
SL Paper 1

Which of the following will reduce random errors in an experiment?

- A. Using an instrument having a greater precision
- B. Checking the calibration of the instrument used
- C. Checking for zero error on the instrument used
- D. Repeating readings

Markscheme

D

Examiners report

[N/A]

The best estimate for the time it takes light to cross the nucleus of the hydrogen atom is

- A. 10^{-23} s.
- B. 10^{-20} s.
- C. 10^{-15} s.
- D. 10^{-7} s.

Markscheme

A

Examiners report

[N/A]

Which is a unit of force?

- A. J m
- B. J m^{-1}
- C. J m s^{-1}
- D. $\text{J m}^{-1} \text{ s}$

Markscheme

B

Examiners report

[N/A]

Which of the following is a derived unit?

- A. Mole
- B. Kelvin
- C. Coulomb
- D. Ampere

Markscheme

C

Examiners report

[N/A]

Which of the following is equivalent to the joule?

- A. N m^2
- B. N m^{-2}
- C. kg m s^{-2}
- D. $\text{kg m}^2\text{s}^{-2}$

Markscheme

D

Examiners report

[N/A]

A boy jumps from a wall 3m high. What is an estimate of the change in momentum of the boy when he lands without rebounding?

- A. $5 \times 10^0 \text{ kg m s}^{-1}$
- B. $5 \times 10^1 \text{ kg m s}^{-1}$
- C. $5 \times 10^2 \text{ kg m s}^{-1}$
- D. $5 \times 10^3 \text{ kg m s}^{-1}$

Markscheme

C

Examiners report

[N/A]

The acceleration of free fall g is determined by the relationship $g = \frac{4\pi^2 l}{t^2}$. The uncertainty in the value of l is 2% and the uncertainty in the value of t is 5%. What is the uncertainty in g ?

- A. 3%
- B. 7%
- C. 8%
- D. 12%

Markscheme

D

Examiners report

Response B proved to be a popular distracter, particularly at SL, with candidates failing to spot that squaring the time doubles its uncertainty.

The resistive force F acting on a sphere of radius r travelling with speed v through a liquid is given by the equation

$$F = 6\pi\eta r v$$

where η is a constant. What are the SI units of η ?

- A. $\text{kg m}^{-1} \text{s}^{-2}$
- B. $\text{kg m}^2 \text{s}^{-1}$
- C. $\text{kg m}^{-1} \text{s}^{-1}$
- D. $\text{kg}^{-1} \text{s}^{-3}$

Markscheme

C

Examiners report

[N/A]

The sides of a square are measured to be 5.0 ± 0.2 cm. Which of the following gives the area of the square and its uncertainty?

- A. 25.0 ± 0.2 cm²
- B. 25.0 ± 0.4 cm²
- C. 25 ± 2 cm²
- D. 25 ± 4 cm²

Markscheme

C

Examiners report

A number of candidates opted for B. Candidates appeared to have added the absolute uncertainty rather than adding the relative uncertainty as the approximation for finding the uncertainty in multiplication.

Which of the following lists two vector quantities and one scalar quantity?

- A. force, mass, time
- B. acceleration, energy, momentum
- C. distance, impulse, power
- D. density, pressure, temperature

Markscheme

B

Examiners report

[N/A]

A small object is attached to a string and rotated in a circle of constant radius in a horizontal plane. The tension T in the string is measured for different speeds v . Which of the following plots should give a straight-line graph?

- A. T against v
- B. T^2 against v
- C. T against v^2

D. T^2 against v^2

Markscheme

C

Examiners report

[N/A]

A stone falls from rest to the bottom of a water well of depth d . The time t taken to fall is 2.0 ± 0.2 s. The depth of the well is calculated to be 20 m using $d = \frac{1}{2}at^2$. The uncertainty in a is negligible.

What is the absolute uncertainty in d ?

- A. ± 0.2 m
- B. ± 1 m
- C. ± 2 m
- D. ± 4 m

Markscheme

D

Examiners report

[N/A]

The length of each side of a sugar cube is measured as 10 mm with an uncertainty of ± 2 mm. Which of the following is the absolute uncertainty in the volume of the sugar cube?

- A. $\pm 6 \text{ mm}^3$
- B. $\pm 8 \text{ mm}^3$
- C. $\pm 400 \text{ mm}^3$
- D. $\pm 600 \text{ mm}^3$

Markscheme

D

Examiners report

A majority of candidates clearly had not translated the absolute uncertainties into percentages.

Which of the following lists three vector quantities?

- A. momentum, electric field strength, displacement
- B. momentum, displacement, pressure
- C. pressure, electric current, displacement
- D. electric current, electric field strength, impulse

Markscheme

A

Examiners report

It should be noted that 'electric field strength' is a vector quantity.

