula of compound X.
 b. Write the structural formula of the compound formed.
 a. Name the compound formed.



Q10. Compound Y reacts with bromine water to form another compound of formula:

e. But-1-ene



c. It is because compound C ionises in water producing free hydrogen ions. The hydrogen ions are responsible for electrical conductivity of compound C.

b. B and E

a. A

Answers

e. Name compound D.

d. Draw full structure of compound D.

c. Explain why a solution of compound C conducts electricity.

b. Which compounds belong to the same homologous series?

a. Identify one compound which is an alkanol.

A. $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ B. $\text{CH}_3\text{CH}_2\text{CH}_3$ C. $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$ D. $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$ E. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$

Q14. The following are formulae of some organic compounds.

a. Addition polymerisation

b. One of the carbon to carbon double bond breaks creating room for the molecule

to bond with other molecules. The carbon atoms at the end of the product

molecule continue to bond with more ethene molecules to form a long chain

molecule (polymer).

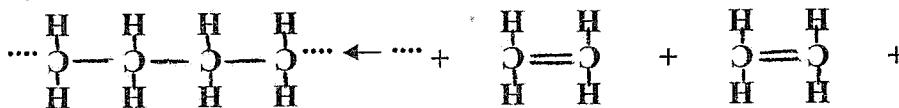
c. Polyvinyl chloride.

d. Polyethylene.

e. Polyester.

Answers

a. Name the type of polymerisation represented by the equation.
 b. Describe how the polymer is formed from ethene molecules
 c. Give two examples of artificial polymers.



Q13. Polymerisation of ethene can be represented by the following equation.

- a. $2C_2H_6 + 7O_2 \longrightarrow 4CO_2 + 6H_2O$.
- b. Complete Combustion/Oxidation reaction
- c. Ethane and oxygen.

Answers

- a. Balance the chemical equation by filling in the missing coefficients.
- b. Name the type of reaction represented by the equation.
- c. Name the reactants in the equation.



Q16. Study the equation below and answer the questions that follow:

The sample from series N undergoes addition reaction with bromine solution and decolorises it. No reaction occurs with member from series M. Shake the contents. Observe colour changes in both test tubes. Add 3 drops of sample of series M to one test tube and gently shake the contents. Add 3 drops of sample of series N to the second test tube and gently shake the contents. Add 3 drops of sample of bromine solution in two separate test tubes. Add 15 drops of bromine solution in two separate test tubes. Sample of series N. Put 15 drops of bromine solution in two separate test tubes. Bromine test can be used to distinguish a sample of member of series M from a sample of series N. Put 15 drops of bromine solution in two separate test tubes. From a sample of series M, add 15 drops of bromine solution in two separate test tubes. A sample of series N, add 15 drops of bromine solution in two separate test tubes.

e. Bromine test can be used to distinguish a sample of member of series M from a sample of series N.

f. O is methanol.

g. N is propane.

h. O is methanol.

i. N is propane.

j. O is methanol.

k. N is propane.

l. O is methanol.

m. N is propane.

n. O is methanol.

o. N is propane.

p. O is methanol.

q. N is propane.

r. O is methanol.

s. N is propane.

t. O is methanol.

u. N is propane.

v. O is methanol.

w. N is propane.

x. O is methanol.

y. N is propane.

z. O is methanol.

aa. N is propane.

ab. O is methanol.

ac. N is propane.

ad. O is methanol.

ae. N is propane.

af. O is methanol.

ag. N is propane.

ah. O is methanol.

ai. N is propane.

aj. O is methanol.

ak. N is propane.

al. O is methanol.

am. N is propane.

an. O is methanol.

ao. N is propane.

ap. O is methanol.

aq. N is propane.

ar. O is methanol.

as. N is propane.

at. O is methanol.

au. N is propane.

av. O is methanol.

aw. N is propane.

ax. O is methanol.

ay. N is propane.

az. O is methanol.

ba. N is propane.

bb. O is methanol.

bc. N is propane.

bd. O is methanol.

be. N is propane.

bf. O is methanol.

bg. N is propane.

bh. O is methanol.

bi. N is propane.

bj. O is methanol.

bk. N is propane.

bl. O is methanol.

bm. N is propane.

bn. O is methanol.

bo. N is propane.

bp. O is methanol.

bp. N is propane.

bp. O is methanol.

<p

c. Manufacture of perfumes.

b. Ethylmethanolate and water

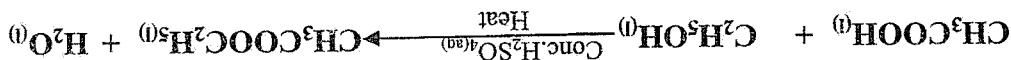
a. Esterification

Answers

c. Give one use of $\text{CH}_3\text{COOC}_2\text{H}_5$.

b. Name the two products of this reaction

a. What is the name of this reaction?



following chemical equation:

Q19. Ethanoic acid (CH_3COOH) reacts with ethanol ($\text{C}_2\text{H}_5\text{OH}$) according to the

