



Answer ALL the questions. Write your answers in the spaces provided.

1. (a) Aluminium is obtained from bauxite. The bauxite is converted into pure aluminium oxide which is then dissolved and electrolysed.

(i) What substance is added to the bauxite in the first stage of the purification process?

..... (1)

(ii) What substance is used to dissolve the purified aluminium oxide in the electrolytic cell?

..... (1)

(iii) State why pure molten aluminium oxide is **not** used as the electrolyte.

..... (1)

(b) (i) Give the half-equation for the reaction that occurs at the cathode of the cell.

..... (1)

(ii) Explain, with the aid of an equation, why the anodes of the electrolytic cell need to be replaced periodically.

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.....  
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.....  
.....  
..... (3)



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(c) Give ONE use of aluminium and state how this use is related to a property of the metal.

Use .....

.....

Property .....

.....

(2)

Q1

(Total 9 marks)



2. (a) A primary alcohol, a secondary alcohol and a tertiary alcohol are isomers with molecular formula  $C_4H_9OH$ . Each was heated under reflux with potassium dichromate(VI) in dilute sulphuric acid.

Complete the table below.

Structural type	Structural formula of the isomer	Structural formula for the compound (if any) formed by <b>complete</b> oxidation of the alcohol
primary		
secondary		
tertiary		

(6)

- (b) Propan-1-ol,  $CH_3CH_2CH_2OH$ , can be converted to  $CH_3CH_2CH_2I$  using red phosphorus and iodine.

- (i) Name the compound  $CH_3CH_2CH_2I$ .

.....  
(1)

- (ii) State the conditions needed to react propan-1-ol with red phosphorus and iodine.

.....  
.....  
(1)

- (iii) This halogenation of propan-1-ol is brought about by an intermediate compound produced from the reaction between red phosphorus and iodine. Suggest the formula of this intermediate.

.....  
(1)



Leave  
blank

(c)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{I}$  will react with cyanide ions.

(i) State the conditions needed for this reaction.

.....

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**(2)**

(ii) Write the formula of the organic product.

.....

**(1)**

(iii) Classify the type of reaction that has occurred.

.....

**(1)**

Q2

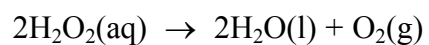
**(Total 13 marks)**

5



Turn over

3. Hydrogen peroxide decomposes according to



The reaction is catalysed by solid manganese(IV) oxide,  $\text{MnO}_2$ .

- (a) Two experiments are carried out under the same conditions except that in one experiment the manganese(IV) oxide is a fine powder and in the other the same mass of coarse granules is used.

Which experiment would show the faster rate of decomposition? Explain your answer in terms of collision theory.

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**(2)**



Leave blank

(b) (i) Draw a labelled Maxwell-Boltzmann distribution of molecular energies in a mixture of gases at two different temperatures  $T_1$  and  $T_2$ , where  $T_2$  is higher than  $T_1$ .



(4)

(ii) Mark on your graph a suitable value for the activation energy,  $E_a$ , for the reaction between the gases. Use your drawing to account for the increase in reaction rate with increasing temperature.

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(3)

(iii) Use the Maxwell-Boltzmann distribution to explain why a catalyst increases the rate of a reaction at temperature  $T_1$ .

.....  
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.....  
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(2)

(Total 11 marks)

Q3

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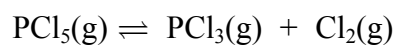


4. (a) Define the term **standard enthalpy of formation**.

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 .....  
 .....

(3)

(b) The dissociation of phosphorus pentachloride is a reversible reaction.



(i) Use the values of enthalpy of formation given to calculate  $\Delta H$  for the forward reaction.

	$\Delta H_f / \text{kJ mol}^{-1}$
$\text{PCl}_5(\text{g})$	- 399
$\text{PCl}_3(\text{g})$	- 306

(1)

(ii) Explain, with reasons, the effect that raising the temperature would have on the composition of the equilibrium mixture.

.....  
 .....  
 .....

(2)

(iii) Other than by changing the temperature, suggest how the amount of  $\text{PCl}_5$  present at equilibrium could be increased. Give a reason for your answer.

.....  
 .....  
 .....

(2)

(Total 8 marks)

Q4





5. (a) (i) Compound **W** contains, by mass, 12.77% C, 2.13% H, 85.1% Br.  
Calculate its empirical formula.

(2)

(ii) The relative molecular mass of **W** is 188. Deduce its molecular formula.

.....

.....

(2)

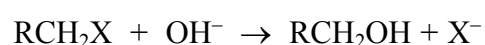
(iii) Compound **W** reacts with aqueous potassium hydroxide to form a compound **X**.  
Compound **X** is also formed by the reaction of ethene with aqueous alkaline potassium manganate(VII). Draw the structural formula of **X**.

(1)

(iv) Hence draw the structural formula of **W**.

(1)

(b) Primary halogenoalkanes ( $\text{RCH}_2\text{X}$ ) react with aqueous hydroxide ions:



The rate of reaction depends on the halogen and is in the order



Explain, in terms of bond enthalpies and kinetic factors, why this difference in rate is observed.

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.....

.....

.....

(3)

Q5

(Total 9 marks)



6. The electrolytic manufacture of chlorine in the membrane cell is important in the manufacture of chloroethene and hence of poly(chloroethene).

(a) (i) State the electrolyte that is used in chlorine manufacture.

