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

Thursday 14 January 2021

Morning (Time: 1 hour 15 minutes) | Paper Reference **4CH1/2C**

Chemistry

Unit: 4CH1

Paper 2C

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.*
- 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.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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P 6 7 0 8 1 A 0 1 2 4

Pearson

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.

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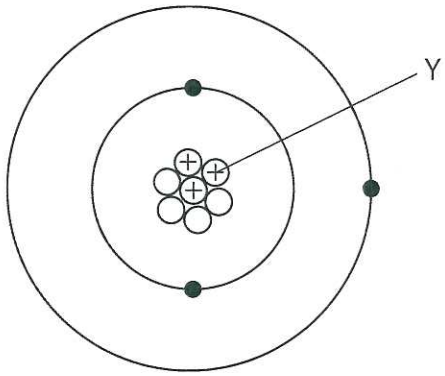
Answer ALL questions. Write your answers in the spaces provided.

1 The diagram shows an atom of an element.



(a) (i) What is the name of the particle labelled Y?

(1)

- ☐ **A** electron
- ☐ **B** ion
- ☐ **C** neutron
- ☒ **D** proton

(ii) Give the mass number of this atom.

(1)

7

(iii) Name this element.

Use the Periodic Table on page 2 to help you.

(1)

Lithium

(b) There are two isotopes of this element.

Give one way, in terms of sub-atomic particles, that these isotopes are the same and one way that they are different.

(2)

same Number of protons

different Number of neutrons.

(Total for Question 1 = 5 marks)

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2 This question is about gases.

(a) The box gives the names of some gases.

argon	carbon dioxide	hydrogen	nitrogen	oxygen

Use gases from the box to answer these questions.

Each gas may be used once, more than once or not at all.

(i) Name the most abundant gas in the Earth's atmosphere.

(1)

Nitrogen

(ii) Name the gas that is a compound.

(1)

Carbon dioxide

(iii) Name the least reactive of the gases.

(1)

Argon

(iv) Name the gas formed by the complete combustion of hydrocarbons.

(1)

Carbon dioxide

(b) Describe the test for hydrogen gas.

(1)

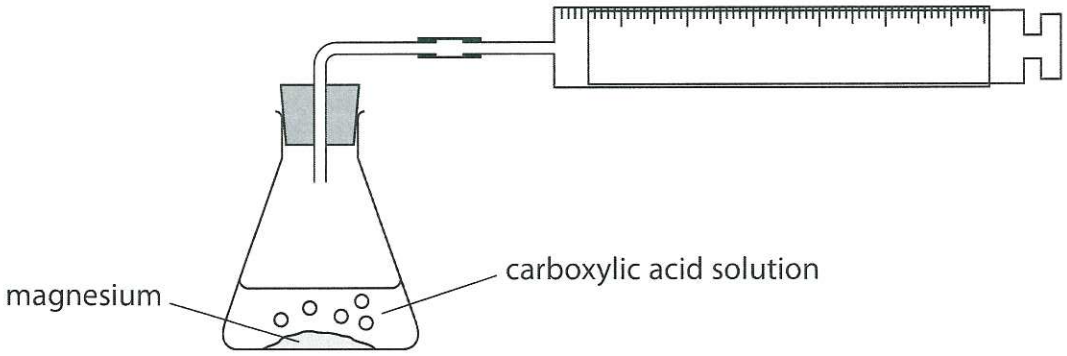
When a lit Splint is added to a Sample of the gas, a Squeaky pop is produced.

(Total for Question 2 = 5 marks)

3 This question is about carboxylic acids.

Solutions of carboxylic acids react with magnesium metal to form hydrogen gas.

A student uses this apparatus to investigate the time taken to produce 10 cm^3 of hydrogen gas from different carboxylic acids.



This is the student's method.

- pour some carboxylic acid solution into a conical flask
- add some magnesium powder
- quickly connect the gas syringe and start a timer
- record the time taken to collect 10 cm^3 of hydrogen gas

The student repeats the method with three other carboxylic acids.

(a) (i) All the carboxylic acids are of the same concentration.

Give two other variables the student should control in his investigation.

(2)

1 Volume of acid

Temperature

2 Mass of magnesium

Surface area of magnesium.

