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 | | | | |

Wednesday 10 June 2020

Afternoon (Time: 1 hour 15 minutes)

Paper Reference **4CH1/2CR**

Chemistry

Unit: 4CH1

Paper: 2CR

You must have:
Calculator

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 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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P 6 2 0 4 8 A 0 1 2 0

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 damstadtium 110	[272] Rg roentgenium 111	Elements with atomic numbers 112–116 have been reported but not fully authenticated						

Key

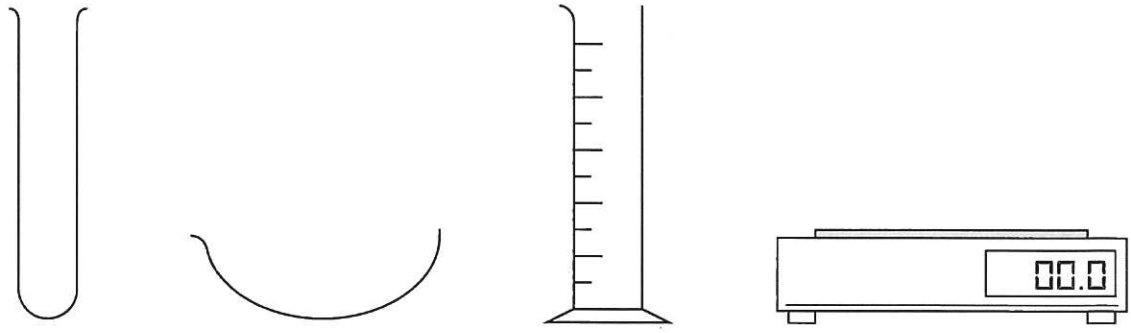
relative atomic mass
atomic symbol
name
atomic (proton) number

**** 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 The diagram shows some pieces of apparatus.



A B C D

(a) Complete the table by giving the name of each piece of apparatus.

(4)

Letter	Name
A	Test tube / Boiling tube
B	Evaporating basin.
C	Measuring Cylinder
D	Top-pan balance.

(b) Which piece of apparatus can be used to measure the volume of a liquid?

(1)

☐ **A**

☐ **B**

☒ **C**

☐ **D**

(Total for Question 1 = 5 marks)

2 Thallium, Tl, is an element in Group 3 and Period 6 of the Periodic Table.

The atomic number of thallium is 81

(a) How many electrons are there in the outer shell of an atom of thallium?

(1)

☒ **A** 3

☐ **B** 6

☐ **C** 13

☐ **D** 81

(b) A thallium ion has a charge of 3+

How many electrons are there in this thallium ion?

(1)

☐ **A** 3

☒ **B** 78 = 81 - 3

☐ **C** 81

☐ **D** 84

(c) A sample of thallium contains two isotopes.

The table shows the mass number and percentage abundance of each isotope in the sample.

Isotope	Mass number	Percentage abundance (%)
thallium-203	203	30.80
thallium-205	205	69.20

(i) Give the number of protons and the number of neutrons in one atom of the thallium-205 isotope.

(2)

number of protons 81

number of neutrons 124

(ii) Calculate the relative atomic mass of this sample of thallium.

Give your answer to one decimal place.

(3)

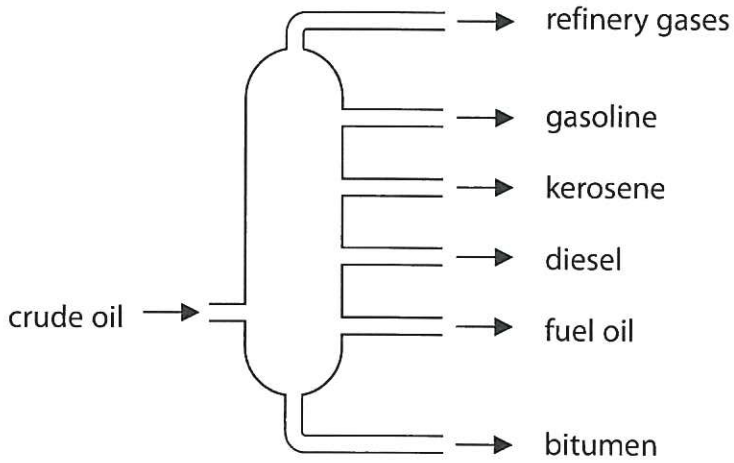
$A_r = 0.308(203) + 0.692(205)$

$= 204.384$

relative atomic mass = 204.4 (1 d.p.)

