Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Monday 20 May 2019

Morning (Time: 1 hour 30 minutes) | Paper Reference **WCH01/01**

Chemistry

Advanced Subsidiary
Unit 1: The Core Principles of Chemistry

Candidates must have: Scientific calculator

Total Marks

Instructions

- Use **black** ink or **black** 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.*

Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
  – *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*
- A Periodic Table is printed on the back cover of this paper.

Advice

- Read each question carefully before you start to answer it.
- Show all your working in calculations and include units where appropriate.
- Check your answers if you have time at the end.

Turn over ▶

P56108A

2/1/1/1/1/

P 5 6 1 0 8 A 0 1 2 4

Pearson

SECTION A

Answer ALL the questions in this section. You should aim to spend no more than 20 minutes on this section. For each question, select one answer from A to D and put a cross in the box ☒. If you change your mind, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 The relative atomic mass of an element is always

☒ **A** the mass of an atom of the element relative to ½ the mass of a carbon-12 atom.

☒ **B** the mass of an atom of the element relative to the mass of a hydrogen atom.

☒ **C** the weighted mean mass of an atom of the element relative to the mass of a hydrogen atom.

☒ **D** the weighted mean mass of an atom of the element relative to ½ the mass of a carbon-12 atom.

(Total for Question 1 = 1 mark)

2 The value of the Avogadro constant is equal to the number of

☒ **A** grams of carbon in one mole of carbon.

☒ **B** atoms in one mole of oxygen gas.

☒ **C** atoms in one mole of helium gas.

☒ **D** ions in one mole of sodium chloride.

(Total for Question 2 = 1 mark)

3 The alkane with the same empirical formula as butane is

☒ **A** ethane.

☒ **B** propane.

☒ **C** 2-methylpropane.

☒ **D** 2,2-dimethylpropane.

(Total for Question 3 = 1 mark)

4 The percentage by mass of hydrogen in heptane, C_7H_{16}, is

☒ **A** 84.0

☒ **B** 69.6

☒ **C** 19.0

☒ **D** 16.0

(Total for Question 4 = 1 mark)

5 What is the **total** number of alkenes and cycloalkanes with the molecular formula C_4H_8?

☒ **A** 3

☒ **B** 4

☒ **C** 5

☒ **D** 6

(Total for Question 5 = 1 mark)

6 How many **electrons** are in 10.1 g of neon?

[Avogadro constant = 6.0×10^{23} mol^{-1}]

☒ **A** 6.0×10^{24}

☒ **B** 3.0×10^{24}

☒ **C** 6.0×10^{23}

☒ **D** 3.0×10^{23}

(Total for Question 6 = 1 mark)

7 Bioethanol can be made by the fermentation of glucose.

$$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$$

The atom economy by mass for the production of ethanol in this reaction is

☒ **A** 67%.

☒ **B** 51%.

☒ **C** 50%.

☒ **D** 40%.

(Total for Question 7 = 1 mark)

8 A typical adult human has 5.0 dm^3 of blood, which contains a total of 35 cm^3 of white blood cells.

What is the concentration of white blood cells, in parts per million, by volume?

☒ **A** 142.9

☒ **B** 7000

☒ **C** 7 000 000

☒ **D** 142 900 000

(Total for Question 8 = 1 mark)

9 What type of reaction occurs when dilute sulfuric acid reacts with aqueous barium chloride?

☒ **A** Displacement

☒ **B** Neutralisation

☒ **C** Oxidation

☒ **D** Precipitation

(Total for Question 9 = 1 mark)

10 When 10 cm^3 of 1.0 mol dm^{-3} hydrochloric acid is added to 5.0 cm^3 of 0.50 mol dm^{-3} sodium hydroxide in a polystyrene cup, the temperature rises by 2.3 °C.

$$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$$

The temperature rise when 10 cm^3 of 1.0 mol dm^{-3} hydrochloric acid is added to 20 cm^3 of 0.50 mol dm^{-3} sodium hydroxide is

☒ **A** 18.4 °C.

☒ **B** 9.2 °C.

☒ **C** 4.6 °C.

☒ **D** 2.3 °C.

