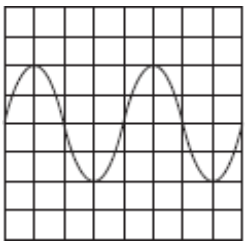
Measurement Techniques

TOPIC QUESTIONS (1)

Level	AS Level
Subject	Physics
Exam Board	CIE
Paper Type	Multiple Choice

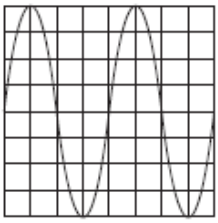
Time Allowed : 60min

1. The following trace is seen on the screen of a cathode-rayoscilloscope.

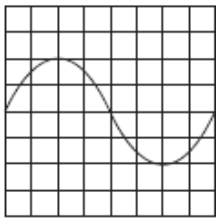


The setting of the time base is then changed from 10 ms cm^{-1} to20 ms $cm^{-1}$and the Y-sensitivity is unaltered. Which trace is now seen on the screen?

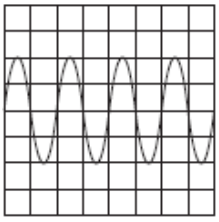
A



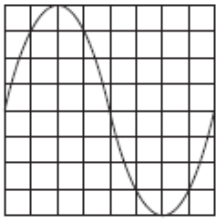
B



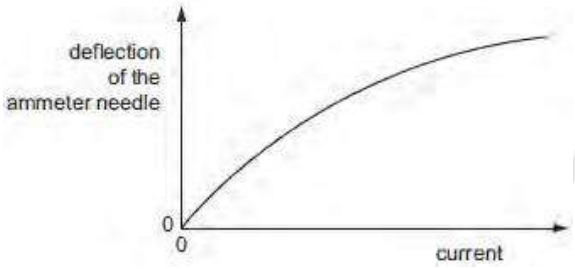
C



D

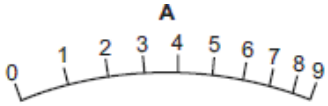


2. The deflection of the needle of an ammeter varies with the currentpassing through the ammeter as shown in the graph.

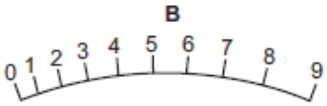


Which diagram could represent the appearance of the scale of thismeter?

A



B



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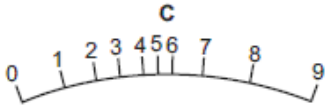
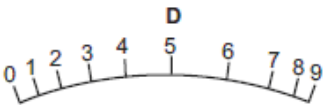
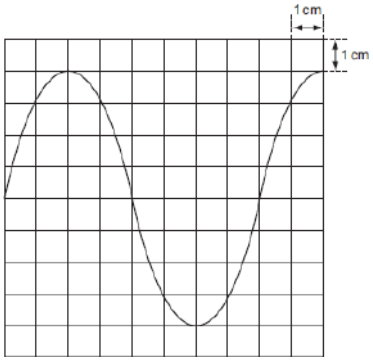


D



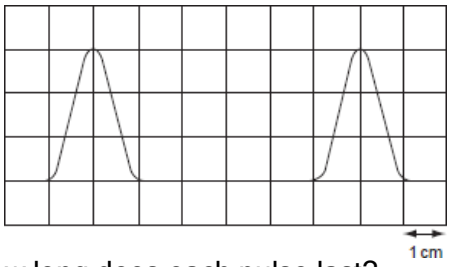
3. When a 12 V 50 Hz supply is connected to the Y-terminals of anoscilloscope, the trace in the diagram is obtained.



What is the setting of the time-base control?

A 2.0 ms cm^{-1} B 2.5 ms cm^{-1} C 5 ms cm^{-1} D 20 ms cm^{-1}

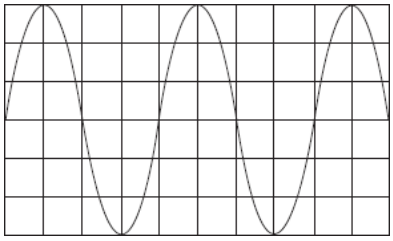
4. The diagram shows two pulses on the screen of a cathode ray oscilloscope. A grid of 1 cm squares covers the screen. The timebase setting is 1 μs cm^{-1}.



How long does each pulse last?

A 2 μs B 3 μs C 4 μs D 6 μs

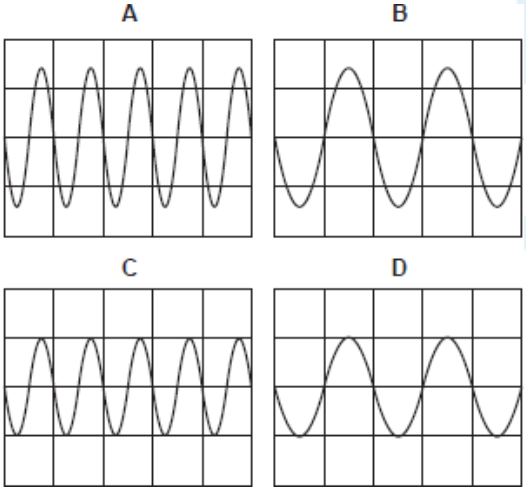
5. The cathode-ray oscilloscope (c.r.o.) display shows the waveform produced by an electronic circuit. The c.r.o. time-baseis set at 10 ms per division.



