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Candidate surname					Other names				
Centre Number					Candidate Number				
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**Pearson Edexcel Level 1/Level 2 GCSE (9–1)**

**Tuesday 13 June 2023**

Morning (Time: 1 hour 45 minutes)

Paper reference **1CH0/2H**

**Chemistry**

**PAPER 2**

**Higher Tier**

**You must have:**  
Calculator, ruler

Total Marks

### Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided  
– *there may be more space than you need.*
- Calculators may be used.
- Any diagrams may NOT be accurately drawn, unless otherwise indicated.
- You must **show all your working out** with **your answer clearly identified** at the **end of your solution**.

### Information

- The total mark for this paper is 100.
- The marks for **each** question are shown in brackets  
– *use this as a guide as to how much time to spend on each question.*
- In questions marked with an **asterisk** (\*), marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.
- There is a periodic table on the back cover of the paper.

### Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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

Some questions must be answered with a cross ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

- 1 Butanol is a liquid fuel.

A student investigated the mass of butanol needed to increase the temperature of  $100\text{ cm}^3$  of water by  $1^\circ\text{C}$ .

The student used the following method.

**step 1** add  $100\text{ cm}^3$  of water to a beaker

**step 2** measure the mass of a spirit burner containing butanol

**step 3** measure the initial temperature of the water in the beaker

**step 4** place the spirit burner containing butanol under the beaker of water

**step 5** light the wick of the burner and start to stir the water with the thermometer

**step 6** stop heating the water when the temperature of the water has increased by  $30^\circ\text{C}$

**step 7** remeasure the mass of the spirit burner containing butanol.

Figure 1 shows the apparatus used.

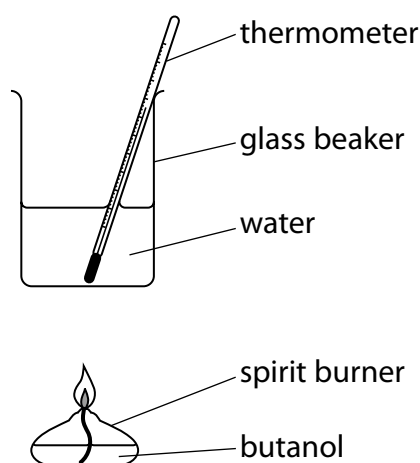


Figure 1

- (a) Figure 2 shows the student's results.

mass of spirit burner at start in g	mass of spirit burner at end in g
134.67	133.59

Figure 2

In the student's investigation, the temperature of the  $100\text{ cm}^3$  water increased by  $30^\circ\text{C}$ .

Calculate the mass of butanol needed to increase the temperature of the  $100\text{ cm}^3$  water by  $1^\circ\text{C}$ .

(2)

mass of butanol = g

- (b) The student investigated the effect of changing the fuel on the mass of fuel needed to heat the water.

The student used an identical spirit burner filled with pentanol, another liquid fuel.

Give **two** variables that the student should keep the same in this investigation.

(2)

variable 1

variable 2

- (c) Suggest **two** improvements that the student could make to their apparatus so that more of the heat energy is transferred to the water.

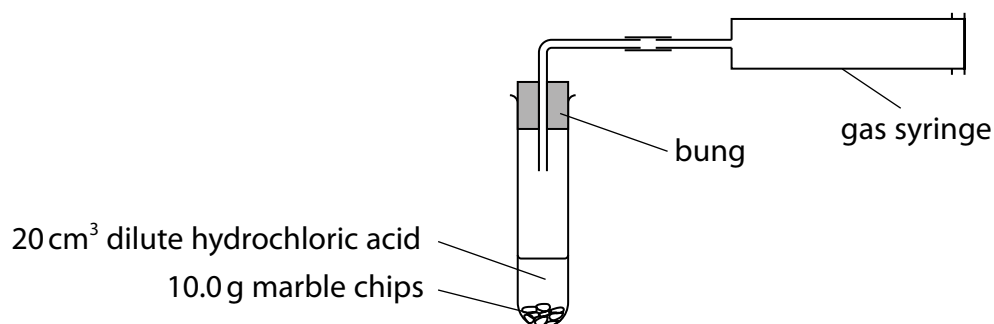
(2)

improvement 1

improvement 2

(Total for Question 1 = 6 marks)

- 2 A student used the apparatus shown in Figure 3 to investigate the reaction between marble chips and dilute hydrochloric acid.



