Write your name here

Surname	Other names

Pearson Edexcel International GCSE

Centre Number

Candidate Number

Chemistry

Unit: 4CH0
Science (Double Award) 4SC0
Paper: 1C

Wednesday 10 January 2018 – Morning
Time: 2 hours

Paper Reference
4CH0/1C
4SC0/1C

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 120.
- 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 ▶

1/1/1/1/1/

Pearson

THE PERIODIC TABLE

Period	1	2					Group						3	4	5	6	7	0
1							1 H Hydrogen 1											4 He Helium 2
2	7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
3	23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
4	39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	63.5 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
5	86 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	99 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
6	133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	179 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
7	223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89															

Key

Relative atomic mass
Symbol
Name
Atomic number

Answer ALL questions.

1 Use the Periodic Table on page 2 to help you answer this question.

(a) Give the symbol of the element that has an atomic number of 14.

(1)

....

(b) Give the symbol of the element that has a relative atomic mass of 14.

(1)

....

(c) Give the number of the group that contains the noble gases.

(1)

....

(d) Identify the group whose atoms form ions with a charge of +1.

(1)

☒ **A** 1

☒ **B** 2

☒ **C** 6

☒ **D** 7

(e) Identify the group whose atoms form ions with a charge of –1.

(1)

☒ **A** 1

☒ **B** 2

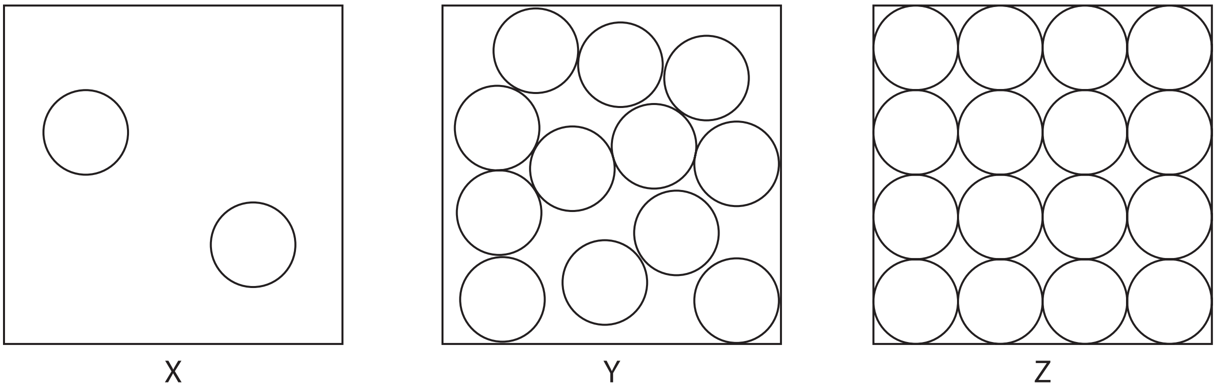
☒ **C** 6

☒ **D** 7

(Total for Question 1 = 5 marks)

2 The diagram shows the arrangement of particles in the three states of matter.

Each circle represents a particle.



(a) Use the letters X, Y and Z to give the starting and finishing states of matter for each of the changes in the table.

The first one has been done for you.

(3)

Change	**Starting state**	**Finishing state**
ice to water	Z	Y
solid iodine to iodine gas		
molten iron to solid iron		
ethene to poly(ethene)		

(b) Which of these changes takes place when solid iodine is heated to form iodine gas?

(1)

☒ **A** crystallisation

☒ **B** evaporation

☒ **C** melting

☒ **D** sublimation

(Total for Question 2 = 4 marks)

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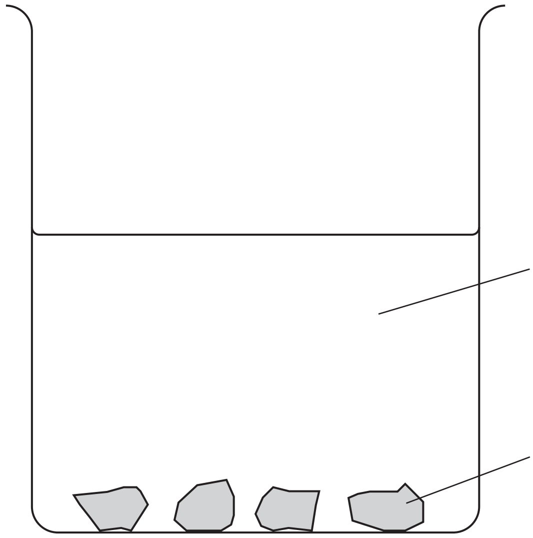
3 A student places a few purple crystals at the bottom of a beaker containing some cold water.

The crystals start to dissolve.



(a) State how the appearance of the crystals and the water change as the crystals dissolve.

(2)

crystals ....

