AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



MARK SCHEME

4.8.1 PURITY, FORMULATIONS AND CHROMATOGRAPHY (PACK 2)

SCORE	PERCENTAGE
/146	%

STEMUP

These questions belong to AQA, not to us.

The examination questions, mark schemes and examiner comments in this pack were written and published by AQA. They are past assessment materials, reproduced here so that students can revise from them.

What we do not own

STEMUP is not affiliated with AQA and does not own, and makes no claim to own, any of the question, mark scheme or examiner report material in this pack. AQA has not endorsed, approved or been involved in the production of it. AQA and the qualification titles used here belong to their respective owners and appear for identification only.

Where to find the originals

AQA publishes its past papers, mark schemes and examiner reports. Always check the current specification at aqa.org.uk before you revise, because content and wording can change between series.

If you hold the rights to any material in this pack and would like it amended or removed, contact admin@stemup.co.uk and we will act on it.

Q1.

(a) red **and** blue

1

unknown

1

both needed for the mark

(b) red

ignore black

1

travels least far

dependent on correct colour allow closest to the start line

1

(c) distance moved by green colour = 12 mm

allow 10 to 14 mm

1

distance moved by solvent = 36 mm

allow 35 to 36 mm

1

$\frac{12}{36}$

allow correct substitution of student's measurements

1

R_f value = 0.33

*allow correct answer from student's measurements for **2** marks*

1

[8]

Q2.

(a) 80

1

(b) volcanoes

allow ammonia
allow meteorites

1

(c) ⇌

ignore any extra words

1

(d) rate

STEMUP.CO.UK

allow speed
allow pace

*do **not** accept time*
*do **not** accept amount*
*do **not** accept level*
*do **not** accept point*

1

(e) a mixture designed as a useful product

1

(f) bar for K to 5.8%

allow ± ½ a small square

1

(g) $\frac{0.225 \times 100}{3.0}$

1

(h) use has increased

1

(increase is) less in country B
or (increase is) less in country D

allow (increase is) more in country A
***or** (increase is) more in country C*

1

example of data

1

[10]

Q3.

(a) 16(.0)

1

(b) advantage: more accurate result

*do **not** accept reliable*

1

disadvantage: takes a long(er) time, more energy needed (to heat more water)

ignore expensive

1

(c) pure: no dissolved solids / impurities
or no (dissolved) chlorine

allow only water / H_2O
ignore safe to drink

and
potable: has dissolved solids / impurities
or has (dissolved) chlorine

ignore safe to drink

1

a clear comparative statement referring to solutes gains the mark

STEMUP.CO.UK

(d) groundwater:
- filtered

allow acceptable method of filtration

1

- sterilised

allow acceptable method of sterilisation

1

groundwater:
- distilled **or** reverse osmosis

allow desalination
ignore salt removed
ignore boiling alone
ignore filtering
*do **not** accept fractional distillation*

1

(e) $\frac{2.2}{100} \times 6.50$

1

(=) 0.143 (g)

1

an answer of 0.143 (g)
***or** 0.14 (g) scores **2** marks*

[9]

Q4.

(a) a mixture designed as a useful product

1

(b) mass = 14 520 g

1

$(=)\frac{14\,520}{80\ (\text{mol})}$

allow correct substitution of incorrectly converted mass
must use M_r given (80) to gain marks in steps 2 and 3

1

(=) 181.5 (mol)

1

(=) 1.8×10^2 (mol)

allow answer correctly given in standard form to correct sig figs from an incorrect calculation

1

*an answer of 1.8×10^2 (mol) gains **4** marks*

(c) (giant) lattice

allow giant structure

1

STEMUP.CO.UK

ionic

1

strong bonds **or** strong electrostatic forces

*do **not** accept strong intermolecular forces / bonds*

1

large amounts of energy needed to overcome

ignore heat

1

***max 2 marks** for incorrect reference to bonding **or** structure **or** particles*

[9]

Q5.

