cookie

Practice paper: mark scheme

GCSE Double Award Science Higher, practice paper: Chemistry Unit C1 (CCEA style)

In the style of CCEA GCSE Science Double Award (2017) Unit C1: Chemistry, Higher Tier

Practice paper written by cookie in the style of CCEA GCSE Science Double Award (2017) Unit C1: Chemistry, Higher Tier. Not a CCEA paper; not affiliated with or endorsed by CCEA.

This mark scheme was written by cookie with its practice paper. Each row gives the answer, the marks and how they are given; where an answer is worded differently but means the same, give the mark.

Key

- Each line is one marking point, worth one mark unless it says otherwise.
- allow an answer that is also acceptable; do not accept an answer that gets no mark; ignore words that neither gain nor lose the mark
- Extended responses (6 marks) are marked by level: decide the level from the descriptors, then the mark within it.

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Question	Answer and marking	Marks
1(a)	**Answer: Magnesium atom: 12 protons, 14 neutrons, 12 electrons. Sulfide ion: 16 protons, 16 neutrons, 18 electrons. Calcium ion: 20 protons, 20 neutrons, 18 electrons.** magnesium atom: 12, 14, 12; [1] sulfide ion: 16, 16, 18; [1] calcium ion: 20, 20, 18; [1] *Each mark needs the whole row correct. Do not accept 14 electrons for the sulfide ion or 22 electrons for the calcium ion (the charge applied the wrong way).*	**3**
1(b)	**Answer: 2,8,8** 2,8,8; [1] *Allow 2.8.8 or 2:8:8. Do not accept 2,8,6 (the configuration of a sulfur atom).*	**1**
1(c)	**Answer: 20.2** (20 × 90.5) + (21 × 0.3) + (22 × 9.2) / 1810 + 6.3 + 202.4 = 2018.7; [1] ÷ 100; [1] = 20.2; [1] *An answer of 20.2 with working scores 3 marks. An answer of 20.187 or 20.19 (not to one decimal place) scores 2 marks. Carry an error through from one wrong product. Do not accept a simple mean of the mass numbers (21) for any mark.*	**3**
1(d)	**Answer: They have the same number of electrons, arranged in the same way (the same electronic configuration, 2,8).** (both have) the same number of electrons / the same electronic configuration / the same number of outer-shell electrons; [1] *Do not accept 'the same number of protons' on its own. Do not accept 'they are the same element' on its own. Ignore references to neutrons.*	**1**
2(a)	**Answer: The student is wrong: rubidium will sink, because its density (1.53 g/cm^3) is greater than the density of water (1.00 g/cm^3).** rubidium sinks / does not float / the student is wrong; [1] (because) its density (1.53 g/cm^3) is greater than that of water (1.00 g/cm^3) / rubidium is denser than water; [1] *The second mark needs a comparison with water, using the data or in words. 'The student is wrong' with no reason scores 0. Do not accept 'rubidium is heavier than water' for the second mark. Ignore any description of how vigorous the reaction is.*	**2**
2(b)	**Answer: $2Rb(s) + 2H_2O(l) \rightarrow 2RbOH(aq) + H_2(g)$** correct formulae: $Rb + H_2O \rightarrow RbOH + H_2$; [1] correct balancing: $2Rb + 2H_2O \rightarrow 2RbOH + H_2$; [1] correct state symbols: (s), (l), (aq), (g); [1] *The balancing mark depends on correct formulae. Allow multiples, e.g. $Rb + H_2O \rightarrow RbOH + ½H_2$. The state symbol mark can be awarded on an unbalanced equation with correct formulae. Do not accept Rb_2O or RbH as a product.*	**3**
2(c)	**Answer: Purple (violet): a strong alkali.** purple / violet and strong alkali / pH 12–14; [1] *Both are needed for the mark. Allow 'alkaline, pH 13' or 'pH 14' for 'strong alkali'. Do not accept 'blue' or 'weak alkali'.*	**1**

2(d) **1**

Answer: $Rb \rightarrow Rb^+ + e^-$

$Rb \rightarrow Rb^+ + e^-$; [1]

Allow $Rb - e^- \rightarrow Rb^+$. Ignore state symbols. Do not accept $Rb + e^- \rightarrow Rb^+$ or $Rb \rightarrow Rb^{2+} + 2e^-$.

