MODEL ANSWERS

Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel International GCSE (9–1)

Centre Number | Candidate Number

Time 1 hour 15 minutes

Paper reference **4CH1/2C**

Chemistry

PAPER: 2C

NOVEMBER 2021

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.
- Good luck with your examination.

Turn over ▶

P66059RA

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The Periodic Table of the Elements

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 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
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
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
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **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
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	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112–116 have been reported but not fully authenticated						

Key

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.

P 6 6 0 0 5 9 R A 0 2 2 2 4

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Answer ALL questions.

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

(a) Identify the element with atomic number 7

(1)

nitrogen

(b) Identify a solid non-metallic element in Period 3

(1)

Silicon

(c) Name an element in Group 7 that is a liquid at room temperature.

(1)

bromine

(d) State the relative atomic mass of the element that is in Group 4 and Period 4

(1)

73

(e) Which row shows the most reactive element in Group 1 and Group 7?

(1)

	Most reactive element in Group 1	Most reactive element in Group 7
☐ **A**	lithium	fluorine
☐ **B**	francium	astatine
☐ **C**	lithium	astatine
☒ **D**	francium	fluorine

(Total for Question 1 = 5 marks)

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2 (a) The box lists words that may be used to explain the term **saturated solution**.

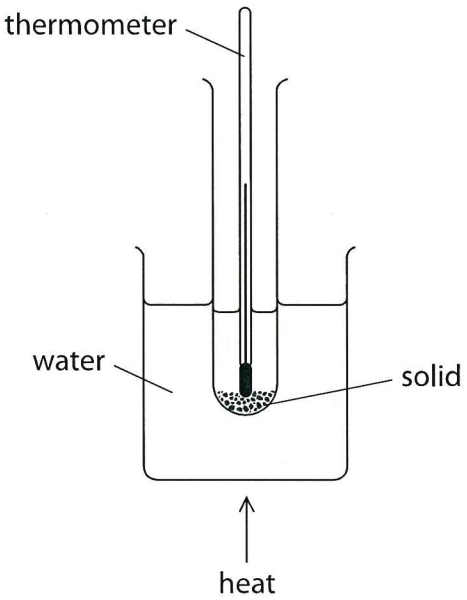
solute	solvent	temperature

Explain, using all the words in the box, the term **saturated solution**.

(2)

Solvent
a ~~solution~~ which contains as much solute as possible at a given temperature

(b) The diagram shows the apparatus a student uses to make a saturated solution.



This is the student's method.

Step 1 add 4.5 g of solid to a boiling tube

Step 2 measure exactly 10.0 cm^3 of pure water and pour into the boiling tube

Step 3 place the boiling tube in the beaker of water and heat gently, stirring the mixture continuously until all the solid dissolves

Step 4 remove the boiling tube from the beaker and allow it to cool

Step 5 record the temperature when crystals start to form in the boiling tube

The recorded temperature shows when the solution becomes saturated.

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(i) Name the piece of apparatus that the student should use in Step 2 to measure exactly 10.0 cm^3 of pure water.

(1)

burette

(ii) Suggest why the boiling tube is not heated directly using a Bunsen burner in Step 3.

(1)

The solution would be heated too quickly

(iii) Suggest how the student could improve the reliability of her recorded temperature in Step 5.

(1)

repeat and find the mean temperature

(iv) In Step 5, crystals start to form at 26 °C.

Calculate the solubility of the solid, in g per 100 g of water, at 26 °C.

[1.0 cm^3 of pure water has a mass of 1.0 g]

