Questions

Q1.

Figure 1 shows toothbrushes in a container.

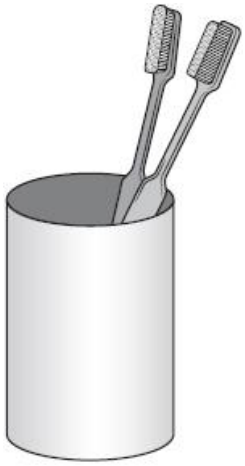


Figure 1

Toothpastes contain abrasives and other substances to make them effective.

Figure 2 is a pie chart of the percentage composition by volume of one toothpaste.

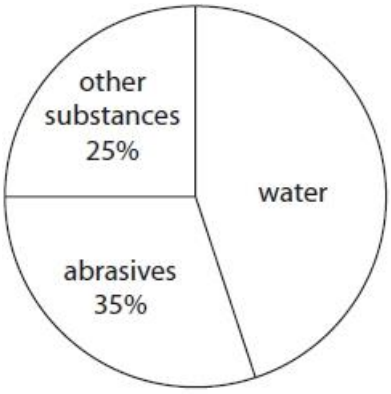


Figure 2

Calculate the volume of water in 150 cm^3 of this toothpaste.

(2)

.....

.....

volume of water = ... cm^3

(Total for question = 2 marks)

Q2.

Some questions must be answered with a cross in a box (☒). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☒).

Figure 1 shows toothbrushes in a container.

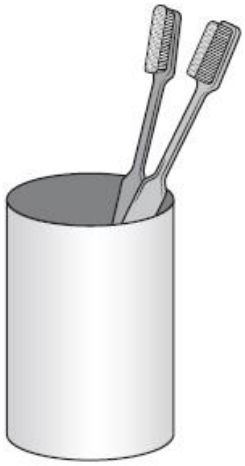


Figure 1

The container is made of a ceramic material.

Which is a property of the ceramic that makes it suitable for the container?

(1)

- ☒ **A** it will break if dropped
- ☒ **B** it does not react with water
- ☒ **C** it melts at over 2 000 °C
- ☒ **D** it is a good conductor of heat

(Total for question = 1 mark)

Q3.

Figure 1 shows a mug made of clay ceramic.

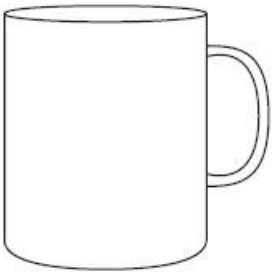


Figure 1

Which property of clay ceramic makes it suitable for use as a mug?

(1)

- ☒ **A** is brittle
- ☒ **B** is not transparent
- ☒ **C** does not conduct electricity
- ☒ **D** does not dissolve in water

(Total for question = 1 mark)

Q4.

Some questions must be answered with a cross in a box (☒). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☒).

Figure 1 shows toothbrushes in a container.

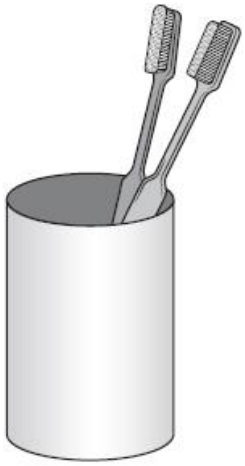


Figure 1

In some countries, toothpastes contain nanoparticles of silver.

Which statement describes the size of a nanoparticle?

(1)

- ☐ **A** the size of an electron
- ☐ **B** the size of an atom
- ☐ **C** the size of a few hundred atoms
- ☐ **D** the size of 1 million molecules

(Total for question = 1 mark)

Q5.

This question is about properties of materials.

Figure 6 shows some properties of steel and Kevlar®.

property	steel	Kevlar®
density / g cm^{-3}	7.85	1.44
relative strength	1	5
flexibility	low	high
resistance to corrosion	low	high

Figure 6

Body armour, such as a bullet-proof vest, could be manufactured using either of these materials.

Explain **two** reasons why Kevlar® is preferred to steel as the material for body armour.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 4 marks)

Q6.

Nanoparticles are very small particles that have unusual properties.

(i) Particles less than 100 nanometres in size are classified as nanoparticles.

