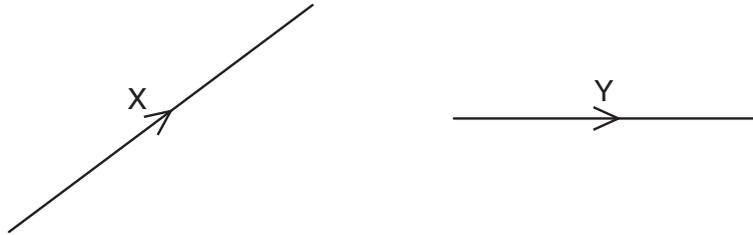


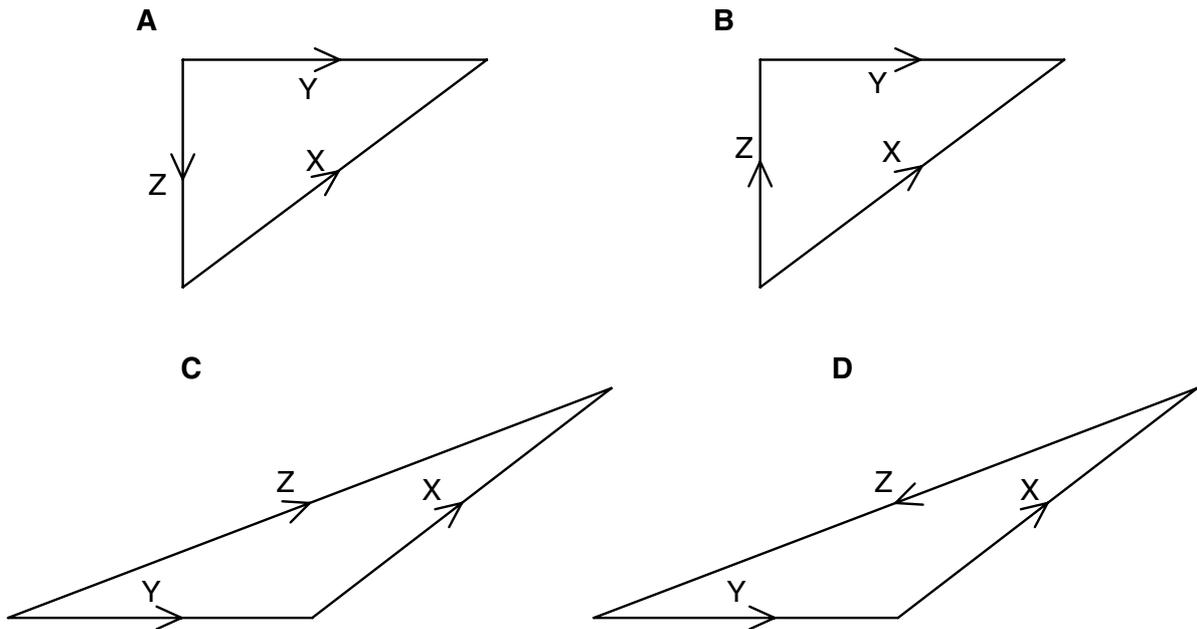
1 Which of the following pairs of units are both SI base units?

- A ampere, degree celsius
- B ampere, kelvin
- C coulomb, degree celsius
- D coulomb, kelvin

2 The diagram shows two vectors X and Y.



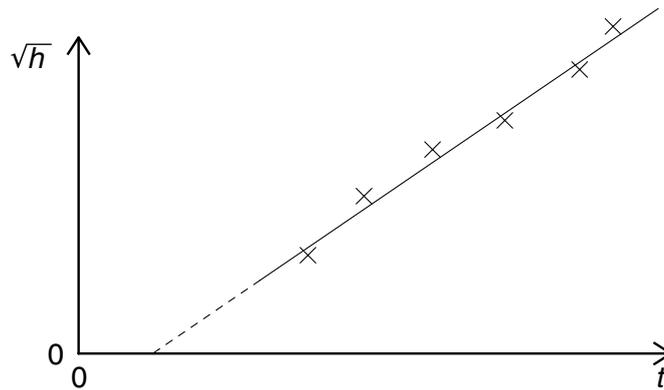
In which vector triangle does the vector Z show the magnitude and direction of vector $X - Y$?



3 Which formula could be correct for the speed v of ocean waves in terms of the density ρ of sea-water, the acceleration of free fall g , the depth h of the ocean and the wavelength λ ?

- A $v = \sqrt{g\lambda}$
- B $v = \sqrt{\frac{g}{h}}$
- C $v = \sqrt{\rho gh}$
- D $v = \sqrt{\frac{g}{\rho}}$

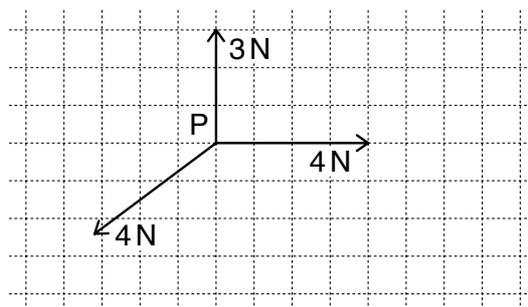
- 4 A student measures the time t for a ball to fall from rest through a vertical distance h . Knowing that the equation $h = \frac{1}{2}gt^2$ applies, the student plots the graph shown.



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 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%

- 6 The vector diagram shows three coplanar forces acting on an object at P.



The magnitude of the resultant of these three forces is 1 N.

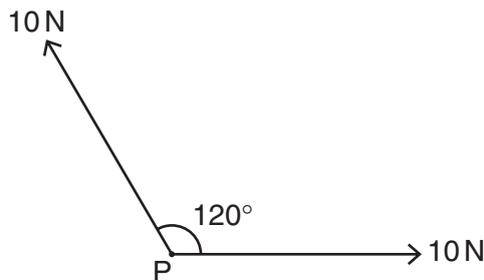
What is the direction of this resultant?

- A ↓ B ↘ C ↙ D ↗

- 7 Which of the following is a scalar quantity?
- A acceleration
 B mass
 C momentum
 D velocity
- 8 The unit of work, the joule, may be defined as the work done when the point of application of a force of 1 newton is moved a distance of 1 metre in the direction of the force.

Express the joule in terms of the base units of mass, length and time, the kg, m and s.

