MODEL ANSWERS

Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel International GCSE

Centre Number | | | | | |

Candidate Number | | | | |

Monday 20 January 2020

Afternoon (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.*
- 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 ▶

P59924A

1/1/1/1/1/1/1/

P 5 9 9 2 4 A 0 1 1 6

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.

Answer ALL questions.

1 This question is about elements, compounds and mixtures.

(a) Name the element that burns with a lilac flame.

(1)

potassium

(b) Name the technique used to separate the mixture of colours in black ink.

(1)

Paper Chromatography.

(c) The box gives the names of some substances.

air	bromine	magnesium	neon	sodium chloride	sulfur

Choose substances from the box to answer these questions.

(i) Identify the compound.

(1)

Sodium Chloride

(ii) Identify the mixture.

(1)

Air

(iii) Identify the non-metal element that is a solid at room temperature.

(1)

Sulphur

(Total for Question 1 = 5 marks)

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2 Crude oil is a mixture of hydrocarbons.

(a) Name the process used to separate crude oil into fractions.

(1)

Fractional distillation

(b) Give one use of the kerosene fraction.

(1)

Aircraft fuel.

(c) One of the hydrocarbons in the refinery gas fraction is an alkane with the structural formula $CH_3CH_2CH_2CH_3$

(i) Give the name of this alkane.

(1)

butane

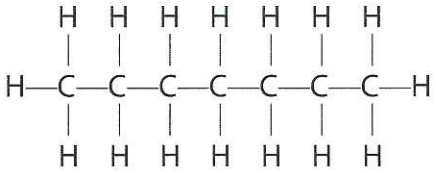
(ii) Calculate the relative molecular mass (M_r) of this alkane.

(1)

M_r = 12+3+12+2+12+2+12+3

M_r = 58

(d) One of the alkanes in the gasoline fraction has the displayed formula



(i) Determine the molecular formula of this alkane.

(1)

C_7H_{16}

(ii) Give the general formula for the alkanes.

(1)

C_nH_{2n+2}

(e) Catalytic cracking is used to convert long-chain alkanes into shorter-chain alkanes.

(i) Name the catalyst used in catalytic cracking.

(1)

Alumina / Silica.

(ii) Explain why it is necessary to convert long-chain alkanes into shorter-chain alkanes.

(2)

There is greater demand for short chain alkanes than for long chain alkanes.

There is a surplus of long-chain alkanes and not enough short chain alkanes to meet demands.

(f) Catalytic cracking also produces alkenes.

$C_{11}H_{24}$ can undergo cracking to give pentane (C_5H_{12}) and two different alkenes.

Complete the equation for this cracking reaction.

(2)

$$C_{11}H_{24} \rightarrow C_5H_{12} + \underline{C_2H_4} + \underline{C_4H_8}$$

(Total for Question 2 = 11 marks)

3 This question is about copper and its compounds.

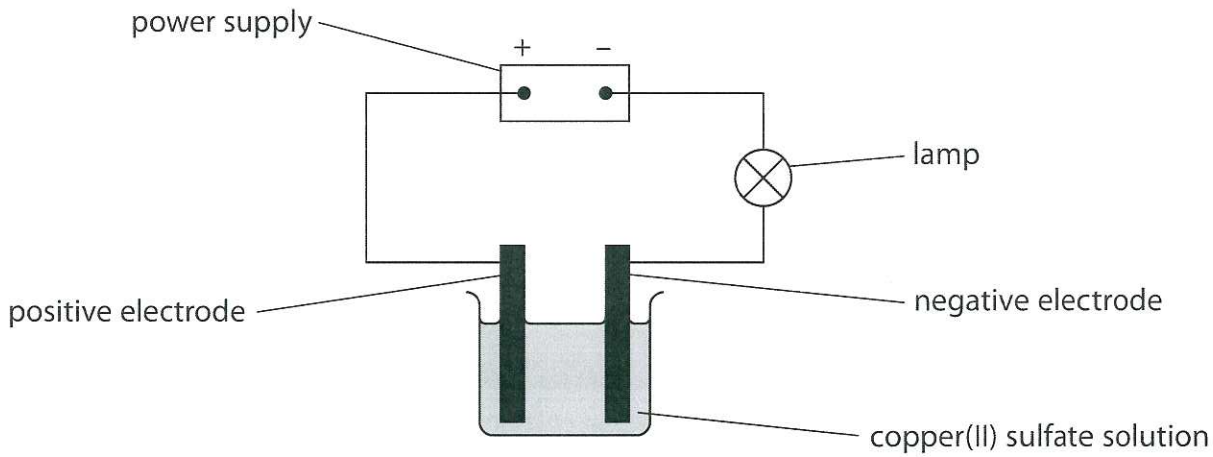
(a) Copper is a metal used for electrical wiring.

