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Examiners' Report
June 2018

GCSE Combined Science 1SC0 1CF

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Introduction

This was the first paper of the new Combined Science specification, graded 9-1. It consisted of six questions, all of which were in the Foundation Tier for Chemistry. The paper also has questions in common with Higher Tier Combined Science and Higher Tier Chemistry.

Whilst there were some excellent responses to this paper, it was disappointing to see quite a large number of blank responses, even for straightforward questions (such as the test for carbon dioxide). The level of basic knowledge of some candidates was low. Whilst some candidates could explain some areas of knowledge, for example on distillation and electrolysis, their response was not always directed to the question being asked. Some candidates could not interpret the question terminology – describe, explain, explain how/why – and need to know the differences between them in order to answer appropriately. Candidates' application of knowledge to new situations is a challenge for many, and another area that caused difficulty was questions regarding practical work, including the specified required practicals.

Question 1 (a) (i)

Candidates knew the charges of sub-atomic particles well, although some reversed the charges on the electron and the neutron.

Question 1 (c)

The better candidates answered this question clearly. However, many did not describe the structure of **these two atoms**, but gave a generalised response merely describing what an isotope was, and not calculating the number of sub-atomic particles. Candidates must use the data with which they are presented (not just ignore it or copy it out).

Specific errors included: stating a mass difference, but not by how much,stating that there are the same numbers of protons and electrons, but not that there were 18 of each for both atoms, argon-38 having 38 electrons and argon-40 having 40, confusing mass number with atomic number, and giving a different number of protons and not neutrons. Others talked only about the nucleus and ignored completely the electrons.

(c) Figure 1 shows the atomic number and mass number of two isotopes of argon.

isotope	atomic number	mass number
argon-38	18	38
argon-40	18	40

Figure 1

Describe the structure of an atom of argon-38 and of an atom of argon-40.

(3)

Argon 40 has a higher mass because it has more Protons in the nucleus, the mass of the atom is in the nucleus

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Examiner Comments

Even if the candidate had mentioned neutrons rather than protons, they have still not fully used the data and give the difference of two neutrons.

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Examiner Tip

When describing atoms, talk about all of the sub-atomic particles

(c) Figure 1 shows the atomic number and mass number of two isotopes of argon.

isotope	atomic number	mass number
argon-38	18	38
argon-40	18	40

Figure 1

Describe the structure of an atom of argon-38 and of an atom of argon-40.

(3)

Argon 38 has 18 protons & 20 neutrons ~~electrons~~ with three ~~outer shell~~ full shells. Argon 40 has 18 protons & 22 neutrons with 3 full shells.

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Examiner Comments

A good answer in terms of protons and neutrons but sadly the number of electrons is not mentioned.

Question 2 (b)

This was answered well with many of candidates gaining the 2 marks. A number of candidates seemed to be unsure of what was expected as they gave the correct calculation i.e. (4 x 12) and (8 x 1) but then (i) did not do the addition, or (ii) wrote answer of $C_{48}H_8$, or (iii) multiplied these values 48 x 8 = 384. Others made simple addition errors e.g. 48 + 8 = 52. Sometimes the atomic masses were transposed 8 x 12 + 4 x 1 = 100.

Some must have performed some sort of incorrect working, but only gave a final, incorrect answer which scores 0. Candidates are strongly advised to show working, even in a simple calculation, as they may then receive part marks if they make an error.

(b) Calculate the relative formula mass of butene, C_4H_8.

(relative atomic masses: H = 1, C = 12)

(2)

(4 x 12 = 48) + (1 x 8) = 8   48 + 8 =

56   56

relative formula mass 56

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Examiner Comments

Working clearly shown, and final answer clearly given on answer line.

(b) Calculate the relative formula mass of butene, C_4H_8.

(relative atomic masses: H = 1, C = 12)

(2)

12x4=48 1x8=8 48+8=56

relative formula mass 56

ResultsPlus
Examiner Comments

This is perfectly set out.