Which of the following expresses the watt in terms of fundamental units?

- A. $\text{kg m}^2 \text{s}$
- B. $\text{kg m}^2 \text{s}^{-1}$
- C. $\text{kg m}^2 \text{s}^{-2}$
- D. $\text{kg m}^2 \text{s}^{-3}$

Markscheme

D

Examiners report

[N/A]

Which of the following is a fundamental unit?

- A. Ampere
- B. Coulomb
- C. Ohm
- D. Volt

Markscheme

A

Examiners report

[N/A]

The maximum acceleration a_{\max} of an oscillator undergoing simple harmonic motion (SHM) has a percentage uncertainty of 12%. The amplitude x_0 of the oscillation has a percentage uncertainty of 20%. If $k = \sqrt{\frac{a_{\max}}{x_0}}$ what is the percentage uncertainty in the constant k ?

- A. 4%
- B. 8%
- C. 16%
- D. 32%

Markscheme

C

Examiners report

It was surprising to see the number of candidates who clearly did not realise that the square root involves halving the percentage uncertainty.

How many significant figures are there in the number 0.0450?

- A. 2
- B. 3
- C. 4
- D. 5

Markscheme

B

Examiners report

[N/A]

The radius of a sphere is measured with an uncertainty of 2%. What is the uncertainty in the volume of the sphere?

- A. 2%
- B. 4%
- C. 6%
- D. 8%

Markscheme

C

Examiners report

Consideration of units leads to C. It is not necessary to know the formula for the volume of a sphere.

Which of the following is a scalar quantity?

- A. Velocity
- B. Momentum
- C. Kinetic energy
- D. Acceleration

Markscheme

C

Examiners report

[N/A]

A student measures the radius r of a sphere with an absolute uncertainty Δr . What is the fractional uncertainty in the volume of the sphere?

- A. $\left(\frac{\Delta r}{r}\right)^3$
- B. $3\frac{\Delta r}{r}$
- C. $4\pi\frac{\Delta r}{r}$
- D. $4\pi\left(\frac{\Delta r}{r}\right)^3$

Markscheme

B

Examiners report

[N/A]

What is the unit of energy density?

- A. J kg^{-1}
- B. $\text{J kg}^{-1} \text{ m}^3$
- C. J mol^{-1}
- D. J K^{-1}

Markscheme

A

Examiners report

[N/A]

A swimming pool contains 18×10^6 kg of pure water. The molar mass of water is 18 g mol^{-1} . What is the correct estimate of the number of water molecules in the swimming pool?

- A. 10^4
- B. 10^{24}
- C. 10^{25}
- D. 10^{33}

Markscheme

D

Examiners report

[N/A]

An object is positioned in a gravitational field. The measurement of gravitational force acting on the object has an uncertainty of 3 % and the uncertainty in the mass of the object is 9 %. What is the uncertainty in the gravitational field strength of the field?

- A. 3 %
- B. 6 %
- C. 12 %
- D. 27 %

Markscheme

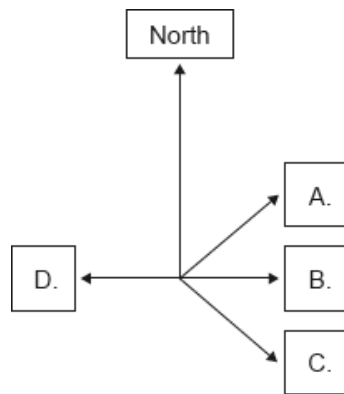
C

Examiners report

[N/A]

A river flows north. A boat crosses the river so that it only moves in the direction east of its starting point.

What is the direction in which the boat must be steered?



Markscheme

C

Examiners report

[N/A]

A car moves north at a constant speed of 3m s^{-1} for 20s and then east at a constant speed of 4m s^{-1} for 20s. What is the average speed of the car during this motion?

- A. 7.0m s^{-1}
- B. 5.0m s^{-1}
- C. 3.5m s^{-1}
- D. 2.5m s^{-1}

Markscheme

C

Examiners report

[N/A]

What is the correct SI unit for momentum?

