

Please check the examination details below before entering your candidate information

Candidate surname

Other names

Pearson Edexcel
International GCSE (9–1)

Centre Number

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Candidate Number

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Thursday 14 January 2021

Morning (Time: 1 hour 15 minutes)

Paper Reference **4CH1/2CR**

Chemistry

Unit: 4CH1

Paper: 2CR

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.*
- Show all the steps in any calculations and state the units.
- Some questions must be answered with a cross in a box . If you change your mind about an answer, put a line through the box and then mark your new answer with a cross .

Information

- The total mark for this paper is 70.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Write your answers neatly and in good English.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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The Periodic Table of the Elements

| | | | | | | | | |
|------------------------------------|-------------------------------------|--------------------------------------|--|------------------------------------|---------------------------------------|--------------------------------------|--------------------------------------|---------------------------------------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 0 | |
| 7 Li lithium 3 | 9 Be beryllium 4 | 11 Na sodium 11 | 12 C carbon 6 | 13 Al aluminium 13 | 14 N nitrogen 7 | 15 O oxygen 8 | 16 F fluorine 9 | 17 Ne neon 10 |
| 19 K potassium 19 | 20 Ca calcium 20 | 23 Sc scandium 21 | 24 Ti titanium 22 | 25 V vanadium 23 | 26 Cr chromium 24 | 27 Mn manganese 25 | 28 Fe iron 26 | 29 Co cobalt 27 |
| 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 |
| 55 Cs caesium 55 | 56 Ba barium 56 | 57 La* lanthanum 57 | 72 Hf hafnium 72 | 73 Ta tantalum 73 | 74 W tungsten 74 | 75 Re rhenium 75 | 76 Os osmium 76 | 77 Ir iridium 77 |
| 87 Fr francium 87 | 88 Ra radium 88 | 89 Ac* actinium 89 | 104 Rf rutherfordium 104 | 105 Db dubnium 105 | 106 Sg seaborgium 106 | 107 Bh bohrium 107 | 108 Hs hassium 108 | 109 Mt meitnerium 109 |
| 133 Cs caesium 55 | 137 Ba barium 56 | 139 La* lanthanum 57 | 178 Hf hafnium 72 | 181 Ta tantalum 73 | 184 W tungsten 74 | 186 Re rhenium 75 | 190 Os osmium 76 | 192 Ir iridium 77 |
| 209 Bi bismuth 83 | 207 Pb lead 82 | 209 Bi bismuth 83 | 204 Tl thallium 81 | 201 Hg mercury 80 | 197 Au gold 79 | 195 Pt platinum 78 | 199 Ir iridium 77 | 200 Hg mercury 80 |
| 122 Sb antimony 51 | 119 Sn tin 50 | 112 Cd cadmium 48 | 106 Pd palladium 46 | 103 Rh rhodium 45 | 108 Ag silver 47 | 106 Pd palladium 46 | 101 Ru ruthenium 44 | 103 Rh rhodium 45 |
| 127 I iodine 53 | 128 Te tellurium 52 | 112 Cd cadmium 48 | 106 Pd palladium 46 | 103 Rh rhodium 45 | 108 Ag silver 47 | 106 Pd palladium 46 | 101 Ru ruthenium 44 | 103 Rh rhodium 45 |
| 85 At astatine 85 | 84 Po polonium 84 | 80 Hg mercury 80 | 78 Pt platinum 78 | 77 Ir iridium 77 | 79 Au gold 79 | 78 Pt platinum 78 | 76 Os osmium 76 | 77 Ir iridium 77 |
| 36 Kr krypton 36 | 35 Br bromine 35 | 30 Zn zinc 30 | 28 Ni nickel 28 | 27 Co cobalt 27 | 29 Cu copper 29 | 28 Ni nickel 28 | 26 Fe iron 26 | 27 Co cobalt 27 |
| 36 Kr krypton 36 | 35 Br bromine 35 | 30 Zn zinc 30 | 28 Ni nickel 28 | 27 Co cobalt 27 | 29 Cu copper 29 | 28 Ni nickel 28 | 26 Fe iron 26 | 27 Co cobalt 27 |
| 18 Ar argon 18 | 17 Cl chlorine 17 | 16 S sulfur 16 | 14 N nitrogen 7 | 13 Al aluminium 13 | 14 Si silicon 14 | 15 P phosphorus 15 | 16 S sulfur 16 | 17 Cl chlorine 17 |
| 2 He helium 2 | 10 Ne neon 10 | 18 Ar argon 18 | 36 Kr krypton 36 | 54 Xe xenon 54 | 86 Rn radon 86 | 118 Og oganesson 118 | 118 Og oganesson 118 | 118 Og oganesson 118 |