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Examiner Tip

Always show working. If this candidate had made a slip, they may have scored a mark because the examiner can see what they are doing.

Question 2 (c) (i)

Balancing this equation proved difficult, with some getting 2 marks but many more achieving 1 mark. Some candidates inserted the symbols of elements instead of using numbers to balance the equation. Numbers up to 30 were seen.

Question 2 (c) (ii)

It was rather indicative of many candidates that they gave a response not even close to the correct answer. Some had clearly blown through straws into limewater but many had no idea. It should be stated that extinguishing a lit splint is not an acceptable answer (whilst true this will also happen for a number of other gases). Some could not name limewater – alternatives were limestone, lime juice, lemon juice, water. Most of the candidates that did give limewater as the liquid got both marks by saying it went cloudy/milky.

Incorrect responses included a full range of tests for other gases, including 'squeaky pop', glowing splint relights, using litmus paper. Some even suggested putting a plant in the gas and seeing whether it thrived or not. There were also a large number of blank responses.

(ii) Describe the test to show that a gas is carbon dioxide.

(2)

Relighting a Splint, So blow the Split out then Put it into a tube with only Co_2 in and it should relight

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Examiner Comments

This is the test for oxygen.

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Examiner Tip

Learn gas tests - they are accessible marks and are likely to be in most papers.

Question 2 (e)

The majority of students gave a valid property of diamond: hard, high boiling/melting point and does not conduct were given. Common incorrect responses included strong bonds, shiny or “hard to break”. As with some lack of understanding of the word ‘test’ shown in question 2(c)(ii), it seemed that in this question, some candidates do not understand the meaning of the word ‘property’. There were a number of responses that showed confusion between ‘uses’ and ‘properties’ for example stating ‘used in jewellery’ and quite a lot of responses linked to the structure/ bonding rather than giving a property.

(e) Diamond has a giant covalent structure.

State one property of diamond that is the result of its giant covalent structure.

(1)

it is very strong.

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Examiner Comments

Use 'strong' as a property of metals/alloys and 'hard' for diamond.

Question 3 (a)

The hazard symbol's name was reasonably well known.

Question 3 (b)

Barium and sulfur were often stated, thus scoring the mark. Others included barium and sulfide, or adding a random third element. Oxygen was sometimes quoted, indicating confusion between sulfide and sulfate. Boron and Beryllium were interesting incorrect answers.

Question 3 (c)

Almost all candidates were able to identify a safety precaution, which was not difficult, but it was pleasing that many went on to give a valid reason for their suggestion. Others did not think about the specific safety hazard here and gave random precautions. Answers included wearing safety goggles, a mask or gloves, but a significant number were vague in their responses and simply stated 'wear protective clothing' or 'PPE'. Other generalised answers do not score: tying hair back, using a well-ventilated room.

Note that glasses are worn by many people – safety glasses are a different thing. Others did not consider the actual hazard and stated 'wear gloves because barium chloride will burn you' even though the hazard stated it is toxic, not corrosive.

(c) Barium chloride is toxic.

Explain one safety precaution that should be taken when using barium chloride.

(2)

Dont go near the barium chloride because it can harm you. Dont Put on Skin.

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Examiner Comments

This answer is vague and does not address the specific issues with a toxic substance.

(c) Barium chloride is toxic.

Explain one safety precaution that should be taken when using barium chloride.

(2)

wear safety goggles to protect your eyes during the time you use barium chloride.

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Examiner Comments

This answer has given a safety precaution with a reason - the reason could have been more specific than this.

Question 3 (d) (i)

Although 25.7g was often stated, equally popular incorrect answers of 51.4g (2 x 25.7) and values slightly less than the 'reacting mass' figure were seen.

Question 3 (d) (ii)

Barium sulfate was rarely cited as the identity of the white precipitate. Commonly given were 'barium sulfide' or 'salt'

Question 3 (e) (i)

Students often knew that 'charged particle' movement was important for electrical conductivity in solution. Fewer answers referred to the free movement of ions within the solution and 'ions' were rarely mentioned compared to an unacceptable reference to 'particles' or 'electrons'. More responded correctly in terms of liquid / solution conducting or solid not conducting electricity.

