10. At 700 °C, nitrogen monoxide and hydrogen react as follows:

$$2NO(g) + 2H_2(g) \rightarrow N_2(g) + 2H_2O(g)$$

The initial concentrations and the initial rates of reaction for the experiments are shown in the table below.

Experiment number	Initial concentration/mol dm^{-3}		Initial rate of reaction/ mol dm^{-3} s^{-1}
	NO	H_2	
1	0.0020	0.0120	0.0033
2	0.0040	0.0120	0.0130
3	0.0120	0.0020	0.0200
4	0.0120	0.0040	0.0400

What is the initial rate of reaction when the concentrationof NO and H_2 are 0.0060 mol dm^{-3}?

A 4.5×10^{-2} mol dm^{-3} s^{-1}.
B 3.0×10^{-2} mol dm^{-3} s^{-1}.
C 1.5×10^{-2} mol dm^{-3} s^{-1}.
D 9.0×10^{-2} mol dm^{-3} s^{-1}.

11. The rate of a first order reaction is 6.9×10^{-4} mol dm^{-3} s^{-1} when the concentration of the reactant is 0.10 mol dm^{-3}. Which statement is true about the reaction?

A The half-life for the reaction is 1.0×10^{-2} s.
B The activation energy for the reaction is low.
C The rate constant for the reaction is 6.9×10^{-3} s^{-1}.
D The rate-determining step of the reaction involves two species.

12. The equilibrium equation for a saturated solution of magnesium hydroxide is shown below.

$$Mg(OH)_2(s) \leftrightarrow Mg^{2+}(aq) + 2OH^-(aq)$$

Which statement is true of the equilibrium equation?

A The solubility product is $K_{sp} = 2x^2$
B $Mg(OH)_2$ is less soluble when NH_4Cl is added.
C $Mg(OH)_2$ is more soluble when NaOH is added.
D The pH of the saturated solution increases with temperature.

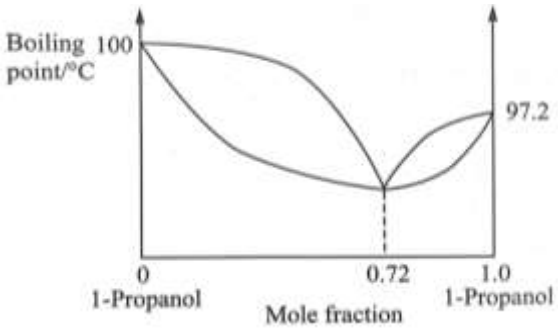
13. In the manufacture of nitric acid, ammonia gas and cleaned air are passed rapidly through platinum-rhodium gauze at 900°C. Nitrogen monoxide formed is then oxidised according to the following equilibrium.

$$2NO(g) + O_2(g) \leftrightarrow 2NO_2(g)$$

Which condition gives a higher yield of nitrogen dioxide?

A Low pressure
B Low temperature
C Addition of catalyst
D Addition of nitrogen gas

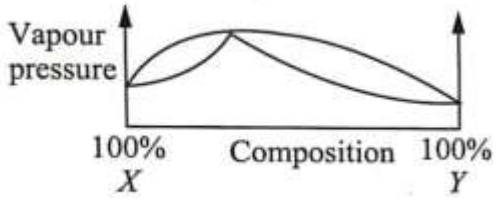
14. The liquid-vapour phase diagram of a mixture of 1-propanol and water is shown below.

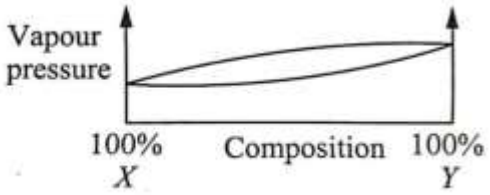


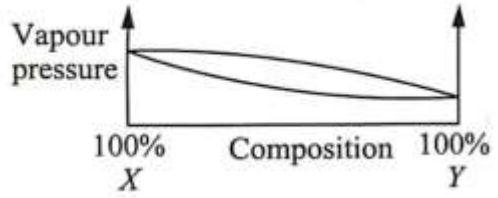
What is the distillate obtained if a solution which contains equal masses of 1-propanol and water is fractionally distilled?

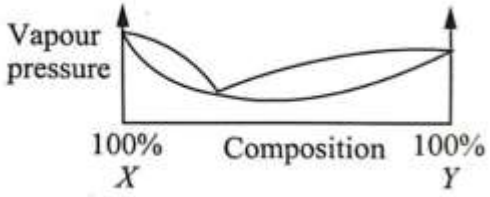
A A mixture with 0.72 mole fraction of 1-propanol
B A mixture with 0.77 mole fraction of water
C 1-propanol
D Water

15. The boiling points of two pure components, X and Y are 86°C and 100°C respectively. A solution consisting of 70% X and 30% Y boils at 120°C. Which vapour pressure-composition curve is correct for the solution?

