



Our country, our future

525/1

S6 CHEMISTRY

Exam 25

PAPER 1

DURATION: 2 HOUR 45 MINUTES

Instructions:

- This paper consists of three sections (i.e. physical, inorganic and organic)
- Attempt all questions. Answers must be given in the spaces provided.
- Hand in the different sections separately.
- All working/calculations must clearly be shown.

1. (a) Steam distillation is one of the methods used for the separation of a component from a liquid mixture. State one requirement for the component to be separated by steam distillation. (1 mark)

- Volatile
- Immiscible with water
- Mixt with nonvolatile substances

- (b) A mixture containing a substance Z was steam distilled at 760 mmHg and 95°C. The distillate contained 85% by mass of water. If the vapour pressure of water is 734mmHg at 95°C, calculate the formula mass of x.

(3 marks)

Percentage of Z = $100 - 85 = 15\%$

Vapour pressure of Z = $760 - 734 = 26\text{mmHg}$

Let formula mass of Z be Mr

Formula mass of water = 2 + 16 = 18

$$\frac{15}{85} = \frac{26 \times Mr}{18 \times 734} = 89.6$$

2. The table shows the rates of the reaction between substances A and B at different conditions.

Experiment	Initial concentration in mol dm^{-3}		Initial rate of reaction in $\text{mol dm}^{-3} \text{ s}^{-1}$
	A	B	
1	0.50	0.50	2.0×10^{-2}
2	1.00	0.50	8.0×10^{-2}
3	1.00	1.00	16.0×10^{-2}

- (a) Determine

- (i) the order of reaction with respect to A and B

A: 3

(1 mark)

B:1

(1 mark)

- (ii) The overall order of the reaction

(1 mark)

$$(3+1) = 4$$

- (b) (i) Write an expression for the rate of the reaction

(1 mark)

$$\text{Rate} = K[A]^3[B]$$

- (ii) Calculate the rate constant for the reaction and state the units

(2marks)

$$K(0.5^3 \times 0.5) = 2 \times 10^{-2}$$

$$K = 0.32 \text{ mol}^{-3} \text{ dm}^3$$

3. (a) (i) What is meant by the term colligative property?

(1 mark)

It is a property of dilute solution of nonvolatile solution that depend on the number of dissolved molecule rather than their chemical nature.

- (ii) 1.45g of compound Y was dissolved in 80g of ethanol. The boiling point of the solution was 78.97°C while that of pure ethanol is 78.8°C (K_b of ethanol is 1.15°C for 1 mole in 1000g). Calculate the molecular mass of Y (4 marks)

Mass of Y in 1000g of ethanol

80g of ethanol contain 1.45 g of Y

1000g of ethanol contain $\frac{1.45 \times 1000}{80}$ 18.125

Temperature lowering = $78.97 - 78.8 = 0.17^{\circ}\text{C}$

Formula mass of Y = $\frac{18.125 \times 1.15}{0.17} = 123$

- (c) (i) Explain the term mole fraction

Mole fraction is the mole of a component divided by total moles of components in the mixture

- (ii) Calculate the mole fraction of sodium chloride in an aqueous solution containing 10g of sodium chloride per 100g of water. (Na = 23, Cl = 35.5) (3 marks)

Formula mass of sodium chloride = $35.5 + 23 = 58.5$

Moles of sodium chloride = $\frac{10}{58.5} = 0.17$

Moles of water = $\frac{100}{18} = 5.56$

Mole fraction of NaCl = $\frac{0.17}{(0.17+5.56)} = 0.03$

4. (a) Define the term first ionization energy

It is enthalpy change when 1 mole of electrons is added to gaseous atoms to form 1 mole of gaseous ion with single positive charge.

The table below gives four ionization energies in kJmol^{-1} for four elements in the same short period.

Element	Ionization energies in kJmol^{-1}			
	First	Second	Third	Fourth
W	577	1816	2745	11575
X	738	1450	7730	10550
Y	495	4563	6912	9540
Z	1255	2297	3849	6540

One of the elements belongs to group (VII)

Z

(b) (i) Arrange the elements in order of increasing atomic number (1 mark)

Y, W, X, Z

(ii) Which of the elements will form an ionic compound 1:1 with each other.
Give a reason.