**Figure 3**

The student recorded the volume of gas every minute as shown in Figure 4.

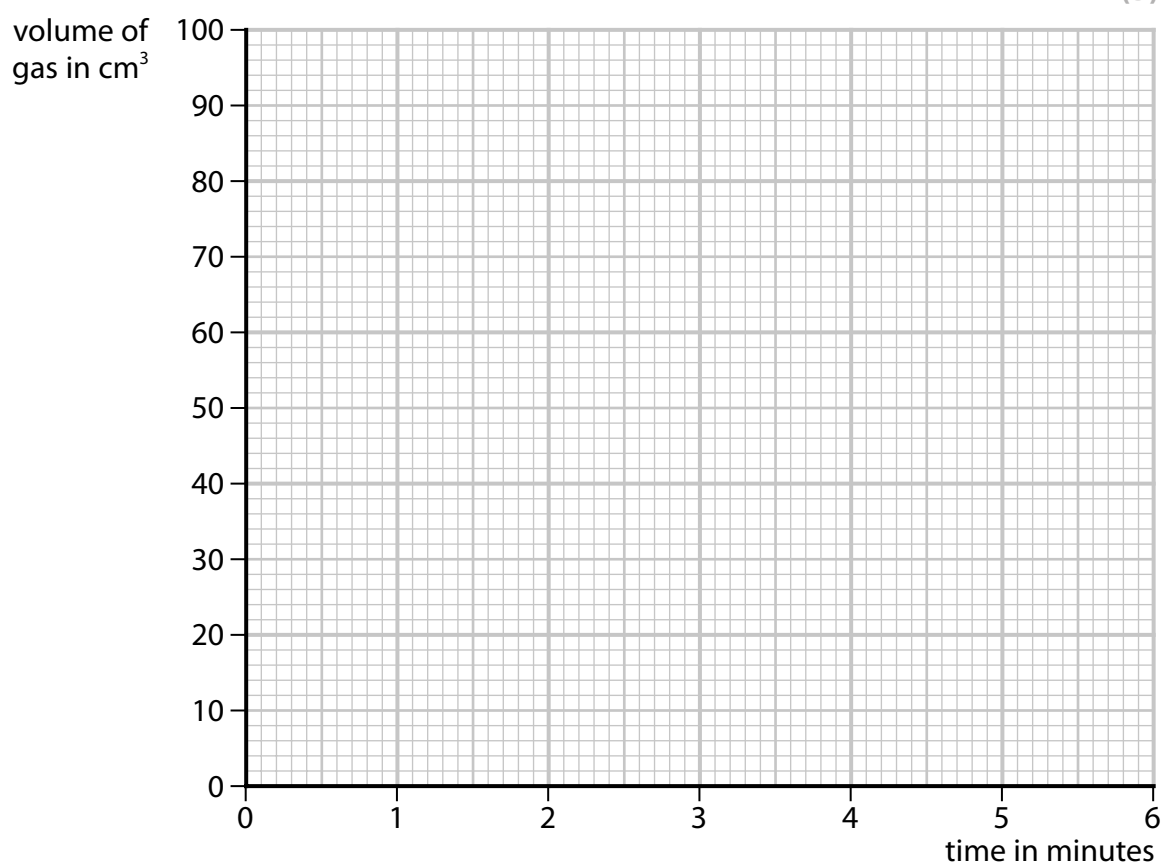
time in minutes	0	1	2	3	4	5	6
volume of gas in cm <sup>3</sup>	0	52	78	91	97	100	100

**Figure 4**

- (a) On the grid, plot the results shown in Figure 4.

Draw a curve of best fit.

(3)



(b) Rate of reaction can be calculated using

$$\text{rate of reaction} = \frac{\text{volume of gas produced in 1 minute}}{1 \text{ minute}}$$

Figure 5 shows the rates of reaction calculated from the results of this experiment.

The rate of reaction for the time interval 2 to 3 minutes is missing.

time interval	0 to 1 minute	1 to 2 minutes	2 to 3 minutes	3 to 4 minutes	4 to 5 minutes
rate of reaction in $\text{cm}^3 \text{min}^{-1}$	52	26		6	3

**Figure 5**

(i) Calculate the rate of reaction for the time interval 2 to 3 minutes.

(1)

$$\text{rate of reaction} = \quad \quad \quad \text{cm}^3 \text{min}^{-1}$$

(ii) State and explain what happens to the rate of reaction as the acid reacts with the marble chips in this experiment.

