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Examiners' Report
June 2022

International GCSE Chemistry 4CH1 1C

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June 2022

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Introduction

Candidates generally performed well on paper 1C. Candidates had clearly read the Advance Notice and were well prepared for most questions. Some of the extended response questions were particularly well answered, most notably Q2(b)(iii), Q5(b) and Q8(b). Candidates found questions difficult where they needed to apply their knowledge, most notably Q3(b)(ii), Q3(c) and Q9(a)(iii). Most candidates performed well on calculations, most notably Q9(c), where they were able to calculate the formula of a hydrated ionic compound and Q9(b)(ii), where most candidates were able to perform a mole calculation. Ratios in equations were a problem for some candidates and this was often missed. Many candidates found questions relating to a practical context most difficult. Q4(c) proved challenging along with Q6(a)(iv) and Q7(c)(iii). In extended response questions, many candidates did not answer the question given and should be encouraged to draft their ideas first or tick parts of the question off when they appear in the answer.

Question 1 (a)

Question 1 was well answered by most candidates. Q1(d) caught some candidates out: Period 1 of the Periodic table contains hydrogen and helium only; many candidates did not realise this and gave an answer of 2 rather than 3.

Question 2 (a)

Question 2 was well answered. Most candidates knew the changes of state. The modifications to the method were well understood in Q2(b)(i) and most candidates knew to filter the mixture in Q2(b)(ii).

Question 2 (b)(iii)

Many candidates answered Q2(b)(iii) very well and presented a concise and clear method to produce pure dry crystals of sodium chloride.

(iii) Describe how the student can obtain pure dry crystals of salt from the salt solution.

(4)

The Student should first filter the sand out of the solution with filter paper in order to seperate them. They should then heat the solution until all the water evaporates in order to obtain salt crystals without any water. To purify the crystals, the Student should first ~~wash~~ rinse them with water and evaporate it again.

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Examiner Comments

Candidates need to ensure they are answering the question set. They have been asked to produce crystals of salt from salt solution. The comments about filtering at the start were therefore ignored as filtering would add nothing to the method.

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Examiner Tip

Read the question twice. Highlight what is important before answering.

(iii) Describe how the student can obtain pure dry crystals of salt from the salt solution.

(4)

From the salt solution, filter to remove sand ~~and any other insoluble~~, then heat to partially evaporate, then test with glass rod, to see if crystals form immediately after the glass rod has been removed [to check if saturation has been reached] from the solution, then leave to cool, ~~to prevent any impurities~~ then ~~filter~~ filter off the crystals, wash them [to remove any other impurities] with distilled water and dry them with filter paper or potentially a warm oven

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Examiner Comments

A great answer that scores full marks.

ResultsPlus
Examiner Tip

Consider using bullet points or a numbered list to show a method clearly.

Question 3 (a)(i)

Candidates were familiar with fractional distillation and the uses of fractions in Q3(a). Most knew the conditions for cracking in Q3(b)(i). Candidates answered the rest of the question less well.

Question 3 (b)(i)

(b) One of the compounds in fraction D is tridecane ($C_{13}H_{28}$) which can be cracked to form shorter-chain hydrocarbons.

(i) State the catalyst and temperature used in this cracking reaction.

(2)

catalyst

Silica

temperature

~~600-700°c~~ 650-750°c

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Examiner Comments

Avoid giving a range for answers. The specification quotes 600-700ºC so the range given here doesn't score marks as 750ºC is too high.

Question 3 (b)(ii)

Q3(b)(ii) was poorly answered with most candidates scoring 1 mark.

(ii) The equation shows an example of a catalytic cracking reaction.

$$C_{13}H_{28} \rightarrow C_8H_{18} + C_2H_4 + C_3H_6$$

Give two reasons why this reaction is important.

(2)

1 it breaks dawn longer chain hydrocarbon, into shorter chain hydrocarbons which are more useful.

2 It separates the hydrocarbons so that each can be used for different things such as household fuels or road surfacing.

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Examiner Comments

Candidates should think carefully about what the equation shows us. $C_{13}H_{28}$ is being heated to produce C_8H_{18}, a shorter alkane present in the gasoline fraction and two very short alkenes. This answer only scored 1 mark.

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Examiner Tip

Link your answer to the equation. Shorter alkanes are more flammable than longer alkanes and are therefore more useful as fuels. Short alkenes such as C_2H_4 and C_3H_6 can be used to make polymers.