(a) (wear safety) goggles

allow (wear) <u>safety</u> glasses
allow (wear) eye protection
allow keep ethanol away from flame or in a water bath
allow use tweezers or a glass rod to remove leaf from ethanol / water
ignore gloves

1

(b) iodine solution

1

(c) blue-black

1

(d) separate

1

mobile

1

in this order only

(e) $\frac{17}{110}$

allow 0.154545 or correctly rounded answer

1

= 0.15

allow an answer from an incorrect calculation correctly given to 2 significant figures

1

*an answer of 0.15 scores **2** marks*

(f) carotene

1

[8]

STEMUP.CO.UK

Q6.

(a) (boil ethanol) in a water bath

1

(b) (test) add iodine (solution)

1

(result) blue-black

allow black
allow blue / black
allow dark blue
ignore purple unqualified

1

(c) solvent moves through paper

1

different pigments have different solubilities in solvent
or
different pigments have different attractions for the paper

1

(and so) are carried different distances

1

allow references to solvent as the mobile phase and paper as the stationary phase

(d) any **one** from:

- R_f values overlap
  or
  0.20 is within range for two pigments
- R_f ranges overlap
- could be chlorophyll b or xanthophyll
- there may be other pigments (that are not in table 2)

1

(e) $$(R_f \text{ value}) = \frac{\text{distance moved by substance}}{\text{distance moved by solvent}}$$

1

$$0.89 = \frac{\text{distance moved by substance}}{140}$$

or

$$0.98 = \frac{\text{distance moved by substance}}{140}$$

1

(distance moved by substance)
= 0.89 × 140
or
= 0.98 × 140

1

STEMUP.CO.UK

= 125 / 124.6 **or** 137 / 137.2

1

(from) 125 / 124.6 (mm to) 137 / 137.2 (mm)

1

*an answer of (from) 125 / 124.6 (mm to) 137 / 137.2 (mm) scores **5** marks*

*calculation using an incorrect distance moved by solvent scores a maximum of **4** marks*

(f) **Level 3:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.

5–6

Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logically linking. The resulting account is not fully clear.

3–4

Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.

1–2

No relevant content

0

Indicative content

- variation arising from mutations
- mutations occurring randomly
- produce a different protein / pigment / enzyme responsible for pigment production
- produce if more likely to survive
- will pass on favourable genes
- idea of timescale
- if more light captured, faster rate of photosynthesis
- increased photosynthesis causes faster growth
- outcompete neighbouring plants
- different colours of light have different wavelengths
- absorbing wider range of wavelengths means more light is absorbed
- more likely to survive in changing conditions

[18]

Q7.

(a) formulation

1

(b) 1/10

1

(c) make them palatable

1

(d) neutralisation

1

(e) carbon dioxide

1

STEMUP.CO.UK

(f) water has a boiling point of 100 °C

1

water has a melting point lower than room temperature

1

(g) $CaCl_2$

1

(h) crushed

1

melted

must be in this order

1

[10]

Q8.

(a) more than 1 dot in a vertical line

1

(b) correct equation and substitution 7/39

accept R_f = distance moved by spot C / distance moved by solvent

1

calculation and answer 0.1795

1

answer to 2 significant figures 0.18

1

(c)

Level 3: The plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5-6
Level 2: The plan would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.	3-4
Level 1: The plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1-2
No relevant content	0
Indicative content • put dots of known colours, and a dot of the ink on a pencil line on the chromatography paper. • place the bottom of the paper in water, making sure the start line is above the water • leave for solvent to rise up through	

STEMUP.CO.UK

paper. • when solvent near top of paper, remove and leave to dry. • compare positions of dots for known colours with those from ink	

6

[10]

Q9.

(a) only one spot (on the chromatogram)

1

(b) (distance moved by substance =) 4.2 (cm) **and** (distance moved by solvent =) 9.4 (cm)

allow in range 4.0–4.4 (for substance)

1

$$\frac{4.2(\text{cm})}{9.4(\text{cm})}$$

1

0.4468

1

0.45

allow answer in range 0.43 to 0.47

1

(c) (made of) three substances

1

two are unknown

1

one is cocaine

1

[8]

Q10.

