



Year 11

Christmas Homework

Science- Chemistry

Students should answer the questions and review using the attached mark schemes (marking in a different colour pen). I'd recommend answering on a separate piece of paper the first time round, so that they can re-attempt the questions.

They should then re-attempt the questions after at least a week has passed.

Total time excluding videos (3 hours)

Total time including videos (4 hours)

For those who missed interventions and drop-in sessions here are some useful video links to support:

Structure and bonding:

<https://youtu.be/MdU44WeiLps?si=uCM8V64ii5-ASrXx>

<https://youtu.be/7IkYm7ZgiAw?si=A2wsEWMcREM3i7c5>

<https://youtu.be/SxuldWdqFB0?si=eIprNHI2jbPtnmub>

<https://youtu.be/RVV8pncaA7A?si=oDM0-4GYphB6oYw1>

<https://youtu.be/ZeJubj0KWdM?si=LsJ9j76nFguo39iQ>

<https://youtu.be/tRKkGRBndto?si=jkF9Ox3PhK1ovXbY>

Electrolysis:

https://youtu.be/RAEm-kJ_QkU?si=Ty1dMadXCqG4IEpD

<https://youtu.be/t11ViUTDNzE?si=QtSlxxh93ctP3-ql>

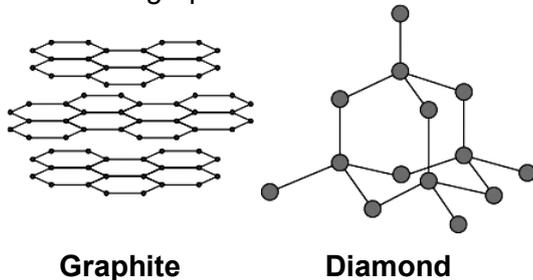
<https://youtu.be/me19WmGg8Dw?si=-WUq6QwFqEkeOaQZ>

STRUCTURE AND BONDING:

Q5.

Graphite and diamond are different forms of the element carbon.
Graphite and diamond have different properties.

The structures of graphite and diamond are shown below.



- (a) Graphite is softer than diamond.

Explain why.

(4)

- (b) Graphite conducts electricity, but diamond does not.

Explain why.

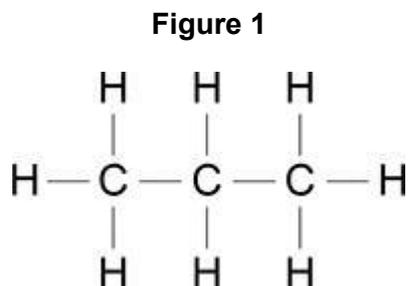
(3)

(Total 7 marks)

Q6.

This question is about propane (C_3H_8).

Figure 1 shows the displayed structural formula of propane.



(a) Explain why propane has a low boiling point.

(3)

(Total 3 marks)

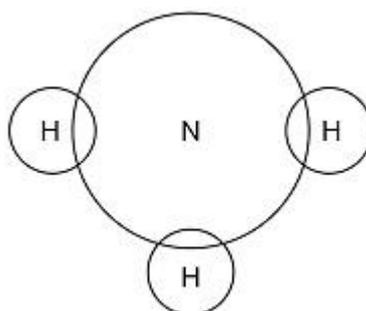
Q7.

This question is about ammonia, NH_3

(a) Complete the dot and cross diagram for the ammonia molecule shown in **Figure 1**.

Show only the electrons in the outer shell of each atom.

Figure 1



(2)

(b) Give **one** limitation of using a dot and cross diagram to represent an ammonia molecule.

(1)

(c) Explain why ammonia has a low boiling point.

You should refer to structure and bonding in your answer.

(3)

Ammonia reacts with oxygen in the presence of a metal oxide catalyst to produce nitrogen and water.

(d) Which metal oxide is most likely to be a catalyst for this reaction?

Tick (✓) **one** box.

CaO

Cr₂O₃

MgO

Na₂O

(1)

(Total 7 marks)

Q8.

This question is about Group 1 elements.

Sodium reacts with oxygen to produce the ionic compound sodium oxide.

Oxygen is a Group 6 element.

- (d) Draw a dot and cross diagram to show what happens when atoms of sodium and oxygen react to produce sodium oxide.

Diagram

(4)

- (e) Why is oxygen described as being reduced in the reaction between sodium and oxygen?

(1)

- (f) Explain why sodium oxide has a high melting point.

(3)

(Total 8 marks)

Q9.

Oil rigs are used to drill for crude oil.



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- (a) Drill heads are made from steel. Steel is an alloy.

