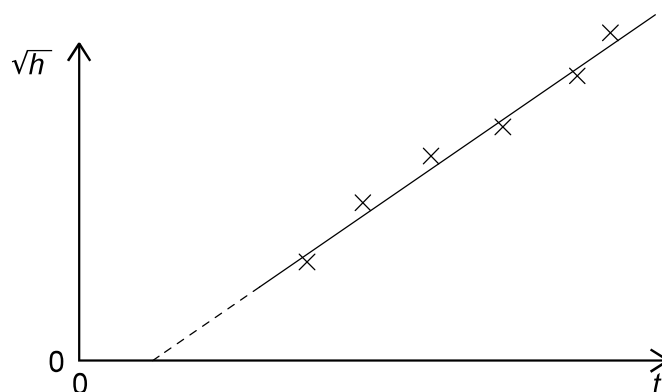


- 4 A student measures the time t for a ball to fall from rest through a vertical distance h . Knowing that the equation $h = \frac{1}{2}gt^2$ applies, the student plots the graph shown.

9702/11/M/J/02



Which of the following is an explanation for the intercept on the t axis?

- A Air resistance has not been taken into account for larger values of h .
 - B There is a constant delay between starting the timer and releasing the ball.
 - C There is an error in the timer that consistently makes it run fast.
 - D The student should have plotted h against t^2 .
- 5 A student carries out a series of determinations of the acceleration of free fall g . The table shows the results.

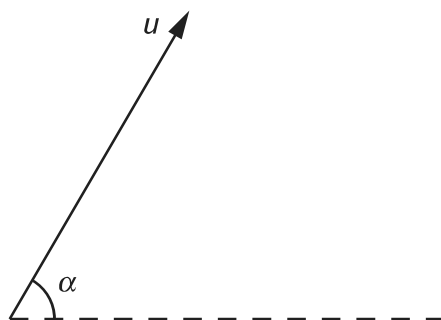
9702/11/O/N/02

g/ms^{-2}
4.91
4.89
4.88
4.90
4.93
4.92

What can be said about this experiment?

- A It is accurate and precise.
- B It is accurate but not precise.
- C It is not accurate and not precise.
- D It is not accurate but is precise.

- 5 The power loss P in a resistor is calculated using the formula $P = V^2/R$.
The uncertainty in the potential difference V is 3% and the uncertainty in the resistance R is 2%.
What is the uncertainty in P ?
A 4% **B** 7% **C** 8% **D** 11%
- 4 Which experimental technique reduces the systematic error of the quantity being investigated?
A adjusting an ammeter to remove its zero error before measuring a current
B measuring several internodal distances on a standing wave to find the mean internodal distance
C measuring the diameter of a wire repeatedly and calculating the average
D timing a large number of oscillations to find a period
- 5 A student makes measurements from which she calculates the speed of sound as 327.66 m s^{-1} .
She estimates that her result is accurate to $\pm 3 \%$.
Which of the following gives her result expressed to the appropriate number of significant figures?
A 327.7 m s^{-1} **B** 328 m s^{-1} **C** 330 m s^{-1} **D** 300 m s^{-1}
- 7 A projectile is fired at an angle α to the horizontal at a speed u , as shown.



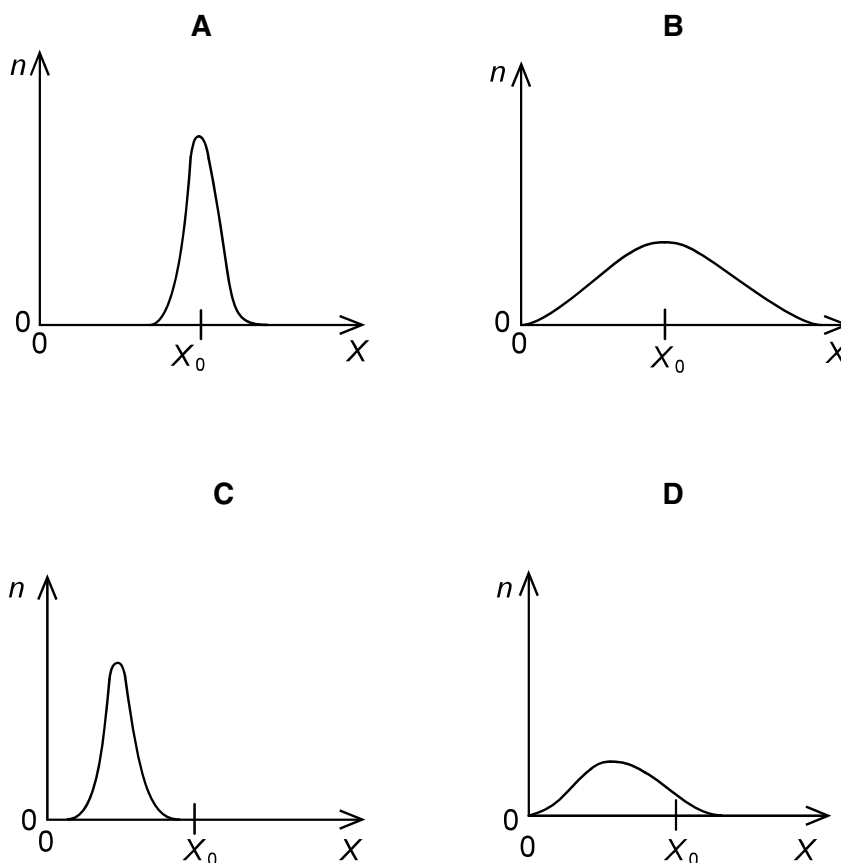
What will be the vertical and horizontal components of its velocity after a time t ?
Assume that air resistance is negligible. The acceleration of free fall is g .

	vertical component	horizontal component
A	$u \sin \alpha$	$u \cos \alpha$
B	$u \sin \alpha - gt$	$u \cos \alpha - gt$
C	$u \sin \alpha - gt$	$u \cos \alpha$
D	$u \cos \alpha$	$u \sin \alpha - gt$

- 6 A quantity X is measured many times. A graph is plotted showing the number n of times a particular value of X is obtained. X has a true value X_0 .

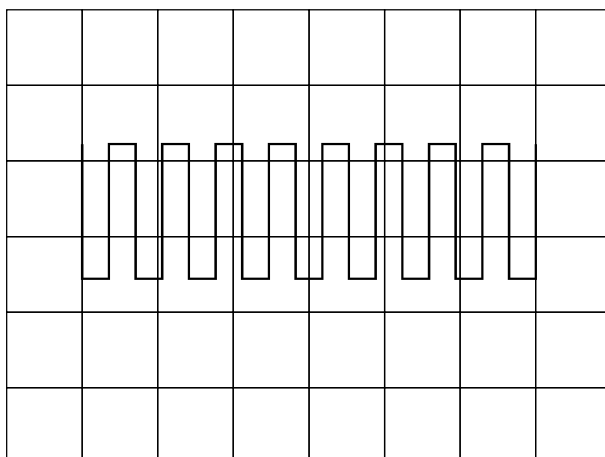
9702/1/O/N/02

Which graph could be obtained if the measurement of X has a large systematic error but a small random error?



- 7 The diagram shows a square-wave trace on the screen of a cathode-ray oscilloscope. A grid of 1 cm squares covers the screen. The time-base setting is 10 ms cm^{-1} .

9702/1/O/N/02



What is the approximate frequency of the square-wave?

- A** 70 Hz **B** 140 Hz **C** 280 Hz **D** 1400 Hz

- 6 A steel rule can be read to the nearest millimetre. It is used to measure the length of a bar whose true length is 895 mm. Repeated measurements give the following readings.

9702/01/M/J/03

length / mm	892, 891, 892, 891, 891, 892
-------------	------------------------------

Are the readings accurate and precise to within 1 mm?

	results are accurate to within 1 mm	results are precise to within 1 mm
A	no	no
B	no	yes
C	yes	no
D	yes	yes

- 4 A thermometer can be read to an accuracy of $\pm 0.5^\circ\text{C}$. This thermometer is used to measure a temperature rise from 40°C to 100°C .

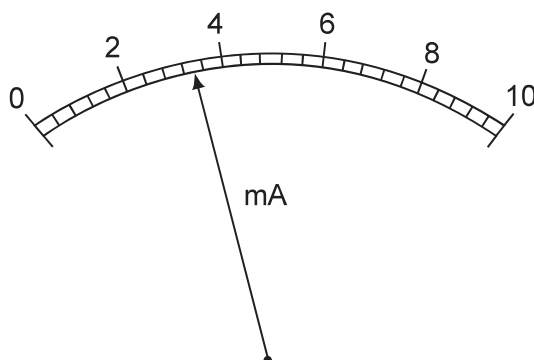
9702/01/O/N/03

What is the percentage uncertainty in the measurement of the temperature rise?

- A 0.5 % B 0.8 % C 1.3 % D 1.7 %

- 4 at is t e rea ing s o n o n t is mi iammeter

97 2 1 4



- A 2.5 mA B 2.7 mA C 4 mA D 7 mA

- 4 n an e eriment a ra io contro e car ta es 2.5 5 s to tra e 4 1 m

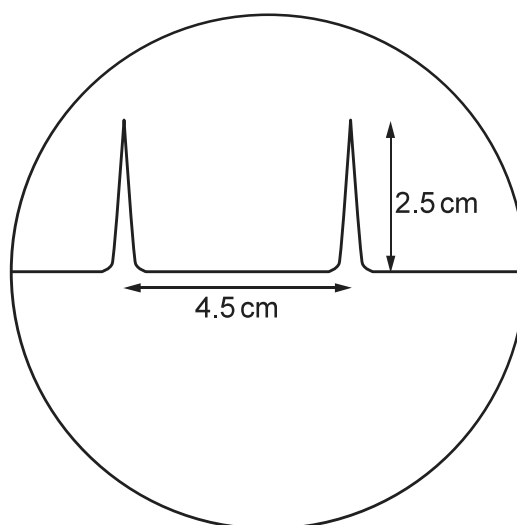
97 2 1 5

at is t e cars a erage s ee an t e uncertaint in t is a ue

- A $16 \pm 1 \text{ m s}^{-1}$
 B $16 \pm 2 \text{ m s}^{-1}$
 C $16 \pm 4 \text{ m s}^{-1}$
 D $16 \pm 6 \text{ m s}^{-1}$

- 5 The time-base on a cathode-ray oscilloscope is set at 6 ms/cm .

A trace consisting of two pulses is recorded as shown in the diagram.



What is the time interval between the two pulses?

- A** 0.42 ms **B** 0.75 ms **C** 1.33 ms **D** 27 ms

- 6 A micrometer screw gauge is used to measure the diameter of a copper wire.

The reading with the wire in position is shown in diagram 1. The wire is removed and the jaws of the micrometer are closed. The new reading is shown in diagram 2.

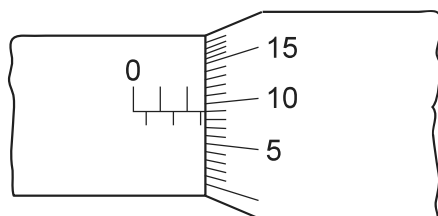


diagram 1

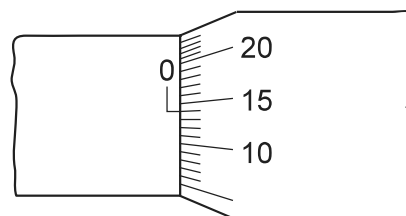


diagram 2

What is the diameter of the wire?

- A** 1.90 mm **B** 2.45 mm **C** 2.59 mm **D** 2.73 mm

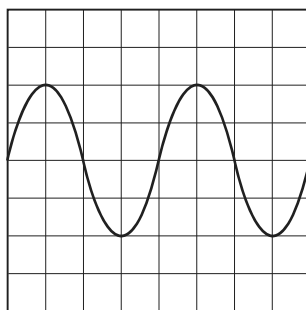
- 6 The resistance of an unknown resistor is found by measuring the potential difference across the resistor and the current through it and using the equation $R = \frac{V}{I}$, where V is the potential difference and I is the current. The potential difference is measured using a voltmeter with a reading of $1.5 \pm 0.1 \text{ V}$ and the current is measured using an ammeter with a reading of $0.5 \pm 0.05 \text{ A}$. The uncertainty in the calculated resistance is $\pm x\%$. What is the value of x ?

What is the uncertainty in the calculated resistance?

- A** 15% **B** 10% **C** 5% **D** 6%

5 The following trace is seen on the screen of a cathode ray oscilloscope

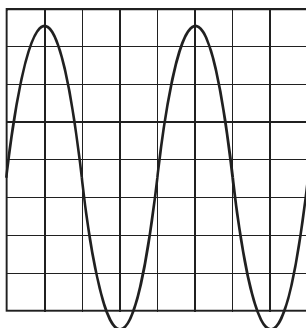
97 2 1 4



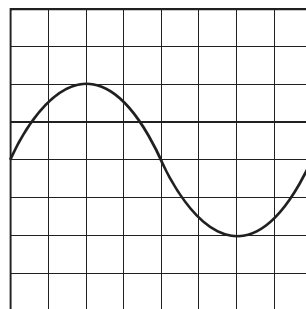
The setting of the time base is then changed from 1 ms cm^{-1} to 2 ms cm^{-1} and the sensitivity is unchanged

The trace is now seen on the screen

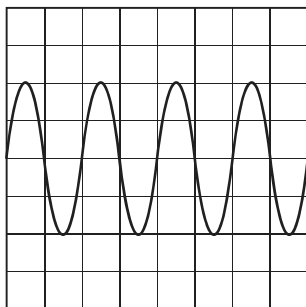
A



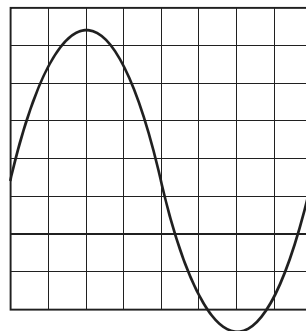
B



C



D



6 Four students each make a series of measurements of the acceleration of free fall. The following are their results in m s^{-2}

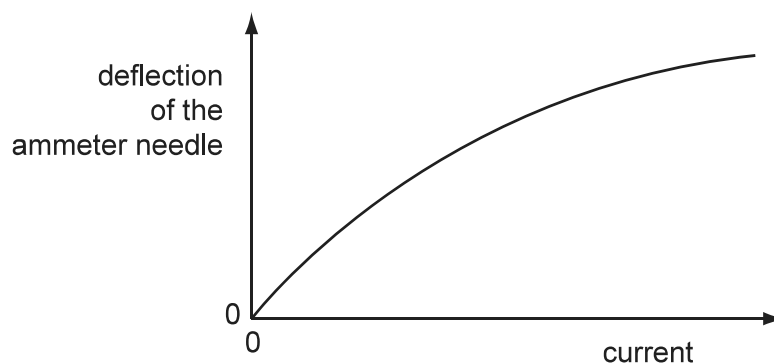
97 2 1 4

The student who obtained a set of results that could be described as precise but not accurate is

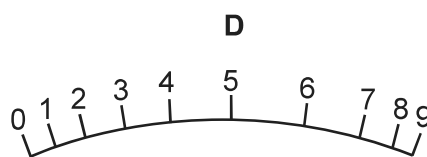
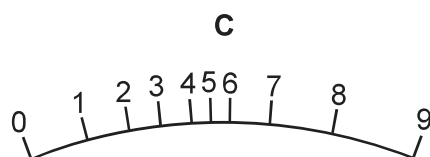
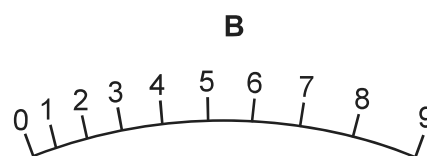
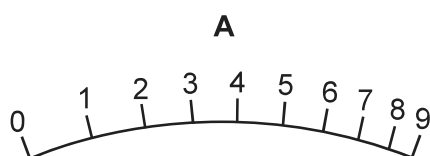
student	results m s^{-2}			
A	9.81	9.79	9.84	9.8
B	9.81	10.12	9.89	8.94
C	9.45	9.21	8.99	8.76
D	8.45	8.46	8.5	8.41