1
H
hydrogen
1

relative atomic mass
atomic symbol
name
atomic (proton) number

* The lanthanoids (atomic numbers 58–71) and the actinoids (atomic numbers 90–103) have been omitted.

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

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Answer ALL questions.

1 Substances can exist as solids, liquids or gases.

(a) (i) Give the change of state that occurs when a substance melts.

(1)

(ii) Complete the word equation for the sublimation of iodine.

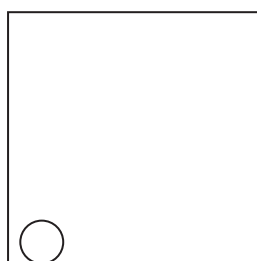
iodine (s) → iodine (.....)

(1)

(b) The circle in the diagram represents a particle.

Complete the diagram to show the arrangement of particles in a gas.

(1)



(c) The table lists some statements about particles.

Place ticks (✓) in boxes to show which two statements are correct for water particles.

(2)

| Statement | Tick |
|--|------|
| the particles only vibrate | |
| the particles do not move | |
| the particles have no gaps between them | |
| the particles move randomly | |
| the particles have more energy than in ice | |
| the particles have a regular arrangement | |

(Total for Question 1 = 5 marks)

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2 This question is about elements in Group 7 and their compounds.

The table gives information about some of these elements.

| Element | Symbol | Melting point in °C | Boiling point in °C | Colour at room temperature (20 °C) |
|----------|--------|---------------------|---------------------|------------------------------------|
| fluorine | F | -220 | -188 | |
| chlorine | Cl | -101 | -35 | pale green |
| bromine | Br | -7 | 59 | red-brown |
| iodine | I | 114 | 184 | grey |

(a) (i) Predict the colour of fluorine at room temperature.

(1)

(ii) How many of the elements in the table are liquids at room temperature (20 °C)?

(1)

- A 0
- B 1
- C 2
- D 3

(iii) The element astatine is below iodine in Group 7.

Predict the formula of a molecule of astatine.

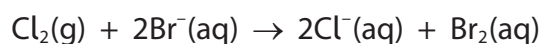
(1)



(b) Sea water contains bromide ions.

Bromine can be obtained by bubbling chlorine through a sample of sea water.

The ionic equation for the reaction is



(i) Explain which species acts as an oxidising agent in this reaction.

(2)

(ii) The reaction occurs because chlorine is more reactive than bromine.

Bromine is below chlorine in Group 7.

Explain the decrease in reactivity from chlorine to bromine.

(3)

(c) Elements in Group 7 react with elements in Group 1 to form ionic compounds.

Which pair of ions both have the electronic configuration 2.8.8?

(1)

- A** Li^+ and Cl^-
- B** K^+ and F^-
- C** Li^+ and F^-
- D** K^+ and Cl^-

(Total for Question 2 = 9 marks)



3 (a) Explain why metals conduct electricity but covalent compounds do not conduct electricity.

(4)

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(b) Hydrogen chloride, HCl, is a covalent substance.

When hydrogen chloride is added to water, a solution of dilute hydrochloric acid is formed.

This solution does conduct electricity.

Name the type of particle in the solution of the dilute hydrochloric acid that allows it to conduct electricity.

