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1. Four of the structural isomers of $C_4H_{10}O$ are alcohols. One of these isomers is butan-2-ol.

(a) Draw the structural formulae of two other alcohols with molecular formula $C_4H_{10}O$ and name each of these isomers.

Diagrams

Isomer 1

Isomer 2

Name of isomer 1

Name of isomer 2

.....

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(4)

(b) A sample of butan-2-ol, C_4H_9OH , was heated with a mixture of sulphuric acid and potassium dichromate(VI).

(i) State the colour change that would be observed during the reaction.

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(1)

(ii) Give the name of the organic product formed, and name the type of reaction occurring.

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(2)

(Total 7 marks)

Q1

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2. In the preparation of the alcohol butan-2-ol, 13.7 g of 2-bromobutane was hydrolysed with 9.0 g of potassium hydroxide in aqueous solution. The following reaction occurred.



- (a) Calculate the amount (number of moles) of each **reactant** in the above experiment, and use your answers to state which reactant was present in excess.

(4)

- (b) Calculate the maximum possible mass of butan-2-ol which could be obtained in the above experiment.

(3)

- (c) The reaction taking place can be classified as nucleophilic substitution. Explain the term **nucleophile** and identify the nucleophile in the reaction.

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(2)

(d) The above experiment was repeated under identical conditions, except that 2-iodobutane was used in place of 2-bromobutane. State and explain the effect that this change would have on the rate of reaction.

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(2)

Q2

(Total 11 marks)

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3. (a) During the manufacture of sulphuric acid in the Contact Process sulphur dioxide reacts with oxygen, in a reversible reaction, to form sulphur trioxide.

(i) Write an equation to show the reaction between sulphur dioxide and oxygen.

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(1)

(ii) Give the name of the catalyst, and the values of temperature and pressure used.

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(3)

(iii) Give one large scale use of sulphuric acid.

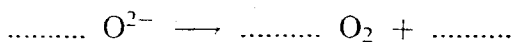
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(1)

(b) Aluminium is manufactured by electrolysis of a solution of aluminium oxide in molten cryolite.

(i) Name the ore most commonly used in the extraction of aluminium.

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(1)

(ii) Complete and balance the half equations below, to show the reactions occurring at the electrodes during the extraction of aluminium.



(2)

(iii) From what material are the electrodes used in aluminium extraction made?

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(1)

(iv) State the major cost to the manufacturer during the extraction of aluminium.

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(1)

(v) Give two reasons why aluminium is commonly recycled.

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(2)

(vi) Give one large scale use of aluminium.

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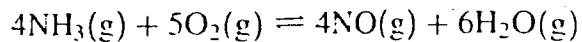
(1)

(Total 13 marks)

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Q3

4. Ammonia reacts with oxygen, in a reversible, **exothermic reaction**, as shown in the equation below. This is the first stage in the manufacture of nitric acid.



(a) (i) State and explain the effect of an increase in pressure on the **position** of this equilibrium.

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(2)

(ii) State and explain the effect of an increase in temperature on the **position** of the equilibrium.

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(2)

(b) (i) State and explain the effect of an increase in pressure on the **rate** of the reaction.

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(3)

(ii) State and explain the effect of an increase in temperature on the **rate** of the reaction.

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(3)

(c) (i) Name the catalyst used in the reaction, during the manufacture of nitric acid.

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blank*

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(1)

(ii) Explain the effect of a catalyst on the rate of the reaction.

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(3)

(iii) Suggest why the catalyst is in the form of a gauze or mesh.

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(1)

Q4

(Total 15 marks)

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5. (a) A sample of 2-bromobutane was heated with potassium hydroxide in ethanolic solution. A reaction occurred producing a mixture of but-1-ene and but-2-ene.

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(i) Write an equation for the above reaction to show the production of **either** but-1-ene **or** but-2-ene.

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(1)

(ii) State the type of reaction taking place.

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(1)

(b) Some bromine solution was shaken with a sample of but-2-ene, and a reaction occurred.

(i) State what would be seen during this reaction.

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(1)

(ii) Draw the structural formula of the product of this reaction, and name this product.

Diagram:

Name

(2)

(c) But-2-ene can exist as two stereoisomers.