(2)

solid water

4.5 g in 10g

∴ 4.5 x10 = 45g in 100g water

solubility = 45 g per 100 g of water

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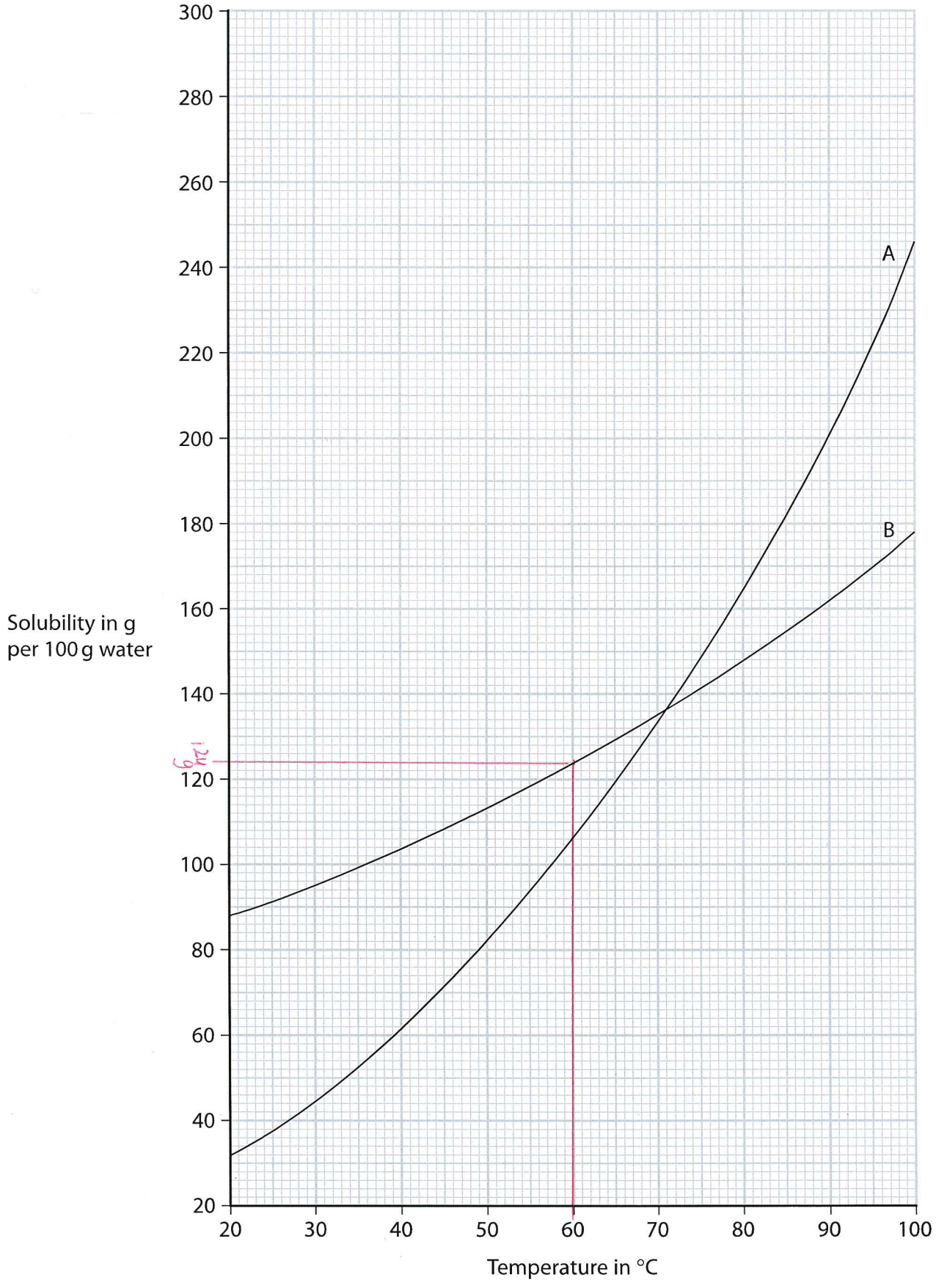
(c) The solubility curves for two solids, A and B, are shown on the grid.



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(i) State the temperature when A and B have the same solubility.

(1)

temperature = 71°C °C

(ii) Calculate the mass of B that will dissolve in 250 g of water at 60 °C.

Show your working.

(2)

124g from graph

solid B

124 in 100g water

124 × 2·5 = 310

mass = 310 g

(iii) Suggest why the values for the solubility of A and B may be less accurate at 95 °C than at lower temperatures.

(1)

Some of the water may have been lost due to evaporation

(Total for Question 2 = 11 marks)

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3 Sulfur dioxide (SO_2) and hydrogen sulfide (H_2S) are both gases.

