

P525/ 2

CHEMISTRY

Paper 2

May-June 2019

2½hours

UACE RESOURCEFUL EXAM

CHEMISTRY

PAPER 2

2 hours 30 minutes

INSTRUCTIONS TO THE CANDIDATES

Answer **five** questions including **three** questions in section **A** and any **two** questions in section **B**.

Write the answers in the answer booklet provided.

Mathematical tables and graph papers are provided.

Begin each question on a fresh page.

Non-programmable scientific electronic calculators may be used.

Illustrate your answers with equations where applicable.

Indicate the questions in the grid below.

Where necessary use C = 12 , O = 16 , H =1

Molar gas volume is 22.4dm³ at s.t.p

1 atmosphere = 101325Nm⁻²

Question						Total
Marks						

Turn Over

1. (a) Write the electronic configuration of manganese
(Atomic number = 25) (01mark)
- (b) Explain why manganese is
- (i) a transition element. (01mark)
 - (ii) has variable oxidation states. (02marks)
 - (iii) has a high melting point (1890°C) compared to calcium with melting point (860°C) (03marks)
- (c) Describe how manganese reactions with
- (i) water (2½marks)
 - (ii) sulphuric acid (4½marks)
- (d) Aqueous sodium hydroxide solution was added to manganese(II) sulphate solution dropwise until in excess and the resultant mixture allowed to stand.
- (i) State what was observed. (1½marks)
 - (ii) Write equation (s) for the reaction(s) that took place. (03marks)
- (e) Write equation for the reaction between trimanganese tetroxide (Mn_3O_4) and aluminium (1½marks)
2. The table below shows the variation in pH when 30cm^3 of 0.2M ammonia solution was titrated with hydrochloric acid .

Volume of HCl added (cm^3)	0	4	8	12	16	18	19	19.4	19.8
pH	10.8	9.9	9.4	9.1	8.7	8.3	8.0	7.8	7.3

20.2	20.6	21	22	26	28
3.9	3.5	3.2	2.9	2.5	2.4

- (a) Plot a graph of pH against volume of hydrochloric acid. (04marks)
- (b) Use the graph to determine the:
- (i) pH and volume at the end point. (02marks)
 - (ii) molarity of hydrochloric acid (02marks)
 - hydrolysis constant of ammonium chloride formed at the end point. (3½marks)
 - (iii) ratio of $[\text{NH}_4\text{Cl}]$: $[\text{NH}_3]$ when 10cm^3 of hydrochloric acid has been added to ammonia solution. (2½marks)
- (K_b for ammonia = $1.78 \times 10^{-5} \text{mol dm}^{-3}$, $K_w = 1 \times 10^{-14} \text{mol}^2 \text{dm}^{-6}$)
- (c) Explain the shape of the graph. (05marks)
- (d) Which of the indicators shown below is suitable for the titration . Give a reason for your answer.

Indicator	pH range
Thymol blue	1.2 – 2.8
Methyl orange	3.1 – 4.4
Methyl red	4.2 – 6.3
Phenolphthalein	8.3 – 10.0

3. When 7.5g of an organic compound **Q** was burnt completely in excess oxygen , 11.2dm^3 of carbon dioxide and 4.5g of water were formed at s.t.p.
- (a) (i) Calculate the empirical formula of Q. (3½marks)
- (ii) Determine the molecular formula of **Q** (02mark)
- .(Density of **Q** is 5.357g dm^{-3} at s.t.p)
- (b) **Q** burns with a sooty flame and forms a yellow precipitate with 2,4-dinitrophenylhydrazine and also forms a pale yellow precipitate with iodine solution in sodium hydroxide solution. Identify **Q**. (0½mark)