- 4 The deflection of the needle of an ammeter varies with the current passing through the ammeter as shown in the graph

97 2 1 4

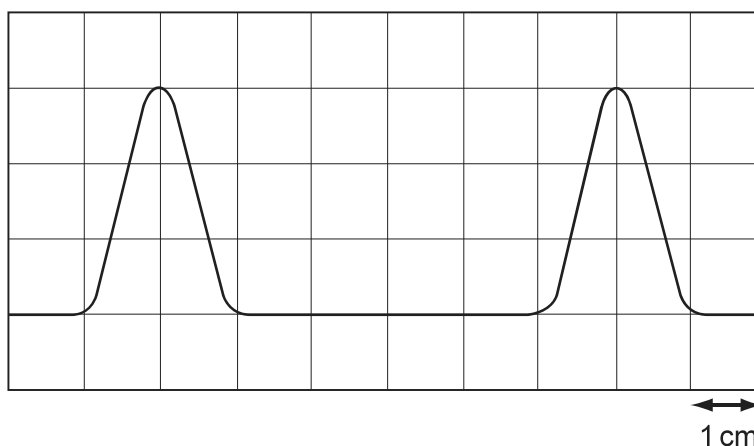


Which diagram could represent the appearance of the scale of this meter



- 5 The diagram shows a trace on the screen of a cathode ray oscilloscope. The grid has 1 cm squares across the screen. The time base setting is $1 \mu\text{s cm}^{-1}$

97 2 1 5

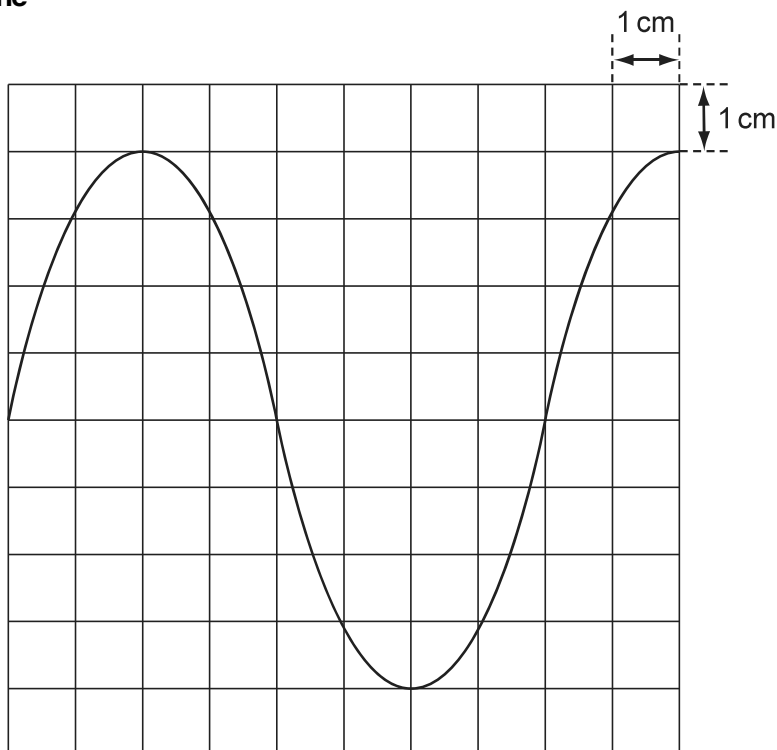


What is the time interval between the start of each pulse?

- A $2 \mu\text{s}$ B $3 \mu\text{s}$ C $4 \mu\text{s}$ D $6 \mu\text{s}$

5. A sinusoidal wave is connected to the terminals of an oscilloscope and the trace in the diagram is obtained.

97 2 1 4



What is the setting of the time base control?

- A 2 ms cm^{-1} B 2.5 ms cm^{-1} C 5 ms cm^{-1} D 2 ms cm^{-1}
4. A steel rule can be read to the nearest millimetre. It is used to measure the length of a bar. The true length is 895 mm. The eight measurements given are the following readings.

97 2 1 5

Length / mm 892 891 892 891 891 892

Are the readings accurate and precise to within 1 mm?

	Results are accurate to within 1 mm	Results are precise to within 1 mm
A	no	no
B	no	yes
C	yes	no
D	yes	yes

6. In a simple electrical circuit the current in a resistor is measured as 2.5 mA and the resistor is marked as having a value of 47Ω .

97 2 1 4

These values are used to calculate the power dissipated in the resistor. What is the percentage uncertainty in the value obtained?

- A 2 B 4 C 6 D 8

- 5 The density of the material of a rectangular block is determined by measuring the mass and linear dimensions of the block. The table shows the results obtained together with their uncertainties

97 2 1 5

mass	25	1 g
length	5	1 cm
breadth	2	1 cm
height	1	1 cm

The density is calculated to be 2.5 g cm^{-3}

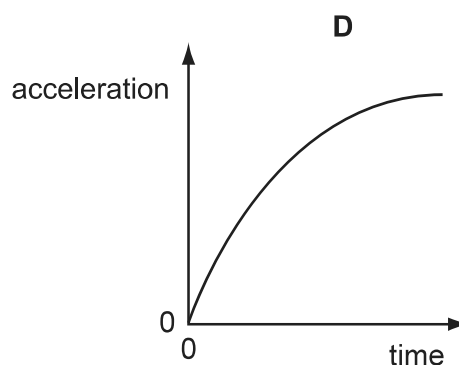
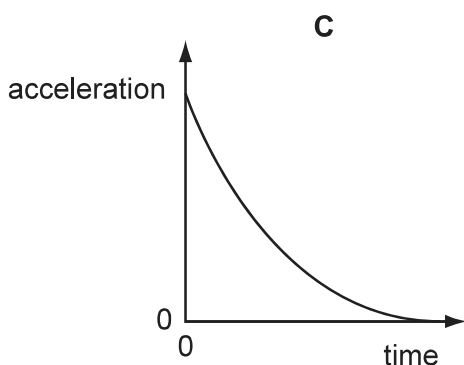
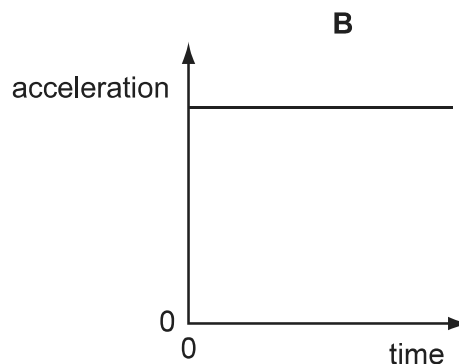
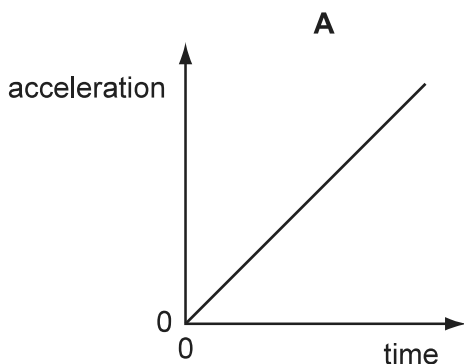
What is the uncertainty in this result?

- A 1 g cm^{-3} B 2 g cm^{-3} C 5 g cm^{-3} D 10 g cm^{-3}

- 6 A foot pump is used to pump the air into a bicycle tyre.

97 2 1 5

The acceleration-time graph best represents the motion of the foot pump through the air.



- 4 A metre rule is used to measure the length of a piece of wire. It is found to be 7.12 cm long to the nearest millimetre.

97 2 12 1

Which of the following is the correct way to record this result?

- A 7 m B 7.1 m C 7.12 m D $7.12 \times 10^{-2} \text{ m}$

- 4 A light meter measures the intensity of the light falling on it. The theory suggests that the intensity varies as the inverse square of the distance.

97 2 1 6

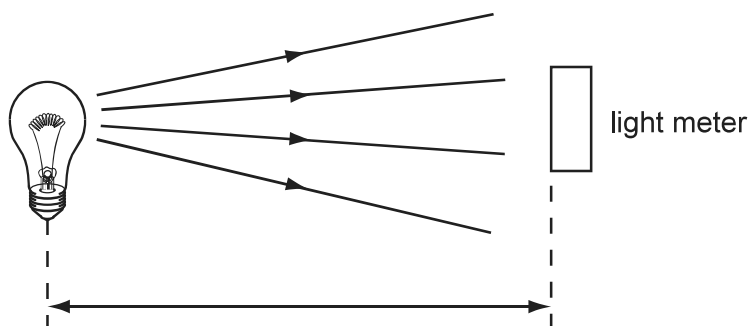
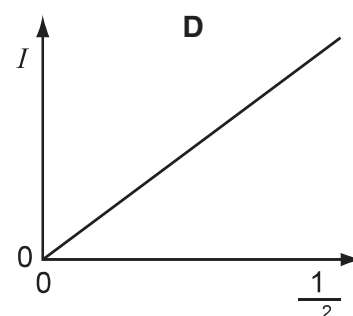
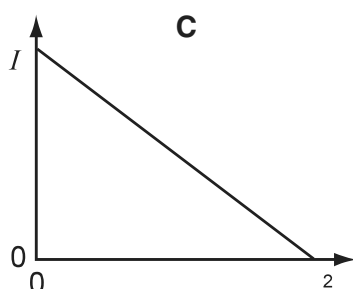
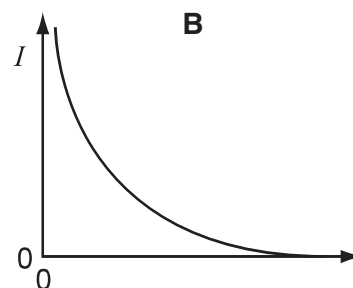
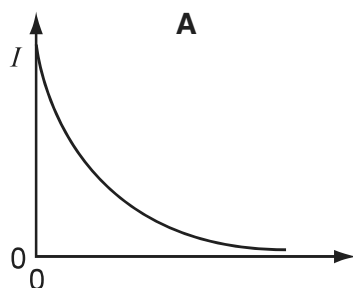
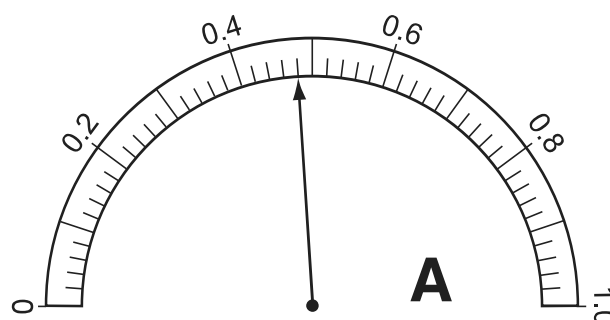


Figure 1 shows the results of the experiment.



- 5 The resistance of an electrical component is measured using a digital multimeter. The readings are shown in Figure 2.

97 2 1 7

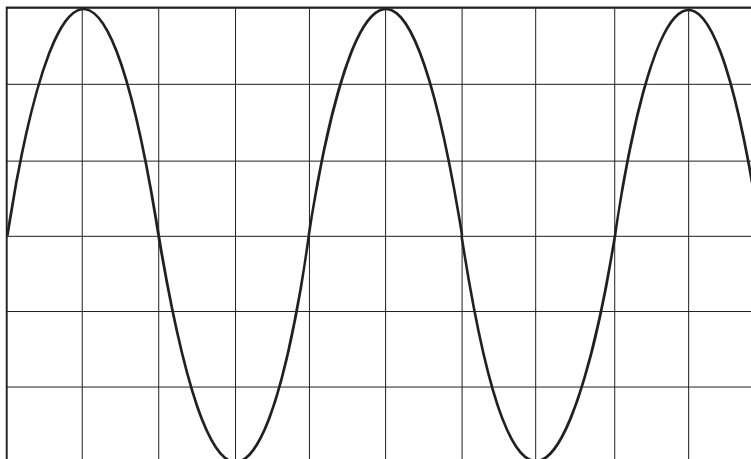


What is the resistance?

- A 25Ω B 27Ω C 25Ω D 27Ω

- 5 The cathode ray oscilloscope is a system for use in a circuit. The time base is set at 1 ms per division.

an electronic
97 2 1 6



What is the period of the signal shown?

- A 2 ms B 1 ms C 4 ms D 8 ms

- 4 A series of measurements of the acceleration of free fall is shown in the table. The set of results is precise but not accurate.

97 2 1 7

	g ms^{-2}				
A	9.81	9.79	9.84	9.8	9.79
B	9.81	10.12	9.89	8.94	9.42
C	9.45	9.21	8.99	8.76	8.51
D	8.45	8.46	8.5	8.41	8.47

- 5 A mass m has acceleration a . It moves through a distance s in time t . The order of use in accelerating the mass is equivalent to the order of force and velocity. The percentage uncertainties are

97 2 1 7

- 1% in m
1% in a
1.5% in s
5% in t

What is the percentage uncertainty in the average force?

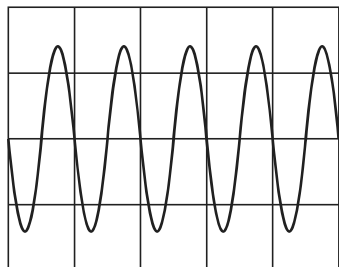
- A 2.1 B 2.6 C 1 D 4.1

- 4 The input terminals of a cathode ray oscilloscope are connected to a sinusoidal wave of frequency 5 kHz. The time base is set at 1 ms per division and the gain at 5 divisions.

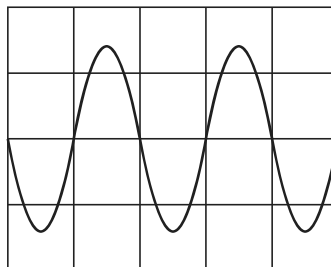
97 2 1 6

Which trace is obtained?

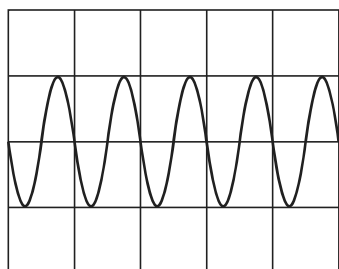
A



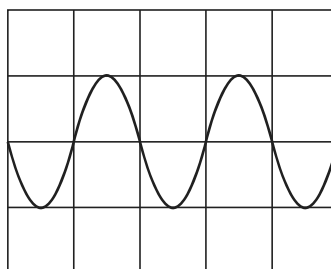
B



C



D



- 5 The measurement of a physical quantity may be subject to random errors and to systematic errors.

97 2 1 6

Which statement is correct?

- A Random errors can be reduced by taking the average of several measurements.
- B Random errors are always caused by the person taking the measurement.
- C A systematic error cannot be reduced.
- D A systematic error results in a different reading each time the measurement is taken.

- 6 An experiment is done to measure the resistance of a wire.

97 2 1 6

The current in the wire is 1.2 A and the potential difference across the wire is 8.4 V.