Explain why alloys are harder than pure metals.

(3)

- (b) Drill heads also contain diamonds.

Describe, as fully as you can, the structure and bonding in diamond.

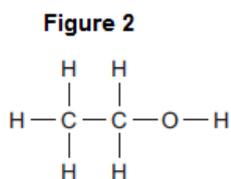
(4)

(Total 7 marks)

Q10.

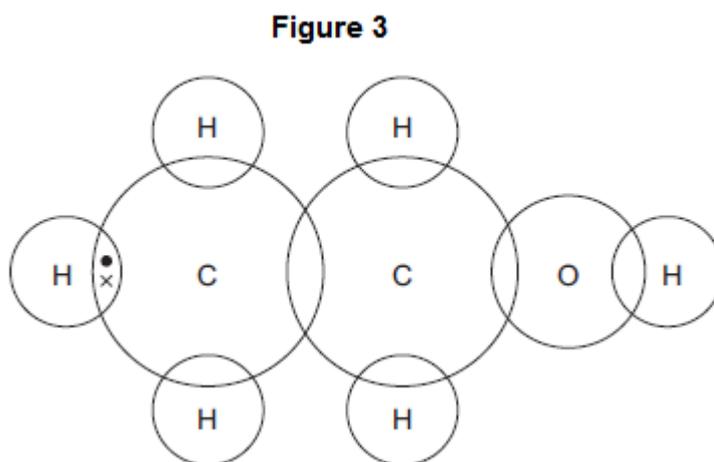
This question is about ethanol.

(b) **Figure 2** shows the displayed structure of ethanol.



Complete the dot and cross diagram in **Figure 3** to show the bonding in ethanol.

Show the outer shell electrons only.



(2)
(Total 2 marks)

Q11.

This question is about Group 7 elements.

Chlorine is more reactive than iodine.

(c) Chlorine reacts with hydrogen to form hydrogen chloride.

Explain why hydrogen chloride is a gas at room temperature.

Answer in terms of structure and bonding.

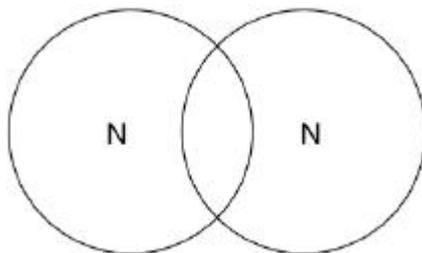
(3)
(Total 3 marks)

Q12.

This question is about structure and bonding.

- (a) Complete the dot and cross diagram to show the covalent bonding in a nitrogen molecule, N_2

Show only the electrons in the outer shell.



(2)

- (b) Explain why nitrogen is a gas at room temperature.

Answer in terms of nitrogen's structure.

(3)

- (c) Graphite and fullerenes are forms of carbon.

Graphite is soft and is a good conductor of electricity.

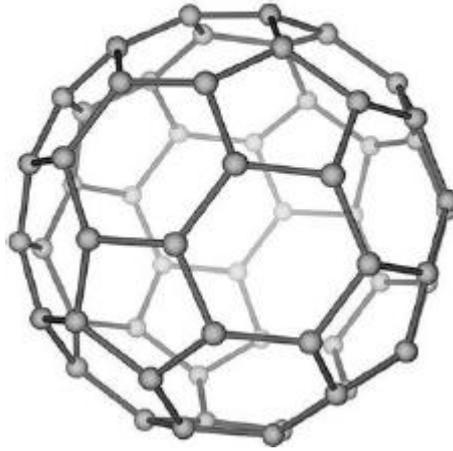
Explain why graphite has these properties.

Answer in terms of structure and bonding.

(4)

- (d) **Figure 1** shows a model of a Buckminsterfullerene molecule.

Figure 1



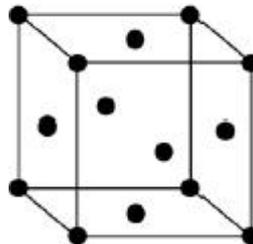
A lubricant is a substance that allows materials to move over each other easily.

Suggest why Buckminsterfullerene is a good lubricant. Use **Figure 1**.

(2)

Silver can form cubic nanocrystals. **Figure 2** represents a silver nanocrystal.

Figure 2



(e) A silver nanocrystal is a cube of side 20 nm

Calculate the surface area to volume ratio of the nanocrystal.

Surface area to volume ratio = _____

(3)

(f) Silver nanoparticles are sometimes used in socks to prevent foot odour.

Suggest why it is cheaper to use nanoparticles of silver rather than coarse particles of silver.