.....  
(1)

(ii) Give the half-equations for the electrode processes at:

the anode

.....

the cathode.

.....  
(2)

(iii) Give ONE large-scale use of chlorine, other than the manufacture of chloroethene.

.....  
(1)

(iv) The membrane separates the anode and cathode compartments of the cell. State how the membrane works.

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.....  
(2)

(b) Chloroethene,  $\text{CH}_2=\text{CHCl}$ , can be polymerised to poly(chloroethene). Draw the repeating unit of poly(chloroethene).

(2)



Leave  
blank

(c) Suggest a property of poly(chloroethene) which makes it suitable for use as window-frames, guttering and pipes.

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.....  
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**(1)**

(d) What is the difficulty with disposing of poly(chloroethene) by incineration?

.....  
.....

**(1)**

**Q6**

**(Total 10 marks)**

**TOTAL FOR PAPER: 60 MARKS**

**END**





# THE PERIODIC TABLE

Period **1** **2** **3** **4** **5** **6** **7** **0** Group

Period

1	H Hydrogen 1
4	He Helium 2

Molar mass g mol <sup>-1</sup>
Symbol
Name
Atomic number

7	Li Lithium 3	9	Be Beryllium 4	11	Na Sodium 11	12	Mg Magnesium 12	13	Al Aluminium 13	14	C Carbon 6	15	N Nitrogen 7	16	O Oxygen 8	17	F Fluorine 9	18	Ne Neon 10																
19	K Potassium 19	20	Ca Calcium 20	21	Sc Scandium 21	22	Ti Titanium 22	23	V Vanadium 23	24	Cr Chromium 24	25	Mn Manganese 25	26	Fe Iron 26	27	Co Cobalt 27	28	Ni Nickel 28	29	Cu Copper 29	30	Zn Zinc 30	31	Ga Gallium 31	32	Ge Germanium 32	33	As Arsenic 33	34	Se Selenium 34	35	Br Bromine 35	36	Kr Krypton 36
37	Rb Rubidium 37	38	Sr Strontium 38	39	Y Yttrium 39	40	Zr Zirconium 40	41	Nb Niobium 41	42	Mo Molybdenum 42	43	Tc Technetium 43	44	Ru Ruthenium 44	45	Rh Rhodium 45	46	Pd Palladium 46	47	Ag Silver 47	48	Cd Cadmium 48	49	In Indium 49	50	Sn Tin 50	51	Sb Antimony 51	52	Te Tellurium 52	53	I Iodine 53	54	Xe Xenon 54
55	Cs Caesium 55	56	Ba Barium 56	57	La Lanthanum 57	58	Ce Cerium 58	59	Pr Praseodymium 59	60	Nd Neodymium 60	61	Pm Promethium 61	62	Sm Samarium 62	63	Eu Europium 63	64	Gd Gadolinium 64	65	Tb Terbium 65	66	Dy Dysprosium 66	67	Ho Holmium 67	68	Er Erbium 68	69	Tm Thulium 69	70	Yb Ytterbium 70	71	Lu Lutetium 71		
87	Fr Francium 87	88	Ra Radium 88	89	Ac Actinium 89	90	Th Thorium 90	91	Pa Protactinium 91	92	U Uranium 92	93	Np Neptunium 93	94	Pu Plutonium 94	95	Am Americium 95	96	Cm Curium 96	97	Bk Berkelium 97	98	Cf Californium 98	99	Es Einsteinium 99	100	Fm Fermium 100	101	Md Mendelevium 101	102	No Nobelium 102	103	Lr Lawrencium 103		
133	Cs Caesium 133	137	Ba Barium 137	139	La Lanthanum 139	140	Ce Cerium 140	141	Pr Praseodymium 141	144	Nd Neodymium 144	(147)	Pm Promethium 147	150	Sm Samarium 150	152	Eu Europium 152	157	Gd Gadolinium 157	159	Tb Terbium 159	163	Dy Dysprosium 163	165	Ho Holmium 165	167	Er Erbium 167	169	Tm Thulium 169	173	Yb Ytterbium 173	175	Lu Lutetium 175		
223	Fr Francium 223	226	Ra Radium 226	227	Ac Actinium 227	232	Th Thorium 232	231	Pa Protactinium 231	238	U Uranium 238	237	Np Neptunium 237	242	Pu Plutonium 242	243	Am Americium 243	247	Cm Curium 247	245	Bk Berkelium 245	251	Cf Californium 251	254	Es Einsteinium 254	253	Fm Fermium 253	256	Md Mendelevium 256	254	No Nobelium 254	257	Lr Lawrencium 257		

140	Ce Cerium 58	141	Pr Praseodymium 59	144	Nd Neodymium 60	(147)	Pm Promethium 61	150	Sm Samarium 62	152	Eu Europium 63	157	Gd Gadolinium 64	159	Tb Terbium 65	163	Dy Dysprosium 66	165	Ho Holmium 67	167	Er Erbium 68	169	Tm Thulium 69	173	Yb Ytterbium 70	175	Lu Lutetium 71
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232	Th Thorium 90	231	Pa Protactinium 91	238	U Uranium 92	237	Np Neptunium 93	242	Pu Plutonium 94	243	Am Americium 95	247	Cm Curium 96	245	Bk Berkelium 97	251	Cf Californium 98	254	Es Einsteinium 99	253	Fm Fermium 100	256	Md Mendelevium 101	254	No Nobelium 102	257	Lr Lawrencium 103
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