....

water ....

....

(b) Which process occurs as the crystals dissolve to form a solution?

(1)

☒ **A** condensation

☒ **B** crystallisation

☒ **C** diffusion

☒ **D** melting

(c) The student repeats the experiment using hot water instead of cold water.

(i) State how the change in the appearance of the water differs when hot water is used instead of cold water.

(1)

....

....

(ii) Explain, in terms of particles, why the change differs when hot water is used instead of cold water.

(2)

....

....

....

....

(Total for Question 3 = 6 marks)

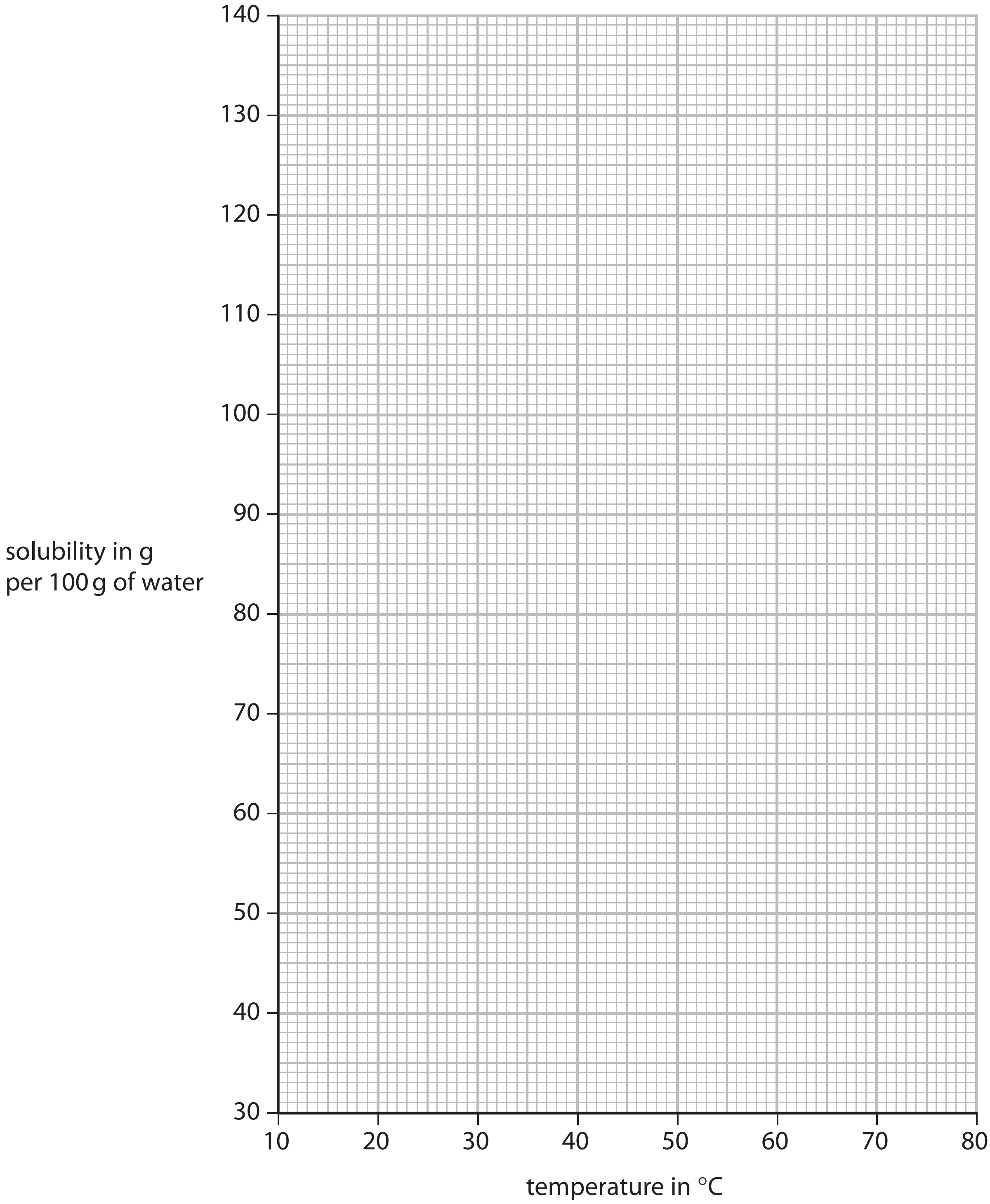
4 The maximum mass of a solid that dissolves in 100 g of water at a given temperature is called its solubility.

The table gives the solubility of potassium nitrate at six different temperatures.

Temperature in °C	20	30	40	50	60	70
Solubility in g per 100 g of water	41	52	65	83	106	135

(a) Plot the points on the grid and draw a curve of best fit.

(3)



(b) Extend your curve to find the solubility of potassium nitrate at 10 °C.