(2)

(Total 16 marks)

Q13.

This question is about the properties and uses of materials.

Use your knowledge of structure and bonding to answer the questions.

(a) Explain how copper conducts electricity.

(2)

(b) Explain why diamond is hard.

(2)

(Total 4 marks)

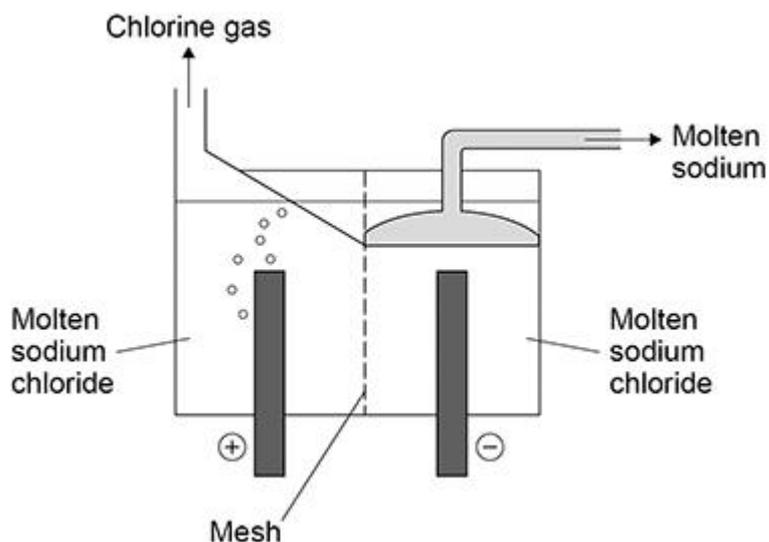
ELECTROLYSIS

Q14.

This question is about electrolysis.

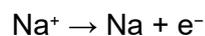
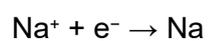
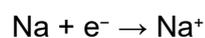
Molten sodium chloride is electrolysed in an industrial process to produce sodium.

The figure below shows a simplified version of the electrolysis cell used.



- (a) Which is the correct half equation for the production of sodium?

Tick (✓) **one** box.



(1)

A mesh is used to keep the products of the electrolysis apart.

- (b) Suggest **one** reason why the products of the electrolysis must be kept apart.

(1)

(c) Which type of particle passes through the mesh in the electrolysis of molten sodium chloride?

Tick (✓) **one** box.

Atom

Electron

Ion

Molecule

(1)

Aqueous sodium chloride solution is electrolysed in a different industrial process.

Two gases and an alkaline solution are produced.

(d) Which **two** ions are present in aqueous sodium chloride solution in addition to sodium ions and chloride ions?

1 _____

2 _____

(2)

(e) Name the alkaline solution produced.

(1)

(f) Explain how the alkaline solution is produced.

You should refer to the processes at the electrodes.

(3)

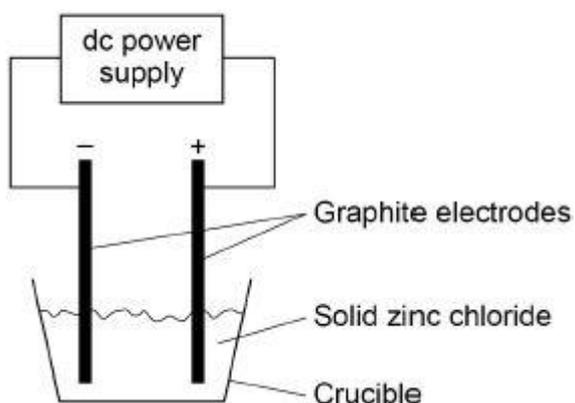
(Total 9 marks)

Q15.

A student investigated the electrolysis of different substances.

Figure 1 shows the apparatus.

Figure 1



(a) Explain why electrolysis would not take place in the apparatus shown in **Figure 1**.

(2)