Explain why copper is a good conductor of electricity.

(2)

Delocalised electrons can move.

(b) This apparatus is used to investigate the electrolysis of copper(II) sulfate solution with graphite electrodes.



Copper forms at the negative electrode and oxygen forms at the positive electrode.

(i) State what would be observed at each electrode.

(2)

negative electrode Pink-brown solid formed

positive electrode ~~Fizzing~~.

(ii) The ionic half-equation for the reaction at the negative electrode is

$$Cu^{2+} + 2e^- \rightarrow Cu$$

State why this is a reduction reaction.

(1)

Copper ions gain electrons.

(iii) Explain why the copper(II) sulfate solution becomes paler blue during the electrolysis.

(2)

The blue colour is caused by Cu^{2+} ions. Copper ions are being removed from the solution.

(c) When hydrated copper(II) sulfate crystals are heated, anhydrous copper(II) sulfate forms.

A mass of 12.5 g of hydrated copper(II) sulfate crystals is heated in a crucible until all the water of crystallisation is removed.

A mass of 8.0 g of anhydrous copper(II) sulfate forms.

Show by calculation that the formula of hydrated copper(II) sulfate is $CuSO_4.5H_2O$

[M_r of $CuSO_4$ = 159.5 M_r of H_2O = 18]

(4)

	$CuSO_4$	H_2O
mass	8.0	12.5 - 8.0
M_r	159.5	18
=	0.0502 :	0.25
smallest	~~0.0502~~ 0.0502	0.0502
=	1 :	5

$\therefore CuSO_4.5H_2O$

(Total for Question 3 = 11 marks)

4 A student investigates the reaction between sodium hydroxide solution and dilute sulfuric acid.

He does a titration to find the concentration of the sulfuric acid.

This is his plan for the titration. There are some mistakes and omissions in his plan.

- rinse a conical flask with the sodium hydroxide solution
- use a measuring cylinder to measure out 25 cm^3 of the sodium hydroxide solution and add it to the conical flask
- add a few drops of methyl orange indicator to the conical flask
- rinse a burette with water and then fill it with the sulfuric acid
- add the acid from the burette to the conical flask until the indicator changes colour at the end-point of the titration
- record the final burette reading

(a) Give the colour change of the methyl orange indicator at the end-point.

(2)

from yellow to Orange

(b) Describe four changes that the student could make to improve his plan.

(4)

1 - Rinse the flask with water, not Sodium hydroxide.
- Measure Sodium hydroxide Solution with pipette.
- Rinse burette with Sulphuric acid, not water.

2 - Record the initial buvette reading.
- Place a white tile under the flask.
- Swirl the flask whilst adding acid.

3 - Add acid drop-wise near endpoint.
- Repeat the titration to obtain concordant results and Calculate an average.

4

(c) The student then does the titration correctly.

He finds that 16.70 cm^3 of the dilute sulfuric acid neutralises 25.0 cm^3 of sodium hydroxide solution of concentration 0.200 mol/dm^3

The equation for the reaction is

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

Calculate the concentration, in mol/dm^3, of the sulfuric acid.