- A $\text{kg m}^{-1} \text{s}^2$ B $\text{kg m}^2 \text{s}^{-2}$ C $\text{kg m}^2 \text{s}^{-1}$ D kg s^{-2}
- 9 Two forces, each of 10 N, act at a point P as shown in the diagram. The angle between the directions of the forces is 120° .



What is the magnitude of the resultant force?

- A 5 N B 10 N C 17 N D 20 N
- 10 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
- 11 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}

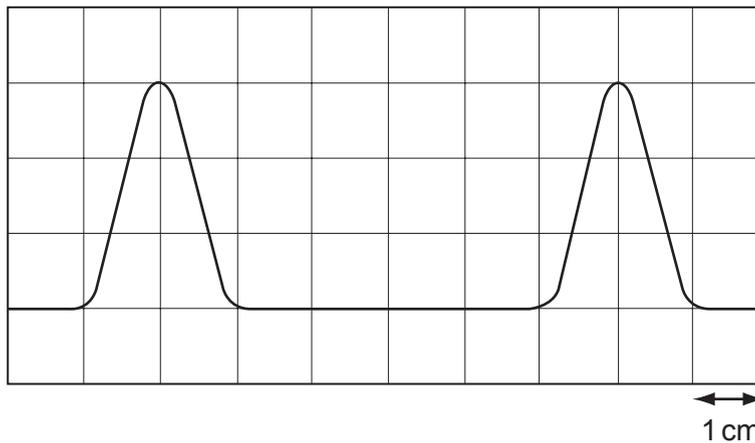
- 12 A steel rule can be read to the nearest millimetre. It is used to measure the length of a bar whose true length is 895 mm. Repeated measurements give the following readings.

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

- 13 The diagram shows two pulses on the screen of a cathode ray oscilloscope. A grid of 1 cm squares covers the screen. The time base setting is $1 \mu\text{s cm}^{-1}$.



How long does each pulse last?

- A** $2 \mu\text{s}$ **B** $3 \mu\text{s}$ **C** $4 \mu\text{s}$ **D** $6 \mu\text{s}$
- 14 In an experiment, a radio-controlled car takes $2.50 \pm 0.05 \text{ s}$ to travel $40.0 \pm 0.1 \text{ m}$.

What is the car's average speed and the uncertainty in this value?

- A** $16 \pm 1 \text{ m s}^{-1}$
B $16.0 \pm 0.2 \text{ m s}^{-1}$
C $16.0 \pm 0.4 \text{ m s}^{-1}$
D $16.00 \pm 0.36 \text{ m s}^{-1}$

15 Which pair contains one vector and one scalar quantity?

- A displacement : acceleration
- B force : kinetic energy
- C momentum : velocity
- D power : speed

16 Which of the following could be measured in the same units as force?

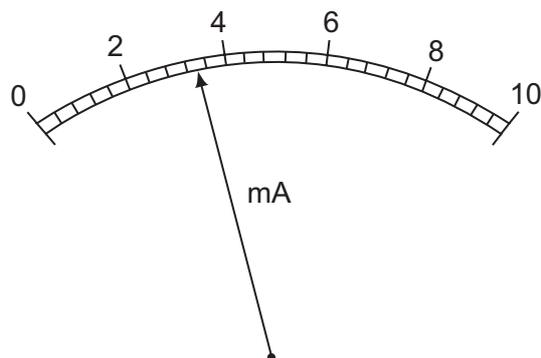
- A energy / distance
- B energy x distance
- C energy / time
- D momentum x distance

17 The notation μs is used as an abbreviation for a certain unit of time.

What is the name and value of this unit?

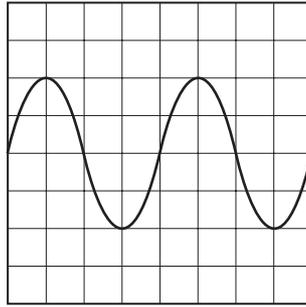
	name	value
A	microsecond	10^{-6} s
B	microsecond	10^{-3} s
C	millisecond	10^{-6} s
D	millisecond	10^{-3} s

18 What is the reading shown on this milliammeter?



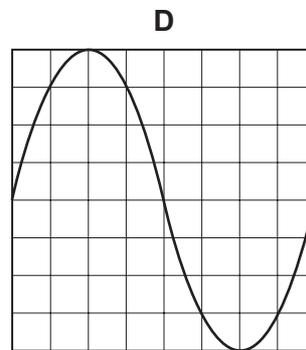
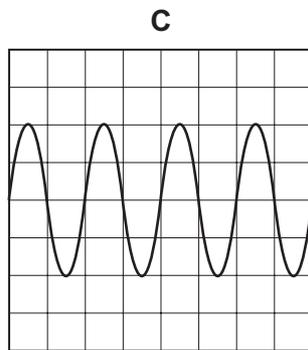
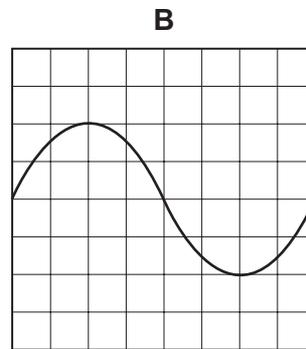
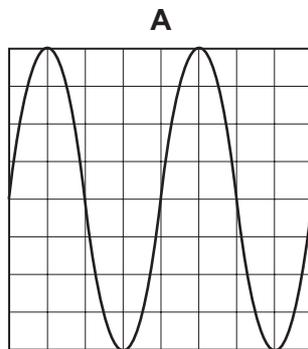
- A 2.35 mA
- B 2.7 mA
- C 3.4 mA
- D 3.7 mA

- 19 The following trace is seen on the screen of a cathode-ray oscilloscope.



The setting of the time base is then changed from 10 ms cm^{-1} to 20 ms cm^{-1} and the Y-sensitivity is unaltered.

Which trace is now seen on the screen?



- 20 In a simple electrical circuit, the current in a resistor is measured as $(2.50 \pm 0.05) \text{ mA}$. The resistor 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%

- 21 Decimal sub-multiples and multiples of units are indicated using a prefix to the unit. For example, the prefix milli (m) represents 10^{-3} .