- A. $\text{kg m}^{-1}\text{s}^{-1}$
- B. $\text{kg m}^2\text{s}^{-1}$
- C. kg ms^{-1}
- D. kg ms^{-2}

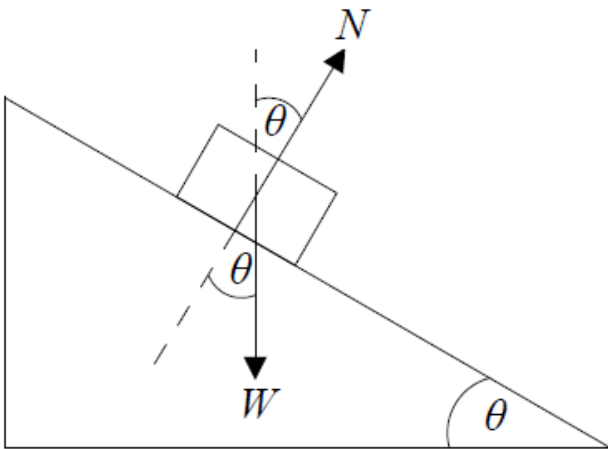
Markscheme

C

Examiners report

[N/A]

The diagram below shows the forces acting on a block of weight W as it slides down a slope. The angle between the slope and the horizontal is θ , the normal reaction force on the block from the slope is N and friction is negligible.



Which of the following gives the resultant force on the block?

- A. $W \sin \theta$
- B. $W \cos \theta$
- C. $N \sin \theta$
- D. $N \cos \theta$

Markscheme

A

Examiners report

[N/A]

What is the best estimate for the diameter of a helium nucleus?

- A. 10^{-21} m
- B. 10^{-18} m
- C. 10^{-15} m
- D. 10^{-10} m

Markscheme

C

Examiners report

[N/A]

Which of the following lists **two** scalar quantities?

- A. emf, momentum
- B. emf, weight
- C. impulse, kinetic energy
- D. temperature, kinetic energy

Markscheme

D

Examiners report

[N/A]

Which of the following is a unit of energy?

- A. $\text{kg m}^{-1} \text{s}^{-1}$
- B. $\text{kg m}^2 \text{s}^{-2}$
- C. kg m s^{-2}
- D. $\text{kg m}^2 \text{s}^{-1}$

Markscheme

B

Examiners report

[N/A]

A body accelerates from rest with a uniform acceleration a for a time t . The uncertainty in a is 8% and the uncertainty in t is 4%. The uncertainty in the speed is

- A. 32%.
- B. 12%.
- C. 8%.
- D. 2%.

Markscheme

B

Examiners report

[N/A]

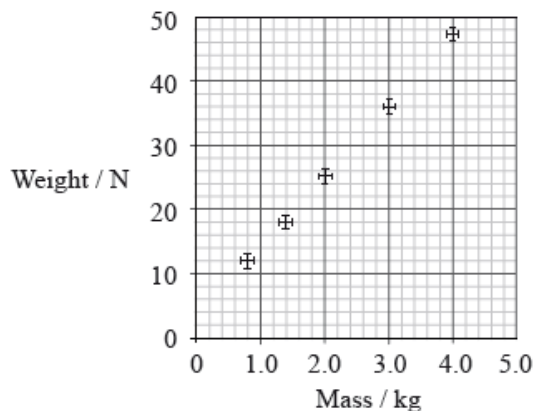
The force of air resistance F that acts on a car moving at speed v is given by $F=kv^2$ where k is a constant. What is the unit of k ?

- A. kg m^{-1}
- B. $\text{kg m}^{-2}\text{s}^2$
- C. kg m^{-2}
- D. $\text{kg m}^{-2}\text{s}^{-2}$

Markscheme

Examiners report

The masses and weights of different objects are independently measured. The graph is a plot of weight versus mass that includes error bars.



These experimental results suggest that the

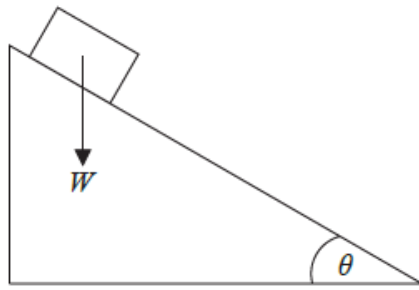
- A. measurements show a significant systematic error but small random error.
- B. measurements show a significant random error but small systematic error.
- C. measurements are precise but not accurate.
- D. weight of an object is proportional to its mass.

Markscheme

Examiners report

As the weights of different objects are plotted against the corresponding masses of those objects, it is expected that the data plotted would yield a best fitting straight line that passed through the origin. Given that the best fitting line for the data plotted is straight but does not pass through the origin and that the uncertainty bars are small, it is indicated that the measurements show a significant systematic error but a small random error.

An object slides down an inclined plane that makes an angle θ with the horizontal. The weight of the object is W .



Which of the following is the magnitude of the component of the weight parallel to the plane?

- A. $W \sin \theta$
- B. $\frac{W}{\sin \theta}$
- C. $W \cos \theta$
- D. $\frac{W}{\cos \theta}$

Markscheme

A

Examiners report

B and C were commonly chosen distractors. A simple teaching strategy for such situations is to invite the candidates to consider what happens if the angle is zero. Clearly the required component also becomes zero, in which case neither B nor C can be correct.

What is the order of magnitude of the mass, in kg, of an apple?