Y and Z; Y is in group 1 and Z in group 7

(iii) Which element will form an ion of +2 Oxidation State? Give a reason

X, the third ionization energy is much higher compared to the second ionization energy

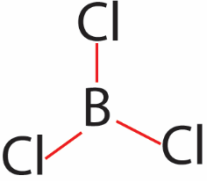
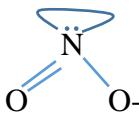
5. (a) Sketch and name the shape of the following species whose central atom has atomic number as shown

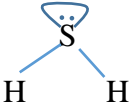
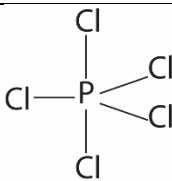
B = 5

N = 7

S = 16

P = 15

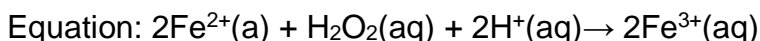
Species	Shape	Name of shape
BCl_3		Trigonal planar
NO_2^-		V- shaped

H ₂ S		V-shaped
PCl ₅		Trigonal bipyramidal

(b) State the conditions and write equations for the reaction between hydrogen peroxide and

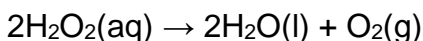
(i) Iron (II) ions.

Conditions: acidic medium



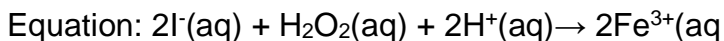
(ii) Iron (III) ions

Condition: no special condition



(iii) Iodide ions

Condition: acidic medium



6. A sample of a divalent metal M, contaminated with its oxide was dissolved in 50.0 cm³ of 0.1 M hydrochloric acid. 30.0 cm³ of hydrogen measured at s.t.p was evolved. 20.0 cm³ of 0.1 M sodium hydroxide was required to neutralize the excess acid. Calculate the percentage of the metal, M.
(1 mole of gas occupies 22.4 dm³ at s.t.p)

Moles hydrogen produced at stp

22400 cm³ of hydrogen are equivalent to 1 mole

30 cm³ of hydrogen are equivalent to $\frac{1 \times 30}{22400} = 0.00134$ moles

Moles of metal M = moles of hydrogen = 0.00134 moles

total moles of acid = $\frac{50 \times 0.1}{1000} = 0.005$ moles

moles of sodium hydroxide that reacted with excess acid = $\frac{20 \times 0.1}{1000}$
= 0.002 moles

Moles of excess acid = mole of sodium hydroxide = 0.002 moles

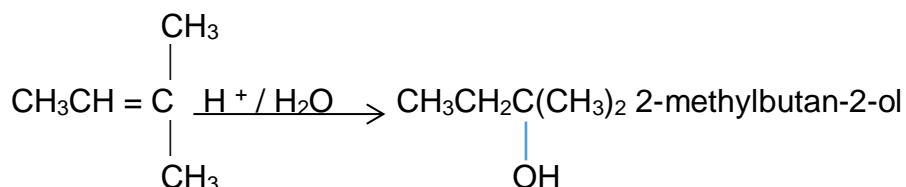
Moles of acid that reacted with metal and metal oxide = $0.005 - 0.002$
 $= 0.003$

Total moles of M and MO = $\frac{0.003}{2} = 0.0015$ moles

Moles of metal oxide = $0.0015 - 0.00134$ moles
 $= 0.00016$ moles

The percentage of metal M in terms of moles = $\frac{0.00134}{0.0015} \times 100 = 89.3\%$

7. Complete the following equation and name the main organic product



8. Name one reagent that can be used to distinguish between the following pairs of compounds. In each case state what would be observed in each case if the reagents are reacted with the compounds.

- (a) $(\text{CH}_3)_3\text{COH}$ and $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$

Reagent

Anhydrous zinc chloride and concentrated hydrochloric acid

Observations

$(\text{CH}_3)_3\text{COH}$ immediate cloudiness

$\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ no observable change

- (b) $\text{CH}_3\text{C} \equiv \text{C CH}_3$ and $\text{CH}_3\text{CH}_2\text{C} \equiv \text{CH}$

Reagent

Ammoniacal silver nitrate

Observations

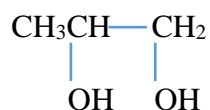
$\text{CH}_3\text{C} \equiv \text{C CH}_3$ no observable change

$\text{CH}_3\text{CH}_2\text{C} \equiv \text{CH}$ white precipitate

9. State what would be observed and write the name of the product formed when the following pairs of substances are mixed.

- (i) $\text{CH}_3\text{CH} = \text{CH}_2$ and a alkaline potassium permanganate solution
 Observation: potassium permanganate decolorized

