

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

1. Aluminium is extracted industrially from aluminium oxide, Al_2O_3 , using electrolysis. The aluminium oxide is obtained from an aluminium ore.

(a) Name an ore of aluminium.

.....
(1)

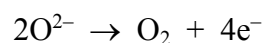
(b) What is carbon used for in the extraction process?

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(1)

(c) (i) Write the half-equation for the process occurring at the cathode.

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(1)

(ii) The process occurring at the anode is shown by the following half-equation.



Name this type of change and explain your answer in terms of electrons.

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(2)

(d) State the temperature used in the electrolysis.

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(1)

(e) State the role of cryolite in this process.

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(1)

(f) What is the major cost in the manufacture of aluminium?

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(1)



(g) State ONE major use of aluminium and state ONE property of aluminium that makes it suitable for this use.

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(1)

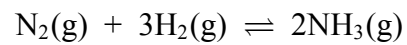
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Q1



2. This question is about ammonia, NH_3 , which is produced as shown in the following equation.



- (a) Use oxidation numbers to explain why this is a redox reaction.

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(2)

- (b) (i) Use the average (mean) bond enthalpy data to calculate a value for the enthalpy change for this reaction. You are reminded to show **all** your working.

Bond	Average bond enthalpy /kJ mol ⁻¹
$\text{N}\equiv\text{N}$	944
$\text{H}-\text{H}$	436
$\text{N}-\text{H}$	388

(3)



(ii) The actual standard enthalpy change for this reaction is -92 kJ mol^{-1} . Explain why the value you calculated in (b)(i) is not the same as this.

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(1)

(iii) At room temperature, a mixture of nitrogen and hydrogen is thermodynamically unstable with respect to ammonia, but is kinetically stable.

Use the data in (b)(i) and (ii) to help you explain why this mixture is thermodynamically unstable

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kinetically stable

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(3)



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(c) The manufacturer of ammonia would like to achieve a high rate of reaction and a high equilibrium yield of product.

(i) State and explain, in terms of collision theory, TWO ways to increase the rate of the reaction. An increase in pressure does **not** alter the rate in this process.

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(6)



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(ii) State and explain TWO ways to increase the equilibrium yield of ammonia.

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(4)

(d) At equilibrium in the Haber Process only a small percentage of the hydrogen and nitrogen is converted to ammonia.

(i) How is the ammonia separated from unreacted nitrogen and hydrogen?

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(1)

(ii) How is nearly all the hydrogen eventually converted to ammonia?

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(1)

(Total 21 marks)

Q2

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N 2 9 2 6 0 A 0 7 1 6

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3. (a) Compound A, $\text{CH}_3\text{CHBrCH}_2\text{CH}_3$, can be converted into butan-2-ol by reaction with potassium hydroxide solution.

(i) Name compound A.

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(1)

(ii) Write an equation for the conversion of compound A into butan-2-ol.

.....
(1)

(iii) Identify the solvent required for this reaction.

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(1)

(iv) Classify this reaction.

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(1)

(b) Compound A can also be converted into a mixture of the structural isomers but-1-ene and but-2-ene by reaction with potassium hydroxide under different conditions.

(i) Write the **ionic** equation for the conversion of compound A into **either** but-1-ene **or** but-2-ene.

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(1)

(ii) What is the solvent required for this reaction?

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(1)

(iii) Classify this reaction.

.....
(1)



(c) But-2-ene exists as two geometric isomers.

(i) Draw the structural formulae of these TWO geometric isomers.

(1)

(ii) Explain why but-2-ene exists as two geometric isomers.

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(2)

(d) Both but-1-ene and but-2-ene react with hydrogen, in the presence of a suitable catalyst, to give the same product.

(i) Identify the catalyst.

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(1)

(ii) Identify the product of this reaction.

.....

(1)



(e) Compound **A**, $\text{CH}_3\text{CHBrCH}_2\text{CH}_3$, reacts with ammonia.

(i) Write an equation for this reaction.

.....
(1)

(ii) Give ONE essential condition for this reaction.