- A. 10^{-3}
- B. 10^{-1}
- C. 10^{+1}
- D. 10^{+3}

Markscheme

B

Examiners report

[N/A]

A volume is measured to be 52 mm^3 . This volume in m^3 is

- A. $5.2 \times 10^3 \text{ m}^3$.
- B. $5.2 \times 10^1 \text{ m}^3$.
- C. $5.2 \times 10^{-1} \text{ m}^3$.
- D. $5.2 \times 10^{-8} \text{ m}^3$.

Markscheme

D

Examiners report

[N/A]

Which of the following is a fundamental SI unit?

- A. Ampere
- B. Joule
- C. Newton
- D. Volt

Markscheme

A

Examiners report

[N/A]

The length of the side of a cube is $10.0 \pm 0.3 \text{ cm}$. What is the uncertainty in the volume of the cube?

- A. $\pm 0.027 \text{ cm}^3$
- B. $\pm 2.7 \text{ cm}^3$
- C. $\pm 9.0 \text{ cm}^3$
- D. $\pm 90 \text{ cm}^3$

Markscheme

D

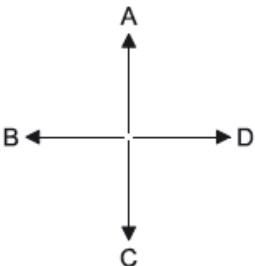
Examiners report

The candidates found this question difficult with the statistics indicating that many may have been guessing. It is clear (also from paper 2) that many candidates are not comfortable with percentages. It may be a good idea for teachers to make sure their candidates can perform simple percentage calculations without recourse to a calculator.

The velocities \mathbf{v}_X and \mathbf{v}_Y of two boats, X and Y, are shown.



Which arrow represents the direction of the vector $\mathbf{v}_X - \mathbf{v}_Y$?



Markscheme

D

Examiners report

[N/A]

Which is a vector quantity?

- A. Pressure
- B. Electric current
- C. Temperature
- D. Magnetic field

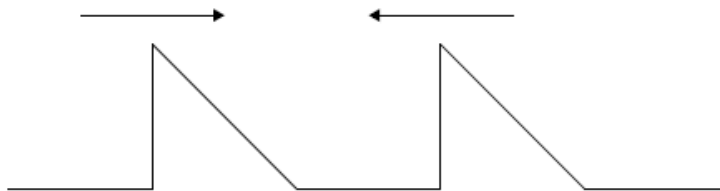
Markscheme

D

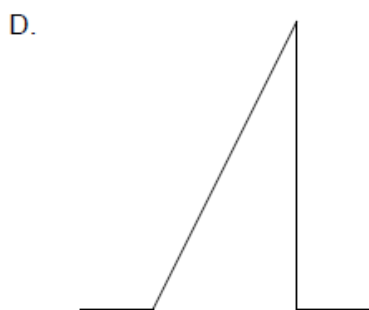
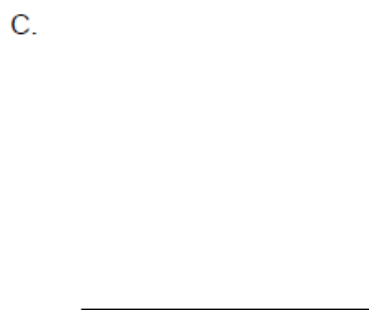
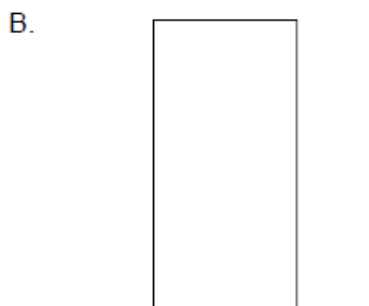
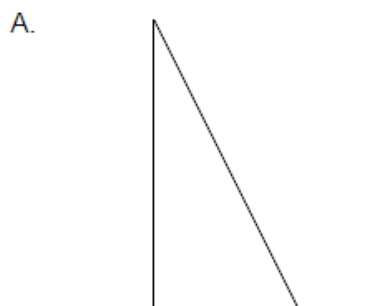
Examiners report

[N/A]

Two pulses are travelling towards each other.



What is a possible pulse shape when the pulses overlap?



Markscheme

A

Examiners report

[N/A]

Light of wavelength 400nm is incident on two slits separated by $1000\mu\text{m}$. The interference pattern from the slits is observed from a satellite orbiting 0.4Mm above the Earth. The distance between interference maxima as detected at the satellite is

- A. 0.16Mm .
- B. 0.16km .
- C. 0.16m .
- D. 0.16mm .

Markscheme

B

Examiners report

[N/A]

What is the unit of electrical energy in fundamental SI units?