(2)

solubility = ... g per 100 g of water

(c) Use your graph to find the maximum mass of potassium nitrate that could dissolve in 50 g of water at 35 °C.

(2)

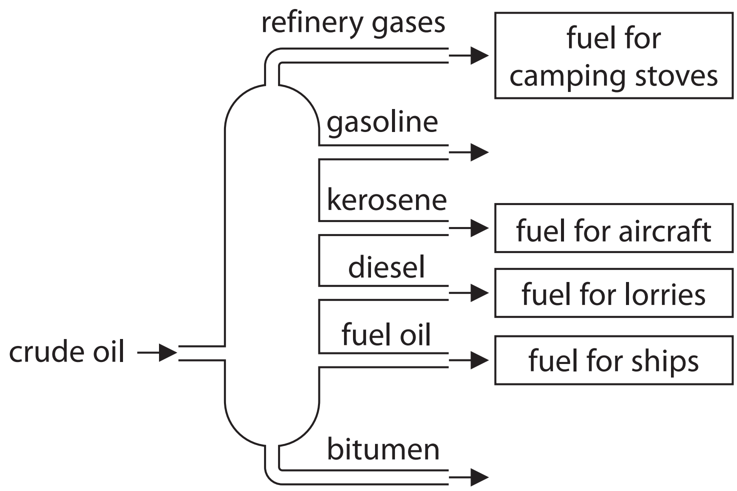
maximum mass = ... g

(Total for Question 4 = 7 marks)

5 Crude oil is a liquid that contains a mixture of many hydrocarbons.

The diagram shows a fractionating column used in the distillation of crude oil.

The six fractions obtained are shown. One use for each of four of the fractions is also shown.



(a) Describe what is done to the crude oil before it enters the fractionating column. **(2)**

....

....

(b) State how the temperature changes from the top of the column to the bottom. **(1)**

....

(c) Give a use for gasoline and a use for bitumen. **(2)**

gasoline ....

bitumen ....

(d) Name the fraction that contains the largest molecules. **(1)**

....

(e) State the physical property that allows the different fractions to be collected at different heights in the column. **(1)**

....

(Total for Question 5 = 7 marks)

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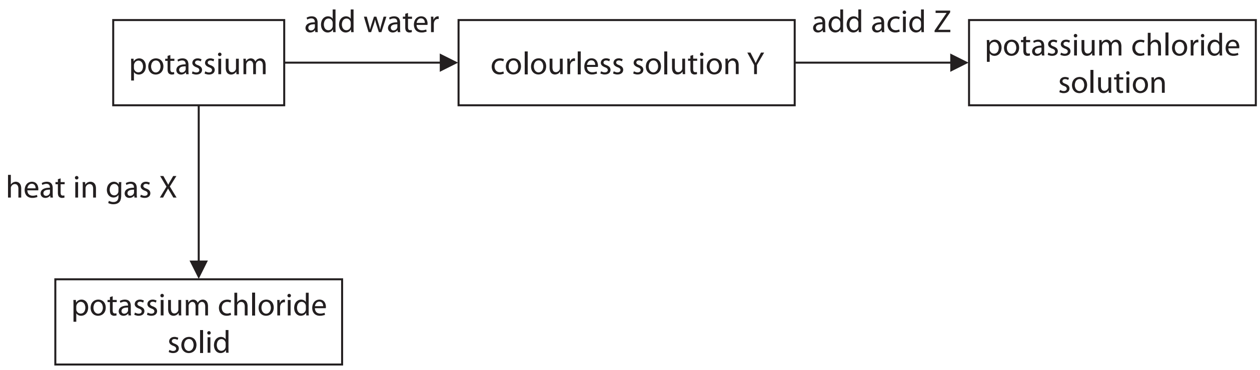
6 This question is about elements in Groups 1 and 7 of the Periodic Table.

(a) The diagram shows two ways in which potassium can be converted into potassium chloride.



Give the names of gas X, colourless solution Y and acid Z.

(3)

gas X ....

colourless solution Y ....

acid Z ....

(b) When sodium is burned in iodine gas, sodium iodide is formed.

(i) Write a chemical equation for the reaction between sodium and iodine.

(1)

....

(ii) Give a test to show that an aqueous solution of sodium iodide contains iodide ions.

(3)

test for iodide ions ....

....

....

observation ....

(Total for Question 6 = 7 marks)

7 Copper pyrites is an ore of copper that contains copper, iron and sulfur.

(a) The percentage composition by mass of copper pyrites is

Cu 34.60% Fe 30.52% S 34.88%

Show, by calculation, that the empirical formula of copper pyrites is $CuFeS_2$

(3)

(b) Copper is obtained from copper pyrites in a two-stage process.