Therefore, the molecular formula of the compound is C_8H_{18}

$$= 18.$$

Number of hydrogen atoms in the molecule = $9(114 \div 57)$

$$= 8$$

Number of carbon atoms in the molecule = $4(114 \div 57)$

Given Relative Formula Mass of the hydrocarbon = 114

$$= 57$$

$$= 48 + 9$$

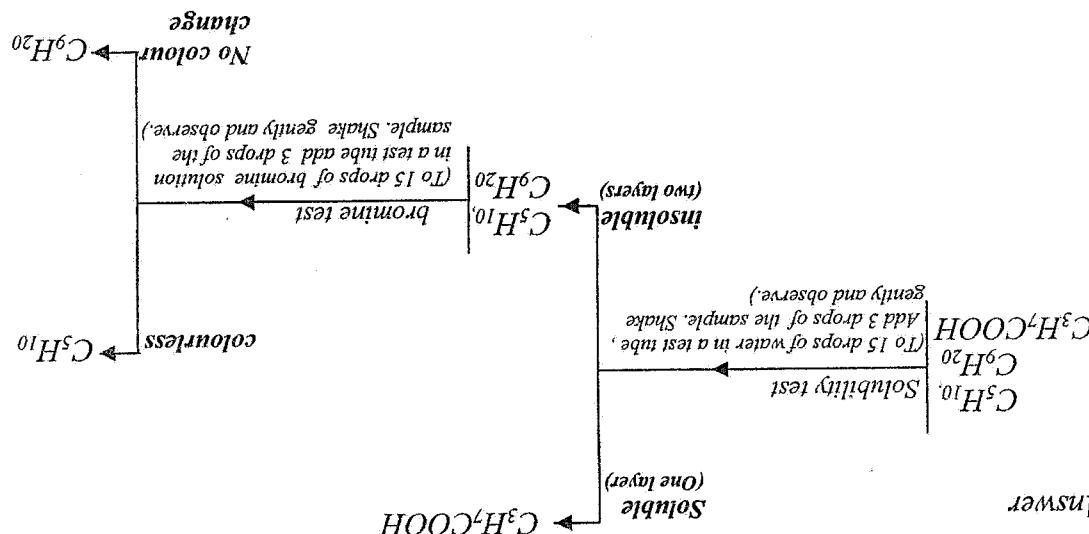
Relative Formula Mass = $(4 \times 12) + (9 \times 1)$

The empirical formula of the hydrocarbon is C_4H_9

Answers

the compound.

Q18. A certain hydrocarbon has a carbon to hydrogen ratio of 4:9 and a relative molecular mass of 114 (RAM: C=12, H=1). Work out the molecular formula of



Answer

order to identify the samples. Using a flow diagram, describe an investigation he would carry out in bottles. Was given samples of C_3H_{10} , C_9H_{20} and $\text{C}_3\text{H}_7\text{COOH}$ in unlabelled

Therefore, the percentage by mass of oxygen is 21.6%

$$= 21.6\%$$

Therefore, percentage by mass of oxygen = $(16 \div 74) 100\% = 21.6\%$

Mass of oxygen in the compound = 16 amu

Formula mass of the compound = 74 amu

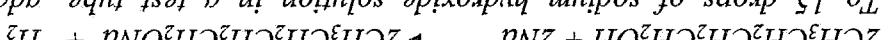
Phenolphthalein indicator while sample A does not.

Sample B decolourises the pink solution of sodium hydroxide and

of sample A, shake gently and observe. Repeat the experiment with sample B.

Phenolphthalein indicator solution. A pink colour is observed. Add three drops

To 15 drops of sodium hydroxide solution in a test tube, add 3 drops of

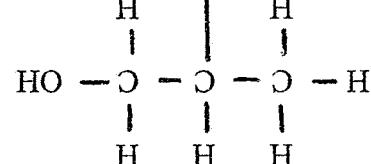
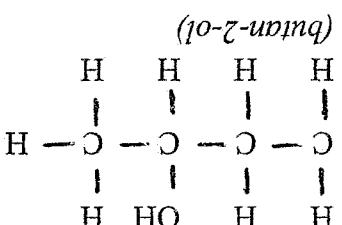
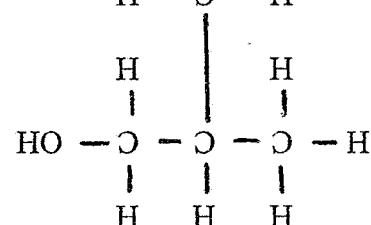
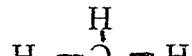


f.

e.

d.

(2-methylpropan-1-ol)



b. Carboxylic acids

a. Butan-1-ol

Answers

(RAM: C=12, O=16, H=1).

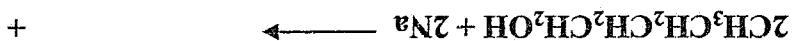
Calculate the percentage by mass of oxygen in compound A.

Explain briefly how you would distinguish a sample of A from B.

c.

d.

e.



(Na).

Complete the equation for the reaction between compound A and sodium

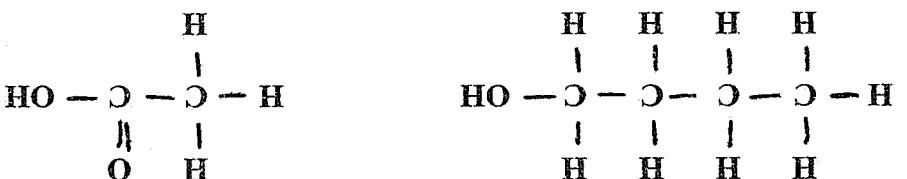
c. Write two isomers of compound A.

b. To which family of organic compounds does B belong?

a. Name compound A.

(A)

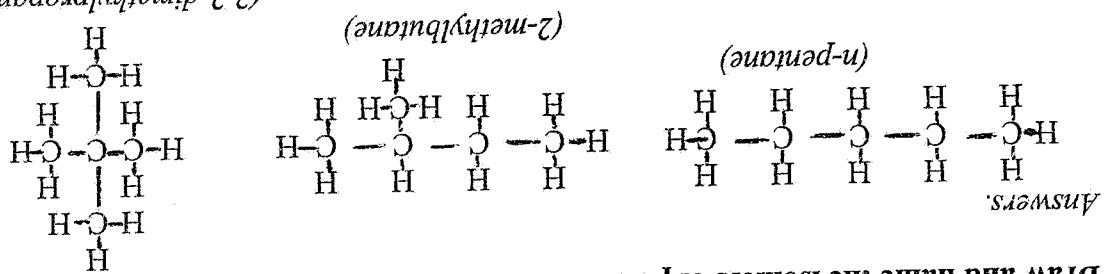
(B)



follow.

Q20. Study the structures of compounds A and B below and answer the questions that

Q23. Draw and name the isomers of pentane.



