

Units, prefixes and reliable measurements

Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Worksheet answers

Each answer shows the formula or rule, the substitution and the final result in bold with its unit. Check your significant figures as well as your numbers, because examiners award marks for both.

Level: Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** GCSE WS, IGCSE 1.1

Problem 1 Base units

1 and 2. Length: **metre (m)**; mass: **kilogram (kg)**; time: **second (s)**; current: **ampere (A)**; temperature: **kelvin (K)**.

3. The **kilogram** contains the prefix kilo.

Problem 2 Prefix factors

1. kilo = 10^3 .
2. milli = 10^{-3} .
3. micro = 10^{-6} .
4. giga = 10^9 .

Problem 3 Simple conversions

1. $2.5 \times 1000 = \mathbf{2500\ m}$.
2. $340 \times 10^{-3} = \mathbf{0.34\ m}$.
3. $75 \times 10^{-2} = \mathbf{0.75\ m}$.
4. $0.8 \times 1000 = \mathbf{800\ g}$.

Problem 4 Standard form

1. $\mathbf{4.5 \times 10^7}$.
2. $\mathbf{6.2 \times 10^{-4}}$.
3. $\mathbf{3800}$.
4. $\mathbf{0.071}$.

Problem 5 Counting significant figures

1. 502 has **3 s.f.** (the zero is between digits).
2. 0.0405 has **3 s.f.**

3. 1.050 has **4 s.f.** (the trailing zero after the point counts).
4. 0.0090 has **2 s.f.**

Problem 6 Rounding

1. **3.14.**
2. **0.0068.**
3. **25 000** (2.5×10^4).
4. 9.996 rounds up to **10.0**.

Problem 7 Reading a ruler

1. The smallest division is 1 mm, so the resolution is **1 mm (0.1 cm)**.
2. The strip ends 3 small marks after 6 cm: **6.3 cm**.
3. $6.3 \times 10^{-2} = \mathbf{0.063\ m}$.

Problem 8 Area of a tile

1. $18.4 \times 12.5 = \mathbf{230\ cm^2}$ (3 s.f.).
2. $1\ m^2 = 10\ 000\ cm^2$, so $230 \div 10\ 000 = \mathbf{0.023\ m^2}$ ($2.3 \times 10^{-2}\ m^2$).
3. Both measurements have **3 s.f.**

Problem 9 Area and volume units

1. $3.2 \times 10\ 000 = \mathbf{32\ 000\ cm^2}$ ($3.2 \times 10^4\ cm^2$).
2. $1\ m^3 = 10^6\ cm^3$, so $450 \div 10^6 = \mathbf{4.5 \times 10^{-4}\ m^3}$.
3. A square metre is 100 cm wide and 100 cm long, so it holds $100 \times 100 = \mathbf{10\ 000\ cm^2}$.
The factor 100 applies to each of the two lengths.

Problem 10 Time conversions

1. $2.4 \times 3600 = \mathbf{8640\ s}$.
2. $45 \times 60 + 30 = 2700 + 30 = \mathbf{2730\ s}$.
3. $0.5 \times 10^{-3} = \mathbf{5 \times 10^{-4}\ s}$.

Problem 11 Averaging a pendulum

1. Sum = $14.8 + 15.2 + 15.0 + 14.9 + 15.1 = 75.0$, so mean = $75.0 \div 5 = \mathbf{15.0\ s}$.
2. $15.0 \div 10 = \mathbf{1.50\ s}$ per swing.

3. $(15.2 - 14.8) \div 2 = \mathbf{0.2 \text{ s}}$.

Problem 12 Two balances

1. A: $(5.31 + 5.30 + 5.32) \div 3 = 15.93 \div 3 = \mathbf{5.31 \text{ g}}$. B: $(4.9 + 5.2 + 5.0 + 4.9) \div 4 = 20.0 \div 4 = \mathbf{5.00 \text{ g}}$.

