

# Checking units, uncertainties and vector components

Physics grades 11-12 (A Level · IB · Class 11-12) · Test answers (mark scheme)

Marks are given for correct method as well as correct answers. Follow-through marks apply when an earlier error is carried into a later part correctly. The marking notes show where each mark is earned.

**Level:** Physics grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** A Level 1, IB A

## Question 1 Base units (2 marks)

- a. Pressure = force  $\div$  area =  $\text{kg m s}^{-2} \div \text{m}^2 = \mathbf{\text{kg m}^{-1} \text{s}^{-2}}$ .
- b. Power = energy  $\div$  time =  $\text{kg m}^2 \text{s}^{-2} \div \text{s} = \mathbf{\text{kg m}^2 \text{s}^{-3}}$ .

Marking: 1 mark for each correct set of base units.

## Question 2 Test an equation (3 marks)

- a. E is in joules:  $\text{kg m}^2 \text{s}^{-2}$ . mv is  $\text{kg m s}^{-1}$ . **The base units differ.**
- b. The equation **cannot be correct** because the two sides have different units; the correct form is  $\frac{1}{2}mv^2$ .

Marking: 1 mark for each correct set of base units; 1 mark for the conclusion with reason.

## Question 3 Uncertain area (3 marks)

- a.  $A = 20.12 \times 3.05 = \mathbf{61.4 \text{ m}^2}$ .
- b.  $0.02 \div 20.12 = 0.099 \%$ ;  $0.01 \div 3.05 = 0.328 \%$ ; total **0.43 %**.
- c.  $0.0043 \times 61.4 = 0.26 \text{ m}^2$ , so  **$61.4 \pm 0.3 \text{ m}^2$** .

Marking: 1 mark for each part; accept any rounding that agrees with the data.

## Question 4 Two forces (4 marks)

- a.  $R = \sqrt{(40^2 + 30^2)} = \sqrt{2500} = \mathbf{50 \text{ N}}$ .
- b.  $\tan \theta = 30 \div 40 = 0.75$ , so  **$\theta = 36.9^\circ$** .

Marking: (a) 1 mark for the Pythagoras substitution, 1 for the answer; (b) 1 mark for the tangent ratio, 1 for the angle.

**Question 5 Resolve a kick** (2 marks)

Horizontal:  $18 \cos 50^\circ = 18 \times 0.643 = \mathbf{11.6 \text{ m/s}}$ . Vertical:  $18 \sin 50^\circ = 18 \times 0.766 = \mathbf{13.8 \text{ m/s}}$ . Check:  $\sqrt{(11.6^2 + 13.8^2)} = 18.0 \text{ m/s}$ .

*Marking: 1 mark for each component.*

**Question 6 Scalar and vector** (2 marks)

Speed is a scalar with no direction, while velocity is a vector that includes direction. On a round trip back to the start, the distance travelled is not zero, but the displacement and so the **average velocity are zero**.

*Marking: 1 mark for the scalar and vector distinction; 1 mark for a correct journey.*

**Question 7 Random and systematic** (2 marks)

- a. Mean =  $16.5 \div 5 = 3.3 \text{ s}$ . Half the range =  $(3.5 - 3.1) \div 2 = 0.2 \text{ s}$ .  **$3.3 \pm 0.2 \text{ s}$** .
- b. It is a **systematic error** because it shifts every reading the same way, so repeating and averaging does not remove it.

*Marking: 1 mark for the mean with uncertainty; 1 mark for the type of error with reason.*

**Question 8 Close readings** (2 marks)

Extension =  $12.9 - 12.4 = 0.5 \text{ cm}$ . Absolute uncertainties add for a difference:  $0.1 + 0.1 = 0.2 \text{ cm}$ . Percentage =  $0.2 \div 0.5 = \mathbf{40 \%}$ , so the extension is  $0.5 \pm 0.2 \text{ cm}$ .

*Marking: 1 mark for the extension and absolute uncertainty; 1 mark for the percentage.*