Which of the following gives the sub-multiples or multiples represented by pico (p) and giga (G)?

	pico (p)	giga (G)
A	10^{-9}	10^9
B	10^{-9}	10^{12}
C	10^{-12}	10^9
D	10^{-12}	10^{12}

- 22 A metal sphere of radius r is dropped into a tank of water. As it sinks at speed v , it experiences a drag force F given by $F = kr v$, where k is a constant.

What are the SI base units of k ?

- A** $\text{kg m}^2 \text{s}^{-1}$ **B** $\text{kg m}^{-2} \text{s}^{-2}$ **C** $\text{kg m}^{-1} \text{s}^{-1}$ **D** kg m s^{-2}
- 23 An Olympic athlete of mass 80 kg competes in a 100 m race.
- What is the best estimate of his mean kinetic energy during the race?
- A** $4 \times 10^2 \text{ J}$ **B** $4 \times 10^3 \text{ J}$ **C** $4 \times 10^4 \text{ J}$ **D** $4 \times 10^5 \text{ J}$

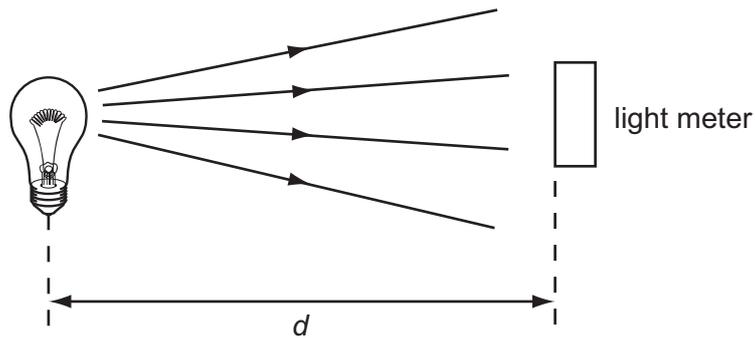
- 24 Which pair includes a vector quantity and a scalar quantity?

- A** displacement; acceleration
B force; kinetic energy
C power; speed
D work; potential energy

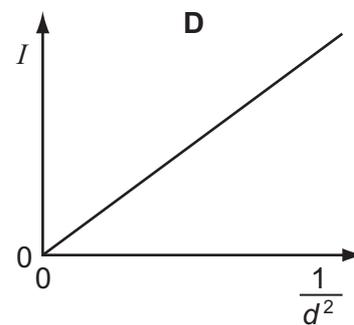
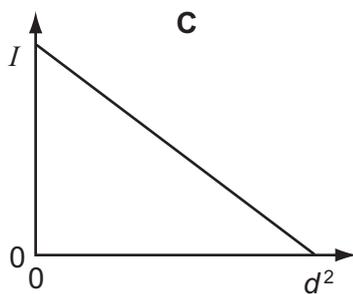
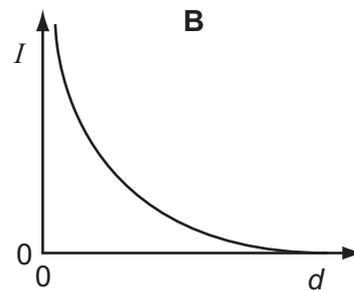
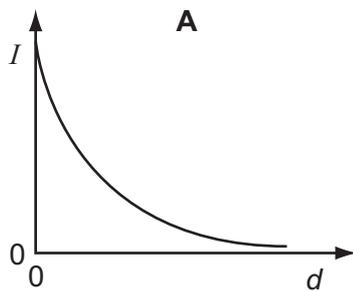
- 25 For which quantity is the magnitude a reasonable estimate?

- 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

- 26 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?



- 27 The following physical quantities can be either positive or negative.

s : displacement of a particle along a straight line

θ : temperature on the Celsius scale

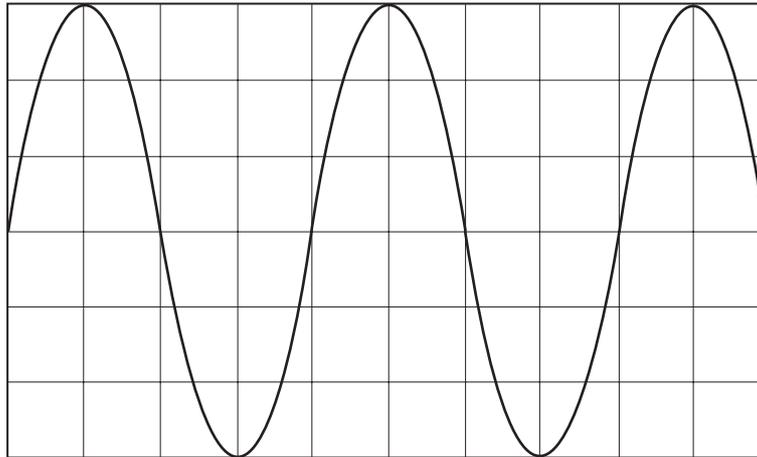
q : electric charge

V : readings on a digital voltmeter

Which of these quantities are vectors?

- A** s, θ, q, V
B s, q, V
C θ, V
D s only

- 28 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
- 29 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%
- 30 Which is a pair of SI base units?

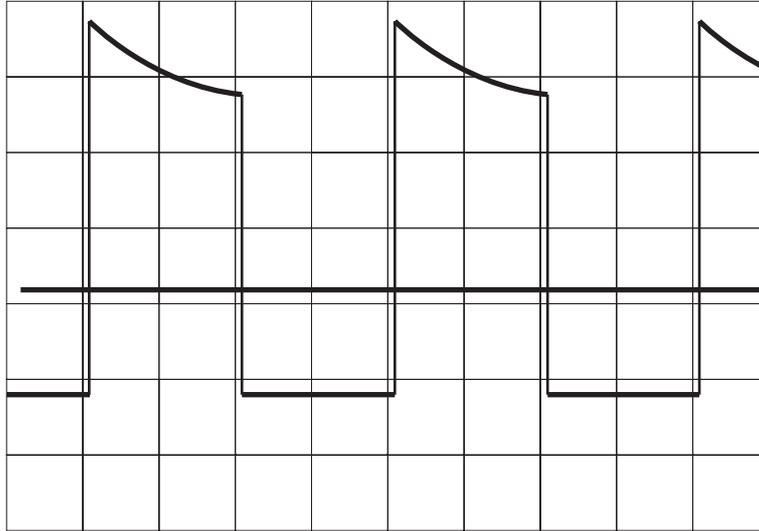
A	ampere	joule
B	coulomb	second
C	kilogram	kelvin
D	metre	newton

- 31 What is the ratio $\frac{1\mu\text{m}}{1\text{Gm}}$?
- A** 10^{-3} **B** 10^{-9} **C** 10^{-12} **D** 10^{-15}
- 32 Which formula could be correct for the speed v of ocean waves in terms of the density ρ of sea-water, the acceleration of free fall g , the depth h of the ocean and the wavelength λ ?