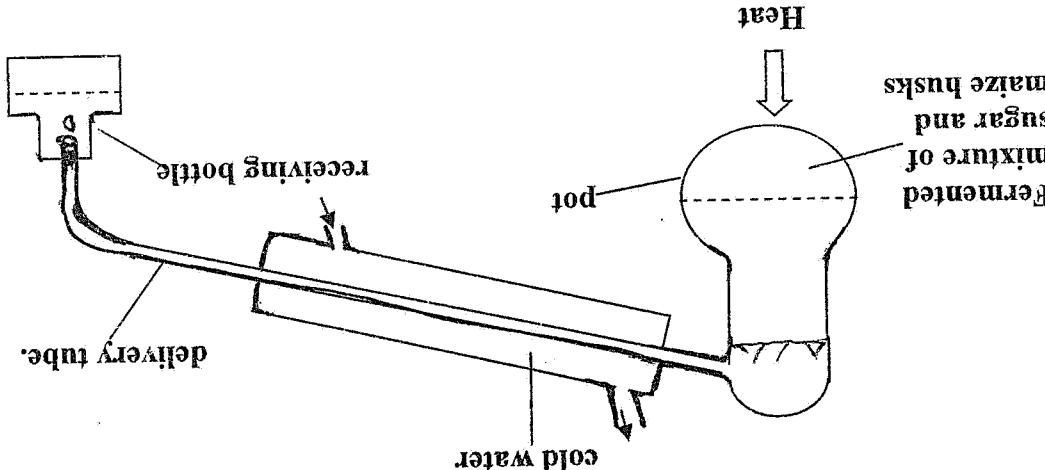
Answers.

Q23. Draw and name the isomers of pentane.

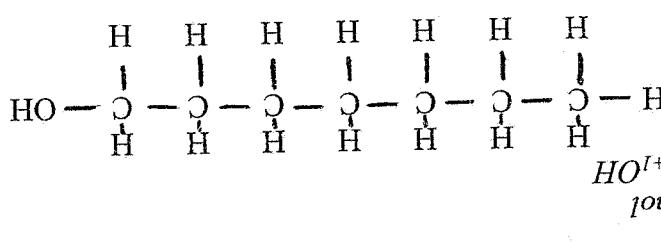
- a. Distillation b. Ethanol c. $\text{C}_6\text{H}_{12}\text{O}_6 \xrightarrow{\text{Yeast}} \text{C}_2\text{H}_5\text{OH} + \text{CO}_2$
- d. Fermentation
- Answers

d. What name is given to the process represented by the equation in part (c) above?

- a. Name the process illustrated in the diagram.
- b. Name the alcohol received in the collecting bottle.
- c. Complete the following chemical equation for the process:
- $$\text{C}_6\text{H}_{12}\text{O}_6 \xleftarrow{\text{Yeast}} \dots + \dots$$



Q22. The diagram below shows one indigenous way of preparing alcohol.



Answers

- a. Name the compound $\text{C}_7\text{H}_{16}\text{OH}$.
- b. What is the general formula of the homologous series to which compound $\text{C}_7\text{H}_{16}\text{OH}$ belongs.
- c. Draw the structure of the compound $\text{C}_7\text{H}_{15}\text{OH}$.

- Answers**
- a. Compound C has stronger intermolecular forces because its molecules are bigger and more polar than molecules of compound B.
- b. A and D
- c. A and C
- d. A and D

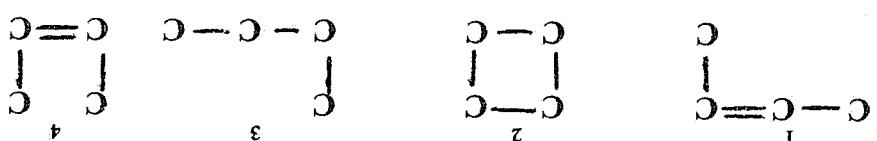
- e. Describe a test that can be done to distinguish compounds C and D.
- f. Explain why the boiling point of compound C is higher than the boiling point of compound B.
- g. Which compounds in the table are gases at room temperature?
- h. Which compounds in the table are soluble in water?
- i. Which compounds in the table are hydrocarbons?

Compound	Molecular formula	Boiling point ($^{\circ}\text{C}$)
D	C_2H_6	-89
C	CH_3COOH	118
B	$\text{C}_2\text{H}_5\text{OH}$	79
A	C_2H_4	-104

- Q26. The table below shows molecular formulae and boiling points of some compounds.

- a. Molecule I is but-2-ene.
- b. I and 4.
- Answers**

- a. Name the molecules I and 2
- b. Which two structures are conformations of each other?



- Q25. The following are structural formulae of four molecules with the molecular formulae.

- a. Plastics are used for making PVC pipes.
- b. Carbohydrates are used as a source of energy in both plants and animals.
- Answers**

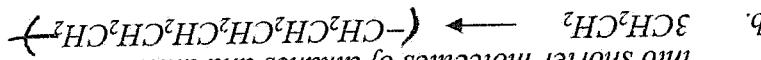
- a. State one use of each of the following polymers.
- b. State two ways of disposing of plastics to prevent pollution of the environment.
- c. Carbohydrate
- d. Plastic
- e. Environment
- Answers**

B is 2-methylprop-1-ene.

Answers: A is prop-1-ene



Q29. Name the following compounds.



- a. It is a chemical process which involves breaking long chain alkane molecules into shorter molecules of alkanes and alkenes.

Answers

molecules.

- b. Ethene is used for making of polyethylene by a process known as addition polymerisation. Write an equation for the process showing only three ethene molecules.

a. Explain what is meant by cracking.

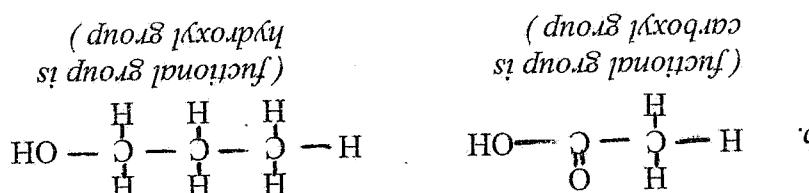
cracking.

Q28. Ethene is an important industrial chemical produced from crude oil fraction by

than ethanol molecules.

- c. The carboxylic acid is expected to have higher boiling point than the ethanol because it has stronger intermolecular forces. Its molecules are more polar

c.



- a. It is an atom or group of atoms or a chemical bond which determines the chemical properties of a molecule.

Answers

Give reason.