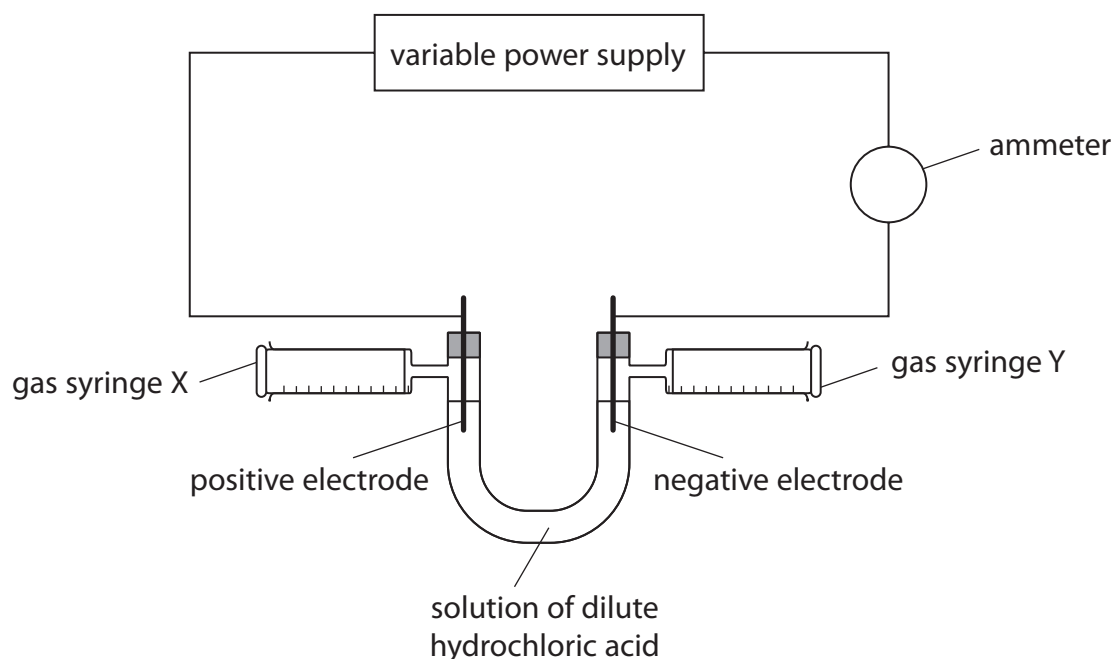
(1)

.....



(c) The teacher uses this apparatus to investigate the electrolysis of a solution of dilute hydrochloric acid.

The ammeter measures the current.



The teacher wants to find out if there is a relationship between current and volume of gas collected at each electrode.

She adjusts the power supply until the current is 0.1 amp.

After 5 minutes she records the volume of gas collected in syringe X and syringe Y.