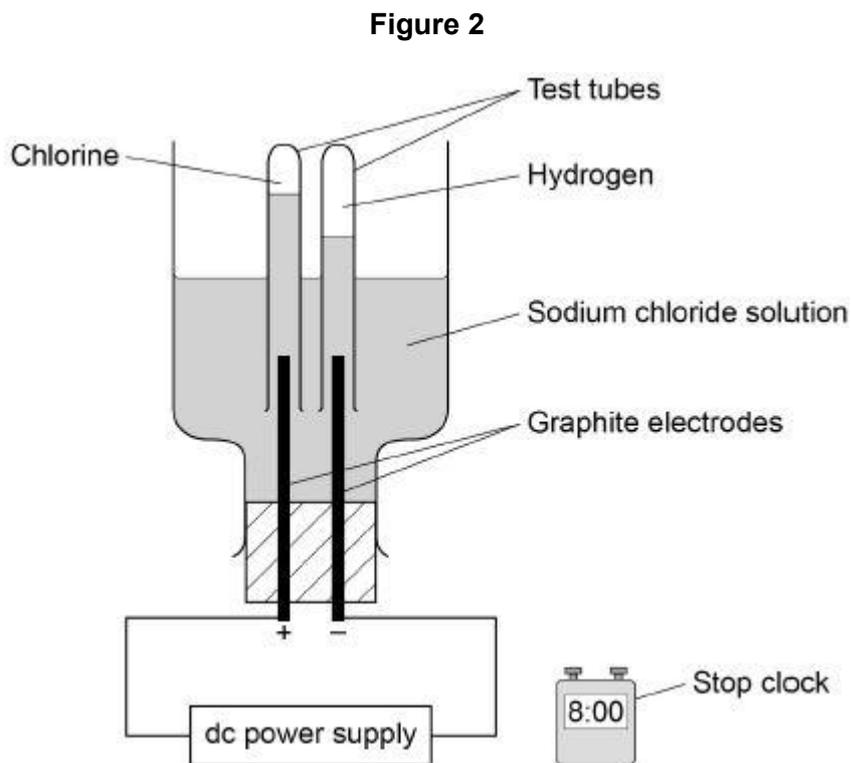
(b) Explain why graphite conducts electricity.

Answer in terms of the structure and bonding in graphite.

(3)

The student investigated how the volume of gases produced changes with time in the electrolysis of sodium chloride solution.

Figure 2 shows the apparatus.



(c) The student made an error in selecting the apparatus for this investigation.

How should the apparatus be changed?

Give **one** reason for your answer.

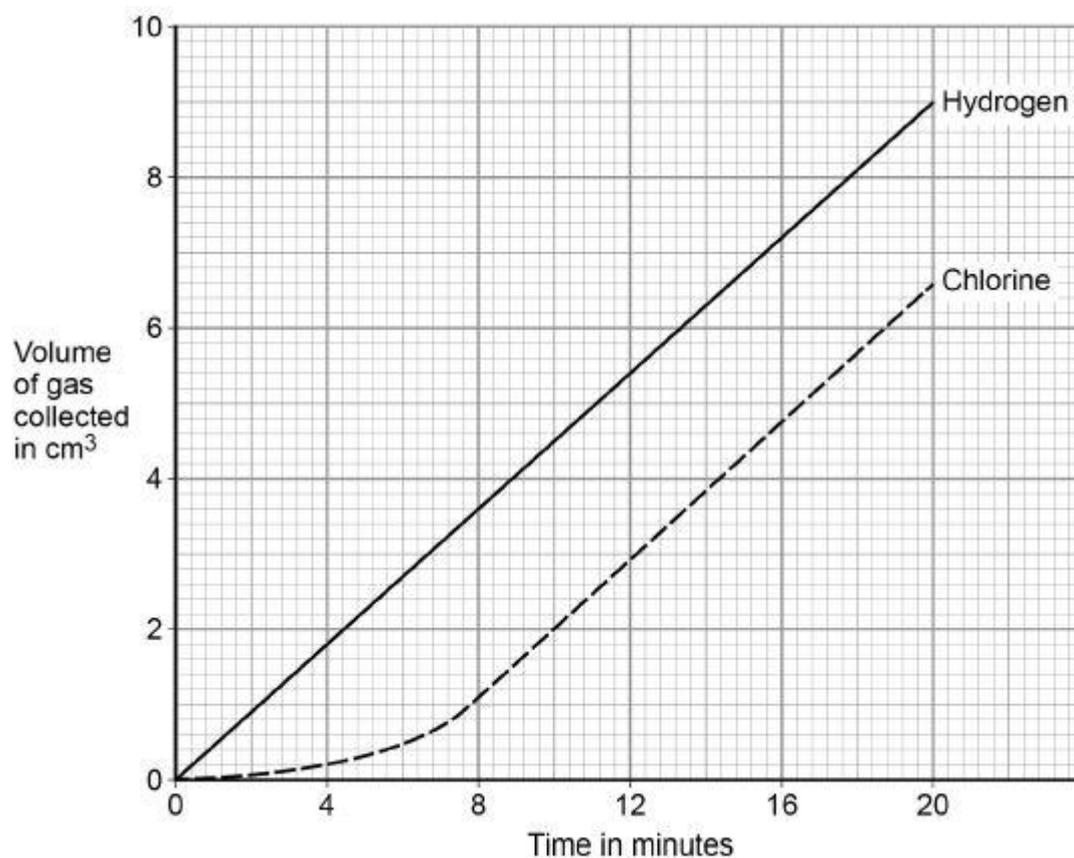
(2)

Another student used the correct apparatus.