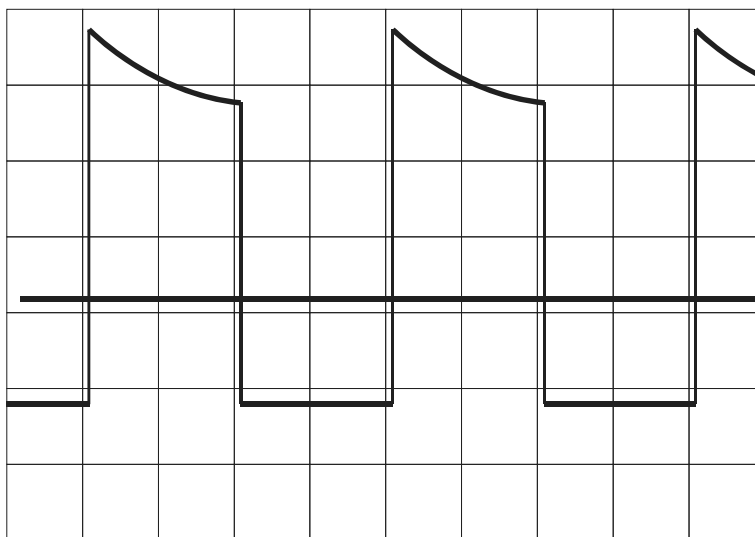
What is the resistance of the wire and its uncertainty?

- A $8.2 \, \Omega$
- B $8.6 \, \Omega$
- C $8.1 \, \Omega$
- D $8.2 \, \Omega$

- 4 An oscilloscope is a device that consists of a cathode ray tube on which a trace of a signal is displayed. The trace is a line on the screen and its length is measured in cm. The time base setting is 2.5 ms cm^{-1} and the sensitivity is 5 mV cm^{-1} .

97 2 1 7

The grid on the screen is calibrated in cm squares. The time base setting is 2.5 ms cm^{-1} and the sensitivity is 5 mV cm^{-1} .



Calculate the period and the peak-to-peak voltage of the waveform in the diagram.

	Period / ms	Peak-to-peak voltage / mV
A	5	17
B	5	25
C	1	17
D	1	25

- 4 The resistance of a resistor is determined by measuring the potential difference across it and the current in it. The value is then calculated using the equation

97 2 1 8

—

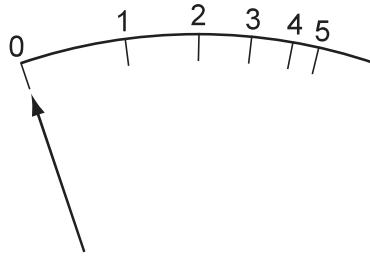
The values measured are 1.5 V and 5.0 A .

Calculate the percentage uncertainty in the value of

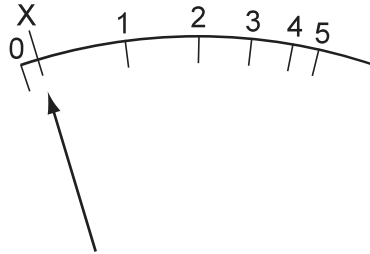
- A 2.5 B 7.5 C 7.5 D 15

- 6 The diagram shows the graduations of a correct calibration ammeter when the current is zero. The pointer is at

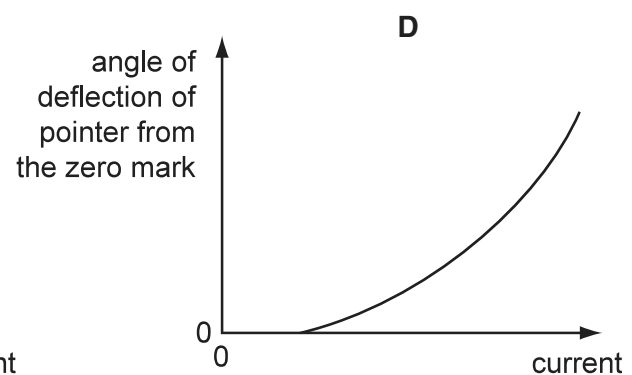
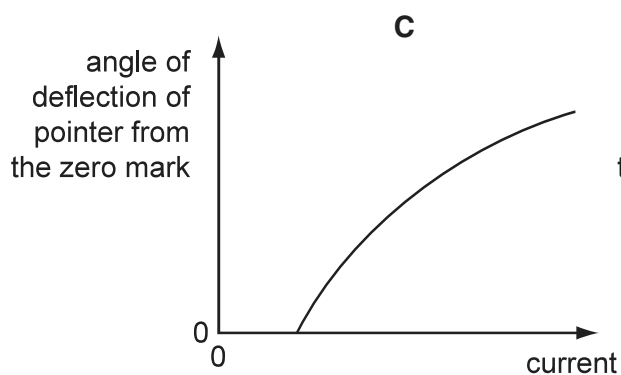
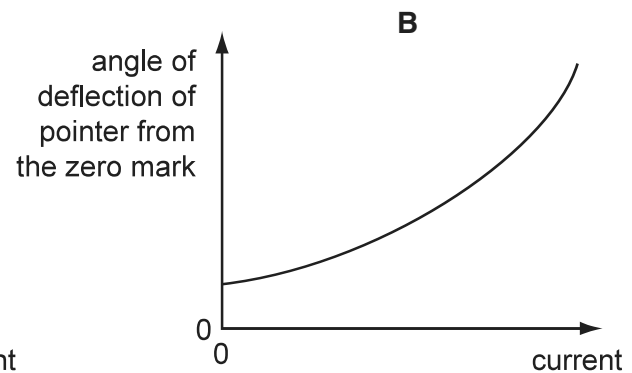
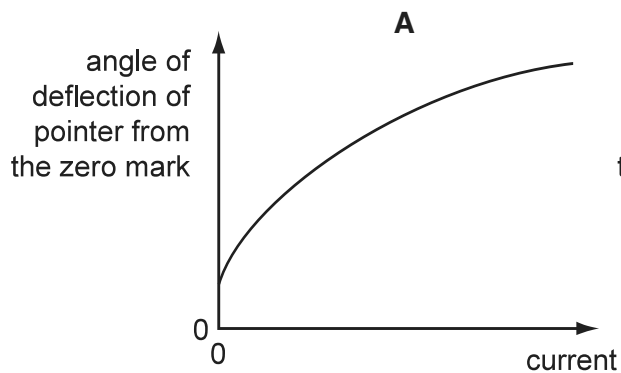
97 2 1 7



The ammeter is accidentally reversed so that when the current is zero the pointer is at



The calibration graph best represents the response of the reversed ammeter



- 5 Four students each make a series of measurements of the acceleration of free fall. They obtain the following results in m s^{-2}

97 2 1 8

Which set of results could be described as precise but not accurate?

	g ms^{-2}			
A	9.81	9.79	9.84	9.8
B	9.81	11.12	9.89	8.94
C	9.45	9.21	8.99	8.76
D	8.45	8.46	8.5	8.41

- 4 A student uses a digital ammeter to measure a current. The reading on the ammeter is shown to be accurate to within $\pm 1.98 \text{ A}$ and $\pm 2.2 \text{ A}$

97 2 1 8

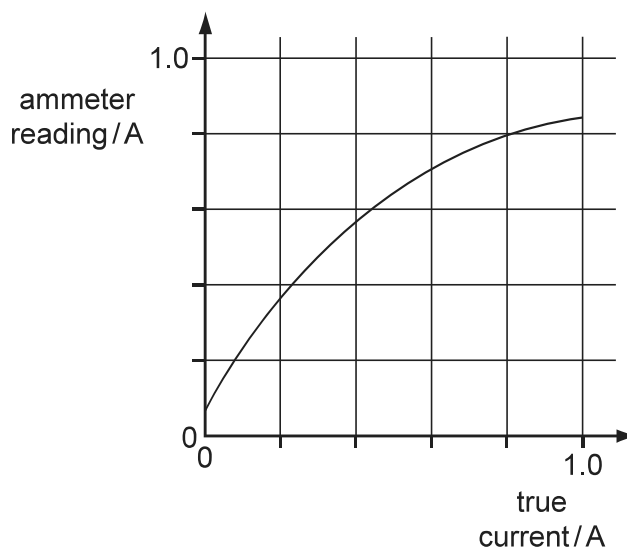
The manufacturer of the ammeter states that an reading has a systematic uncertainty of ± 1

Which value of current should be quoted by the student?

- A 2.1 A
 B 2.2 A
 C 2 A
 D 2.4 A

- 5 A calibration graph is produced for an auto ammeter

97 2 1 8

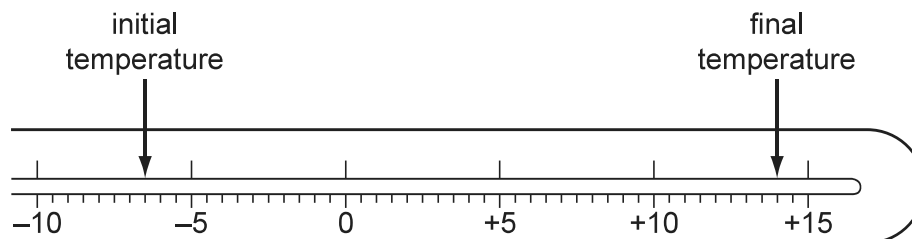


Which ammeter reading is the nearest to the correct value?

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

The diagram shows the stem of a Celsius thermometer marked to show initial and final temperature readings

97 2 1 9

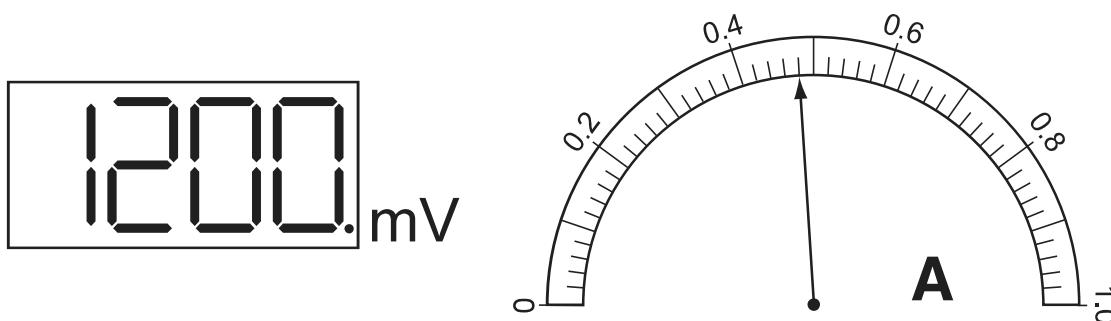


What is the temperature change recorded to an appropriate number of significant figures

- A 14 C B 25 C C 21 C D 22 C

4 The diagrams show a digital voltmeter and an analogue ammeter readings from a circuit in which electrical heating is occurring

97 2 1 9

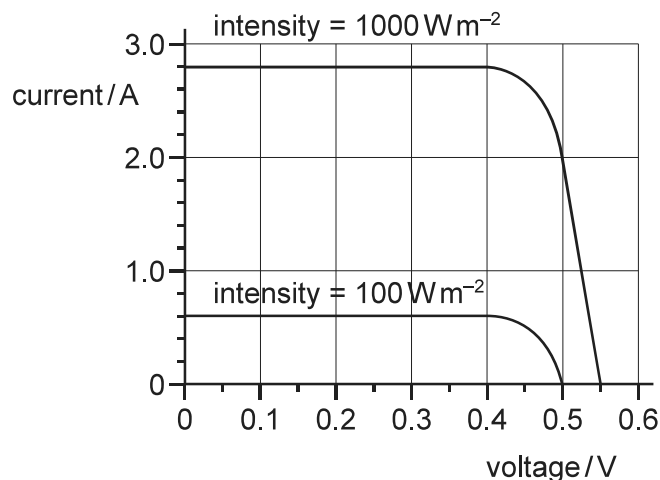


What is the electrical power of the heater

- A 5 B 58 C 5 D 58

The graphs show the variation of photocurrent for a solar cell exposed to different light intensities

97 2 11 9

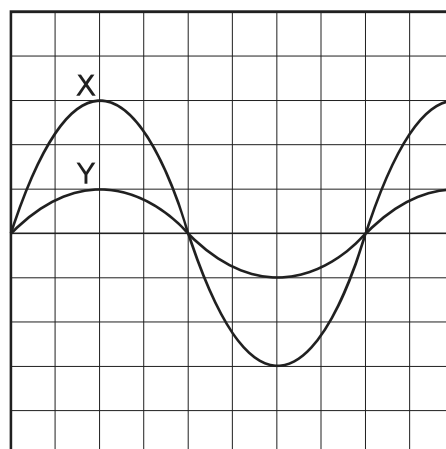


At zero voltage what is the ratio $\frac{\text{current at } 1 \text{ m}^2}{\text{current at } 1 \text{ m}^2}$

- A 11 B 47 C 8 D 1

4 The diagram shows an oscilloscope screen displaying two signals

97 2 11 9



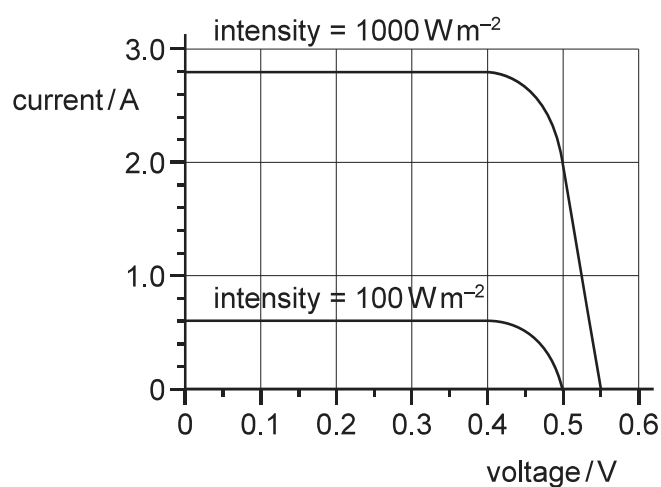
Signal X has a frequency of 5 kHz and a peak-to-peak voltage of 12 V

At this frequency, the peak-to-peak voltage of signal

	Frequency / kHz	Peak-to-peak voltage / V
A	2	4
B	2	12
C	5	4
D	5	12

2 The graph shows the variation of current with voltage for a solar cell at two different light intensities

97 2 12 9

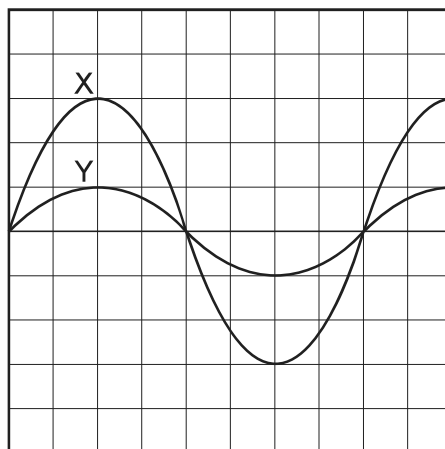


At this voltage	at this ratio	<u>current at 1</u>	<u>m²</u>
		current at 1	m ²
A 1.1	B 4.7	C 8	

Diagram shows an oscilloscope screen displaying two signals X and Y.

97 2 12

9



Signal X has a frequency of 5 Hz and a period of 12 ms.

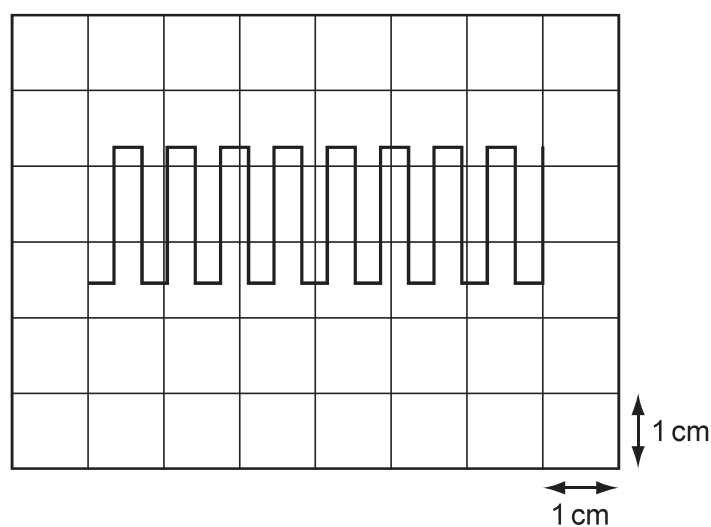
At this frequency, the period of signal Y is

	Period (ms)	Frequency (Hz)
A	2	4
B	2	12
C	5	4
D	5	12

4. The diagram shows a square wave trace on the screen of a cathode ray oscilloscope. The grid is 1 cm square. The time base setting is 1 ms cm⁻¹.