- c. Which compound would you expect to have a higher boiling point.

c.

- b. Write down the structure and name of the functional group in each

b.



functional groups and boiling points.

Q27. The following organic compounds all have the same molecular mass but different

not change the colour of blue litmus paper.

Compound C changes colour of blue litmus paper to red while compound D does colour change.

e.

e. Dip another blue litmus paper in a solution of compound D. Observe the colour change. Dip blue litmus paper into a solution of compound C. Observe the colour

change. Dip another blue litmus paper in a solution of compound D. Observe the colour

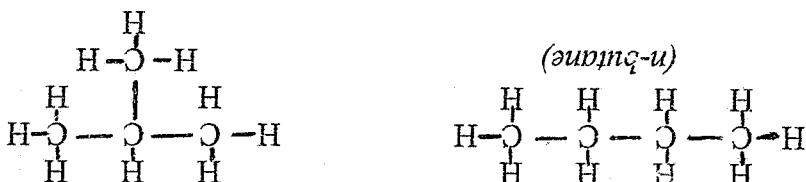
Answers

- a. Name the type of reaction.
b. State one condition necessary for this reaction to take place.



Q34. Ethane reacts with chlorine according to the following equation

(2-methylpropane)



Answers

Q33. Draw and name two isomers of C_4H_{10} .



Q32. Write the equation for the complete combustion of C_2H_{20} .

- a. Cracking.
b. C_3H_6 .
c. Propene.
d. The red brown bromine solution will be decolourised.

Answers

- a. Name the process
b. Write the molecular formula of X
c. Name compound X.
d. What observation will be made if a few drops of X are added to a solution of bromine solution.



The chemical process below.

Q31. The hydrocarbon (C_4H_{24}) can be converted into other hydrocarbons as shown in

- a. Propylethanoate.
b. Esterification.
c. Reaction takes place in the presence of concentrated sulphuric acid

Answers:

- a. Name product R.
b. Name the type of reaction.
c. Name the condition necessary for the above reaction to take place.



Q30. Propanol and ethanoic acid according to the following equation.

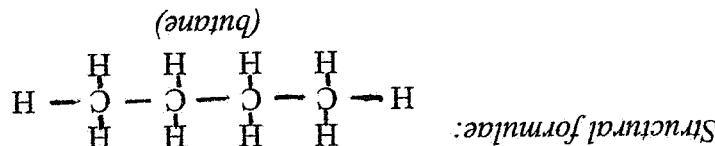
straight chain alkanes of comparable mass.

- c. *n*-butane has higher melting point than 2-methylpropane because the latter is branched alkane. Branched alkanes have weaker intermolecular forces than straight chain alkanes of comparable mass.
- a. Butane.
b. 2-methylpropane.

Answers.

- c. How do their boiling points compare. Explain.
a. $\text{CH}_3(\text{CH}_2)_2\text{CH}_3$
b. $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_3$

Q38. Name the following compounds.

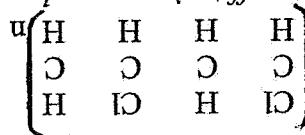


$$\begin{aligned} \text{Number of hydrogen atoms} &= 2(4) + 2 = 10 \\ \text{Number of carbon atoms} &= 4 \end{aligned}$$

Answer

Name and draw the structural formula of fourth member of this series.
Q37. The general formula of a homologous series of organic compounds is $\text{C}_n\text{H}_{2n+2}$

- c. It gives off toxic gases when burnt which pollutes the environment.

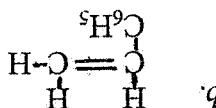


without formation of any other products.

- a. It is a process where unsaturated monomers join to form long chain molecules
Answers

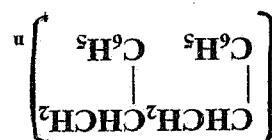
c. Why is it hazardous to burn the above polymer in a room.
b. Draw the structure of part of the polymer chain in polyvinyl chloride (PVC).
a. What is meant by addition polymerisation.

Q36. Polyvinyl chloride (PVC) is an example of addition polymer.



- a. Addition polymerisation
Answers

- b. Draw the structure of polymerisation exhibited by the above structure.
a. Name the type of polymerisation exhibited by the above structure.



Q35. A certain polymer has the following structure.

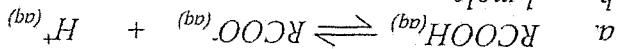
of which are reactive compounds like the alkenes. Through cracking, long chain molecules are broken into useful shorter molecules some of which are reactive compounds like the alkenes.

Answer

Q42. Why is cracking important in industries.

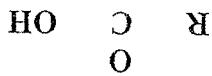
c. It is because they are able to ionise and generate free hydrogen ions.

b. 1 mole.



Answers

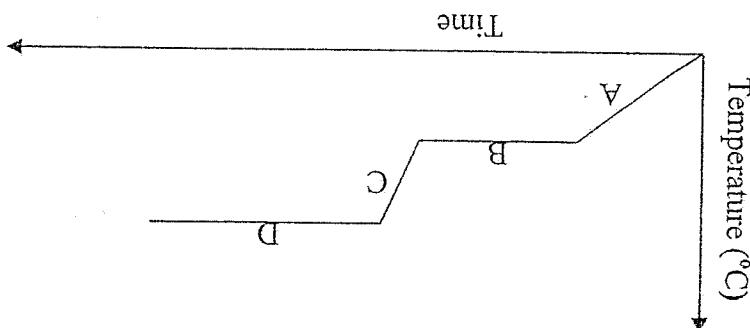
- c. Explain why alkanoic acids conduct electricity.
 b. How many moles of the acid would you expect to react with 1 mole of sodium hydroxide?
 a. Write an equation showing the ionisation of alkanoic acids.



Q41. Alkanoic acids have the following general structure:

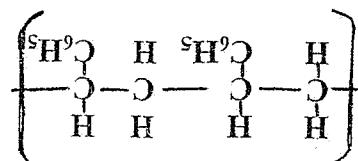
- heptane, so it distils first.
 Region B. This is because 2,2-dimethyl pentane has a lower boiling point than heptane, so it distils first.
 Answer

At what region of the graph does 2,2-dimethyl pentane start to distil. Explain your answer.