(Total for Question 10 = 1 mark)

11 Which equation represents the **second** ionisation energy of magnesium?

☒ **A** $Mg(s) \rightarrow Mg^{2+}(s) + 2e^-$

☒ **B** $Mg(g) \rightarrow Mg^{2+}(g) + 2e^-$

☒ **C** $Mg^+(s) \rightarrow Mg^{2+}(s) + e^-$

☒ **D** $Mg^+(g) \rightarrow Mg^{2+}(g) + e^-$

(Total for Question 11 = 1 mark)

12 From aluminium to silicon, the first ionisation energy increases by about 200 kJ mol^{-1}.

From silicon to phosphorus, the first ionisation energy

☒ **A** increases by about 200 kJ mol^{-1}.

☒ **B** does not change.

☒ **C** decreases by about 200 kJ mol^{-1}.

☒ **D** increases by about 400 kJ mol^{-1}.

(Total for Question 12 = 1 mark)

13 The melting temperatures, in kelvin, of nine successive elements in the Periodic Table are given.

The numbers are not the atomic numbers of the elements.

Element	1	2	3	4	5	6	7	8	9
T_m / K	25	371	922	933	1683	863	386	172	84

Which numbered element is in Group 2 of the Periodic Table?

☒ **A** 2

☒ **B** 3

☒ **C** 4

☒ **D** 5

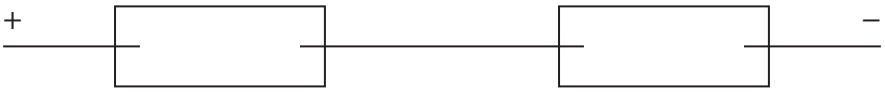
(Total for Question 13 = 1 mark)

14 Which is correct for the elements going **down** Group 1?

	Melting temperature	First ionisation energy
☒ **A**	decreases	decreases
☒ **B**	decreases	increases
☒ **C**	increases	decreases
☒ **D**	increases	increases

(Total for Question 14 = 1 mark)

15 Two microscope slides covered in damp filter paper are connected to wires by crocodile clips.



A crystal of copper(II) sulfate is placed in the centre of the left-hand slide and a crystal of potassium manganate(VII) is placed in the centre of the right-hand slide.

A DC electrical supply is connected to make the left-hand side positive as shown.

The directions in which the blue colour and the purple colour move are

	Blue colour	Purple colour
☒ **A**	left	right
☒ **B**	left	left
☒ **C**	right	left
☒ **D**	right	right

(Total for Question 15 = 1 mark)

16 Which molecule has the same **total** number of electrons as a molecule of carbon dioxide?

☒ **A** N_2O

☒ **B** NO_2

☒ **C** COS

☒ **D** CS_2

(Total for Question 16 = 1 mark)

17 Which species move when a potential difference is applied to a solid metal?

- ☒ **A** Positive ions only
- ☒ **B** Electrons only
- ☒ **C** Positive and negative ions
- ☒ **D** Positive ions and electrons

(Total for Question 17 = 1 mark)

18 The numbers of sigma (σ) and pi (π) bonds in ethene are

	sigma (σ)	pi (π)
☒ **A**	four	two
☒ **B**	four	one
☒ **C**	five	two
☒ **D**	five	one

(Total for Question 18 = 1 mark)

19 Crude oil is separated by fractional distillation in a fractionating column.

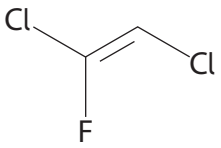
The fractions obtained have different boiling temperature ranges and mean molar masses.

How does the boiling temperature range and the mean molar mass of the fractions change, moving **down** the fractionating column?

	Boiling temperature	Mean molar mass
☒ **A**	increases	increases
☒ **B**	decreases	increases
☒ **C**	increases	decreases
☒ **D**	decreases	decreases

(Total for Question 19 = 1 mark)

20 What is the systematic name for the chlorofluorocarbon compound shown?



- ☒ **A** *E*-1,2-dichloro-2-fluoroethene
- ☒ **B** *Z*-1,2-dichloro-2-fluoroethene
- ☒ **C** *E*-1,2-dichloro-1-fluoroethene
- ☒ **D** *Z*-1,2-dichloro-1-fluoroethene

(Total for Question 20 = 1 mark)