- A. $\text{kg m}^2 \text{C}^{-1} \text{s}$
- B. kg m s^{-2}
- C. $\text{kg m}^2 \text{s}^{-2}$
- D. $\text{kg m}^2 \text{s}^{-1} \text{A}$

Markscheme

C

Examiners report

[N/A]

An object falls for a time of 0.25 s. The acceleration of free fall is 9.81 m s^{-2} . The displacement is calculated. Which of the following gives the correct number of significant digits for the calculated value of the displacement of the object?

- A. 1
- B. 2
- C. 3
- D. 4

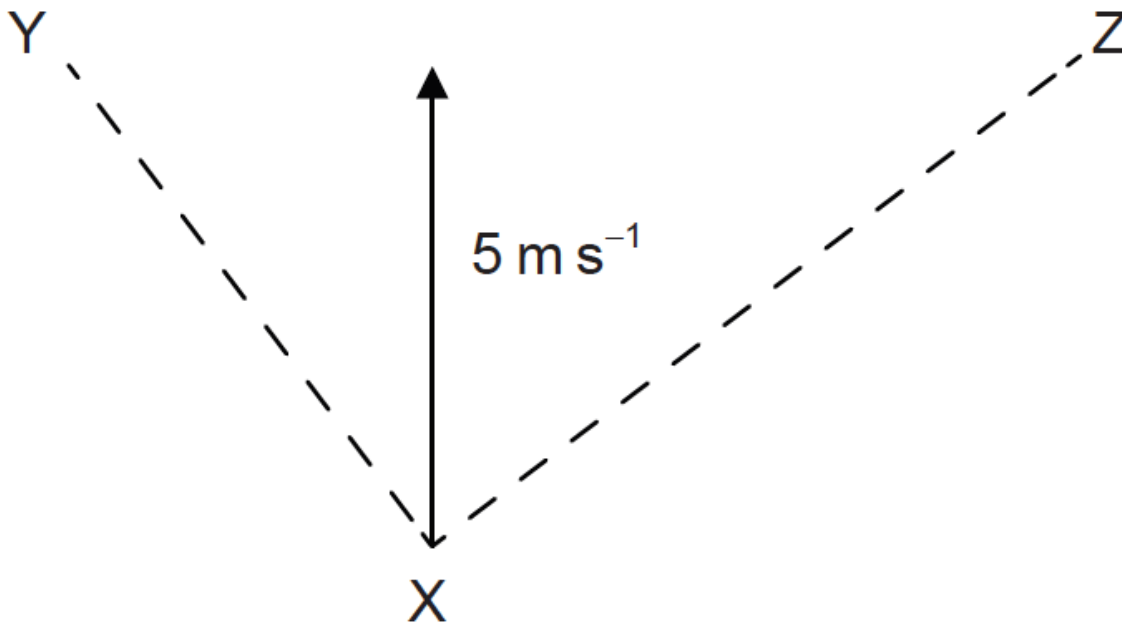
Markscheme

B

Examiners report

[N/A]

A velocity of 5 m s^{-1} can be resolved along perpendicular directions XY and XZ.



The component of the velocity in the direction XY is of magnitude 4 m s^{-1} . What is the magnitude of the component in the direction XZ?

- A. 4 m s^{-1}
- B. 3 m s^{-1}
- C. 2 m s^{-1}
- D. 1 m s^{-1}

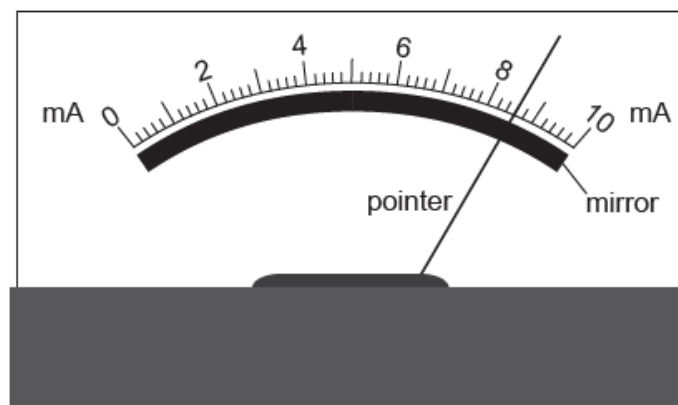
Markscheme

B

Examiners report

[N/A]

The diagram shows an analogue meter with a mirror behind the pointer.



What is the main purpose of the mirror?