(ii) The equation shows an example of a catalytic cracking reaction.

$$C_{13}H_{28} \rightarrow C_8H_{18} + C_2H_4 + C_3H_6$$

Give two reasons why this reaction is important.

(2)

1 it breaks dawn long-chain alkanes to shorter-chain alkanes used by oil companies to make more petrol.

2 it ~~breaks~~ produces alkenes used to make polymers (plastic).

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Examiner Comments

This answer was clearly linked to the products in the equation and scored the candidate 2 marks.

Question 3 (c)

(c) Sulfur is an impurity in crude oil.
Explain why this is a problem for the environment.

(3)

When crude oil is combusted, it reacts with oxygen. If sulfur is an impurity in crude oil, it can react with oxygen to form sulfur dioxide. Sulfur dioxide causes acid rain which is dangerous for the environment because it acidifies lakes which kills fish.

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Examiner Comments

This answer scored 2 out of 3 marks. The candidate understood that sulfur reacts with oxygen forming sulfur dioxide but did not state that sulfur dioxide dissolves in or reacts with water forming acid rain.

(c) Sulfur is an impurity in crude oil.
Explain why this is a problem for the environment.

(3)

As sulfur is emitted, it reacts with the oxygen in the air to form sulfur dioxide. Then as it goes in the atmosphere, it reacts with the water vapour in the clouds to form sulfuric acid. This then becomes acid rain which can damage vegetation and animals.

ResultsPlus
Examiner Comments

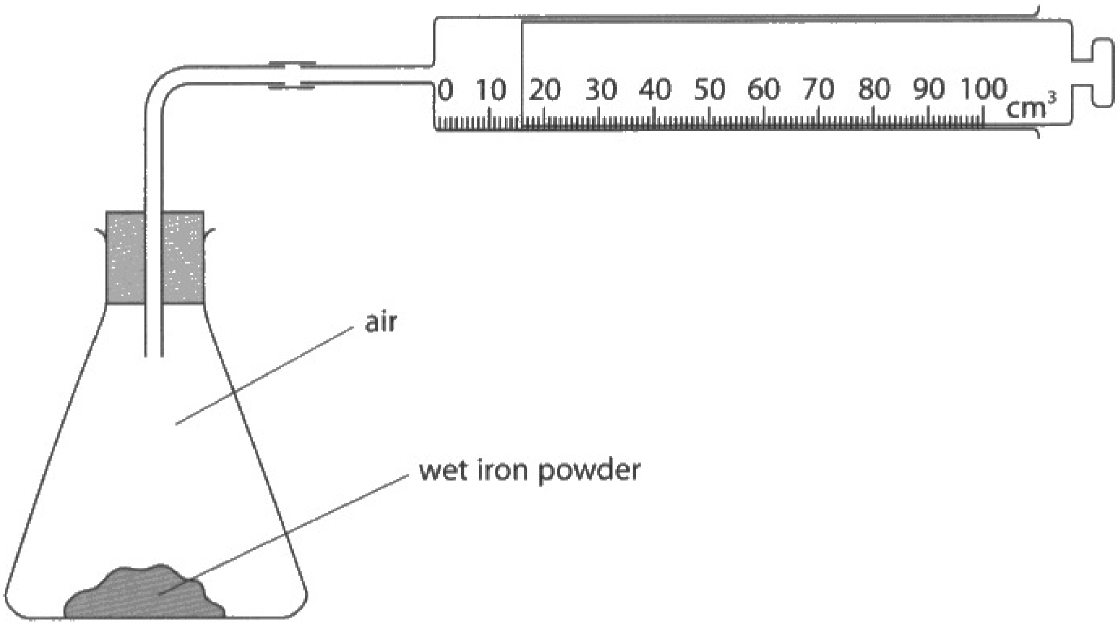
An excellent answer linking formation of sulfur dioxide from sulfur and the formation of acid rain from sulfur dioxide.

Question 4 (a)(i)

Question 4(a) was well answered by most candidates who were familiar with the formation of rust and the conditions for rusting. Most candidates made the link between the increased surface area of iron in Q4(a)(iv) and an increased rate of reaction.

4 A student uses the reaction between iron and oxygen to find the percentage of oxygen in air.

The diagram shows the apparatus the student uses.



(a) (i) State why the iron powder needs to be wet.