This student measured the volumes of gases collected every minute for 20 minutes.

Figure 3 shows the student's results.

Figure 3



(d) Describe the trends shown in the results.

Use values from **Figure 3**.

(3)

(e) The number of moles of each gas produced at the electrodes is the same.

No gas escapes from the apparatus.

Suggest **one** reason for the difference in volume of each gas collected.

(1)

(Total 11 marks)

Q16.

This question is about electrolysis.

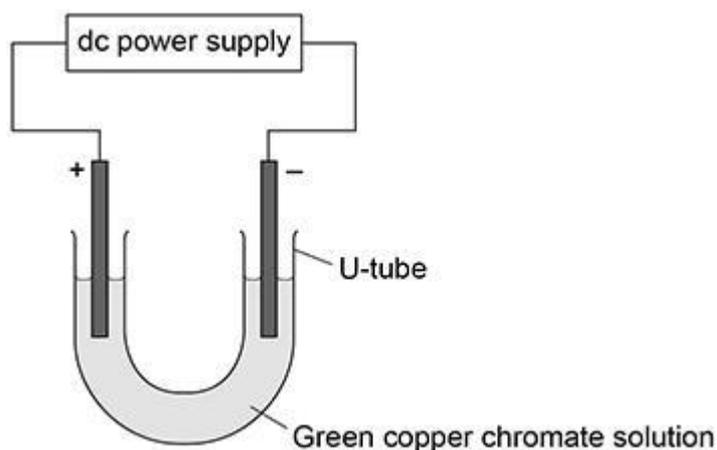
A student investigated the electrolysis of copper chromate solution.

Copper chromate solution is green.

Copper chromate contains:

- blue coloured Cu^{2+} ions
- yellow coloured CrO_4^{2-} ions.

The diagram below shows the apparatus used.



The student switched the power supply on.

The student observed the changes at each electrode.

The table below shows the student's observations.

Changes at positive electrode	Changes at negative electrode
Solution turned yellow Bubbles formed at the electrode	Solution turned blue Solid formed on the electrode

(a) Explain why the colour changed at the positive electrode.

(2)

(b) The gas produced at the positive electrode was oxygen.

The oxygen was produced from hydroxide ions.

Name the substance in the solution that provides the hydroxide ions.

(1)

(c) Describe how the solid forms at the negative electrode.

(3)

(d) The student repeated the investigation using potassium iodide solution instead of copper chromate solution.

Name the product at each electrode when potassium iodide solution is electrolysed.

Negative electrode

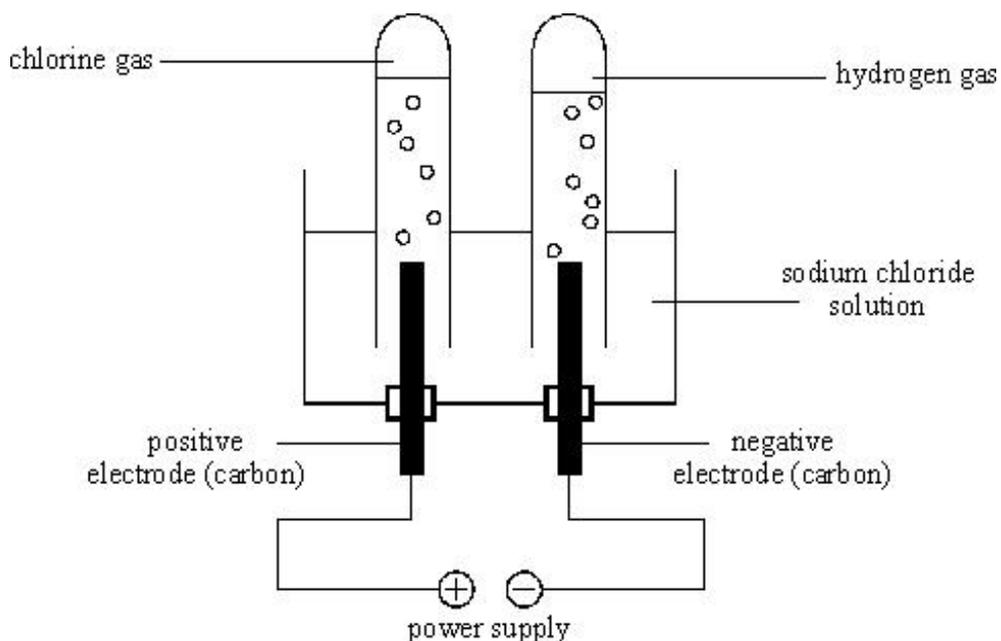
Positive electrode

(2)

(Total 8 marks)

Q17.