100 nanometres is

(1)

- ☒ **A** 1×10^{-4} metres
- ☒ **B** 1×10^{-5} metres
- ☒ **C** 1×10^{-7} metres
- ☒ **D** 1×10^{-9} metres

(ii) Nanoparticles of titanium(IV) oxide are used in some sunscreens.

Describe a reason why nanoparticles of titanium(IV) oxide are used in some sunscreens.

(2)

.....

.....

.....

.....

(iii) Some people are concerned that there is a risk when sunscreens containing nanoparticles are used.

Explain a possible risk associated with using nanoparticles in sunscreens.

(2)

.....

.....

.....

.....

(Total for question = 5 marks)

Q7.

Nanoparticles are found in some sunscreens.

(i) An atom has a radius of about 0.1 nm.

A nanoparticle might have a radius of about

(1)

- ☒ **A** 0.01 nm
- ☒ **B** 0.1 nm
- ☒ **C** 50 nm
- ☒ **D** 1 cm

(ii) A useful property of nanoparticles in sunscreens is that they

(1)

- ☒ **A** have a low surface area to volume ratio
- ☒ **B** are toxic
- ☒ **C** are white
- ☒ **D** prevent harmful UV radiation reaching the skin

(iii) A nanoparticle has a surface area of 38 400 nm^2 and a volume of 51 200 nm^3.

Calculate the surface area to volume ratio.

(2)

.....

.....

.....

.....

surface area to volume ratio = 100 : .....

(Total for question = 4 marks)

Q8.

Explain a possible risk associated with nanoparticulate materials.

(2)

.....

.....

.....

.....

(Total for question = 2 marks)

Q9.

Some acids are used in tests for ions.

A bottle of one acid is shown in Figure 17.

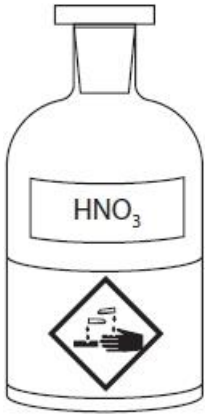


Figure 17

(i) The acid in Figure 17 can be used in the test for carbonate ions.

Explain, giving the name of the hazard symbol shown, what safety precautions should be taken when using this acid.

(2)

.....

.....

.....

.....

(ii) Give the name of the acid shown in Figure 17.

(1)

.....

(iii) State a property of glass that makes it a suitable material to make the container for an acid.

(1)

.....

.....

(Total for question = 4 marks)

Q10.

Explain the advantage of using catalysts made of nanoparticles rather than larger particles.

(2)

.....

.....

.....

.....

(Total for question = 2 marks)

Q11.

Figure 2 shows information about three different materials, a composite, a glass and a metal.

	a composite	a glass	a metal
density	low	high	high
ability to conduct electricity	poor	poor	good
resistance to corrosion	good	good	poor

Figure 2

Explain which material in Figure 2 is the most suitable material to use in electrical circuits.

(2)

.....

.....

.....

.....

(Total for question = 2 marks)

Q12.

Bottles can be made of polymers, such as poly(ethene), and of glass.

Give **one** advantage of a bottle made of a polymer rather than a bottle made of glass.

(1)

.....

.....

(Total for question = 1 mark)

Q13.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

(i) Nanoparticles are very small.

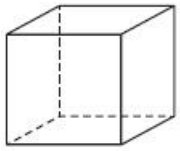
Some nanoparticles have a radius of 17 nm.
The radius of a magnesium atom is 0.16 nm.
Approximately how many times larger is the radius of these nanoparticles than the radius of the magnesium atom?

(1)

- ☐ **A** 0.01
- ☐ **B** 0.10
- ☐ **C** 10
- ☐ **D** 100

(ii) A catalyst contains cube-shaped nanoparticles.

Figure 3 shows a diagram of a cube-shaped nanoparticle.
The length of each side of the cube is 9 nm.



© Gauravjuvekar

Figure 3

Calculate the surface area of the cube, in nm^2.

(2)

.....

.....

.....

surface area = ... nm^2

(iii) Nanoparticles have many uses.

Some scientists are concerned about the possible risks of using nanoparticles.
Give **one** possible risk of using nanoparticles.