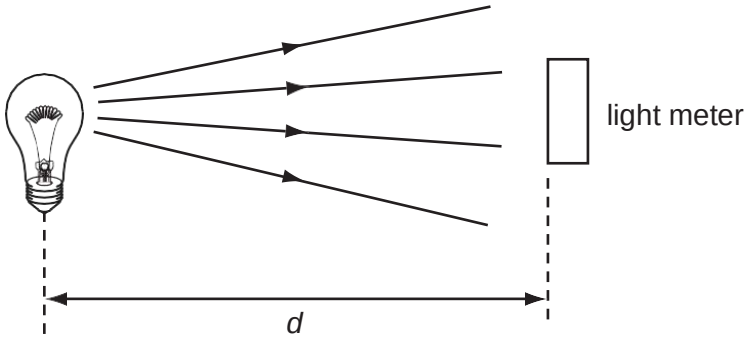
What is the period of the signal shown?

A 20 ms B 30 ms C 40 ms D 80 ms

6. The Y-input terminals of a cathode-ray oscilloscope (c.r.o.) are connected to a supply of peak value 5.0 V and of frequency 50 Hz. The time-base is set at 10 ms per division and the Y-gainat 5.0 V per division. Which trace is obtained?

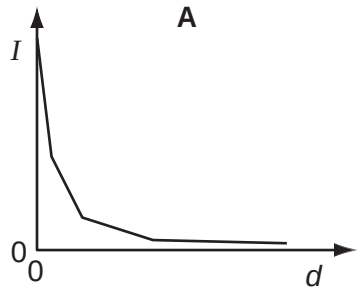


7. A light meter measures the intensity I of the light falling on it. Theory suggests that this varies asthe inverse square of the distance d.

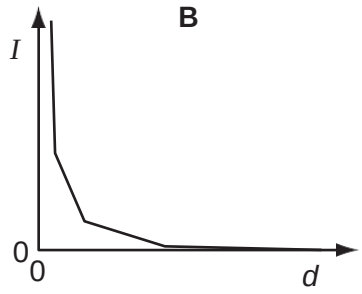


Which graph of the results supports this theory?

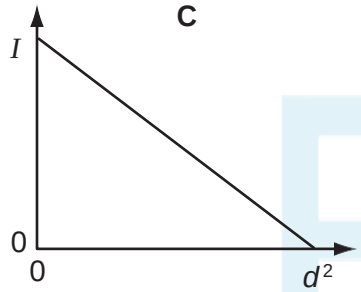
A



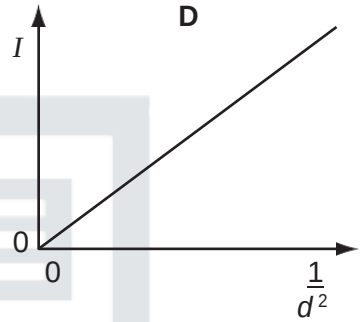
B



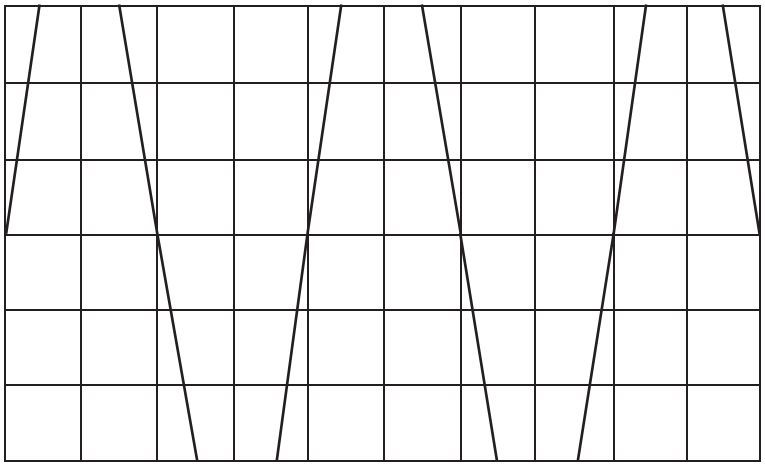
C



D



8. The cathode-ray oscilloscope (c.r.o.) display shows the waveform produced by an electronic circuit. The c.r.o. time-base is set at 10 ms per division.



What is the period of the signal shown?

A 20 ms B 30 ms C 40 ms D 80 ms

9. The resistance R of an unknown resistor is found by measuring the potential difference V across the resistor and the current I through it and using the equation $R = \frac{V}{I}$. The voltmeter reading has a 3 % uncertainty and the ammeter reading has a 2 % uncertainty.

What is the uncertainty in the calculated resistance?

A 1.5 % B 3 % C 5 % D 6 %

10. An experiment is done to measure the acceleration of free fall of a body from rest.

Which measurements are needed?