(3)

$n(NaOH) = Conc \times Vol = 0.2 \times 25 \times 10^{-3} = 5 \times 10^{-3}$ mol

Ratio $n(NaOH : H_2SO_4) = 2:1$

$\therefore n(H_2SO_4) = \frac{5 \times 10^{-3}}{2} = 2.5 \times 10^{-3}$ mol

$Conc(H_2SO_4) = \frac{mol}{Vol} = \frac{2.5 \times 10^{-3}}{16.7 \times 10^{-3}} = 0.149700599\ 88\ mol\ dm^{-3}$

concentration of sulfuric acid = 0.150 (3 S.f.) mol/dm^3

(Total for Question 4 = 9 marks)

5 Oxygen can be prepared from hydrogen peroxide using a catalyst.

(a) Which is a correct statement about oxygen?

(1)

- ☐ **A** it burns with a squeaky pop
- ☒ **B** it relights a glowing splint
- ☐ **C** it turns blue litmus red
- ☐ **D** it turns limewater milky

(b) Explain how a catalyst increases the rate of a reaction.

(2)

The Catalyst provides an alternative reaction pathway with a lower activation energy.

(c) The equation for the preparation of oxygen from hydrogen peroxide is

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

This equation can also be written using displayed formulae to show all the covalent bonds in the molecules.

$$2H—O—O—H \rightarrow 2H—O—H + O=O$$

The table gives the bond energies for these bonds.

Bond	H—O	O—O	O=O
Bond energy in kJ/mol	463	143	498

(i) Use the values in the table to calculate the enthalpy change, ΔH, for the reaction.

Include a sign in your answer.

(3)

Breaking:

4 H-O	4(463)
+2 O-O	2(143)
	2138

Making:

4 H-O	4(463)
1 O=O	498
	2350

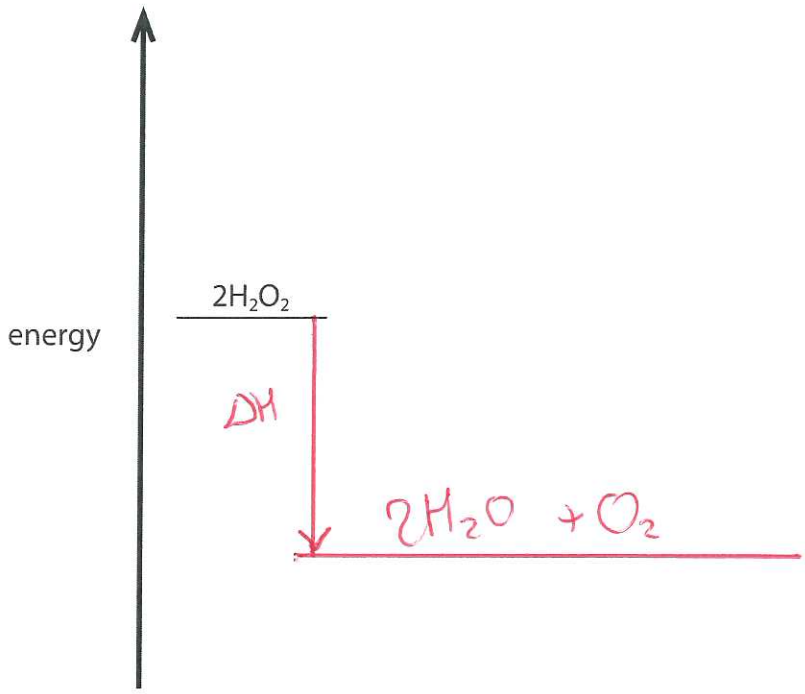
ΔH = Breaking - making

= -212 kJ mol^{-1}

ΔH = -212 kJ

(ii) Complete the energy level diagram to show the position of the products and the enthalpy change, ΔH, for the reaction.

(2)



(Total for Question 5 = 8 marks)

6 Ethanol, C_2H_5OH, can be manufactured from ethene and steam using a phosphoric acid catalyst.

(a) (i) State the temperature and pressure used in this manufacturing process.

