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CHEMISTRY

PAPER 3

Tuesday 22 JUNE 2021 12:00 NOON–1:30 P.M.

Additional materials:

Graph paper Calculator (not graphing) may be used

MINISTRY OF EDUCATION NATIONAL EXAMINATIONS

BAHAMAS GENERAL CERTIFICATE OF SECONDARY EDUCATION

INSTRUCTIONS AND INFORMATION TO CANDIDATES

Do not open this booklet until you are told to do so.

Write your school number, candidate number, surname and initials at the top of this page as well as at the top of all lined paper submitted.

Answer **ALL** questions in **Section A** in the spaces provided on this question booklet and any **TWO** questions from **Section B** on the lined paper provided at the back of this question booklet.

Equations and diagrams should be given wherever they are helpful.

Essential working must be shown.

The intended marks for each question or part question are given in brackets [].

Relative atomic masses are given in the Periodic Table printed on page 2.

ADDITIONAL INFORMATION

s.t.p. ($t = 0^{\circ}\text{C}$, $p = 1 \text{ atm.}$)

The volume of one mole of gas at room temperature and pressure (r.t.p.) is $24\,000 \text{ cm}^3$.

For Examiner's Use	
Section A	
1	
2	
3	
4	
Section B	
5	
6	
7	
TOTAL	

This question paper consists of 14 printed pages, 4 lined pages and 2 blank pages.



The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
1 H Hydrogen																	
3 7 Li Lithium	4 9 Be Beryllium											5 11 B Boron	6 12 C Carbon	7 14 N Nitrogen	8 16 O Oxygen	9 19 F Fluorine	2 4 He Helium
												13 27 Al Aluminium	14 28 Si Silicon	15 31 P Phosphorus	16 32 S Sulphur	17 35.5 Cl Chlorine	
11 23 Na Sodium	12 24 Mg Magnesium											31 70 Ga Gallium	32 73 Ge Germanium	33 75 As Arsenic	34 79 Se Selenium	35 80 Br Bromine	36 84 Kr Krypton
19 39 K Potassium	20 40 Ca Calcium	21 45 Sc Scandium	22 48 Ti Titanium	23 51 V Vanadium	24 52 Cr Chromium	25 55 Mn Manganese	26 56 Fe Iron	27 59 Co Cobalt	28 59 Ni Nickel	29 64 Cu Copper	30 65 Zn Zinc	49 115 In Indium	50 119 Sn Tin	51 122 Sb Antimony	52 128 Te Tellurium	53 127 I Iodine	54 131 Xe Xenon
37 85 Rb Rubidium	38 88 Sr Strontium	39 89 Y Yttrium	40 91 Zr Zirconium	41 93 Nb Niobium	42 96 Mo Molybdenum	43 101 Tc Technetium	44 106 Ru Ruthenium	45 103 Rh Rhodium	46 106 Pd Palladium	47 108 Ag Silver	48 112 Cd Cadmium	81 204 Tl Thallium	82 207 Pb Lead	83 209 Bi Bismuth	84 208 Po Polonium	85 210 At Astatine	86 210 Rn Radon
55 133 Cs Caesium	56 137 Ba Barium	57 139 La Lanthanum	72 178 Hf Hafnium	73 181 Ta Tantalum	74 184 W Tungsten	75 186 Re Rhenium	76 190 Os Osmium	77 192 Ir Iridium	78 195 Pt Platinum	79 197 Au Gold	80 201 Hg Mercury						
87 226 Fr Francium	88 226 Ra Radium	89 227 Ac Actinium															