(3)

(c) The student repeated the experiment using the same volume of acid and the same mass of marble chips but used smaller marble chips.

All other conditions remained the same.

The student found that the reaction with the smaller marble chips was faster to start with but produced the same volume of gas.

Using this information, draw a line on the grid to show the results for the reaction with the smaller marble chips.

Label this line 'C'.

(2)

**(Total for Question 2 = 9 marks)**

3 Figure 6 shows some information about the group 1 metals.

group 1 metal	atomic number	relative atomic mass
lithium	3	7
sodium	11	23
potassium	19	39
rubidium	37	85
caesium	55	133

**Figure 6**

(a) Explain, in terms of their electronic configurations, why these metals are placed in group 1 of the periodic table.

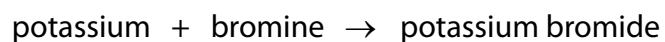
(2)

(b) Which row shows two correct properties of group 1 metals?

(1)

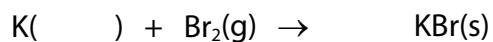
	properties of group 1 metals	
<b>A</b>	compounds are white in colour	high density
<b>B</b>	low melting points	compounds are blue in colour
<b>C</b>	soft enough to be cut by a knife	low melting points
<b>D</b>	high density	conduct electricity

- (c) The word equation for the reaction of potassium with bromine is



Add the missing state symbol and balance the equation for this reaction.

(2)



- (d) A sample of potassium contains three isotopes, potassium-39, potassium-40 and potassium-41.

- (i) Explain the meaning of the term **isotopes**.

(2)

- (ii) This sample of potassium contains

93.25% potassium-39

0.02% potassium-40

6.73% potassium-41

Calculate the relative atomic mass of this sample of potassium.

(2)

relative atomic mass =

**(Total for Question 3 = 9 marks)**

- 4 (a) Atoms, molecules, nanoparticles and protons are types of particle.

List these four types of particle in order of size from smallest to largest.

(2)

smallest



largest

- (b) Nanoparticles have a large surface area to volume ratio.

Figure 7 shows a cube-shaped nanoparticle with sides of 90 nm.

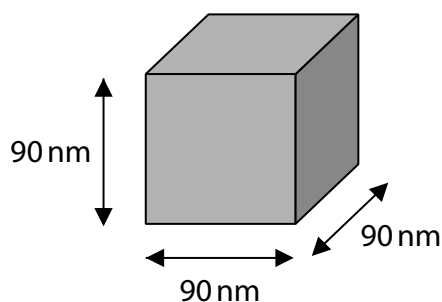


Figure 7

- (i) What is 90 nm in metres?

(1)

- A  $9.0 \times 10^{-5}$
- B  $9.0 \times 10^{-6}$
- C  $9.0 \times 10^{-8}$
- D  $9.0 \times 10^{-11}$

- (ii) Calculate the simplest surface area to volume ratio for the nanoparticle in Figure 7.

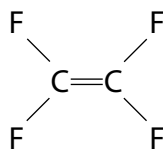
Show your working.

(3)

surface area to volume ratio = 1 :



(c) Figure 8 shows the structure of a molecule of tetrafluoroethene.



**Figure 8**

- (i) Tetrafluoroethene can form the polymer poly(tetrafluoroethene).

Draw a diagram to show the structure of the repeating unit of this polymer.

(2)

- (ii) Poly(tetrafluoroethene) is also known as Teflon<sup>TM</sup>.

State one use of poly(tetrafluoroethene) and explain how one of its properties makes it suitable for that use.