(ii) Give a reason why it is important to connect the gas syringe quickly.

(1)

This minimises the amount of gas that escapes.

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

Carboxylic acid	Formula of carboxylic acid	Time taken to produce 10 cm^3 of hydrogen in s				
		Experiment 1	Experiment 2	Experiment 3	Experiment 4	Mean time in s
Methanoic acid	HCOOH	48	50	47	49	49
Ethanoic acid	CH_3COOH	61	63	60	61	61
Propanoic acid	CH_3CH_2COOH	69	93	70	71	
Butanoic acid	$CH_3CH_2CH_2COOH$	83	85	82	81	83

(i) Calculate the mean (average) time for propanoic acid to produce 10 cm^3 of hydrogen gas.

(2)

Mean = $\frac{69 + 70 + 71}{3}$ = 70

mean time = 70 s

(ii) Deduce the relationship between the number of carbon atoms in the molecule and the time taken to produce 10 cm^3 of hydrogen gas.

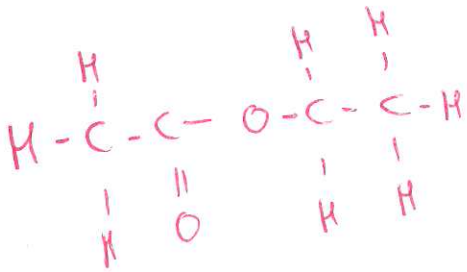
(1)

As the number of Carbon atoms in the Molecule increases, the mean time taken to produce $10cm^3$ of hydrogen gas increases.

(c) An ester is formed by adding ethanoic acid to ethanol in the presence of sulfuric acid.

Give the displayed formula of the ester produced when ethanoic acid reacts with ethanol.

(2)



(Total for Question 3 = 8 marks)

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4 This question is about sodium and potassium.

A trough is filled with water and a few drops of phenolphthalein indicator are added.

(a) A small piece of sodium is dropped into the water. One of the products of the reaction is an alkali.

(i) Complete the chemical equation for the reaction of sodium with water.

(2)

2 Na(s) + 2 H_2O(l) → 2 NaOH(aq) + H_2(g)

(ii) Identify the ion that causes the solution to become alkaline.

(1)

OH^-

(iii) Give three observations that would be made when sodium reacts with water.

(3)

1 Sodium moves on the surface
Sodium gets smaller

2 Bubbling of gas
Sodium melts & turns into ball.

3 phenolphthalein turns pink.

(b) Explain why potassium is more reactive than sodium.

Refer to the electronic configurations of the atoms in your answer.

(3)

Sodium has the electron Configuration 2,8,1 whereas potassium has the electron Configuration of potassium is 2,8,8,1.

Hence, the outer electron in potassium is less strongly attracted to the potassium nucleus.

Hence, the outer shell electron of potassium is more easily lost, making potassium more reactive than Sodium.

(Total for Question 4 = 9 marks)

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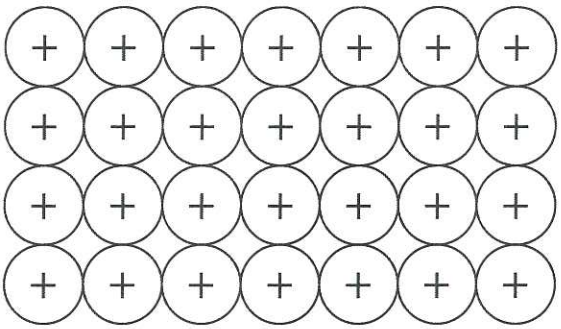
5 This question is about the metal aluminium.

(a) Aluminium is malleable and conducts electricity.

The diagram shows the arrangement of the ions in aluminium metal.



+ aluminium ion

(i) Explain why aluminium is malleable.

(2)

Layers of ions can slide over each other.

(ii) Explain why aluminium conducts electricity.

(2)

Delocalised electrons can move.

(b) Aluminium cannot be extracted by heating a mixture of carbon and aluminium oxide.

Give a reason why heating a mixture of aluminium oxide and carbon does not produce aluminium.