a

X

b

Key

a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

* 58-71 Lanthanoid series
† 90-103 Actinoid series

58 140 Ce Cerium	59 141 Pr Praseodymium	60 144 Nd Neodymium	61 150 Pm Promethium	62 152 Sm Samarium	63 157 Eu Europium	64 162 Gd Gadolinium	65 165 Tb Terbium	66 167 Dy Dysprosium	67 169 Ho Holmium	68 173 Er Erbium	69 175 Tm Thulium	70 177 Yb Ytterbium	71 179 Lu Lutetium	90 232 Th Thorium	91 233 Pa Protactinium	92 238 U Uranium	93 238 Np Neptunium	94 242 Pu Plutonium	95 244 Am Americium	96 247 Cm Curium	97 251 Bk Berkelium	98 259 Cf Californium	99 267 Es Einsteinium	100 271 Fm Fermium	101 281 Md Mendelevium	102 285 No Nobelium	103 289 Lr Lawrencium
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SECTION A

Answer **all** questions.

1. An experiment was conducted in a laboratory for a fixed mass of carbon dioxide gas at a constant pressure.

The data for the experiment is shown in the table.

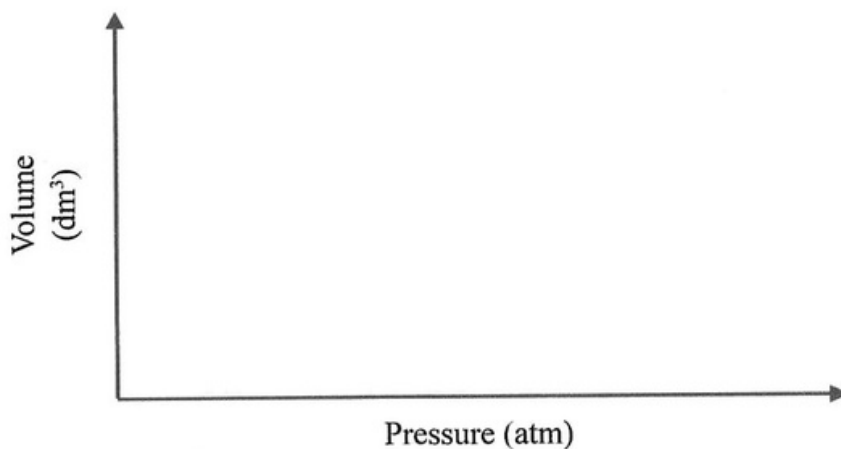
Volume (cm ³)	91	100	106	113
Temperature (K)	270	294	313	324

Use the table to answer the following questions:

- (a) (i) Explain the relationship between volume and temperature for the fixed mass of carbon dioxide collected in the experiment.
- _____ [1]
- (ii) Name the gas law demonstrated in the data.
- _____ [1]
- (iii) Write the formula for the gas law named.
- [1]
- (iv) A balloon at 293K has a volume of 120 dm³. If the temperature was increased to 323K, what will be the new volume of the balloon?

[2]

- (b) (i) Using the axes of the graph sketch a line to represent the relationship between volume and pressure for a fixed mass of gas at a constant temperature.



[1]

- (ii) Write the mathematical formula for the Combined Gas Law.

[1]

- (iii) A helium filled balloon has a volume of 25.0 cm^3 at 298K and 2.0 atm . Calculate the new volume in dm^3 of the balloon at 4.0 atm and 283K .

[2]

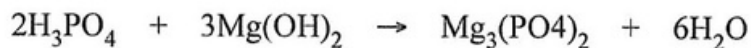
- (c) State the environmental condition caused by having too much carbon dioxide gas in the atmosphere.

[1]

TOTAL MARKS [10]



2. The balanced equation for the reaction of phosphoric acid with magnesium hydroxide is:



In this reaction, 23.00 cm^3 of 0.25 mol/dm^3 of phosphoric acid, H_3PO_4 is titrated with magnesium hydroxide, $\text{Mg}(\text{OH})_2$.

The titration results are shown in the table.

rough titre/ cm^3	titre 1/ cm^3	titre 2/ cm^3
23.00	22.20	22.30

- (a) (i) Calculate the number of moles of phosphoric acid used in the reaction.

_____ mols [2]

- (ii) Determine the average volume of magnesium hydroxide produced.