(1)

.....

.....

(Total for question = 4 marks)

Q14.

Figure 10 shows information about a glass, a ceramic, a polymer and a metal.

	glass	ceramic	polymer	metal
flexibility	low	low	high	high
hardness	medium	medium	low	low
reaction with water	no reaction	no reaction	no reaction	very slow reaction
electrical conductivity	low	low	low	high
melting point	high	high	medium*	high

*polymers soften, rather than melt, when heated.

Figure 10

Figure 11 shows part of a household wire that connects a kettle to a plug.

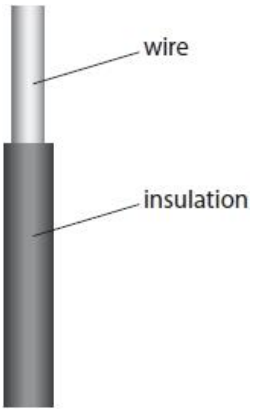


Figure 11

(i) Why is this wire made of metal?

(1)

- ☒ **A** the metal is hard
- ☒ **B** the metal reacts with water
- ☒ **C** the metal is an element
- ☒ **D** the metal conducts electricity

(ii) Which type of material would be most suitable for the insulation on this household wire?

(1)

- ☒ **A** the glass
- ☒ **B** the ceramic
- ☒ **C** the polymer
- ☒ **D** the metal

(Total for question = 2 marks)

Q15.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Figure 2 shows the properties of some materials.

material	property			
	brittle	conducts electricity	conducts heat	transparent
clay ceramic	yes	no	no	no
glass	yes	no	no	yes
metal	no	yes	yes	no
polymer	no	no	no	no

Figure 2

Figure 3 shows an electrical cable.
The electrical cable is made of metal wire coated with another material.
The metal wire inside the electrical cable conducts electricity.

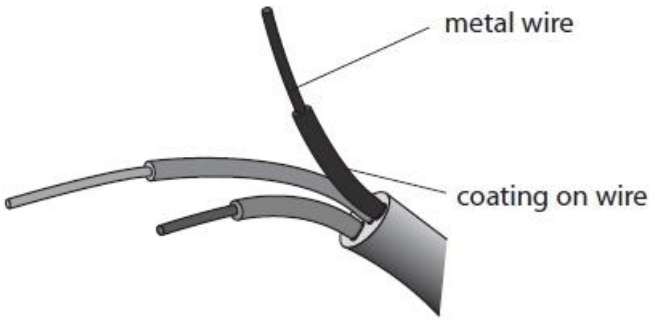


Figure 3

(i) Name a material from Figure 2 that would be suitable for coating the metal wire.

(1)

.....

(ii) Which type of particle moves through the metal wire to allow it to conduct electricity?

(1)

- ☒ **A** atoms
- ☒ **B** electrons
- ☒ **C** neutrons
- ☒ **D** protons

(Total for question = 2 marks)

Q16.

The use of nanoparticles has increased in recent years.

(i) The length of one side of a cube of silver is 2 cm as shown in Figure 7.

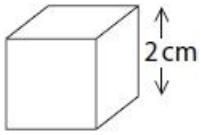


Figure 7

Calculate the surface area to volume ratio of this cube of silver.

(3)

surface area to volume ratio = ...

(ii) Suggest an explanation of why a given mass of silver is more effective as a catalyst when used as nanoparticles rather than in a powder form.

(3)

.....

.....

.....

.....

.....

.....

(Total for question = 6 marks)

Q17.

A different nanoparticle is cube shaped, as shown in Figure 2.

The length of one side of this cube is 60 nm.

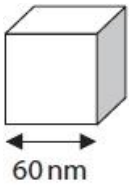


Figure 2

Show that the surface area : volume ratio for this cube is 1 : 10.

(3)

.....

.....

.....

.....

.....

.....

(Total for question = 3 marks)

Q18.

Titanium dioxide nanoparticles are used in some sunscreens.

(i) State one property of titanium dioxide nanoparticles that make them suitable for use in sunscreens.

(1)

.....

.....

(ii) Suggest one possible risk associated with using nanoparticles.

(1)

.....

.....

