Mark schemes

Q1.

(a) spherical

allow ball-shaped

ignore round / circular

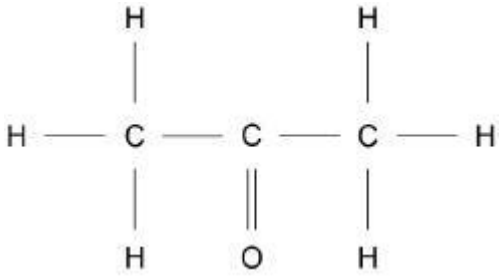
1

(b) any **one** from:

- drug delivery (round the body)
- hydrogen storage
- anti-oxidants
- reduction of bacterial growth
- catalysts
- (cylindrical fullerenes for) strengthening materials
- (spherical fullerenes for) lubricants

1

(c)



1

(d) C_3H_6O

allow CH_3COCH_3

allow elements in any order

1

(e) the intermolecular forces are weak

1

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

5–6

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

3–4

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

1–2

No relevant content

0

Indicative content

- bonds are covalent
- giant / macromolecular structure

- three (covalent) bonds per carbon atom
  or
  only three electrons per carbon atom used in (covalent) bonds
- so one electron per carbon atom (is delocalised)
- these delocalised electrons
- can move through the structure
- carrying (electrical) charge
- so graphite conducts electricity

- layered structure
- of (interlocking) hexagonal rings
- with weak (intermolecular) forces between layers
  or
  no (covalent) bonds between layers
- so the layers can slide over each other
- so graphite is soft and slippery

[11]

Q2.

(a) contain delocalised electrons
allow contain free electrons

1

(so) electrons can move through the structure / nanotube
allow (so) electrons can carry charge through the structure / nanotube
ignore throughout for through
ignore current / electricity for charge

1

(b) **Level 2:** Some logically linked reasons are given. There may also be a simple judgement.

3–4

Level 1: Relevant points are made. They are not logically linked.

1–2

No relevant content

0

Indicative content

- wood is the least dense so lightest to use
- aluminium is the most dense so will make the racket too heavy

- carbon nanotube is the strongest so least likely to break
- wood / aluminium are too weak so the racket will break more easily

- carbon nanotube is the stiffest so least likely to bend out of shape
- wood / aluminium are not very stiff so could bend out of shape

- justified conclusion

(c)

*an answer of 4.0 x 10^4 (nm^2) scores **3** marks*
*an answer of 40344 (nm^2) scores **2** marks*

(822 =) 6724 (nm^2)

1

(6 x 6724 =) 40344 (nm^2)

allow 40344 (nm^2) correctly rounded to any number of significant figures
allow correct calculation using incorrectly calculated value of area of one face from step1

1

= 4.0 x 10^4 (nm^2)

allow 4.0344 x 10^4 (nm^2) correctly rounded to 1 or more significant figures
allow a correctly calculated and rounded conversion to standard form of an incorrect calculation of surface area

1

(d)

allow converse statements about fine particles

any **one** from:
- less can be used (for the same effect)
  ignore nanoparticles are smaller
- greater surface area (to volume ratio)

1

[10]

Q3.

(a) 3.6 (cm^3)

1

(b) hydrogen line only

1

(c) both lines

1

(d) graphite has delocalised electrons

1

(e) **cathode** **anode**

zinc (1) chlorine (1)

*do **not** accept chloride*

*allow **1** mark if chlorine and zinc the wrong way around*

1+1

hydrogen (1) bromine (1)

*do **not** accept bromide*

*allow **1** mark if bromine and hydrogen the wrong way around*

1+1

[8]

Q4.

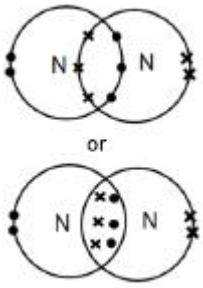
(a) six electrons in the overlap

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 × 20 × 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

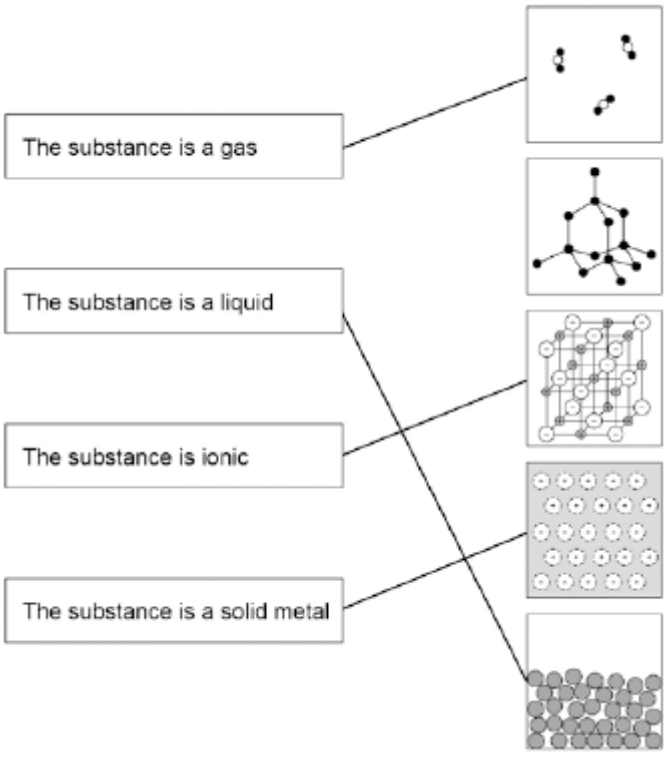
so less can be used for the same effect

1

[16]

Q5.

(a) **Statement** **Structure**



more than one line drawn from a variable negates the mark

4

(b) Carbon

1

(c) It has delocalised electrons

1

(d) the atoms / particles / ions are different sizes

*do **not** accept molecules*

1

so there are no rows / layers to slide

accept the layers are disrupted

1

(e) $\frac{2}{27} \times 100$

1

7.4%

1

*allow 7.4% with no working shown for **2** marks*

(f) Mixture

1

[11]

Q6.

(a) (i) hard

ignore strong

1

(ii) hundred

1

(b) (i) Covalent

1

(ii) 3

1

(iii) Soft and slippery

1

(c) (i) cross-links

allow bonds

ignore links

*do **not** accept intermolecular*

1

(ii) melt

1

(iii) any **two** from:

- temperature

  allow heat(ing)
- pressure

- catalyst

2

(d) (i) CH_4

1

(ii) Small molecules

1

[11]

Q7.

(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***

(c) thermosetting polymers do not melt (when heated)

accept thermosetting polymers do not change shape (when heated)

accept thermosetting polymers have high(er) melting points

ignore thermosetting polymers do not soften (when heated)

1

due to cross-links (between chains)

accept due to bonds between chains

1

*reference to smart polymers = **max 1***

accept converse argument

[6]