_____ dm^3 [1]

- (iii) Use the equation given and (a) (i) to determine the number of moles of magnesium hydroxide.

_____ mols [2]

- (iv) Using the volume in (a) (ii) and the moles in (a) (iii) determine the concentration of magnesium hydroxide.

_____ mols/dm^3 [2]

- (b) State **one** use of magnesium hydroxide.

_____ [1]

- (c) Give the balanced symbol equation for the reaction between magnesium hydroxide and sulfuric acid, H_2SO_4 .

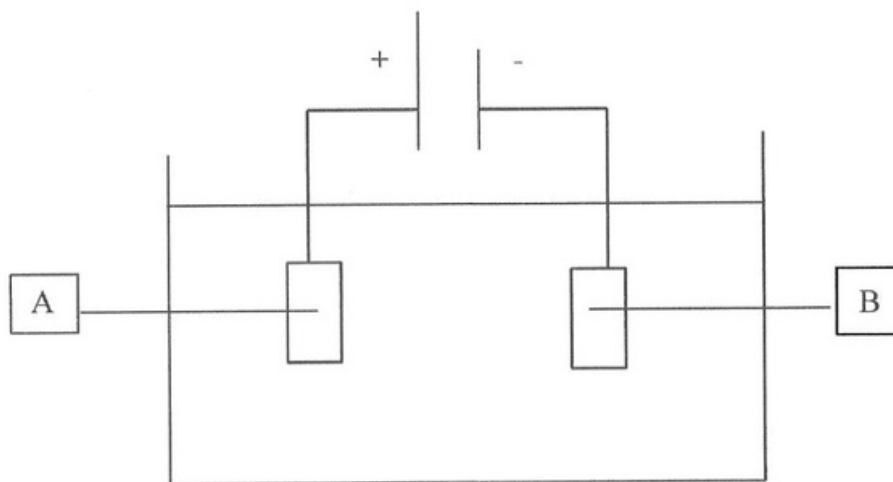
_____ [2]

TOTAL MARKS [10]

[Turn over]



3. The diagram shows the electrolysis of copper sulfate using copper electrodes.



- (a) (i) Identify A and B as anode and cathode.

A _____

B _____ [1]

- (ii) Describe the composition of electrodes A and B.

 _____ [1]

- (b) (i) Draw diagrams to show how the positive and negative electrodes would look after the reaction has occurred.

Diagram of positive electrode	Diagram of negative electrode

[2]



- (ii) Write the equations to depict the reaction at the positive electrode and at the negative electrode.

Reaction at positive electrode _____

Reaction at negative electrode _____ [4]

- (c) Electroplating is an important chemical process. Give **two** reasons for its importance.

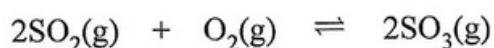
_____ [2]

TOTAL MARKS [10]

4. Sulfuric acid is a commercially important chemical. It is produced during the Contact Process.

In stage one of the process, sulfur is burned in air to make sulfur dioxide.

The equation for the reaction in stage two of the process is shown.



The reaction occurs at equilibrium.

- (a) (i) Define the term equilibrium.

_____ [1]

- (ii) Name the catalyst used in stage two of the Contact Process.

_____ [1]

- (b) Use Le Chatelier's Principle to explain the changes, if any, in yield of SO_3 .

- (i) The total pressure of the system was increased.

_____ [2]

- (ii) The catalyst was removed.

_____ [1]

- (c) In the final stage of the process the SO_3 reacts with water.

Write the balanced symbol equation for this reaction. Include state symbols.

_____ [3]

- (d) Sulfuric acid is a powerful oxidising agent. Name another property of sulfuric acid.

_____ [1]



- (e) Write a word equation for the formation of ammonium sulfate from sulfuric acid.

_____ [1]

TOTAL MARKS [10]

SECTION B

Answer any **TWO** questions from this Section.

