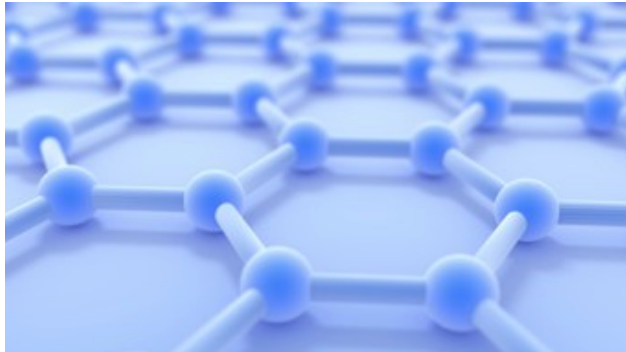


Q1. The article gives some information about graphene.

🎵 Nanotunes! 🎵

Carbon can be made into nano-thin, strong sheets called graphene.
A graphene sheet is a single layer of graphite.
Graphene conducts electricity and is used in loudspeakers.
The picture shows the structure of graphene.



© Timmy/iStock

(a) Use the picture and your knowledge of bonding in graphite to:

(i) explain why graphene is strong;

.....
.....
.....
.....
.....
.....

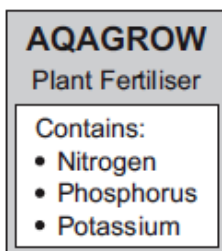
(3)

(ii) explain why graphene can conduct electricity.

.....
.....
.....
.....
.....
.....

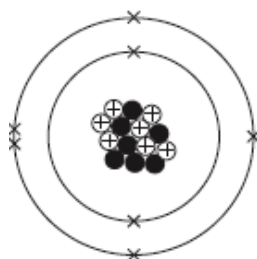
(2)

Q3. Fertilisers contain elements that plants need.



(a) **Figure 1** represents a nitrogen atom.

Figure 1

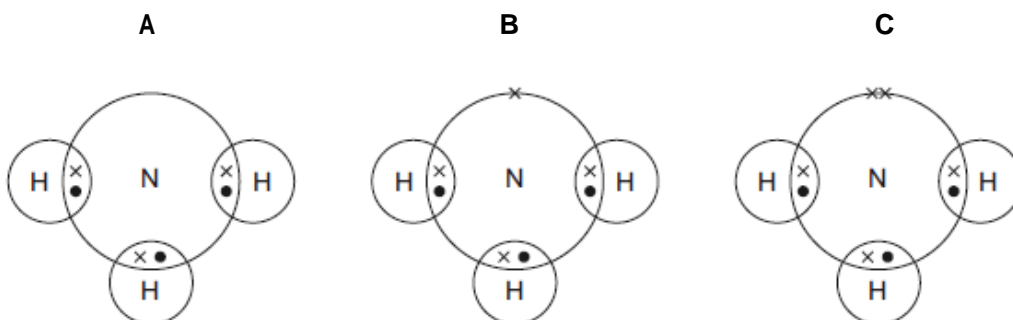


Complete each sentence.

- (i) The mass number of this nitrogen atom is (1)
- (ii) Atoms of nitrogen with different numbers of neutrons are called (1)
- (iii) Compared with a proton, the mass of an electron is (1)

(b) Fertilisers can be made from ammonia.

(i) Which diagram, **A**, **B**, or **C**, represents the electronic structure of an ammonia molecule?



(1)

The electronic structure of an ammonia molecule is shown in diagram

(ii) What is the correct formula of ammonia?

Draw a ring around the correct answer.



(1)

(c) A student made ammonium nitrate by reacting ammonia solution with an acid.

(i) Name the acid used to make ammonium nitrate.

.....

(1)

(ii) Complete the sentence.

The student added a few drops of, which changed colour when the ammonia solution had neutralised the acid.

(1)

(iii) The student added charcoal and filtered the mixture.

This produced a colourless solution of ammonium nitrate.

How is solid ammonium nitrate obtained from the solution?

.....

(1)

(iv) A farmer put ammonium nitrate fertiliser onto a field of grass.

Suggest what would happen to the grass.

.....

.....

(1)

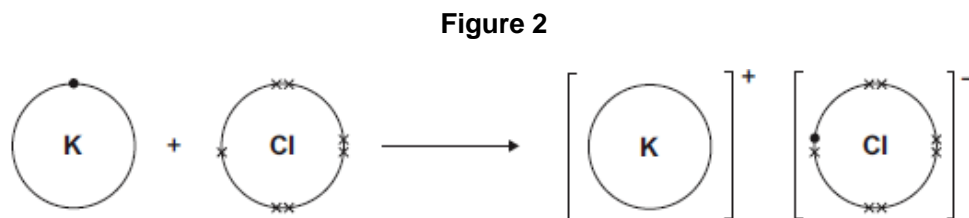
(d) Some fertilisers contain potassium chloride.