The diagram shows electrolysis of sodium chloride solution.



- (a) Complete and balance these equations to show the reactions during electrolysis.

At the positive electrode



At the negative electrode



(2)

- (b) Silver halides such as silver chloride and silver bromide are used in photography. The equation shows a reaction to prepare a silver halide.



Name and describe the products of this reaction, in words, as fully as you can.

product 1

product 2

(4)

(Total 6 marks)

Mark schemes

Q5.

(a) **Graphite:**

because the layers (of carbon atoms) in graphite can move / slide

it = graphite

1

this is because there are only weak intermolecular forces **or** weak forces between layers

accept Van der Waals' forces allow no covalent bonds between layers

1

Diamond:

however, in diamond, each carbon atom is (strongly / covalently) bonded to 4 others

allow diamond has three dimensional / tetrahedral structure

1

so no carbon / atoms able to move / slide

*allow so no layers to slide **or** so diamond is rigid*

1

(b) because graphite has delocalised electrons / sea of electrons

allow free / mobile / roaming electrons

1

which can carry charge / current **or** move through the structure

1

however, diamond has no delocalised electrons

accept however, diamond has all (outer) electrons used in bonding

1

[7]

Q6.

(a) propane is a small molecule

allow propane is a simple molecule

1

(so) the forces between molecules are weak

or

(so) the intermolecular forces are weak

*do **not** accept covalent bonds are weak*

1

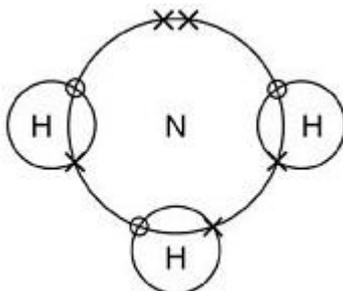
(which) require little energy to overcome

*do **not** accept answers in terms of breaking covalent bonds*

1

Q7.

(a)



scores 2 marks

allow dots, crosses, circles or e⁽⁻⁾ for electrons

1 bonding pair of electrons in each overlap

1

2 non-bonding electrons on nitrogen

do **not** accept non-bonding electrons on hydrogen

ignore inner shell electrons drawn on nitrogen

1

(b) does not show the shape

or

only two-dimensional

allow is not three-dimensional

1

(c) (ammonia has) small molecules

allow (ammonia has) a simple molecular (structure)

1

(ammonia has) weak intermolecular forces

allow (ammonia has) weak intermolecular bonds

do **not** accept weak covalent bonds

1

(so) little energy is needed to overcome the intermolecular forces

allow (so) little energy is needed to break the intermolecular bonds

allow (so) little energy is needed to separate the molecules

do **not** accept references to breaking covalent bonds

1

(d) Cr₂O₃

1

Q8.

- (d) (dot and cross diagram to show) sodium atom **and** oxygen atom
allow use of outer shells only