5. A student reacts equal masses of sodium hydrogencarbonate, NaHCO_3 tablets (5.0 g) with equal volumes, (30 cm^3) but different concentrations of sulfuric acid, H_2SO_4 .

The results are shown in the table

Trial	Concentration of sulfuric acid, H_2SO_4 (mol/dm^3)	Time (min)	0	1	2	3	4	5	6	7	8	9	10
A	1.0	Volume of gas (cm^3)	0	15	24	31	37	41	44	46	47	48	48
B	2.5		0	30	39	45	47	48	48	48	48	48	48

- (a) (i) Using the data in the table plot a graph of volume against time for the two different concentrations of sulfuric acid, H_2SO_4 . Label the plotted lines trial A and trial B respectively. [6]
- (ii) Using laboratory apparatus sketch a diagram demonstrating how a student can conduct the experiment in (a)(i). [3]
- (iii) Write a balanced chemical equation for the reaction of sodium hydrogencarbonate, NaHCO_3 with sulfuric acid, H_2SO_4 to form sodium sulfate, Na_2SO_4 . [2]
- (iv) State which Trial is faster. Use collision theory to explain the difference in the rate of A and B. [2]
- (v) 30 cm^3 of sulfuric acid, H_2SO_4 in Trial B was reacted with the sodium hydrogencarbonate, NaHCO_3 tablet. Calculate the number of moles of sulfuric acid. [1]
- (vi) Using your answer in (a)(v) and the equation in (a)(iii), calculate the mass of sodium sulfate, Na_2SO_4 produced. [2]
- (b) Trial A was repeated with 5.0g of powdered sodium hydrogencarbonate instead of solid tablets. All other conditions were kept the same.

Using the collision theory, explain whether the solid or powdered form of sodium hydrogencarbonate will react faster. [2]



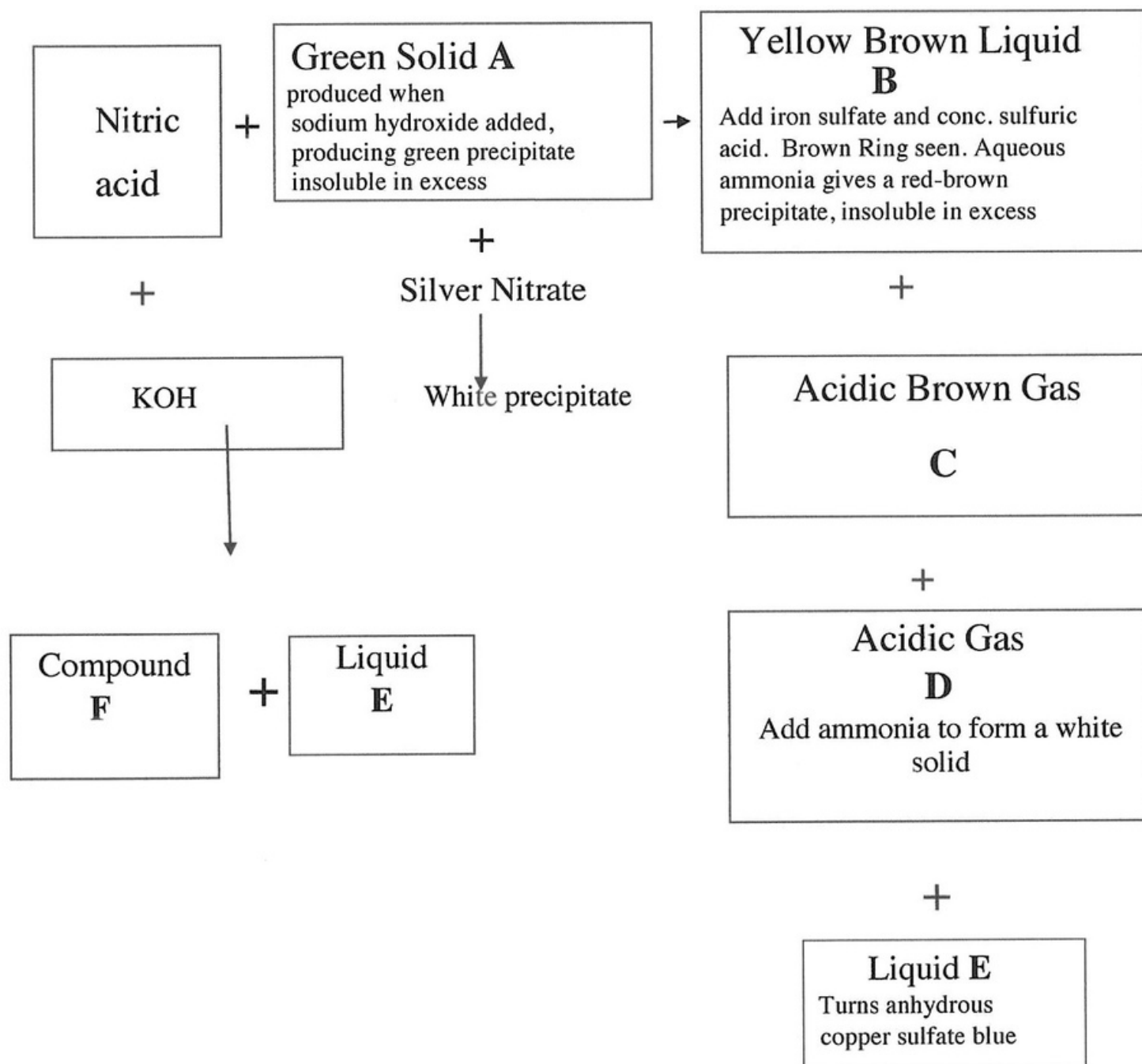
(c) The presence of calcium hydrogencarbonate in water causes temporary hardness.