Stage 1 Copper pyrites is heated in air.

$$2CuFeS_2 + 3O_2 \rightarrow 2CuS + 2FeO + 2SO_2$$

Stage 2 The copper(II) sulfide is separated and then heated in air. It reacts with oxygen to form copper and sulfur dioxide.

(i) State why the sulfur in the reaction in stage 1 is described as being oxidised.

(1)

....

....

(ii) Write a chemical equation for the reaction that occurs in stage 2.

(1)

....

(c) Sulfur dioxide dissolves in water to form an acidic solution.

(i) Identify the ion that causes this solution to be acidic.

(1)

....

(ii) State how litmus paper can be used to show that the solution is acidic.

(1)

....

....

(iii) Give two observations that are made when a piece of magnesium ribbon is added to the acidic solution.

(2)

1 ....

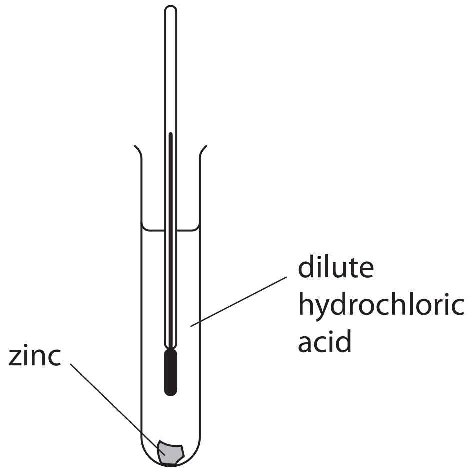
....

2 ....

....

(Total for Question 7 = 9 marks)

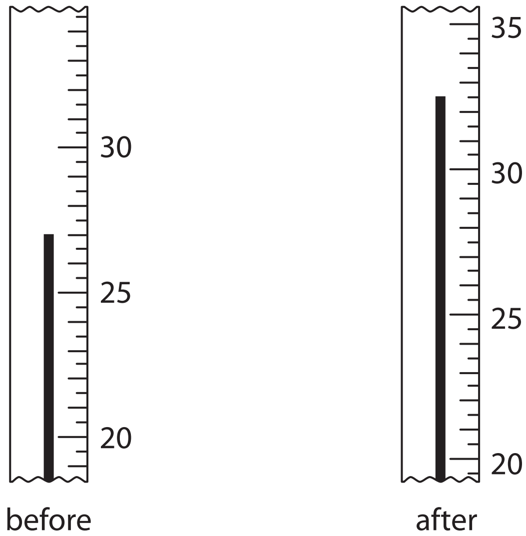
8 In an experiment, a student adds a piece of zinc to some dilute hydrochloric acid in a test tube.



The student measures the temperature before adding the zinc.

After adding the zinc, he stirs the mixture and measures the highest temperature reached.

The diagram shows his results.



(a) Use the readings to complete the table, giving all values to the nearest 0.5 °C.

(2)

Temperature in °C after adding the zinc	
Temperature in °C before adding the zinc	27.0
Change in temperature in °C	

P 5 3 2 7 5 A 0 1 4 3 2

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(b) The student wants to find out if there is a relationship between the reactivity of a metal and the temperature rise.

He repeats the experiment four times, using a different metal each time.

The table shows his results.

Metal added	**Temperature rise in °C**
magnesium	7.5
gold	0.0
iron	3.0
calcium	10.5

(i) State three factors that the student should keep constant in each experiment.

(3)

1 ....

2 ....

3 ....

(ii) Using information from the table, state the relationship between the reactivity of a metal and the temperature rise.

(1)

....

....

(iii) State why there is no temperature rise when gold is added to the acid.

(1)

....

....

(Total for Question 8 = 7 marks)

9 The ions present in ionic compounds can be identified using simple tests.

- some cations (positive ions) can be identified using a flame test
- some anions (negative ions) can be identified by observing reactions in solutions of the compounds

Table 1 shows the flame test colours for four cations.

Cation	Flame test colour
caesium	blue
rubidium	violet
strontium	red
tantalum	blue

Table 1

Table 2 shows the results of three tests used to identify anions in solution.

Anion	Test and Result		
	Hydrochloric acid added	Magnesium chloride solution added	Methyl orange added
carbonate	effervescence	white precipitate forms	yellow
chloride	no change	no change	orange
hydrogencarbonate	effervescence	no change	yellow
hydrogensulfate	no change	no change	red
hydroxide	no change	white precipitate forms	yellow

Table 2

Use the information in the tables to answer these questions.

(a) In the tests, compound X gives a red flame and produces effervescence when hydrochloric acid is added.

Suggest two possible identities for compound X.

(2)

1 ....

2 ....

(b) (i) In the tests, compound Y gives a blue flame and produces a yellow colour when methyl orange is added.

A student concludes that compound Y is tantalum hydroxide.

Give two reasons why this conclusion may not be correct.

(2)

1 ....

....

2 ....