Among the large number of incorrect responses was the expected lack of movement of, or absence of, 'free' electrons. Some talked about the difficulty of getting electrodes into a beaker of solid. Others simply said you can't electrolyse a solid, or the reaction 'not working' when solid NaCl was used. There seemed to be a misunderstanding for some about what electrolysed actually meant.

(e) Solid sodium chloride is dissolved in water.

The sodium chloride solution is electrolysed in the apparatus shown in Figure 5.

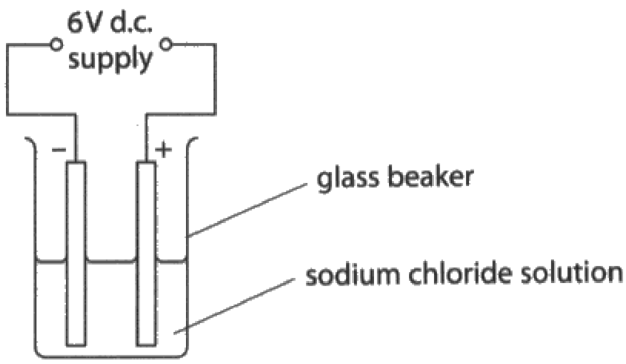

Figure 5

(i) State why sodium chloride solution, rather than solid sodium chloride, must be used in this experiment.

(1)

As it can conduct electricity when its a liquid

ResultsPlus
Examiner Comments

This answer would have been even better if it had added "...but not as a solid"

Question 3 (e) (ii)

Many students circled either both the anions or both the cations, showing some understanding. Others circled only one ion.

Question 3 (e) (iii)

It was beyond most candidates to realise that the solid needed to be heated. They could not link the need for the fact the electrolyte needed to be molten and heat would be needed for this to happen. Slightly more talked about possible problems with the beaker. Otherwise, there was a random selection of changes to do with catching the bromine gas or other perceived issues. Some common errors were to increase the voltage, adding a light bulb/ ammeter, using a bigger beaker.

Question 4 (b) (i)

A Liebig condenser is necessary apparatus in the required practicals. It would seem, however, that few candidates having used this/ seen this demonstrated, have actually realised what is happening. Quite a few candidates did not have the water running through the outside jacket of the condenser at all. Of those that did, most of them had the water running downhill.

Many responses had conflicting arrows and also conflicting labelling. A large number of candidates had the water coming out of the end of the condenser (into the beaker). Some candidates simply showed the water evaporating and going up the flask with the condensate coming down the middle of the condenser. A significant group believed that the water flow began from the condenser and was somehow connected to the inner section, so many drew an arrow from the top of the condenser and an arrow finishing where the condensed vapour was exiting.

(b) The apparatus shown in Figure 6 can be used to separate water from ink.