A the height of fall and the time of fall

B the height of fall and the weight of the body

C the mass of the body and the height of fall

D the mass of the body and the time of fall

11. A steel rule can be read to the nearest millimeter. It is used to measure the length of a bar whosetrue length is 895 mm. Repeated measurements give the following readings.

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

12. 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.

mass = (25.0 ± 0.1) g

length = (5.00 ± 0.01) cm

breadth = (2.00 ± 0.01) cm

height = (1.00 ± 0.01) cm

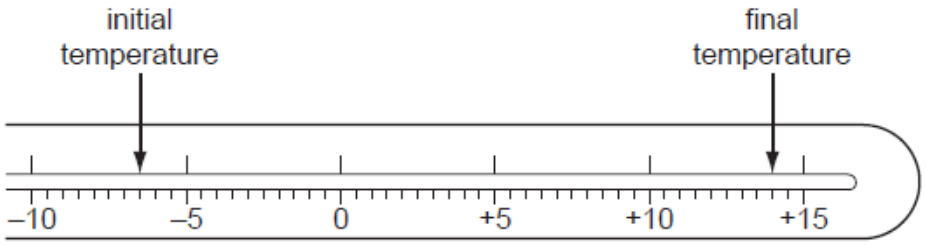
The density is calculated to be 2.50 g

cm^{-3}.What is the uncertainty in this

result?

A ± 0.01 g cm^{-3} B ± 0.02 g cm^{-3} C ± 0.05 g cm^{-3} D ± 0.13 g cm^{-3}

13. The diagram shows the stem of a Celsius thermometer, marked to show initial and final temperature values.



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

A 14 °C **B** 20.5 °C **C** 21 °C **D** 22.0 °C

14. The density of the material of a coil of thin wire is to be found.

Which set of instruments could be used to do this most accurately?A

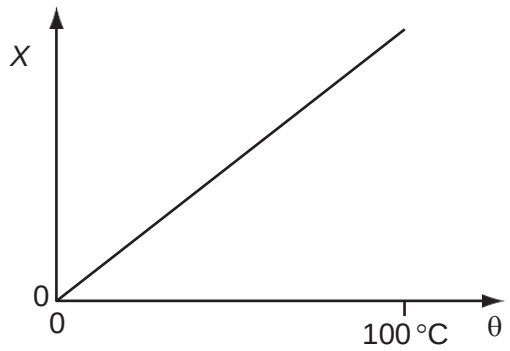
metre rule, protractor, spring balance

B micrometer, metre rule, top-pan balance

C stopwatch, newton-meter, vernier calipers

D tape measure, vernier calipers, lever balance

15. A quantity *X* varies with temperature θ as shown.



θ is determined from the corresponding values of *X* by using this graph.
X is measured with a percentage uncertainty of ±1 % of its value at all temperatures.

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.

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

Which statement is correct?

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

17. A student is given a reel of wire of diameter less than 0.2 mm and is asked to find the density of the metal.

Which pair of instruments would be most suitable for finding the volume of the wire?

A balance and micrometer

B metre rule and micrometer

C metre rule and vernier calipers

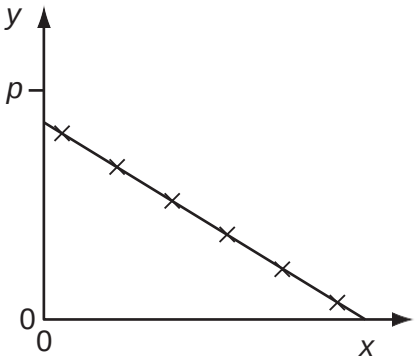
D micrometer and vernier calipers

18. Variables x and y are related by the equation $y = p - qx$ where p and q are constants.

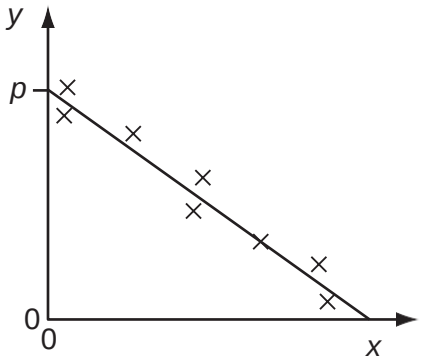
Values of x and y are measured experimentally. The results contain a systematic error.

Which graph best represents these results?