....

(ii) Which additional test from Table 2 would show that the only anion in compound Y is the hydroxide ion?

(1)

....

....

(c) An aqueous solution contains either carbonate ions or hydrogencarbonate ions.

Using only information from the tables, explain how you could decide if the solution contains carbonate or hydrogencarbonate ions.

(3)

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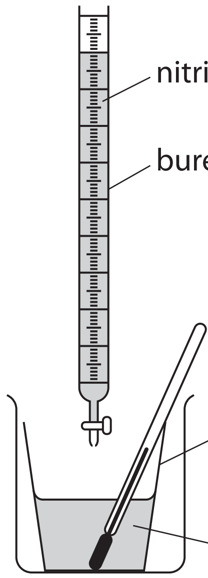
....

(Total for Question 9 = 8 marks)

10 A student uses this apparatus to investigate the heat energy released when nitric acid is added to potassium hydroxide solution.



She uses this method.

- put 25.0 cm^3 of potassium hydroxide solution into the polystyrene cup
- measure the temperature of the potassium hydroxide solution
- add 5.00 cm^3 of nitric acid from the burette
- stir the mixture and measure the highest temperature reached
- add further 5.00 cm^3 samples of nitric acid, stir and measure the highest temperature reached after each addition

(a) Name the piece of apparatus that should be used to measure the 25.0 cm^3 of potassium hydroxide solution.

(1)

....

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

Total volume of acid added in cm^3	0.00	5.00	10.00	15.00	20.00	25.00	30.00
Highest temperature reached in °C	18.0	22.0	25.0	29.0	31.0	37.0	40.00

(i) The result for 20.00 cm^3 of acid is anomalous.

Suggest two possible mistakes, other than misreading the thermometer, that the student might have made to produce the anomalous result.

(2)

1 ....

....

2 ....

....

(ii) Suggest a true value for the temperature when 20.00 cm^3 of acid is added.

(1)

....

(c) In another experiment, the student records these results.

volume of potassium hydroxide solution	25.0 cm^3
starting temperature of potassium hydroxide solution	16.0 °C
total volume of acid added	25.00 cm^3
highest temperature reached by the mixture	35.0 °C

Calculate the heat energy released using the equation

$$Q = m \times 4.18 \times \Delta T$$

Q = the heat energy released in J
m = mass of the mixture in g
ΔT = change in temperature in °C

[assume mass of 1.00 cm^3 of the mixture is 1.00 g]

(3)

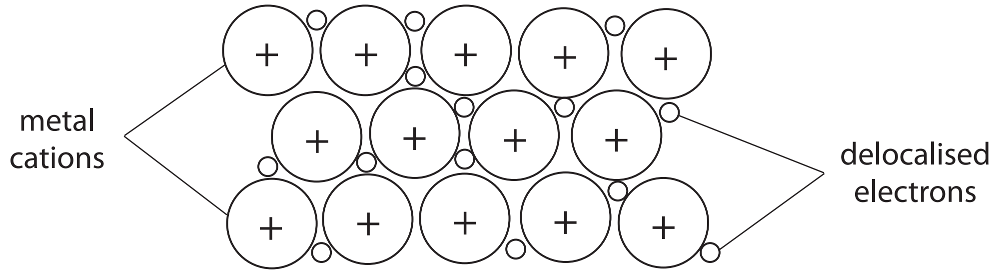
heat energy released = ... J

(Total for Question 10 = 7 marks)

11 This question is about titanium and its compounds.

(a) Titanium is a metal.

The diagram shows the arrangement of the particles in titanium.



(i) State why metals such as titanium are good conductors of electricity.

(1)

....

....

(ii) Explain why metals such as titanium are malleable.

(2)

....

....

....

....

....

....

(b) Titanium(IV) chloride, $TiCl_4$, and titanium(IV) oxide, TiO_2, are both covalent compounds.

$TiCl_4$ is a liquid at room temperature. TiO_2 is a solid with a high melting point.

Explain these properties in terms of the structures of the two compounds.

(5)

....

....

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(c) (i) A mixture of titanium(IV) oxide and carbon reacts with chlorine to form titanium(IV) chloride and carbon dioxide.

Write a chemical equation for this reaction.

(2)

....

(ii) Titanium(IV) chloride reacts with magnesium to form titanium and magnesium chloride, $MgCl_2$

Write a chemical equation for this reaction.

(1)

....

(Total for Question 11 = 11 marks)

12 A mixture of carbon monoxide, carbon dioxide and hydrogen is known in industry as synthesis gas.

Synthesis gas is converted to methanol, CH_3OH, by passing it over a heated solid catalyst.

The equations for the two reactions are

Reaction 1	$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$	$\Delta H = -91$ kJ/mol
Reaction 2	$CO_2(g) + 3H_2(g) \rightleftharpoons CH_3OH(g) + H_2O(g)$	$\Delta H = -49$ kJ/mol

(a) Assume that both reactions reach a position of equilibrium.