A $v = \sqrt{g\lambda}$ **B** $v = \sqrt{\frac{g}{h}}$ **C** $v = \sqrt{\rho gh}$ **D** $v = \sqrt{\frac{g}{\rho}}$

- 33 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.

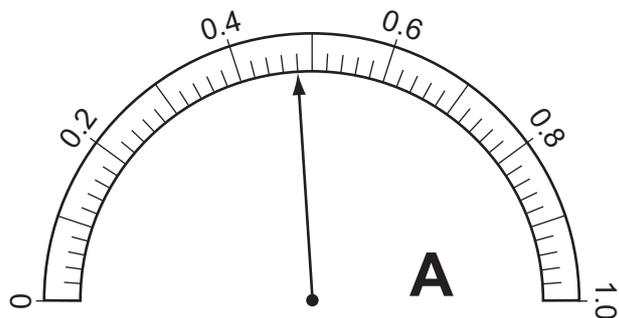
The grid on the screen is calibrated in cm squares, the timebase setting is 2.5 ms cm^{-1} , and the Y-sensitivity is 5 mV cm^{-1} .



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

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



What is the resistance?

- A** 2.5Ω **B** 2.7Ω **C** 2500Ω **D** 2700Ω

35 Five energies are listed.

5 kJ

5 mJ

5 MJ

5 nJ

Starting with the smallest first, what is the order of increasing magnitude of these energies?

A 5 kJ → 5 mJ → 5 MJ → 5 nJ

B 5 nJ → 5 kJ → 5 MJ → 5 mJ

C 5 nJ → 5 mJ → 5 kJ → 5 MJ

D 5 mJ → 5 nJ → 5 kJ → 5 MJ

36 Which of the following correctly expresses the volt in terms of SI base units?

A $A\Omega$

B WA^{-1}

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

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

37 What is a reasonable estimate of the average kinetic energy of an athlete during a 100 m race that takes 10 s?

A 40 J

B 400 J

C 4000 J

D 40 000 J

38 The resistance R of a resistor is determined by measuring the potential difference V across it and the 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%

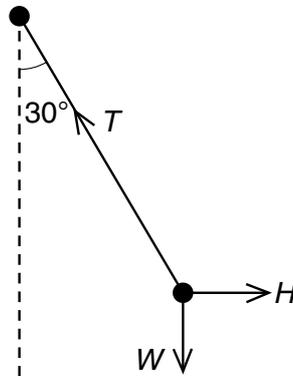
D 10.0%

- 39 The prefix 'centi' indicates $\times 10^{-2}$. That is, 1 centimetre is equal to 1×10^{-2} metre.

Which line in the table correctly indicates the prefixes micro, nano and pico?

	$\times 10^{-12}$	$\times 10^{-9}$	$\times 10^{-6}$
A	nano	micro	pico
B	micro	pico	nano
C	pico	nano	micro
D	pico	micro	nano

- 40 A pendulum bob is held stationary by a horizontal force H . The three forces acting on the bob are shown in the diagram.



The tension in the string of the pendulum is T . The weight of the pendulum bob is W .

Which statement is correct?

- A** $H = T \cos 30^\circ$ **B** $T = H \sin 30^\circ$ **C** $W = T \cos 30^\circ$ **D** $W = T \sin 30^\circ$
- 41 Which line of the table gives values that are equal to a time of 1 ps (one picosecond) and a distance of 1 Gm (one gigametre)?

	time of 1 ps	distance of 1 Gm
A	10^{-9} s	10^9 m
B	10^{-9} s	10^{12} m
C	10^{-12} s	10^9 m
D	10^{-12} s	10^{12} m

- 42 A student carries out a series of determinations of the acceleration of free fall g . The table shows the results.

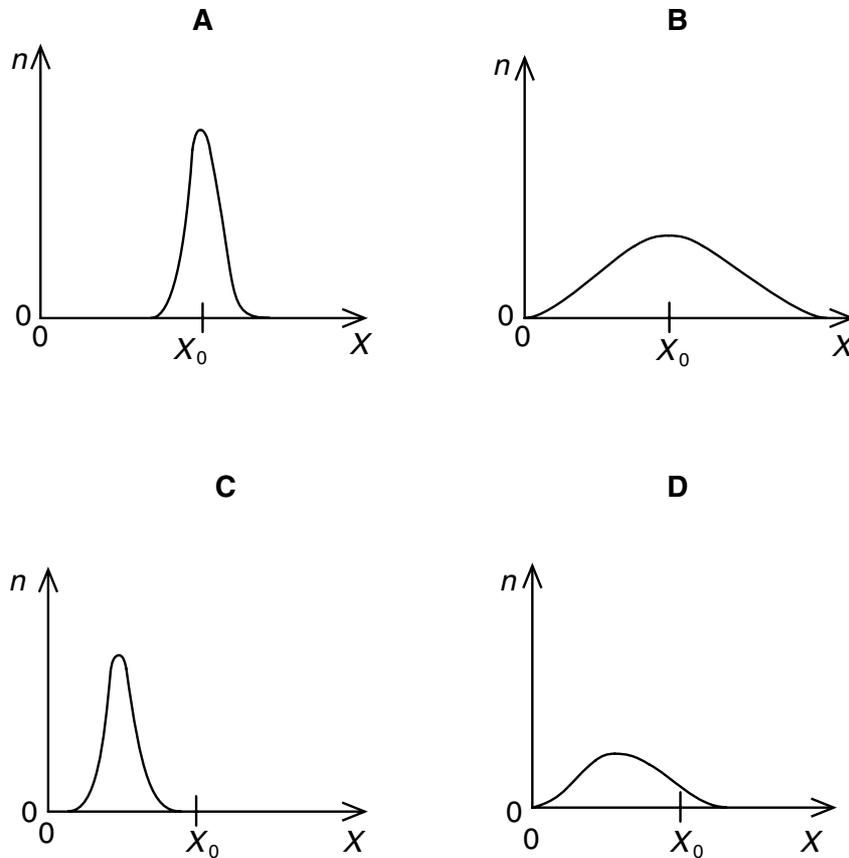
g/ms^{-2}
4.91
4.89
4.88
4.90
4.93
4.92

What can be said about this experiment?