(Total for Question 2 = 7 marks)

3 (a) The diagram shows a fractionating column used to separate crude oil into fractions.



(i) Give a use for bitumen and a use for gasoline.

(2)

use for bitumen Surfacing roads & roofs

use for gasoline fuel for Cars

(ii) Explain why bitumen is collected at the bottom of the fractionating column and gasoline is collected near the top of the fractionating column.

(2)

The Column is Colder at the ~~bottom~~ top than at the bottom. Gasoline has a lower boiling point than bitumen So is Collected nearer the top.

(b) There is a low demand for some of the fractions obtained from crude oil.

Cracking can be used to convert these fractions into more useful substances.

(i) State the conditions needed for cracking.

(2)

Alumina / Silica Catalyst.

600 - 700° C

(ii) Dodecane ($C_{12}H_{26}$) can be cracked to produce an alkane and two alkenes.

Complete the equation by giving the formulae of the two alkenes.

(2)

$C_{12}H_{26} \rightarrow C_7H_{16} +$ C_2H_4 + C_3H_6

(Total for Question 3 = 8 marks)

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4 This question is about some of the alkali metals and their compounds.

(a) When a teacher drops a small piece of sodium into a trough of cold water, she observes bubbles of gas.

Give two other observations that would be made when sodium reacts with cold water.

(2)

1 Sodium floats on the water surface.
Sodium melts & forms a ball

2 Sodium gets smaller / disappears.
Sodium forms white trail.

(b) Lithium reacts with fluorine to form the compound lithium fluoride.

(i) Give a chemical equation for this reaction.

(1)

$2Li + F_2 \rightarrow 2LiF$

(ii) Give a test to show that lithium fluoride contains lithium ions.

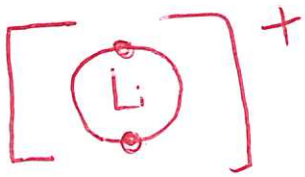
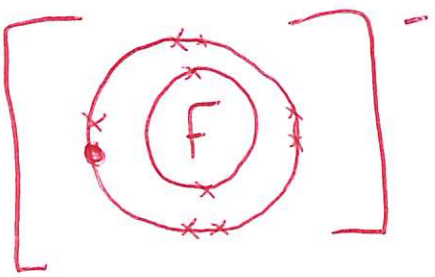
(2)

A flame test produces a red flame, showing lithium ions are present.

(iii) Draw diagrams to show the arrangement of the electrons in a lithium ion and in a fluoride ion.

Include the charge on each ion.

(3)

lithium ion	fluoride ion
	

(c) The table shows the electronic configurations of sodium and potassium.

Element	Electronic configuration
sodium	2.8.1
potassium	2.8.8.1

Explain, in terms of their electronic configurations, why potassium is more reactive than sodium.

(3)

Potassium has a larger atomic radius with more inner shell shielding than in Sodium. There is less attraction between the outer electron and the nucleus of potassium, meaning it can be lost more easily than Sodium's outer electron, making potassium more reactive than Sodium.

(Total for Question 4 = 11 marks)