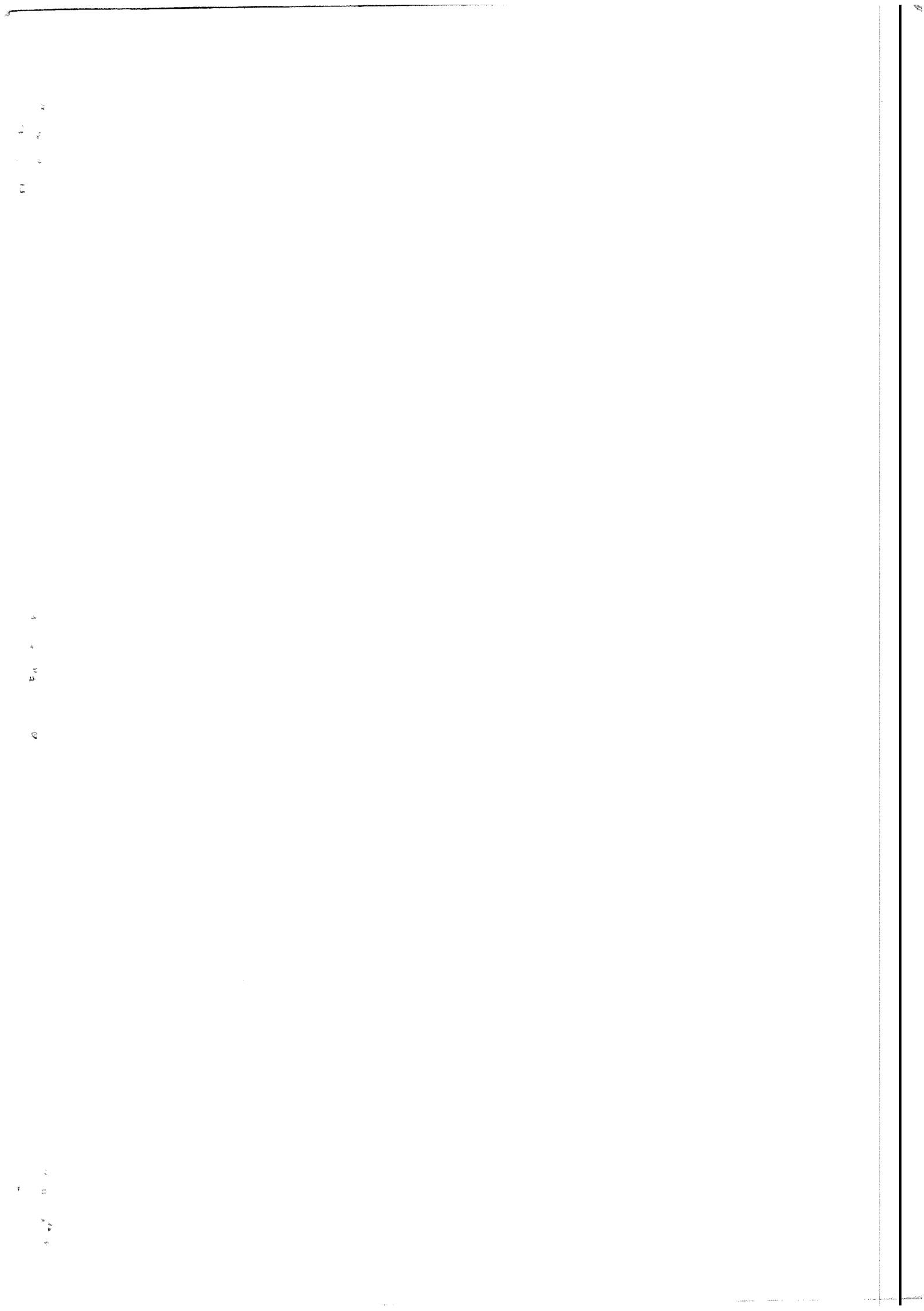


- Q40. A mixture of heptane, boiling point 98 °C, and 2,2-dimethylpentane of boiling point 80 °C was separated by fractional distillation. The graph below shows the temperature of vapour entering the condenser over a period of time.

Monomers of polystyrene have a carbon to carbon double bond one of which easily breaks up allowing addition reaction to occur between the monomers forming polystyrene.
 Answer:



- Q39. The following is a small portion of polystyrene polymer. Briefly explain how polystyrene is formed from its monomer.



- a. It is a good solvent dissolving many compounds which are not soluble in water.
- b. It is a raw material for the synthesis of many compounds such as esters.
- c. Used in alcoholic drinks.
- Answers**

Q47. a. Give three reasons why ethanol is an important compound.

Answer: The 'I' shows the position of the functional group.

Q46. What does the 'I' show in propen-1-ol?

Answer: They all have the same functional group, the hydroxyl group.

Q45. Explain why alkans react in the same way?

- a. Addition reaction.
- b. $\text{C}_3\text{H}_6 + \text{H}_2 \longleftrightarrow \text{C}_3\text{H}_8$
- c. Heat, high pressure and catalyst.
- Answers**

- a. Name the type of reaction.
- b. Write an equation for the reaction.
- c. Name the conditions necessary for the reaction to take place.
- Q44. Propene reacts with hydrogen to form propane.**

- a. Ethanol is used because fats and oils are not soluble in water.
- b. Olive oil because it has a greater degree of unsaturation.
- Answers**

- a. Why was ethanol and not water used as a solvent in this reaction?
- b. One medical theory states that using unsaturated fats in the diet instead of saturated fats reduces chances of getting heart diseases. Which of the cooking products is least likely to cause heart diseases? Explain.

Cooking oil product	Number of drops of bromine water	Margarine
Olive oil	14	
Peanut oil	12	
Butter	5	
Olive oil		7

Results on variety of cooking oil products are shown below.