The two gases react together to form solid sulfur and water.

(a) (i) Complete the chemical equation for the reaction.

(2)

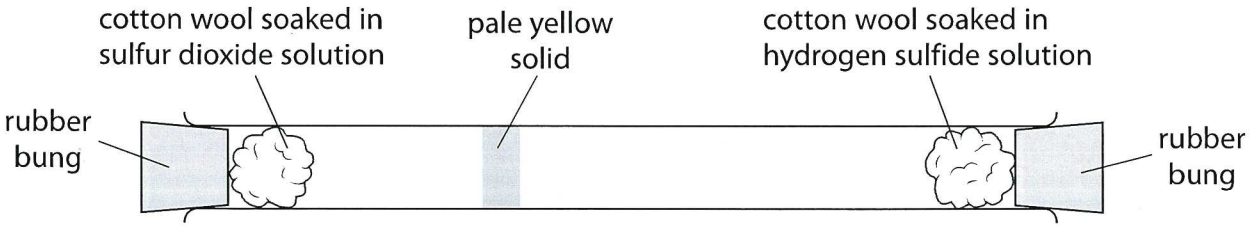
$$2H_2S(\text{g}) + SO_2(\text{g}) \rightarrow 3\,S(s) + 2\,H_2O(\text{l})$$

(ii) State why the sulfur dioxide is reduced in the reaction.

(1)

as sulfur dioxide loses oxygen

(b) The diagram shows apparatus used to compare the speed at which particles of the two gases diffuse.



The two pieces of cotton wool and rubber bungs are put in position at the same time.

A pale yellow solid soon forms.

(i) Explain how the diagram shows that hydrogen sulfide gas diffuses more quickly than sulfur dioxide gas.

(2)

Sulfur solid forms nearer to sulfur dioxide side so hydrogen sulfide particles moved further in the same time

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(ii) Deduce a relationship between the relative formula mass (M_r) of a gas and the speed at which a gas diffuses.

Use the A_r values to help you.

[A_r values: H = 1 S = 32 O = 16]

(3)

M_r of $H_2S = 1 \times 2 + 32 = 34$

M_r of $SO_2 = 32 + 16 \times 2 = 64$

therefore the larger the Mr the slower a gas diffuses

(Total for Question 3 = 8 marks)

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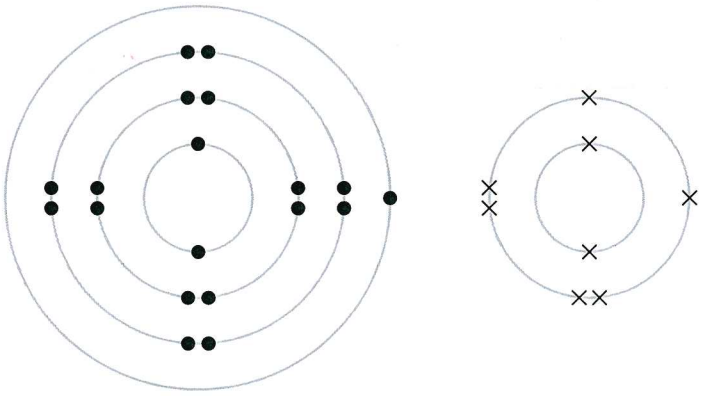
4 This question is about ionic compounds.

(a) State the formula of the cation and the anion in magnesium sulfate.

(2)

cation Mg^{2+} anion SO_4^{2-}

(b) The diagram shows the electronic configuration of a potassium atom and an oxygen atom.