(Total for question = 2 marks)

Q19.

Some questions must be answered with a cross in a box (☒). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☒).

Figure 1 shows the surface area to volume ratio for different diameters of spherical nanoparticles.

diameter of nanoparticle in nm	surface area : volume ratio
10	3:5
20	3:10
30	3:15
40	3:20
50	3:25

Figure 1

(i) State the trend shown by the data in Figure 1.

(1)

.....

.....

(ii) What is the surface area : volume ratio for a spherical nanoparticle with a diameter of 80 nm?

(1)

- ☐ **A** 3 : 35
- ☐ **B** 3 : 40
- ☐ **C** 3 : 45
- ☐ **D** 3 : 50

(Total for question = 2 marks)

Q20.

There are some concerns that nanoparticles may cause harm if they enter the human body.

(i) Suggest one way that nanoparticles can enter the human body.

(1)

.....

(ii) Suggest one possible risk if nanoparticles enter the human body.

(1)

.....

(iii) The surface area of a nanoparticle of gold is 150 nm^2.

The volume of a nanoparticle of gold is 125 nm^3.

$$\text{ratio} = \frac{\text{surface area}}{\text{volume}}$$

Calculate the surface area to volume ratio of this nanoparticle of gold.

(1)

.....

.....

surface area to volume ratio = ...: 1

(Total for question = 3 marks)

Q21.

Explain, using information from Figure 10, why the ceramic is a suitable material to make a cup that will contain a hot drink of tea or coffee.

(2)

.....

.....

.....

(Total for question = 2 marks)

Q22.

Figure 4 shows information about a ceramic and a metal.

	ceramic	metal
flexibility	low	high
hardness	medium	low
reaction with water	no reaction	very slow reaction
density	medium	high

Figure 4

The ceramic, rather than the metal, is a more suitable material for washbasins.

Give a reason for this, using a property from Figure 4.

(1)

.....

.....

.....

(Total for question = 1 mark)

Q23.

Figure 1 shows a list of particles.

ethene molecule
nanoparticle
sodium atom
starch molecule

Figure 1

In the spaces below, write the names of these particles in order of increasing particle size.

(2)

smallest particle .....

.....

.....

largest particle .....

(Total for question = 2 marks)

Mark Scheme

Q1.

Question number	Answer	Additional guidance	Mark
	• % water = 100 – 35 – 25 = 40% (1) • 40% x 150 = 60 (cm^3) (1)	60 **with no working at all** scores 2 35 + 25 = 60 scores 0. with ANY working shown: MP1 – for 40(%) (do not need to show how calculated). Can be shown on pie chart. allow 0.4 or 2/5 ECF for MP2	**(2)** **AO2 1**

Q2.

Question number	Answer	Mark
	B it does not react with water is the only correct answer **A, C** are not correct because they are not useful **D** is an incorrect statement	**(1)** **AO1 1**

Q3.

Question number	Answer	Mark
	D does not dissolve in water **A**, **B** and **C** are not factually correct	**(1)** **AO2**

Q4.

Question number	Answer	Mark
	C the size of a few hundred atoms is the only correct answer **A** and **B** are incorrect because nanoparticles are made of more than one atom **D** is incorrect as there are too many molecules	**(1)** **AO1 1**

Q5.

Question number	Answer	Mark
	An explanation that combines identification via a judgement (maximum 2 marks) to reach a conclusion via justification/reasoning, which must be linked to the judgement (maximum 2 marks): • it is lighter/has a lower density/than steel (1) • so it is easier/more comfortable to wear (1) OR • it is stronger (1) • so it is less likely to be penetrated (1) OR • it is more flexible (1) • so it is easier/more comfortable to wear (1) OR • does not (corrode/rust) (1) • so it will last longer (1)	**(4)**

Q6.