2(e) **3**

Answer: A rubidium atom is larger, with more electron shells, so its outer electron is further from the nucleus and more shielded. The attraction between the nucleus and the outer electron is weaker, so rubidium loses its outer electron more easily.

a rubidium atom is larger / has more (occupied) shells (than a sodium atom); [1]

so its outer electron is further from the nucleus / is more shielded (by inner shells); [1]

so there is less attraction between the nucleus and the outer electron, so it is lost more easily; [1]

Answers must make clear which atom is being described; allow the reverse argument for sodium. The third mark needs the idea of the electron being lost (more easily). Do not accept 'rubidium gains electrons more easily'. Do not accept answers about molecules or bonds breaking.

3(a) **2**

Answer: Nitric acid is a strong acid and is completely ionised in water; ethanoic acid is a weak acid and is only partially ionised. So the nitric acid solution has a higher concentration of hydrogen ions, which gives it a lower pH.

nitric acid is (a strong acid and is) completely ionised but ethanoic acid is (a weak acid and is) partially ionised (in water); [1]

so nitric acid has a higher concentration of hydrogen ions / $H^+(aq)$ (so a lower pH); [1]

Allow 'dissociated' for 'ionised'. The first mark needs both acids. Do not accept 'nitric acid is more concentrated' (the question states the concentrations are the same). Do not accept 'nitric acid has more hydroxide ions'.

3(b)(i) **3**

Answer: $2KHCO_3 + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O + 2CO_2$

correct reactants: $KHCO_3 + H_2SO_4$; [1]

correct products: $K_2SO_4 + H_2O + CO_2$; [1]

correct balancing: $2KHCO_3 + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O + 2CO_2$; [1]

The balancing mark depends on all formulae being correct. Ignore state symbols. Do not accept KSO_4 or $K(HCO_3)$.

3(b)(ii) **2**

Answer: Bubble the gas through limewater; the limewater changes from colourless to milky.

bubble the gas through limewater / calcium hydroxide solution; [1]

(changes from) colourless to milky / cloudy (white); [1]

Allow 'turns milky' or 'clear to milky' for the second mark. Do not accept a lighted or glowing splint test for any mark. The second mark depends on limewater being named.

3(c) **2**

Answer: $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

$H^+ + OH^- \rightarrow H_2O$; [1]

state symbols (aq), (aq), (l); [1]

The state symbol mark depends on the correct equation. Do not accept a full symbol equation for a named acid and alkali. Do not accept $H_2O(aq)$.

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4 **Answer: Add a few drops of each halogen solution to separate samples of the two potassium halide solutions that do not contain the same halogen, and look for a colour change. Chlorine turns potassium bromide solution yellow-orange and potassium iodide solution brown; bromine turns potassium iodide solution brown but does not react with potassium chloride; iodine reacts with neither. A more reactive halogen displaces a less reactive one from its compound, so the order is chlorine > bromine > iodine. A halogen atom reacts by gaining one electron. Down the group the atoms are larger, with more shells, so the outer shell is further from the nucleus and more shielded; the attraction for an extra electron is weaker, so the halogen is less reactive.** **6**

Band A (5–6 marks): A full answer that deals with all three bullet points and gives at least eight points from the indicative content in a sensible order. Terms such as displace, halide and electron shell are used correctly throughout, and spelling, punctuation and grammar are accurate, so the meaning is always clear.
Band B (3–4 marks): A sound answer that gives five to seven points from the indicative content, covering at least two of the bullet points. Some specialist terms are used correctly, and spelling, punctuation and grammar are good enough for the meaning to be clear.
Band C (1–2 marks): A brief answer that gives one to four points from the indicative content. Few specialist terms are used, and weak spelling, punctuation or grammar may make some of the meaning unclear.
Band D (0 marks): Nothing worth credit.
Indicative content:
Method:
add (a few drops of) each halogen solution to samples of the other two potassium halide solutions in test tubes / on a spotting tile
do not add a halogen to its own halide / use equal volumes / shake and look for a colour change
use a fume cupboard (chlorine and bromine are toxic)
Results:
chlorine with potassium bromide: colourless to yellow / orange (bromine formed)
chlorine with potassium iodide: colourless to brown (iodine formed)
bromine with potassium iodide: brown solution (iodine formed)
no change when bromine is added to potassium chloride, or iodine to potassium chloride or potassium bromide
Explanation:
a more reactive halogen displaces a less reactive halogen from a solution of its compound
chlorine displaces both others and iodine displaces neither, so the order is chlorine > bromine > iodine
a halogen atom reacts by gaining one electron (to form a negative ion)
down the group the atoms are larger / have more shells, so the outer shell is further from the nucleus / more shielded
so there is less attraction for the extra electron, it is gained less easily and reactivity decreases
Within a band, award the higher mark where the written communication is better. To reach Band A the answer must include at least one correct colour change and an explanation in terms of gaining an electron. Do not credit 'chlorine displaces chloride' or answers that describe the halogen losing electrons. Allow yellow, orange or yellow-orange for bromine in solution, and yellow-brown or brown for iodine in solution. Balanced equations are not needed but may be credited as evidence of a result.