- A. To provide extra light when reading the scale

B. To reduce the risk of parallax error when reading the scale

C. To enable the pointer to be seen from different angles

D. To magnify the image of the pointer

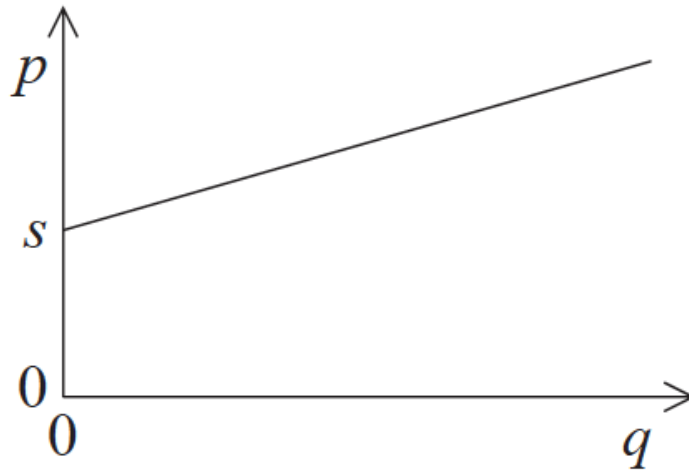
Markscheme

B

Examiners report

[N/A]

The graph shows the relationship between two quantities p and q . The gradient of the graph is r and the intercept on the p axis is s .



Which of the following is the correct relationship between p and q ?

A. $p = sq+r$

B. $p = rq+s$

C. $p = rq-s$

D. $p = rs+q$

Markscheme

B

Examiners report

[N/A]

Which of the following contains one fundamental and one derived unit?

A.	ampere	kilogram
B.	ampere	coulomb
C.	joule	newton
D.	joule	coulomb

Markscheme

B

Examiners report

[N/A]

The current I through a resistor is measured with a digital ammeter to be 0.10 A. The uncertainty in the calculated value of I^2 will be

- A. 1 %.
- B. 2 %.
- C. 5 %.
- D. 20 %.

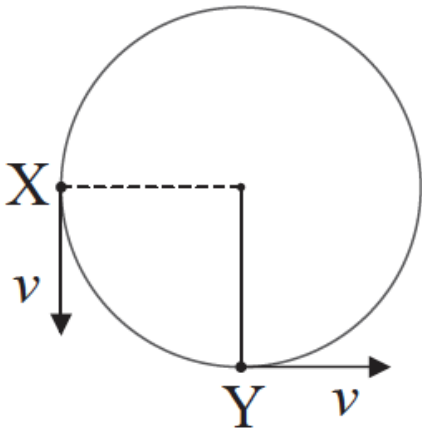
Markscheme

D

Examiners report

[N/A]

A stone attached to a string is moving in a horizontal circle. The constant speed of the stone is v . The diagram below shows the stone in two different positions, X and Y.



Which of the following shows the direction of the change of velocity of the stone when moving from position X to position Y?

- A.
- B.
- C.
- D.

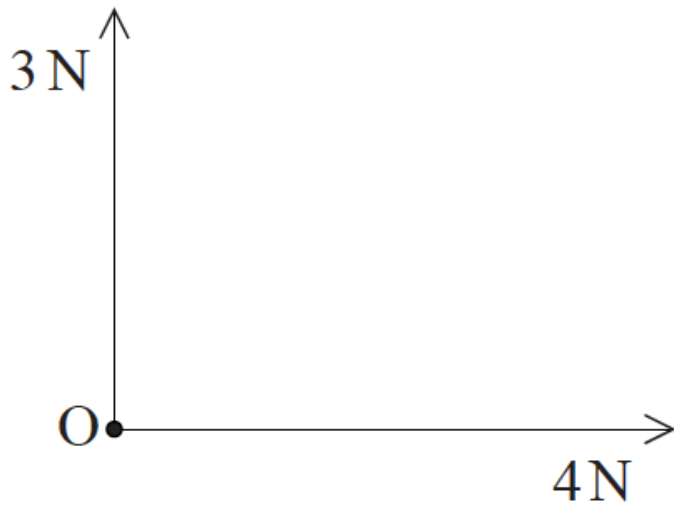
Markscheme

D

Examiners report

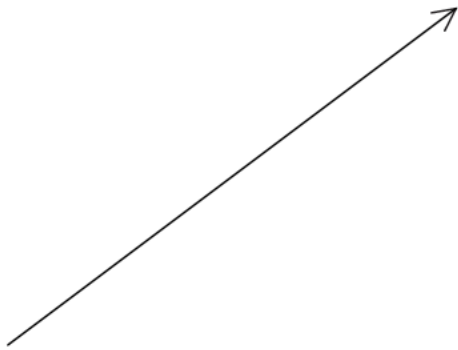
[N/A]

The vector diagram shows two forces acting on a point object O. The forces are in the plane of the page.