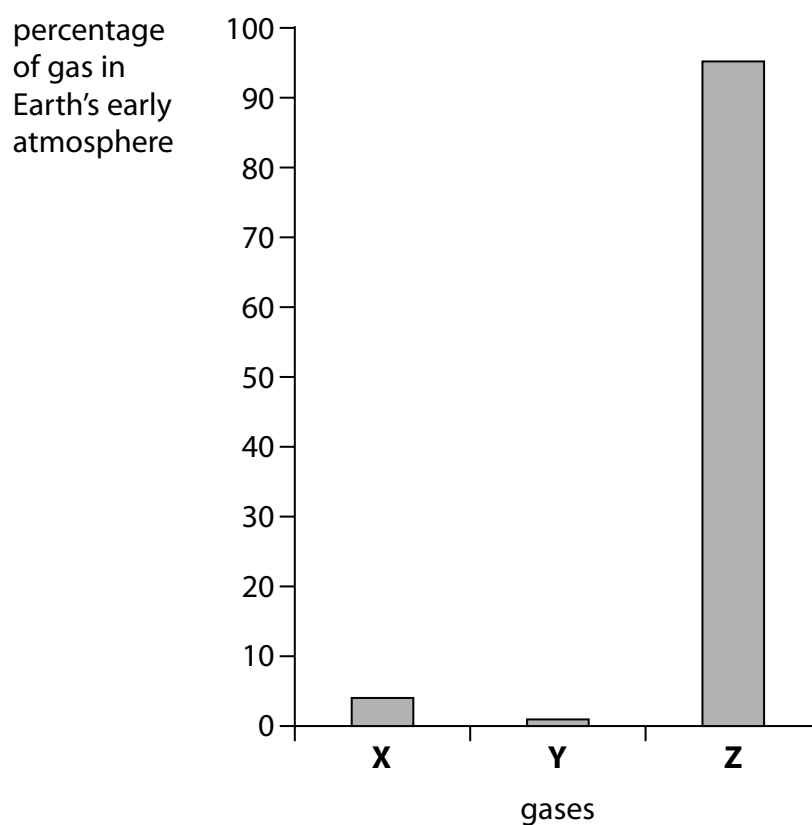
(3)

use

explanation

**(Total for Question 4 = 11 marks)**

- 5 (a) Figure 9 shows the percentage of three gases, **X**, **Y** and **Z**, in the Earth's early atmosphere.



**Figure 9**

What is the name of gas **Z**?

(1)

- A** argon
- B** carbon dioxide
- C** nitrogen
- D** oxygen

- (b) It is thought that small quantities of hydrogen sulfide,  $\text{H}_2\text{S}$ , were also in the Earth's early atmosphere.

Draw the dot and cross diagram for a molecule of hydrogen sulfide.

Show outer electrons only.

(2)

- (c) Acid rain is caused by some pollutant gases present in the atmosphere.

Explain how impurities in fossil fuels can result in acid rain.

(3)

(d) A student investigates the effect of acid rain on cress plants.

The student uses this method.

**step 1** grow 20 cress plants in each of two dishes, **A** and **B**

**step 2** water the cress plants in dish **A** with  $10\text{ cm}^3$  of dilute hydrochloric acid with a pH of 2

**step 3** water the cress plants in dish **B** with  $10\text{ cm}^3$  of pure water with a pH of 7

**step 4** repeat steps 2 and 3 every day for one week

**step 5** count how many plants are still alive after one week.

(i) State what piece of equipment the student could use to measure the pH of each liquid. (1)

(ii) Explain **one** improvement that the student could make to the method to make the results more valid. (2)

(Total for Question 5 = 9 marks)

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- 6 Chlorine gas can be prepared by reacting concentrated hydrochloric acid with solid potassium manganate(VII).

Figure 10 shows the apparatus used.