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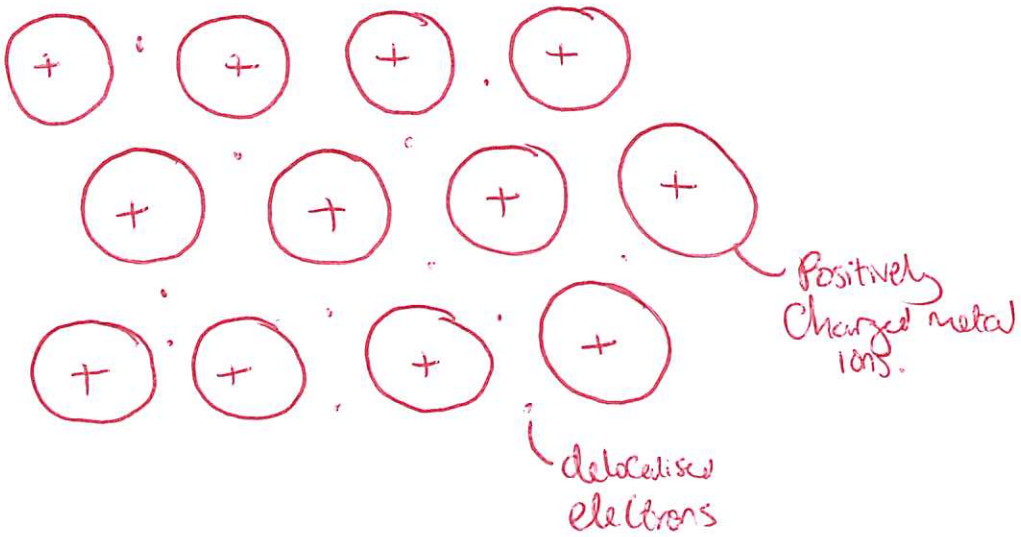
5 This question is about the metal aluminium.

(a) (i) Draw a labelled diagram to represent the structure and bonding in a metal.

(2)

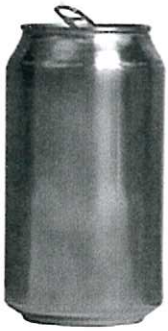


(ii) Explain why a metal conducts electricity.

(2)

Delocalised electrons can move.

(b) Aluminium is used to make cans for drinks.



Give two properties of aluminium that make it suitable for this use.

(2)

1 Low density

malleable

2 doesn't react with drink

(c) Aluminium is extracted from aluminium oxide (Al_2O_3) by electrolysis.

The electrolyte is aluminium oxide dissolved in molten cryolite.

(i) State why aluminium cannot be extracted by heating aluminium oxide with carbon.

(1)

Aluminium is more reactive than Carbon.

(ii) Aluminium is produced at the negative electrode.

The ionic half-equation for the reaction is

$$Al^{3+} + 3e^- \rightarrow Al$$

State why this is a reduction reaction.

(1)

~~Electrons gain~~ The Al^{3+} ions gain electrons (reduction is the gain of electrons).

(iii) Complete the ionic half-equation for the reaction at the positive electrode.

(2)

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

(Total for Question 5 = 10 marks)

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6 A student wants to prepare sodium chloride crystals from sodium hydroxide solution and dilute hydrochloric acid.

He does a titration to find the volume of dilute hydrochloric acid needed to neutralise the sodium hydroxide solution.

This is his method.

- add 25.0 cm^3 of sodium hydroxide solution to a conical flask
- add a few drops of phenolphthalein indicator to the conical flask
- titrate the solution with the hydrochloric acid

(a) Name a suitable piece of apparatus that the student should use to measure 25.0 cm^3 of sodium hydroxide solution.

(1)

Pipette

(b) (i) Give the colour of the phenolphthalein indicator in sodium hydroxide solution and in hydrochloric acid.

(2)

colour in sodium hydroxide solution Pink

colour in hydrochloric acid Colourless

(ii) Suggest why universal indicator is never used in a titration.

(1)

There is no clear colour change at the end point.

(c) The student finds that 21.50 cm^3 of hydrochloric acid is needed to neutralise 25.0 cm^3 of sodium hydroxide solution.

(i) Describe what the student should do next to prepare a pure solution of sodium chloride.

(2)

Add 21.50 cm^3 of hydrochloric acid to 25 cm^3 of Sodium hydroxide Silution.

(ii) Describe how the student could obtain dry crystals of sodium chloride from the pure sodium chloride solution.

(4)

Heat the Solution to evaporate some of the water, forming a Saturated Solution. Leave the Solution to cool, allowing Crystals to form. Filter off the Crystals and then dry the Crystals on filter paper.

(d) The student needs 21.50 cm^3 of hydrochloric acid to neutralise 25.0 cm^3 of sodium hydroxide solution of concentration 0.800 mol/dm^3.