1

two sodium atoms to one oxygen atom
allow two sodium ions to one oxide ion

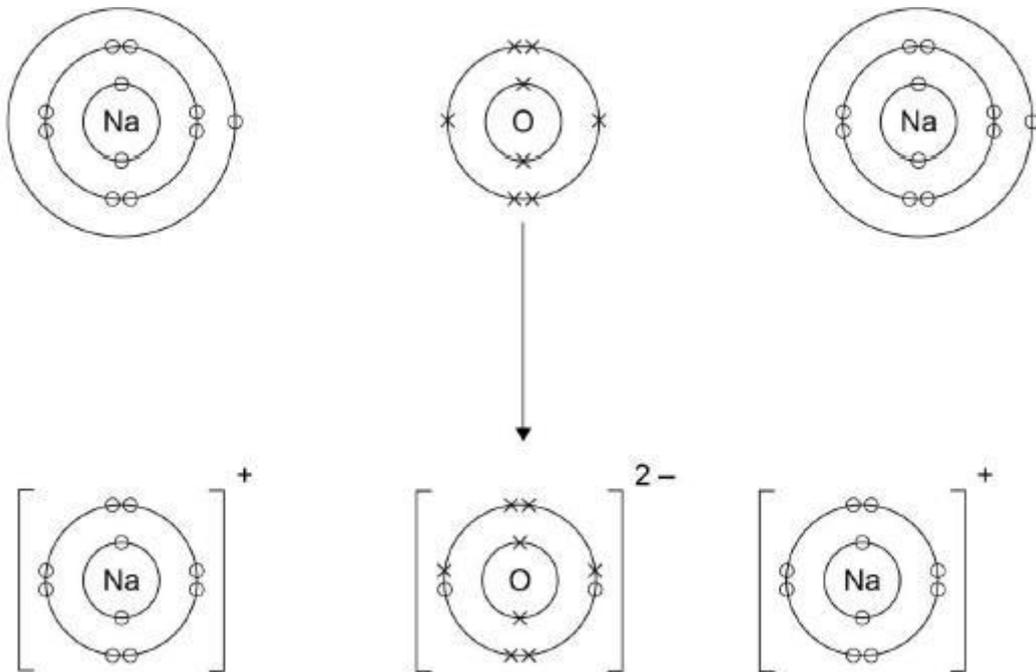
1

(to produce) sodium ion with a + charge

1

(to produce) oxide ion with a 2- charge

1



scores **4** marks

- (e) (oxygen) gains electrons

1

- (f) giant structure

allow (giant ionic) lattice

1

(with) strong (electrostatic) forces of attraction between (oppositely charged) ions

1

(so) large amounts of energy are needed to break the bonds / forces
allow (so) large amounts of energy are needed to separate the ions

1

[16]

Q9.

- (a) because atoms / ions / particles in alloy are different (sizes)

*do **not** allow reference to molecules*

ignore reference to compounds

1

so layers distorted

(and layers / atoms / ions / particles) don't slide **or** slide less easily

accept all marking points in a suitably labelled or annotated diagram

1

*if no other mark awarded accept an alloy is a mixture **or** contains different metals / elements for **1** mark*

1

- (b) giant structure **or** lattice **or** macromolecule

*max **3** marks if incorrect bonding*

1

strong bonds (between carbon / atoms)

1

covalent (bonds)

1

each carbon / atom forms 4 bonds

accept tetrahedral

*if no other marks awarded, allow carbon (atoms) for **1** mark*

1

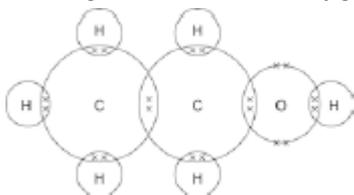
Q10.

- (b) one pair of electrons in each overlap (8 pairs in total)

allow any combination of dots, crosses or other symbols

1

the rest of the diagram correct with four non-bonding electrons on the oxygen giving a total of eight electrons in oxygen outer energy level.



*gains **2** marks*

1

Q11.

- (c) hydrogen chloride is made of small molecules

allow hydrogen chloride is simple molecular

1

(so hydrogen chloride) has weak intermolecular forces*

1

(intermolecular forces) require little energy to overcome*

1

do **not accept reference to bonds breaking unless applied to intermolecular bonds*

Q12.

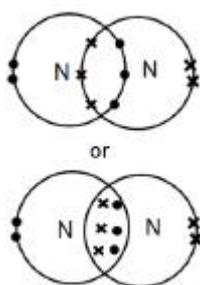
(a) six electrons in the overlap

allow dots, crosses or e^{-} for electrons

1

2 non-bonding electrons on each nitrogen atom

2 marks for an answer of:



1

(b) weak forces

1

between molecules

or

intermolecular

do not allow references to covalent bonding between molecules

1

(which) need little energy to overcome

1

(c) each (carbon) atom forms three covalent bonds

1

forming layers (of hexagonal rings)

1

(soft)

(because) layers can slide over each other

1

(conducts electricity)

(because of) delocalised electrons

1

(d) molecules are spherical

1

(so molecules) will roll

1

(e) surface area ($= 20 \times 20 \times 6$) = 2400 (nm^2) 1

volume ($= 20^3$) = 8000 (nm^3) 1

ratio = 0.3 (nm^3): 1 (nm^3)

ratio = 0.3 (nm^3): 1 (nm^3)

or

1 (nm^3): 3.33 (nm^3) 1

(f) (nanoparticles) have a larger surface area to volume ratio 1

so less can be used for the same effect 1

[16]

Q13.

(a) has delocalised electrons
accept free (moving) electrons 1

(so electrons) can move through the structure/metal
accept (so electrons) can carry charge through the structure/metal
accept (so electrons) can form a current 1

reference to incorrect particles or incorrect bonding or incorrect structure = max 1

(b) giant structure
accept lattice
accept each atom forms four bonds (with other carbon atoms)
ignore macromolecular 1

strong bonds
accept covalent
do not accept ionic 1

reference to intermolecular forces/bonds or incorrect particles = max 1

Q14.