97 2 11

1



At this frequency, the period of the square wave is

A 7

B 14

C 28

D 14

- 6 A student in science class is measuring the mass and the volume of a substance. The student's measurements are summarized in the table below.

97 2 11 1

mass of object = 21 g

mass of water = 71 g

volume of water = 16 cm³

The correct calculation for the density of the object is 5 g/cm³.

What is the uncertainty in this value?

- A 1 g/cm³ B 5 g/cm³ C 6 g/cm³ D 26 g/cm³

- 7 A micrometer screw gauge is used to measure the diameter of a cylinder.

The reading of the cylinder in position is shown in diagram 1. The cylinder is removed and the same micrometer are closed. The new reading is shown in diagram 2.

97 2 11 1

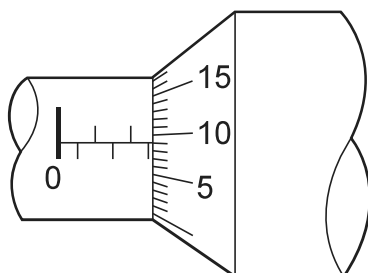


diagram 1

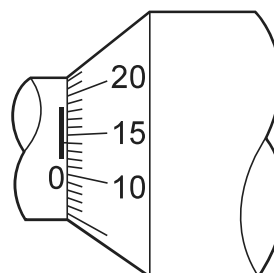


diagram 2

What is the diameter of the cylinder?

- A 1.9 mm B 2.45 mm C 2.59 mm D 2.7 mm

- 1 A micrometer screw gauge is used to measure the diameter of a cylinder.

97 2 12 1

The reading of the cylinder in position is shown in diagram 1. The cylinder is removed and the same micrometer are closed. The new reading is shown in diagram 2.

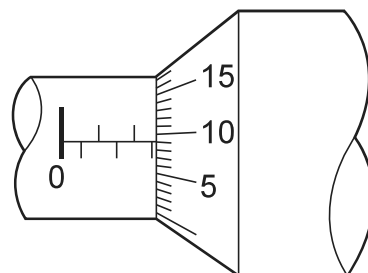


diagram 1

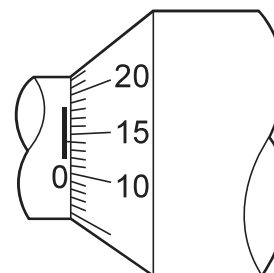
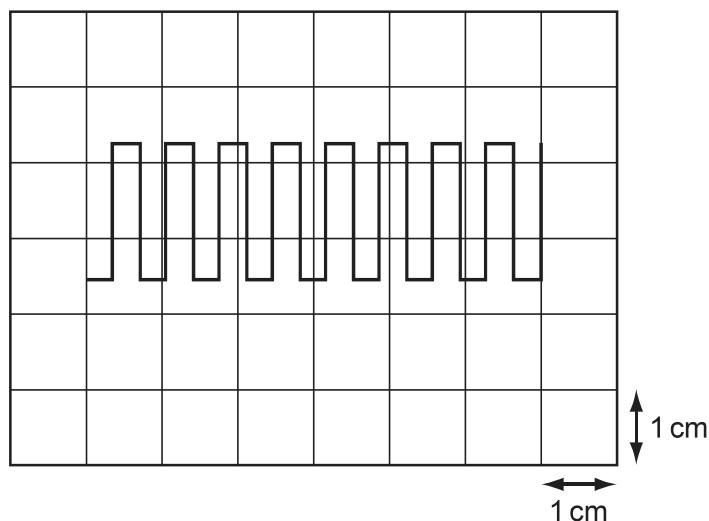


diagram 2

What is the diameter of the cylinder?

- A 1.9 mm B 2.45 mm C 2.59 mm D 2.7 mm

- 5 The diagram shows a square wave trace on the screen of a cathode ray oscilloscope. A grid of 1 cm squares covers the screen. The time base setting is 1 ms cm⁻¹. 97/2/12 1



What is the approximate frequency of the square wave?

- A 7 B 14 C 28 D 14
- 5 A micrometer screw gauge is used to measure the diameter of a copper wire. The reading of the wire in position is shown in diagram 1. The wire is removed and the same micrometer is used to measure the diameter of a steel wire. The reading is shown in diagram 2. 97/2/1 1

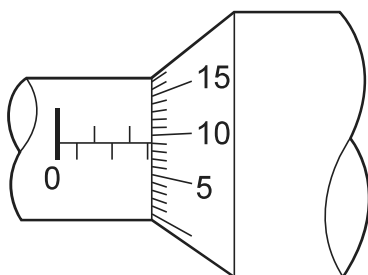


diagram 1

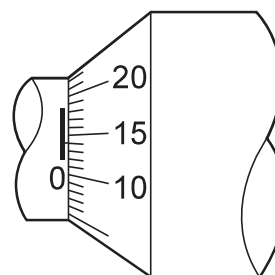


diagram 2

What is the diameter of the steel wire?

- A 1.9 mm B 2.45 mm C 2.59 mm D 2.7 mm
- 5 A quantity is to be determined from the equation 97/2/12 1

is measured as 1.27 ± 0.02 m

is measured as 8.0 ± 0.1 m

What is the percentage uncertainty in the result to one significant figure?

- A 4 B 2 C 1 D 7

A student in science is measuring its mass and its volume. The following is a summary of his measurements

97 2 12 1

mass of metal = 2.1 g

mass of water = 7.1 g

volume of water = 1.6 cm³

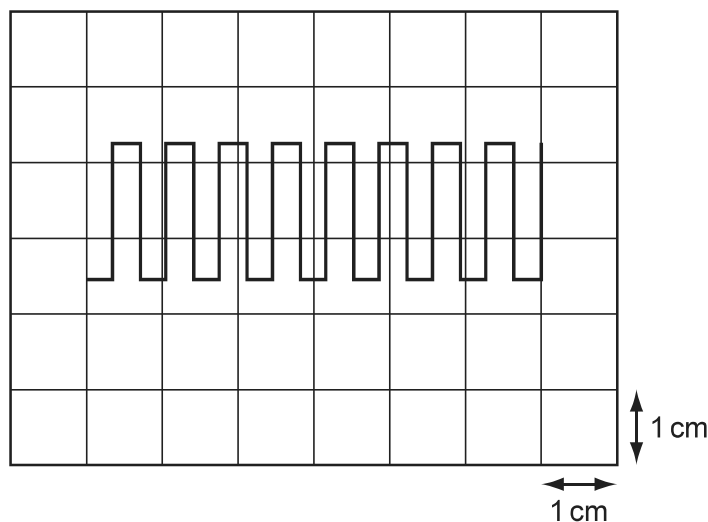
The correct calculation for the density is 5 g/cm³

What is the uncertainty in this value?

- A 7 g/cm³ B 5 g/cm³ C 6 g/cm³ D 2.6 g/cm³

The diagram shows a square wave trace on the screen of a cathode ray oscilloscope. A grid of 1 cm squares covers the screen. The time base setting is 1 ms/cm.

97 2 1 1



What is the approximate frequency of the square wave?

- A 7 B 14 C 28 D 14

4. A student in science is measuring its mass and its volume. The following is a summary of his measurements

97 2 1 1

mass of metal = 2.1 g

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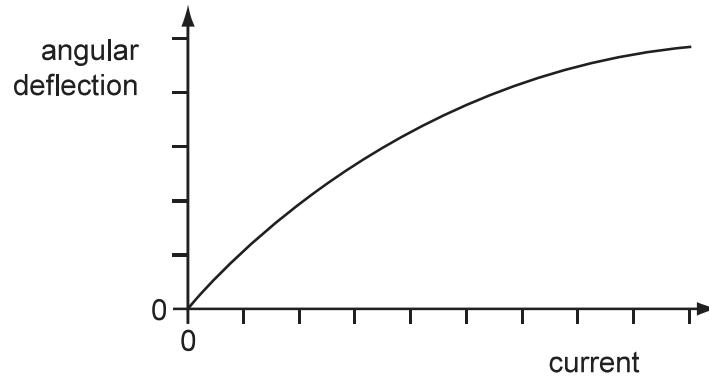
The correct calculation for the density is 5 g/cm³

What is the uncertainty in this value?

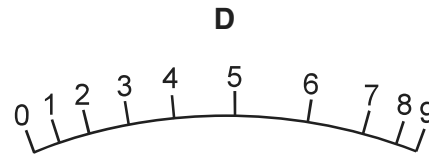
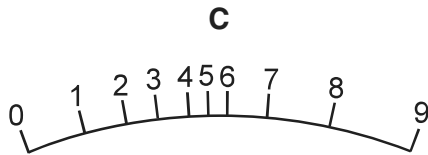
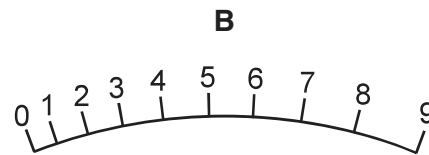
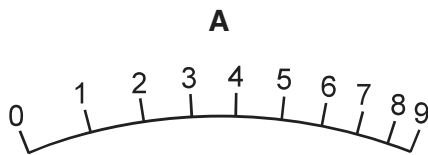
- A 7 g/cm³ B 5 g/cm³ C 6 g/cm³ D 2.6 g/cm³

- 4 The angular deflection of the needle of an ammeter varies with the current passing through it. The ammeter has a non-linear scale.

97 2 11 1

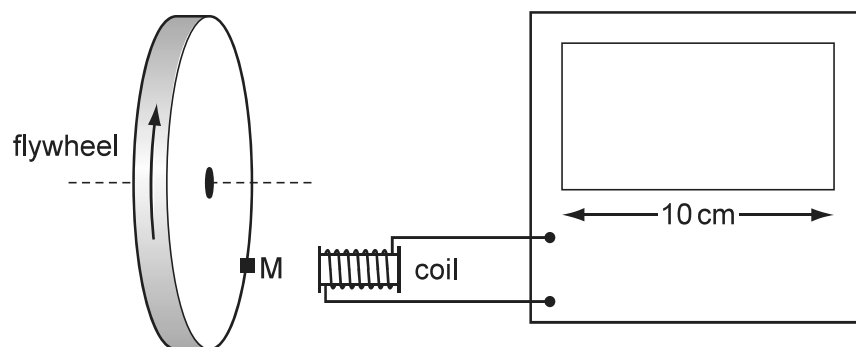


Which diagram could represent the appearance of the scale on this meter?



- 5 The diagram shows a cathode ray oscilloscope being used to measure the rate of rotation of a flywheel.

97 2 11 1



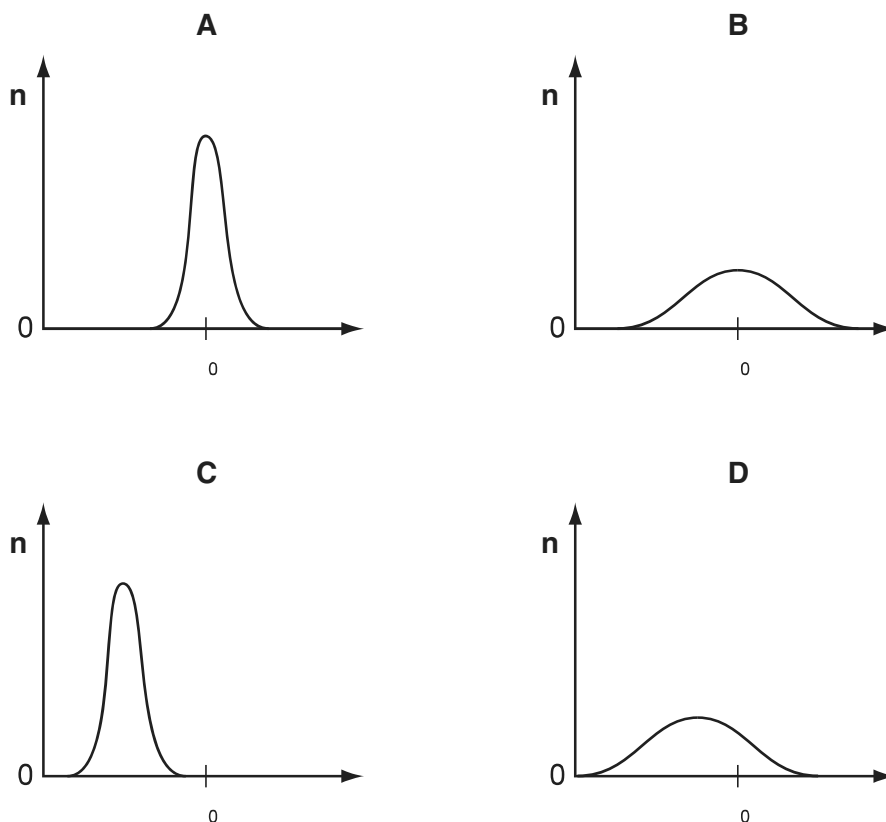
The flywheel is a small magnet mounted on it. As time passes, the magnet passes the coil, and a voltage is generated. This is connected to the CRO. The CRO is a cathode ray oscilloscope. The flywheel is rotating at a rate of 1000 revolutions per minute.

Which time base setting is a clear separation of the traces on the screen?

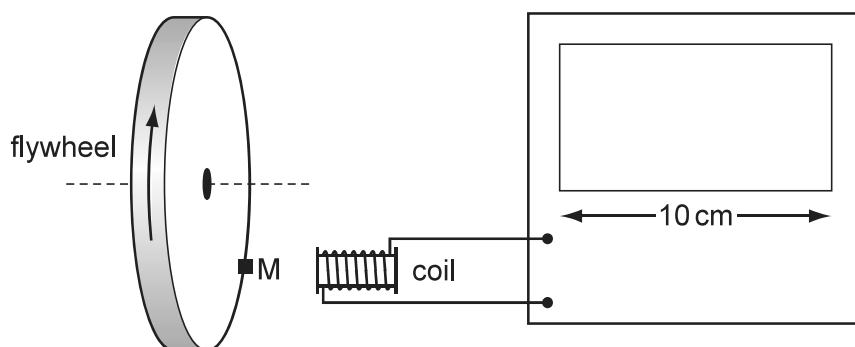
- A 1 s cm^{-1} B 1 ms cm^{-1} C 1 s cm^{-1} D 1 s cm^{-1}

6 A quantity is measured many times in an experiment that has experimental uncertainty. A graph is plotted to show the number of times that a particular value is obtained. 97 2 11 1

The graph could also show the measurement of a quantity as a large systematic error but a small random error.