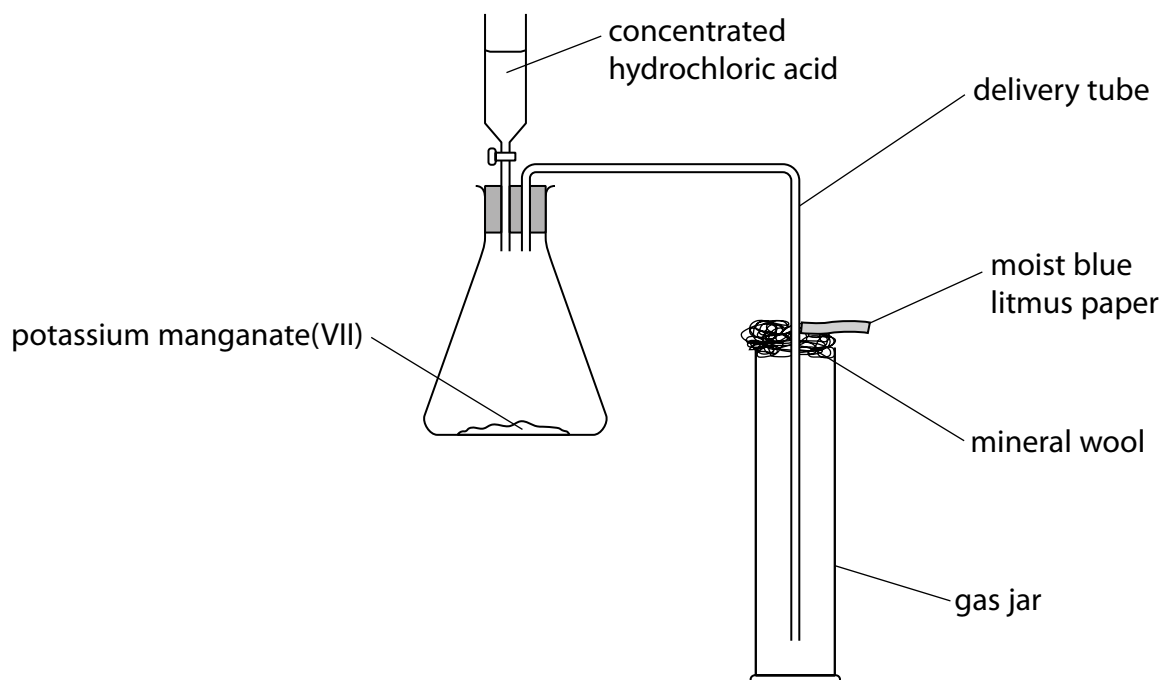


Figure 10

- (a) Figure 11 shows the hazard symbols for concentrated hydrochloric acid, potassium manganate(VII) and chlorine gas.









substance	hazard symbol
concentrated hydrochloric acid	 
potassium manganate(VII)	  
chlorine gas	  

Figure 11

Use the information in Figure 11 to help you answer (a)(i) and (a)(ii).

(i) What are the hazards associated with potassium manganate(VII)?

(1)

- A flammable, harmful and corrosive
- B flammable, toxic and hazardous to the environment
- C oxidising, harmful and hazardous to the environment
- D oxidising, toxic and corrosive

(ii) Explain **one** precaution that should be taken when preparing the sample of chlorine gas.

(2)

precaution

reason

(b) State the purpose of the delivery tube.

(1)

(c) Suggest why damp blue litmus is placed at the top of the gas jar.

(2)

(d) In the reaction, potassium manganate(VII),  $\text{KMnO}_4$ , reacts with hydrochloric acid to form manganese chloride,  $\text{MnCl}_2$ , potassium chloride, chlorine and water.

Write the balanced equation for the reaction.

(3)

(Total for Question 6 = 9 marks)

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7 Figure 12 shows the structure of the molecules of three organic compounds.

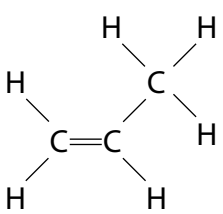
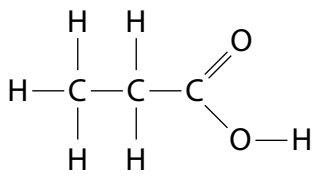
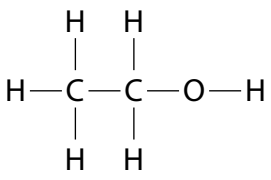
propene	propanoic acid	ethanol
		

Figure 12

- (a) (i) Each molecule in Figure 12 contains a different functional group.

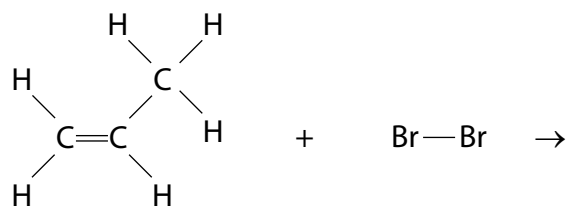
Circle the alkene functional group in **propene**.

(1)

- (ii) Propene reacts with bromine water.

Complete the equation for the reaction of propene with bromine by drawing the structure of a molecule of the product.

(2)



**propene**

**bromine**

**product**

- (iii) Propanoic acid reacts with calcium carbonate,  $\text{CaCO}_3$ , to form calcium propanoate,  $\text{Ca}(\text{C}_2\text{H}_5\text{COO})_2$ , and two other products.

Name the **two** other products.

(2)

product 1

product 2

\*(b) Glucose,  $C_6H_{12}O_6$ , is a carbohydrate.

A dilute solution of ethanol can be produced from glucose by fermentation.

The dilute solution of ethanol can then be processed to form a concentrated solution of ethanol.

Describe how the fermentation of glucose is carried out and how the dilute solution of ethanol produced can then be processed to form a concentrated solution of ethanol.