TOTAL FOR SECTION A = 20 MARKS

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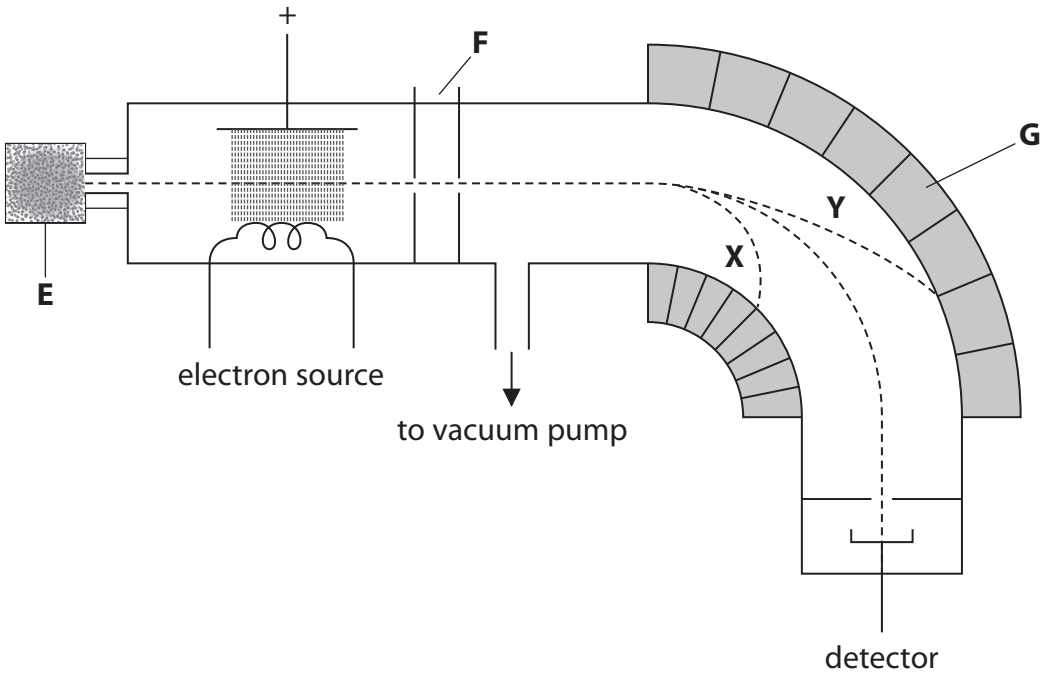
SECTION B

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

21 This question is about mass spectrometry, and the elements gold and copper.

A diagram of a mass spectrometer is shown.



(a) (i) Identify the three parts of the mass spectrometer, **E**, **F** and **G**.

(3)

E .....

F .....

G .....

*(ii) Suggest how the ions travelling along paths **X** and **Y** differ in mass or charge from the ions reaching the detector.

(2)

.....

.....

.....

.....

(b) Copper has two stable isotopes with mass numbers of 63 and 65.

(i) For each isotope of copper, complete the table to show the number of protons, neutrons and electrons present in Cu^+ ions.

(2)

Mass number	Number of protons	Number of neutrons	Number of electrons
63			
65			

(ii) State the meaning of the term isotopes, quoting information from the table.

(1)

.....

.....

.....

.....

(c) Gold and copper are used to make alloys.

The composition of gold-copper alloys may be found using mass spectrometry.

The mass number and percentage abundance of each isotope in an alloy are given in the table.

Mass number	Percentage abundance
63	36
65	15
197	49

(i) Calculate the relative atomic mass of copper to **one decimal place** using the data for the two copper isotopes only.

You must show your working.

(3)

(ii) Calculate the percentage by mass of copper and of gold in this alloy.
Give your answer to **two** significant figures.

(2)

(iii) The purity of gold by mass is often expressed in carats, where pure gold is 24 carat.

Calculate the purity of this gold alloy in carats.

Give your answer to **two** significant figures.

(1)

(Total for Question 21 = 14 marks)

22 This question is about some reactions of acids.

(a) Copper(II) oxide reacts with sulfuric acid to form copper(II) sulfate.

(i) State what you would **see** on adding a small amount of copper(II) oxide to excess dilute sulfuric acid, and warming the mixture.

(2)

.....

.....