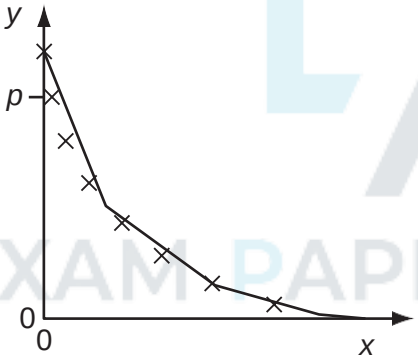
A



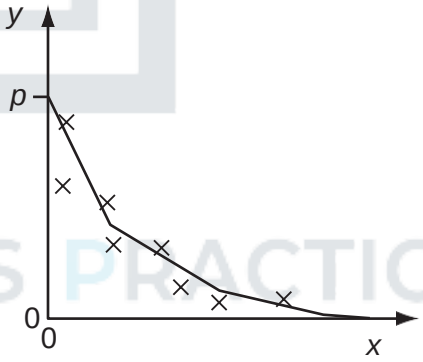
B



C



D



19. The speed of a car is calculated from measurements of the distance travelled and the time taken.

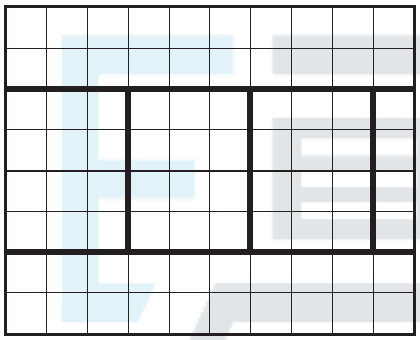
The distance is measured as 200 m, with an uncertainty of ±2 m.

The time is measured as 10.0 s, with an uncertainty of ± 0.2 s.

What is the percentage uncertainty in the calculated speed?

A ±0.5 % **B** ±1 % **C** ±2 % **D** ±3 %

20. A cathode-ray oscilloscope displays a square wave, as shown in the diagram.



. The time-base setting is 0.20 ms per division.What is

the frequency of the square wave?

A 8.3 Hz B 830 Hz C 1300 Hz D 1700 Hz

21. The resistance *R* of a resistor is determined by measuring the potential difference *V* across it andthe current I in it. The value of *R* is then calculated using the equation

$$R = \frac{V}{I}.$$

The values measured are $V = 1.00 \pm 0.05$ V and $I = 0.50 \pm 0.01$ A.

What is the percentage uncertainty in the value of *R*?

A 2.5 % B 3.0 % C 7.0 % D 10.0 %

22. Four students each made a series of measurements of the acceleration of free fall g. The table shows the results obtained.

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

	g / m s^{-2}			
A	9.81	9.79	9.84	9.83
B	9.81	10.12	9.89	8.94
C	9.45	9.21	8.99	8.76
D	8.45	8.46	8.50	8.41

23. A series of measurements of the acceleration of free fall g is shown in the table.

Which set of results is precise but not accurate?

	g / m s^{-2}				
A	9.81	9.79	9.84	9.83	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	8.50	8.41	8.47

24. A mass m has acceleration a. It moves through a distance s in time t. The power used in accelerating the mass is equal to the product of force and velocity. The percentage uncertainties are

0.1 % in m,

1 % in a,

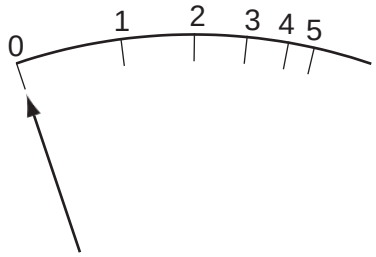
1.5 % in s,

0.5 % in t.

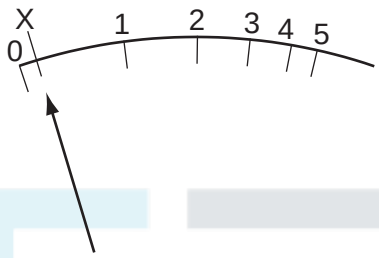
What is the percentage uncertainty in the average power?

A 2.1 % B 2.6 % C 3.1 % D 4.1 %

25. The diagram shows the graduations of a correctly calibrated ammeter. When the current is zero,the pointer is at 0.

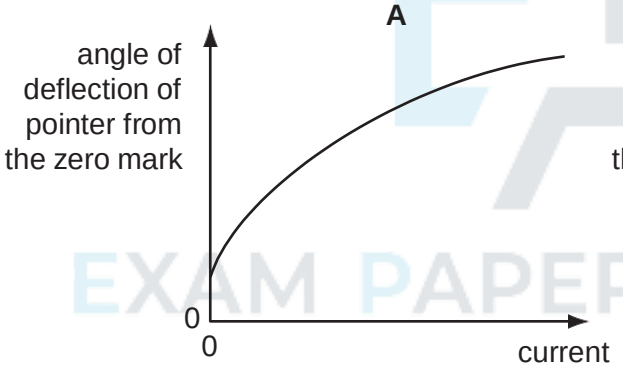


The ammeter is accidentally readjusted so that when the current is zero, the pointer is at X.

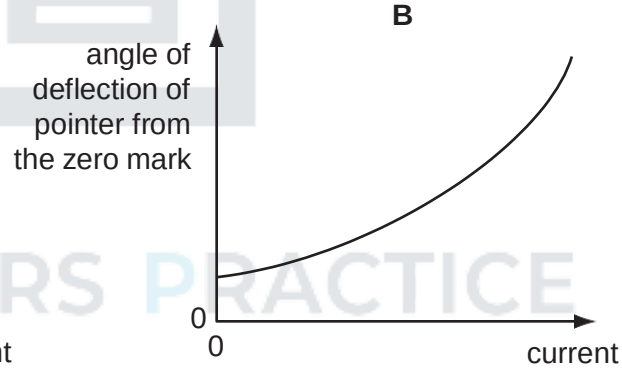


Which calibration graph best represents the response of the readjusted ammeter?