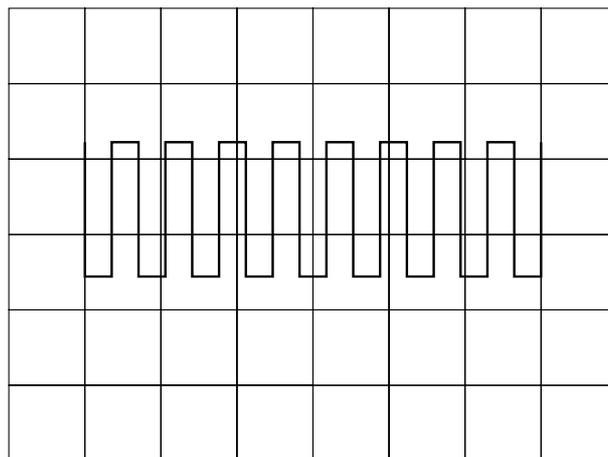
- A It is accurate and precise.
 B It is accurate but not precise.
 C It is not accurate and not precise.
 D It is not accurate but is precise.
- 43 The momentum of an object of mass m is p .
 Which quantity has the same base units as $\frac{p^2}{m}$?
- A energy
 B force
 C power
 D velocity
- 44 Which of the following definitions is correct and uses only quantities rather than units?
- A Density is mass per cubic metre.
 B Potential difference is energy per unit current.
 C Pressure is force per unit area.
 D Speed is distance travelled per second.
- 45 When a beam of light is incident on a surface, it delivers energy to the surface. The intensity of the beam is defined as the energy delivered per unit area per unit time.
 What is the unit of intensity, expressed in SI base units?
- A $\text{kg m}^{-2} \text{s}^{-1}$ B $\text{kg m}^2 \text{s}^{-3}$ C kg s^{-2} D kg s^{-3}

- 46 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 .

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



- 47 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} .



What is the approximate frequency of the square-wave?

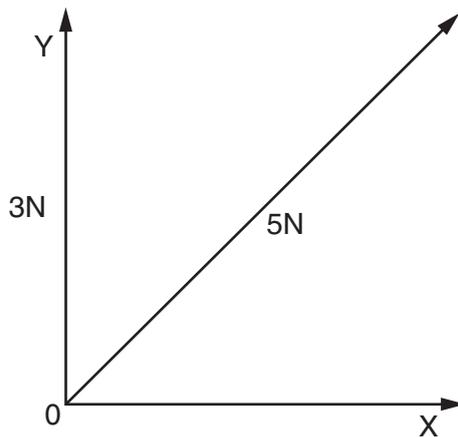
- A** 70 Hz **B** 140 Hz **C** 280 Hz **D** 1400 Hz

- 48 A student measures a current as 0.5 A.

Which of the following correctly expresses this result?

- A** 50 mA **B** 50 MA **C** 500 mA **D** 500 MA

- 49 A force of 5 N may be represented by two perpendicular components OY and OX as shown in the diagram, which is **not** drawn to scale.



OY is of magnitude 3 N.

What is the magnitude of OX?

- A** 2 N **B** 3 N **C** 4 N **D** 5 N

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

Which student obtained a set of results that could be described as precise but not accurate?

student	results, $g / \text{m s}^{-2}$			
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

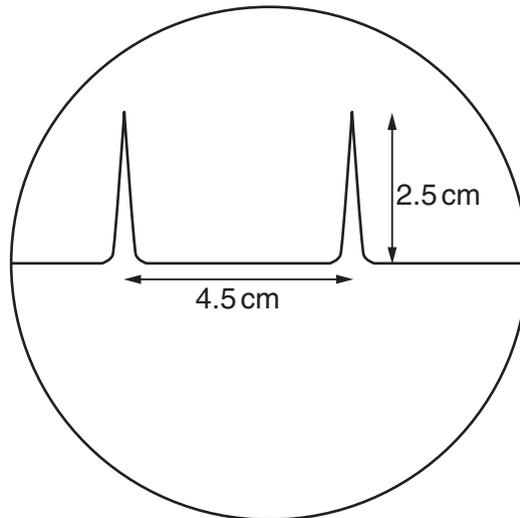
- 51 A thermometer can be read to an accuracy of $\pm 0.5^\circ\text{C}$. This thermometer is used to measure a temperature rise from 40°C to 100°C .

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

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

52 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

53 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.

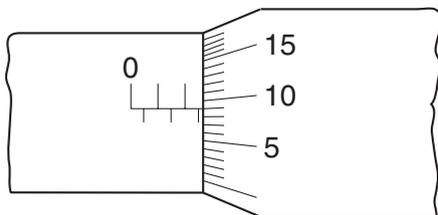


diagram 1

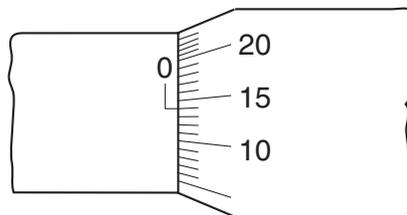


diagram 2

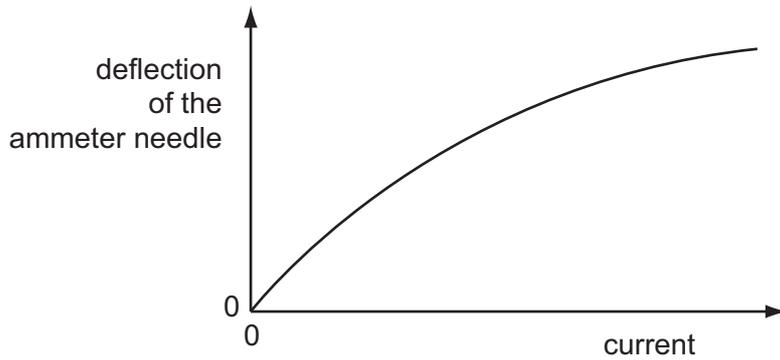
What is the diameter of the wire?