- (a) $\text{Na}^+ + \text{e}^- \rightarrow \text{Na}$ 1
- (b) so the products do not react (to reform sodium chloride) 1
- (c) ion 1
- (d) hydrogen / H^+ (ions) 1
- hydroxide / OH^- (ions) 1
- (e) sodium hydroxide 1
allow NaOH
- (f) sodium ions and hydroxide ions are left (in solution) 1

(because) hydrogen ions are discharged / reduced (at the negative electrode to form hydrogen)

allow (because) hydrogen ions gain electrons (at the negative electrode to form hydrogen)

allow (because at the negative electrode) $2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$

1

(and because) chloride ions are discharged / oxidised (at the positive electrode to form chlorine)

allow (and because) chloride ions lose electrons (at the positive electrode to form chlorine)

allow (and because at the positive electrode) $2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$

1

[9]**Q15.**

- (a) solid (zinc chloride) does not conduct (electricity)
or
zinc chloride needs to be in solution **or** molten
allow liquid / aqueous 1
- (because) ions cannot move in the solid
or
(as) ions can (only) move in liquid / solution
*do **not** accept references to movement of electrons in zinc chloride* 1
- (b) each carbon / atom forms 3 (covalent) bonds 1

one electron per carbon / atom is delocalised

1

(so) these electrons carry charge through the graphite

or

(so) these electrons move through the structure

ignore carry current / electricity

1

if no other mark scored, allow 1 mark for

delocalised / free electrons

allow free electrons for delocalised electrons

(c) use measuring cylinders (instead of test tubes)

allow use burettes

allow use (gas) syringes

allow Hoffmann voltameter

1

(because) test tubes cannot measure volume

or

(because) test tubes have no graduations / scale

allow (so that) volume can be measured

1

(d) any **three** from:

- the volume of hydrogen collected is directly proportional to the time

allow the (volume of) hydrogen is collected at a

constant / steady rate

- the rate of collection of hydrogen is 0.45 (cm³/min)

- up to 8 minutes chlorine is collected at an increasing rate

allow any value from 6 to 8 minutes

allow initially chlorine is collected at an increasing

rate

- after 8 minutes the rate of collection of chlorine is the same as that of hydrogen

allow any value from 6 to 8 minutes

or

after 8 minutes the rate of collection of chlorine is 0.45 (cm³/min)

allow after 8 minutes the (volume of) chlorine is

collected at a constant / steady rate

if neither bullet point 3 nor bullet point 4 is

awarded allow 1 mark for chlorine is collected

slowly up to 8 minutes and then more quickly

allow any value from 6 to 8 minutes

3

(e) chlorine reacts with water

or

chlorine dissolves (in the solution).

1

Q16.

- (a)
- CrO_4^{2-}
- / chromate ions moved to the positive electrode

*allow anode for positive electrode**allow yellow (coloured) ions moved to the positive electrode*

1

(because) opposite charges attract

allow (because) negative ions are attracted to the positive electrode

1

- (b) water

ignore copper chromate solution

1

- (c) copper ions gain two electrons

*allow Cu^{2+} for copper ions**allow 1 mark for copper ions gain electrons***or***allow 1 mark for copper ions are reduced**do **not** accept copper ions are oxidised*

2

(to) form copper (atoms)

*allow Cu for copper (atoms)**the equation:**scores 3 marks*

1

- (d) (negative electrode) hydrogen

allow H_2

1

(positive electrode) iodine

allow I_2

1

[8]**Q17.**

- (a)
- $2\text{Cl}^- - 2\text{e}^- \rightarrow \text{Cl}_2$
- (allow unaltered LHS to produce
- $\frac{1}{2} \text{Cl}_2$
-)
-
- $\text{Na}^+ + \text{e}^- \rightarrow \text{Na}$
- (allow
- $\times 2$
- for
- all**
- terms)

*(credit candidates who point out that hydrogen / H_2 is in fact produced)**for 1 mark each*

2

- (b) for
- product 1*
- ,
- idea of a solid / precipitate or silver bromide*
-
- gains 1 mark*

but solid / a precipitate of silver bromide*gains 2 marks*

for product 2*, *idea of* aqueous / a solution / dissolved (in water) / **or** sodium nitrate

gains 1 mark
(do not allow liquid)

but aqueous / a solution / dissolved (in water) of sodium nitrate

(*do not credit formulae)
gains 2 marks

4

[6]