(i) What is temporary hardness? [1]

(ii) State one way in which this temporary hardness can be removed. [1]

TOTAL MARKS [20]

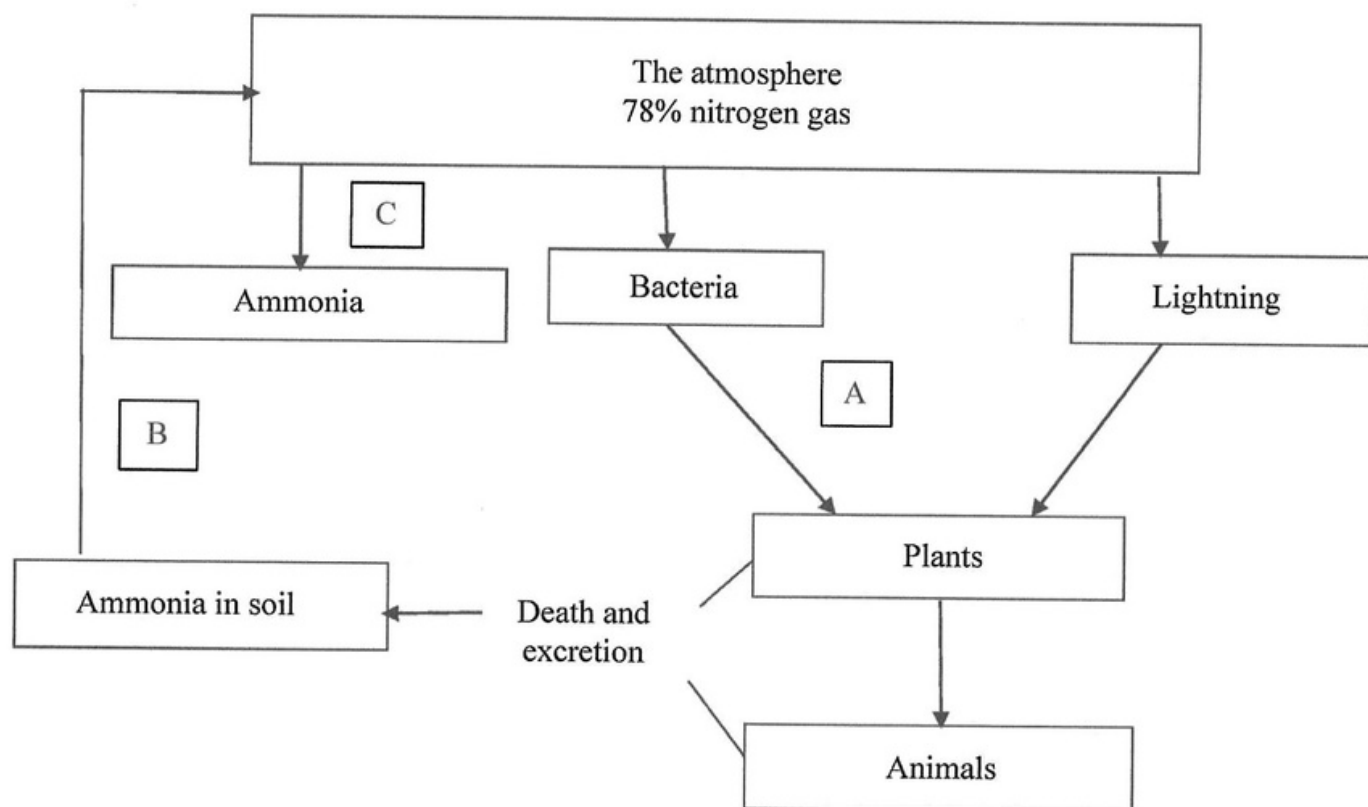
6. Use the flow chart to answer the questions.