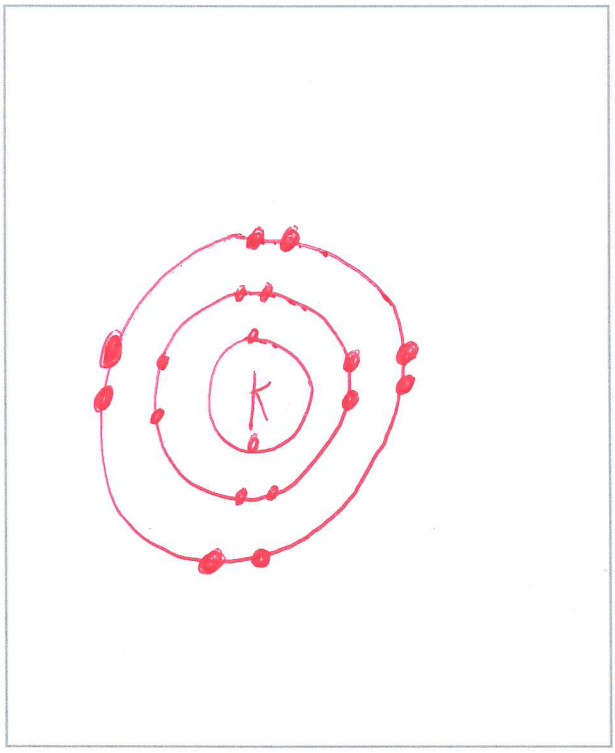
potassium oxygen

Potassium oxide (K_2O) is an ionic compound.

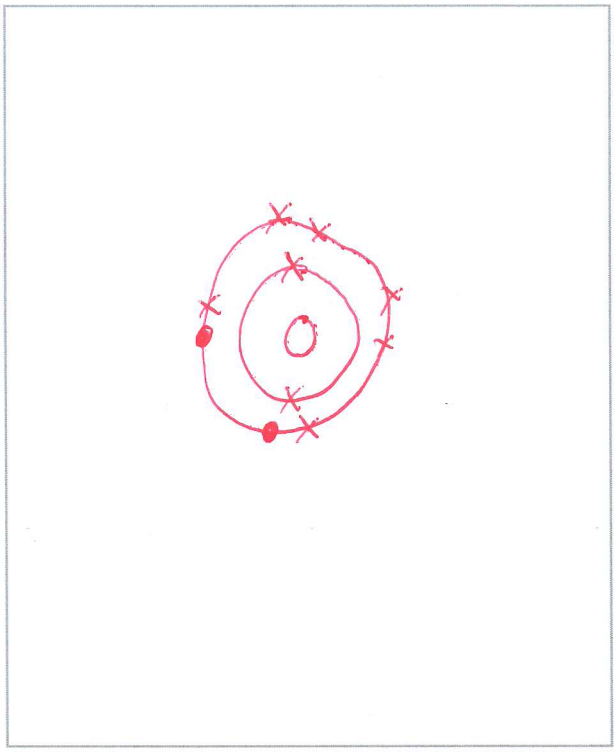
Draw the electronic configuration of a potassium ion and an oxide ion.

Show the charge on each ion.

(3)



potassium ion



oxide ion

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(c) A sample of solid potassium oxide is added to water.

A reaction occurs and a colourless solution forms.

When a few drops of phenolphthalein indicator are added to the solution it turns pink.

(i) Identify the ion responsible for the colour change.

(1)

OH^-

(ii) Give a chemical equation for the reaction between potassium oxide and water.

(1)

$K_2O + H_2O \rightarrow 2KOH$

(d) Explain why ionic compounds conduct electricity when molten or in aqueous solution, but not when in the solid state.

(2)

when molten Ions can move

insolids Ions cannot move

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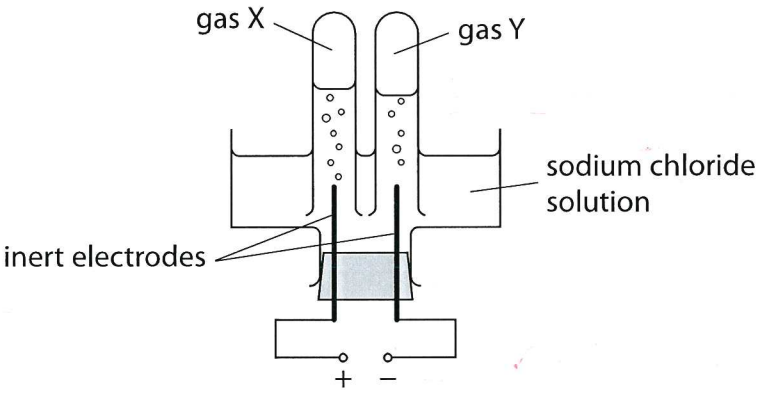
(e) The diagram shows the apparatus a teacher uses to demonstrate the electrolysis of a concentrated aqueous solution of sodium chloride.