You may include diagrams in your answer.

(6)

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(Total for Question 7 = 11 marks)



8 Ammonia can be produced from the reaction of hydrogen with nitrogen.

(a) What is the percentage by mass of nitrogen in ammonia,  $\text{NH}_3$ ?

(relative atomic masses:  $\text{H} = 1.0$ ,  $\text{N} = 14$ )

(1)

- A 18%
- B 42%
- C 51%
- D 82%

(b) The reaction between hydrogen and nitrogen is exothermic.

Figure 13 shows the reaction profile of this exothermic reaction.

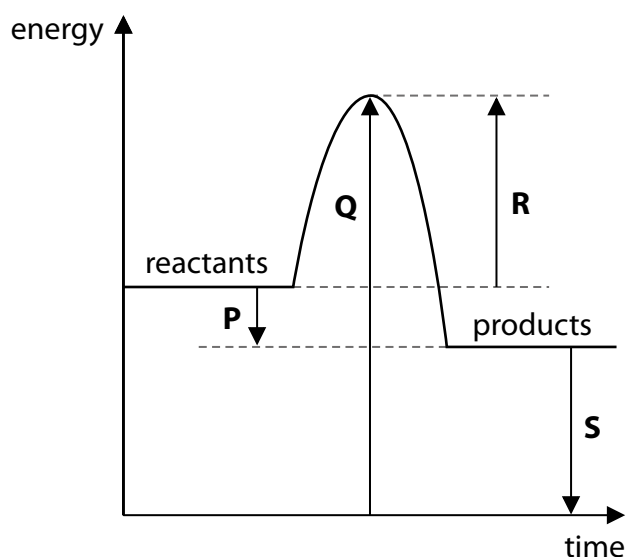


Figure 13

(i) Which arrow represents the activation energy for the reaction?

(1)

- A arrow P
- B arrow Q
- C arrow R
- D arrow S

- (ii) Describe what the reaction profile shows about the energy involved in bond breaking and bond making in this reaction.

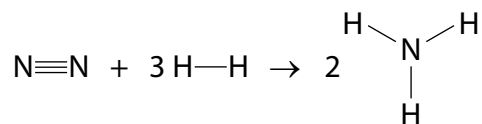
(2)

- (iii) Figure 14 shows the energies of some bonds.

bond	bond energy in $\text{kJ mol}^{-1}$
$\text{N}\equiv\text{N}$	944
$\text{H}-\text{H}$	436
$\text{H}-\text{N}$	388

**Figure 14**

The equation for the reaction between nitrogen and hydrogen to form ammonia is



Calculate the energy change, in  $\text{kJ mol}^{-1}$ , for this reaction.

(4)

energy change =

$\text{kJ mol}^{-1}$

- (c) Ammonia,  $\text{NH}_3$ , and silicon dioxide,  $\text{SiO}_2$ , are both compounds that are made of two non-metallic elements.

Ammonia has a boiling point of  $-33^\circ\text{C}$ .

Silicon dioxide has a boiling point of  $2230^\circ\text{C}$ .

Explain why the boiling points of ammonia and silicon dioxide are so different.

(3)

**(Total for Question 8 = 11 marks)**

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9 Crude oil is a mixture of hydrocarbons.

Crude oil can be separated into useful fractions by the process of fractional distillation in a fractionating column.

- (a) Figure 15 shows a fractionating column, the fractions obtained and the trend in viscosity of the fractions.