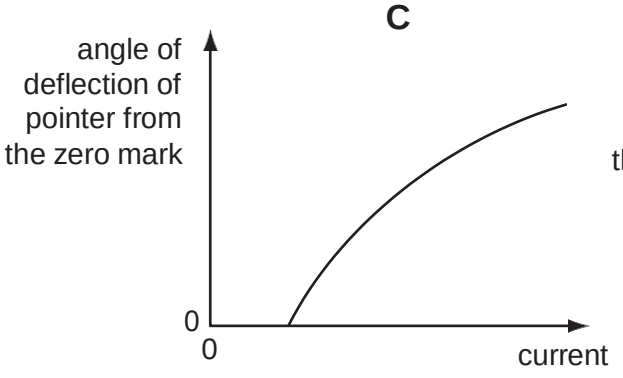
A



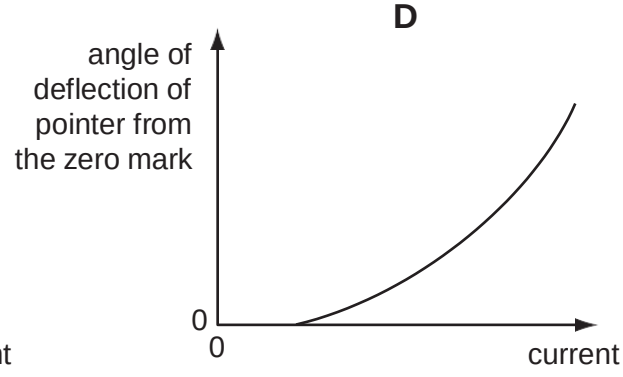
B



C

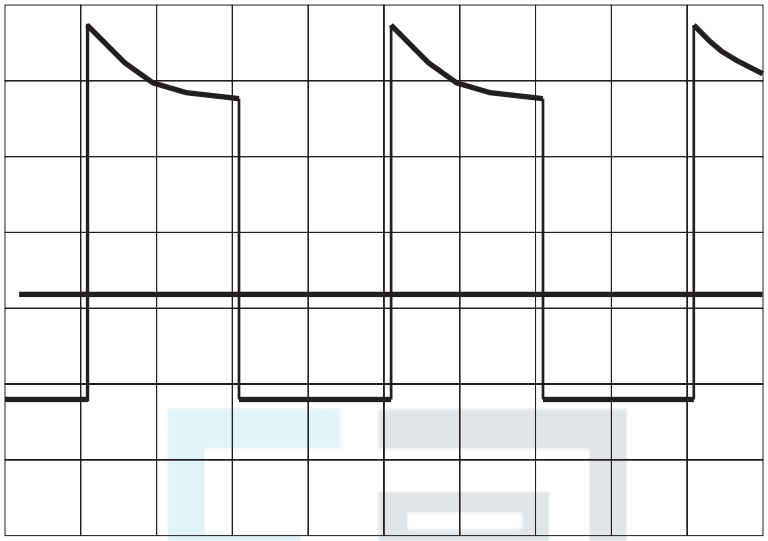


D



26. An oscilloscope display consists of two separate traces, a waveform and a long horizontal line. The horizontal line may be taken as the zero level.

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

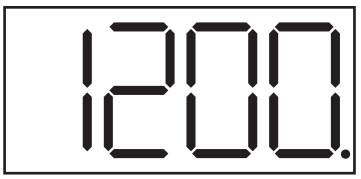


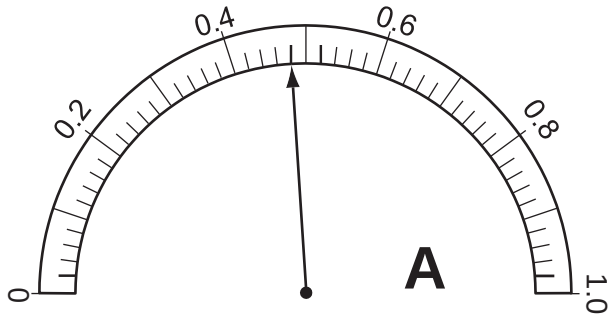
What are the period and the peak positive voltage of the waveform in the diagram?

	period / ms	peak positive voltage / mV
A	5	17
B	5	25
C	10	17
D	10	25

27. The resistance of an electrical component is measured. The following meter readings are obtained.

mV





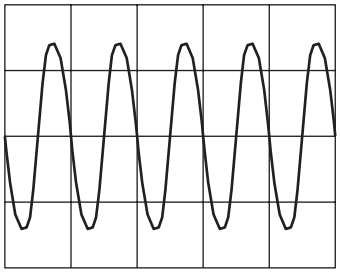
What is the resistance?

A 2.5 Ω B 2.7 Ω C 2500 Ω D 2700 Ω

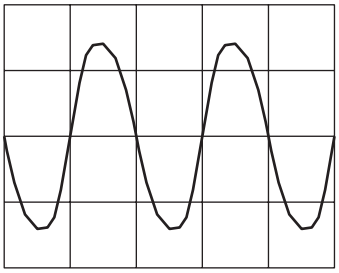
28. The Y-input terminals of a cathode-ray oscilloscope (c.r.o.) are connected to a supply of peak value 5.0 V and of frequency 50 Hz. The time-base is set at 10 ms per division and the Y-gain at V per division.

