



Our country, our future

525/1

## S6 CHEMISTRY

Exam 17

### PAPER 1

**DURATION: 2 HOUR 45 MINUTES**

#### Instructions to candidates

- The paper consists of nine questions in section A and 6 questions in section B
- All questions are compulsory
- Answer the questions in the spaces provided only.

#### SECTION A:

1. Draw the structures and give the name of the shapes of the following chemical species.

Species	Structure	Name
(i) $\text{IF}_5$		
(ii) $\text{BCl}_3$		
(iii) $\text{CO}_3^{2-}$		

(iv) $\text{NH}_4^+$		
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2 (a) Define the term buffer solution

(1 mark)

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(b) Determine the pH of a solution made by adding  $25\text{cm}^3$  of 0.2M nitric acid to  $80\text{cm}^3$  of 0.2M ammonia solution.

( $K_b$  for  $\text{NH}_4\text{OH} = 1.8 \times 10^{-5} \text{mol dm}^{-3}$ )

(5 marks)

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3. (a) What is meant by the term steam distillation?

(1 ½ marks)

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- (b) A compound P is immiscible with water and forms a mixture which boils at 92°C. If the total vapour pressure of the mixture is 101.3kPa and the vapour pressure of water at the same temperature is 88.2 kPa, determine the percentage composition by mass of the mixture given that P has RFM of 125. (3 ½ marks)

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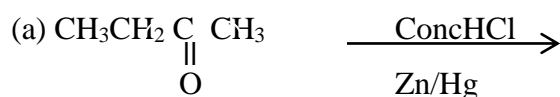
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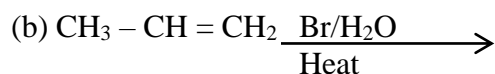
4. Complete the following organic reactions and name the main organic products in each case



Name of product

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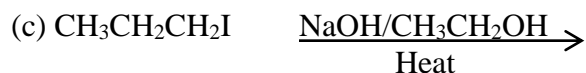
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Name of product

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Name of product

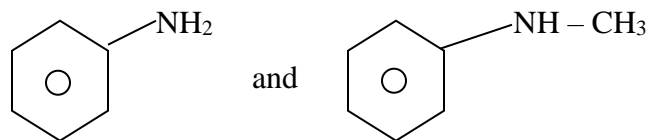
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5. Name the reagents that can be used to distinguish between the following pairs of compounds and state what is observed in each case when the compounds are separately

treated with the reagent

(a)



Reagent

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Observation

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(b)  $\text{CH}_3\text{CH}_2\text{COOCH}_3$  and  $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$

Reagent

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Observation

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6. (a) Iron is extracted by the reduction of the ore in the blast furnace.

(i) State the principle ore of iron (1 mark)

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(ii) Write an equation to show how the ore is converted to iron. (1½ marks)

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(b) Briefly describe how iron reacts with

(i) water (3½ marks)

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(ii) chlorine

(3marks)

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7 Carbon, silicon, germanium, tin and lead are in group ;(iv) of the periodic table

(a) (i) Write the general outermost electronic configuration of the elements.

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(ii) State the common oxidation states exhibited by the elements in their ions or compounds.

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(b) State what would be observed and write the equation for the reaction that would take place, if any, when the following compounds are treated with water.

(i)  $\text{CCl}_4$  (1 mark)

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(ii)  $\text{SiCl}_4$  (3 marks)

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8 Write an ionic equation for the reaction between aqueous sodium hydroxide and

(a) aluminium (III) oxide (1 ½ marks)

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(b) Tin (iv) oxide (1 ½ marks)

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(c) Chromium (III) oxide (1 ½ marks)

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9. The first ionization energies and melting points of the chlorides of some elements of group II of the periodic table are given in the table below

Element	Mg	Ca	Sr	Ba
1 <sup>st</sup> ionization energy (kJmol <sup>-1</sup> )	734	594	548	506
Melting point (°C)	708	772	873	967

(a) Explain

- (i) Why ionization energy decreases with increase in the atomic number.

