



SUBJECT: **Chemistry**
DATE: 17th May 2022
TIME: 4:00 p.m. to 7:05 p.m.

Useful informationIdeal gas constant = $8.314 \text{ JK}^{-1}\text{mol}^{-1}$

Relative atomic masses: Ag = 108, I = 127

A Periodic Table is included.

SECTION A**Answer ALL questions in this section.**

1. (a) Compound C is an alcohol with the formula $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$. Name alcohol C.

(1)

- (b) Draw the structural formula of **TWO** isomers of compound C.

(2)

(Total: 3 marks)

2. Silver iodide is described as a molecular compound of formula AgI.

- (a) Find the number of moles of molecules in 10 g of silver iodide.

(1)

- (b) Find the number of molecules in 10 g of silver iodide.

(1)

- (c) Find the percentage by mass of silver in silver iodide.

(1)**(Total: 3 marks)*****Please turn the page***

3. The following table shows the mass numbers and the number of neutrons of four elements represented as W, X, Y and Z. (W, X, Y and Z are not the symbols of these elements.)

	W	X	Y	Z
Mass number	39	40	40	42
Number of neutrons in the nucleus	20	20	21	22

- (a) Write down the atomic numbers of the four elements W, X, Y and Z.

_____ (1)

- (b) Which of the four elements are isotopes of each other?

_____ (2)

- (c) Write down the electronic configuration of the element W using the spdf notation.

_____ (1)

(Total: 4 marks)

4. The oxides of the period 3 elements exhibit different types of bonding: ionic, giant covalent and simple molecular.

- (a) Indicate the type of bonding in each of the following oxides.

Oxide	Ionic	Giant covalent	Simple molecular
Magnesium oxide			
Aluminium oxide			
Silicon dioxide			
Sulphur dioxide			

_____ (2)

- (b) From the above oxides, write the formulae of the oxides which have a high melting point.

_____ (2)

(Total: 4 marks)

5. A gas syringe was used to find the relative molecular mass of a gas G. A volume of 250 cm³ of gas G at 18 °C and 99090 Nm⁻² weighed 0.162 g. Calculate the molar mass of gas G.

_____ (4)

(Total: 4 marks)

6. In reaction kinetics, it is estimated that a 10 K increase in temperature will roughly double the rate of a reaction.

(a) Explain the above statement in terms of the collision theory.

(2)

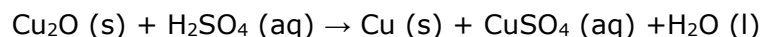
(b) In the space below, sketch a curve showing the distribution of molecular kinetic energies of a sample of gas at a temperature T . Label the axes and mark this curve A. (1)

(c) Using the same set of axes, sketch another curve to show the distribution at a temperature of $T+10\text{K}$. Label this curve B. (1)

(Total: 4 marks)

Please turn the page.

7. Consider the following equation: an oxide of copper reacts with sulphuric acid to form three products.



- (a) How does the oxidation state of copper in Cu_2O change when Cu and CuSO_4 are formed?

_____ (1)

- (b) Name the type of reaction that occurs.

_____ (1)

- (c) Write **TWO** ion-electron equations (ionic half-equations) to show the loss and gain of electrons in the reaction.

 _____ (2)

(Total: 4 marks)

8. Halogens undergo displacement reactions.

- (a) In the following table, mark whether reaction occurs or does **not** occur for each mixture.

Mixture		Reaction occurs	Reaction does not occur
P	$\text{Br}_2 \text{ (aq)} + \text{NaCl (aq)}$		
Q	$\text{Cl}_2 \text{ (aq)} + \text{NaBr (aq)}$		

(1)

- (b) Explain why the mixtures in part (a) react or do **not** react.

 _____ (2)

- (c) Write a balanced equation for the reactions that occur.

 _____ (1)

(Total: 4 marks)

SECTION B**Answer ALL questions in this section.**

9. (a) Polyethene is an example of a non-biodegradable polymer. It is manufactured in two forms: low density and high density polyethene.

(i) Write an equation to represent the formation of polyethene from its monomer.

(2)

(ii) What is the main structural difference in the two abovementioned forms of polyethene?

(1)

(b) A different polymerisation reaction resulted in the formation of one product S which was the polymer. Polymer S has the formula: $-[\text{-CH}_2\text{-CHCl-}]_n$.

(i) Name the monomer in this polymerisation reaction.

(1)

(ii) Name the polymer S.

(1)

(iii) Name the type of polymerisation involved in the formation of polymer S.