Which trace is obtained?

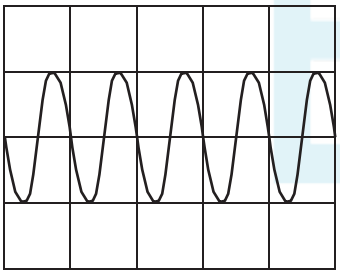
A



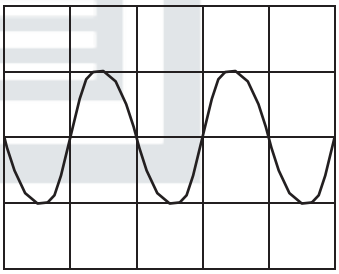
B



C



D



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

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.

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

The current in the wire is 1.0 ± 0.2 A and the potential difference across the wire is 8.0 ± 0.4 V.What is the resistance of the wire and its uncertainty?

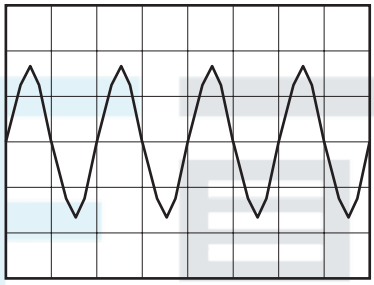
A (8.0 ± 0.2) Ω

B (8.0 ± 0.6) Ω

C (8 ± 1) Ω

D (8 ± 2) Ω

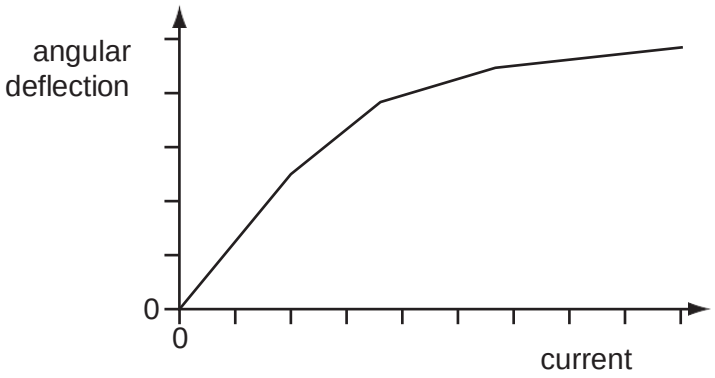
31. A whale produces sound waves of frequency 5 Hz. The waves are detected by a microphone and displayed on an oscilloscope.



What is the time-base setting on the oscilloscope?

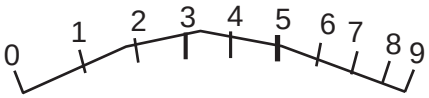
A 0.1 ms div^{-1} B 1 ms div^{-1} C 10 ms div^{-1} D 100 ms div^{-1}

32. The angular deflection of the needle of an ammeter varies with the current in the ammeter asshown in the graph.

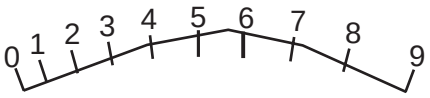


Which diagram could represent the appearance of the scale on this meter?

A

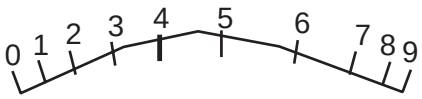


B



C

D



33. The strain energy W of a spring is determined from its spring constant k and extension x. Thespring obeys Hooke's law and the value of W is calculated using the equation shown.

$$W = \frac{1}{2}kx^2$$

The spring constant is $100 \pm 2\,\text{N m}^{-1}$ and the extension is $0.050 \pm 0.002\,\text{m}$.

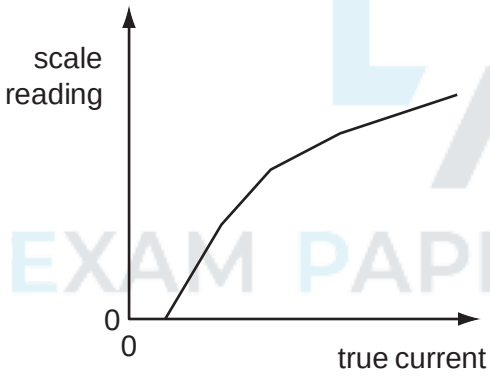
What is the percentage uncertainty in the calculated value of W?

A 6% B 10% C 16% D 32%

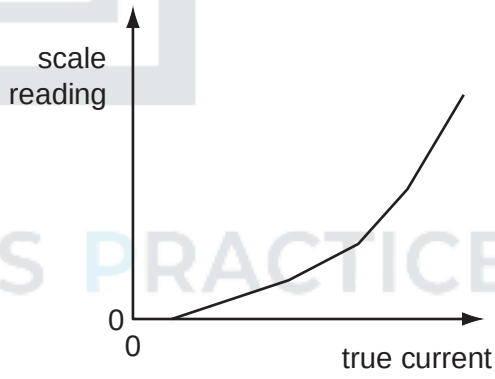
34. An analogue ammeter has a pointer which moves over a scale. Following prolonged use, the pointer does not return fully to zero when the current is turned off and the meter has become less sensitive at higher currents than it is at lower currents.