(a) $$\text{Rf} = \frac{\text{distance moved by substance}}{\text{distance moved by solvent}}$$

1

5.1 ± 0.1 cm **and** 6.8 ± 0.1 cm

both measurements from figure

1

$$\frac{5.1}{6.8}$$

1

0.75

allow answer in range 0.72–0.77

STEMUP.CO.UK

*allow ecf from incorrect measurements to final mark for **3** marks*

*an answer in range of 0.72–0.77 scores **4** marks*

1

(b) drug **D** contains one of the substances in **E**

1

drug **D** contains drug **B**

1

(and) a compound not found in any of the other drugs

allow an unknown substance

*if no other marks awarded allow **1** mark for it is a mixture/ impure **or** it contains three substances*

1

(c) **A** as it has travelled the furthest in the solvent

*ignore **A** unqualified*

1

(d) spot has stayed on the start line

1

(because) it is insoluble

1

[10]

Q11.

(a) Flask

1

(b) Fractional distillation

1

(c) **A** – boiling

in this order

1

B – condensing

1

(d) Octane

1

(e) Formulation

1

(f) the fuel is a pure compound

1

and crude oil is a mixture

or

the fuel is made up of four hydrocarbons

allow crude oil contains a large number of compounds and the fuel contains four

STEMUP.CO.UK

and crude oil could have many more

1

(g) (35 + 37 + 37 / 3) = 36.33

1

36

1

*allow (35 + 48 + 37 + 37 / 4 =) 39(.25) for **1** mark*

[10]

Q12.

(a) start line drawn in ink

1

(so) line would run

1

start line below solvent level

1

(so) samples would wash off

1

(b) red **and** blue

both colours needed

1

(c) yellow

1

travels furthest up the paper

1

(d) distance moved by red ink 13 ±1

*measurements in cm max **1** mark for mps 1 and 2*

1

distance from start line to solvent front 44 ±1

1

correct substitution

1

allow ecf from Table 4

correct answer

1

range if correct is 0.27 to 0.33

to 2 significant figures

1

(e) moves further **or** nearer the top of the paper

1

[13]

Q13.

STEMUP.CO.UK

(a) (medicine is) a mixture **and**

(designed as) a useful product

1

(b) sugar / flavouring

1

to make it taste better

or

colouring

to make it look more attractive

1

(c) $C_8H_9NO_2$

any order of elements

1

151

1

(d) mass of acetylsalicylic acid = 0.3 g

1

$= \frac{0.3}{100}$ (mol)

method mark – divide mass by M_r

1

= 0.00167 (mol)

allow 0.0016666(66)

1

1.67×10^{-3} (mol)

*correct answer with or without working scores **4** marks*

allow ecf from steps1, 2 and 3

1

[9]

Q14.

(a) mobile phase / solvent moves through paper

1

and carries substances different distances

1

which depend on their attraction for paper and solvent

allow which depend on solubility in solvent and attraction to paper

1

(b) **Level 2 (3–4 marks):**
A relevant and coherent description which provides a clear analysis of the chromatogram. The response makes logical links between the points raised and

STEMUP.CO.UK

uses sufficient examples
to support these links.

Level 1 (1–2 marks):
Simple statements are made which demonstrate a basic attempt to analyse the chromatogram. The response may fail to make logical links between the points raised.

0 marks:
No relevant content

Indicative content

- black ink is a mixture
- because more than one spot
- contains blue, red and yellow
- because Rf values / positions match
- does not contain green
- contains an unknown
- which is insoluble
- yellow is most soluble or has highest Rf value, blue is least

4

(c) both measurements from artwork for **1** mark (1.3 ± 0.1 cm and 5.3 ± 0.1 cm)

1

correct equation used for **1** mark

1

0.25 ± 0.02

1

*accept 0.25 ± 0.02 without working shown for **3** marks*
*allow ecf from incorrect measurement to final answer for **2** marks*

[10]

Q27.