(1)

to stop it from reacting to anything other than the O_2

Question 4 (b)

A number of candidates misread the volumes in Q4(b) or scored 1 mark for the volumes the wrong way around.

(b) The syringe in the diagram shows the reading at the end of the experiment.

Complete table 1 to show the readings on the syringe.

Give both values to the nearest 1 cm^3.

(2)

syringe reading at start	81 cm^3
syringe reading at end	16 cm^3
change in volume in cm^3	65

Table 1

(b) The syringe in the diagram shows the reading at the end of the experiment.

Complete table 1 to show the readings on the syringe.

Give both values to the nearest 1 cm^3.

(2)

syringe reading at start	16
syringe reading at end	4981
change in volume in cm^3	65

Table 1

ResultsPlus Examiner Comments

Read the question carefully. The question states the volume at the start is shown in the diagram. These volumes are reversed.

Question 4 (c)

Very few candidates scored 3 marks here as few appreciated that there was air in the conical flask, gas tube and syringe making a total of $350cm^3$.

(c) The student repeats the experiment and obtains a different set of results.

Table 2 shows these results.

volume of air in conical flask and glass tube in cm^3	260
syringe reading at start	90
syringe reading at end	22

Table 2

Use the results from table 2 to calculate the percentage by volume of oxygen in the air.

(3)

% of oxygen $= \frac{90-22}{260} \times 100$

$= 26.15$

$\approx 26.2\%$

percentage by volume of oxygen in air = 26.2 %

ResultsPlus
Examiner Comments

Think where the air is coming from that is reacting. Also check your answer. This is a sample of air, so the expected answer is around 20%. This answer is too high as the candidate has only considered the air in the conical flask and glass tube.

(c) The student repeats the experiment and obtains a different set of results.

Table 2 shows these results.

volume of air in conical flask and glass tube in cm^3	260
syringe reading at start	90
syringe reading at end	22

Table 2

Use the results from table 2 to calculate the percentage by volume of oxygen in the air.

(3)

260 + 90 = 350 cm^3

90 - 22 = 68 cm^3

$\frac{68}{350} \times 100 = 19.4$

percentage by volume of oxygen in air = 19.4 %

ResultsPlus
Examiner Comments

This was a perfect answer.

Question 5 (a)(i)

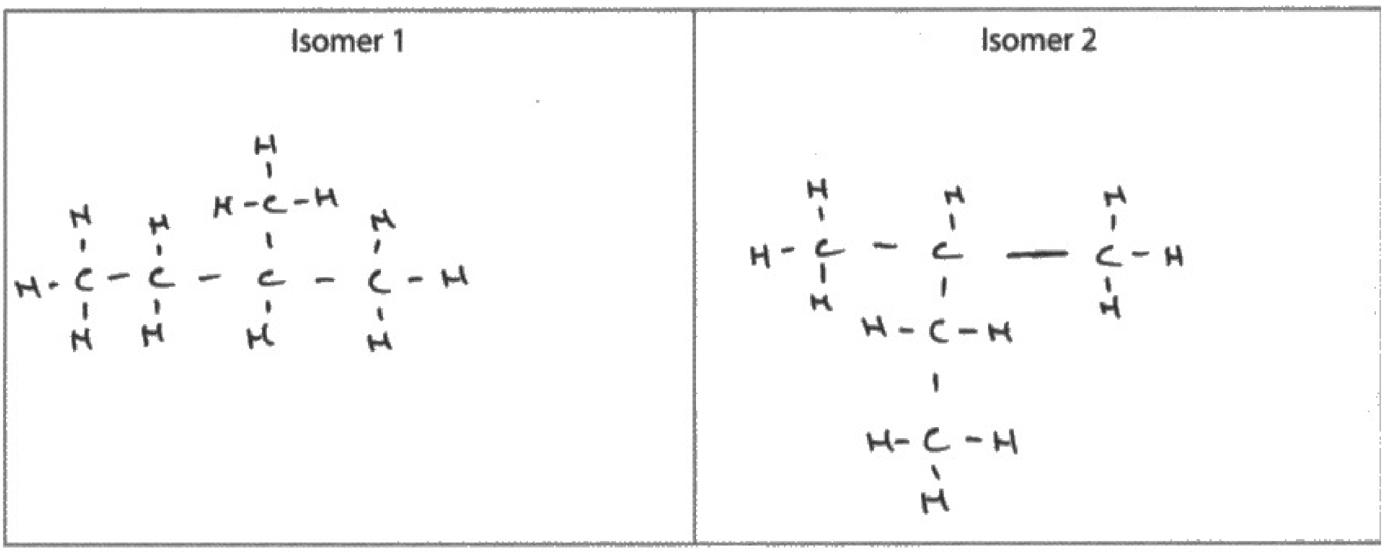
Question 5 was well answered by most. Candidates knew the definition for isomers although there was some confusion with isotopes. The relative atomic mass in Q5(a)(ii) was well answered and most candidates knew the name of pentane in Q5(a)(iii).