5(a) **Answer: 3 shared pairs and 1 lone pair.** **2**

shared pairs: 3; [1]

lone pairs: 1; [1]

The numbers must be clearly linked to shared and lone pairs. Do not accept 6 for the shared pairs (that is the number of shared electrons).

5(b) **Answer: The carbon atom forms a double covalent bond with each sulfur atom (S=C=S), so 8 electrons are shared in total.** **2**

two double (covalent) bonds / a double bond between carbon and each sulfur atom / S=C=S; [1]

8 (electrons shared); [1]

Allow 'four shared pairs' for the second mark. Do not accept 'two single bonds' or 4 electrons for the second mark. Do not accept 'ionic bonds'.

5(c) **Answer: W giant ionic lattice; X molecular covalent; Y giant covalent; Z metallic.** **4**

W: giant ionic (lattice); [1]

X: molecular covalent; [1]

Y: giant covalent; [1]

Z: metallic; [1]

Allow 'simple molecular' or 'simple covalent' for X. Do not accept 'covalent' on its own for X or Y. Each type may be given only once; if a type is used for two substances, credit neither.

5(d) **Answer: The forces between the molecules (van der Waals' forces) are weak, so little energy is needed to overcome them and separate the molecules.** **2**

(the) forces between (the) molecules / intermolecular forces / van der Waals' forces are weak; [1]

so little energy is needed to overcome them / separate the molecules; [1]

Do not accept 'the covalent bonds are weak' or 'little energy is needed to break the covalent bonds' for either mark. The second mark depends on the first.

6(a) **Answer: Each carbon atom is covalently bonded to four other carbon atoms in a giant structure, so there are a great many strong covalent bonds that need a lot of energy to break.** **2**

each carbon atom is (covalently) bonded to four other carbon atoms / giant (covalent) structure; [1]

(many) strong covalent bonds which need a lot of energy to break; [1]

Do not accept 'strong intermolecular forces' or 'strong ionic bonds'. Do not accept 'diamond is a molecule'.

6(b) **Answer: Graphite is made of layers of carbon atoms with only weak forces between the layers, so the layers slide over each other easily.** **2**

(graphite has) layers (of carbon atoms) with weak forces / van der Waals' forces between them; [1]

so the layers can slide over each other (easily); [1]

Do not accept 'weak covalent bonds between the layers'. Do not accept 'the atoms slide over each other'. Ignore references to delocalised electrons.

6(c)(i) **1**

Answer: 0.000 000 035 m = 35 nm, which is between 1 nm and 100 nm, so they are nanoparticles.

35 (nm) and within the range 1–100 nm; [1]

Both the size in nm and the comparison with 1–100 nm are needed. Allow 3.5 × 10^{-8} m compared correctly with 1 × 10^{-9} m and 1 × 10^{-7} m.

6(c)(ii) **1**

Answer: They may damage cells in the body (or harm the environment).

(potential) damage to (skin / body) cells / harmful effects on the environment (e.g. aquatic life); [1]

Allow 'they may get into the body through the skin and harm cells'. Do not accept 'they may not protect the skin' or 'they are expensive'.

7(a)(i) **3**

Answer: Rf values 0.20 and 0.68, so the ink contains P and R.

2.5 ÷ 12.5 = 0.20 (0.2); [1]

8.5 ÷ 12.5 = 0.68; [1]

P and R; [1]

Carry an error through: the third mark can be awarded for colourings that match the candidate's calculated Rf values. Do not accept Rf values greater than 1 (distance of solvent divided by distance of spot) for the first two marks. Do not accept Q or S as an extra answer (listing).

7(a)(ii) **1**

Answer: That colouring is insoluble in the solvent.

the substance / colouring is insoluble in the solvent; [1]

Allow 'does not dissolve in the solvent'. Do not accept 'it is too heavy' or 'it is not a colouring'.