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

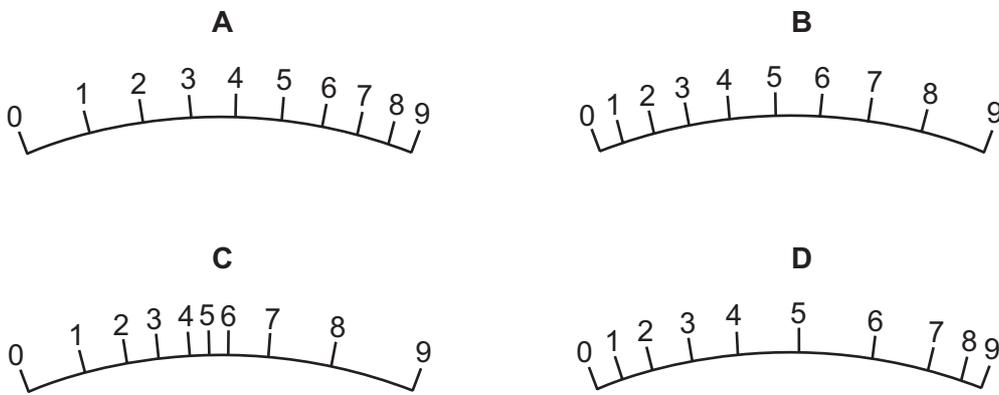
54 Which pair of units are both SI base units?

- A** ampere, degree celsius
B ampere, kelvin
C coulomb, degree celsius
D coulomb, kelvin

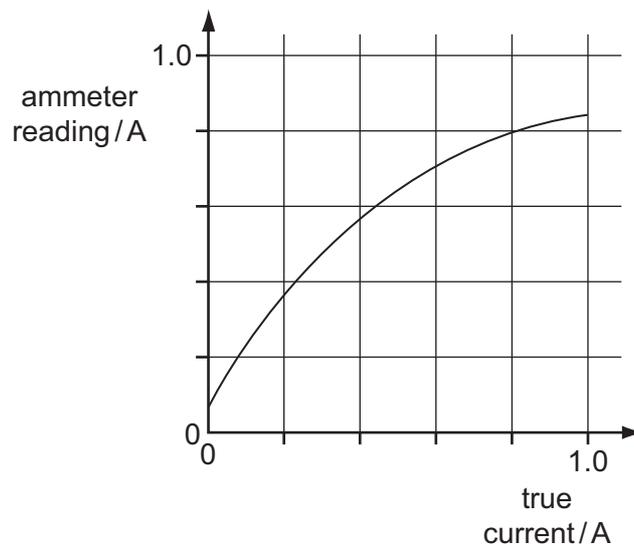
- 55 The deflection of the needle of an ammeter varies with the current passing through the ammeter as shown in the graph.



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



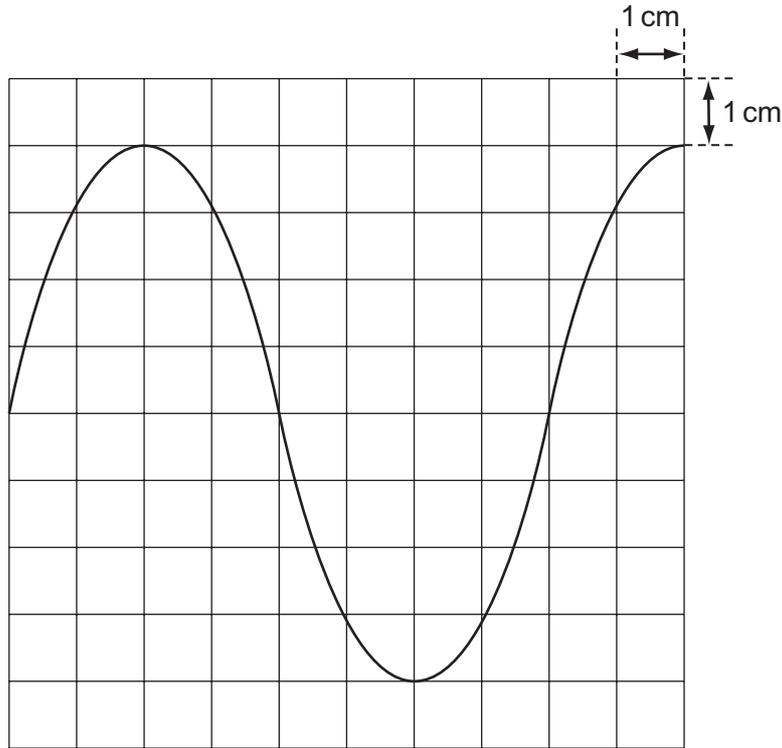
- 56 A calibration graph is produced for a faulty ammeter.



Which ammeter reading will be nearest to the correct value?

- A** 0.2A **B** 0.4A **C** 0.6A **D** 0.8A

- 57 When a 12 V 50 Hz supply is connected to the Y-terminals of an oscilloscope, 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}
- 58 The prefix 'centi' indicates $\times 10^{-2}$.

Which line in the table correctly indicates the prefixes micro, nano and pico?

	$\times 10^{-12}$	$\times 10^{-9}$	$\times 10^{-6}$
A	nano	micro	pico
B	nano	pico	micro
C	pico	nano	micro
D	pico	micro	nano

- 59 Which expression involving base units is equivalent to the volt?

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

- 60 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	=	$(25.0 \pm 0.1)\text{g}$
length	=	$(5.00 \pm 0.01)\text{cm}$
breadth	=	$(2.00 \pm 0.01)\text{cm}$
height	=	$(1.00 \pm 0.01)\text{cm}$

The density is calculated to be 2.50g cm^{-3} .

What is the uncertainty in this result?

- A $\pm 0.01\text{g cm}^{-3}$ B $\pm 0.02\text{g cm}^{-3}$ C $\pm 0.05\text{g cm}^{-3}$ D $\pm 0.13\text{g cm}^{-3}$
- 61 Which product-pair of metric prefixes has the greatest magnitude?
- A pico \times mega
 B nano \times kilo
 C micro \times giga
 D milli \times tera
- 62 Which row of the table shows a physical quantity and its correct unit?

	physical quantity	unit
A	electric field strength	$\text{kg m s}^{-2}\text{C}^{-1}$
B	specific heat capacity	$\text{kg}^{-1}\text{m}^2\text{s}^{-2}\text{K}^{-1}$
C	tensile strain	$\text{kg m}^{-1}\text{s}^{-2}$
D	the Young modulus	$\text{kg m}^{-1}\text{s}^{-3}$

- 63 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

64 In the expressions below

- a is acceleration,
- F is force,
- m is mass,
- t is time,
- v is velocity.