(i) For reaction 1, predict whether using a high or a low temperature would produce the higher yield of methanol.

Give a reason for your choice.

(1)

prediction ....

reason ....

....

(ii) For reaction 2, predict whether using a high or a low pressure would produce the higher yield of methanol.

Give a reason for your choice.

(1)

prediction ....

reason ....

....

(b) The catalyst increases the rate of both the forward reaction and the backward reaction.

Suggest why the catalyst has no effect on the position of equilibrium.

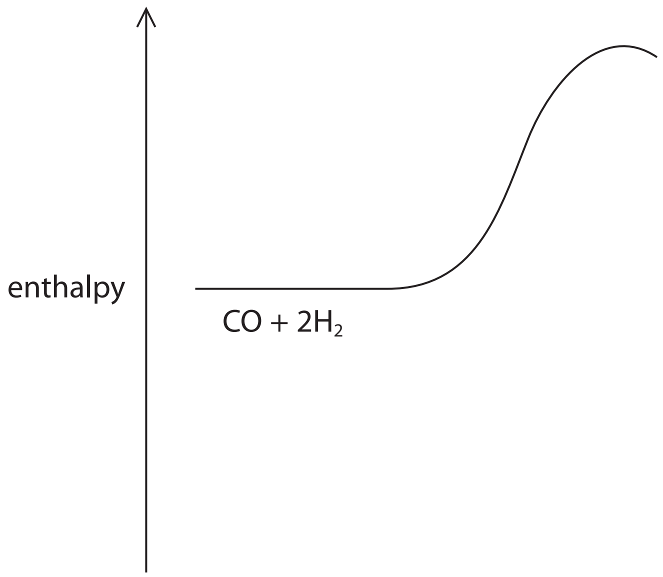
(1)

....

....

....

(c) Reaction 1 can be represented by a reaction profile diagram.



(i) Complete the profile by showing the products of the reaction and the enthalpy change, ΔH, for the reaction.

(2)

(ii) Draw an arrow on the profile to represent the activation energy for the forward reaction.

Label this arrow E.

(1)

(iii) State the effect, if any, of the catalyst on the enthalpy change for the reaction.

(1)

....

(Total for Question 12 = 7 marks)

13 Calcium carbonate decomposes when heated. The equation for the reaction is

$$CaCO_3 \rightarrow CaO + CO_2$$

(a) Calculate the maximum mass of CaO that could be obtained when 20 tonnes of $CaCO_3$ is decomposed.

Give the unit.

[M_r of CaO = 56; M_r of $CaCO_3$ = 100; 1 tonne = 10^6 g]

(3)

mass of CaO = ... unit ....

(b) Slaked lime, $Ca(OH)_2$, forms when water is added to calcium oxide. Give the chemical name of slaked lime.

(1)

....

(c) Slaked lime is often added to soil to raise the pH of the soil.

A chemist neutralises 25.0 cm^3 of 0.500 mol/dm^3 hydrochloric acid with slaked lime.

$$Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$$

(i) Calculate the amount, in moles, of HCl that is neutralised.

(2)

amount of HCl = ... mol

(ii) Calculate the minimum mass, in grams, of $Ca(OH)_2$ required to neutralise the HCl.

[M_r of $Ca(OH)_2$ = 74]

(2)

minimum mass of $Ca(OH)_2$ = ... g

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(d) A clear solution of slaked lime is made by dissolving $Ca(OH)_2$ in an excess of water.

This solution is left exposed to air. The solution slowly goes milky as a faint white precipitate forms.

Explain why a faint white precipitate forms.

(2)

....

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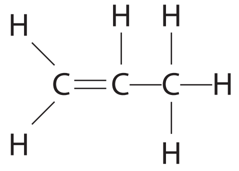
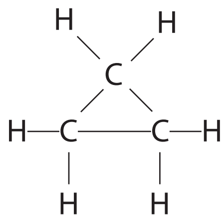
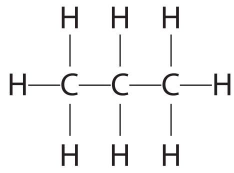
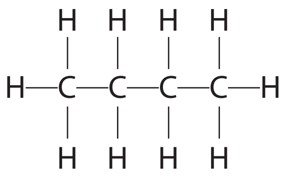
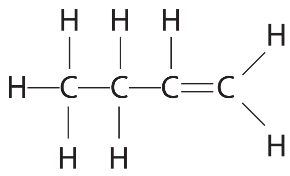
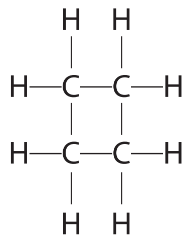
....

....

....