2 The diagram shows a cathode ray oscilloscope being used to measure the rate of rotation of a flywheel. 97 2 1 1



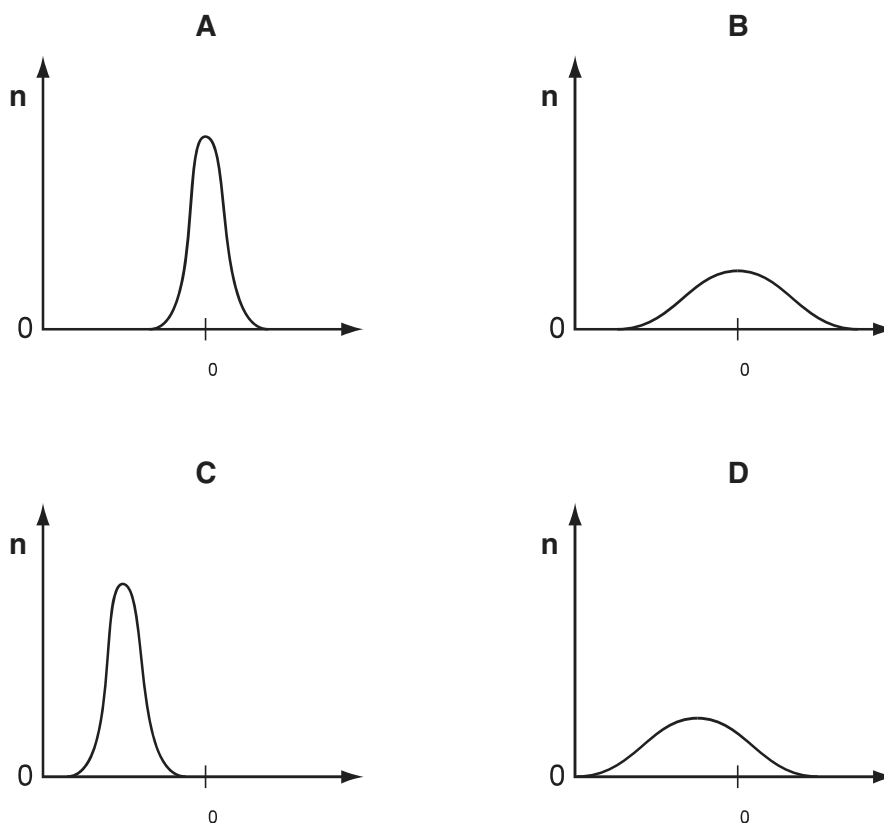
The flywheel has a small magnet mounted on it. As the flywheel rotates, the magnet passes the coil and a voltage is generated. This is connected to the oscilloscope. The oscilloscope is 1 cm high. The flywheel is rotating at a rate of about 1000 revolutions per minute.

The time base setting is a clear square wave on the screen.

A 1 s cm⁻¹ B 1 ms cm⁻¹ C 1 s cm⁻¹ D 1 s cm⁻¹

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- 4 e uncertaint in t e a ue o t e momentum o a tro e assing et een t o oints an aries it t e c oice o measuring e ices 97 2 12 11

eamasurements or t e same tro e ma e i erent instruments ere recor e

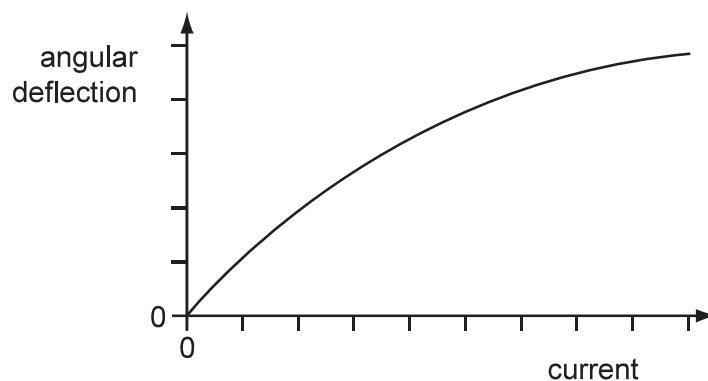
- 1 istance et een an using a metre ru e it cm i isions 55 m
- 2 istance et een an using a metre ru e it mm i isions 547 m
- timings using a rist atc measuring to t e nearest 5 s at s an at 4 5 s
- 4 timings using ig t gates measuring to t e nearest 1 s at s an at 4 s
- 5 mass o tro e using a a ance measuring to t e nearest 6.4×10^{-2} g
- 6 mass o tro e using a a ance measuring to t e nearest 1×10^{-2} g

ic measurements one or eac uantit measure ea to t e east uncertaint in t e a ue o t e momentum o t e tro e

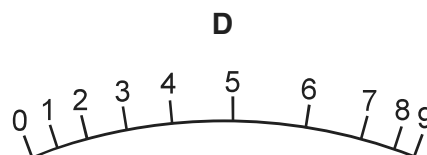
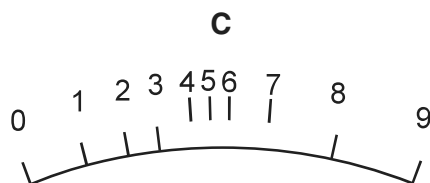
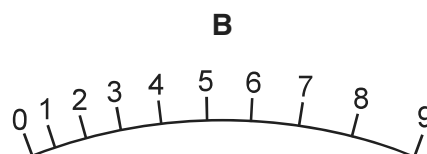
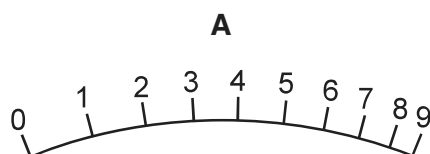
- A 1 an 6 B 1 4 an 6 C 2 an 6 D 2 4 an 5

- 5 The angular deflection of the needle of an ammeter varies with the current passing through the ammeter as shown in the graph

97 2 1 1



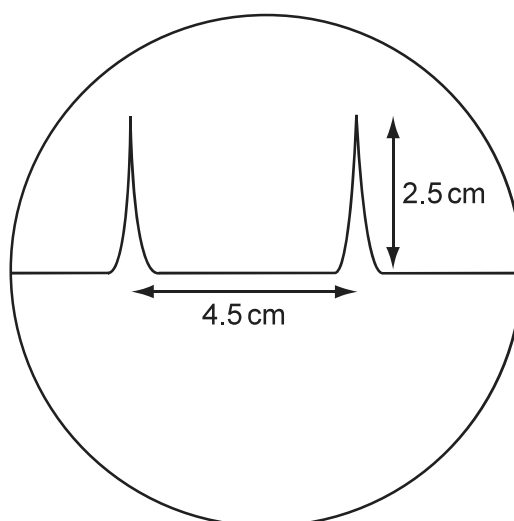
Which diagram could represent the appearance of the scale on this meter?



- 5 The time base on a cathode ray oscilloscope is set at 6 ms/cm

97 2 12 11

A trace consisting of two pulses is recorded as shown in the diagram



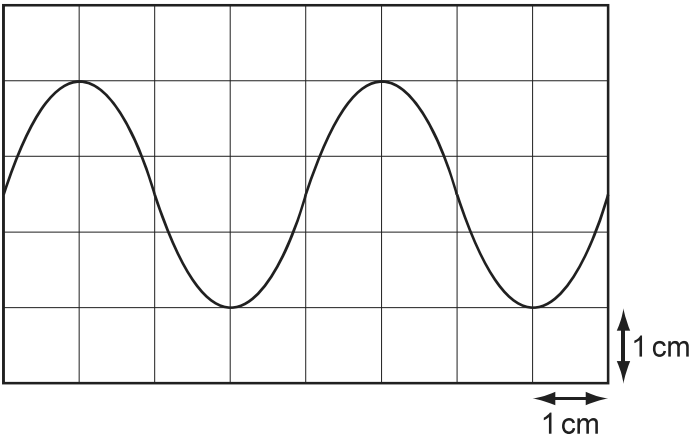
What is the time interval between the two pulses?

- A 42 ms B 75 ms C 1 ms D 27 ms

4

The diagram shows a trace on a cathode ray oscilloscope. The vertical axis represents voltage and the horizontal axis represents time. The trace is a sine wave. The peak-to-peak voltage is 4 cm and the time scale is 5 ms cm⁻¹.

97 2 11 11



Calculate the amplitude and period of the wave.

	amplitude	period ms
A	1.5	4
B	5	1
C	6	2
D	12	2

4

A car is moving on a slope of inclination θ . The distance in time t is given by the equation

97 2 11 11

$$\left(\frac{a^2}{g} \right) \sin \theta$$

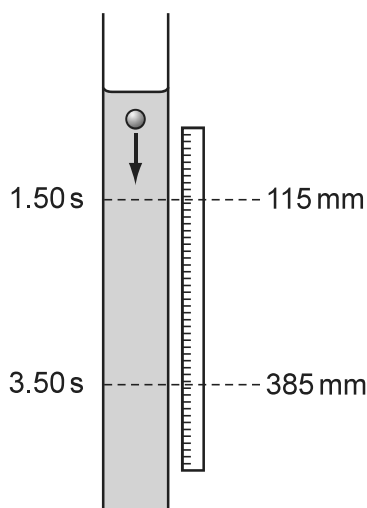
where a is the internal radius of the tube and g is the acceleration due to gravity. Both a and g are constants.

Which of the following are the correct units for t ?

	units	units
A	m ²	m ² s ²
B	m ²	ms ²
C	m ²	ms ²
D	m	ms ²

- 5 The diagram shows an experiment to measure the speed of a small ball falling at constant speed through a clear liquid in a glass tube.

97/2/11 11



There are two marks on the tube. The ball passes the first mark at 115 mm on the adjacent ruler and the other mark at 385 mm. The ball passes the first mark at 1.50 s and passes the other mark at 3.50 s.

The constant speed of the ball is calculated as $\frac{385 - 115}{3.50 - 1.50} = 115 \text{ mm s}^{-1}$.

Which expression calculates the fractional uncertainty in the speed of the ball?

- A $\frac{2}{27} \times \frac{4}{2}$
 B $\frac{2}{27} \times \frac{4}{2}$
 C $\frac{1}{27} \times \frac{2}{2}$
 D $\frac{1}{27} \times \frac{2}{2}$

- 5 The speedometer in a car consists of a pointer which rotates. The pointer is situated 50 mm from the centre of rotation.

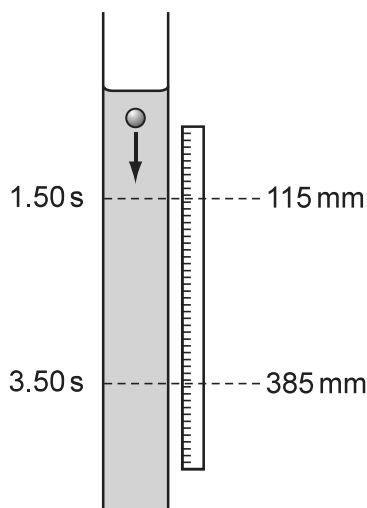
97/2/12 11

What could cause a random error in the driver's measurement of the car's speed?

- A The car's speed is affected by the direction of travel.
 B The driver's eye is not always in the same position in relation to the pointer.
 C The speedometer does not read zero when the car is at rest.
 D The speedometer reads 10% higher than the car's actual speed.

- 4 The diagram shows an experiment to measure the speed of a small ball falling at constant speed through a clear liquid in a glass tube.

97 2 1 11



Here are two marks on the tube. The top mark is positioned at 115 mm on the adjacent ruler and the other mark at 85 mm. The ball passes the top mark at 1.50 s and passes the other mark at 5.00 s.

The constant speed of the ball is calculated as $\frac{85 - 115}{5 - 1.50} = \frac{-30}{3.50} = -8.57 \text{ mm s}^{-1}$

The expression calculates the fractional uncertainty in the value of this speed.

- A $\frac{2}{27} \times \frac{4}{2}$
 B $\frac{2}{27} \times \frac{4}{2}$
 C $\frac{1}{27} \times \frac{2}{2}$
 D $\frac{1}{27} \times \frac{2}{2}$

- 4 A micrometer is used to measure the diameters of two cylinders.

97 2 12 11

Diameter of first cylinder = 12.78 mm

Diameter of second cylinder = 16.24 mm

The difference in the diameters is calculated as

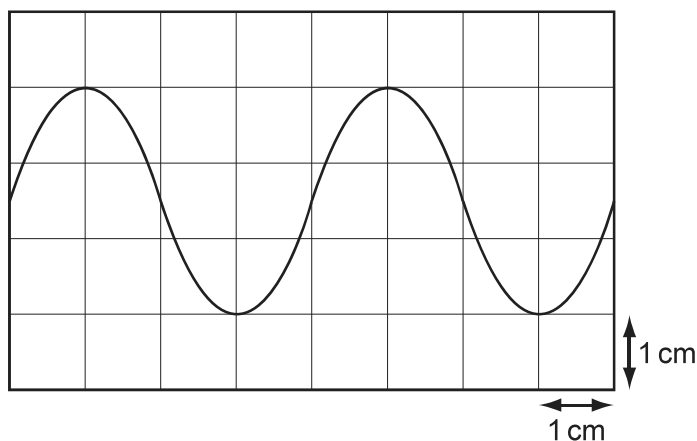
What is the uncertainty in this difference?

- A 1 mm B 2 mm C 3 mm D 5 mm

5 The diagram shows a trace on a cathode ray oscilloscope

97 2 1 11

The vertical axis represents a sine wave with a frequency of 1 cm and the time scale is 5 ms cm⁻¹ and the time scale is 5 ms cm⁻¹



What are the amplitude and period of the wave?

	amplitude	period ms
A	1.5	4
B	5	1
C	6	2
D	12	2

5 The Young's modulus of the material of a wire is to be found. The Young's modulus is given by the equation

97 2 11 11

$$\frac{4}{\pi^2}$$

The wire is extended and the following measurements are made

Which measurement has the largest effect on the uncertainty in the value of the calculated Young's modulus?

	measurement	symbol	value
A	length of wire before force applied		2.4 2 m
B	diameter of wire		54 2 mm
C	force applied		19.62 1
D	extension of wire after force applied		5.2 2 mm

The Young modulus of the material of a wire is to be found. The Young modulus is given by the equation

97 2 1 11

$$\frac{4}{\pi^2}$$

The wire is extended by a known force and the following measurements are made

Which measurement has the largest effect on the uncertainty in the value of the calculated Young modulus

	measurement	symbol	value
A	length of wire before force applied		2.4 2 m
B	diameter of wire		54 2 mm
C	force applied		19.62 1
D	extension of wire after force applied		5.2 2 mm

5. A car is accelerating from rest at an angle θ to the horizontal. The distance travelled in time t is given by the equation

97 2 1 11

$$\left(\frac{a^2}{g} \right) \sin \theta$$

where a is the internal radius of the tube and g is the acceleration due to gravity. Both a and g are constants.

Which line gives the correct units for a ?

A	m^2	$m^2 s^{-2}$
B	m^2	ms^{-2}
C	m^2	$m s^{-2}$
D	m	ms^{-2}

5. In an experiment a radio-controlled car travels 2.5 m in 5 s. The distance travelled is given by the equation

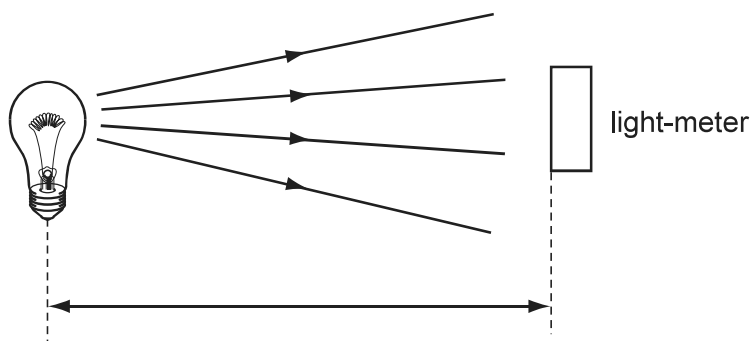
97 2 11 12

What is the error in the value of the acceleration?