Question number	Answer	Mark
(i)	**C** 1×10^{-7} metres (correct 100 nanometers) is the only correct answer. **A** is not correct because it is 100 000 nanometers **B** is not correct because it is 10 000 nanometers **D** is not correct because it is 1 nanometer	**(1)**

Question number	Answer		Mark
(ii)	A description to include the following points can {absorb/block} **UV** light from the skin (1) therefore can prevent sunburn (1) OR particles are very small (1) (therefore) appear invisible / cannot be seen on the skin (1)	allow reflects **UV** light ignore sunlight allow can prevent {skin/cell} damage / protects skin /can help prevent skin cancer allow is not white on the skin ignore insoluble in water so water resistant	(2)

Question number	Answer	Additional guidance	Mark
(iii)	An explanation linking two from do not know the risks fully / long term risks not yet known (1) because they have not been used for a long enough time / are new technology / no long term research (1) might pass into the body / through cell membranes / enter skin / enter the bloodstream (1) could {change / catalyse} reactions in body (1)	allow named change / damage to named organ ignore harm the skin/ body/ causes rashes /illness ignore nanoparticles could be inhaled allow any plausible risk of sunscreen (1) with linked explanation (1)	(2)

Q7.

Question Number	Answer	Mark
(i)	C 50 nm **The only correct answer is C** ***A*** *is not correct because this is too small* ***B*** *is not correct because this is too small* ***D*** *is not correct because this is too large*	**(1)** AO 1 1

Question Number	Answer	Mark
(ii)	D prevent harmful UV radiation reaching the skin **The only correct answer is D** ***A*** *is not correct because ratio is high* ***B*** *is not correct because this is not useful* ***C*** *is not correct because this is not useful*	**(1)** AO 1 1

Question Number	Answer	Additional guidance	Mark
(iii)	allow 2 for correct answer with or without working 51200 (1) 38400 1 : 1.33 (1)	allow 2 marks for 3:4 allow 1.3, 1.333... Allow 1 mark for final answer 1.00: 0.75 or 4:3 Ignore 'rec' or dots	**(2)** AO 2 1

Q8.

Question number	Answer	Additional guidance	Mark
	An explanation linking two from • do not know the risks fully / long term risk not yet known (1) • because they have not been used for a long time / are new technology / no long term research (1) • might pass into the body / through cell membranes / enter the skin / enter the bloodstream (1) • could {change / catalyse} reactions in body (1)	allow 'cause a change'	**(2)** **AO1**

Q9.

Question number	Answer	Additional guidance	Mark
(i)	An explanation linking • corrosive (1) • so wear gloves/ (safety) goggles (1)	allow safety glasses/ safety spectacles / eye protection ignore glasses and any other precautions mark independently	**(2)** **A03 3a**

Question number	Answer	Mark
(ii)	nitric acid	**(1)** **AO1 1**

Question number	Answer	Additional guidance	Mark
(iii)	inert/ unreactive/ does not corrode	reject 'is not corrosive' allow acid will not dissolve/ react with glass ignore 'acid won't burn through' ignore references to clear / strong	**(1)** **AO2 1**

Q10.

Question number	Answer		Mark
	An explanation linking two from • catalyst particles have much larger surface area (when made from nanoparticles) (1) • leads to increased reaction rate (1)		**(2) AO1**

Q11.

Question number	Answer	Mark
	An explanation linking • metal (1) • good conductor (of electricity) (1)	**(2)**

Q12.

Question number	Answer	Additional guidance	Mark
	Any **one** from the following points: polymer • is lighter/has a lower density (1) • is more resistant to shattering (1)	Ignore any reference to cost.	**(1)**

Q13.

Question number	Answer	Mark
(i)	**D** 100 **D** is the only correct answer because 17 / 0.16 ≈ 100 **A**, **B** and **C** are incorrect because 17 / 0.16 ≈ 100	**(1)**

Question number	Answer	Additional guidance	Mark
(ii)	allow 2 for correct answer with or without working surface area of 1 side of cube = 9 x 9 (1) (= 81 (nm^2)) total area of cube = 6 x (9 x 9) (1) (= 486 (nm^2))	 allow 9 x 9 (1) x 9 (= 729 (nm^2)) allow 6 x 9 (1) (= 54 (nm^2))	(2)

Question number	Answer	Mark
(iii)	damages cells/heart problems/get into the bloodstream/pass into cells/catalysing harmful reactions/harmful to aquatic life	(1)

Q14.