(2 marks)

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- (ii) Why the melting points of the chlorides increase with increase in atomic number of the elements

(2 marks)

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- (b) How would you expect the solubility of the chlorides in water to vary with atomic number of the elements? Give a reason for your answer. (2 marks)

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### SECTION B:

10. When tri-lead tetraoxide,  $\text{Pb}_3\text{O}_4$  is reacted with nitric acid, a dark brown solid was formed.

- (a) Write an equation for the reaction which took place. (1 ½ marks)

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- (b) The resultant mixture obtained in the reaction was filtered and the residue warmed with concentrated hydrochloric acid. The filtrate was divided into two parts.

State what was observed and write equation(s) for the reaction which took place. (2 ½ marks)

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- (c) To the first part of the filtrate was added a few drops of potassium chromate solution followed by dilute nitric acid.



(i) State what was observed

(1 ½ marks)

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(ii) Write ionic equation(s) for the reaction.

(2 ½ marks)

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11. (a) Define the terms

(i) Radioactivity

(1 mark)

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(ii) Nuclear fission

(1 mark)

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(b) (i) What is meant by the term binding energy of a nucleus?

(2 marks)

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(ii) Copper has relative atomic mass 63.5. Determine the binding energy of the copper atoms given that the mass number of copper is 64.

(2 marks)

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- (c) A radioactive element Q has a half life of 24 years. Given 8g of Q, what mass of Q will be left after 72 years? (2 marks)
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- (d) Give two uses of radioactive isotopes. (1 mark)
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12. (a) Define the terms:

- (i) Activation energy. (1 mark)
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- .....

- (ii) Enthalpy of atomization (1 mark)
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- (b) Lattice energy of rubidium chloride  $= 665 \text{ KJmol}^{-1}$   
 Enthalpy of bond dissociation of chlorine  $= 226 \text{ KJmol}^{-1}$   
 Enthalpy of atomisation of rubidium  $= 84 \text{ KJmol}^{-1}$   
 Ionisation energy of rubidium atom  $= 397 \text{ KJmol}^{-1}$

Standard enthalpy of formation of solid rubidium chloride =  $-439\text{KJmol}^{-1}$

Calculate the electron affinity of chlorine (4 marks)

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(c) Sodium chloride and potassium chloride have lattice enthalpies  $-788$  and  $-718\text{KJmol}^{-1}$  respectively.

Explain the difference. (3 marks)

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13. 3.7g of an organic compound Q containing carbon, hydrogen and oxygen was exploded in excess oxygen. 4.5g of water and  $6.48\text{dm}^3$  of gaseous substances were passed through sodium hydroxide solution.  $2\text{dm}^3$  of oxygen was found unreacted (All volumes of gaseous substances were measured at s.t.p)

(a) (i) Determine the empirical formula of Q

(C = 12, H = 1, O = 16)

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(ii) If the vapour density of Q is 37, determine the molecular formula of Q and write all the possible structural formulae of Q

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(b) Q reacts with a mixture of sodiumhydroxide and iodine solution to give a yellow precipitate.

(i) Identify Q

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(ii) Name the reagent(s) used to confirm the functional group in Q

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(iii) Starting from but – 1 – yne and using equations, outline methods by which Q could be prepared.

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14. (a) Acidified potassium manganate (VII) reacts with ethanedioic acid.

Write:

(i) the half equations for the reaction (2 marks)

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(ii) The overall equation for the reaction (2 marks)

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(b) 20.2 cm<sup>3</sup> of a 0.01M manganate (VII) ion solution required exactly 16.55 cm<sup>3</sup> of a solution containing 4.8 g l<sup>-1</sup> of an oxalate (COO<sup>-</sup> X<sup>+</sup>)<sub>2</sub>. 2H<sub>2</sub>O

Calculate the atomic mass of X. (5 marks)

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15. (a) Phenylamine was mixed with concentrated hydrochloric acid and sodium nitrite at a temperature of  $0^{\circ} - 5^{\circ}\text{C}$ . The resultant solution (Y) was then treated with a mixture of phenol in aqueous sodiumhydroxide. State what is observed and write the equation of reaction that takes place between

(i) phenyl amine and a mixture of concentrated hydrochloric acid and sodium nitrite.

Observation

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Equation

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(ii) Y and phenol in aqueous sodiumhydroxide

Observation

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Equation

(i) Calculate the number of moles of bromine that reacted with 1 mole of phenylamine

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