- Q43. Fats and vegetable oils can be saturated or unsaturated. To measure degree of unsaturation in these compounds, five drops of liquid or similar volume of the solid is dissolved in 4cm^3 of ethanol. Dilute bromine water is added, a drop at a time. It is observed that bromine is decolorised, but when all double bonds have reacted, brown colour of bromine reappears. The number of drops of bromine needed to produce a permanent brown colour is recorded.**
- Q44. Give an experiment to prove that esters are immiscible in water.**

P

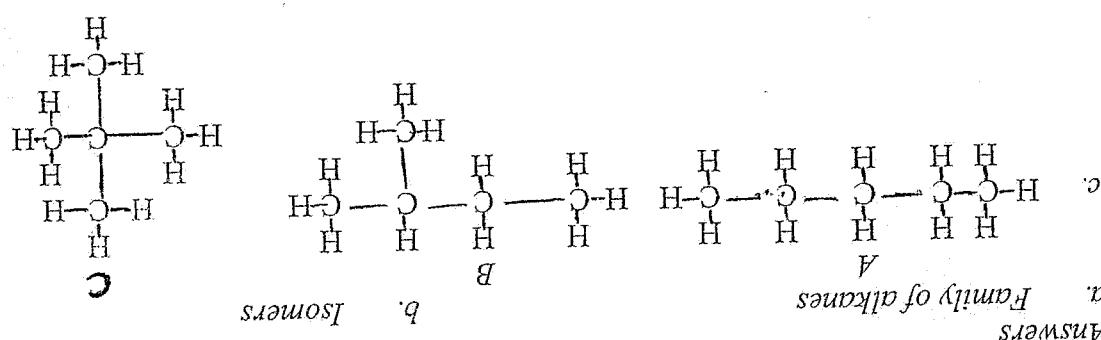


- Q50. a. Give any two properties of polymers.
- b. Explain how condensation polymerisation occurs.
- c. Mention any two properties of alkanes.
- d. Ethanol ($\text{CH}_3\text{CH}_2\text{OH}$) changes to ethanoic acid (CH_3COOH) in the presence of atmospheric oxygen (O_2).
- e. What is the function of atmospheric oxygen in the reaction?
- (ii). Write a balanced chemical equation for the reaction.
- Name the following organic compounds.

The three hydrocarbons will have the same chemical properties because they branched therefore least strength of intermolecular forces.

A has the highest boiling point because it is unbranched and has the strongest intermolecular forces. C has the lowest boiling point because it is more branched therefore least strength of intermolecular forces.

The three hydrocarbons will have the same homologous series. They all have no functional group.



- a. To which family of hydrocarbons do they belong?
- b. What name is given to different compounds that have the same molecular formula but different structures?
- c. Draw structures of the three hydrocarbons.
- d. Assign a boiling point to each structure and explain your choice.
- e. Would you expect the three hydrocarbons to have the same chemical properties? Explain.

Q49. Three hydrocarbons share the molecular formula C_5H_{12} . Their boiling points are 36°C , 28°C , and 10°C .

Answer: $\text{C}_2\text{H}_5\text{OH}(l) + 3\text{O}_2(g) \rightarrow 2\text{CO}_2(g) + 3\text{H}_2\text{O}(l) + \text{heat}$

Q48. Write a balanced equation for the complete combustion of ethanol.

- a. Polymers are insoluble in water.
- b. Condensation polymerisation occurs when monomers combine to form long chain molecules with loss of a small molecule like water, ammonia or hydrogenc chloride.
- c. Have higher melting points and boiling points than corresponding alkanes or alkenes.
- d. Small molecules are completely soluble in water.
(i). Atmospheric oxygen acts as an oxidising agent.
- e. P: cyclopentane Q: but-2-ene.
- (ii). $\text{CH}_3\text{CH}_2\text{OH} + \text{O}_2 \longrightarrow \text{CH}_3\text{COOH} + \text{H}_2\text{O}$

Answers

- The following list of books is not exhaustive.
1. Keith Wallis, Chancos Physical Science for Malawi, Book 2 (3rd edition), pages 277-294.
 2. Samuel Kalea, MSCE Physical Science (New edition), pages 122-133.
 3. Tom Duncane, GCSE Physics (4th edition), pages 264-278.
 4. Stephen Popple, Complete Physics, pages 263-277.
 5. Keith Johnson, Physics for You (Revised edition), pages 348-360.

After reading the chapter, test your understanding by answering the 37 questions in this chapter. Cross check your answers with the answers provided.

Before attempting the following questions, you are **STRONGLY ADVISED** to read the chapter in your notes or one of the books listed below.

To the student,

37 QUESTIONS WITH ANSWERS

RADIOACTIVITY

CHAPTER 4.

Answers: Has ionising effect, has less penetrating ability compared to alpha radiation, deflected towards the positive end of an electric field.

Q6. State any two properties of beta radiation.

- b. Cosmic rays from space and underground rocks.
 - a. Background radiation refers to the radiation that is detected even if there is no known radiation source around.
- Answers.

Q5. a. What is meant by 'background radiation'?

b. Mention any two sources of background radiation.

Answer: It is because gamma rays are electromagnetic waves with no charge and no mass.

Q4. Explain why even the strongest magnetic field can not deviate gamma rays.

$$\text{Therefore, percentage of sample left after 20 hours} = 6.25\%$$

$$\begin{aligned} \text{Initial amount of sample as a percentage} &= 100\% \\ \text{Percentage of sample left after 5 hours} &= 50\% \\ \text{Percentage of sample left after 10 hours} &= 25\% \\ \text{Percentage of sample left after 15 hours} &= 12.5\% \end{aligned}$$

Answer.

Q3. An Isotope has a half-life of 5 hours. What percentage of a given mass of the isotope would remain after 20 hours?

Used to detect gas and oil leaks from underground pipe lines.

Used in sterilisation of hospital equipment

Used in radiotherapy in hospitals

Used in smoke detectors

Used to detect gas and oil leaks from underground pipe lines.

Answers.

Q2. State any four uses of radioactive substances.

$$\begin{aligned} \text{Let the half-life be } x \text{ minutes} \\ \text{Therefore: Initial activity} &= 360 \text{ counts per second} \\ \text{Activity after } x \text{ minutes} &= 180 \text{ counts per second} \\ \text{Activity after } 2x \text{ minutes} &= 90 \text{ counts per second} \\ \text{Activity after } 3x \text{ minutes} &= 45 \text{ counts per second} \\ \text{Which means: } 3x &= 30 \text{ minutes} \\ x &= 10 \text{ minutes} \\ \text{The sample has a half-life of 10 minutes.} \end{aligned}$$

Answer.

