Contents

Chapter 1 Measurement

Beginner

1. *This question is about uncertainty*

While measuring the diameter of a wire, John made the following readings,

2.38 mm, 2.41 mm, 2.39 mm, 2.40 mm, 2.42 mm

How should he express the diameter measurement?

(A) 2.400 mm
(B) (2.40 ± 0.02) mm
(C) (2.40 ± 0.01) mm
(D) between 2.38 mm and 2.42 mm

[ ]

2. *This question is about uncertainty*

The calculated value of the speed of sound is 338.45 ms^{-1}. If this result was accurate only to ±4%, how should this value be accurately recorded?

(A) 338.45 ms^{-1}
(B) 300 ms^{-1}
(C) 340 ms^{-1}
(D) 338 ms^{-1} [ ]

3. *This question is about percentage uncertainty*

The density of a rod can be found by measuring its diameter, length, and mass. If the percentage error in the measurement of its diameter, length, and mass are 1%, 2%, and 3% respectively, what are the percentage error in the calculated value of its density?

(A) 6%
(B) 8%
(C) 7%
(D) 9% [ ]

4. *This question is about percentage uncertainty*

The drag force acting on a sphere travelling through a fluid is directly proportional to the square of its speed. If the speed has a maximum error of 2%, what is the maximum error allowed in measuring the drag force?

(A) 2%
(B) 6%
(C) 4%
(D) 8% [ ]

5. *This question is about precision*

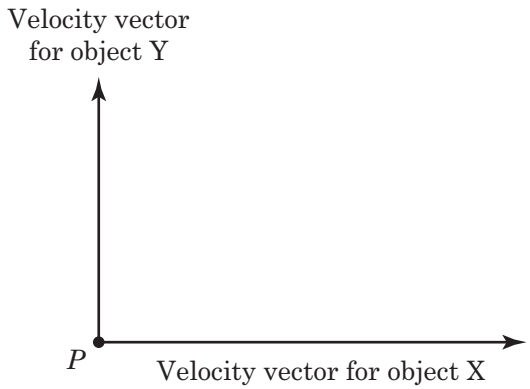
Audrey measures the diameter of a cylindrical rod using a vernier calipers. Which of the following techniques would increase the precision of the measurement?

(A) Measure the diameter along different parts of the cylinder using vernier calipers and then take the average value of the readings.
(B) Measure the diameter along different parts of the cylinder using a ruler and then take the average value of the readings.
(C) Measure the diameter using a micrometer.
(D) Measure the diameter using a vernier calipers without zero error.

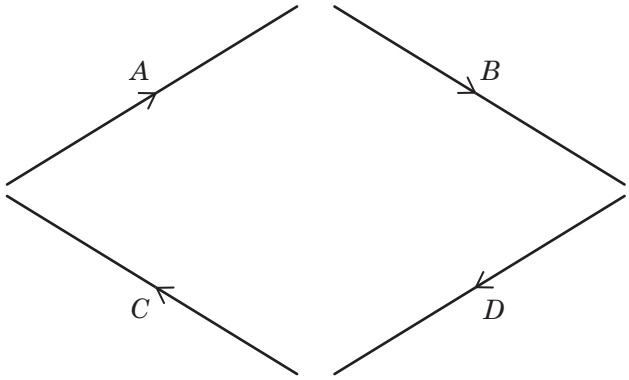
[ ]

41. *This question is about vectors relative to each other*

2 objects, X and Y are moving away from point P as shown below. The arrows signify the vector velocities of both X and Y.



Which of the following represents the velocity of X relative to Y?



Intermediate

1. *This question is about uncertainties*

The dimensions of a rectangular block of metal are (90.0 ± 0.5) mm by (200.0 ± 0.5) mm by (160.5 ± 0.5) mm. If the mass of the block is (152 ± 1) g, what is the percentage error in the calculated value of density?

(A) 3%
(C) 6%
(B) 1%
(D) 2% **[ ]**

2. *This question is about uncertainties*

In order to determine the thickness of a metal cylinder, its external diameter d_2 and internal diameter d_1 were measured as follows:

$d_1 = (58.5 \pm 0.5)\text{mm}$

$d_2 = (67.5 \pm 0.5)\text{mm}$

What is the percentage error of $\frac{1}{2}(d_2 - d_1)$?

(A) 11%
(C) 6%
(B) 5.5%
(D) 8% **[ ]**

3. *This question is about uncertainties*

In order to determine the power dissipated in a resistor, the following quantities were measured:

$I = (3.45 \pm 0.05)\text{mA}$

$R = 5.3\Omega \pm 3\%$

What would be the percentage uncertainty in the power measurement?