.....
(1)

(iii) With excess halogenoalkane, further substitution of the hydrogen atoms in the ammonia molecule takes place and a different product, compound **B**, is formed.

Analysis of compound **B** gave the following data.

Element	% by mass
carbon	74.4
hydrogen	14.7
nitrogen	10.9

Use the data to calculate the empirical formula of compound **B**.

(2)

Q3

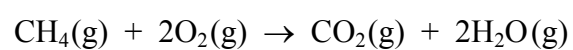
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4. (a) (i)

Formula of substance	Standard enthalpy of formation /kJ mol ⁻¹
CH ₄ (g)	-75
O ₂ (g)	0
CO ₂ (g)	-394
H ₂ O(g)	-242

The equation for the complete combustion of methane at 150 °C is:



Use the given data to calculate the enthalpy of combustion of methane under these conditions.

(2)

(ii) The **standard** enthalpy of combustion of methane is -891 kJ mol⁻¹.

Explain why this is very different from the value you have calculated in (a)(i).

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(1)



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(b) Ethanol is a primary alcohol and can be oxidised if heated with an acidified solution of potassium dichromate(VI). Two possible organic oxidation products may be obtained.

(i) Draw the **full** structural formula, showing all bonds, of **both** oxidation products.

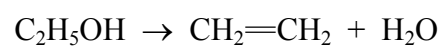
(2)

(ii) Give the name **and** structural formula of an alcohol that would **not** be oxidised by heating it with an acidified solution of potassium dichromate(VI).

(2)



- (c) Ethanol can be converted in the laboratory into ethene as shown by the following equation.



Give the other substance needed to achieve this conversion.

..... (1)

- (d) (i) Ethene can be polymerised to produce poly(ethene).

Draw the repeat unit of poly(ethene).

(1)

- (ii) Give ONE major use for poly(ethene).

..... (1)

Q4

(Total 14 marks)

TOTAL FOR PAPER: 60 MARKS

END



THE PERIODIC TABLE

Period 1 2 3 4 5 6 7 0

Period

1	H
	Hydrogen
	1

Key	
Molar mass g mol ⁻¹	Symbol
Symbol	Name
Name	Atomic number

4	He
	Helium
	2

7	Li	Be											B	C	N	O	F	Ne
	Lithium	Beryllium											Boron	Carbon	Nitrogen	Oxygen	Fluorine	Neon
	3	4											5	6	7	8	9	10
23	Na	Mg											27	28	31	32	35.5	40
	Sodium	Magnesium											Aluminium	Silicon	Phosphorus	Sulphur	Chlorine	Argon
	11	12											13	14	15	16	17	18
39	K	Ca											70	73	75	79	80	84
	Potassium	Calcium											Aluminium	Silicon	Phosphorus	Sulphur	Chlorine	Argon
	19	20											31	32	33	34	35	36
85	Rb	Sr											115	119	122	128	127	131
	Rubidium	Strontium											Gallium	Germanium	Arsenic	Selenium	Bromine	Krypton
	37	38											49	50	51	52	53	54
133	Cs	Ba											204	207	209	210	210	222
	Caesium	Barium											Indium	Tin	Antimony	Tellurium	Iodine	Xenon
	55	56											81	82	83	84	85	86
137	Fr	Ra											204	207	209	210	210	222
	Francium	Radium											Thallium	Lead	Bismuth	Polonium	Astatine	Radon
	87	88											81	82	83	84	85	86

140	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
	Cerium	Praseodymium	Neodymium	Promethium	Samarium	Europium	Gadolinium	Terbium	Dysprosium	Holmium	Erbium	Thulium	Ytterbium	Lutetium
	58	59	60	61	62	63	64	65	66	67	68	69	70	71

232	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr
	Thorium	Protactinium	Uranium	Neptunium	Plutonium	Americium	Curium	Berkelium	Californium	Einsteinium	Fermium	Mendelevium	Nobelium	Lawrencium
	90	91	92	93	94	95	96	97	98	99	100	101	102	103