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

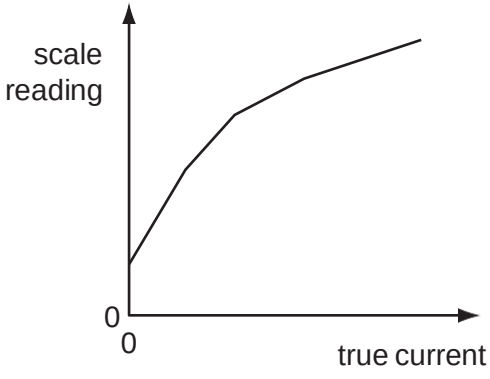
A



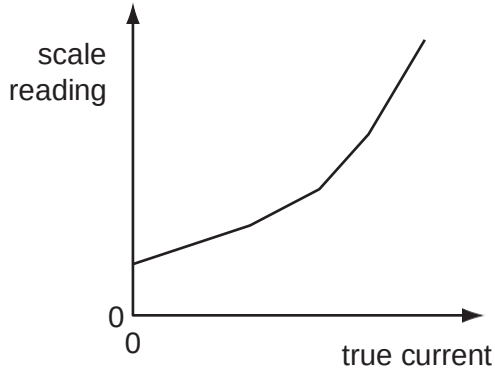
B



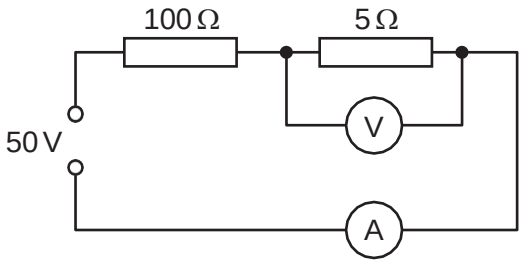
C



D



35. A power supply of electromotive force (e.m.f.) 50 V and negligible internal resistance is connected in series with resistors of resistance 100 Ω and 5 Ω, as shown.



A voltmeter measures the potential difference (p.d.) across the 5 Ω resistor and an ammeter measures the current in the circuit.

What are suitable ranges for the ammeter and for the voltmeter?

	ammeter range / A	voltmeter range / V
A	0 – 0.1	0 – 1
B	0 – 0.1	0 – 3
C	0 – 1.0	0 – 1
D	0 – 1.0	0 – 3

36. Which expression involving base units is equivalent to the volt?

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

37. 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.

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

38. 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.

mass = (25.0 + 0.1) g
length = (5.00 + 0.01) cm
breadth = (2.00 + 0.01) cm
height = (1.00 + 0.01) cm

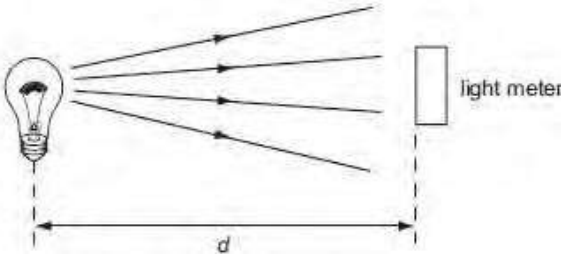
The density is calculated to be 2.50 g cm^{-3}. What is the uncertainty in this result?

A + 0.01 g cm^{-3} B + 0.02 g cm^{-3}
C + 0.05 g cm^{-3} D + 0.13 g cm^{-3}

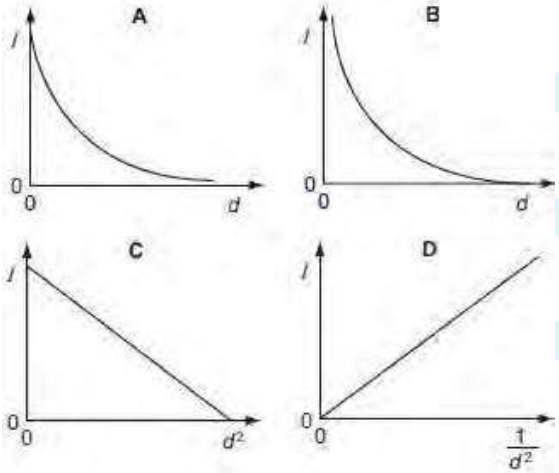
39. For which quantity is the magnitude a reasonable estimate?

A frequency of a radio wave 500 pHz B mass of an atom 500 μg
C the Young modulus of a metal 500 kPa D wavelength of green light 500 nm

40. A light meter measures the intensity I of the light falling on it. Theory suggests that this varies as the inverse square of the distance d.



Which graph of the results supports this theory?



41. A single sheet of aluminium foil is folded twice to produce a stack of four sheets. The total thickness of the stack of sheets is measured to be (0.80 ± 0.02) mm. This measurement is made using a digital caliper with a zero error of (−0.20 ± 0.02) mm.