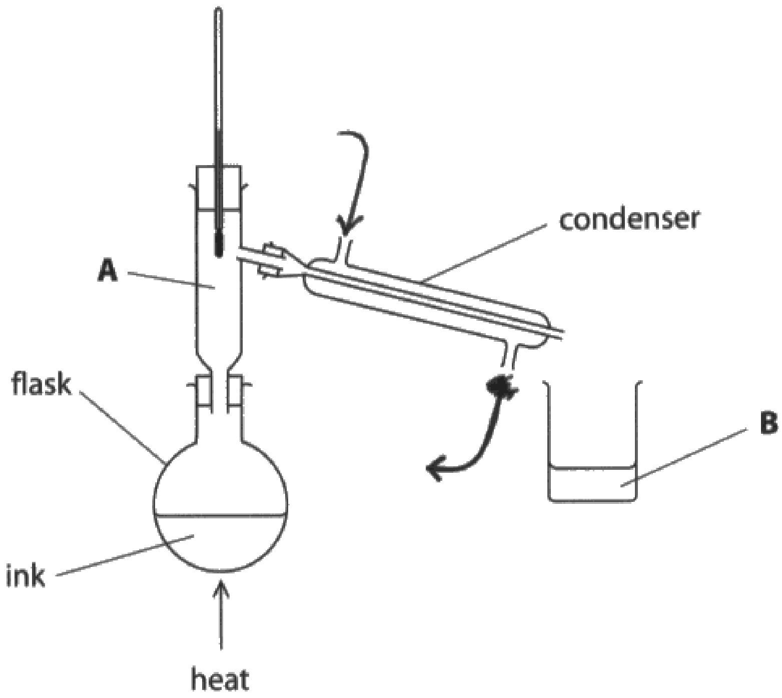

Figure 6

(i) Cold water flows through the condenser.

On Figure 6 use arrows to show where the water should flow in and where it should flow out.

(1)

ResultsPlus
Examiner Comments

Water always flows uphill in a condenser.

(b) The apparatus shown in Figure 6 can be used to separate water from ink.

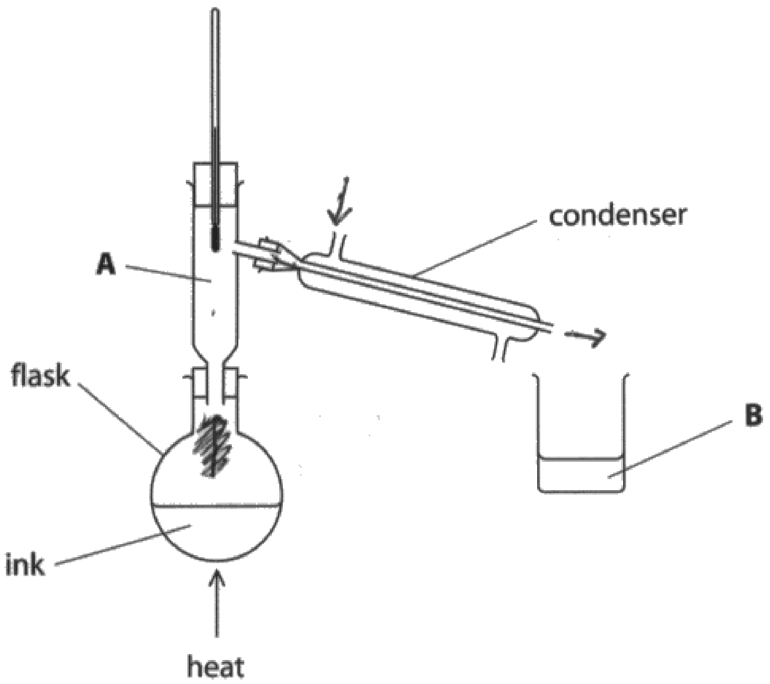

Figure 6

(i) Cold water flows through the condenser.

On Figure 6 use arrows to show where the water should flow in and where it should flow out.

(1)

ResultsPlus
Examiner Comments

Trace the water flow through the condenser. This answer cannot be correct as it crosses a glass wall.

Question 4 (b) (ii)

The general idea of water evaporating was understood by most. However, the function of a condenser proved confusing to some. While some were able to state it turns the water vapour/steam/gas back to a liquid, many responses referred to water or evaporated water being turned back to a liquid. How this happened was sometimes left out; reference to cooling was often omitted or students stated that the condenser just condensed the gas/steam/vapour. Some non-scoring answers just said it "separates the water from the ink" or that the "condenser collects the water in the beaker" or "to condense water" without getting to grips with the practical context. This was an example where the question said "explain" but candidates often answered it as a"describe" question.

(ii) Explain why a condenser is used.

(2)

The condenser is used to cool down the water and [illegible] transport it to the beaker.

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Examiner Comments

The candidate has realised that the condenser has a cooling effect - but not why the cooling is needed.