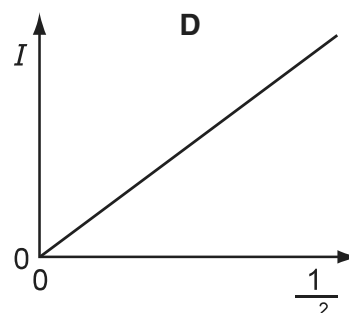
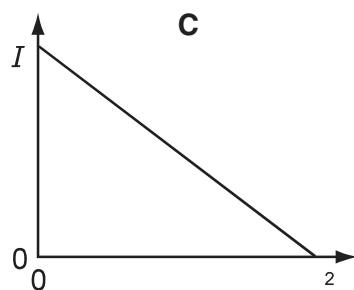
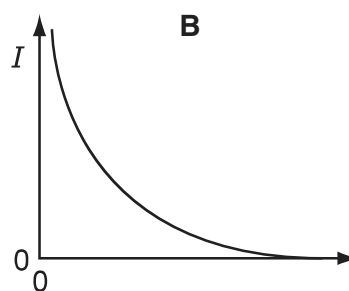
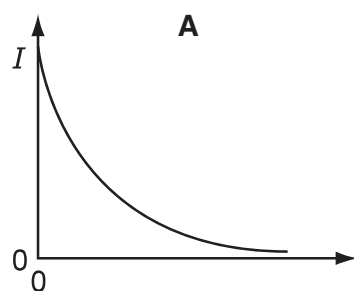
- A 16 1 ms⁻¹
 B 16 2 ms⁻¹
 C 16 4 ms⁻¹
 D 16 6 ms⁻¹

- 4 A light meter measures the intensity of the light falling on it. The graph suggests that the intensity varies inversely as the square of the distance.

97 2 11 12

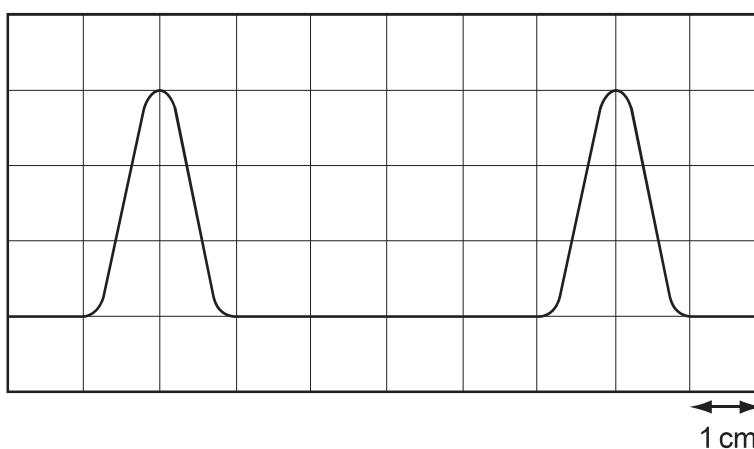


Which graph of the results supports this theory?



- 6 The diagram shows the trace of a cathode ray oscilloscope. The grid is 1 cm square. The time base setting is 1 $\mu\text{s}/\text{cm}$.

97 2 12 12

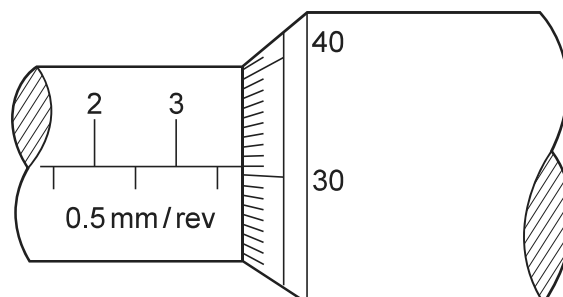


Which of the following is the correct use of the oscilloscope?

- A 2 s B 1 s C 4 s D 6 s

4 The diameter of a cylindrical metal rod is measured using a micrometer screw gauge 97 2 12 12

The diagram shows an enlargement of the scale on the micrometer screw gauge when taking the measurement



What is the cross-sectional area of the rod

- A 81 mm^2 B 114 mm^2 C 228 mm^2 D 456 mm^2

5 A mass is released from rest and falls through a distance of 2 m in a vacuum. An observer records the time taken for the mass to fall through this distance using a manual stopwatch. The observer repeats the measurements a further two times. The average result of these measurement times is 0.639 s . This is used to determine the value of the acceleration of free fall. This is calculated to be 9.8 ms^{-2} 97 2 12 12

	first measurement	second measurement	third measurement	average
time / s	0.639	0.647	0.659	0.648

Which statement best relates to the experiment

- A The measurements are precise and accurate. It is not possible to estimate random errors.
- B The measurements are not accurate and not a good record of the degree of precision of the measuring device. The calculated experimental result is accurate.
- C The measurements are not a good record of the degree of precision of the measuring device but are accurate. Systematic errors may be present.
- D The range of results suggests that there are random errors. The calculated value is correct so the experiment was successful.

4 In an experiment, a radio-controlled car takes $2.5 \pm 0.5 \text{ s}$ to travel $4 \pm 1 \text{ m}$ 97 2 1 12

What is the car's average speed and its uncertainty

- A $16 \pm 1 \text{ ms}^{-1}$
- B $16 \pm 2 \text{ ms}^{-1}$
- C $16 \pm 4 \text{ ms}^{-1}$
- D $16 \pm 6 \text{ ms}^{-1}$

- 5 A light meter measures the intensity of the light falling on it. The theory suggests that the intensity varies inversely as the square of the distance.

97 2 1 12

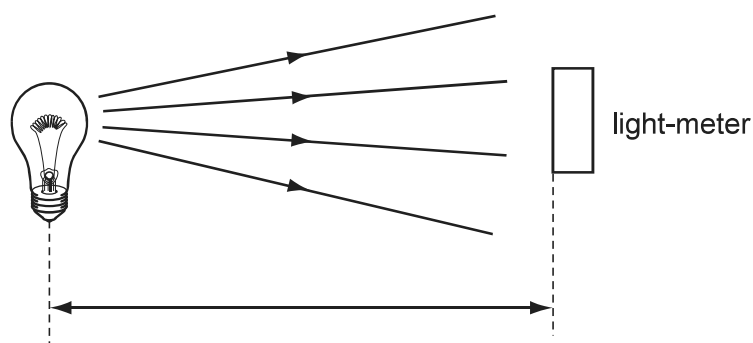
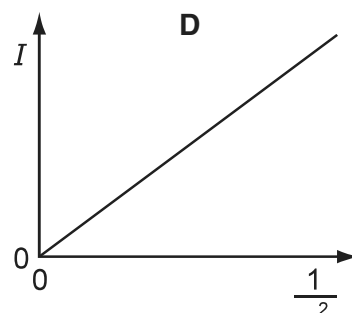
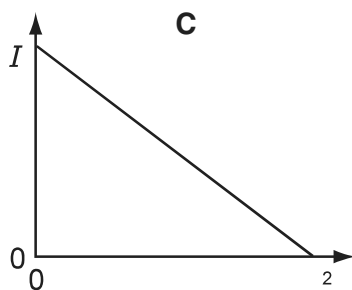
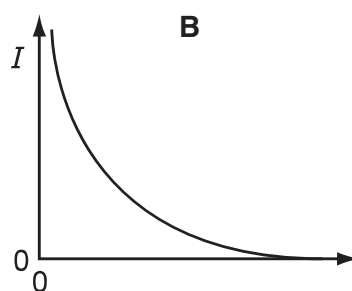
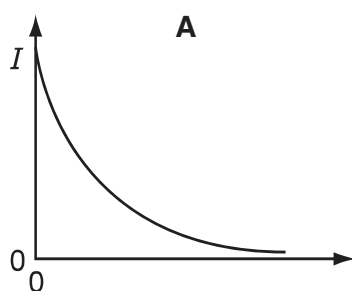


Figure 1 shows the results of the experiment.



- 5 A student is given a wire of diameter less than 2 mm and is asked to find the intensity of the light.

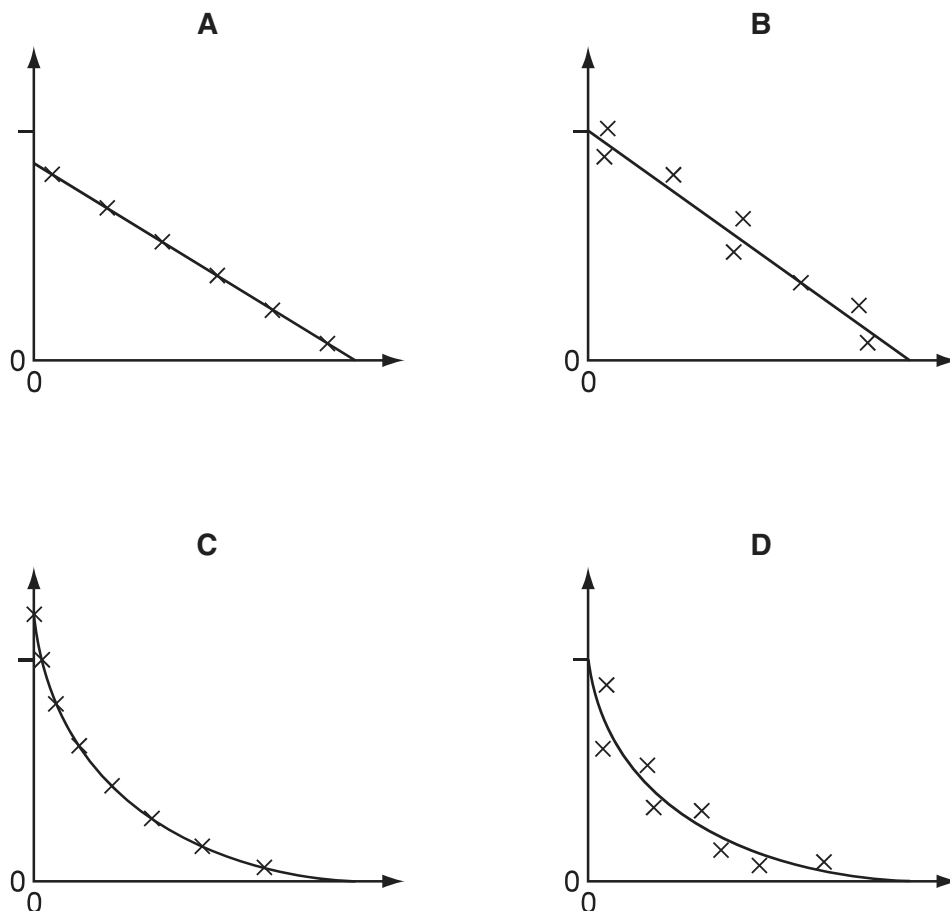
97 2 12 12

Which pair of instruments would be most suitable for measuring the diameter of the wire?

- A a vernier caliper and a micrometer
- B a metre rule and a micrometer
- C a metre rule and a vernier caliper
- D a micrometer and a vernier caliper

6. A graph of $\frac{1}{v}$ against $\frac{1}{u}$ is shown. The data points are plotted and a straight line is drawn through them. The line is extended to the axes. The intercepts on the axes are used to determine the values of a and b . The values of a and b are constants. The results contain a systematic error. The graph best represents these results.

97 2 12 12



7. The speed of a car is calculated from measurements of the distance travelled and the time taken. The distance is measured as 200 m with an uncertainty of 2 m. The time is measured as 10 s with an uncertainty of 0.2 s. What is the percentage uncertainty in the calculated speed?

97 2 12 12

A 5% B 1% C 2% D 10%

8. A science museum designs an experiment to show that a feather falls at the same rate as a coin in a vacuum. The time of fall from rest is to be close to 5 s. What length of tube is required?

97 2 12 12

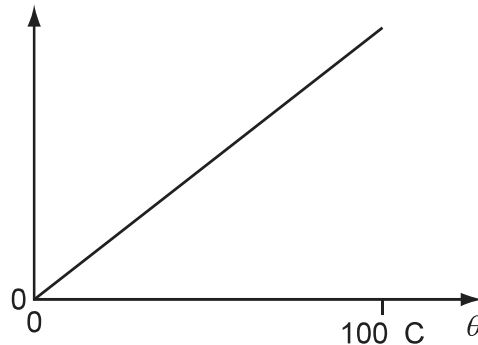
A 1 m B 2.5 m C 5 m D 10 m

- 5 The sensitivity of the material of a coil of a thermocouple is to be found. Which set of instruments could be used to find the most accurate value for the sensitivity?
- A metre rule, protractor, spring balance
 - B micrometer, metre rule, thermometer
 - C stopwatch, Newton meter, vernier callipers
 - D thermometer, vernier callipers, screwdriver

97/2/11 12

- 6 A quantity varies with temperature θ as shown.

97/2/11 12



θ is determined from the corresponding values of the quantity using the graph. The percentage uncertainty in the value of θ at a temperature is 1%.

Which statement about the uncertainty in θ is correct?

- A The percentage uncertainty in θ is least near 0°C
 - B The percentage uncertainty in θ is least near 100°C
 - C The actual uncertainty in θ is least near 0°C
 - D The actual uncertainty in θ is least near 100°C
- 7 The measurement of a physical quantity may be subject to random errors and to systematic errors.

97/2/11 12

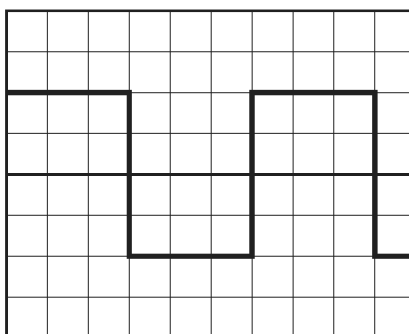
Which statement is correct?

- A Random errors can be reduced by taking the average of several measurements.
- B Random errors are always caused by the person taking the measurement.
- C A systematic error cannot be reduced by using the same apparatus.
- D A systematic error results in a different reading each time the measurement is taken.

5 A cathode ray oscilloscope is used to measure the period of a square wave signal.

97 2 1

12



The time base setting is 2 ms per division.

What is the frequency of the signal?

A 8

B 8

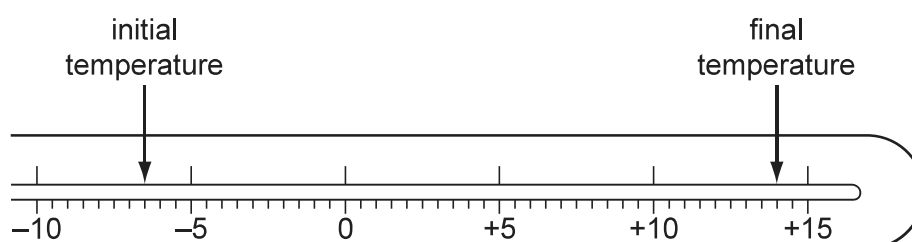
C 1

D 17

6 The diagram shows the scale of a Celsius thermometer. The initial temperature is -7.5°C and the final temperature is $+13.5^{\circ}\text{C}$.

97 2 1

1



What is the temperature change recorded to an appropriate number of significant figures?

A 14 C

B 2.5 C

C 21 C

D 22 C

5 A student takes measurements of the current in a resistor of constant resistance and the potential difference across it. The readings are then used to plot a graph of current against potential difference.

97 2 1

1

There is a systematic error in the current readings.

Which of the following is a possible cause of the error?

A At least one anomalous data point can be identified.

B The data points are scattered about the straight line of best fit.

C The graph is a curve, not a straight line.

D The straight line graph does not pass through the origin.

- 5 In an experiment to determine the acceleration of free fall the period of oscillation of a simple pendulum is measured. The uncertainty in the measurement of t is estimated to be 4% and the uncertainty in the measurement of l is estimated to be 1%.

97 2 11 1

The value of g is determined using the formula

$$g = \frac{4\pi^2 l}{T^2}$$

What is the uncertainty in the calculated value of g ?

A 2%

B 3%

C 5%

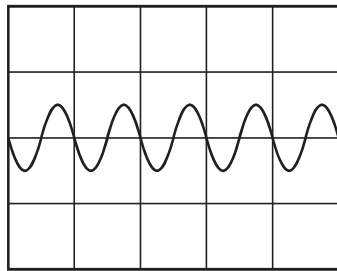
D 6%

- 6 The input terminals of a cathode ray oscilloscope are connected to a sinusoidal wave of amplitude 5 cm and frequency 5 kHz. The time base is set at 1 ms per division and the gain at 5 V per division.