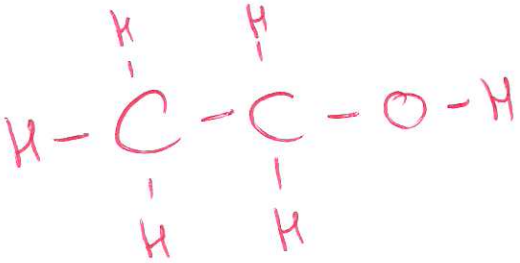
(2)

temperature 300°C

pressure 60 - 70 atm

(ii) Draw the displayed formula of ethanol.

(1)



(b) Ethanol burns in a plentiful supply of air to form carbon dioxide and water.

(i) Give the chemical equation for this reaction.

(2)

$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$

(ii) When the air supply is limited, incomplete combustion occurs and carbon monoxide forms.

State why carbon monoxide is poisonous to humans.

(1)

It reduces the capacity of the blood to carry oxygen.

(c) When ethanol reacts with ethanoic acid, an ester forms.

Give the name of this ester.

(1)

Ethyl ethanoate.

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DO NOT WRITE IN THIS AREA

(d) Butanedioic acid and ethanediol react together to form a polyester and water.

(i) Give the name of this type of polymerisation.

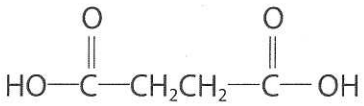
(1)

Condensation polymerisation.

(ii) Complete the equation.

Show only one repeat unit of the polyester.

(3)



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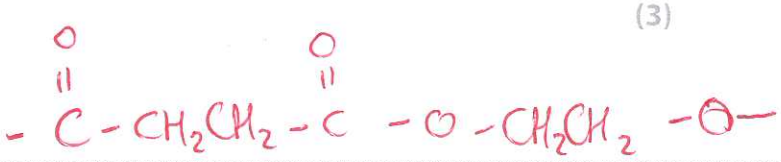

+

$2H_2O$

(Total for Question 6 = 11 marks)

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

(a) Calcium reacts with water to produce calcium hydroxide and hydrogen gas.

(i) Give the word equation for this reaction.

(1)

Calcium + Water → Calcium hydroxide + Hydrogen.

(ii) State two observations that would be made during this reaction.

(2)

1 fizzing

2 Calcium metal disappears
Beaker feels hot.

(b) (i) Describe how a pure, dry sample of the insoluble salt, barium sulfate, could be made from the two solids sodium sulfate and barium chloride.

(5)

- Dissolve each of the two solids in water.
- Mix the two solutions together.
- Filter the mixture
- Wash the precipitate.
- Dry the solid in a warm oven.

(ii) Give an ionic equation for the reaction that occurs.

Include state symbols in your equation.

(2)

$Ba^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)} \rightarrow BaSO_{4(s)}$

(c) When magnesium nitrate is heated, magnesium oxide, nitrogen dioxide and oxygen form.

The equation for the reaction is

$$2Mg(NO_3)_2(s) \rightarrow 2MgO(s) + 4NO_2(g) + O_2(g)$$

(i) What is the name for this type of reaction?

(1)

☐ **A** addition

☐ **B** combustion

☒ **C** decomposition

☐ **D** neutralisation

(ii) Calculate the **total** volume, in dm^3, of gas produced at rtp when 7.7 g of magnesium nitrate completely reacts.

[Assume that the molar volume of a gas at rtp is 24 dm^3]

[M_r of $Mg(NO_3)_2$ = 148]

Give your answer to two significant figures.

(4)

$n(Mg(NO_3)_2) = \frac{mass}{Mr} = \frac{7.7}{148} = 0.052027027703$ mol

Ratio $n(Mg(NO_3)_2) : n(Gas) = 2:5$

$n(Gas) = \frac{5}{2} \times 0.052$

$= 0.1300$ mol

$V(Gas) = 24 \times 0.130$

$= 3.1$ dm^3

total volume of gas = 3.1 (2 S.f.) dm^3

(Total for Question 7 = 15 marks)

TOTAL FOR PAPER = 70 MARKS