

GCSE Chemistry

Worksheet: Sizes of particles and their properties

TIME 35 min	TOTAL 31 marks	CALCULATOR Allowed	DIFFICULTY Easy, Medium
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Topics: Sizes of particles and their properties

NAME	CLASS	DATE
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- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Answer all questions in the spaces provided.
- In all calculations, show clearly how you work out your answer.
- The marks for questions are shown in brackets.

0 1

Nanoscience is the study of very small structures, such as nanoparticles.

0 1 . 1

What size are nanoparticles?

Tick (✓) **one** box.

1–100 nm

☐

100–2500 nm

☐

2500–10 000 nm

☐

more than 1 mm

☐

[1 mark]

0 1 . 2

What is 1 nm in metres?

Tick (✓) **one** box.

1×10^{-3} m

☐

1×10^{-6} m

☐

1×10^{-9} m

☐

1×10^{-12} m

☐

[1 mark]

0 1 . 3

Complete the sentence.

Nanoparticles have a high to volume ratio.

.....

.....

.....

[1 mark]

0 1 . 4

How do fine particles (PM_{2.5}) compare in size with nanoparticles?

Tick (✓) **one** box.

They are larger.

☐

They are smaller.

☐

They are the same size.

☐

They are single atoms.

☐

[1 mark]

0 2

A nanoparticle is a cube with sides of length 20 nm.

0 2 . 1

Calculate the surface area of the cube.

.....

.....

.....

Surface area = nm²

[1 mark]

0 2 . 2

Calculate the volume of the cube.

.....

.....

.....

Volume = nm³

[1 mark]

0 2 . 3

Calculate the surface area to volume ratio of the cube.

.....

.....

.....

.....

[1 mark]

0 3

Particles are classified by their diameter:

- nanoparticles: 1 nm to 100 nm
- fine particles (PM_{2.5}): 100 nm to 2500 nm
- coarse particles (PM₁₀): 2.5×10^{-6} m to 1×10^{-5} m

Table 1 shows the diameters of four particles.

Table 1

Particle	Diameter
A	8×10^{-6} m
B	45 nm
C	5×10^{-7} m
D	0.3 nm

0 3 . 1

Which particle is a nanoparticle?

.....

.....

.....

.....

[1 mark]

0 3 . 2 Classify particle **C**. Show your working.

.....

.....

.....

.....

[2 marks]

0 3 . 3 Explain why particle **D** is **not** a nanoparticle.

.....

.....

[1 mark]

0 3 . 4 Calculate how many times larger the diameter of particle **A** is than the diameter of particle **B**.

.....

.....

.....

.....

.....
[2 marks]

0 4

Cube **P** is a nanoparticle with sides of length 8 nm.

Cube **Q** is a larger particle of the same substance, with sides of length 80 nm.

0 4 . 1 Calculate the surface area to volume ratio of cube P.

.....

.....

.....

.....

.....
[2 marks]

0 4 . 2

Calculate the surface area to volume ratio of cube Q.

.....

.....

.....

.....

[1 mark]

0 4 . 3

How many times greater is the surface area to volume ratio of cube P than that of cube Q?

.....

.....

.....

.....

[1 mark]

0 4 . 4

Suggest why nanoparticles of a substance can have different properties from larger particles of the same substance.

.....

.....

[1 mark]

0 5

A cube has sides of length L.

0 5 . 1

Show that the surface area to volume ratio of the cube is $\frac{6}{L}$.

.....

.....

.....

.....

[2 marks]

0 5 . 2

Use $\frac{6}{L}$ to explain why the surface area to volume ratio increases by a factor of 10 when the length of the side of a cube decreases by a factor of 10.

.....

.....

[1 mark]

0 5 . 3

Calculate the surface area to volume ratio of a cube-shaped nanoparticle with sides of length 5 nm.

.....

.....

.....

.....

[1 mark]

0 6

Nanoparticles have sizes from 1 nm to 100 nm. Table 2 shows the diameters of four particles, **J**, **K**, **L** and **M**.

$1 \text{ nm} = 1 \times 10^{-9} \text{ m}$

Table 2

Particle	Diameter
J	60 nm
K	$3 \times 10^{-4} \text{ m}$
L	0.4 nm
M	90 nm

0 6 . 1

Which particle is too small to be a nanoparticle?

.....

.....

.....

.....

[1 mark]

0 6 . 2

Give the diameter of particle K in nanometres.

.....

.....

.....

Diameter = nm

[1 mark]

0 6 . 3

Explain why particle K is not a nanoparticle.

.....

.....

[1 mark]

0 6 . 4

Particle M is 1.5 times the diameter of particle J.
Explain why both J and M are nanoparticles.

.....

.....

[1 mark]

0 7

A typical atom has a diameter of about 0.2 nm. A gold nanoparticle has a diameter of 20 nm.

0 7 . 1

How many times larger is the diameter of the gold nanoparticle than the diameter of a typical atom?

.....

.....

.....

.....

[1 mark]

0 7 . 2

The largest nanoparticles have a diameter of 100 nm.
Estimate how many typical atoms would fit side by side across a particle with a diameter of 100 nm.