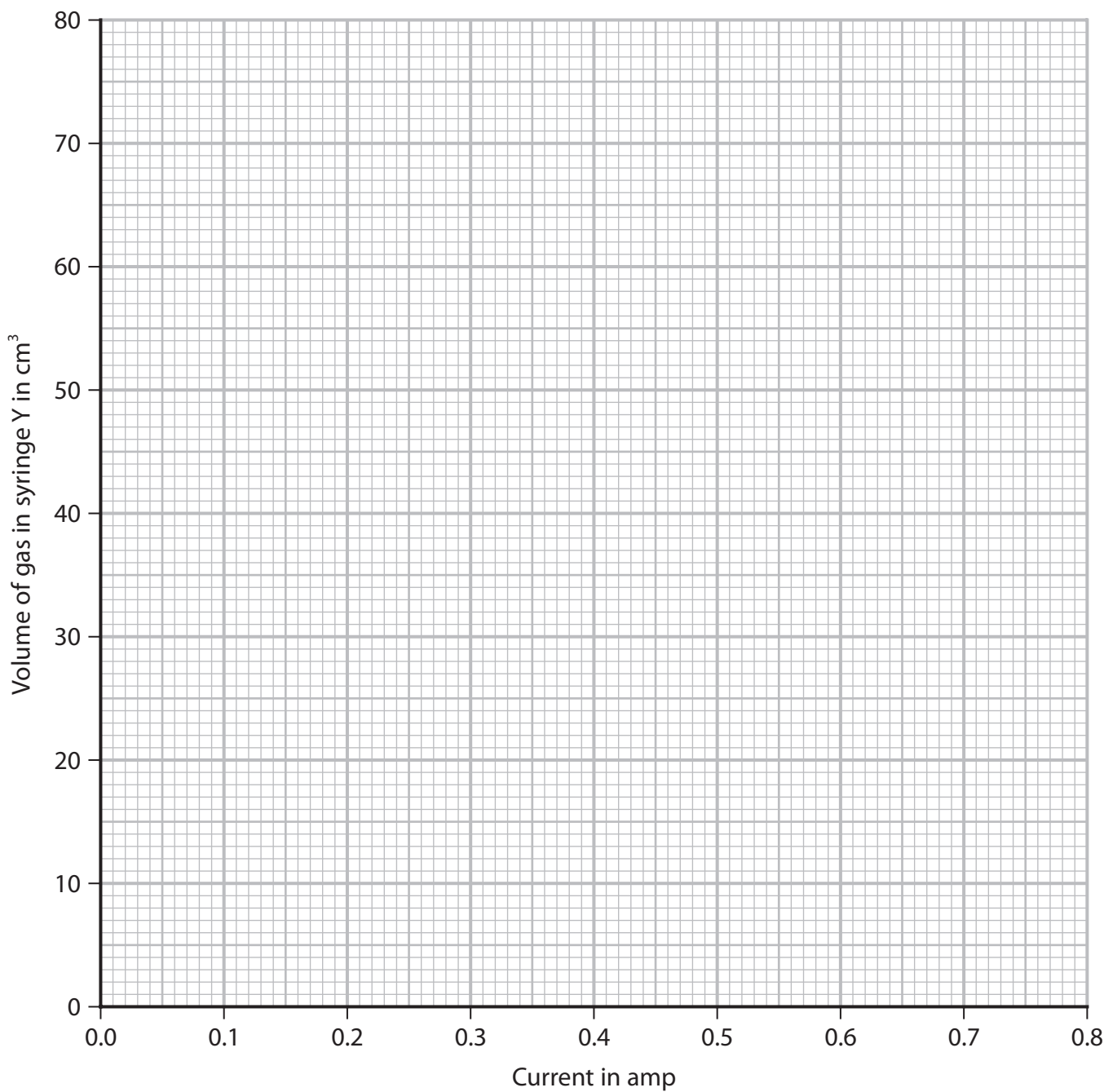
The teacher repeats the experiment several times, using a different current each time.



The table gives the teacher's results for syringe Y.

| Current in amp | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 |
|----------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| Volume of gas in cm ³ | 8 | 15 | 22 | 25 | 37 | 44 | 52 | 60 |

- (i) Plot the results for syringe Y. (1)
- (ii) Draw a circle around the anomalous result. (1)
- (iii) Draw a line of best fit. (1)



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(iv) Explain a possible cause of the anomalous result, other than misreading the apparatus.

(2)

(v) Deduce the relationship between current and volume of gas collected in syringe Y.

(1)

(d) The ionic half-equation for the reaction that produces the gas in syringe X is



The ionic half-equation for the reaction that produces the gas in syringe Y is



(i) Suggest how these ionic half-equations show that the volume of chlorine collected in syringe X should be the same as the volume of hydrogen collected in syringe Y.

(1)

(ii) Suggest why the volume of chlorine collected in syringe X is always less than the volume of hydrogen collected in syringe Y.

(1)

(Total for Question 3 = 13 marks)

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4 This question is about alcohols, carboxylic acids and esters.

(a) The table gives information about some alcohols.

| Alcohol | Structural formula | Relative formula mass |
|----------|----------------------------------|-----------------------|
| methanol | CH ₃ OH | 32 |
| ethanol | C ₂ H ₅ OH | |
| | C ₄ H ₉ OH | 74 |

Complete the table by giving the missing information.

(2)

(b) Ethanol can be oxidised to ethanoic acid by heating with potassium dichromate(VI) and another reagent.