Formula of product



Name of product

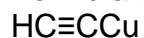
Propane-1,2-diol

(ii) $\text{HC} \equiv \text{CH}$ and ammoniacal copper (I) chloride solution

Observation

Brown ppt

Formula of product



Name of product

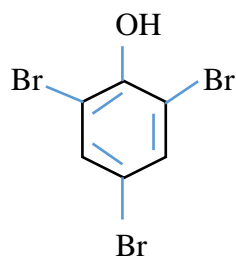
copper acetylide

(iii) Phenol and bromine water

Observation

Bromine decolorized

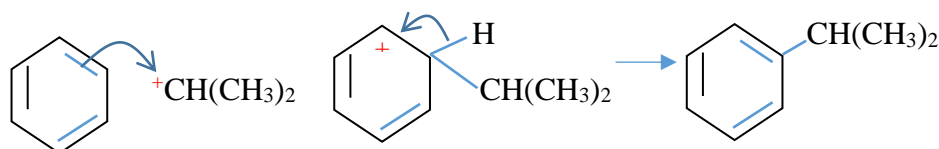
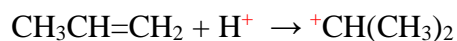
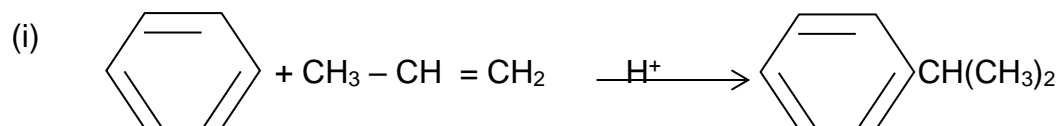
Formula of product



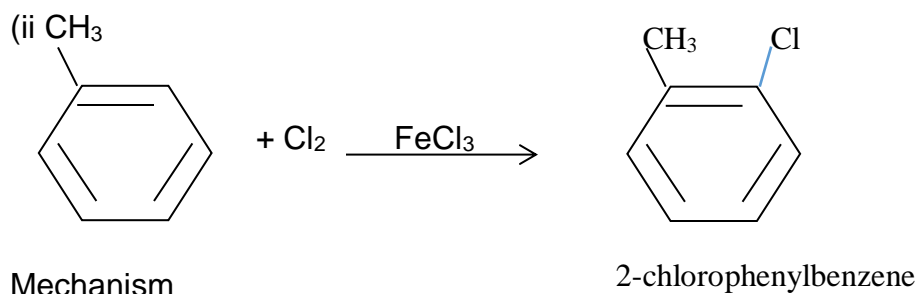
Name of product

2,4,6-tribromophenol

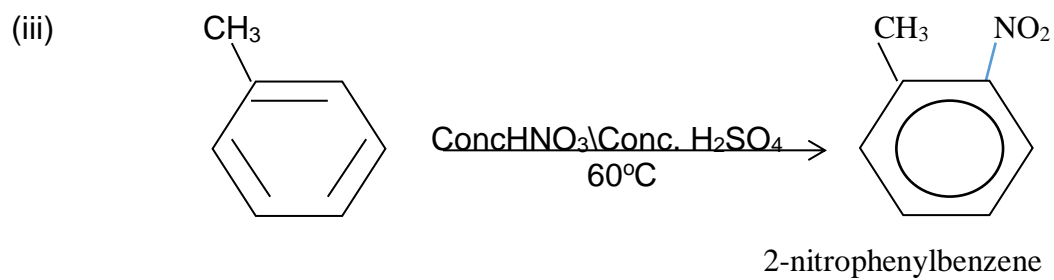
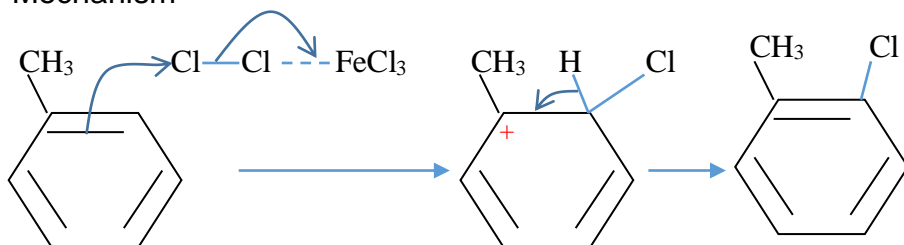
10. Complete the following reaction equations showing their mechanisms.



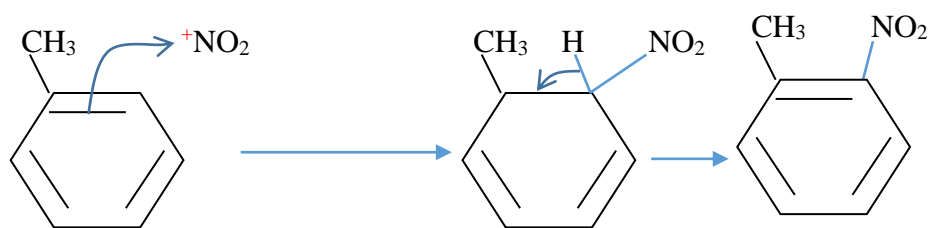
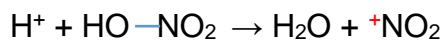
2-phenylpropane



Mechanism



Mechanism



(b) Write the names of the products formed in 10. (a) above

END