During the electrolysis two gases, X and Y, are formed. One of the gases produces a squeaky pop when tested with a lighted splint.

Use ionic half-equations to identify X and Y.

(4)

X is Cl_2

Y is H_2

$2Cl^- \rightarrow Cl_2 + 2e^-$

$2H^+ + 2e^- \rightarrow H_2$

(Total for Question 4 = 13 marks)

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5 Metals are found in the Earth's crust either as uncombined elements or in metal compounds in rocks.

The method of extraction of a metal is related to its position in the reactivity series.

The table shows the positions of some metals and carbon in the reactivity series.

most reactive ↑	potassium
	sodium
	lithium
	calcium
	magnesium
	aluminium
	carbon
	zinc
	iron
	lead
	copper
	silver
	gold
least reactive	platinum

(a) (i) State the name given to rocks that contain metal compounds used in the extraction of metals.

(1)

Ore

(ii) Name a metal that is found as an uncombined element in the Earth's crust.

(1)

gold

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(b) Carbon extraction and electrolysis are two methods of obtaining a metal from a compound.

(i) Explain, without giving practical details, which method is most suitable to obtain calcium from calcium chloride.

(2)

electrolysis

because calcium is more reactive than carbon

(ii) Explain, without giving practical details, which method is most suitable to obtain lead from lead oxide.

(2)

carbon extraction

because carbon is more reactive than lead

(c) Explain, using a labelled diagram, why lead metal is malleable.

(3)

the layers are free to slide over each other

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(d) Aluminium is extracted from aluminium oxide.

The overall equation for the process is

$$2Al_2O_3 \rightarrow 4Al + 3O_2$$

Calculate the maximum mass, in grams, of aluminium that could be obtained from 1.275 kg of aluminium oxide.

(3)

M_r of Al_2O_3 = 102

mol of Al_2O_3 = $\frac{1275}{102}$ = 12.5 mol

mol of Al = 2 x 12.5 = 25

mass of Al_2O_3 = 25 x 27 = 675

mass = 675 g

(Total for Question 5 = 12 marks)

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

(a) Ethanol can be manufactured by reacting ethene with steam in the presence of a phosphoric acid catalyst.

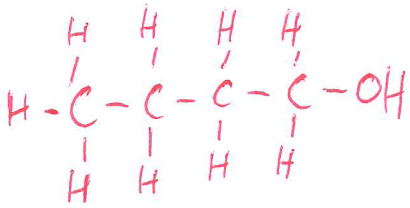
Which row gives the correct conditions of temperature and pressure for this reaction?

	Temperature in °C	Pressure in atmospheres
☐ **A**	35	300
☐ **B**	65	300
☒ **C**	300	65
☐ **D**	300	35

(1)

(b) Give the displayed formula of butanol.

(1)



(c) Ethanoic acid (CH_3COOH) is a carboxylic acid present in vinegar.

(i) The concentration of CH_3COOH in vinegar can be found by titration with aqueous potassium hydroxide (KOH).

The equation for the reaction is

$$CH_3COOH + KOH \rightarrow CH_3COOK + H_2O$$

In a titration, a 25.0 cm^3 sample of vinegar is neutralised by 45.00 cm^3 of KOH solution of concentration 0.400 mol/dm^3.

Calculate the concentration, in mol/dm^3, of CH_3COOH in this sample of vinegar.

(2)

$mol(KOH) = \frac{45.00 \times 0.40}{1000} = 0.018$

$conc(CH_3COOH) = \frac{0.018 \times 1000}{25}$

concentration = 0.72 mol/dm^3

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(ii) A sample of vinegar containing 0.0030 mol of CH_3COOH is poured into a flask.

Calculate the maximum volume, in cm^3, of carbon dioxide gas formed at rtp when excess sodium carbonate is added to the flask.