(i) Name the other reagent.

(1)

(ii) State the colour change that occurs during this reaction.

(1)

from to

(c) Alcohols react with carboxylic acids to form esters.

(i) Name the ester that forms when ethanol reacts with ethanoic acid.

(1)

(ii) Complete the equation for the reaction between methanol and ethanoic acid.

(2)

CH₃OH + → + H₂O

(Total for Question 4 = 7 marks)



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- 5 Hydrogen peroxide solution decomposes slowly at room temperature to form water and oxygen.

The equation for the reaction is



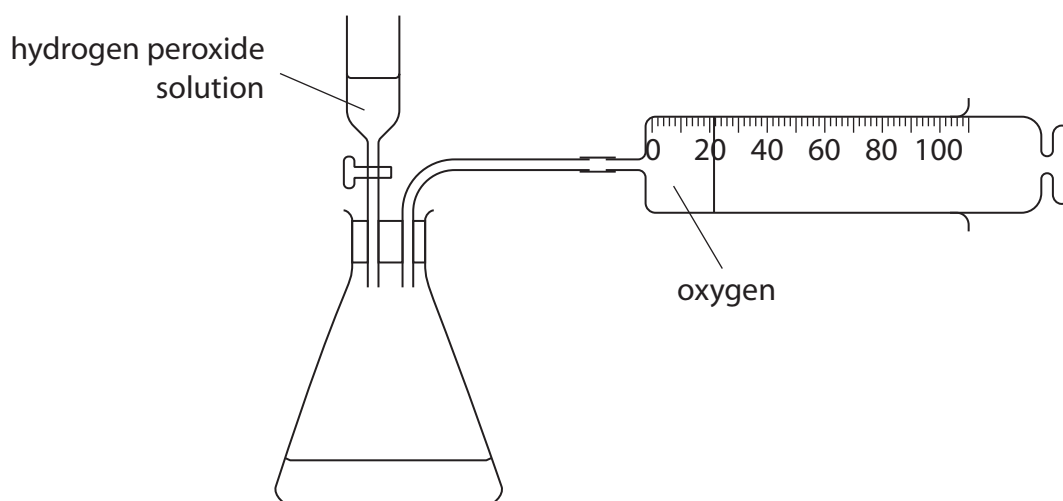
- (a) A catalyst increases the rate of this reaction.

State one other property of a catalyst.

(1)

- (b) A student has samples of three solids, X, Y and Z.

The student uses this apparatus to find out which solids act as catalysts in the decomposition of hydrogen peroxide solution.



Describe the method that the student should use to find out which solids act as catalysts.

(6)

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Area with horizontal dotted lines for writing the answer.