7(a)(iii) **1**

Answer: Pencil (graphite) is insoluble in the solvent and does not move, but the dyes in ink would dissolve and separate, spoiling the chromatogram.

pencil / graphite does not dissolve in the solvent / does not move up the paper / ink would dissolve and separate (and mix with the spots); [1]

Do not accept 'pencil can be rubbed out' or 'pencil is easier to see'.

7(b)(i) **2**

Answer: Fractional distillation: the liquids are miscible but have different boiling points, so propanone, with the lower boiling point, boils off first and is collected.

fractional distillation; [1]

(the liquids are miscible and) have different boiling points, so propanone (with the lower boiling point) evaporates / distils first; [1]

Do not accept 'distillation' or 'simple distillation' for the first mark. Do not accept filtration, crystallisation or chromatography. The second mark can be awarded with 'distillation' but not with a method that does not involve boiling.

7(b)(ii) **1**

Answer: Fraction 2, because it boiled over a range of temperatures; a pure substance boils at one fixed temperature.

fraction 2 and it boils / distils over a range of temperatures (not at one fixed temperature); [1]

Both the fraction and the reason are needed. Do not accept fraction 1 or 3. Do not accept 'it is in the middle' as a reason.

8(a) **Answer: 133.5** **1**

133.5; [1]

Do not accept 134 or 62.5.

8(b) **Answer: 20.2%** **2**

27 ÷ 133.5 × 100; [1]

= 20.2 (%); [1]

Carry an error through from (a). Allow 20.22 for 1 mark (not to one decimal place). An answer of 79.8 (the percentage of chlorine) scores 1 mark only if the working shows 106.5 ÷ 133.5 × 100.

8(c)(i) **Answer: Aluminium: 0.150 mol. Chlorine: 0.200 mol.** **2**

4.05 ÷ 27 = 0.15 (mol of Al); [1]

14.20 ÷ 71 = 0.2 (mol of Cl_2); [1]

Allow 0.150 and 0.200. Do not accept 0.4 mol of Cl_2 (dividing by 35.5) for the second mark, but carry it through the later parts.

8(c)(ii) **Answer: 0.150 mol of aluminium would need 0.150 × 3 ÷ 2 = 0.225 mol of chlorine, but only 0.200 mol is present, so the chlorine runs out first (it is limiting) and aluminium is in excess.** **2**

use of the 2 : 3 ratio: 0.15 mol of Al needs 0.225 mol of Cl_2 / 0.2 mol of Cl_2 reacts with 0.133 mol of Al; [1]

comparison: only 0.2 mol of Cl_2 is present / more than 0.133 mol of Al is present, so chlorine is used up first; [1]

Carry an error through from (c)(i): award the marks for a correct comparison using the candidate's figures. 'Chlorine, because there are fewer moles' (ignoring the ratio) scores 0.

8(c)(iii) **Answer: 0.45 g** **2**

moles of Al that react = 0.2 × 2 ÷ 3 = 0.133 (mol), so mass reacting = 0.133 × 27 = 3.6 (g); [1]

mass left = 4.05 − 3.60 = 0.45 (g); [1]

Allow 0.46 g from rounding 0.133 early. Allow the moles route: 0.15 − 0.133 = 0.0167 mol left × 27 = 0.45 g. An answer of 3.6 g (the mass that reacts) scores 1 mark. Carry an error through from (c)(i).

8(c)(iv) **Answer: 17.8 g** **2**

moles of $AlCl_3$ = 0.2 × 2 ÷ 3 = 0.133 (mol); [1]

mass = 0.133 × 133.5 = 17.8 (g); [1]

An answer of 17.8 g with working scores 2 marks. Allow 17.76 or 17.7 from rounding 0.133 early. Carry an error through from (a) and (c)(i). Taking aluminium as limiting gives 0.15 × 133.5 = 20.0 g, which scores 1 mark. Using a 1 : 1 ratio with chlorine (0.2 × 133.5 = 26.7 g) scores 1 mark.

8(d) **Answer: 87.6%** **2**

15.6 ÷ 17.8 × 100; [1]

= 87.6 (%); [1]

Carry an error through from (c)(iv): e.g. 15.6 ÷ 20.0 × 100 = 78.0% scores 2 marks. Allow 87.64 for 1 mark (not to one decimal place). Do not accept a percentage greater than 100 for the second mark.

Total: 70 marks