.....

.....

.....

.....
[1 mark]

0 7 . 3

Give the diameter of the gold nanoparticle in metres, in standard form.

.....

.....

.....

Diameter = m
[1 mark]

0 7 . 4

Explain why gold nanoparticles can have different properties from a lump of gold.

.....

.....

.....

.....

[2 marks]

END OF QUESTIONS

Original practice questions written to match the specification. Not produced by, affiliated with or endorsed by AQA.

Mark scheme

GCSE Chemistry · Worksheet: Sizes of particles and their properties · 31 marks

Question 1 (4 marks)

01.1 [1 mark]

Correct: 1–100 nm

01.2 [1 mark]

Correct: 1×10^{-9} m

01.3 [1 mark]

Answer: surface area

- surface area (1)
-

01.4 [1 mark]

Correct: They are larger.

Question 2 (3 marks)

02.1 [1 mark]

Answer: 2400 nm²

- $6 \times 20 \times 20 = 2400$ (nm²) (1)
-

02.2 [1 mark]

Answer: 8000 nm³

- $20 \times 20 \times 20 = 8000$ (nm³) (1)
-

02.3 [1 mark]

Answer: 0.3 (per nm)

- $2400 \div 8000 = 0.3$ (nm⁻¹) (1)
-

Notes: Allow the answer written as 0.3 : 1. Allow ECF from the surface area and volume calculated.

Question 3 (6 marks)

03.1 [1 mark]

Answer: B

- B (1)
-

03.2 [2 marks]

Answer: $5 \times 10^{-7} \text{ m} = 500 \text{ nm}$, so C is a fine particle (PM_{2.5}).

- $5 \times 10^{-7} \text{ m} = 500 \text{ nm}$ (1)
 - fine particle / PM_{2.5} (1)
-

03.3 [1 mark]

Answer: It is smaller than 1 nm — about the size of a single atom or small molecule.

- it is smaller than 1 nm / is the size of an atom or small molecule (1)
-

03.4 [2 marks]

Answer: about 180 (178)

- $8 \times 10^{-6} \div 45 \times 10^{-9} / 8000 \div 45$ (1)
 - 178 / 180 (1)
-

Question 4 (5 marks)

04.1 [2 marks]

Answer: 0.75 (per nm)

- surface area = $6 \times 8^2 = 384 \text{ (nm}^2\text{)}$ and volume = $8^3 = 512 \text{ (nm}^3\text{)}$ (1)
- $384 \div 512 = 0.75 \text{ (nm}^{-1}\text{)}$ (1)

04.2 [1 mark]

Answer: 0.075 (per nm)

- $(6 \times 80^2) \div 80^3 = 0.075 \text{ (nm}^{-1}\text{)}$ (1)

04.3 [1 mark]

Answer: 10

- 10 (1)

Notes: Allow ECF from the ratios calculated.

04.4 [1 mark]

Answer: They have a much higher surface area to volume ratio, so a much larger proportion of their atoms are at the surface.

- they have a (much) higher surface area to volume ratio, so a larger proportion of their atoms are at the surface (where they can react) (1)

Question 5 (4 marks)

05.1 [2 marks]

Answer: Surface area = $6L^2$; volume = L^3 ; ratio = $6L^2 \div L^3 = 6 \div L$

- surface area = $6L^2$ and volume = L^3 (1)
- $6L^2 \div L^3 = \frac{6}{L}$ (1)

05.2 [1 mark]

Answer: The ratio is inversely proportional to L, so dividing L by 10 multiplies 6/L by 10.

- the ratio is inversely proportional to L / if L is divided by 10, $6 \div L$ is multiplied by 10 (1)

05.3 [1 mark]

Answer: 1.2 (per nm)

- $6 \div 5 = 1.2 \text{ (nm}^{-1}\text{)}$ (1)
-

Question 6 (4 marks)

06.1 [1 mark]

Answer: L

- L (1)
-

06.2 [1 mark]

Answer: 300 000 nm

- $300\,000 / 3 \times 10^5$ (nm) (1)
-

06.3 [1 mark]

Answer: Its diameter (300 000 nm) is much larger than 100 nm.

- its diameter is (much) larger than 100 nm (1)

Notes: Allow ECF from the diameter in nm.

06.4 [1 mark]

Answer: Both diameters are between 1 nm and 100 nm.

- both diameters (60 nm and 90 nm) are within the range 1 nm to 100 nm (1)
-

Question 7 (5 marks)

07.1 [1 mark]

Answer: 100

- 100 (1)
-

07.2 [1 mark]

Answer: 500

- $(100 \div 0.2 =) 500$ (1)
-

07.3 [1 mark]

Answer: 2×10^{-8} m

- 2×10^{-8} (m) (1)

Notes: The answer must be in standard form. Do not accept 0.000 000 02.

07.4 [2 marks]

Answer: Nanoparticles have a much higher surface area to volume ratio, so a much larger proportion of their atoms are at the surface.

- nanoparticles have a much higher surface area to volume ratio (1)
 - so a much larger proportion of the atoms are at the surface (and can react / interact) (1)
-