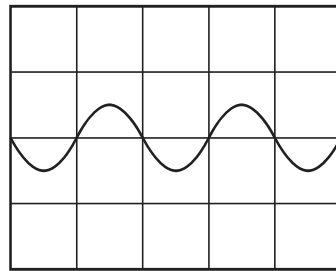
97 2 11 1

The trace is obtained

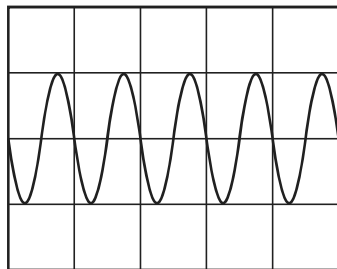
A



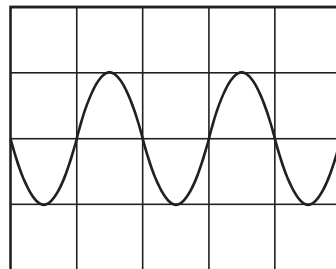
B



C



D



- 4 A student carries out an experiment in which an electric current is allowed to decrease with time. The readings are shown from first to last were 62 mA, 2.81 mA, 1.1 mA, 1.76 mA and 0.9 mA.

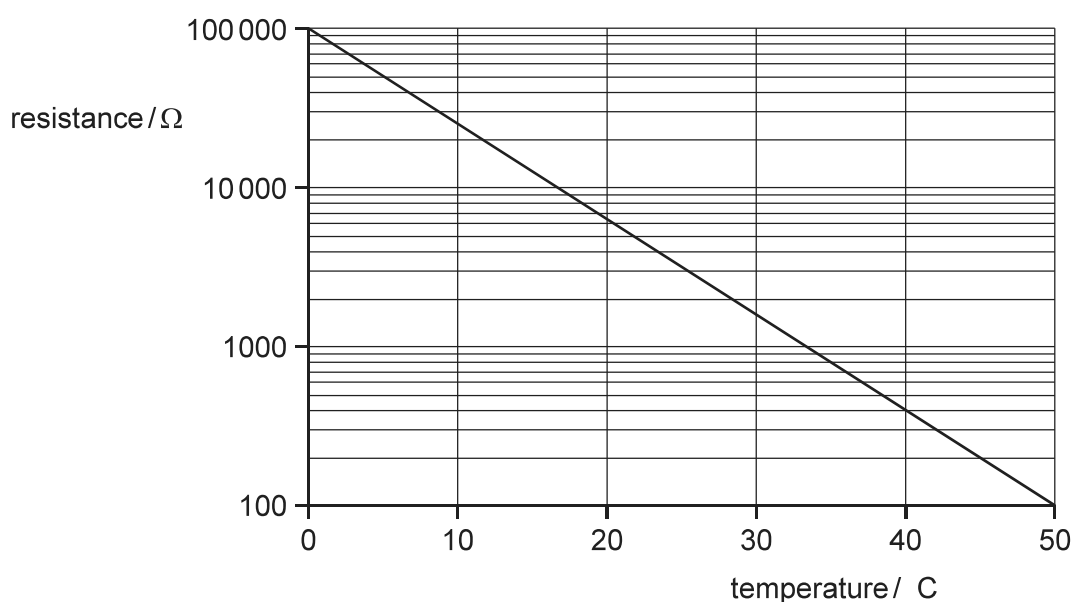
97 2 12 1

Which statement could not explain the anomalous 1.1 mA reading?

- A The reverse test circuit readings in the results table
- B The resistance ammeter incorrect. The readings should have been 2.1 mA
- C The total current reading at the long time
- D There was a systematic error in the readings from the ammeter

- 5 The diagram shows a calibration curve for a thermistor. The vertical axis is

97 2 12 1



What is the thermistor resistance corresponding to a temperature of 4 °C?

- A 1 Ω
- B 15 Ω
- C 4 Ω
- D 94 Ω

- 6 What is the best way to reduce systematic errors when taking a measurement?

97 2 1 12

- A Using the needle on a voltmeter so that it reads zero when there is no potential difference across it
- B Measuring the diameter of a wire at different points and taking the average
- C Reducing the area affected by using a marker and a mirror when measuring the amplitude of an oscillation of a pendulum
- D Timing 20 oscillations rather than a single oscillation when finding the period of a pendulum

- 7 In an experiment to determine the acceleration of free fall, the time taken for a ball to fall through a distance s is measured. The uncertainty in the measurement of s is estimated to be 2%. The uncertainty in the measurement of t is estimated to be 12%.

The value of g is determined using the equation

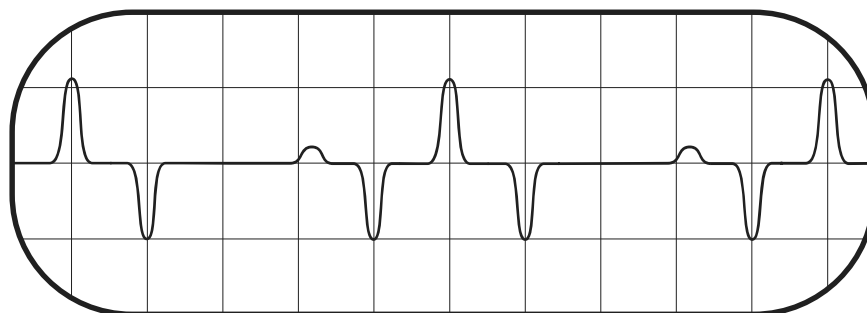
$$g = \frac{2s}{t^2}$$

What is the uncertainty in the calculated value of g ?

- A 1% B 5% C 8% D 11%

- 4 A signal that repeats periodically is displayed on the screen of a cathode ray oscilloscope.

97/2/11 1



The screen has 1 cm squares and the time base is set at 2 ms cm⁻¹.

What is the frequency of this periodic signal?

- A 5 Hz B 1 Hz C 125 Hz D 2 Hz

- 5 A micrometer screw gauge is used to measure the diameter of a small uniform steel sphere. The micrometer reading is 5.12 mm.

97/2/11 1

What is the percentage uncertainty in a calculation of the volume of the sphere using these values?

- A 2% B 4% C 6% D 12%

- 6 A student wishes to determine the density ρ of a small sphere. She measures the mass and diameter of a small sphere.

97/2/1 1

mass 5.6 g

diameter 2.2 mm

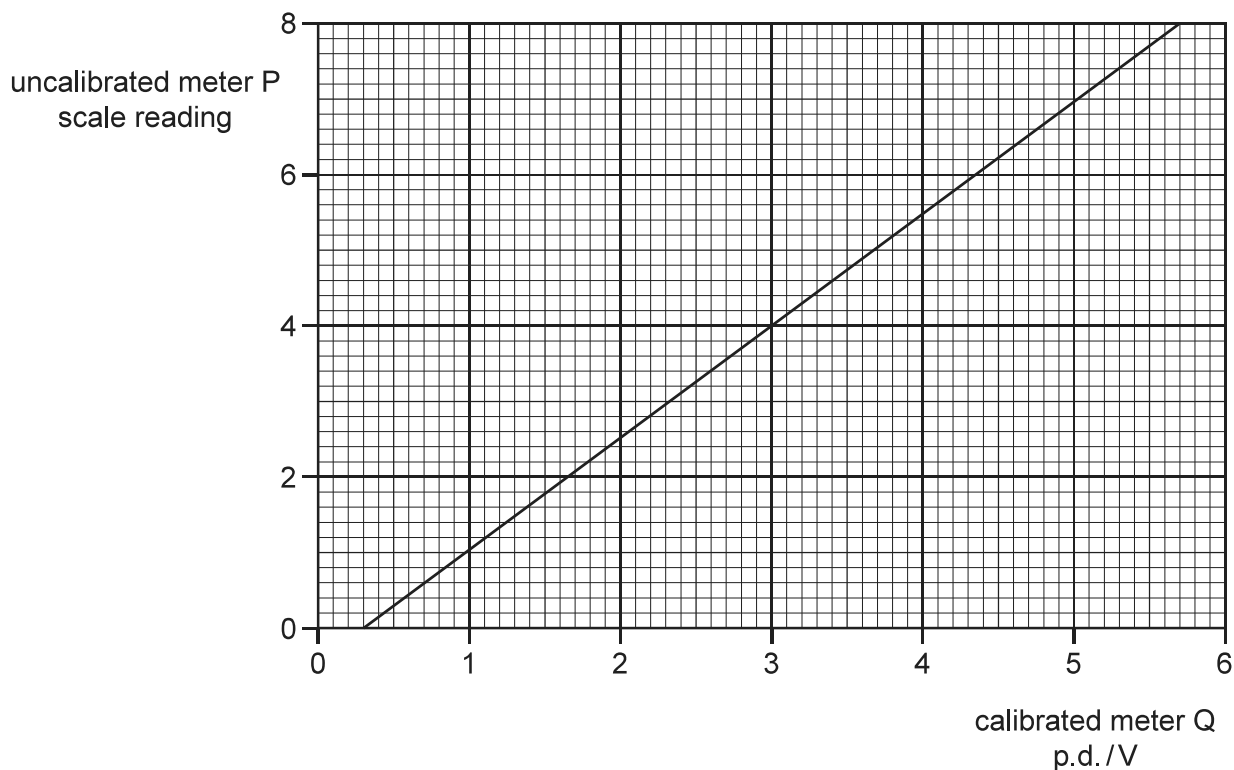
What is the best estimate of the percentage uncertainty in her value of ρ ?

- A 19% B 2% C 28% D 7%

- 5 An uncalibrated analogue ohmmeter is connected in parallel with another ohmmeter which is known to be accurate. A range of values of potential difference readings are taken from the two meters

97 2 1 1

The diagram shows the calibration graph obtained



The graph shows that meter P has a zero error. This meter is now adjusted to remove this zero error. The error in the meter is recalculated. The gradient of the calibration graph is found to be 0.8.

What is the new scale reading on meter P when it is used to measure a p.d. of 5 V?

- A 6.6 B 6.7 C 7.2 D 7.4

- 4 An experiment is carried out to measure the resistance of a wire

97 2 11 14

The current in the wire is 1.2 A and the potential difference across the wire is 8.4 V.

What is the resistance of the wire and its uncertainty?

- A $8 \pm 2 \, \Omega$
 B $8 \pm 6 \, \Omega$
 C $8 \pm 1 \, \Omega$
 D $8 \pm 2 \, \Omega$

5. The Young modulus of the material of a wire is to be found. The Young modulus is given by the equation

97 2 11 14

$$\frac{4}{\pi^2}$$

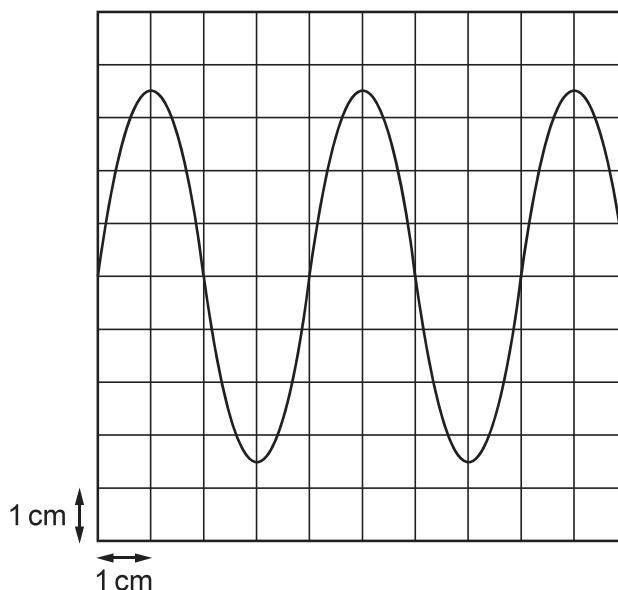
The wire is extended by a non-uniform force and the following measurements are made

Which measurement has the largest effect on the uncertainty in the value of the calculated Young modulus

	measurement	symbol	value
A	length of wire before force applied		2.4 m
B	diameter of wire		54 mm
C	force applied		19.62 N
D	extension of wire at force applied		5.2 mm

- A cathode ray oscilloscope is connected to an alternating voltage. The following trace is produced on the screen

97 2 12 14



The oscilloscope time base setting is 5 ms cm^{-1} and the vertical sensitivity is 2 V cm^{-1}

Which statement about the alternating voltage is correct

- A The amplitude is 5 cm
- B The frequency is 5
- C The period is 1 ms
- D The average value is 4 cm

4 A quantity is to be determined from the equation

97 2 12 14

$$\frac{\dots}{2}$$

The percentage uncertainties in x and y are shown

	percentage uncertainty
x	6
y	2
z	4

What is the percentage uncertainty in z

- A 5 B 1 C 16 D 192

5 A thermometer can be read to an accuracy of $\pm 0.5^\circ\text{C}$. This thermometer is used to measure a temperature rise from 4°C to 1°C .

97 2 12 14

What is the percentage uncertainty in the measurement of the temperature rise

- A 5 B 8 C 1 D 17

4 The resistance of a wire is calculated from the value of the potential difference across it and the value of the current passing through it.

97 2 1 14

Which statement correctly describes how to combine the uncertainties in the potential difference and the current

- A Add together the actual uncertainty in the potential difference and the actual uncertainty in the current
- B Add together the percentage uncertainty in the potential difference and the percentage uncertainty in the current
- C Subtract the actual uncertainty in the current from the actual uncertainty in the potential difference
- D Subtract the percentage uncertainty in the current from the percentage uncertainty in the potential difference

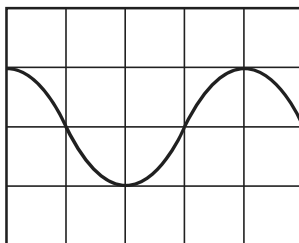
6 A digital calliper is used to measure the length of a wire. The digital calliper reads to the nearest 0.1 mm .

97 2 1 14

What is the correct way to record the length

- A $285 \pm 1\text{ m}$
- B $285 \pm 1\text{ m}$
- C $285 \pm 1.1 \times 10^{-2}\text{ m}$
- D $285 \pm 1.1 \times 10^{-3}\text{ m}$

- 5 The time base is set at 5 ns per division and the gain at 1 V per division. The signal is a sine wave on a cathode ray oscilloscope screen. The signal is produced by an electronic circuit.



What is the frequency of the signal?

- A 2×10^8
 B 2.5×10^2
 C 5×10^7
 D 1×10^8

- 1 A 1 kg mass is taken to Mars and then weighed on a spring balance and on a beam balance. The acceleration due to gravity on Mars is 8 m s^{-2} of its value on Earth.

97/2/11 14

What are the readings on the two balances on Mars? Assume that on Earth $g = 10 \text{ m s}^{-2}$.

	spring balance	beam balance
A	8	8
B	8	1
C	1	8
D	1	1

- 4 A steel wire is stretched in an experiment to determine the Young's modulus of steel. 97/2/11 14

The uncertainties in the measurements are given below.

measurement	uncertainty
load on wire	2
length of wire	2
diameter of wire	1.5
extension	1

What is the percentage uncertainty in the Young's modulus?