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

A 1.0% B 2.0% C 4.0% D 6.7%

42. In an experiment to determine the acceleration of free fall *g*, a ball bearing is held by an electromagnet. When the current to the electromagnet is switched off, a clock starts and the ball bearing falls. After falling a distance *h*, the ball bearing strikes a switch to stop the clock which measures the time *t* of the fall.

If systematic errors cause *t* and *h* to be measured incorrectly, which error must cause *g* to appear greater than 9.81 m s^{-2}?

a. *h* measured as being smaller than it actually is and *t* is measured correctly

b. *h* measured as being smaller than it actually is and *t* measured as being larger than it actually is

c. *h* measured as being larger than it actually is and *t* measured as being larger than it actually is

d. *h* is measured correctly and *t* measured as being smaller than it actually is

43. A student is given a reel of wire of diameter less than 0.2 mm and is asked to find the density of the metal.

Which pair of instruments would be most suitable for finding the volume of the wire?

A balance and micrometer

B metre rule and micrometer

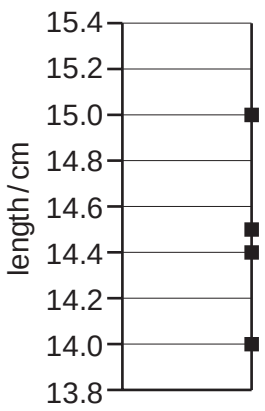
C metre rule and vernier calipers

D micrometer and vernier calipers

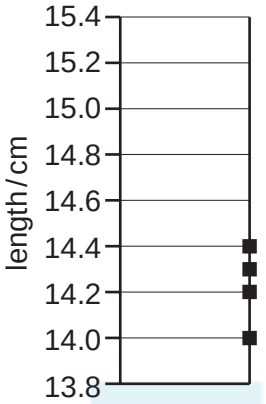
44. Four different students use a ruler to measure the length of a 15.0 cm pencil. Their measurements are recorded on four different charts.

Which chart shows measurements that are precise but not accurate?

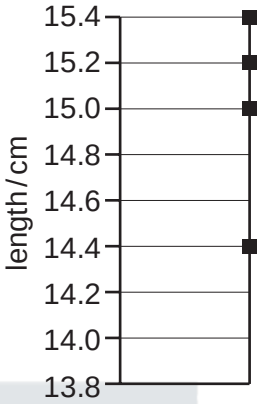
A



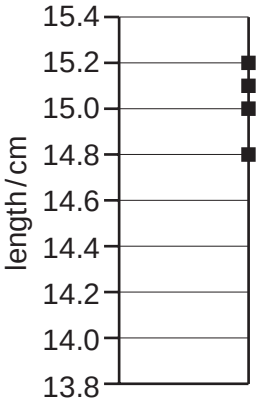
B



C



D



45. In a simple electrical circuit, the current in a resistor is measured as (2.50 ± 0.05) mA. Theresistor is marked as having a value of $4.7\,\Omega \pm 2\,\%$.

    If these values were used to calculate the power dissipated in the resistor, what would be the percentage uncertainty in the value obtained?

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

46. A thermometer can be read to an accuracy of ± 0.5 °C. This thermometer is used to measure a temperature rise from 40 °C to 100 °C.

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

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

47. The resistance of a lamp is calculated from the value of the potential difference (p.d.) across itand the value of the current passing through it.

    Which statement correctly describes how to combine the uncertainties in the p.d. and in the current?

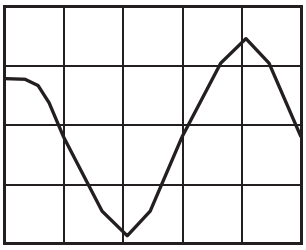
    A Add together the actual uncertainty in the p.d. and the actual uncertainty in the current.

    B Add together the percentage uncertainty in the p.d. and the percentage uncertainty in thecurrent.

    C Subtract the actual uncertainty in the current from the actual uncertainty in the p.d.

    D Subtract the percentage uncertainty in the current from the percentage uncertainty in the p.d.

48. The display on a cathode-ray oscilloscope shows the signal produced by an electronic circuit. The time-base is set at 5.0 ns per division and the Y-gain at 10 V per division.



What is the frequency of the signal?

A 2.0×10^{-8} Hz

B 2.5×10^{-2} Hz

C 5.0×10^{7} Hz

D 3.1×10^{8} Hz

49. A digital caliper is used to measure the 28.50 mm width of a plastic ruler. The digital caliper reads to the nearest 0.01 mm.

What is the correct way to record this reading?

A 0.02850 ± 0.01 m

B 0.0285 ± 0.001 m

C $(2.850 \pm 0.001) \times 10^{-2}$ m

D $(2.85 \pm 0.001) \times 10^{-3}$ m

50. A cathode-ray oscilloscope (c.r.o.) displays a waveform corresponding to a sound wave.

In order to determine the frequency of the sound wave, which part of the displayed waveform must be measured and which c.r.o. setting must be known?

	on-screen measurement	c.r.o. setti
A	amplitude	time-base
B	amplitude	Y-gain
C	wavelength	time-base
D	wavelength	Y-gain