(a) contains only one sort of atom

1

(b) platinum is not a compound / mixture / alloy

or

platinum is an element so should have own (unique) symbol

or

symbol shown represents 2 different sorts of atom

allow platinum is (an element so) not made of gold and silver

1

(c) it contains two silver ions **and** one oxide ion

maximum of 1 mark if mention of being mixed together / covalently bonded
allow silver atoms for silver ions
allow oxygen atom / ion for oxide ion

STEMUP.CO.UK

*allow for **1** mark:*
it is silver oxide
or
it is made of silver and oxygen
or
it is a compound
or
correct ratio of 2:1 atoms / ions for incorrect element(s)

2

[4]

STEMUP.CO.UK

Q1.

(a) 65% of students achieved the first marking point by stating that red and blue were in the black ink, but only a very small proportion correctly identified the other colour as unknown. Some students attempted to identify the remaining colour as green.

Provided students only gave three colours, the first marking point for red and blue was still awarded. However, when a list of four or more colours was given, the list principle was applied.

(b) 70% of students achieved the first marking point for stating that the least soluble colour was red. A sizeable minority of students thought that the least soluble colour could be green or black. 32% of students were able to give a correct reason.

A comparison with the other colours, the start line or the solvent front, was needed so answers such as ‘it doesn’t move far’ were not credited. Some students incorrectly suggested that the red colour did not move at all up the chromatography paper, or that the reason related to the darkness of the colour or its reactivity.

(c) 19% of students correctly measured both distances and were able to complete the calculation correctly. A range was allowed for the measurements.

Some students confused units, perhaps measuring in centimetres, or suggesting 120 mm and 360 mm instead of 12 mm and 36 mm respectively. Others were able to measure the distance of the green colour from the start line, but gave measurements such as 20 mm for the distance moved by the solvent front. This suggests that the term ‘solvent front’ may be unfamiliar.

A small number of students inverted the calculation, and some incorrectly rounded their final answer. Students were still able to gain the two calculation marks with incorrect measurements. It appeared that some students may not have had access to a ruler.

It was clear that a small minority of students were completely unable to access the question, as they gave descriptive answers for this numerical response.

Q2.

(a) A majority of students indicated that nitrogen makes up 20% of the Earth’s atmosphere, suggesting confusion with oxygen. 32% of students correctly ticked the box for 80%.

(b) 24% of students knew a source of nitrogen in the first billion years of the Earth’s existence, most suggesting volcanoes. The students who did not gain credit often forgot that they were asked to consider this time period and gave an answer from modern times, e.g. fertiliser, plants, animals, or human activity such as transport.

Some students revealed a misunderstanding of basic chemical principles in giving answers such as oxygen, argon, carbon dioxide or water. These elements and compounds contain no nitrogen, so cannot be its source.

(c) 35% of students achieved this mark by giving an acceptable symbol for a reversible reaction. Some students added further reactants or products, which were ignored. Incorrect responses included ↔ and ≡

STEMUP.CO.UK

(d) ‘Time’ was a frequently seen incorrect response. 16% of students achieved credit for a response such as rate, speed or pace.

(e) There were some very creative attempts at this question, however, the definition of a formulation was not well known. 4% of students were awarded this mark. There were a small number of accurate, succinct responses, but although a larger proportion of students realised that a formulation is a mixture, few were able to add that it has a use or purpose.

Some students were able to give examples, but not a definition. Others confused formulation with formula, defined a compound, or suggested that a formulation is a compound designed as a useful product.

(f) 82% of students achieved this mark with a clearly drawn bar to 5.8%. A tolerance of ± ½ square was allowed, but rarely needed. Some students appeared to mistake the scale and counted down two small squares from the 6.0% line, giving a bar to 5.6%, rather than the 5.8% they expected. A very small minority of students drew bars which finished a long way from the 5.8% line.

(g) Most students were aware that $\frac{3.0 \times 100}{0.225}$ was **not** a correct calculation for the percentage of iron in the fertilizer. However, the other three options proved almost equally popular, suggesting that many students find percentage calculations challenging. 39% of students achieved a mark here.