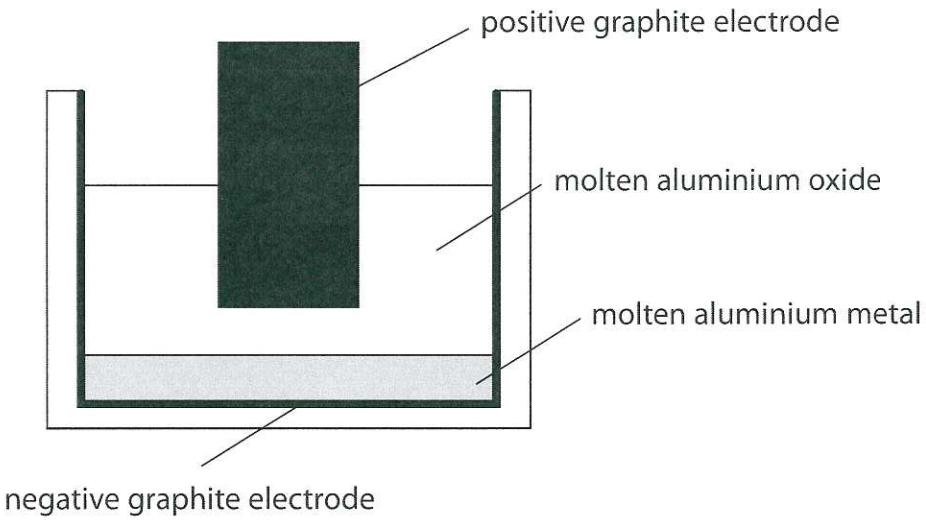
(1)

Aluminium is more reactive than Carbon.

(c) Aluminium is extracted industrially by the electrolysis of molten aluminium oxide Al_2O_3 at a temperature of about 950 °C.

Aluminium metal forms at the negative electrode and oxygen gas forms at the positive electrode. The positive and negative electrodes are made of graphite.

The diagram shows the apparatus used.



(i) Explain how aluminium metal forms at the negative electrode.

(2)

Al^{3+} ions are attracted to the negative electrode where they gain electrons to form aluminium.

(ii) Write an ionic half-equation for the formation of oxygen gas at the positive electrode.

(1)

$2O^{2-} \rightarrow 4e^- + O_2$

(iii) Suggest why carbon dioxide gas is also produced at the positive electrode.

(2)

Electrodes are made of Carbon (graphite) which reacts with oxygen.

(d) Aluminium reacts with iron(III) oxide. The reaction is exothermic.

The equation for the reaction is

$$2Al + Fe_2O_3 \rightarrow Al_2O_3 + 2Fe$$

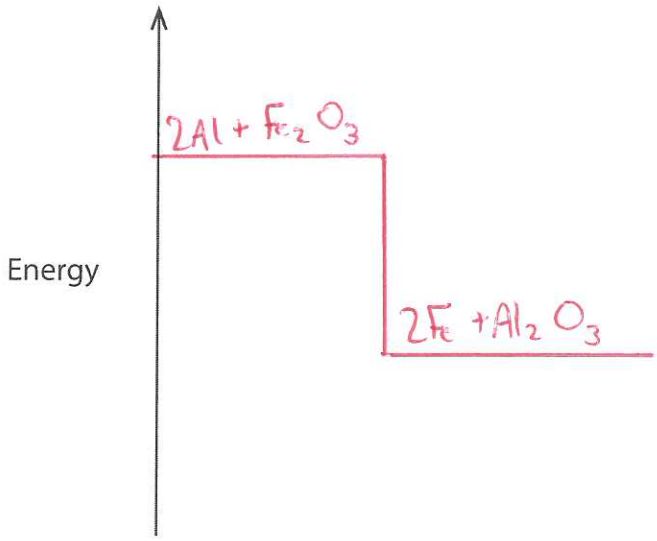
(i) State how the equation shows that iron(III) oxide is reduced.

(1)

Iron (III) oxide loses oxygen.

(ii) Draw an energy level diagram for the reaction between aluminium and iron(III) oxide.

(3)



(Total for Question 5 = 14 marks)

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6 This question is about the insoluble salt silver chloride (AgCl).