Question Number	Answer	Mark
(i)	**D** the metal conducts electricity **The only correct answer is D** ***A*** *is not correct because metals are not hard* ***B*** *is not correct because this is not useful* ***C*** *is not correct because this is not relevant*	**(1)** AO 2 1

Question Number	Answer	Mark
(ii)	**C** the polymer **The only correct answer is C** ***A*** *is not correct because this in not flexible* ***B*** *is not correct because this is not flexible* ***D*** *is not correct because this is a conductor*	**(1)** AO 3 1a

Q15.

Question number	Answer	Mark
(i)	polymer	**(1)** **AO3**

Question number	Answer	Mark
(ii)	**B** electrons **A** is not correct because atoms do not move through the metallic structure. **C** is not correct because neutrons do not move through the metallic structure. **D** is not correct because protons do not move through the metallic structure.	**(1)** **AO1**

Q16.

Question number	Answer	Additional guidance	Mark
(i)	• calculates total surface area (1) • calculates volume (1) • calculates surface area to volume ratio (1)	Example of calculation Surface area = 6 × 2 × 2 = 24 (cm^2) Volume = 2 × 2 × 2 = 8 (cm^3) Surface area to volume ratio = 24/8 = 3 : 1 Award full marks for correct numerical answer without working	**(3)**

Question number	Answer	Mark
(ii)	An explanation that combines identification – application of knowledge (1 mark) and reasoning/justification – application of understanding (2 marks): • silver nanoparticles have a much greater surface area to volume ratio than powder (1) OR • silver nanoparticles have a much greater surface area than the same volume of a powder (1) Plus • because chemical reactions take place on the surface of the solid silver catalyst (1) • so there will be more frequent collisions/the rate of reaction will be faster (1) OR • So in a given time, more molecules can come together to react (1)	**(3)**

Q17.

Question number	Answer	Additional guidance	Mark
	calculate surface area 60 x 60 x 6 (= 21 600) (1) calculate volume 60 x 60 x 60 (= 216 000) (1) s.a : vol ratio 216000 (1) (= 10) 21600	 allow 10 : 1 (or multiples of) with calculation ignore = instead of :	**(3)** **AO2 1**

Q18.

Question number	Answer	Additional guidance	Mark
(i)	colourless / absorbs **UV** / non-toxic / large SA : vol ratio	allow transparent / does not leave white marks allow reflects **UV**	**(1)** **AO2 1**

Question number	Answer	Additional guidance	Mark
(ii)	long term effects not known/ may build up in {living things/ water supplies/ environment}	allow specific examples of effects on health but ignore 'health risks' allow may get into the body and cause harm	**(1)** **AO1 1**

Q19.

Question number	Answer	Additional guidance	Mark
(i)	as the diameter of the nanoparticle increases the surface area volume ratio decreases	ORA allow negative correlation/inversely proportional ignore that as volume increases surface area also increases	**(1)** **AO3 1**

Question number	Answer	Mark
(ii)	**B** 3 : 40 is the only correct answer. **A** is the correct ratio for a 70nm diameter sphere **C** is the correct ratio for a 90nm diameter sphere **D** is the correct ratio for a 100nm diameter sphere	**(1)** **AO3 1**

Q20.

Question number	Answer	Mark
(i)	breathed in / absorbed by the skin / consumed within food and drink / medication	**(1)** **AO2**

Question number	Answer	Mark
(ii)	catalyse (harmful) reactions / build up and form blockages	**(1)** **AO1**

	Answer	Mark
(iii)	1.2 :1	**(1)** **AO2**

Q21.

Question Number	Answer	Additional guidance	Mark
	Correct property • no reaction with water/unreactive/ high melting point / low flexibility (1) Linked to correct reason • drinks contain water/will not react with drink/ ceramic will not melt / cup will not distort / cup will keep shape (1)	No property given = no marks If more than one property given Ignore any incorrect propeties and associated reasons	**(2)** AO 3 1a AO 3 1b

Q22.

Question Number	Answer	Additional guidance	Mark
	(ceramic) has no reaction with water (1)		**(1)** AO 3 1a

Q23.

Question number	Answer	Additional guidance	Mark
	smallest - sodium atom ethene molecule starch molecule largest - nanoparticle (2)	Any 3 particles in correct order (1)	**(2)** **AO1**