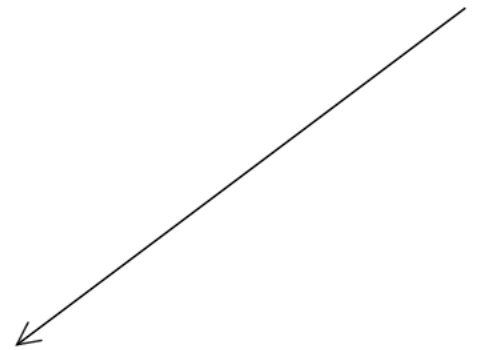


Another 5 N force is applied to O in the plane of the page. Which of the following gives the direction of this force to ensure that O is in equilibrium?

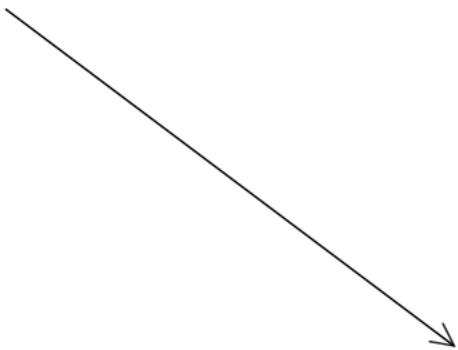
A.



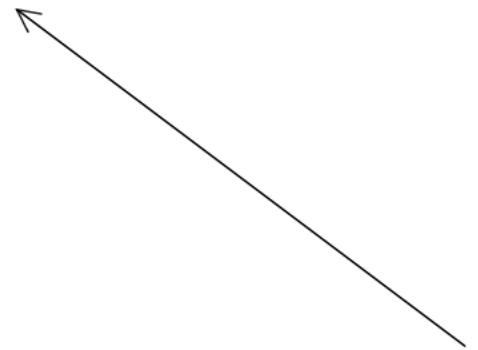
B.



C.



D.



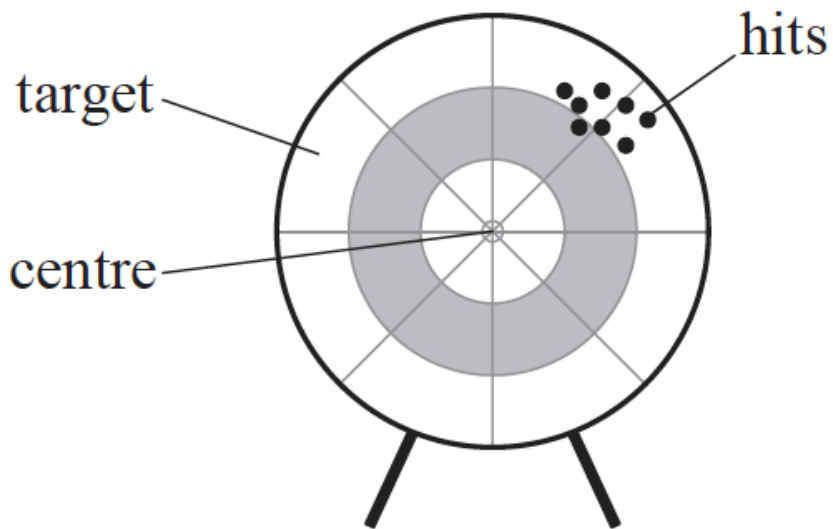
Markscheme

B

Examiners report

[N/A]

Aiming for the centre of a target, an archer fires arrows which produces a pattern of hits as shown below.



The pattern suggests the presence of

- A. random and systematic uncertainties.
- B. random uncertainties but no systematic uncertainties.
- C. systematic uncertainties but no random uncertainties.
- D. neither random nor systematic uncertainties.