Which expression represents energy?

- A** Ft **B** Fvt **C** $\frac{2mv}{t}$ **D** $\frac{at^2}{2}$

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

The current in the wire is $1.0 \pm 0.2 \text{ A}$ and the potential difference across the wire is $8.0 \pm 0.4 \text{ V}$.

What is the resistance of the wire and its uncertainty?

- A** $(8.0 \pm 0.2) \Omega$
- B** $(8.0 \pm 0.6) \Omega$
- C** $(8 \pm 1) \Omega$
- D** $(8 \pm 2) \Omega$

66 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 .

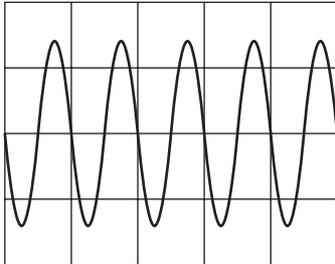
What is the percentage uncertainty in the average power?

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

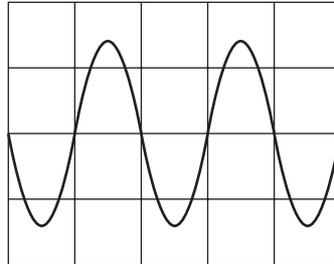
- 67 The Y-input terminals of a cathode-ray oscilloscope (c.r.o.) are connected to a supply of peak value 5.0 V and of frequency 50 Hz. The time-base is set at 10 ms per division and the Y-gain at 5.0 V per division.

Which trace is obtained?

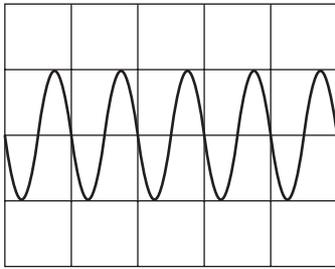
A



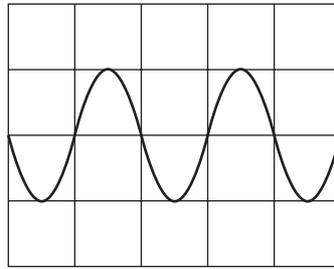
B



C



D



- 68 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.
- 69 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/ms^{-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

70 The equation relating pressure and density is $p = \rho gh$.

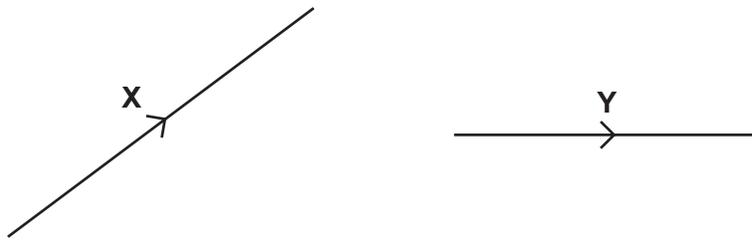
How can both sides of this equation be written in terms of base units?

- A $[\text{N m}^{-1}] = [\text{kg m}^{-3}] [\text{m s}^{-1}] [\text{m}]$
- B $[\text{N m}^{-2}] = [\text{kg m}^{-3}] [\text{m s}^{-2}] [\text{m}]$
- C $[\text{kg m}^{-1} \text{s}^{-2}] = [\text{kg m}^{-3}] [\text{m s}^{-2}] [\text{m}]$
- D $[\text{kg m}^{-1} \text{s}^{-1}] = [\text{kg m}^{-1}] [\text{m s}^{-2}] [\text{m}]$

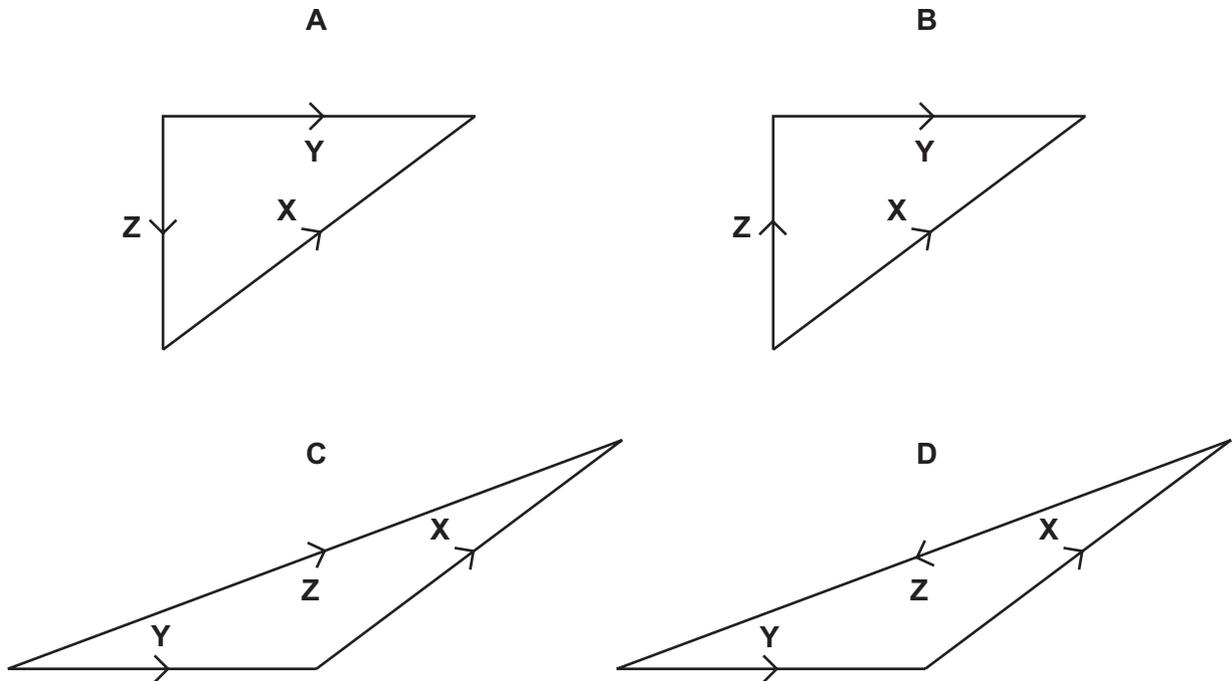
71 What is a reasonable estimate of the diameter of an alpha particle?