Question 5 (a)(iv)

Many candidates did not score both marks here. Candidates need to appreciate that branches do not occur on the end carbon and that there are multiple ways of drawing methylbutane.

(iv) Draw the displayed formulae of the other two isomers.

(2)



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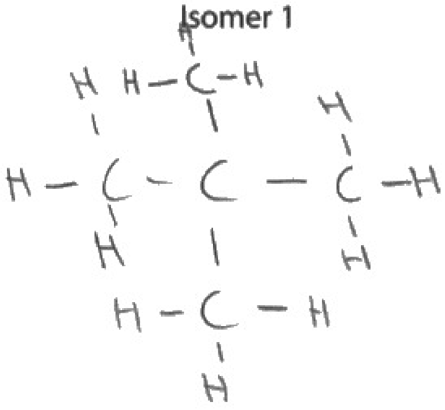
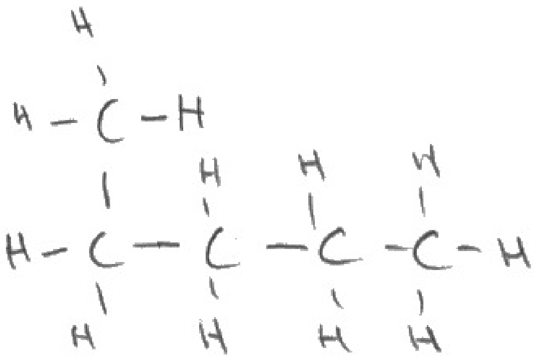
Examiner Comments

These are both methylbutane so this only scores 1 mark.

(iv) Draw the displayed formulae of the other two isomers.

(2)

Isomer 1	Isomer 2
	

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Examiner Comments

Isomer 2 does not score as the candidate has drawn pentane.

Question 5 (b)

In Q5(b) many candidates did not take the time to plan their answer or ensure that they answered the question that was asked. A paragraph for ethane and one for ethene would help to ensure every point in the question was covered.

(b) Ethane (C_2H_6) and ethene (C_2H_4) both react with bromine.

Describe the differences in the reactions of ethane and ethene with bromine.

Refer to the conditions, the products and the types of reaction involved.

(5)

Ethene reacts with bromine water and an addition reaction takes place. There is a colour change from orange to colourless. It produces C_2H_4Br. The double bond between the carbons is broken. Ethane only reacts with bromine in the presence of UV light, a substitution reaction takes place which produces $C_2H_5Br + HBr$.

ResultsPlus
Examiner Comments

A concise answer that scored full marks. The comment about colour change was not asked for in the question so was ignored. There were enough correct points in the answer so the incorrect formula of dibromoethane could be ignored too.

(b) Ethane (C_2H_6) and ethene (C_2H_4) both react with bromine.

Describe the differences in the reactions of ethane and ethene with bromine.

Refer to the conditions, the products and the types of reaction involved.

(5)

· ethane, bromine water will stay brown.

· ethene, bromine water will go clear.

· when reacted with ethane it will stay bromine.

· when reacted with ethene it will became bromide.

ResultsPlus
Examiner Comments

Read the question carefully before starting. This candidate's answer scored 0 marks as the question did not ask for colour changes.

Question 6 (a)(i)

Many candidates understood rates of reaction and the collision theory in question 6. Many coped well with a challenging calculation in Q6(a)(iii) although some candidates missed the ratio in the equation. The graph was well drawn by most and the vast majority of candidates knew how increasing the temperature would change the graph. When answering rate of reaction questions, candidates need to appreciate that only changing the temperature changes the energy of the particles. Particles do not have more energy at the start of a reaction.

Question 6 (a)(iii)

(iii) The student uses 0.090 g of magnesium and 0.025 mol of hydrochloric acid.

Show by calculation that the hydrochloric acid is in excess.