(1)

(Total: 6 marks)

Please turn the page.

10. (a) In laboratory and industrial processes, the products of a reaction are separated or isolated. From the following list, select the suitable separation technique in each case in the following table: filtration, simple distillation, fractional distillation, sublimation, crystallisation, chromatography, solvent extraction.

	Substance to be isolated/extracted	Technique
(i)	The isolation of an alcohol from a mixture of an alcohol and water. The boiling point of the alcohol is 85 °C.	
(ii)	The isolation of iodine from a mixture containing aqueous iodine and dissolved inorganic reagents which were used for its preparation. (Iodine changes directly from the gaseous state to the solid state.)	
(iii)	A solute is transferred between two immiscible solvents according to its solubility in each solvent.	
(iv)	The production of pure water from salt water.	
(v)	The isolation of the precipitate barium sulfate, formed when an aqueous solution of barium chloride is added to a solution of sodium sulfate.	
(vi)	An impure solid is added to a small volume of hot solvent in which it dissolves. On cooling, the solid pure solid is retrieved.	

(3)

- (b) Paper chromatography is used to separate a mixture of compounds into individual compounds.

- (i) Explain the principle of the chromatographic process.

(2)

- (ii) How can this technique be used to test whether a substance is pure or impure?

(1)

(Total: 6 marks)

11. (a) Explain the term saturated vapour pressure.

(2)

(b) The saturated vapour pressure of water increases with an increase in temperature. Discuss.

(2)

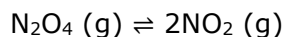
(c) In view of your answer to part (b), and applying Le Chatelier's principle, explain whether the vaporisation process is an endothermic or exothermic process.

(2)

(Total: 6 marks)

Please turn the page.

12. Dinitrogen tetroxide (N_2O_4), a colourless gas, exists in equilibrium with nitrogen dioxide (NO_2), a dark brown gas.



(a) Write an expression for the equilibrium constant K_c . Write the units for K_c .

(2)

(b) The concentration of nitrogen dioxide at a particular temperature was $1.15 \times 10^{-3} \text{ mol dm}^{-3}$. What was the equilibrium concentration of dinitrogen tetroxide? The value of $K_c = 1.06 \times 10^{-5} \text{ mol dm}^{-3}$ at this temperature.

(2)

(c) A syringe was filled with a mixture of dinitrogen tetroxide and nitrogen dioxide. The colour of the mixture was a shade of brown.

(i) What would you observe if the plunger of the syringe is pushed down to reduce the volume of the syringe?

(1)

(ii) Explain the observation in part (c)(i).

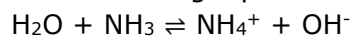
(1)

(Total: 6 marks)

13. (a) (i) Define a Bronsted-Lowry acid.

(1)

(ii) Identify the reactants in the following equation as an acid or a base.



(1)

(iii) Identify the conjugate acid and the conjugate base in the above reaction.

(1)

(b) (i) What is an amphoteric substance?

(1)

(ii) One of the four components in the reaction in part (a)(ii) has an amphoteric nature. Identify this amphoteric substance.

(1)

(iii) Write another equation, apart from the one in part (a)(ii), to show the amphoteric nature of this substance.

(1)

(Total: 6 marks)

Please turn the page.

SECTION C

Answer any TWO questions from this section. Write your answers on the lined pages of this booklet.

14. This question is about energetics.

- (a) The values of the standard enthalpy change of combustion of C (s, graphite), H₂(g) and CH₄(g) are -394 kJmol^{-1} , -286 kJmol^{-1} and -890 kJmol^{-1} respectively.
- (i) What are the standard conditions for enthalpy changes? (2)
 - (ii) Define the standard enthalpy of combustion. (2½)
 - (iii) Write the equations that correspond to the standard enthalpy changes of combustion of graphite, hydrogen and methane. (5)
 - (iv) Define the standard enthalpy of formation. (2½)
 - (v) Write the equation that correspond to the standard enthalpy change of formation of methane. (2)
- (b) Considering the information given in part (a), draw a Hess' cycle and calculate the standard enthalpy change of formation of methane. (6)

(Total: 20 marks)

15. This question is about bonding.

Explain each of the following statements.