(ii) Write the **ionic** equation, including state symbols, for this reaction.

(2)

(b) Magnesium reacts with hydrochloric acid to form magnesium chloride and hydrogen gas.

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

Calculate the volume of hydrogen formed at room temperature and pressure (r.t.p.) when excess magnesium reacts with 25.0 cm^3 of 0.500 mol dm^{-3} hydrochloric acid.

[Molar volume of a gas at r.t.p. is 24.0 dm^3 mol^{-1}]

(3)

(c) Write the **ionic** equation for the reaction in solution of any strong acid with any strong alkali.
State symbols are not required.

(1)

(Total for Question 22 = 8 marks)

23 This question is about the lattice energy of lithium sulfide, Li_2S.

(a) Complete the electronic configuration for the element sulfur.

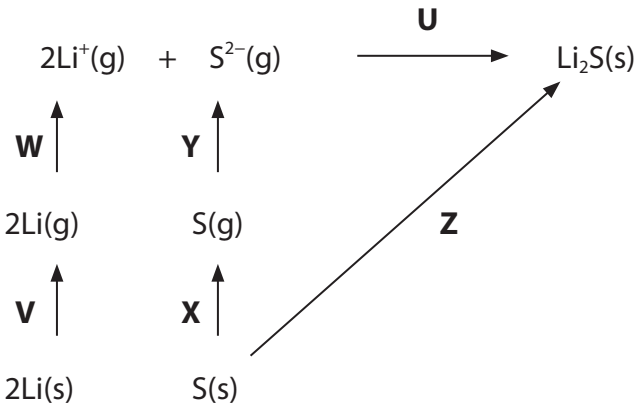
(1)

$1s^2$ .....

(b) Draw a dot-and-cross diagram for lithium sulfide.
Show outer shell electrons only.

(2)

(c) An energy cycle used to determine the experimental lattice energy, **U**, of lithium sulfide is shown.



(i) Complete the list by identifying the enthalpy or energy changes represented by **W**, **X**, **Y** and **Z**.
Include any appropriate multiples.

(4)

V 2 × enthalpy change of atomisation of Li

W .....

X .....

Y .....

Z .....

(ii) Complete the equation for the lattice energy, **U**, in terms of **V**, **W**, **X**, **Y**, and **Z**.

(1)

U =

(d) Lattice energies can be obtained experimentally from the Born-Haber cycle or from theoretical calculation.

*(i) The theoretical lattice energies of four compounds are shown.

Compound	Lattice energy / kJ mol^{-1}
LiF	−1031
LiCl	−845
Li_2O	−2799
Li_2S	−2376

Explain, using the data, the factors that affect the magnitude of the lattice energy of these compounds.

(3)

*(ii) The value of the experimental lattice energy of lithium sulfide is −2499 kJ mol^{-1}. Whereas the theoretical value is −2376 kJ mol^{-1}.

Explain the difference between the experimental and theoretical values for the lattice energy of lithium sulfide.

(3)

(iii) Draw a diagram to show the shapes of the electron clouds around the lithium and sulfide ions.

(1)

Li^+ S^{2-}

(Total for Question 23 = 15 marks)

24 This question is about butane, C_4H_{10}, and but-2-ene, C_4H_8.

(a) (i) Write equations for the complete combustion of butane and but-2-ene in oxygen. State symbols are not required.

(2)

Butane equation

But-2-ene equation

(ii) 0.1 mol of butane is burned in 0.8 mol (an excess) of oxygen gas.

0.1 mol of but-2-ene is also burned in 0.8 mol (an excess) of oxygen gas.

Calculate the final total number of moles of gas at the end of these reactions at **room temperature**.

(2)

Moles of gas from butane .....

Moles of gas from but-2-ene .....

(b) Butane and but-2-ene react differently with bromine.

(i) Give the condition needed for the reaction of bromine with butane.

(1)

.....

(ii) Give the initiation step for the reaction of bromine with butane.
Show the movement of electrons with curly half-arrows.

(2)

(iii) Give **two** propagation steps for the reaction of bromine with butane to form C_4H_9Br.

Curly half arrows are not required.

(2)

(iv) Give **one** termination step for the reaction of bromine with butane, forming an **organic** compound.