- (a) (i) Identify the names of the substances A – F in the flow chart. [6]
- (ii) State **one** use of Compound F. [1]
- (iii) Describe what happens if compound F gets into a river. [1]
- (b) (i) Write the chemical symbol equation showing the manufacture of nitric acid when nitrogen oxide and oxygen are dissolved in water. [2]
- (ii) Give **one** use of nitric acid. [1]



(c) The diagram shows a part of the nitrogen cycle.



- (i) Nitrogen is an important component of living organisms. State the form in which it is found in plants and animals. [1]
- (ii) Name the kind of bacteria that carry out the process at A and state the kind of compounds they form. [2]
- (iii) Give one way in which the electrical discharge of lightning can have a negative impact on the environment. [1]
- (iv) Name the kind of bacteria that would be responsible for the process at B. [1]
- (v) Name the manufacturing process at C. [1]
- (vi) Write a balanced equation for the process at C, include at least **ONE** special condition needed for this reaction to occur. [3]

TOTAL MARKS [20]

[Turn over]

7. (a) A hydrocarbon **X**, contains 75% of carbon and 25% of hydrogen. It reacts with chlorine in the presence of sunlight.
- (i) Determine the empirical formula of **X**. [3]
 - (ii) State the relative molecular mass of **X**. [1]
- (b) (i) Another hydrocarbon **Y** has the molecular formula C_4H_{10} .
Draw the structure of C_4H_{10} showing all the atoms and all the bonds. [2]
- (ii) C_4H_{10} can exist as an isomer.
What is an isomer? [2]
 - (iii) Draw **one** isomer of **Y** showing all the atoms and all the bonds. [2]
- (c) (i) Write the balanced chemical equation for the complete combustion of C_4H_{10} . [2]
- (ii) The combustion of a hydrocarbon is an exothermic reaction.
Draw a fully labelled energy profile diagram to show the combustion of C_4H_{10} . [3]
 - (iii) If 10g of C_4H_{10} , is burned, determine the volume of oxygen needed. [3]
- (d) Carbon monoxide is one of the substances formed in car exhaust fumes.
- (i) Give the chemical formula for carbon monoxide. [1]
 - (ii) What conditions result in the formation of carbon monoxide? [1]

TOTAL MARKS [20]



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