Mark schemes

1

(a) (i) Filtration

1

(ii) Chlorine

1

(b) (i) nanoparticles are small / smaller / much smaller / tiny

*allow any in range 1−100 nm or 1 × 10^{-9} m − 1 × 10^{-7} m **or** a few hundred atoms in size*

ignore numbers if stated smaller

1

(ii) they have a high surface area to volume ratio

reference to surface area without volume ratio is insufficient

*allow nanoparticles are very reactive **or** nanoparticles are more reactive than normal particles.*

1

(c) (sodium hydroxide) produces a white precipitate

accept solid / suspension or ppt or ppte for precipitate.

ignore cloudy / milky

1

which (then) dissolves / disappears (in excess sodium hydroxide)

M2 cannot be awarded unless a solid of some sort has been made

ignore names or formulae of compounds

1

[6]

2

(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 <u>throughout the structure</u>

*do **not** accept just electrons can move.*

1

(b) because there are weak forces between molecules

allow no <u>bonds</u> between the layers

1

so layers / molecules can slip / slide.

1

[7]

3

(a) (i) high

1

(ii) hundred

1

(b) hard

1

(c) (i) carbon

1

(ii) four

1

(iii) covalent

1

(iv) all

1

[7]

4 (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

<u>two</u> 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]

5 (a) a layer a few hundred atoms thick

1

(b) any **two** from:

*any **two** ideas*

- less materials or save resources
- less energy
- less fuel
- less pollution / greenhouse effect / global warming
- less waste

ignore references to cost / recycling

2

[3]

6 (a) (i) In suntan creams

1

(ii) Much smaller

1

(b) (i) have a high surface area to volume ratio

1

(ii) because a catalyst provides an alternative / different pathway / mechanism / reaction route

accept adsorption or 'increases concentration <u>at the surface</u>' ignore absorption

1

(that has) <u>lower</u> <u>activation energy</u>

allow weakens bonds

allow idea of increased successful collisions

*max **1** mark for incorrect chemistry eg increased energy of particles*

1

[5]

7 (a) (i) *mention of molecules / intermolecular / ionic / covalent = **max 2***

atoms / positive ions

1

any **two** from:

- (atoms / positive ions) in regular pattern / lattice / layer / giant structure (or diagram)
- delocalised electrons
  accept electrons move within / through the structure
  allow free (moving) electrons
  allow sea of electrons
- (atoms / positive ions) held together by strong / electrostatic attractions
  allow strong (metallic) bonds

2

(ii) delocalised electrons
accept electrons move within / through the structure
allow free electrons

1

(b) (i) smaller / very small
accept converse
accept 1 - 100 nanometres in size
accept a few hundred atoms
accept larger surface area ***or***
large surface area for their size

1

(ii) nanoparticles / more can fit into (tiny) gaps
allow nanosize particles have large(r) surface area

1

[6]

8 (a) 79

1

79

1

(b) hundred

1

(c) (i) electron(s)

1

(ii) three

1

(d) changes rate of reaction

accept lowers activation energy

or

speeds up / slows down reaction

accept reduces costs

1

(e) (i) melt

1

(ii) crosslinking

allow answers on diagram

or

(covalent) bonds between polymers / chains

allow bonds between layers
*do **not** allow intermolecular*

1

[8]

9

(a) because calcium is +2 and hydroxide is –1

accept to balance the charges

or
to make the compound neutral (in terms of charges)

allow calcium needs to lose 2 electrons and hydroxide needs to gain one electron

1

(b) particles of size 1-100 nm

allow clear comparison to 'normal' size particles

or particles with a few hundred atoms / ions

or particles with a high surface area (to volume ratio)

or as different properties to 'normal' size particles of the same substance

1

(c) $\mathbf{M_r}$ CaO = 56
and

$\mathbf{M_r}$ $Ca(OH)_2$= 74

1

2/56 (x74) **or** 0.036 (x74)
or
allow ecf from step 1

74/56 (x2) **or** 1.3(214…) (x2)

1

2.6(428…) in range 2.6 to 2.96
*correct answer with or without working gains **3** marks*
allow ecf carried through from step 1
ignore final rounding to 3

1

[5]

10 (a) carbon

1

(b) each atom is joined to four other atoms

1

It has a giant structure

1

(c) very small

1

[4]

11 (a) (i) increase

1

(ii) energy is given out to the surroundings

1

(b) (i) NO
allow 2NO
ignore nitrogen oxide
*do **not** allow equations*

1

(ii) harmful / poisonous (owtte)
allow dangerous
ignore reference to pollution / global warming
*do **not** accept references to ozone layer*

1

(c) a catalyst can speed up a chemical reaction

1

different reactions need different catalysts

1

(d) (i) smaller

accept less / tiny / very small

allow 10^{-9}

*do **not** allow small unless qualified*

1

(ii) reduce cost (owtte) **or**

ignore references to energy

save resources / raw materials (owtte)

1

[8]

12

(a) gives out heat / energy

allow release / loses

allow the products have less energy

or

energy / heat transferred to the surroundings

ignore temperature rises

allow more energy given out in forming bonds than taken in to break bonds

1

(b) (i) speed up the reaction (owtte)

accept changes the rate

accept lowers activation energy

accept increases successful collisions

accept allows reaction to take place at a lower temperature

1

(ii) nitrogen (N_2) / oxygen (O_2) / products are safe **or** not harmful / pollutant / toxic / dangerous / damaging

ignore releases nitrogen / oxygen unless qualified

or

(harmful) nitrogen monoxide / NO is not released into the air.