(2)

Mg + 2HCl

mass = 0.090g 0.025mol

rfm = 24.

$\text{moles} = \frac{\text{mass}}{\text{rfm}}$

$\frac{0.090}{24} = 0.00375\text{ mol}$

$0.025 > 0.00375.$

∴ shown.

ResultsPlus

Examiner Comments

Don't forget to use the ratio in the equation in a question like this. If the candidate had shown 0.00375 moles of magnesium needs 0.00750 moles of hydrochloric acid, they would have scored both marks.

Question 6 (b)(iv)

(iv) Explain why the rate of reaction is greatest at the start of the reaction.

(2)

More reacton, more knetic enersy, more frequent collison, more reactive at the beginng

ResultsPlus
Examiner Comments

The energy of particles does not change during a reaction. At the beginning there **will** be more frequent collisions as the concentration of the acid is higher (or the surface area of the magnesium is greater).

(iv) Explain why the rate of reaction is greatest at the start of the reaction.

(2)

At the start of the reaction there is the greatest ~~volume~~ concentration of HCl molecules and Mg particles. This means the HCl and Mg are much closer together and thus there are more particles of hydrochloric acid and magnesium per unit volume which leads to more successful collisions per unit time. Thus the rate of reaction is fastest at the start. However over time, the concentrations will decrease and thus the rate of reaction will slow.

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Examiner Comments

A great answer that scores both marks.

Question 6 (c)(ii)

To score full marks in Q6(c)(ii) candidates needed to link increased energy to successful collisions.

(ii) Explain, in terms of particle collision theory, how increasing the temperature affects the rate of reaction.

(3)

- increase in temp, increase in kinetic energy
- more kinetic energy, hight number of collision ~~to~~ per unit time
- more collisions per unit time, ~~f~~faster rate of reaction

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Examiner Comments

2 marks scored here as there is no link to successful collisions.

(ii) Explain, in terms of particle collision theory, how increasing the temperature affects the rate of reaction.

(3)

Increase on temperature increases the rate of reaction because the particles have more themal energy therefore more faster with ~~a~~ more collisions and therefore more Successful collisions per unit time.

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Examiner Comments

This candidate scores full marks as they have correctly linked increasing temperature to more energy and therefore an increase in frequency of successful collisions.

Question 7 (a)(i)

The calculations in question 7 were well answered by most candidates although many did not give the A_r of copper to 3 significant figures as stated in the question. Few candidates gave a definition for isotopes that scored full marks.

7 This question is about copper and copper compounds.

(a) A sample of copper contains two isotopes.

- Cu-63 with relative abundance 69.5%
- Cu-65 with relative abundance 30.5%

(i) State what is meant by the term **isotopes**.

(2)

Atoms of the same element with a different number of neutrons (but the same number of protons)

7 This question is about copper and copper compounds.

(a) A sample of copper contains two isotopes.

- Cu-63 with relative abundance 69.5%
- Cu-65 with relative abundance 30.5%

(i) State what is meant by the term **isotopes**.

(2)

Same number of protons and electrons different number of neutrons.

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Examiner Comments

A definition for isotopes needs to contain a reference to atoms. These candidates only scored 1 mark. If they had said **atoms** with the same number of protons but different numbers of neutrons both marks would have been scored.

Question 7 (a)(ii)

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

Give your answer to three significant figures.

(3)

$$\frac{(63 \times 69.5) + (65 \times 30.5)}{100}$$

$= 63.61$

A_r of copper = 63.61

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Examiner Comments

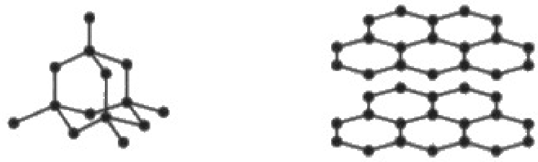
Read the question. This candidate clearly understands how to calculate an A_r value but has not given their answer to 3 significant figures.

Question 8 (a)

Many candidates showed a good understanding of the different properties of diamond and graphite. Some answers, however, referred to properties such as melting and boiling points which were ignored as this is not what the question was asking for. Candidates should take time to plan their answers and consider separate paragraphs for diamond and graphite. Candidates should also focus their answers on the properties in the question and should tick these off when included in the answer.

8 Diamond and graphite are giant covalent structures made of carbon atoms.

The diagram shows their structures.



Diamond   Graphite

(a) Discuss the differences between diamond and graphite.