Potassium reacts with chlorine to produce potassium chloride.

Figure 2 shows how this happens.

The dots (•) and crosses (x) represent electrons.

Only the outer shell is shown.



Use **Figure 2** to help you answer this question.

Describe, as fully as you can, what happens when potassium reacts with chlorine to produce potassium chloride.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

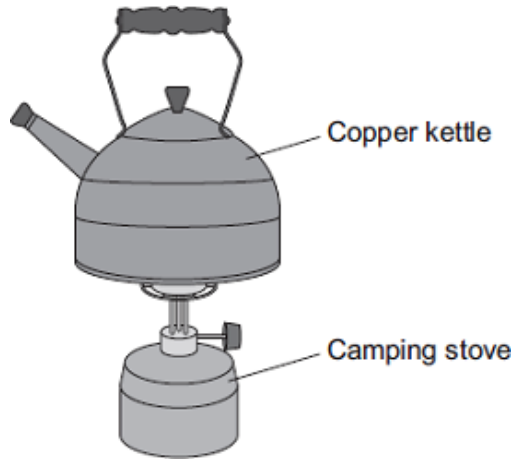
.....

(4)
(Total 13 marks)

Q4. The picture shows a copper kettle being heated on a camping stove.

Copper is a good material for making a kettle because:

- it has a high melting point
- it is a very good conductor of heat.



(a) Explain why copper, like many other metals, has a high melting point.

Your answer should describe the structure and bonding of a metal.

.....

.....

.....

.....

.....

.....

.....

.....

.....

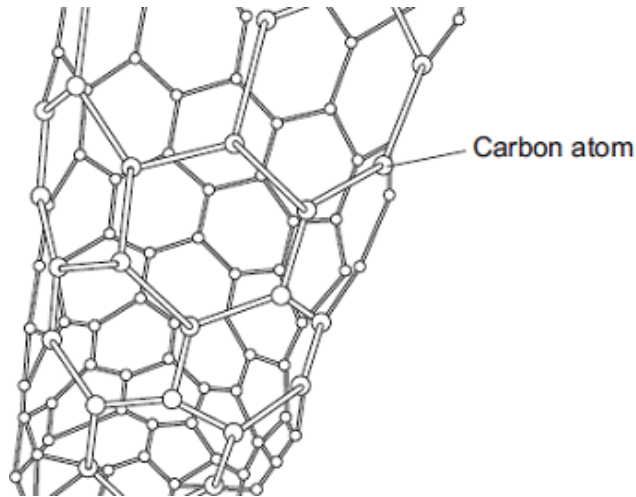
.....

(4)

- (b) Aeroplanes contain many miles of electrical wiring made from copper. This adds to the mass of the aeroplane.

It has been suggested that the electrical wiring made from copper could be replaced by carbon nanotubes which are less dense than copper.

The diagram shows the structure of a carbon nanotube.



- (i) What does the term 'nano' tell you about the carbon nanotubes?

.....
.....

(1)

- (ii) Like graphite, each carbon atom in the carbon nanotube is joined to three other carbon atoms.

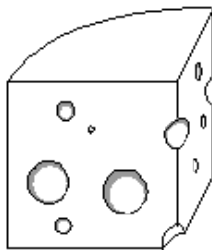
Explain why the carbon nanotube can conduct electricity.

.....
.....
.....
.....
.....

(2)

(Total 7 marks)

Q5. The salt sodium hydrogen phosphate (Na_2HPO_4) is used as a softening agent in processed cheese.



It can be made by reacting phosphoric acid (H_3PO_4) with an alkali.

(a) Complete the name of an alkali that could react with phosphoric acid to make sodium hydrogen phosphate.

..... hydroxide (1)

(b) What is the name given to a reaction in which an acid reacts with an alkali to make a salt?

..... (1)

(c) How would the pH change when alkali is added to the phosphoric acid solution?

.....
..... (1)

(d) What ions are present when any acid is dissolved in water?

..... (1)

(e) What ions are present when any alkali is dissolved in water?