The equation for the reaction is

$$NaOH + HCl \rightarrow NaCl + H_2O$$

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

(3)

$n(NaOH) = Conc \times Vol = 0.8 \times 25 \times 10^{-3}$

$= 0.02 mol$

$n(HCl) = 0.02 mol$

$Conc(HCl) = \frac{Mol}{Vol}$

$= \frac{0.02}{21.5 \times 10^{-3}} = 0.930232558$

concentration = 0.930 (3 sig fig) mol/dm^3

(Total for Question 6 = 13 marks)

7 (a) Ethanol, C_2H_5OH, can be oxidised to produce ethanoic acid, CH_3COOH, by heating it with potassium dichromate(VI).

(i) Name one other reactant needed for this reaction to occur.

(1)

Sulphuric acid

(ii) Which colour change occurs during this reaction?

(1)

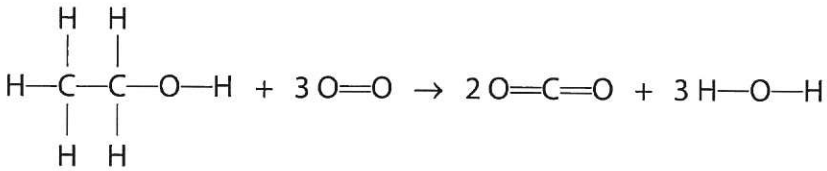
- ☐ **A** colourless to green
- ☐ **B** green to orange
- ☐ **C** orange to colourless
- ☒ **D** orange to green

(b) When ethanol is burned in air, complete combustion can occur.

The equation for this reaction is

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

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



The table gives the bond energies for these bonds.

Bond	C—C	C—H	C—O	O—H	O=O	C=O
Bond energy in kJ/mol	346	412	358	463	496	743

(i) Use values from the table to calculate the energy needed to break all the bonds in the reactants.

(2)

= 5(412) + 358 + 463 + 346 + 3(496)

= 4715 KJ mol^{-1}

energy needed 4715 kJ

(ii) Use values from the table to calculate the energy released when all the bonds in the products are formed.

(2)

= 4(743) + 6(463)

= 5750 kJ mol^{-1}

energy released 5750 kJ

(iii) Calculate the molar enthalpy change (ΔH) in kJ/mol, for the complete combustion of ethanol.

Include a sign in your answer.

(1)

ΔH = Breaking - making

= 4715 - 5750

= -1035

ΔH = -1035 kJ/mol

(c) Ethanol reacts with methanoic acid, HCOOH, in the presence of an acid catalyst to form an ester.

The equation for the reaction is

$$C_2H_5OH + HCOOH \rightleftharpoons HCOOC_2H_5 + H_2O$$

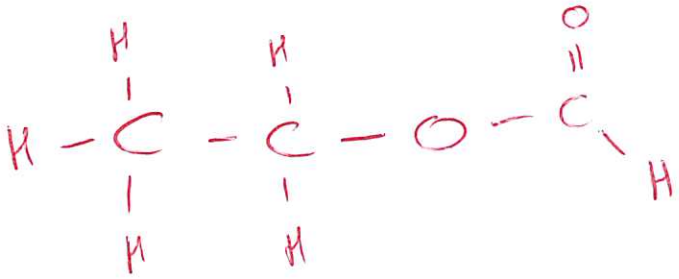
(i) Give the name of the ester that forms.

(1)

ethyl methanoate.

(ii) Draw the displayed formula for this ester.

(2)



(iii) When this reaction takes place in a sealed container, the reaction can reach dynamic equilibrium.

Give two characteristics of a reaction at dynamic equilibrium.

(2)

1 forward and reverse reactions occur at the same rate.

2 Concentrations of reactants and products don't change.

(d) Methanoic acid reacts with sodium carbonate to form sodium methanoate, carbon dioxide and water.

The equation for the reaction is

$$2HCOOH + Na_2CO_3 \rightarrow 2HCOONa + CO_2 + H_2O$$

Calculate the volume, in cm^3, of carbon dioxide gas produced when 2.3 g of methanoic acid reacts completely with sodium carbonate.

[M_r of HCOOH = 46]

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

(4)

$n(HCOOH) = \frac{mass}{Mr} = \frac{2.3}{46} = 0.05$ mol

$n(CO_2) = \frac{0.05}{2} = 0.025$ mol

$V(CO_2) = 24000 \times 0.025$

$= 600 cm^3$

volume of carbon dioxide = 600 cm^3

(Total for Question 7 = 16 marks)

TOTAL FOR PAPER = 70 MARKS

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