(h) This question discriminated well. 92% of students were able to access this question and achieve at least one mark by agreeing that the use of fertilizer increased.

Many students continued to provide some data from Figure 2, with 51% achieving two marks. A large proportion of students gave data from a country chosen to exemplify this, while others added the totals for 2003 and 2015.

10% of students went on to recognise that the increase in fertiliser use differed between the countries in Figure 2, and that in countries A or C the difference was ‘much larger’ but that it wasn’t ‘much larger’ in countries B or D.

Q3.

(a) 76% of students correctly calculated the mass as 16. Some students incorrectly calculated the mass to be 14.

(b) 56% of students achieved at least one mark; 16% achieved both. Incorrect responses describing the length of time ‘for the solids to dissolve’ were regularly seen. Marks were awarded more often for students who correctly gave a disadvantage of using a larger volume of water than those who attempted to give an advantaged by creating a list of reasons, for example reliable, accurate and precise.

(c) 27% of students correctly described the difference between pure water and potable water. ‘Dissolved’ was omitted from the majority of descriptions about potable water having chemicals, minerals or even vitamins and nutrients ‘in it’. A number of students answered in terms of the pH of the two waters.

(d) 70% of students achieved at least one on this question. 25% gave responses that gained either all three marks or two marks. Students failed to separate out their answers highlighting the differences in the treatment methods to produce potable water from ground water and seawater. ‘The water’ was filtered, sterilised and distilled to produce potable water was a common response. The higher-attaining

STEMUP.CO.UK

students gave clear, succinct responses using the correct terminology.

(e) 56% of students achieved full marks on this question. The most common mistake was not converting 2.2 into a percentage (0.022 or 2.2 ÷ 100) when multiplying by 6.50 to calculate the mass of dissolved solids.

Q4.

(a) 22% of students knew the definition from the specification or were able to give an equivalent statement. Often students mentioned only that it was 'a mixture or chemicals mixed together' but omitted the idea of 'to form a useful product'. Some students were able to give examples, but not a definition.

As the question stem mentioned fertilisers, a few students answered the question with phrases such as a substance / something to help plants grow or to enhance plant growth.

(b) 5% of students achieved full marks but many students (63%) gained some credit for their calculation. The most common answers that achieved two marks were 0.18 or 0.1815, (not converting 14.52 kg to g and an omission or incorrect conversion of their calculation into standard form to two significant figures).

An answer of 1.8×10^{-1} achieved three marks, the calculation being correct, but the students had not undertaken the initial conversion of kg into g. Several students had multiplied an answer within their calculation by Avogadro's number.

(c) 51% of students achieved some credit on this question. However, there were many references to intermolecular forces (often strong intermolecular forces), covalent bonds and molecules, all of which limited the response to a maximum of two marks.

Many students described in detail how potassium, being in Group 1 of the periodic table would transfer one electron to chlorine which is in Group 7 to obtain full outer shells meaning that the compound would have a high melting point. 'Ionic bonds' was often seen but normally as part of a lengthy explanation of how and why potassium transfers one electron to chlorine.

1% of students achieved full marks, with 7% of students achieving three marks; the description of a 'lattice' or 'giant structure' was seldom seen.

Q5.

(a) 50% of students gave one safety precaution the students should take. Most of these students gave the idea of safety goggles. Gloves was an insufficient answer, as were general safety measures such as wearing safety clothing, lab coats, or keeping away from fire.

(b) 50% of students knew that iodine solution is used to test for starch.

(c) 61% of students knew the positive result of a test for starch.

(d) 32% of students could correctly select both words from the box add to the sentences to describe chromatography.

(e) This question discriminated between students well. 24% of students achieved a mark for showing the correct working, but then incorrectly rounded, or could not give their answer to two significant figures. 45% of students achieved full marks.

STEMUP.CO.UK

(f) 81% of students could identify carotene from the R_f value and Table 2.

Q6.