..... (1)

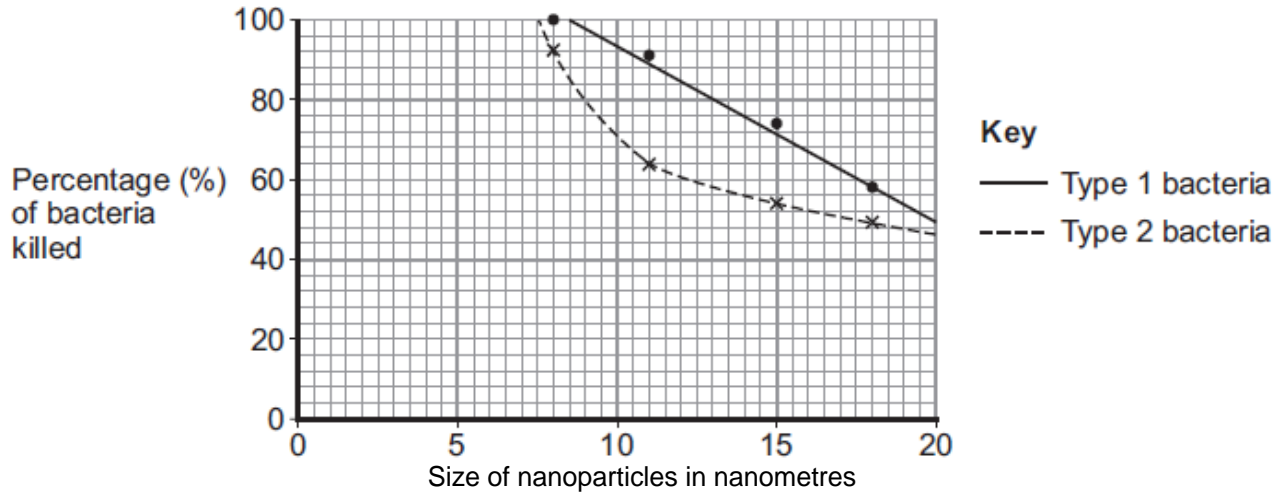
(f) Write a chemical equation for the reaction which takes place between the ions you have named in (e) and (f).

..... (1)

(Total 6 marks)

Q6. Magnesium oxide nanoparticles can kill bacteria.

The figure below shows the percentage of bacteria killed by different sized nanoparticles.



(a) (i) Give **two** conclusions that can be made from the figure above.

.....

.....

.....

.....

.....

.....

(2)

(ii) Points are plotted for only some sizes of nanoparticles.

Would collecting and plotting data for more sizes of nanoparticles improve the conclusions?

Give a reason for your answer.

.....

.....

(1)

(b) Magnesium oxide contains magnesium ions (Mg^{2+}) and oxide ions (O^{2-}).

Describe, as fully as you can, what happens when magnesium atoms react with oxygen atoms to produce magnesium oxide.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(4)
(Total 7 marks)

Q7. Glass is made from silicon dioxide.



© Velirina/iStock/Thinkstock

(a) Silicon dioxide has a very high melting point.

Other substances are added to silicon dioxide to make glass. Glass melts at a lower temperature than silicon dioxide.

Suggest why.

.....

.....

(1)

(b) Sodium oxide is one of the substances added to silicon dioxide to make glass.

(i) Sodium oxide contains Na^+ ions and O^{2-} ions.

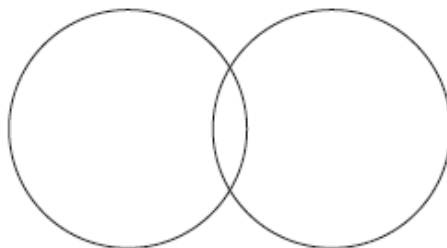
Give the formula of sodium oxide.

.....

(1)

(ii) Sodium oxide is made by heating sodium metal in oxygen gas.

Complete the diagram to show the outer electrons in an oxygen molecule (O_2).



(2)

(c) Glass can be coloured using tiny particles of gold. Gold is a metal.

Describe the structure of a metal.

.....
.....
.....
.....
.....
.....

(3)

(Total 7 marks)

- M1. (a) (i) giant lattice
allow each carbon atom is joined to three others 1
- atoms in graphene are covalently bonded
max. 2 marks if any reference to wrong type of bonding 1
- and covalent bonds are strong **or** need a lot of energy to be broken
allow difficult to break 1
- (ii) because graphene has delocalised electrons
allow each carbon atom has one free electron 1
- which can move throughout the structure
*do **not** accept just electrons can move.* 1
- (b) because there are weak forces between molecules
allow no bonds between the layers 1
- so layers / molecules can slip / slide. 1

[7]

M2. Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response.