Question 4 (b) (iii)

A minority provided a valid alternative to a Bunsen burner. The best answer here was an electric heating mantle (which also has safety advantages in some contexts), but the majority of correct responses referred to the use of a blow torch. The most common incorrect alternative given was a water bath. Some seemed to be casting around in their minds for any source of heat and suggested candles, matches, lit splint, hot water, lighter and even oven, microwave, radiator, bonfire, flame thrower, the Sun. Sadly, Bunsen burner was not that uncommon.

Question 4 (c)

The synthesis of ideas is required here, that both locations had only water and the arrangement of particles in gas and liquid states, proved to be an interesting question. A good number of students realised that the coloured particles would not be present. Further, a good number then realised that the particles would be closer together in the liquid (B) than the gas (A). Candidates must be careful in liquid diagrams to draw a random distribution and not particles in rows or connected strings. It is advisable in a gas diagram just to draw a few, scattered particles, and in a liquid more densely arranged randomly ordered particles. Some candidates labelled their answers 'liquid' and 'gas' which showed that they understood the idea but were then let down by a poor diagram.

(c) The particles in the ink in the flask can be shown as in Figure 7.

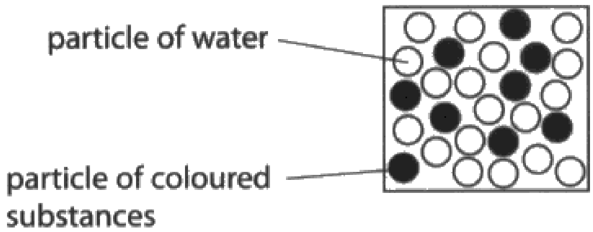
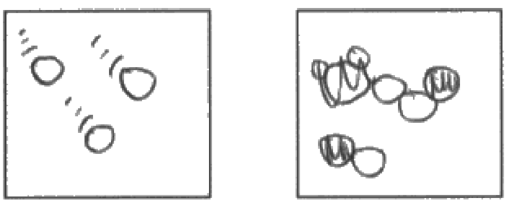


Figure 7

In the boxes below, draw the arrangement of particles that would be expected at **A** and **B** shown in Figure 6.

(2)



particles at **A** particles at **B**

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Examiner Comments

The gas diagram scored a mark (although the 'movement marks' are not recommended).

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Examiner Tip

When drawing a liquid, do not join the particles in 'strings' like this.

(c) The particles in the ink in the flask can be shown as in Figure 7.

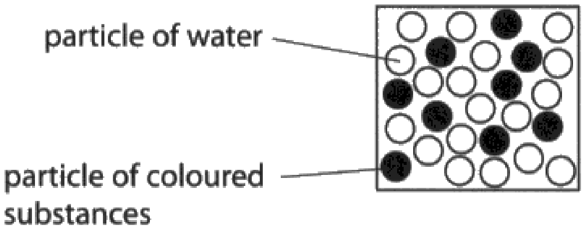
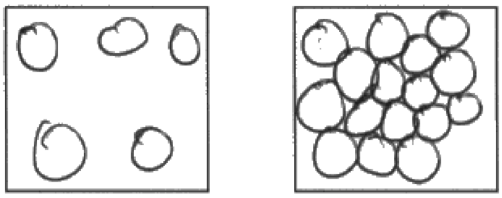


Figure 7

In the boxes below, draw the arrangement of particles that would be expected at **A** and **B** shown in Figure 6.

(2)



particles at **A** particles at **B**

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Examiner Comments

A decent attempt at both gas and liquid.

Question 4 (d)

This question was effectively asking for a definition of physical change and it was clearly something that most candidates had not grasped.

It was apparent that candidates do not understand what reversible arrows in equations mean as reversibility was a mark not often scored. Many described a physical change as what you could see, that they are 'natural' or 'what you experience'. Other candidates described changes of state, describing the need for energy input. The dismissal of the chemical change centered almost entirely around the idea that no chemicals had been added (or were even present at all). (Water was used an example and apparently not regarded as a 'chemical'). The basic idea that a physical change does not result in the formation of a new substance whilst a chemical change does, was not evident or clearly explained almost all responses. Other just repeated the question: 'it is a physical change because there is no chemical change'. Sometimes, it was hard to grasp what the candidate was trying to say, and they are advised to write short, clear sentences.