(a) 65% of students could not describe how to safely boil ethanol. Some referred to safety glasses, despite being directed not to in the question. Others thought that using a beaker above a Bunsen burner is sufficient, or suggested mixing the ethanol with water.

(b) This question tested knowledge of a Required Practical Activity and generally, this was answered well with 51% of students achieving some credit.

Students should be reminded not to describe the positive result of a test for starch as purple, as this could be confused with the Biuret test for protein.

(c) Students were asked to explain how chromatography causes different pigments to separate. It was clear that most students had good understanding of chromatography and detailed descriptions of methods were seen. Students must ensure they take notice of the command word in the question. 'Explain' questions require students to make something clear, or state the reasons for something happening. Descriptions of detailed methods often failed to answer the question.

The best answers referred to solvent moving through the paper, rather than assuming the solvent was water. Most students could explain that different pigments have different solubilities in the solvent and therefore are carried different distances.

Responses using the terms from the specification: stationary and mobile phase, often achieved all three marks, but there were some misconceptions regarding these terms. Some students incorrectly describe the pigment as the stationary phase.

12% of students achieved either two or three marks.

(d) This high demand question required application of knowledge of Rf values to a novel context. 14% of students answered correctly. Many of these students could identify that the pigment could be xanthophyll or chlorophyll b, or describe that the Rf value ranges overlap.

A significant number thought the pigment could be chlorophyll a or chlorophyll b, which was incorrect. It's possible these students used the distance moved (24 mm) and interpreted this as an R_f value of 0.24.

(e) 26% of students demonstrated an excellent understanding of Rf values in a difficult context. Those who did not achieve full marks often recalled the equation incorrectly. If the equation was recalled correctly and then rearranged incorrectly, the first marking point could be awarded. Again, this demonstrates that students should show every stage of their calculations.

Usually, when a mark is awarded for recall of an equation, the full equation should be given. In this instance, because the question was phrased in terms of R_f value, the whole equation was not required.

(f) This 'extended response' high demand question was not answered well. Students often simply repeated the stem of the question, which will never gain marks.

- Level 1 responses included aspects of the indicative content, but with no attempts at linking, or developing simple statements to give a complete

STEMUP.CO.UK

answer to the question.

- Level 2 responses included ideas from the indicative content, with some attempt at logical linking, but were not fully clear.

- Level 3 responses require relevant points to be given in detail and linked to give a clear account. Few students were awarded level three marks.

8% of students gave level 2 or 3 answers. To award level 2 or 3, the answer had to apply to the situation given, rather than straight recall of the process of evolution, without application to the context given.

Weaker answers frequently gave confused accounts of photosynthesis, often confused with respiration. Some responses stated all the student could remember regarding photosynthesis, without engaging with the command word of the question.

Misconceptions regarding mutations, adaptation and evolution were common. Incorrect references to plant camouflage, plant breeding and genetic modification were seen.

Q27.

(a) Less than a third of the students could define what an element is. Reference to atoms was needed in the definition. Some students had obviously learnt about the periodic table and said an element is a metal or a non-metal, or simply that an element is a substance listed in the periodic table. There were some poorly expressed responses that did not gain the mark, for example, “An element is made up of one atom”, or “It is a pure substance”. A few gave confused answers relating to molecules, compounds, mixtures or alloys.

(b) Over half of the students gained the mark, usually for saying that platinum isn’t made from gold or from gold and silver, or that there is no gold in platinum. Students who just said “Platinum is an element” did not gain credit as this was given in the question. They needed to add some value by saying that platinum is not a mixture, compound or an alloy.

(c) Most students recognised that the formula Ag_2O represents a compound made of silver and oxygen, and many gave its name as silver oxide. All of these points could gain 1 mark. Some incorrectly thought the symbol Ag represents gold, but they could still gain 1 mark for the correct ratio of the elements. To gain both marks they had to give the correct numbers and names, as well as referring to ions or atoms. Just saying “There are two silver and one oxygen” only gained 1 mark. Several students thought Ag_2O represented a mixture, or that it was covalently bonded, which restricted their mark to 1.

STEMUP.CO.UK