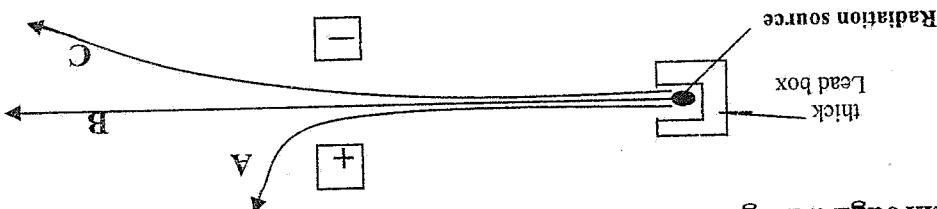
Q1. A radioactive sample is found to have an activity of 360 counts per second. 30 minutes later, its activity is 45 counts per second. Determine the half-life of the sample.

Answer: Radioactivity is a process whereby an unstable nucleus of an atom disintegrates releasing particles and energy.

Q13. Define the term radioactivity.

Answers: A is beta radiation. B is gamma radiation. C is alpha radiation

Identify the radiation represented by letters A, B and C.



Q12. The figure below shows deflection of three types of nuclear radiation as they pass through a magnetic field.

Therefore, two alpha particles are emitted.
Number of alpha particles = $\frac{8}{4} = 2$.
 $= 8 \text{ a.m.u}$
Each alpha particle has a mass of 4 a.m.u
Change in mass = $(230 - 222) \text{ a.m.u}$
Answer.

Q11. When ^{90}Th undergoes radioactive decay, it emits alpha particles to become ^{222}Rn . Find the number of alpha particles emitted.

Answer: Alpha radiation

Q10. Name the type of radiation which causes the most intense ionisation.

Answer: Alpha particles are easily blocked by the skin and have the shortest range in air.

Q9. Americium-241 decays by losing an alpha particle. Explain why smoke detectors containing Americium-241 are not a danger to the people.

Answer: Temperature has no effect on the rate of disintegration.

Q8. How does temperature affect the rate of disintegration of a radioactive material.

Answer: Wear protective clothing when handling radioactive material. Minimise time spent near any radiation source.

Q7. State any two safety precautions that must be observed when handling and storing radioactive materials.

Nuclear radiation refers to the particles and energy released from the nuclei of radioisotopes as they disintegrate.

Answer.

Q18. Define 'nuclear radiation'.

Pa has a half-life of 15 days.

$$x = 15$$

Therefore, $3x = 45$ days

Mass of Pa left after 3x days = 6.25g

Mass of Pa left after 2x days = 12.5g

Mass of Pa left after x days = 25g

Initial mass of Pa = 50g

Let the half-life be x days.

Answer.

Q17. 50g of radioactive $^{91}_{233}$ Pa was reduced to 6.25g after 45 days. Determine the half life of Pa.

- i. Radioisotope refers to an isotope of an element whose nucleus distinguishes itself from other nuclei by its atomic number.
 - ii. Half-life is the time taken for half of a radioactive sample to decay.
 - iii. Activity is the number of disintegrations per second.
- Answers.**

i. Radioisotope ii. Half-life iii. Activity

Q16. Define the following terms:

- Photoelectric effect can be detected by using:
- Gold-leaf electroscope. Radiation causes the leaf of a charged electroscope to fall.
- Diffusion chamber which shows tracks of visible clouds.
- Geiger-Muller tube (GM tube) which can be attached to a scalar or counter to get information about the radiation emitted from a source.
- Answers.

Q15. Mention any four ways of detecting radiation.

Beta particles have less penetrating ability than gamma rays because beta particles are charged particles. They can be stopped by a thin sheet of aluminum metal.

Gamma rays have a stronger penetrating ability than beta particles because gamma rays are electromagnetic waves with no mass and no charge. They easily pass through sheet of aluminum but can be blocked by a thick concrete wall or block of lead metal.

Answer.

Matter,

Q14. Compare the penetrating abilities of gamma rays and beta particles through

Nuclear fusion is a process whereby two or more light nuclei combine to form a heavy nucleus.

Answer:

Q21. Define 'nuclear fusion'.

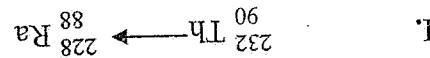
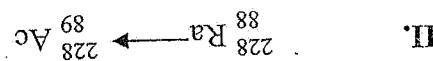
c. Gamma rays are also emitted

b. Stage 1: alpha particles are emitted

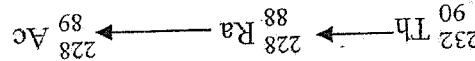
a. I. Alpha decay
II. Beta decay

Answers:

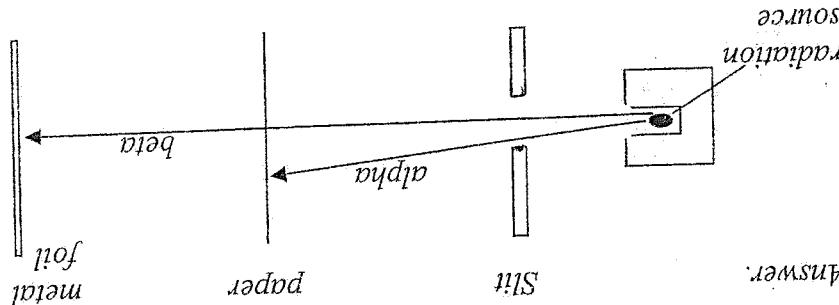
b. Which particles are emitted at each stage?
c. Apart from the particles mentioned in (b) above, what else is emitted?