Silver chloride can be made by the reaction between copper(II) chloride and silver nitrate.

(a) Describe how a student could prepare a pure, dry sample of silver chloride starting with copper(II) chloride solution and silver nitrate solution.

(4)

- Mix Silver nitrate and Copper (II) Chloride.
- Filter the Silver Chloride from the mixture that forms.
- Wash the Silver Chloride Solid with distilled water.
- Dry the Silver Chloride in a Warm oven.

(b) A student investigates the quantity of silver chloride produced when different volumes of silver nitrate solution are added to copper(II) chloride solution.

This is the student's method.

- pour 5.0 cm^3 of copper(II) chloride solution into a test tube
- add 1.0 cm^3 of silver nitrate solution to the test tube
- allow the silver chloride precipitate to settle
- measure the height of the precipitate

The student repeats the method using different volumes of silver nitrate solution.

The table shows the student's results.

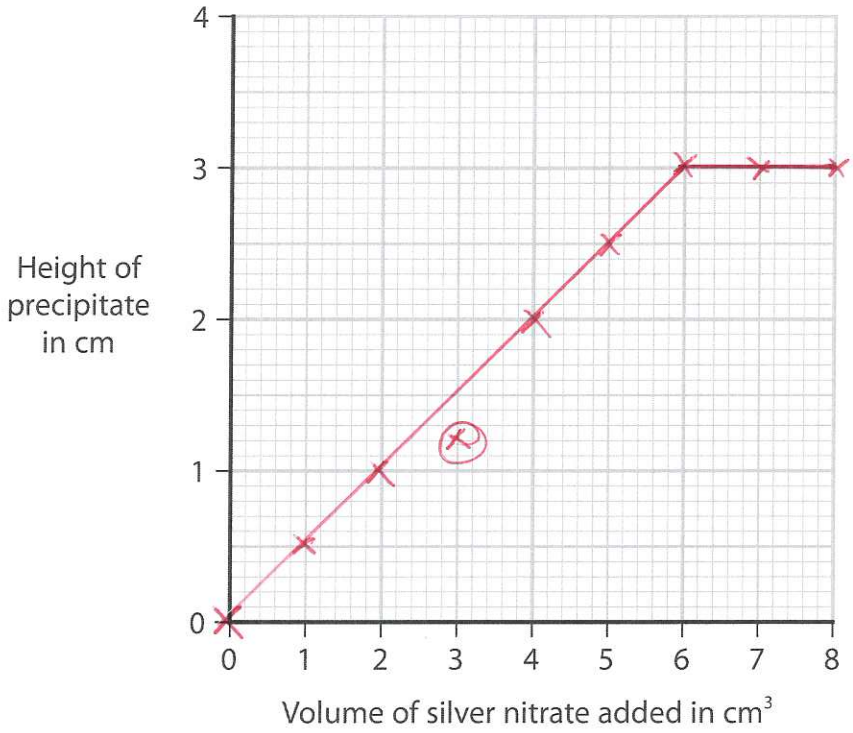
Volume of silver nitrate added in cm^3	Height of precipitate in cm
0.0	0.0
1.0	0.5
2.0	1.0
3.0	1.2
4.0	2.0
5.0	2.5
6.0	3.0
7.0	3.0
8.0	3.0

(i) Plot the student's results.

(2)

(ii) Draw two straight lines of best fit, ignoring the anomalous result.

(1)



(iii) Suggest a mistake the student made to cause the anomalous result.

(1)

- The precipitate wasn't left to settle for long enough.
- The tube wasn't ~~[illegible]~~ vertical, but instead slanted.
- Less than 3cm^3 of Silver Nitrate was added.

(iv) Give a reason why the last three heights are the same.

(1)

All the Copper (II) Chloride has reacted.

(c) The equation for the reaction between copper(II) chloride and silver nitrate is

$$CuCl_2(aq) + 2AgNO_3(aq) \rightarrow 2AgCl(s) + Cu(NO_3)_2(aq)$$

A student measures 25.0 cm^3 of 0.500 mol/dm^3 copper(II) chloride solution and reacts it with silver nitrate solution.

(i) Name a piece of apparatus suitable for measuring 25.0 cm^3 of copper(II) chloride solution.