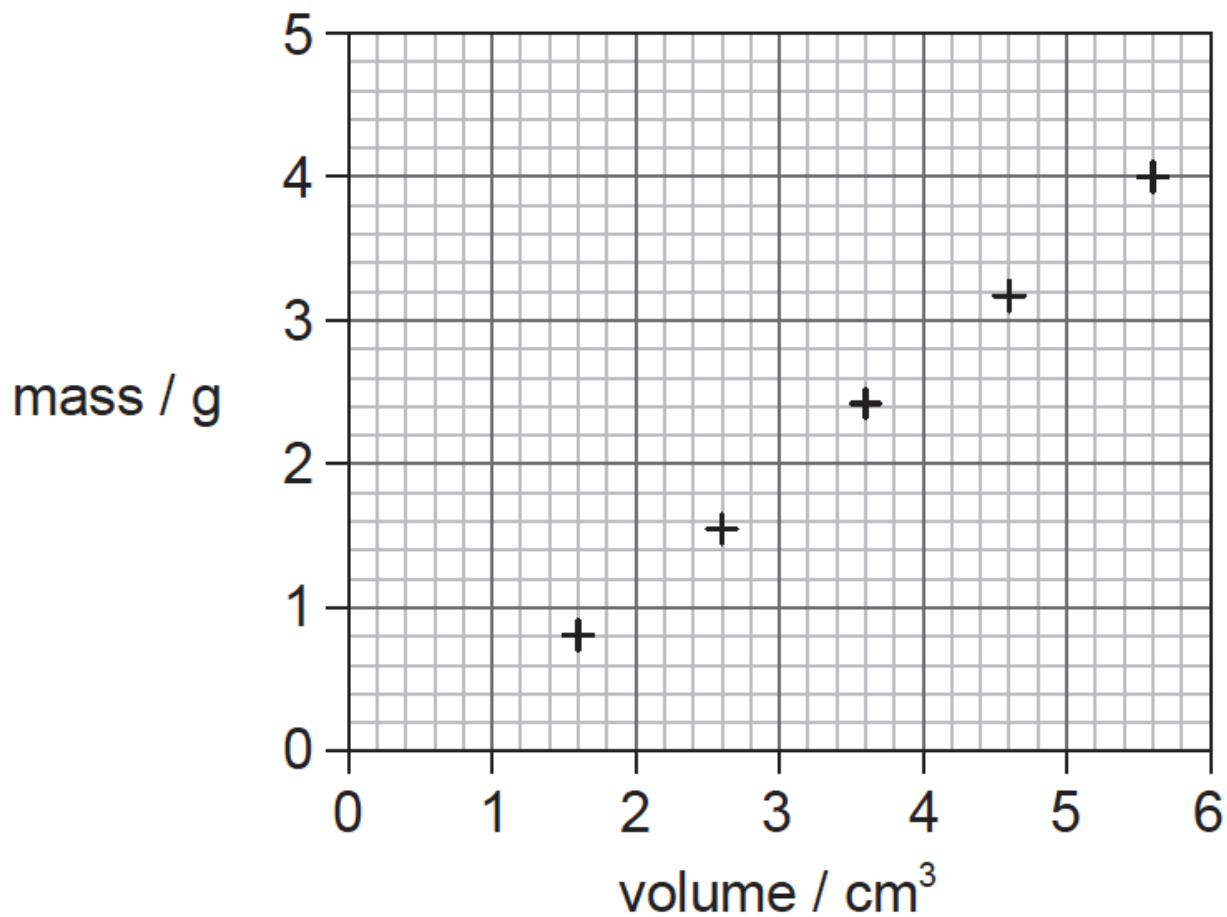
Markscheme

A

Examiners report

Option C was more popular than the correct response A. Candidates failed to recognize that the spread shown indicated that there were random errors in addition to the clear systematic error.

The graph shows a set of experimental results to determine the density of oil. The results have systematic errors and random errors.



Using the information on the graph, what can be said about the measurements used to find the density of oil?

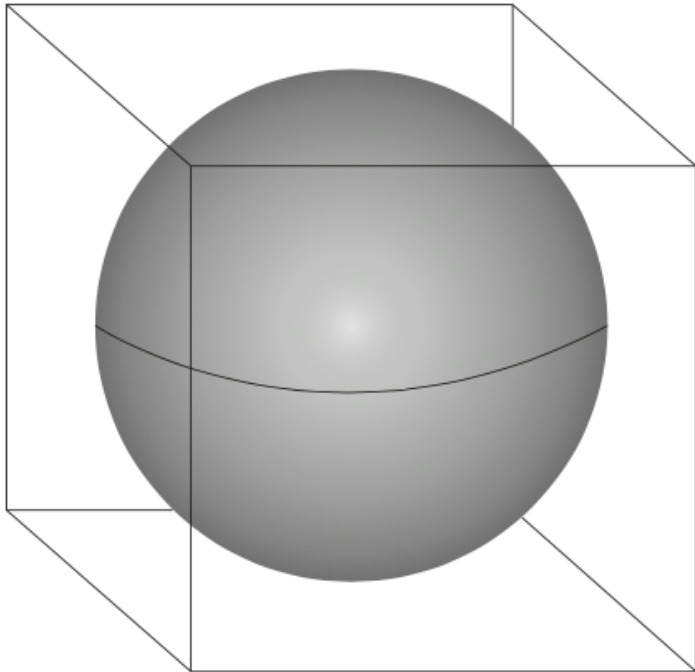
	Systematic errors	Random errors
A.	small	small
B.	small	large
C.	large	small
D.	large	large

Markscheme

Examiners report

[N/A]

A sphere fits inside a cube.



The length of the cube and the diameter of the sphere are 10.0 ± 0.2 cm.

What is the ratio $\frac{\text{percentage uncertainty of the volume of the sphere}}{\text{percentage uncertainty of the volume of the cube}}$?

A. $\frac{3}{4\pi}$

B. 1

C. 2

D. 8

Markscheme

B

Examiners report

[N/A]