(A) 4%
(C) 6%
(B) 3%
(D) 2% **[ ]**

25. *This question is about scalars and vectors*

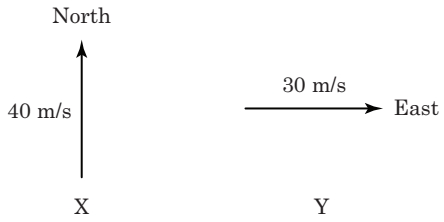
A car was moving North at 40 m/s. It then moved 30 m/s. due East.

(a) Find the change in velocity

(b) Find the change in speed.

26. *This question is about relative velocities*

2 Cars, X and Y are moving with velocities as shown.



Find the relative velocities of the following.

(a) Relative velocity of X as seen by Y.

(b) Relative velocity of Y as measured by X.

Advanced

1. *This question is about uncertainties*

In an experiment to measure g, the acceleration due to gravity, a simple pendulum was used. If the uncertainty in the measurement of period, T is $\pm\Delta T$ and the uncertainty in the measurement of length l is $\pm\Delta l$, find the fractional uncertainty in the calculated value of g.

2. *This question is about uncertainties*

In an experiment to determine the electro-chemical equivalent, Z, of copper by electrolysis, the following formula was used:

$$Z = \frac{m_1 - m_2}{It}$$

Where $m_1 = (57.54 \pm 0.01) \times 10^{-3}$ kg

$m_2 = (53.50 \pm 0.01) \times 10^{-3}$ kg

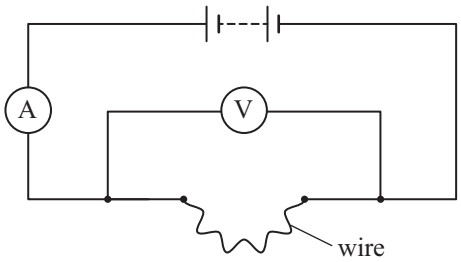
$I = (1.90 \pm 0.05)$A

$t = (5{,}980 \pm 1)$s

Express Z in terms of its uncertainty to the correct significant figures.

3. *This question is about errors and uncertainties*

A student set up the circuit shown below to determine the resistance of a wire and hence the resistivity of the metal of the wire.



The ammeter and voltmeter are both digital

(a) State one possible random error which could occur in the use of the digital meters. How could this error be kept to a minimum?

(b) Explain why the voltmeter must have a resistance much greater than that of the wire in order to avoid a systematic error in the use of the ammeter.

1. *This question is about errors*

(a) When using a digital voltmeter and digital ammeter to determine the resistance of a wire, state one possible random error which could occur in the use of the digital meters.

(b) How could this error be kept to a minimum?

(c) Explain why the voltmeter must have a resistance much greater than that of the wire, whose resistance it is trying to measure, in order to avoid a systematic error in the use of the voltmeter.

2. *This question is about vectors*

Since linear velocity is a vector, angular velocity must also be a vector. Comment

3. *This question is about uncertainties*

3 quantities, u, v and f are related by the equation $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$. The uncertainties of u and v are as follows:

$u = 50 \text{ mm} \pm 3 \text{ mm}$
$v = 200 \text{ mm} \pm 5 \text{ mm}$
If f has a calculated value of 40 mm, find its uncertainty.

4. *This question is about relative velocities in 3-D*

A man is running on a horizontal road towards North at 8 km h^{-1} in the rain. He sees the rain dropping vertically as he runs. He increases his speed to 16 km h^{-1} and finds that the rain drops now make an angle of 30° with the vertical. What is the velocity of the rain drop?

(A) 16 km h^{-1}, 30° with the vertical, downwards, northwards.
(B) 16 km h^{-1}, 30° with the vertical, downwards, northwards.
(C) 32 km h^{-1}, 30° with the vertical, downwards, northwards.
(D) 32 km.h^{-1}, 30° with the vertical, downwards, northwards.

[ ]

(k) The minimum velocity of the ball during its flight

(l) The time that this minimum velocity occurs

(m) The time taken for the ball to return to the ground

(n) The velocity of the ball as it strikes the ground

(o) The horizontal range of the ball

Assume that air resistance is negligible.

(p) Now, if the effects of air resistance were taken into account, explain what would happen.

22. *This question is about sketching s-t graphs*

A compressible rubber ball is dropped from rest, from a height x, above the ground level. It bounces off three times from the ground. Sketch the s-t graph for the motion. Take downwards to be positive. Neglect air resistance.