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blank*

(i) Draw the structural formulae of the two stereoisomers of but-2-ene.

(2)

(ii) Explain why but-2-ene exists as two stereoisomers, and name this type of isomerism.

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(2)

Q5

(Total 9 marks)

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6. (a) (i) Define the term **standard enthalpy of formation**, ΔH_f^\ominus .

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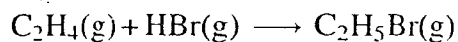
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(3)

(ii) The following table shows some values of standard enthalpy of formation.

Name	Formula	$\Delta H_f^\ominus/\text{kJ mol}^{-1}$
ethene	$\text{C}_2\text{H}_4(\text{g})$	+52.3
hydrogen bromide	$\text{HBr}(\text{g})$	-36.2
bromoethane	$\text{C}_2\text{H}_5\text{Br}(\text{g})$	-60.4

Use the data in the table above to calculate the standard enthalpy change for the following reaction.



(2)

(iii) State the significance of the sign of the value obtained in part (a)(ii) above.

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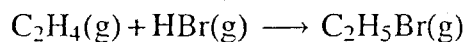
(1)

(b) Enthalpy changes can also be calculated using average bond enthalpy data.

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Bond	Average bond enthalpy/kJ mol ⁻¹
C=C	+612
C—C	+348
C—H	+412
C—Br	+276
H—Br	+366

Use the data in the table above to recalculate the enthalpy change for the reaction in part (a)(ii).



(3)

(c) Suggest why the value obtained in part (b) above is likely to be less accurate than that obtained in part (a)(ii).

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(2)

Q6

(Total 11 marks)

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7. The following table shows some properties of two different fuels.

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Fuel	Hydrogen	Ethanol
Formula	H_2	C_2H_5OH
Boiling temperature / °C	-252	78
Enthalpy of combustion per gram / kJ	-143	-30
Cost per tonne / £	100	500

(a) Write equations to show the complete combustion of:

(i) hydrogen

.....

(ii) ethanol

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(4)

(b) Hydrogen and ethanol are used as motor car fuel. Suggest the advantages and disadvantages of each of these fuels in this application. Use the table, and your answers to part (a) above to help you.

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(5)

Q7

(Total 9 marks)

TOTAL FOR PAPER: 75 MARKS

END

THE PERIODIC TABLE

Period	1	2	Group										3	4	5	6	7	0
1	1 H Hydrogen																	4 He Helium
2	3 Li Lithium	4 Be Beryllium											5 B Boron	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Fluorine	10 Ne Neon
3	11 Na Sodium	12 Mg Magnesium											13 Al Aluminium	14 Si Silicon	15 P Phosphorus	16 S Sulphur	17 Cl Chlorine	18 Ar Argon
4	19 K Potassium	20 Ca Calcium	21 Sc Scandium	22 Ti Titanium	23 V Vanadium	24 Cr Chromium	25 Mn Manganese	26 Fe Iron	27 Co Cobalt	28 Ni Nickel	29 Cu Copper	30 Zn Zinc	31 Ga Gallium	32 Ge Germanium	33 As Arsenic	34 Se Selenium	35 Br Bromine	36 Kr Krypton
5	37 Rb Rubidium	38 Sr Strontium	39 Y Yttrium	40 Zr Zirconium	41 Nb Niobium	42 Mo Molybdenum	43 Tc Technetium	44 Ru Ruthenium	45 Rh Rhodium	46 Pd Palladium	47 Ag Silver	48 Cd Cadmium	49 In Indium	50 Sn Tin	51 Sb Antimony	52 Te Tellurium	53 I Iodine	54 Xe Xenon
6	55 Cs Caesium	56 Ba Barium	57 La Lanthanum	72 Hf Hafnium	73 Ta Tantalum	74 W Tungsten	75 Re Rhenium	76 Os Osmium	77 Ir Iridium	78 Pt Platinum	79 Au Gold	80 Hg Mercury	81 Tl Thallium	82 Pb Lead	83 Bi Bismuth	84 Po Polonium	85 At Astatine	86 Rn Radon
7	87 Fr Francium	88 Ra Radium	89 Ac Actinium															

Key

Molar mass g mol ⁻¹
Symbol
Name
Atomic number

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
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