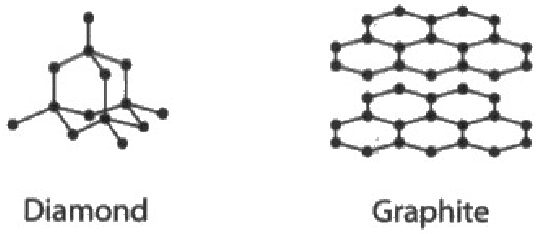
Refer to structure and bonding, electrical conductivity and hardness in your answer.

(6)

· Diamond is hard and does not conduct electricity.
· ~~Diamond~~ Diamond is made of carbon ~~atom~~ atoms (4 bonds per atom). It has lattice shape.
· Diamond is hard because there are strong covalent bonds between all atoms (many), which require lots of force ~~(or energy)~~ to break.
· Diamond does not conduct electricity because there are neither delocalised electrons nor free ions to carry ~~charge~~ charge.
· Graphite is softer than diamond and conducts electricity.
· Graphite is made of ~~layers~~ layers of carbon atoms with 3 bonds per atom
· Graphite is soft because layers can slide over each other. There are weak forces between layers which require little energy to overcome. Graphite conducts electricity because there is one delocalised electron per carbon atom which is free to move and carry charge.

8 Diamond and graphite are giant covalent structures made of carbon atoms.

The diagram shows their structures.



(a) Discuss the differences between diamond and graphite.

Refer to structure and bonding, electrical conductivity and hardness in your answer.

(6)

Diamond is a giant lattice structure made up of carbon. Each carbon atom is covalently bonded to four carbon attoms, this makes it incredibly hard, doesn't conduct electricity, is insoluble and there are no delocalised electrons.

Graphite is also a giant lattice structure of carbon. Each carbon atom is bonded to three carbon atoms, this means that for every carbon atom there is one delocalised electron. This allows it to conduct electricity. Graphite is layers of covalent bonds which are held together with weak intermolecular forces, because of this the layers can slide around making graphite malleable. It can easily be squished and is used as a lubricant whilst diamonds are used to cut through very tough surfaces.

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Examiner Comments

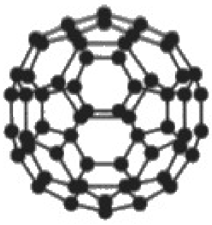
These answers show a very good understanding of the properties of diamond and graphite. Candidates need to be careful about the use of 'intermolecular forces'. Layers of graphite are not molecules so 'intermolecular forces' is not correct here. However, 'weak forces between layers' is perfectly acceptable.

Question 8 (b)

Many candidates clearly understood why C_{60} has a much lower melting point than diamond or graphite. To score full marks here, candidates need to clearly identify what force or bond is being broken and compare the energy required.

(b) C_{60} fullerene is a simple molecular substance made of 60 carbon atoms.

The diagram shows its structure.



The table shows the approximate melting points of diamond, graphite and C_{60} fullerene.

Substance	Approximate melting point in °C
diamond	4000
graphite	3600
C_{60} fullerene	600

Explain why C_{60} fullerene has a much lower melting point than diamond and graphite.

(4)

It is a simple molecular structure. C_{60} fullerene has weak intermolecular forces and so less energy is needed to break the bonds. So it has a much lower melting point.

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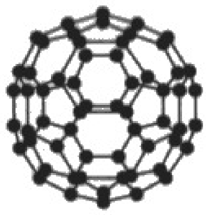
Examiner Comments

Candidates need to be careful to be precise with what is being broken. Although this answer mentions weak intermolecular forces it goes on to mention breaking bonds. This question therefore scores 0 marks.

(b) C_{60} fullerene is a simple molecular substance made of 60 carbon atoms.

The diagram shows its structure.



The table shows the approximate melting points of diamond, graphite and C_{60} fullerene.

Substance	Approximate melting point in °C
diamond	4000
graphite	3600
C_{60} fullerene	600

Explain why C_{60} fullerene has a much lower melting point than diamond and graphite.

(4)

fullerene has weak intermolecular forces which don't require as much energy to overcome them. Weak intermolecullar forces doesn't require high temperatures that give off energy to break them down. Diamond and graphite have strong covalent bonds which require a lot of energy to break them down, therefore higher temperatures are needed.

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Examiner Comments

A perfect answer that scored 4 marks.