A


B


C


D


Section B [15 marks]

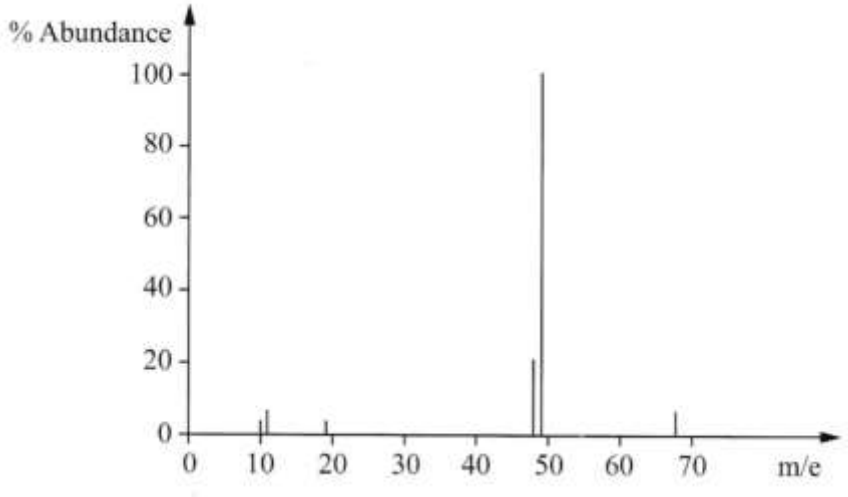
*Answer **all** questions in this section.*

16 (a) The decomposition of $KClO_3$ produces KCl and O_2.

(i) Write a balanced equation for the decomposition of $KClO_3$. [1 mark]

(ii) Calculate the volume of O_2 gas produced from the decomposition of 0.25 mol $KClO_3$ at standard temperature and pressure.
[1 mol gas occupies 22.4 dm^3 at standard temperature and pressure] [3marks]

(b) Boron exists naturally as boron-10 and boron-11. A mass spectrum of boron trifluoride is shown below.



Deduce the fragment represented by the peaks at m/e 48, m/e 49 and m/e 68 in the spectrum above. [3marks]

17 (a) Draw the Lewis structures for species given and predict their shapes. [6 marks]

(i) **I_3^-**

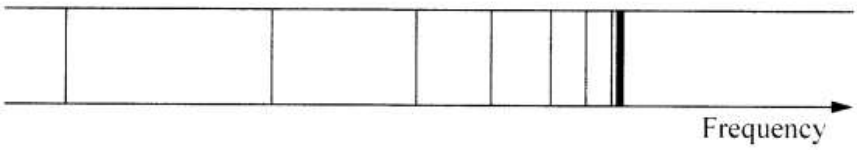
(ii) **NH_4^+**

(iii) **NO_3^-**

(b) Explain why aluminium chloride is a covalent compound whereas aluminium fluoride is an ionic compound. [2 marks]

Section C [30 marks]
*Answer **two** questions in this section.*

18. (a) The Lymann series of emission spectrum of hydrogen atom is shown in the diagram below.



Draw an energy level diagram to show transitions of electrons for the first four lines of Lymann series which emit light at high energies. On the energy level diagram, indicate the transition of electron which emit light with shortest wave length. Explain your answer.

[6 marks]

(b) Explain how electrons are filled in the orbitals of a chlorine atom by using Aufbau principle, Pauli exclusion principle and Hund's rule.

[5 marks]

(c) Potassium, chromium and copper are elements of Period 4 of the Periodic Table. Write the valence electronic configuration of the three elements. State **two** elements which are present in the same block.

[4 marks]

19 (a) A closed vessel of volume 2.5 m^3 at 300K contains 4.0 mol of nitrogen and 5.0 mol of helium gases.
[The gas constant, R, is 8.31 J K^{-1} mol^{-1}]

(i) Calculate the total pressure in the vessel.

[3 marks]

(ii) Which gas behaves almost like an ideal gas? Explain your answer.

[4 marks]

(iii) Sketch the Maxwell-Boltzmann distribution curve to show the distribution of molecular speeds for nitrogen and helium at 300 K.

[3 marks]

(b) Given that the temperature and pressure for water at its triple point and critical point are as below:

	Pressure (atm)	**Temperature (^{0}C)**
Triple point	6.03×10^{-3}	0.01
Critical point	218	374

(i) Sketch and label the phase diagram for water.
(ii) Based on the phase diagram, explain how the melting point of water changes with increasing pressure.

[5 marks]

20 (a) The initial rate of the reaction between substances A and B was measured in a series of

experiments and the following rate equation was deduced.

$$\textbf{rate} = k[A][B]^2$$

(i) Complete the table of data below for the reaction between A and B.