(Total for Question 13 = 10 marks)

14 The table shows the displayed formulae of six hydrocarbons, Q, R, S, T, U and V.

Q 	**R** 	**S** 
T 	**U** 	**V** 

(a) Which two hydrocarbons will instantly decolourise bromine water?

(1)

- ☒ **A** R and V
- ☒ **B** Q and U
- ☒ **C** S and T
- ☒ **D** Q and T

(b) Which two hydrocarbons have the general formula C_nH_{2n+2}?

(1)

- ☒ **A** R and V
- ☒ **B** Q and U
- ☒ **C** S and T
- ☒ **D** Q and T

(c) Which hydrocarbon is an isomer of U?

(1)

- ☒ **A** Q
- ☒ **B** R
- ☒ **C** T
- ☒ **D** V

(d) Which two hydrocarbons have the empirical formula CH_2?

(1)

☒ **A** R and V

☒ **B** Q and S

☒ **C** R and S

☒ **D** T and U

(e) The substitution reaction between hydrocarbon T and bromine is similar to the reaction between methane and bromine.

(i) State a condition, other than temperature, that is required for this reaction to take place.

(1)

....

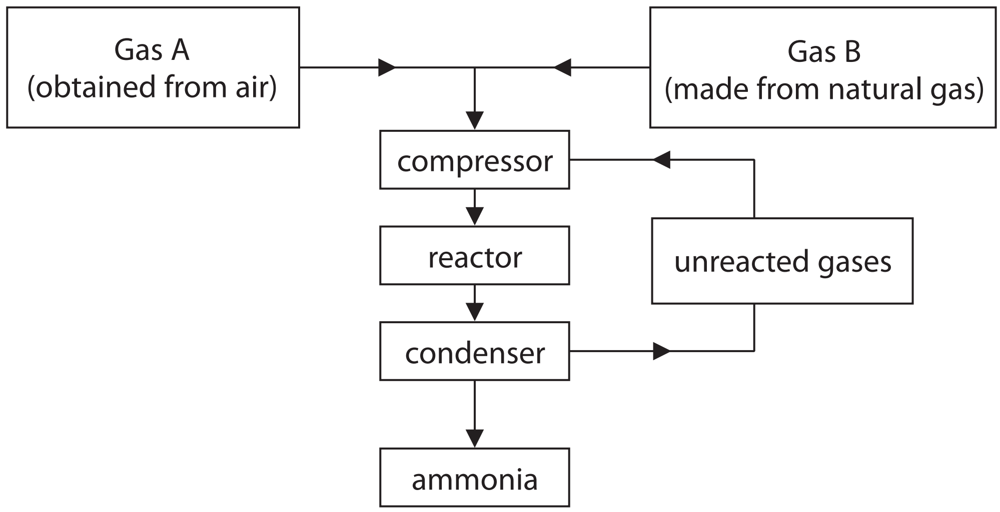
....

(ii) Suggest a displayed formula for a possible organic product of the reaction between hydrocarbon T and bromine.

(1)

(Total for Question 14 = 6 marks)

15 The flow diagram shows the main stages in an industrial process to manufacture ammonia.



(a) Give the name of this industrial process.

(1)

....

(b) Identify gases A and B.

(2)

gas A ....

gas B ....

(c) State the purpose of the condenser.

(1)

....

....

(d) Name the catalyst that is used in the reactor.

(1)

....

(e) Suggest two reasons why the unreacted gases are recycled.

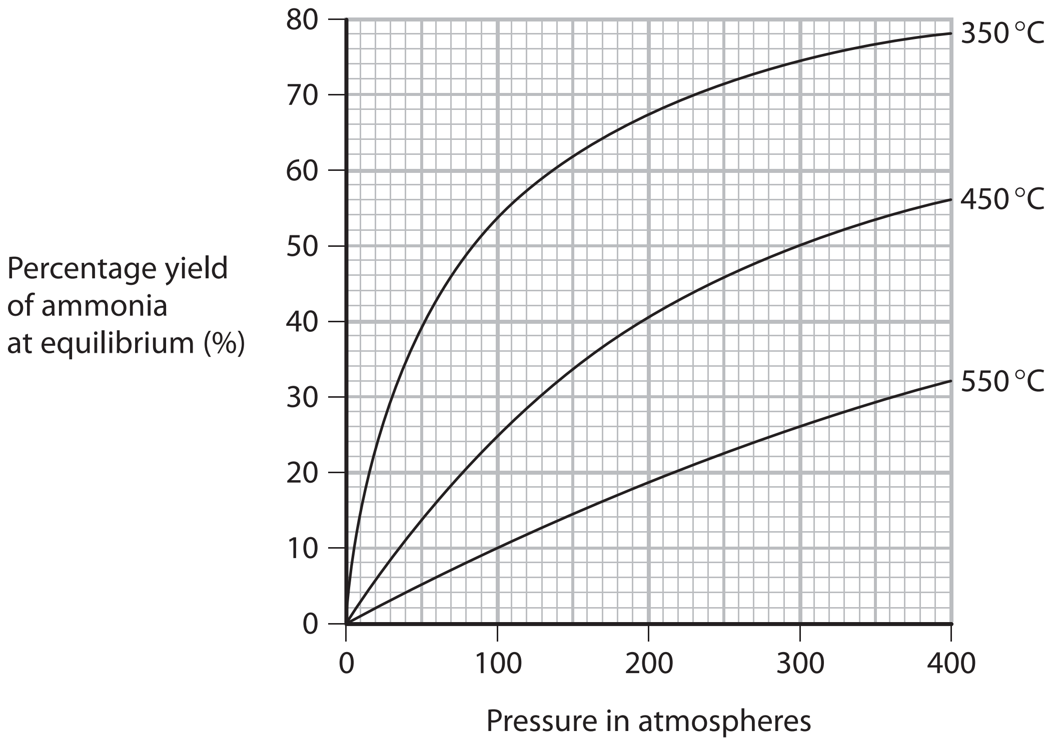
(2)