- (a) Sodium chloride is a compound that is ionically bonded and has a lattice structure. Include diagrams to illustrate your answer where necessary. (4)
- (b) There is covalent bonding in the molecules of hydrogen, oxygen and nitrogen; they are examples of molecules with single and multiple bonds. Use dot-and-cross diagrams to illustrate your answer. (6)
- (c) Dative covalent (or coordinate) bonds and network covalent bonding in macromolecules are examples of covalent bonding. Illustrate your answer with a suitable example in each case. (4)
- (d) The octet rule can be used to predict formulae. There are exceptions to the octet rule, as in the case of electron deficient molecules and the 'octet expansion'. Illustrate your answer by suitable examples. (6)

(Total: 20 marks)

16. This question is about organic compounds.

Write short notes about each of the following statements. Include chemical equations, conditions and any observations wherever necessary.

- (a) Apart from one particular class, organic compounds contain a functional group. They are classified into homologous series. One homologous series contains compounds that do **not** have a functional group. (6)
- (b) There are different types of structural isomerism. Illustrate with suitable examples. (7)
- (c) Both ethers and alkenes can be formed from alcohols. (4)
- (d) Carboxylic acids undergo esterification. (3)

(Total: 20 marks)

17. This question involves volumetric analysis.

An acid-base titration was carried out with sulfuric acid and sodium hydroxide solution. The acid was placed in the burette while the sodium hydroxide solution was placed in the conical flask. A 25 cm³ bulb pipette was used.

- (a) Outline the steps for the procedure of carrying out an acid-base titration. Start with the procedures to be followed for washing the glassware to be used. (10)
- (b) The sulfuric acid solution, of unknown concentration, was titrated against 0.25 moldm⁻³ sodium hydroxide solution. The results are reported in the table below.

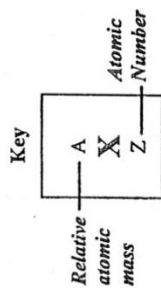
	Titration 1	Titration 2	Titration 3	Titration 4
Final volume (cm ³)	24.2	47.8	48.2	24.1
Initial volume (cm ³)	0.0	24.1	24.2	0.3
Titre value (cm ³)				

- (i) Find the titre value for each of the four titrations. (2)
- (ii) One considers concordant titre values to proceed with the calculation. Explain what is meant by concordant titre values and identify the titrations which provide concordant values and hence calculate the average titre. (2)
- (iii) Write a balanced equation, including state symbols, for the above acid-base reaction. (2)
- (iv) Hence, calculate the concentration of the sulfuric acid solution. (4)

(Total: 20 marks)

PERIODIC TABLE

I	II	III	IV	V	VI	VII	VIII
1 H 1	9 Be 4		12 C 6	14 N 7	16 O 8	19 F 9	20 Ne 10
23 Na 11	24 Mg 12		28 Si 14	31 P 15	32 S 16	35.5 Cl 17	40 Ar 18
39 K 19	40 Ca 20		73 Ge 32	75 As 33	79 Se 34	80 Br 35	84 Kr 36
85 Rb 37	88 Sr 38		119 Sn 50	122 Sb 51	128 Te 52	127 I 53	131 Xe 54
133 Cs 55	137 Ba 56		207 Pb 82	209 Bi 83	209 Po 84	210 At 85	222 Rn 86
223 Fr 87	226 Ra 88						
			65 Zn 30	63.5 Cu 29	59 Ni 28	59 Co 27	
			112 Cd 48	108 Ag 47	106 Pd 46	103 Rh 45	
			201 Hg 80	197 Au 79	195 Pt 78	192 Ir 77	
			55 Mn 25	56 Fe 26	59 Co 27	59 Ni 28	
			99 Tc 43	101 Ru 44	103 Rh 45	106 Pd 46	
			184 W 74	186 Re 75	190 Os 76	192 Ir 77	
			48 Ti 22	51 V 23	56 Fe 26	59 Co 27	
			91 Zr 40	93 Nb 41	101 Ru 44	103 Rh 45	
			178.5 Hf 72	181 Ta 73	186 Re 75	190 Os 76	
			45 Sc 21	52 Cr 24	55 Mn 25	59 Co 27	
			89 Y 39	96 Mo 42	99 Tc 43	103 Rh 45	
			139 La 57	184 W 74	186 Re 75	190 Os 76	
			227 Ac 89				



140 Ce 58	141 Pr 59	144 Nd 60	147 Pm 61	150 Sm 62	152 Eu 63	157 Gd 64	159 Tb 65	162 Dy 66	165 Ho 67	167 Er 68	169 Tm 69	173 Yb 70	175 Lu 71
232 Th 90	231 Pa 91	238 U 92	237 Np 93	244 Pu 94	243 Am 95	247 Cm 96	247 Bk 97	251 Cf 98	252 Es 99	257 Fm 100	258 Md 101	259 No 102	260 Lr 103