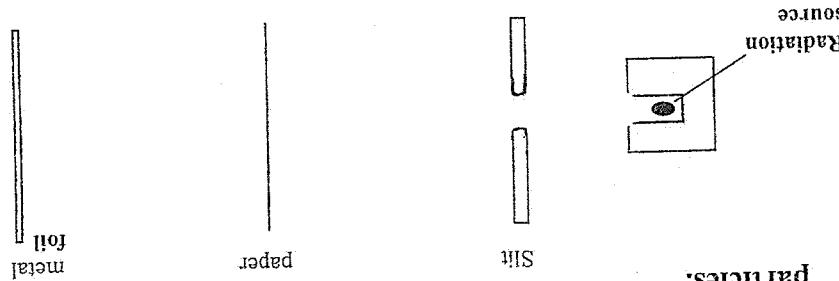
a. Name the type of decay between:



Q20. Radioactive Thorium decays as shown below:



Answer:



Q19. Complete the diagram below to show the penetrating power of alpha and beta particles.

Q22. The following equation shows a nuclear process.



- a. Name the process.
- b. Name the products of the process.

Answers: a. Nuclear fusion b. ${}_{2}^4\text{He}$ is Helium

${}_{0}^1\text{n}$ is a neutron.

Q23 a. Define 'nuclear fission'
b. Explain why fission is a useful process in industry.

Answers.

- a. Nuclear fission is a process whereby an unstable heavy nucleus disintegrates into stable light nuclei.
- b. When fission takes place, an enormous amount of energy is released. The energy released can be used in different ways such as heating water to produce steam. The steam can be used to turn turbines and generate electricity.

Q24. State two industrial and two medical uses of radiation.

Answers.

In industry, radiation is used:

- i. as tracers to detect gas and oil leaks from underground pipes.
- ii. to check weak areas or spots on welds.

In medicine, radiation is used:

- i. in radiotherapy.
- ii. sterilisation of hospital equipment.

Q25. Which type of radiation from radioactive materials is most penetrating and is not affected by an electric field?

Answer: Gamma radiation.

Q26. Explain why a charged leaf electroscope is not suitable for detecting beta radiation.

Answer.

Beta radiation has less ionising effect and does not cause the leaf to fall with an observable magnitude.

Q27. Thorium, $^{232}_{90}\text{Th}$ decays by alpha emission to radium, $^{228}_{88}\text{Ra}$

- What do the numbers 228 and 88 represent in Ra?
- Write the nuclear equation for the decay of thorium.

Answers.

- 228 is the atomic mass.
- 88 is the atomic number.



Q28. Write down two symbols representing isotopes of hydrogen.

Answer: ^1_1H and ^2_1H

Q29. Phosphorus 32 is a beta emitter with a half-life of 14 days.

- What is a beta particle?
- The atomic number of phosphorus-32 atom is 15. State the new values of the atomic and mass numbers of the atom just after it has emitted a beta particle.

Answers.

- A beta particle is an electron emitted at high speed from the nucleus.
- New value of the atomic number is 16.

The mass number remains 32.

Q30. Why is it important to use radioisotopes with a short half-life as tracers in agriculture?

Answer: To obtain quick results because the amount of radiation detected depends on the half life of the sample used.

Q31. Phosphorus-32 is a radioactive isotope. It can be used to prove that plants absorb phosphorus from the soil around them. The stable isotope of phosphorus has a mass number of 31. Explain why both isotopes of phosphorus have identical chemical properties.

Answer

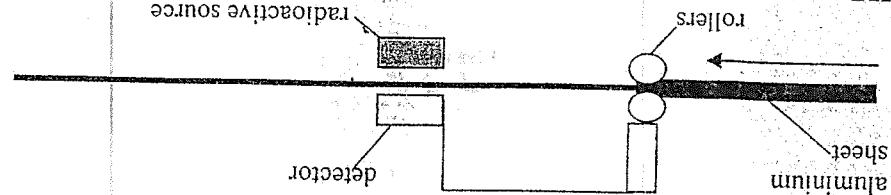
The two isotopes of phosphorus have the same number of valence electrons.

Q32. Iron-59 emits two types of radiation which are beta and gamma radiation. Briefly explain how the gamma radiation could be separated from beta radiation.

Answer.

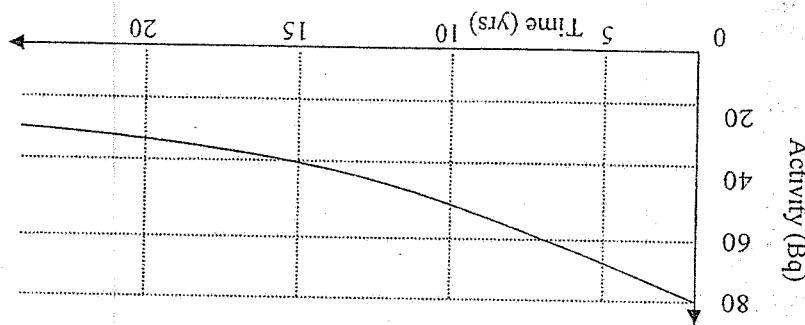
Separation can be achieved by positioning the radioactive sample in such a way that the radiation emitted passes through an aluminium metal foil. Beta radiation is blocked by the aluminium metal foil while gamma radiation passes through.

- a. Why is beta radiation not suitable for checking twenty millimetre aluminium sheet?
- b. Suggest with a reason the type of radiation that can be used to check a twenty millimetre sheet.



Q36 Aluminium is rolled into sheets twenty millimetres thick in a rolling mill. A radioactive source and a detector are used to check the thickness of the sheet as it leaves the rollers.

Answer: It has a half-life of 15 years.



Q35. Determine the half-life of a sample whose decay curve is shown below.

Answers: a. A b. C c. B

- Write down the letter which shows how the mass number and atomic number change for the following:
- a. emission of an alpha particle.
b. emission of a beta particle.
c. emission of gamma radiation.

	Change in atomic number	Change in mass number
C	1	0
B	0	0
A	-2	-4

Q34. The chart below shows the change in mass number and atomic number of an atom for different types of radioactive decay.

Nuclear processes change nuclear composition of the atom while chemical processes affect the valence electrons of an atom.

Nuclear processes are not affected by physical quantities such as temperature, concentration and pressure while chemical processes are affected by temperature, concentration and pressure.

Q33. State any two differences between chemical and nuclear processes.

M-G. CHAMBAICATA