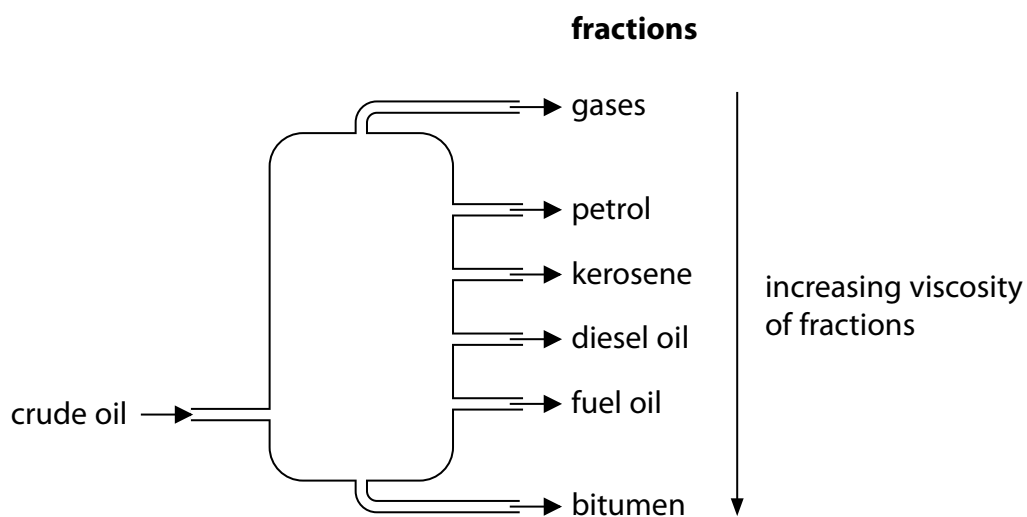


Figure 15

- (i) Which row shows the correct uses for bitumen, diesel oil and fuel oil?

(1)

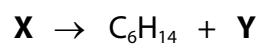
	bitumen	diesel oil	fuel oil
<b>A</b>	fuel for large ships	surfacing roads	fuel for trains
<b>B</b>	fuel for large ships	fuel for trains	surfacing roads
<b>C</b>	surfacing roads	fuel for trains	fuel for large ships
<b>D</b>	surfacing roads	fuel for large ships	fuel for trains

- (ii) Explain the trend in the viscosity of the fractions.

(2)



- (b) Hydrocarbon **X** was cracked to form one molecule of hexane,  $\text{C}_6\text{H}_{14}$ , and one molecule of alkene **Y**.



The relative formula mass of **Y** is 56.

The empirical formula of **Y** is  $\text{CH}_2$ .

Deduce the molecular formula of hydrocarbon **X**.

Show your working.

(relative atomic masses:  $\text{H} = 1.0$ ,  $\text{C} = 12$ )

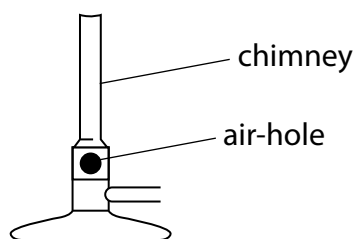
(4)

molecular formula of **X** =

\*(c) Large quantities of methane are used as a fuel.

Figure 16 shows a Bunsen burner.

Methane can be used as fuel for the Bunsen burner.



**Figure 16**

The air-hole on the chimney of the Bunsen burner can be opened and closed.

Explain the effect of opening and closing the air-hole of the Bunsen burner on the products of combustion of methane and the harm that using large quantities of methane as a fuel can cause.

(6)

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(Total for Question 9 = 13 marks)



- 10 (a) A student carried out a flame test on a sample of solid potassium chloride.

The student followed this method.

**step 1** dip a dry wooden splint into water

**step 2** then dip the wooden splint into the sample of potassium chloride

**step 3** hold the wooden splint in a roaring Bunsen burner flame

**step 4** observe the colour seen in the flame.

- (i) The student made the following observation and conclusion.

*'I saw that the flame colour was yellow so the sample must contain sodium ions.'*

Due to the way the student carried out the experiment, this is not a valid conclusion.

Explain **one** improvement that the student could make to their method to obtain a valid conclusion.

(2)

improvement

reason

- (ii) What colour should the student have seen in the flame if the test had been carried out correctly?

(1)

- A** blue-green
- B** lilac
- C** orange-red
- D** red

- (b) A sample of the potassium chloride was also tested for chloride ions.

Describe the test for chloride ions.

(3)

- (c) (i) A student was asked to test a sample of aluminium sulfate for sulfate ions.

The student needed  $25\text{ cm}^3$  of barium chloride solution of concentration  $83\text{ g dm}^{-3}$  for the test.

Calculate the mass of barium chloride that must be dissolved in water to make  $25\text{ cm}^3$  of solution of this concentration.

Give your answer to 2 significant figures.

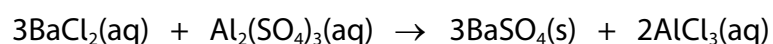
(3)

mass of barium chloride =

g

- (ii) When the barium chloride solution was added to the aluminium sulfate solution, a precipitate was formed.

The balanced equation for this reaction is



Write the ionic equation for this reaction.

(3)

(Total for Question 10 = 12 marks)

**TOTAL FOR PAPER = 100 MARKS**

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[illegible]

*The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.*