All questions are for separate science students only

Q1.

This question is about small particles.

(a) What is the approximate number of atoms in a nanoparticle?

Tick (✓) **one** box.

A few hundred atoms ☐

A few thousand atoms ☐

A few million atoms ☐

A few billion atoms ☐

(1)

(b) Nanoparticles of some elements can be used as catalysts.

Which element is most likely to be used as a catalyst?

Use the periodic table.

Tick (✓) **one** box.

Aluminium ☐

Iron ☐

Magnesium ☐

(1)

(c) Nanoparticles are used in sun creams and in wound dressings.

A wound dressing is placed next to the skin to prevent infection.

Figure 1 shows a wound dressing.

Figure 1

The table below shows some information about substances used in the form of nanoparticles.

Substance	**Property**
Carbon	Strong
Silicon dioxide	Hard
Silver	Kills bacteria
Titanium dioxide	Blocks light

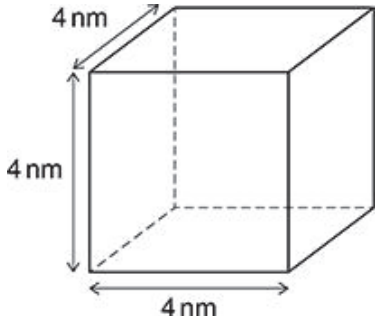
Draw **one** line from each use to the best substance for that use.

Use	**Substance**
Sun creams	Carbon
	Silicon dioxide
Wound dressings	Silver
	Titanium dioxide

(2)

(d) **Figure 2** shows a cubic nanoparticle.

Figure 2



Calculate:

- the surface area of the cubic nanoparticle
- the volume of the cubic nanoparticle
- the simplest whole number ratio of surface area : volume for the cubic nanoparticle.

Use the equation:

surface area of cubic nanoparticle = 6 × surface area of one face

_____

_____

_____

Surface area of cubic nanoparticle = _____ nm^2

_____

_____

_____

Volume of cubic nanoparticle = _____ nm^3

_____

_____

_____

Simplest whole number ratio of surface area: volume = _____ : _____

(6)

(Total 10 marks)

Q2.

This question is about small particles.

(a) Which type of particle is often referred to as dust?

Tick (✓) **one** box.

Coarse particle ☐

Fine particle ☐

Nanoparticle ☐

(1)

(b) A spherical coarse particle has a diameter of 4000 nm.

A spherical fine particle has a diameter of 200 nm.

How many times larger is the diameter of the coarse particle than the diameter of the fine particle?

Tick (✓) **one** box.

2 times ☐

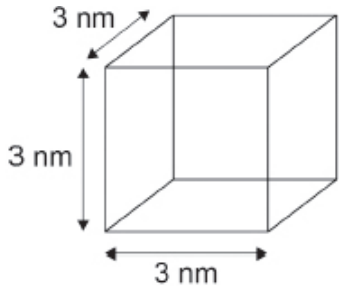
5 times ☐

20 times ☐

50 times ☐

(1)

(c) The figure below represents a cubic nanoparticle.



The volume of the cubic nanoparticle is 27 nm^3.

Calculate:

- the surface area of the cubic nanoparticle
- the simplest whole number ratio of surface area : volume for the cubic nanoparticle.

Use the equation:

surface area of cubic nanoparticle = 6 × surface area of one face

_____

_____

Surface area of cubic nanoparticle = _____ nm^2

_____

_____

Simplest whole number ratio of surface area : volume = _____ :1

(4)

Titanium oxide is used in some sun creams.

(d) Which is an advantage of using nanoparticles of titanium oxide rather than normal-sized particles of titanium oxide in sun creams?

Tick (✓) **one** box.

A smaller mass of nanoparticles is needed to be effective.	☐
Nanoparticles cost more than the same mass of normal-sized particles.	☐
Nanoparticles have a lower surface area to volume ratio than normal-sized particles.	☐

(1)

(e) Titanium oxide contains Ti^{4+} ions and O^{2-} ions.

What is the formula of titanium oxide?

Tick (✓) **one** box.

TiO_2 ☐ TiO_4 ☐ Ti_2O ☐ Ti_4O_2 ☐

(1)

(Total 8 marks)

Q3.

This question is about small particles.

(a) Coarse particles, fine particles and nanoparticles are all small particles.

Which is the largest particle?

Tick (✓) **one** box.

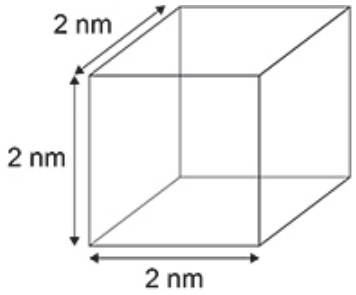
Coarse particle ☐

Fine particle ☐

Nanoparticle ☐

(1)

(b) The figure below shows a cubic nanoparticle.



The surface area of the cubic nanoparticle is 24 nm^2.

Calculate:

- the volume of the cubic nanoparticle
- the simplest surface area : volume ratio of the cubic nanoparticle.

_____

_____

Volume = _____ nm^3

_____

_____

Simplest surface area : volume ratio = _____ : 1

(4)

(c) Catalysts made of nanoparticles are often more effective than catalysts made of normal sized particles.

Complete the sentences.

Compared with normal sized particles, the surface area to volume ratio of nanoparticles is _____.

This means that the mass of a nanoparticle catalyst needed to have the same effect

as the same catalyst made of normal sized particles is _____.

(2)

(d) Silver nanoparticles can be added to the material used to make socks.

Some facts about silver and bacteria are:

- silver nanoparticles are small enough to be breathed in
- silver is very expensive
- silver can kill bacteria
- bacteria can cause infections
- bacteria can break down sweat to produce unpleasant smells.

Suggest **one** advantage and **one** disadvantage of wearing socks containing silver nanoparticles.

Advantage _____

_____

Disadvantage _____

_____

(2)

(e) An atom has a radius of 1×10^{-10} m.

A spherical nanoparticle has a radius of 1×10^{-8} m.

How many times larger is the radius of the nanoparticle than the radius of the atom?

Tick (✓) **one** box.

2 times ☐

10 times ☐

100 times ☐

200 times ☐

(1)

(Total 10 marks)