accept prevents / less acid rain

ignore greenhouse gas / ozone layer

1

(iii) 2 and 2

accept correct multiples or fractions

1

(iv) idea of catalyst not being used up

allow not changed by reaction

ignore catalyst does not take part

ignore catalyst not used in the reaction

1

(v) idea of different reactions (require different catalysts)

accept catalysts work for specific reactions

allow different gases

1

(c) • smaller / very small / or any indication of very small / 1–100 nanometres / a few (hundred) atoms

ignore just small

ignore size of the converter

1

• big(ger) surface area

1

• less (catalyst) needed / small amount of catalyst needed

1

[9]

13 (a) kills <u>bacteria</u>

allow destroys bacteria

ignore attacks / reacts with bacteria

ignore 'traps the smell'

or

stops growth of <u>bacteria</u>

ignore microbes

1

(b) small<u>er</u> / <u>very</u> small / tiny

assume they are referring to nanoparticles unless they state otherwise

accept 1 - 100nm in size

accept a few hundred atoms in size

accept normal size particles are (much) larg<u>er</u>

1

(c) any **one** from:

- big(ger) surface area
- react fast(er)

accept more reactive

ignore kill faster

1

(d) so they do not get released during washing
or so they do not get into rivers / ecosystem / environment

1

because this could harm fish / aquatic life
or so the socks keep their odour-preventing properties (owtte)

1

[5]

14

(a) the diameter of the tube is very small

1

(b) (i) three

1

(ii) covalent

1

(iii) bonds

1

[4]

15 (a) any **four** from:

*max **3** marks if any reference made to covalent / ionic bonding / molecules or intermolecular forces **or** graphite / diamond **or** forces of attraction between electrons and then ignore throughout*

- giant structure / lattice
  ignore layers
- positive ions
- sea of electrons **or** delocalised / free electrons
  ignore electrons can move
- awareness of outer shell / highest energy level electrons are involved
- (electrostatic) attractions / bonds between electrons and positive ions
- bonds / attractions (between atoms/ ions) are strong
  allow hard to break for strong
  ignore forces unqualified
- a lot of energy / heat is needed to break these bonds / attractions
  ignore high temperature

4

(b) (i) that they are very small
accept tiny / really small / a lot smaller / any indication of very small
eg microscopic, smaller than the eye can see

or

1–100 nanometres **or** a few (hundred) atoms
ignore incorrect numerical values if very small is given

1

(ii) any **2** from:

- one (non-bonded) electron from each atom
- delocalised / free electrons
  allow sea of electrons
  ignore electrons can move
- electron carry / form / pass current / charge
  ignore carry electricity

2

[7]

16 (a) Stops / reduces air from escaping (owtte)

*allow keeping shape **or** keeping it hard*

1

(b) a layer a few hundred atoms thick

1

(c) any **two** from:

- last longer
- use fewer balls
- less materials **or** save resources
- less manufactured

  accept less factories
- less energy
- less fuel
- less pollution / greenhouse effect / global warming
- less waste

  ignore references to cost / recycling

  *any **two** ideas*

2

[4]

17 (a) 1-100 nm in size

or

a few (hundred) atoms in size

accept very / really small / tiny

or 10^{-9}

*accept billionth of a metre **or** any number that implies very small*

accept measured in nanometers

if answer 'very small' ignore incorrect numerical values

1

(b) any **two** from:

- less tennis balls need to be made
- tennis balls last longer **or** don't have to replace as often
- less materials / resources / fuel used up / saves resources
  accept saving materials
- less energy used **or** making tennis balls uses energy
  accept saving energy
- less pollution caused
  accept named pollutant
  accept global warming / greenhouse effect
- less waste
  eg fewer tennis balls going to landfill

2

[3]

18 (a) any **one** from:

- they are made of layers
  *do **not** accept line / rows / lattice*
- atoms / ions / particles / layers (of atoms) can slide over each other

1

(b) any **one** from:

- smaller / tiny **or** very small
  *do **not** allow small alone*
- correct size range 1 to 100 nanometres
- a few hundred atoms in size
  if they state smaller and give a size outside range ignore size if it is less than 20,000

1

(c) harder

1

plus **one** from:

- so does not wear as quickly / erode as quickly
  ignore corrode
- less vulnerable to damage owtte
  *harder to wear down = **1** mark*
- because they have a high surface area to volume ratio

or

stronger (1)

plus **one** from: (1)

- less likely to break / do not break
  accept withstand pressure
- not as vulnerable to damage owtte
  *harder and stronger alone gains **1** mark*
- do not bend out of shape
- because they have a high surface area to volume ratio

1

[4]

19 (a) nanoparticles / they are small(er)
accept 1–100 nm or a few atoms in size

1

so can easily pass through pores / skin / cell / membranes / arteries / veins / capillaries / into blood stream owtte
must be a comparative statement
can be inferred from smaller particles
allow absorbed for pass through

1

(b) any **one** from:

- may be toxic (to cells / specific cells)

  *allow may harm / damage / kill cells / organs / tissues **or** may cause cancer*

- to ensure safety **or** reduce risk **or** risk of litigation

  allow may cause allergies / side effects

  ignore harmful / dangerous unqualified eg harmful to body / people

- nanoparticles may have different properties

- to see if they pass into the body

1

(c) any **two** sensible ideas from eg:

- testing is expensive **or** testing costs money

  allow it costs money

  ignore litigation

- testing is time consuming

- don't see any reason to test since normal sized particles (of titanium oxide) do not cause harm

  *accept normal sun cream does **not** cause harm owtte*

- don't want to risk not producing a popular product (owtte)

  *eg if unsafe will have to stop production **or** have to remove product if toxic*

- testing process / unfavourable results might cause alarm / reduce sales / reduce profit (less money)

- do not want to be seen doing animal testing

2

[5]