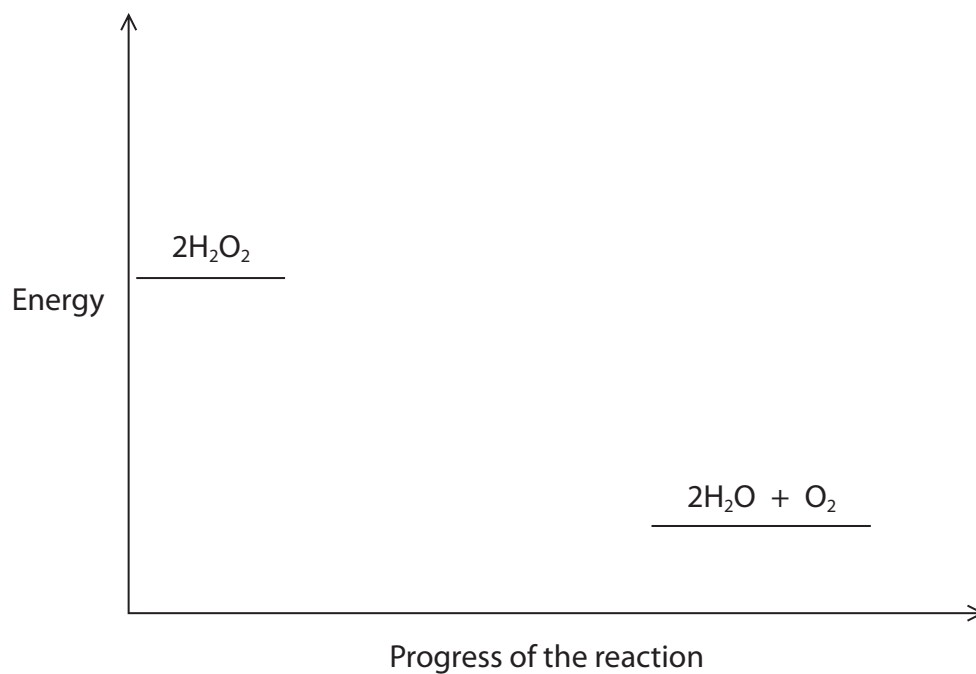


(c) The decomposition of hydrogen peroxide solution is exothermic.

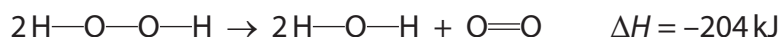
On the diagram, draw and label the reaction profiles for the reaction

- without a catalyst
- with a catalyst

(2)



(d) The equation for the reaction can be shown using displayed formulae.



The table gives the bond energies for two of the bonds.

| Bond | Bond energy in kJ/mol |
|------|-----------------------|
| H—O | 463 |
| O—O | 146 |

(i) Use this information to calculate the total amount of energy needed to break all the bonds in two moles of H_2O_2

(1)

energy needed = kJ

(ii) Use this information to calculate the total amount of energy released when all the bonds in two moles of H_2O are formed.

(1)

energy released = kJ

(iii) Use the value of ΔH and your answers for (i) and (ii) to calculate the bond energy, in kJ/mol, for the $\text{O}=\text{O}$ bond.

(2)

bond energy = kJ/mol

(Total for Question 5 = 13 marks)



- 6 A student does a titration using dilute sulfuric acid to find the concentration of a solution of potassium hydroxide.

The student adds 25.0 cm^3 of the potassium hydroxide solution to a conical flask. He then adds a few drops of methyl orange indicator.

The student does the titration four times.

- (a) (i) Name the piece of apparatus the student should use to add the potassium hydroxide solution. (1)

- (ii) What is the colour of methyl orange in an alkaline solution? (1)

- A blue
 B orange
 C red
 D yellow

- (b) The table shows the student's results.

| titration | 1 | 2 | 3 | 4 |
|---------------------------------------|-------|-------|-------|-------|
| volume of acid added in cm^3 | 20.65 | 20.60 | 20.90 | 20.55 |
| concordant results | | | | |

Concordant results are those within 0.20 cm^3 of each other.

- (i) Place ticks (\checkmark) in the table to show which results are concordant. (1)

- (ii) Use the concordant results to calculate the mean (average) volume of acid added. (2)

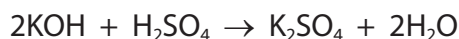
mean volume = cm^3



(c) This table shows the student's results for another titration.

| | |
|--|--------|
| volume of potassium hydroxide solution used in cm^3 | 25.0 |
| concentration of potassium hydroxide solution in mol/dm^3 | 0.0370 |
| mean volume of sulfuric acid added in cm^3 | 21.20 |

The equation for the reaction is



- (i) Calculate the amount, in moles, of KOH in 25.0 cm^3 of the potassium hydroxide solution.

(2)

amount of KOH = mol

- (ii) Calculate the amount, in moles, of H_2SO_4 in 21.20 cm^3 of sulfuric acid.

(1)

amount of H_2SO_4 = mol

- (iii) Calculate the concentration, in mol/dm^3 , of the sulfuric acid.

(2)

concentration of sulfuric acid = mol/dm^3

(Total for Question 6 = 10 marks)



7 A sample of a gaseous hydrocarbon, X, has a volume of 600 cm^3 at room temperature and pressure (rtp).

(a) Calculate the amount, in moles, of hydrocarbon X in the sample.