Question 9 (a)(i)

Most candidates answered Q9(a) correctly, although some wrote the names of the states instead of the state symbols in Q9(a)(i).

Question 9 (a)(iii)

There were many poorly expressed answers in Q9(a)(iii). When explaining why a reaction is a redox reaction, candidates need to explain which **reactant** is oxidised and which is reduced. Many answers lacked precision.

(iii) Explain why the reaction of yellow lead oxide with hydrogen is a redox reaction.

(2)

The lead loses oxygen so is reduced to it's own element and the ~~a~~ hydrogen gains oxygen so to become water

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Examiner Comments

Be clear what is oxidised and what is reduced. **Lead oxide** (not lead) is reduced as it loses oxygen and **hydrogen** is oxidised as it gains oxygen. This answer therefore scored 1 mark.

(iii) Explain why the reaction of yellow lead oxide with hydrogen is a redox reaction.

(2)

Because both oxidation ~~(loss of a~~ (gain of oxygen) and reduction (loss of oxygen) are taking place at the same time. The hydrogen is being oxidised to form water (hydrogen is gaining oxygen) and the lead oxide is being reduced to form lead (lead oxide is losing oxygen).

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Examiner Comments

This answer scores both marks as it is clear what is being oxidised and what is being reduced.

Question 9 (a)(iv)

In Q9(a)(iv) many candidates did not score both marks as they failed to describe a test. Pure water has a boiling point of 100ºC scores 1 mark. Test the boiling point, if it's 100ºC water is pure scores 2 marks.

Question 9 (b)(ii)

Many candidates scored full marks in Q9(b)(ii). The most common reason for losing marks was for incorrect application of the ratio in the equation.

(ii) The red lead oxide used in the reaction has a mass of 5.48 g.

Calculate the maximum mass of yellow lead oxide that could form.

[M_r of Pb_3O_4 = 685 M_r of PbO = 223]

(3)

5.48/685=0.008 X 223=1.784

maximum mass of PbO = 1.784 g

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Don't forget the ratios in equations. This scores 2 marks as the candidate has not used the 2:6 ratio.

(ii) The red lead oxide used in the reaction has a mass of 5.48 g.

Calculate the maximum mass of yellow lead oxide that could form.

[M_r of Pb_3O_4 = 685 M_r of PbO = 223]

(3)

~~5.4~~ Mole of red lead oxide:

$5.48 \div 685 = \frac{1}{125}$ mol

Mole of red lead oxide : Mole of yellow lead oxide

$= 2:6 = 1:3$

∴ Mole of yellow lead oxide $= \frac{3}{125}$ mol

∴ Mass (maximum) of PbO $= 223 \times \frac{3}{125} = 5.352$ g

maximum mass of PbO = 5.352 g

Question 10 (a)

The dot and cross diagram for ammonia was very well answered by most candidates. In Q10(b) few candidates knew, or could work out, the formula for ammonium carbonate as $(NH_4)_2CO_3$

Throughout the question, there was confusion with the molecule ammonia and the ammonium ion.

Question 10 (b)(iii)

In Q10(b)(iii) the test for ammonium ions was poorly understood. Candidates need to make it clear that they need to add sodium hydroxide solution then test the **gas** produced with damp red litmus which turns blue.

(iii) Describe a test for ammonium ions.

(3)

You would get a damp piece of red litmus paper and place it in the ~~amm~~ solution that would contain ammonium ions. If ammonium ions are present, ~~then~~ the damp red litmus paper will change colour from red to blue.

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Examiner Comments

This candidate scored 0 marks. They didn't mention sodium hydroxide and they were clearly testing the solution with red litmus.

(iii) Describe a test for ammonium ions.

(3)

- add sodium hydroxide solution
- no precipitate, but pungent smell of ammonia gas evolved
- ammonia evolved turns damp pink litmus paper blue

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Examiner Comments

This concise answer scored 3 marks.

Question 10 (c)(ii)

In Q10(c)(ii) many candidates did not answer the question. Many compared ammonia with ammonium nitrate.

Candidates are encouraged to plan their answer before starting, as few candidates spotted that ammonia being a gas could make it more problematic to apply to soil.

Paper Summary

Based on their performance on this paper, candidates should:

- read the question carefully before starting their answer.
- ensure their answer addresses the points in the question.
- plan answers to longer answer questions.
- make sure they use ratios in equations.
- consider using bullets or numbers to help write answers that require methods.
- learn chemical tests.

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