(d) Changes of state between the three states of matter are shown in Figure 8.

SOLID $\underset{\text{freezing}}{\overset{\text{melting}}{\rightleftharpoons}}$ LIQUID $\underset{\text{condensing}}{\overset{\text{evaporating}}{\rightleftharpoons}}$ GAS

Figure 8

The changes shown are physical changes.

Explain why these changes are called physical changes rather than chemical changes.

(2)

they are called physical changes as we can see them happening where as chemical changes is what we can't see happening.

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This is a typical incorrect answer. New substances are formed in a chemical reaction, but it may or may not be possible to observe this.

Question 5 (a)

As has been noted, some candidates do not understand the meaning of the term 'property'. There was a wide range of possible answers. Some incorrect responses included: 'can rust', 'magnetic', 'unreactive', 'solid', just giving names of metals, or giving uses. Candidates often confuse strong and hard thinking that they are synonymous. (It is worth referring to the'strength' of metals/alloys, whilst using 'hardness' to refer to diamond).

Question 5 (b)

Quite a few candidates knew that hydrochloric acid was required, but some candidates opted for 'chlorine (acid)', and many suggested the only acid they knew, frequently sulfuric. "Hydrolic" acid was also given by a number of candidates and also "hydrochloride acid".

Question 5 (c) (i)

Many candidates seemed to understand the test in this question. Unfortunately, some thought that 'squeaky pop test' scored marks. In every test, two components are required: what you do and what you observe for a positive result. Some did not say that the splint had to be lit or that it was glowing. There were some very poor spellings of splint, some so far from correct that they did not score (e.g. flint). A fair few stated that a pop would spontaneously be heard, e.g. after taking the bung out the test tube. Tests for other gases were also given. A few, rather than stating the test for hydrogen, described how to produce hydrogen by reacting an acid and a metal.

(c) Salts of metals can be prepared by reacting the metal with an acid to produce the salt and hydrogen.

(i) Describe the test to show that the gas is hydrogen.

(2)

a glowing split is put into the tube of gas and it goes pop. This is called the squeeky pop test.

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Learn all gas tests. This test would not work - the splint has to be lit, not glowing. Basic terms - like splint - should be spelled correctly.

Question 5 (c) (ii)

It should be emphasized that, as in 1c, when candidates are asked about the structure of an atom, they need to respond in terms of sub-atomic particles.In a question like this, about ion formation, anything about covalency or sharing electrons is likely to score 0. Some had the idea that electrons were lost but not how many. It was a delight to see in some answers an explanation that the ion was positive because there were now more protons than electrons. Some drew atom diagrams and these were credited if they showed the loss of two electrons. Others attempted an electronic configuration for nickel.

Misconceptions included: nickel gained positive electrons/ there was a change in mass/ more atom or ions were added/ it gains protons/ it gained (two) electrons/ loss of atoms.

(ii) Nickel is a metal.

Explain how the structure of a nickel atom, Ni, changes when it forms a nickel ion, Ni^{2+}.

(2)

it loses two electrons and becoms a Positive ion.

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Examiner Comments

This is sufficient for both marks.

(ii) Nickel is a metal.

Explain how the structure of a nickel atom, Ni, changes when it forms a nickel ion, Ni^{2+}.

(2)

The nickel atom loses to electrons from its outermost shell, making it have 2 more porton than electrons, giving it an overall positive charge.

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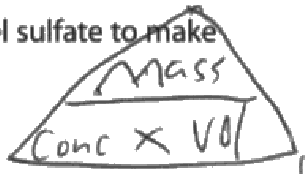
Examiner Comments

A very good answer, spoilt only by the use of 'to' instead of 'two'.