0 marks

No relevant content

Level 1 (1–2 marks)

*There is a statement about the bonding and / or structure **or** melting / boiling point of chlorine **or** sodium chloride.*

Level 2 (3–4 marks)

*There are statements about the bonding and / or structure of chlorine **or** sodium chloride.*

Level 3 (5–6 marks)

*There are statements about the bonding and / or structure of chlorine **and** sodium chloride.*

*There is an explanation of why chlorine is a gas **or** sodium chloride is a solid.*

Examples of chemistry points made in response:

Chlorine:

covalent bonds between atoms

forming (simple) molecules

no / weak attraction / bonds between molecules

low boiling point

Sodium chloride:

*ionic bonds **or** electrostatic attraction*

strong bonds

in all directions

between oppositely charged ions

forming giant lattice

large amounts of energy needed to break bonds

high melting point

[6]

M3.	(a)	(i)	14	1
		(ii)	isotope	1
		(iii)	(very) small <i>accept smaller / tiny / (very) little</i>	1
	(b)	(i)	C	1
		(ii)	NH ₃	1
	(c)	(i)	nitric (acid)	1
		(ii)	indicator	1
		(iii)	crystallisation or evaporation <i>allow by heating or cooling or leave (on windowsill)</i> <i>do not accept freezing</i>	1
		(iv)	any one from: <ul style="list-style-type: none"> • grass grows faster • grass grows taller or thicker <i>allow grass grows better / greener</i>	1
	(d)		potassium (atom) loses (an electron) <i>reference to incorrect bonding or particle = max 3</i>	1
			chlorine (atom) gains (an electron) <i>ignore references to full outer shells</i>	1
			1 (electron)	1
			electron	1
				[13]
M4.	(a)		<i>reference to incorrect bonding or incorrect structure</i> <i>or incorrect particles = max 3</i>	
			giant structure / lattice <i>ignore many bonds</i>	1
			made up of <u>positive</u> ions surrounded by delocalized / free electrons <i>allow <u>positive</u> ions surrounded by a sea of electrons</i>	1

with strong bonds / attractions
allow hard to break for strong

1

so a lot of energy is needed to break these bonds / attractions / forces
ignore high temperature
ignore heat

1

(b) (i) that they are very small

or

1-100 nanometres **or** a few(hundred) atoms

accept tiny / really small / a lot smaller / any indication of very small eg. microscopic, smaller than the eye can see
ignore incorrect numerical values if very small is given

1

(ii) delocalised / free electrons
allow sea of electrons

1

one non-bonded electron from each atom

accept electron(s) moving through the structure / nanotube
allow electron(s) carry / form / pass current / charge

1

[7]

M5. (a) sodium

1

(b) neutralisation

1

(c) increase/inc. number

1

(d) H⁺

1

(e) OH⁻

1

(f) H⁺ + OH⁻ → H₂O

1

[6]

- M6.** (a) (i) any **two** from:
- ignore any conclusion drawn referring to data below 7.5 nm or above 20 nm*
 - *100% of (type 1 and type 2) bacteria are killed with a particle size of 7.5 to 8.5 nm*
 - accept nanoparticles in the range of 7.5 to 8.5 nm are most effective at killing (type 1 and type 2) bacteria*
 - *as the size increases (beyond 8.5 nm), nanoparticles are less effective at killing (type 1 and type 2) bacteria*
 - *type 1 shows a linear relationship **or** type 2 is non-linear*
 - *type 1 bacteria more susceptible than type 2 (at all sizes of nanoparticles shown on the graph)*
 - allow type 2 bacteria are harder to kill*
- 2
- (ii) (yes) because you *could confirm the pattern that has been observed*
- allow would reduce the effect of anomalous points / random errors*
 - allow would give better line of best fit*
 - ignore references to reliability / precision / accuracy / reproducibility / repeatability / validity*
- or**
- (no) because trend / *conclusion* is already clear
- 1
- (b) magnesium loses electron(s)
- 1
- oxygen gains electron(s)
- 1
- two electrons (per atom)
- 1
- gives full outer shells (of electrons) **or** *eight electrons in highest energy level*
- reference to incorrect particles **or** incorrect bonding **or** incorrect structure = max 3*
- 1
- or**
- (electrostatic) attraction between ions **or** forms ionic bonds
- accept noble gas structure*

[7]

M7. (a) weaker bonds
allow (other substances) react with the silicon dioxide

or

fewer bonds
ignore weaker / fewer forces

or

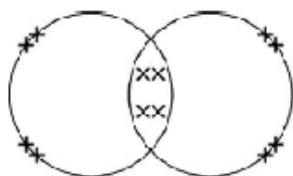
disruption to lattice
do **not** accept reference to intermolecular forces / bonds

1

(b) (i) Na_2O
do **not** accept brackets or charges in the formula

1

(ii)



electrons can be shown as dots, crosses, e or any combination

2 bonding pairs
accept 4 electrons within the overlap

1

2 lone pairs on each oxygen
accept 4 non-bonding electrons on each oxygen

1

(c) lattice / regular pattern / layers / giant structure / close-packed arrangement

1

(of) positive ions **or** (of) atoms

1

(with) delocalised / free electrons

reference to incorrect particles **or** incorrect bonding **or** incorrect structure = max 2

1

[7]