Experiment	Initial [A] /mol dm^{-3}	Initial [B] /mol dm^{-3}	Initial rate/mol $dm^{-3}s^{-1}$
1	0.020	0.020	1.2×10^{-4}
2	0.040	0.040	
3		0.040	2.4×10^{-4}
4	0.060	0.030	
5	0.040		7.2×10^{-4}

(ii) Using the data given above, calculate a value for the rate constant, *k* and state its units.
[7 marks]

(b) Variation of the rate constant with temperature for the reaction

$$\textbf{A} \longrightarrow \textbf{2B + C}$$

is given in the table below.

Temperature/K	Rate constant/s^{-1}
298	1.74×10^{-5}
308	6.61×10^{-5}
318	2.51×10^{-4}
328	7.59×10^{-4}
338	2.40×10^{-3}

By plotting a graph of ln *k* against **1/T**, determine the activation energy for the reaction above.
[8 marks]

End of question

Trial Sem. 1 STPM 2024 Muar Answer

Section A

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	**C**	**C**	**B**	**B**	**A**	**D**	**C**	**B**	**C**	**C**	**D**	**B**	**A**	**A**

Section B

16

16. a) i. $2\ KClO_3 \rightarrow 2\ KCl + 3O_2$ [1]

ii. Since $2\ KClO_3 = 3\ O_2$, mol of $O_2 = 0.25 \times 3/2 = 0.375$ [1]

$V_{O2} = 0.375 \times 22.4$ [1]

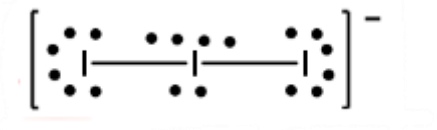
$= 8.4\ dm^3$ [1]

b)

m/e 48 : $(^{10}BF_2)^+$; m/e 49 : $(^{11}BF_2)^+$; m/e 68 : $(^{11}BF_3)^+$ [3]

17

(a) (i)

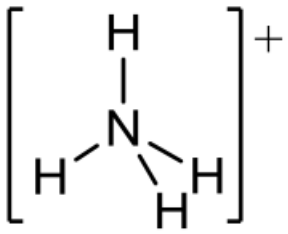


1

1

Shape: Linear

(ii)

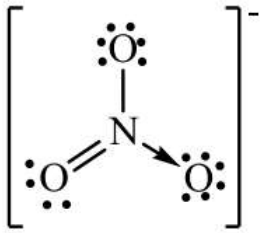


1

1

Shape: Tetrahedral

(iii)



1

1

Shape:Trigonal planar

(b) Al^{3+} ion has high charge density / high polarising power

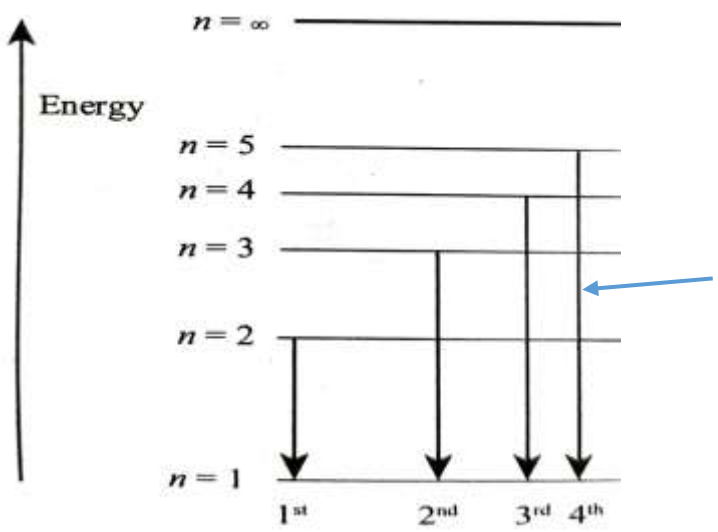
F^- has smaller ionic radius than Cl^-

1

Cl^- high polarisability / electron cloud is easily distorted.

1

Section C

18.		Marks
(a)	 - Light with the shortest wavelength would have the highest frequency. - n = 5 to n = 1 (indicate in diagram)	6 marks - correct energy distance - correct wavelength distance - 4 lines = 2 marks 1 1
(b)	- Proton number Cl = 17 - Electronic configuration = $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$ - Electrons fill in the order 1s, 2s, 2p, 3s, 3p (Aufbau principle) - Each fully filled orbital (1s, 2s, 2p, 3s) contains two electrons with opposite spin (Pauli exclusion principle) - The five 3p electrons are filled as $3px^2$, $3py^2$, $3pz^1$ (Hund's rule)	1 1 1 1 1
(c)	Potassium: $4s^1$ Chromium: $3d^5\ 4s^1$ Copper: $3d^{10}\ 4s^1$ Chromium and copper	1 1 1 1

Suka sampel ini?

Kertas Percubaan STPM

Sem 1 · Kimia

- Semester 1: kertas percubaan (trial) negeri, subjek yang dipilih + skema
- Blueprint 30 hari Semester 1 (setiap subjek)
- Semester 3: percubaan 2024, 10 subjek, banyak negeri, soalan + skema dalam satu fail

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