1 ....

2 ....

(f) The reaction to make ammonia is reversible and can reach a position of equilibrium.

The graph shows the percentage yield of ammonia at equilibrium, and at different temperatures and pressures.



(i) State the conditions of temperature and pressure that would produce the largest percentage yield of ammonia.

(2)

....

....

(ii) Find the percentage yield of ammonia at equilibrium, at a pressure of 200 atmospheres and a temperature of 450 °C.

(1)

....

(iii) Suggest why, in the industrial process, the percentage yield of ammonia at 200 atmospheres and 450 °C is only 15%.

(1)

....

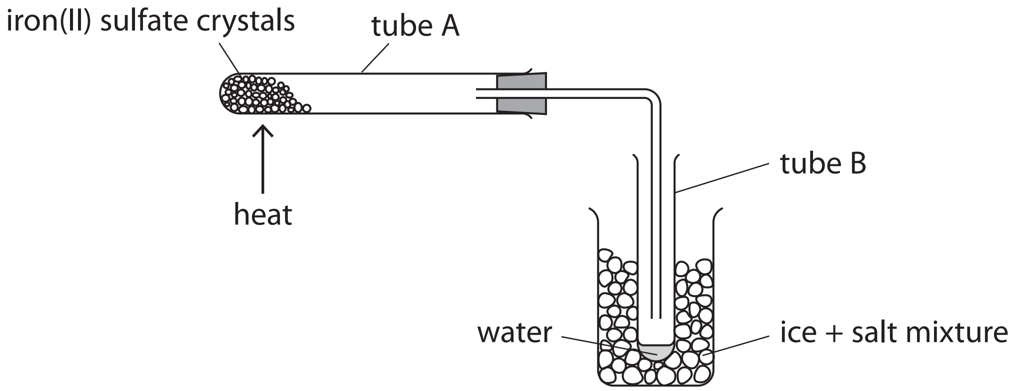
....

(Total for Question 15 = 11 marks)

16 The mineral rozenite contains crystals of hydrated iron(II) sulfate, $FeSO_4.xH_2O$

A student wants to find the value of *x*.

She uses this apparatus to remove and collect the water of crystallisation from a sample of iron(II) sulfate crystals.



She uses this method.

- weigh empty tube A to find its mass
- place a sample of hydrated iron(II) sulfate crystals into tube A and reweigh
- heat tube A
- allow tube A to cool and reweigh
- repeat the process until the mass no longer changes

Heating until the mass no longer changes is known as heating to constant mass.

When iron(II) sulfate crystals are heated gently, they decompose according to this equation.

$$FeSO_4.xH_2O \rightarrow FeSO_4 + xH_2O$$

These are the student's results.

mass of tube A	11.96 g
mass of tube A and $FeSO_4.xH_2O$	17.56 g
mass of tube A and contents after heating to constant mass	15.76 g

(a) State why it is necessary to heat the crystals to constant mass.

(1)

....

....

(b) (i) Calculate the mass of $FeSO_4$ formed after heating to constant mass.

(1)

mass of $FeSO_4$ formed = ... g

(ii) Calculate the mass of water collected in tube B after heating to constant mass.

(1)

mass of water collected = ... g

(iii) Calculate the value for x in the formula $FeSO_4.xH_2O$

Give your answer to the nearest whole number.

[M_r of $FeSO_4$ = 152; M_r of H_2O = 18]

(3)

x = ...

(c) When the student adds the water from tube B to anhydrous copper(II) sulfate, she observes that the mixture gets hot and that there is a colour change from white to blue.

Explain these observations.

(2)

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(Total for Question 16 = 8 marks)

TOTAL FOR PAPER = 120 MARKS

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