Curly half arrows are not required.

(1)

(v) Give the mechanism for the reaction of bromine with but-2-ene.

Include curly arrows, and relevant dipoles and lone pairs.

(4)

(c) But-2-ene reacts with hydrogen bromide. Give the **skeletal** formula for the product.

(1)

(d) But-2-ene reacts with acidified potassium manganate(VII).

Give the **structural** formula and name of the product.

(2)

Name .....

(e) But-2-ene can be polymerised.

Write the balanced equation, using **displayed** formulae, for the polymerisation of but-2-ene.

(2)

(f) (i) Use the data to calculate the enthalpy change of formation, ΔH_f, of but-2-ene.

Quantity	Energy/ kJ mol^{-1}
$\Delta H_{at,298}[\frac{1}{2}H_2(g)]$	+218
$\Delta H_{at,298}$[C(s, graphite)]	+717
E(C—C)	+347
E(C═C)	+612
E(C—H)	+413

(3)

$$4C(s) + 4H_2(g) \rightarrow C_4H_8(g)$$

(ii) Suggest why your answer to (f)(i) is unlikely to be exactly in agreement with the value in a data book.

(1)

.....

.....

(Total for Question 24 = 23 marks)

TOTAL FOR SECTION B = 60 MARKS
TOTAL FOR PAPER = 80 MARKS

The Periodic Table of Elements

1	2											3	4	5	6	7	0 (8)
							1.0 H hydrogen 1										(18) 4.0 He helium 2
(1)	(2)		Key: relative atomic mass / atomic symbol / name / atomic (proton) number									(13)	(14)	(15)	(16)	(17)	
6.9 Li lithium 3	9.0 Be beryllium 4											10.8 B boron 5	12.0 C carbon 6	14.0 N nitrogen 7	16.0 O oxygen 8	19.0 F fluorine 9	20.2 Ne neon 10
23.0 Na sodium 11	24.3 Mg magnesium 12	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	27.0 Al aluminium 13	28.1 Si silicon 14	31.0 P phosphorus 15	32.1 S sulfur 16	35.5 Cl chlorine 17	39.9 Ar argon 18
39.1 K potassium 19	40.1 Ca calcium 20	45.0 Sc scandium 21	47.9 Ti titanium 22	50.9 V vanadium 23	52.0 Cr chromium 24	54.9 Mn manganese 25	55.8 Fe iron 26	58.9 Co cobalt 27	58.7 Ni nickel 28	63.5 Cu copper 29	65.4 Zn zinc 30	69.7 Ga gallium 31	72.6 Ge germanium 32	74.9 As arsenic 33	79.0 Se selenium 34	79.9 Br bromine 35	83.8 Kr krypton 36
85.5 Rb rubidium 37	87.6 Sr strontium 38	88.9 Y yttrium 39	91.2 Zr zirconium 40	92.9 Nb niobium 41	95.9 Mo molybdenum 42	[98] Tc technetium 43	101.1 Ru ruthenium 44	102.9 Rh rhodium 45	106.4 Pd palladium 46	107.9 Ag silver 47	112.4 Cd cadmium 48	114.8 In indium 49	118.7 Sn tin 50	121.8 Sb antimony 51	127.6 Te tellurium 52	126.9 I iodine 53	131.3 Xe xenon 54
132.9 Cs caesium 55	137.3 Ba barium 56	138.9 La* lanthanum 57	178.5 Hf hafnium 72	180.9 Ta tantalum 73	183.8 W tungsten 74	186.2 Re rhenium 75	190.2 Os osmium 76	192.2 Ir iridium 77	195.1 Pt platinum 78	197.0 Au gold 79	200.6 Hg mercury 80	204.4 Tl thallium 81	207.2 Pb lead 82	209.0 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

140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	[147] Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	163 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
232 Th thorium 90	[231] Pa protactinium 91	238 U uranium 92	[237] Np neptunium 93	[242] Pu plutonium 94	[243] Am americium 95	[247] Cm curium 96	[245] Bk berkelium 97	[251] Cf californium 98	[254] Es einsteinium 99	[253] Fm fermium 100	[256] Md mendelevium 101	[254] No nobelium 102	[257] Lr lawrencium 103

* Lanthanide series

* Actinide series