- A 1 B 1.8 C 4.7 D 6.2

5 The acceleration of free fall on the moon is one sixth that on earth.

97 2 11 14

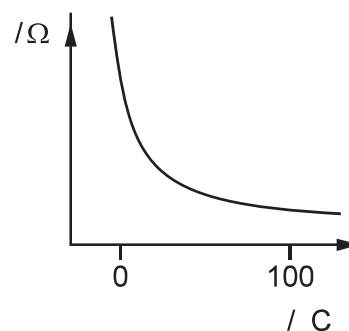
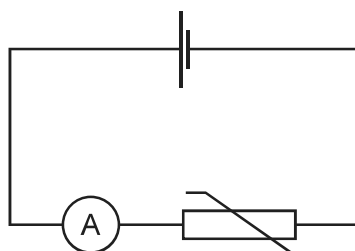
Find the time taken for a stone to fall from rest a distance of 2 m

What is the time taken for a stone to fall from rest a distance of 2 m on the moon

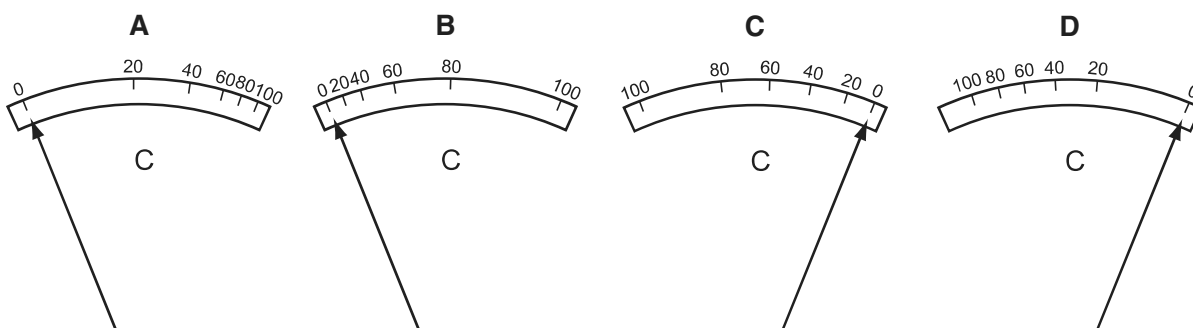
- A $6t$ B $\frac{t}{6}$ C $t\sqrt{6}$ D $\frac{t}{\sqrt{6}}$

In the circuit shown an analogue ammeter is to be recalibrated as a thermometer. The graph shows the resistance of the thermistor changes with temperature.

97 2 1 14

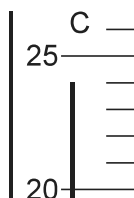


Which diagram could represent the temperature scale on the ammeter



4 The diagram shows a thermometer.

97 2 1 14



What is the correct reading on the thermometer and the uncertainty in this reading

	reading / °C	uncertainty in reading / °C
A	24	1
B	24	5
C	24	2
D	24	5

- 5 The resistance of a resistor is to be determined by measuring the current in the resistor and the potential difference across it. The measurements are

97 2 1 14

The results, with their uncertainties, are

$$I = (2.0 \pm 0.2) \text{ A} \quad V = (15.0 \pm 0.5) \text{ V}$$

The value of the resistance is calculated to be 7.5Ω

What is the uncertainty in this value?

- A 0.5Ω B 5Ω C 7Ω D 1Ω

- 5 The speed of an aeroplane in still air is 250 m s^{-1} . The wind speed from the east at a speed of 85 m s^{-1} is

97 2 1 15

in which direction must the pilot steer the aeroplane in order to fly due north?

- A 2° east of north
B 2° west of north
C 25.2° east of north
D 25.2° west of north

- 4 A student is given a range of instruments to measure the diameter of a wire and is asked to choose the most suitable one to measure the diameter of the wire.

97 2 1 15

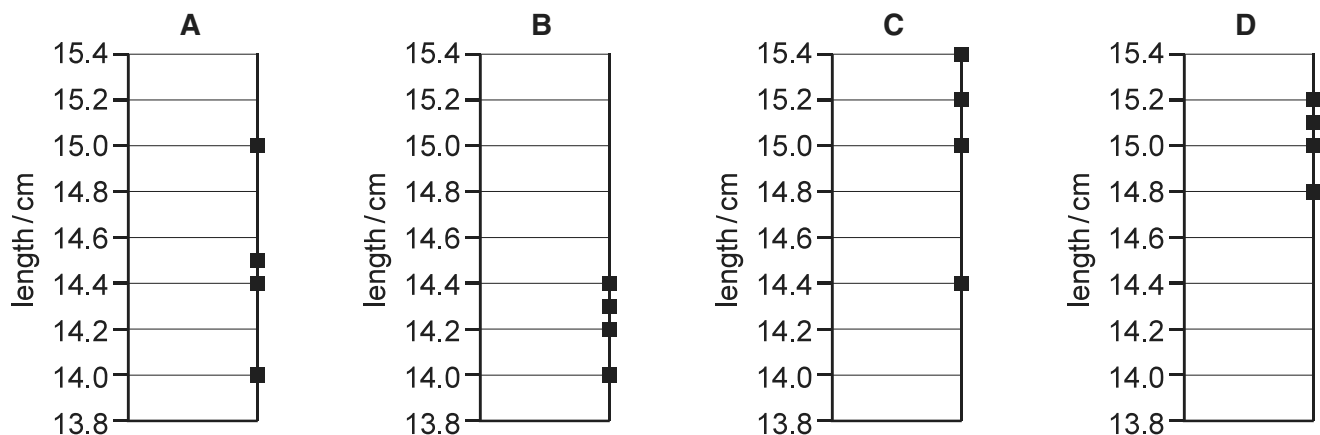
Which pair of instruments would be most suitable for measuring the diameter of the wire?

- A a micrometer and a micrometer
B a metre rule and a micrometer
C a metre rule and vernier callipers
D a micrometer and vernier callipers

- 5 Four different students use a ruler to measure the length of a 15 cm object. Their measurements are recorded on four different cards.

97 2 1 15

Which cards show measurements that are precise but not accurate?



- 6 In a simple electrical circuit the current in a resistor is measured as $2.5 \pm 0.5 \text{ mA}$ and the resistor is marked as having a value of $47 \Omega \pm 2\%$.

97 2 1 15

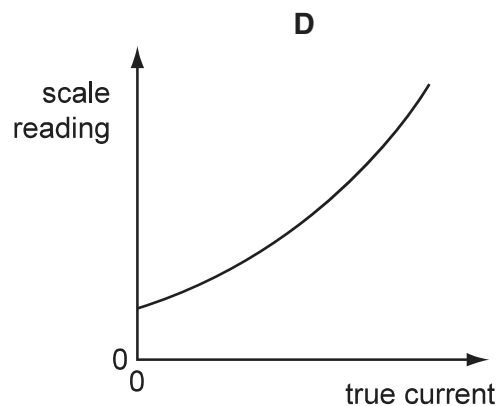
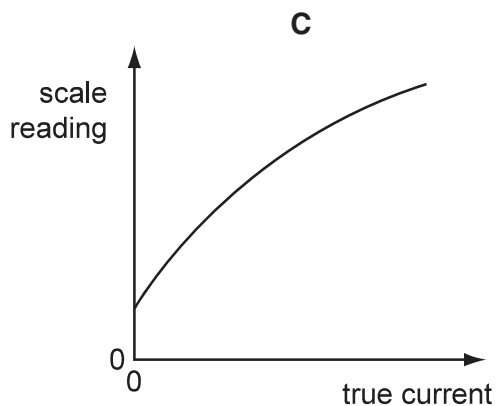
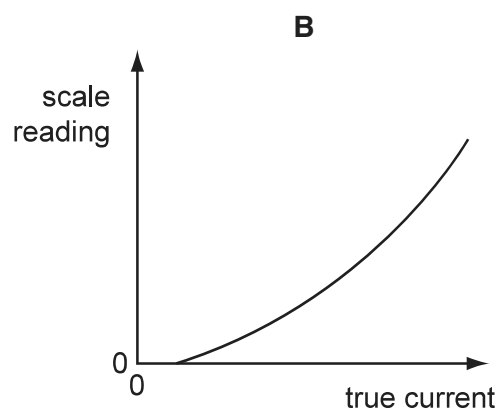
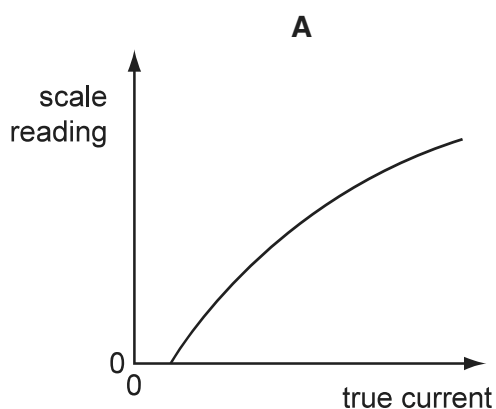
These values are used to calculate the power dissipated in the resistor at about the percentage uncertainty in the value obtained.

- A 2 B 4 C 6 D 8

An analogue ammeter has a pointer which moves over a scale of 0 to 100. The pointer does not return to zero when the current is turned off and the meter becomes less sensitive at higher currents than it is at lower currents.

97 2 12 15

Which diagram best represents the calibration graph needed to obtain an accurate current reading?



- 6 A single sheet of aluminium foil is used to produce a stack of four sheets. The total thickness of the stack of sheets is measured to be $8.2 \text{ mm} \pm 0.2 \text{ mm}$. This measurement is made using a digital caliper with a zero error of -0.2 mm .

97 2 12 15

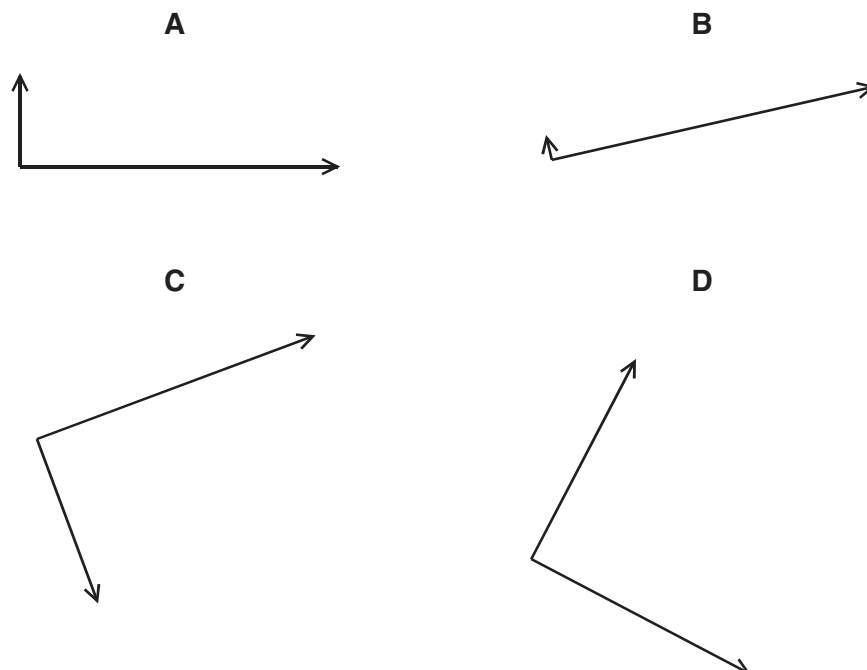
What is the percentage uncertainty in the calculated thickness of a single sheet?

- A 1 B 2 C 4 D 6.7

4 e arrow represents the vector

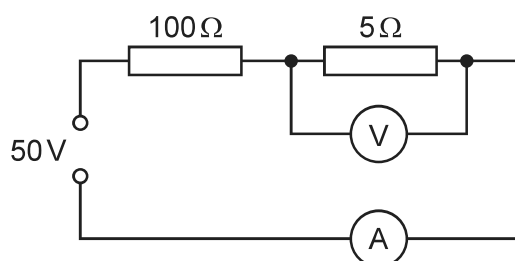
97 2 12 15

which diagram does not represent a vector in a 2D Cartesian coordinate system



5 A battery with an electromotive force of 50 V and negligible internal resistance is connected in series with resistors of resistance $100\ \Omega$ and $5\ \Omega$ as shown

97 2 12 15



The voltmeter measures the potential difference across the $5\ \Omega$ resistor and the ammeter measures the current in the circuit

What are suitable ranges for the ammeter and for the voltmeter

	ammeter range A	voltmeter range
A	1	1
B	1	1
C	1	1
D	1	1

- 7 In an experiment to determine the acceleration of free fall a ball bearing is released from an electromagnet. When the current to the electromagnet is switched off, the ball starts and the bearing falls. After falling a distance h the bearing strikes a switch to stop the clock. The clock measures the time t for the ball to fall.

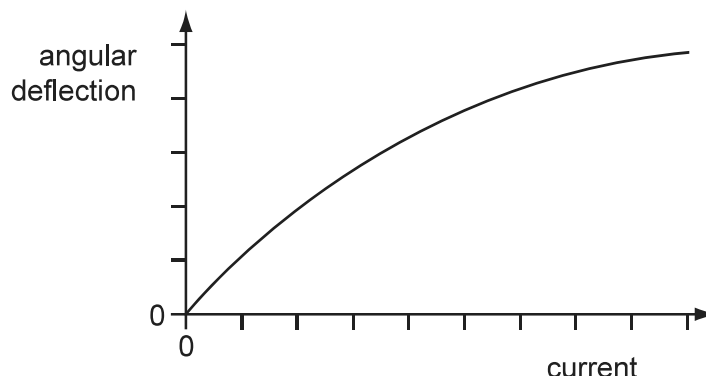
97 2 12 15

Systematic errors cause the time to be measured incorrectly. Which error must cause g to be measured greater than 9.81 ms^{-2} ?

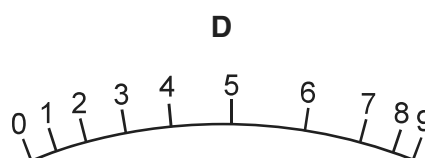
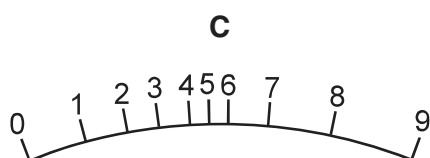
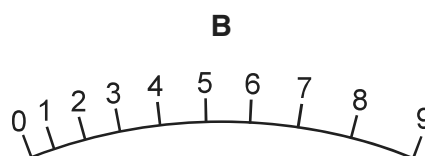
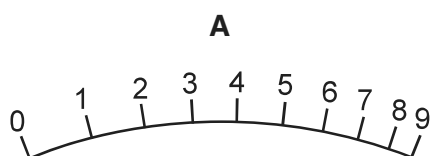
- A The measured time is smaller than the actual time. This measurement is correct.
- B The measured time is smaller than the actual time. This measurement is larger than the actual time.
- C The measured time is larger than the actual time. This measurement is larger than the actual time.
- D The measurement is correct and the measured time is smaller than the actual time.

- 5 The angular deflection of the needle of an ammeter varies with the current in the ammeter as shown in the graph.

97 2 11 15



Which diagram could represent the appearance of the scale on this meter?



- 6 The strain energy of a spring is determined from its spring constant and the tension in the spring. The following table shows the values of the spring constant and the tension used in the calculation. Using the equation on page 97, calculate the percentage uncertainty in the calculated value of the strain energy.

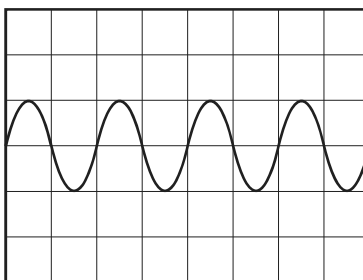
$$\frac{1}{2} k x^2$$

The spring constant is 1.2 N m^{-1} and the tension is 5.2 N .

What is the percentage uncertainty in the calculated value of the strain energy?

- A 6% B 1% C 16% D 2%
- 4 A microphone produces sound waves of frequency 500 Hz. The waves are detected by a microphone and the signal is shown on an oscilloscope.

97 2 11 15



What is the time base setting on the oscilloscope?

- A 1 ms cm^{-1} B 1 ms cm^{-1} C 1 ms cm^{-1} D 1 ms cm^{-1}