- (c) Write equation and suggest a mechanism for the reaction between **Q** and
- (i) 2,4- dinitrophenylhydrazine in acidic medium. (4½marks)
 - (ii) sodium hydrogen sulphite solution (03marks)
- (d) Using equations only show how **Q**
- (i) can be synthesized from benzaldehyde (04marks)
 - (ii) can be converted to a an alkene (2½marks)
4. (a) (i) State Le Chatelier's principle. (01mark)
- (ii) State **two** factors that affect equilibrium reactions apart from catalyst. (02marks)
- (iii) Briefly describe how each of the factors you have named in(a)(i) affect the equilibrium constant and equilibrium position. (05marks)
- (b) Given the reaction
- $$\text{Ni(CO)}_4(\text{g}) \rightleftharpoons \text{Ni(s)} + 4\text{CO(g)}$$
- (i) Write the expression for the equilibrium constants K_c and K_p giving units in each case. (03marks)
 - (ii) What is the effect on position of equilibrium of adding a catalyst. (01mark)
- (c) COCl_2 dissociates according to the following equation.
- $$\text{COCl}_2(\text{g}) \rightleftharpoons \text{CO(g)} + \text{Cl}_2(\text{g})$$
- (i) At 25°C , one mole of COCl_2 was placed in 2dm^3 vessel producing an equilibrium mixture with 20.25% chlorine. Calculate the value of the equilibrium constant K_c at this temperature. (03marks)

- (ii) At 75°C , the degree of dissociation of 2 moles of COCl_2 in the same 2 dm^3 vessel was found to be 15%. Calculate the value of the equilibrium constant K_c at this temperature. (03marks)
- (iii) From your answer in (c)(i) and (c)(ii) above, state whether the reaction is exothermic or endothermic. Give a reason for your answer. (02marks)

SECTION B

*Attempt any **two** questions from this section.*

5. Write equations to show how the following conversions can be effected.
- (a) Bromo benzene from phenol (3½marks)
 - (b) Propanal from chloroethane (05marks)
 - (c) Phenylamine from methylbenzene (05marks)
 - (d) Hexane from propene (2½marks)
 - (e) $(\text{CH}_3)_2\text{C} = \text{NCH}_2\text{CH}_2\text{CH}_3$ from 2-iodopropane (04marks)
6. (a) Define the following terms.
- (i) Lattice energy
 - (ii) Hydration energy. (02marks)
- (b) Given the following thermodynamic data.
- | | |
|--|----------------------------|
| Standard enthalpy of formation of aluminium fluoride | $= -1301\text{kJmol}^{-1}$ |
| Standard enthalpy of atomization of aluminium | $= +314\text{kJmol}^{-1}$ |
| Standard enthalpy of bond dissociation of fluorine gas | $= +158\text{kJmol}^{-1}$ |
| First ionization energy of aluminium | $= +577\text{kJmol}^{-1}$ |
| Second ionization energy of aluminium | $= +1820\text{kJmol}^{-1}$ |

Third ionization energy of aluminium $= +2740\text{kJmol}^{-1}$

First electron affinity of fluorine $= -348\text{kJmol}^{-1}$

- (i) Draw an energy level diagram for the formation of aluminium fluoride and use it to determine the lattice energy of aluminium fluoride. (06marks)
- (ii) Given that the hydration energies of aluminium ions and fluoride ions are -4690 and -364kJmol^{-1} respectively. Calculate the enthalpy of solution of aluminium fluoride and hence comment on its solubility in water. (04marks)
- (d) State and explain **two** factors that affect the lattice energy. (06marks)
- (e) Would you expect the lattice energy of aluminium chloride to be less than, greater than or equal to that of aluminium fluoride. Explain your answer. (04marks)

7. The table below shows the hydrides of group(VII) elements and their boiling points

Period number	2	3	4	5
Hydride	HF	HCl	HBr	HI
Boiling point ($^{\circ}\text{C}$)	+20	-85	-67	-35

- (a) (i) Plot a graph of boiling point against period number. (04marks)
- (ii) Explain the shape of the graph (05marks)
- (b) Describe briefly how the following hydrides are prepared in the laboratory. (Illustrate your answer with an equation).
- (i) Hydrogen chloride (2½marks)
- (ii) hydrogen iodide (2½marks)
- (c) Discuss the reactions of the hydrides with
- (i) sodium hydroxide
- (ii) sulphuric acid
- (iii) Silicon dioxide (06marks)

8. (a) Explain the following processes as used in the extraction of metals
- (i) Flootation
 - (ii) Roasting
 - (iii) Smelting (12marks)
- (b) Briefly describe how the ore of aluminium can be concentrated. (08marks)

END