Question 5 (d)

It is worth emphasising that with units of g dm^{-3}, the calculation must feature something in g divided by something in dm^{3}. As expected, many candidates did not convert the volume from cm^{3}, obtaining 0.094 (1 mark), and others inverted the fraction. Others multiplied the numbers, whilst others showed a confusion with units and cubed 250 (25/ 250^{3}).



(d) A nickel sulfate solution is made by dissolving 23.5 g of nickel sulfate to make 250 cm^{3} of solution.

Calculate the concentration of the solution in g dm^{-3}.

(2)

Concentration = mass / volume , ~~= Concentration = 23.5g / 250cm^{3} =~~

Concentration = 23.5 g / 250 cm^{3} = 0.094 g dm^{-3}

concentration = 0.094 g dm^{-3}

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Examiner Comments

Look at units. Here, g are divided by cm^{3} so the units do not match the question/ answer line which requires g dm^{-3}.

Question 5 (e)

It was a great pity that in this question it was unusual for candidates to pick up the hint in the stem about excess solid reactant. Some answers had no filtration at all. Others filtered, but thought that this would filter out nickel sulfate crystals. Nevertheless, many candidates went on to give some idea of crystallization from a solution, although even the simple description of basic apparatus was not always well tackled. The ability to describe a basic practical was lacking in many answers.

Most candidates referred to heating the unfiltered solution to evaporate water, but only a minority mentioned cooling a concentrated solution. Some referred to leaving the heated solution and waiting for crystals to form or leaving the solution on a window sill to get dry crystals. Almost no candidates presented the correct steps in a logical order.

Question 6 (a) (ii)

This is a tricky idea for most Foundation Tier candidates, so it was pleasing that many calculated the formula mass of iron oxide, and hence gained 1 mark. Few got beyond this, though. Some misinterpreted the numbers in the formula, treating them as powers, rather than multiples, i.e. $56^2 + 16^3$.

A significant number of responses did arrive at 1.5 as a final answer with no further calculation made. It was rare to see the final answer of (1.5 x 112=) 168 tonnes calculated. Almost all varieties of incorrect addition/ subtraction/ multiplication were seen and some candidates attempted to answer this as a question by determining an empirical formula.

(ii) The formula of the iron oxide is Fe_2O_3.

Calculate the maximum mass of iron that can be obtained from 240 tonnes of iron oxide, Fe_2O_3.

(relative atomic masses: O = 16, Fe = 56)

(3)

$(56 \times 2) + (16 \times 3) = 160$

$\frac{240}{160} = 1.5$ tonnes

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This candidate has done well to lay out the working clearly, and so gained 2 marks.

Question 6 (b)

A minority of candidates scored the first marking point for making an appropriate comment about the relative reactivities of aluminium and carbon, or that aluminium was very reactive. Fewer went on to score the second marking point saying that aluminium/ aluminium oxide could not be reduced by carbon or alternatively that carbon cannot displace aluminium from its oxide. Some thought that aluminum would react with carbon. Many answers, incorrectly, considered the physical properties of the metal (melting point, ability to conduct electricity) or warned of the dangers of trying to extract a reactive metal such as aluminium and that it could react violently with carbon. It was clear that “explain” was not condsidered carefully enough with many “describe” answers being presented instead.

(b) Aluminium cannot be extracted by heating its oxide with carbon.
Aluminium has to be extracted from its oxide by electrolysis.

Explain why.

(2)

This is because Aluminium is higher than carbon in the reactivity series

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In an 'explain' question, give some information (aluminium is higher than carbon in reactivity series) and then use this to explain why it is important - so the carbon cannot displace alumiuium.

Question 6 (c)

Quite a number of candidates achieved the mark here if they attempted it, others guessed, with fractional distillation being the favourite incorrect answer.

Question 6 (d)

In extended response (6 mark) question, candidates should cover all aspects of the question in a logical order.