[molar volume of a gas = $24\,000 \text{ cm}^3$ at rtp]

(2)

amount of hydrocarbon X = mol

(b) The mass of the sample of hydrocarbon X is 1.45 g.

Show that the relative molecular mass (M_r) of X is 58

(2)

$M_r = \dots\dots\dots$

(c) Hydrocarbon X is an alkane.

Show that the molecular formula of X is C_4H_{10}

(1)

(d) Give the displayed formula of the branched-chain isomer of hydrocarbon X.

(1)

(Total for Question 7 = 6 marks)



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8 This question is about ammonia gas, NH_3

(a) Ammonia can be prepared in a laboratory from the reaction between ammonium chloride, NH_4Cl , and sodium hydroxide. The other products of the reaction are sodium chloride and water.

(i) Give a chemical equation for this reaction.

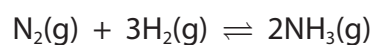
(1)

(ii) Give a test for ammonia gas.

(2)

(b) In industry, ammonia is produced from nitrogen and hydrogen.

The equation for this reaction is



In a sealed container, the reaction can reach a position of dynamic equilibrium.

Explain the meaning of the term **dynamic equilibrium**.

(2)

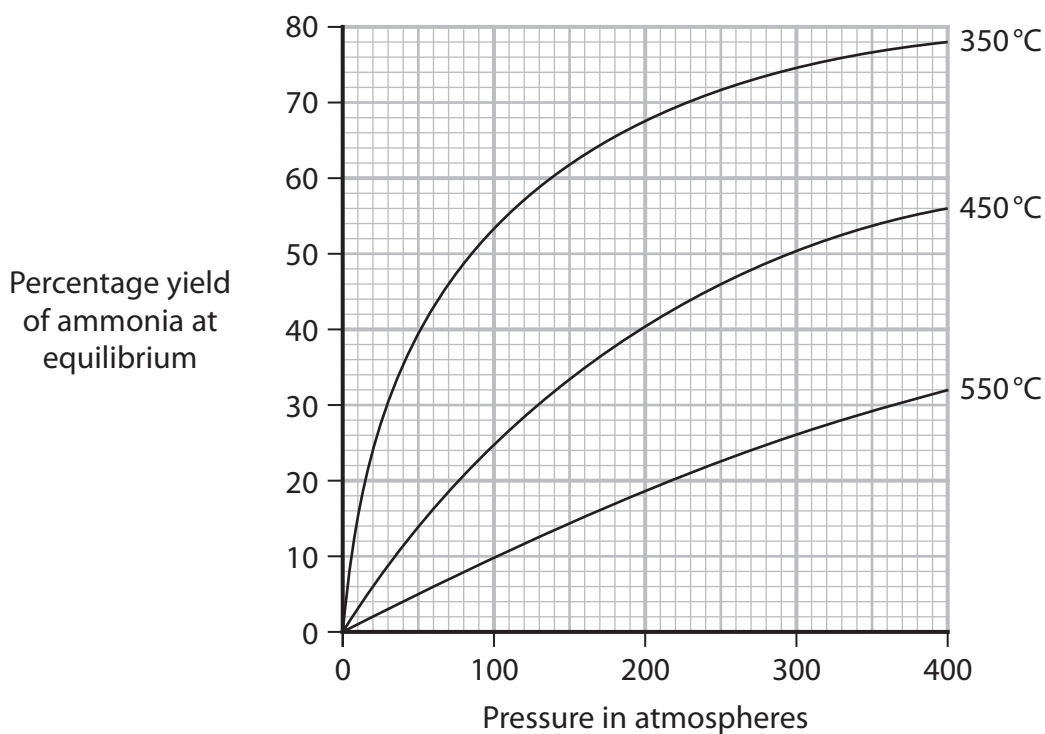


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(c) The graph shows the percentage yield of ammonia at equilibrium for different temperatures and pressures.



Using the graph, explain if the forward reaction is exothermic or endothermic.

(2)

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(Total for Question 8 = 7 marks)

(TOTAL FOR PAPER = 70 MARKS)