Intermediate

1. *This question is about graph sketching*

A sledge slides down an icy slope with a constant acceleration. If it travels a distance s in time t, which of the following pairs of quantities would give a straight line graph when plotted to represent the motion of the sledge?

(A) $\frac{s}{t^3}$ *vs* t

(C) s *vs* $\frac{1}{t^2}$

(B) $\frac{s}{t}$ *vs* t

(D) $\frac{s}{t^2}$ *vs* t [ ]

2. *This question is about equations of motion*

Two identical metal spheres are dropped from rest from different heights at the same instant. As the stones accelerate downwards, the distance between them will

(A) keep decreasing until they collide
(B) keep increasing
(C) stay constant
(D) decrease initially and then stay constant [ ]

3. *This question is about projectile motion*

A ball P is projected horizontally with a speed of 2 ms^{-1} from the edge of a table. At the same time, another ball Q is dropped from the same height. Identify the correct statement.

(A) P will hit the floor before Q
(B) Q will hit the floor before P
(C) Q will have a greater kinetic energy than P just before hitting the floor.
(D) P will have a greater kinetic energy than Q just before hitting the floor.

[ ]

4. *This question is about straight line motion*

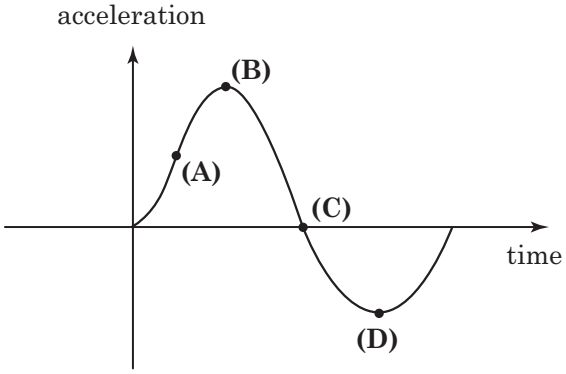
A stone is thrown vertically upwards at the same time as another stone is dropped from rest from a height h_0 directly above the first stone.

(a) If the initial velocity of the first stone is u, find an expression for time 't' when they meet.

(b) If the two stones were to have the same speed at the time they meet, express u in terms of h_0.

1. *This question is about acceleration-time graphs*

The variation of acceleration with time of a vehicle is shown below. If it is travelling on a straight road, identify the part of the graph when the vehicle has the greatest velocity.



2. *This question is about acceleration*

A hot air balloon loaded with stones is accelerating downwards with a constant acceleration of $\frac{1}{4}g$, where g is acceleration due to gravity. If the total mass of the balloon is M, what mass of the stones must be removed in order that the balloon now accelerates upwards with $\frac{1}{4}g$?

(A) $\frac{1}{3}M$

(C) $\frac{2}{3}M$

(B) $\frac{2}{5}M$

(D) $\frac{3}{5}M$ [ ]

3. *This question is about deceleration*

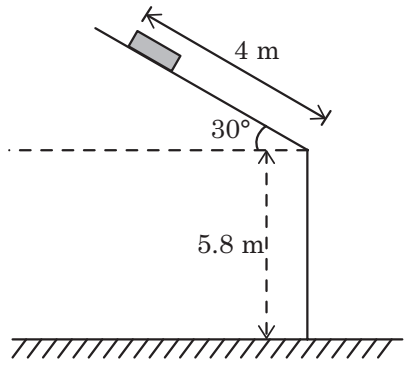
A train A spots another train, B, 80 m ahead, moving in the same direction as train A. If the train A is moving at a speed of 100 km/h and the train B is travelling with a speed of 50 kmh^{-1}, what deceleration must train A apply in order to avoid a collision, assuming that train A presents the brake immediately after spotting train B.

4. *This question is about acceleration*

A lift accelerates upwards from rest with an acceleration of 2 ms^{-2}. At the moment when its speed is 2 ms^{-1} a loose nut drops from rest from the ceiling. Find the time taken for the nut to hit the floor of the lift, if the distance between ceiling and floor is 2 m.

5. *This question is about projectile motion*

The diagram shows a brick sliding from rest along a smooth roof inclined to the horizontal at an angle of 30°. While sliding, the brick experiences a frictional force of 0.5N. The brick of mass 0.3 kg slides a distance of 4 m before falling off the roof. If the edge of the slope is 5.8 m from the ground, determine,



(a) the speed of the brick before if falls freely,

(b) the time taken for the free fall,