In this case, one approach would have been to:

(i) outline the disadvantages of extracting aluminium from its ore

(ii) contrast the benefits of recycling aluminium

(iii) outline the disadvantages of extracting iron from its ore

(iv) contrast the benefits of recycling iron.

There are, of course, other ways of organizing the information. It is important to include as much scientific thought as possible. Vague generalisations ('better for the environment', 'less pollution') do not score. Arguments about cost rarely merit credit, but in this case reference to the cost of electricity in aluminium extraction was accepted.

Common correct points made include the ores being finite resources and recycling conserves them, less fossils fuel are burned and less carbon dioxide is produced if the two metals are recycled which reduces the greenhouse effect and global warming. (Weaker answers did not specify that the gas was carbon dioxide). Many understood energy would be saved with recycling instead of extraction and a few appreciated that the large quantities of electricity used in aluminium extraction would be costly. Damage to the landscape and habitats due to mining were occasionally credited and avoidance of mining was also referred to. Recycling reducing waste and not requiring use of landfill sites were often credited. Many students did not always link their points together, which would have resulted in a higher level being achieved.

Reference to the ozone layer also appeared in a number of answers, in an evident confusion with the greenhouse effect. Another misconception was the term 'renewable' with many thinking that recycling meant that aluminium as renewable. Others had the idea that the ores, as well as crude oil, would eventually replenish. Some candidates missed the point and gave uses of these metals. Some answers read like an advertising pitch for recycling: better, safer, easier, faster, more eco-friendly, cheaper, but with no scientific justification.

Overall, the best answers often continued onto the second page, mentioned specific information about iron and/or aluminium and were specific about the environmental or resources issues. Weaker answers contained little or no scientific information, sometimes giving an odd scattered fact but with no explanation or the linking of ideas.

*(d) Aluminium is extracted from its ore by electrolysis.
Iron is extracted from its ore by heating with carbon.
Both metals can also be obtained by recycling.

Explain the advantages of recycling aluminium and iron rather than extracting them from their ores.

(6)

Recycling aluminium and iron means that less is being extracted from the ground. It is expensive to extract ~~even~~ metals from their ores so recycling would be cheaper and more effective. Metal is a non-renewable source, so eventually it will all be used up. Recycling these elements will make them last longer. Also, it is easier ~~[illegible]~~ for everyone to recycle.

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Examiner Comments

- No specific details about either Aluminium or Iron are given
- Cost is very rarely worth credit
- Metals are in limited supply is only relevant point here.

[Level 1 answer]

*(d) Aluminium is extracted from its ore by electrolysis.
Iron is extracted from its ore by heating with carbon.
Both metals can also be obtained by recycling.

Explain the advantages of recycling aluminium and iron rather than extracting them from their ores.

(6)

Advantages of recycling aluminium and iron are it can be used more than once, reused for other things, it is cheaper to recycle, it is better for the environment. Donate to other countries.

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Examiner Comments

This answer scored 0. Statements such as 'better for the environment' will never score - detail must be given.

Paper Summary

Suggestions for candidates revision for future papers are:

- Candidates need to know what some key terms in questions mean – "test", "properties" are significant.
- When asked about the structure of an atom, candidates need to say something about the constituent particles.
- Learn all the relevant tests for gases
- Learn the masses and charges of the sub-atomic particles and how atoms are made up of protons, electrons and neutrons
- Learn how sub-atomic particles are linked to Mass and Atomic Numbers
- Revise the formation of ions and the electronic configurations of ions of well-known elements
- Revise the advantages of recycling of metals as compared with their extraction from oxides by carbon reduction or electrolysis
- Practise how to describe a procedure in a required practical, how to suggest improvements and the labelling of practical equipment
- Know how specific pieces of chemistry equipment work, and alternatives for them
- Learn definitions of basic concepts
- Check that equations balance
- Practice 6-mark questions, focus on succinct layout and logical presentation of relevant information.
- Focus on behavior of ions when explaining electrolysis

Grade Boundaries

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