- A 10^{-15} m
- B 10^{-12} m
- C 10^{-9} m
- D 10^{-6} m

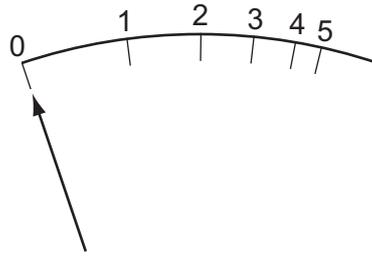
72 The diagram shows two vectors **X** and **Y**.



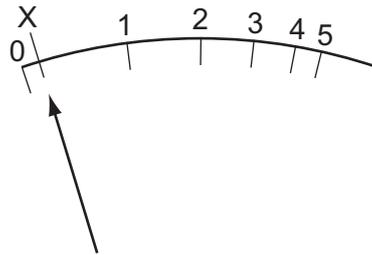
In which vector triangle does the vector **Z** show the magnitude and direction of vector **X–Y**?



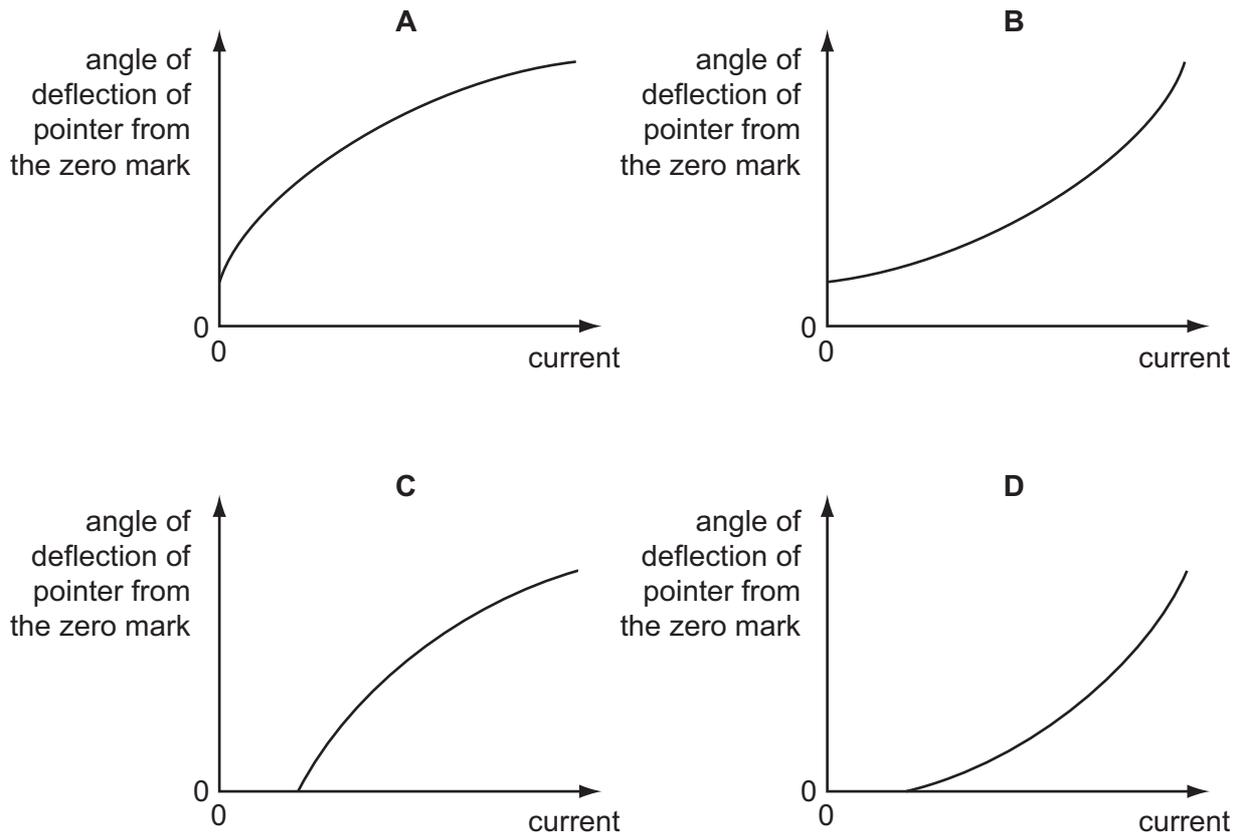
- 73 The diagram shows the graduations of a correctly calibrated ammeter. When the current is zero, the pointer is at 0.



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?



74 A laser emits light of wavelength 600 nm.

What is the distance, expressed as a number of wavelengths, travelled by the light in one second?

- A 5×10^8 B 5×10^{11} C 5×10^{14} D 5×10^{17}

75 At temperatures close to 0 K, the specific heat capacity c of a particular solid is given by $c = bT^3$, where T is the thermodynamic temperature and b is a constant characteristic of the solid.

What are the units of constant b , expressed in SI base units?

- A $\text{m}^2 \text{s}^{-2} \text{K}^{-3}$
 B $\text{m}^2 \text{s}^{-2} \text{K}^{-4}$
 C $\text{kg m}^2 \text{s}^{-2} \text{K}^{-3}$
 D $\text{kg m}^2 \text{s}^{-2} \text{K}^{-4}$

76 The table shows the x -component and y -component of four force vectors.

Which force vector has the largest magnitude?

	x -component/N	y -component/N
A	2	9
B	3	8
C	4	7
D	5	6

77 A student uses a digital ammeter to measure a current. The reading of the ammeter is found to fluctuate between 1.98 A and 2.02 A.

The manufacturer of the ammeter states that any reading has a systematic uncertainty of $\pm 1\%$.

Which value of current should be quoted by the student?

- A $(2.00 \pm 0.01)\text{A}$
 B $(2.00 \pm 0.02)\text{A}$
 C $(2.00 \pm 0.03)\text{A}$
 D $(2.00 \pm 0.04)\text{A}$