(1)

Volumetric pipette.

(ii) Calculate the maximum mass, in grams, of silver chloride that could be produced.

[M_r of AgCl = 143.5]

(3)

$n(CuCl_2) = Conc \times vol$

$= 0.5 \times 25 \times 10^{-3}$

$= 0.0125$ mol

$n(AgCl) = 2 \times n(CuCl_2)$

$= 2 \times 0.0125 = 0.025$ mol

$m(AgCl) = mr \times n(AgCl)$

$= 143.5 \times 0.025$

$= 3.5875$ g

maximum mass = 3.59 g

(3 S.F.)

(iii) In an experiment using different solutions, the mass of silver chloride produced is 0.744 g.

The maximum mass of silver chloride that could be produced is 0.850 g.

Calculate the percentage yield.

(2)

$\%\ yield = \frac{0.744}{0.850} \times 100$

$= 87.5\%$

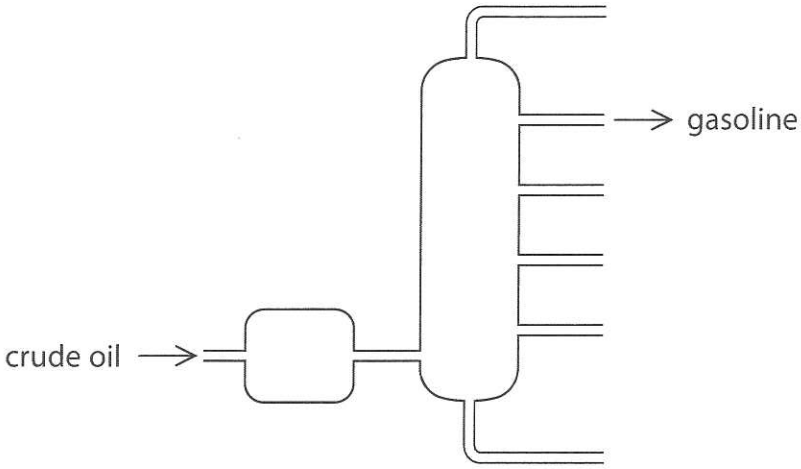
percentage yield = 87.5 %

(3 S.F.)

(Total for Question 6 = 15 marks)

7 This question is about octane (C_8H_{18}) which is produced in the gasoline fraction during fractional distillation of crude oil.

(a) The diagram shows a fractionating column.



Describe how crude oil is separated into fractions in the fractionating column.

(4)

Crude oil is heated, causing gaseous hydrocarbons to rise up the fractionating column. The column is hotter at the bottom than at the top. Vapours condense at their boiling points.

(b) Octane can also be produced by the process of cracking.

Give the conditions for cracking.

(2)

600 - 700 °C

Silica or alumina catalyst.

(c) A car is driven at constant speed for 4.00 km.

The exhaust gases are collected and their volume at room temperature and pressure (rtp) is 5.02×10^5 cm^3.

The exhaust gases include carbon dioxide and oxides of nitrogen.

The carbon dioxide is removed from the exhaust gases. The volume of the remaining gases at rtp is 2.96×10^5 cm^3.

(i) Explain how oxides of nitrogen form in a car engine.

(2)

Nitrogen from the air reacts with oxygen from the air at high temperatures in the car engine.

(ii) Give a reason why oxides of nitrogen should not be released into the atmosphere.

(1)

They can cause acid rain / respiratory problems.

(iii) Show that the car produces less than 100 g of carbon dioxide per km.

[molar volume of carbon dioxide at rtp = 24 000 cm^3]

(5)

$V(CO_2) = (5.02 \times 10^5) - (2.96 \times 10^5)$

$= 2.06 \times 10^5$ cm^3

$n(CO_2) = \frac{2.06 \times 10^5}{24000}$ mol $= 8.53$ mol

$m(CO_2) = mr \times mol = (12 + 2(16)) \times 8.53$

$= 378$ g

$m(CO_2)$ per 1 km $= \frac{378}{4} = 94.5$ g (km)$^{-1}$ < 100 g (km)$^{-1}$

(Total for Question 7 = 14 marks)

TOTAL FOR PAPER = 70 MARKS

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