2. A has a range of 0.02 g and B has 0.3 g, so **balance A** is more precise.

3. B's mean equals the true value, so **balance B** is more accurate. A is precise but not accurate, like the second target.

Problem 13 Percentage uncertainty

1. $0.5 \div 25.0 \times 100 = \mathbf{2.0 \%}$.

2. $0.01 \div 0.40 \times 100 = \mathbf{2.5 \%}$.

3. The **length** has the smaller percentage uncertainty (2.0 % against 2.5 %).

Problem 14 Density from a block

1. $V = 10.0 \times 3.0 \times 6.0 = \mathbf{180 \text{ cm}^3}$.

2. Density = $540 \div 180 = \mathbf{3.0 \text{ g/cm}^3}$.

3. $1 \text{ g/cm}^3 = 1000 \text{ kg/m}^3$, so the density is $\mathbf{3000 \text{ kg/m}^3}$ ($3.0 \times 10^3 \text{ kg/m}^3$).

Problem 15 Thickness of a sheet

1. $2.0 \div 200 = 0.010 \text{ cm} = \mathbf{0.10 \text{ mm}}$.

2. $0.1 \div 2.0 \times 100 = \mathbf{5 \%}$.

3. 5 % of 0.10 mm = 0.005 mm, so $\mathbf{0.100 \pm 0.005 \text{ mm}}$.

4. $0.10 \text{ mm} = 0.10 \times 10^{-3} \text{ m} = \mathbf{1.0 \times 10^{-4} \text{ m}}$.

Problem 16 Speed and sensible rounding

1. $100.0 \div 12.4 = 8.0645... \text{ m/s}$.

2. $\mathbf{8.06 \text{ m/s}}$.

3. The time has 3 s.f. and the distance has 4 s.f., so the answer is limited to 3 s.f. by the time.

Problem 17 Speed unit change

1. $90 \times 1000 \div 3600 = \mathbf{25 \text{ m/s}}$.

2. $1.2 \times 10^{-3} \times 1000 = \mathbf{1.2 \text{ L.}}$

3. $20 \times 3600 \div 1000 = \mathbf{72 \text{ km/h.}}$

Problem 18 Distance light travels in a year

1. $d = 3.0 \times 10^8 \times 3.2 \times 10^7 = 9.6 \times 10^{15}$, so $\mathbf{9.6 \times 10^{15} \text{ m.}}$

2. Dividing by 1000 gives $\mathbf{9.6 \times 10^{12} \text{ km.}}$

3. Both inputs have 2 s.f., so the answer has $\mathbf{2 \text{ s.f.}}$

Problem 19 Spot the errors

1. The student multiplied by 1000 instead of using 10^{-3} . $5.6 \text{ mm} = 5.6 \times 10^{-3} \text{ m} = \mathbf{0.0056 \text{ m.}}$

2. Micro means 10^{-6} , not 10^{-3} . $0.75 \mu\text{A} = 0.75 \times 10^{-6} \text{ A} = \mathbf{7.5 \times 10^{-7} \text{ A.}}$

3. $7.5 \times 10^{-7} \text{ A} \div 10^{-3} \text{ A per mA} = \mathbf{7.5 \times 10^{-4} \text{ mA.}}$

Problem 20 Which result to trust

1. G1: $37.23 \div 3 = \mathbf{12.41 \text{ m.}}$ G2: $38.37 \div 3 = \mathbf{12.79 \text{ m.}}$ G3: $37.2 \div 3 = \mathbf{12.4 \text{ m.}}$

2. The ranges are 0.02 m for G1, 0.02 m for G2 and 0.6 m for G3. G1 and G2 are equally precise and $\mathbf{G3 \text{ is the least precise.}}$

3. The means differ from 12.40 m by 0.01 m (G1), 0.39 m (G2) and 0.0 m (G3). G3's mean is closest, but only by luck because its readings are widely spread. $\mathbf{G1 \text{ is the best overall.}}$

4. A systematic error, such as a stretched tape or a measurement started from the wrong mark, shifts all of G2's readings the same way.