The equation for the reaction is

$$2CH_3COOH + Na_2CO_3 \rightarrow 2CH_3COONa + H_2O + CO_2$$

[Assume that the molar volume of carbon dioxide at rtp is 24 000 cm^3]

(2)

mol(CO_2) = (0.0030 ÷ 2) = 0.0015

vol(CO_2) = 0.0015 × 24000

volume = 36 cm^3

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

Which alcohol could react to form the ester ethyl propanoate?

alcohol

(1)

- ☐ **A** CH_3OH
- ☒ **B** C_2H_5OH
- ☐ **C** C_3H_7OH
- ☐ **D** C_4H_9OH

(e) Polyesters are formed in condensation polymerisation reactions between dicarboxylic acids and diols.

(i) State one difference between condensation polymerisation and addition polymerisation.

(1)

water is produced

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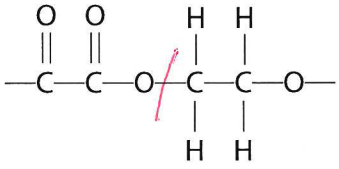
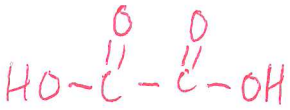
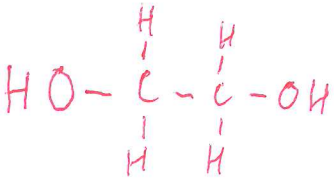
(ii) The repeat unit of a polyester is



Give the displayed formula of each of the two monomers needed to form this polyester.

(2)

(iii) Give one advantage of biopolyesters.

(1)

biodegradable

(Total for Question 6 = 11 marks)

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7 Hydrogen gas and iodine gas react together to form hydrogen iodide gas.

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

(a) (i) The pressure of an equilibrium mixture of the three gases is increased.

Predict the effect of this change on the yield of hydrogen iodide at equilibrium, giving a reason for your answer.

(2)

no effect on yeild because same number of gas moles on both sides of equation

(ii) A catalyst is added to an equilibrium mixture of the three gases.

Predict the effect of the catalyst on the yield of hydrogen iodide at equilibrium, giving a reason for your answer.

(2)

no effect because effects rate of both for ward and back ward reaction by same ammount

(b) Hydrogen gas reacts with fluorine gas to form hydrogen fluoride gas.

$$H_2(g) + F_2(g) \rightarrow 2HF(g)$$

The table gives some bond energies.

Bond	Bond energy in kJ/mol
H—H	436
F—F	158
H—F	562

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Use the equation and the data in the table to calculate the enthalpy change (ΔH) in kJ/mol, for the reaction.

Include a sign in your answer.

(3)

broken

H-H 436

F-F 158

436+158

made

2(H-F)

2(562)

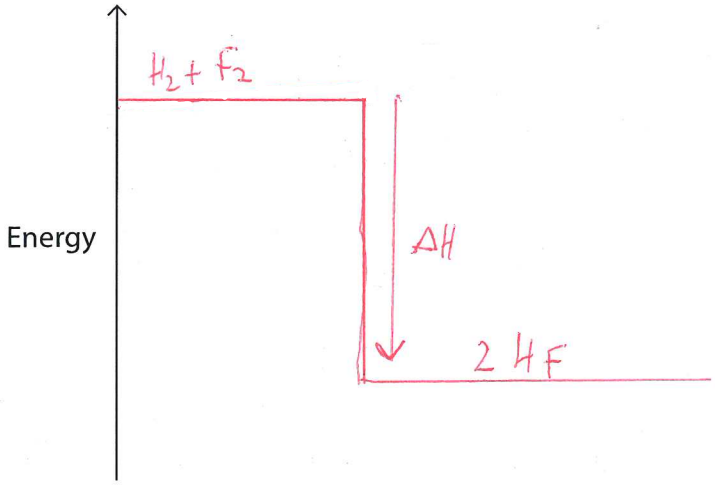
594 − 1124 = -530

ΔH = -530 kJ/mol

(c) Draw an energy level diagram for the reaction between hydrogen and fluorine.

Label the enthalpy change, ΔH.

(3)



(Total for Question 7 = 10 marks)

TOTAL FOR PAPER = 70 MARKS

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