CIA A-Level Physics 9702 Paper 1

Measurement and Vectors (2018 – 2019)

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9702/11/M/J/18

1 What is a unit for stress?

A $kg\,m^{-1}\,s^{-2}$ **B** $kg\,m^{-2}\,s^{-2}$ **C** $N\,m^{-1}$ **D** $N\,m$

2 Physical quantities can be classed as vectors or as scalars.

Which pair of quantities consists of two vectors?

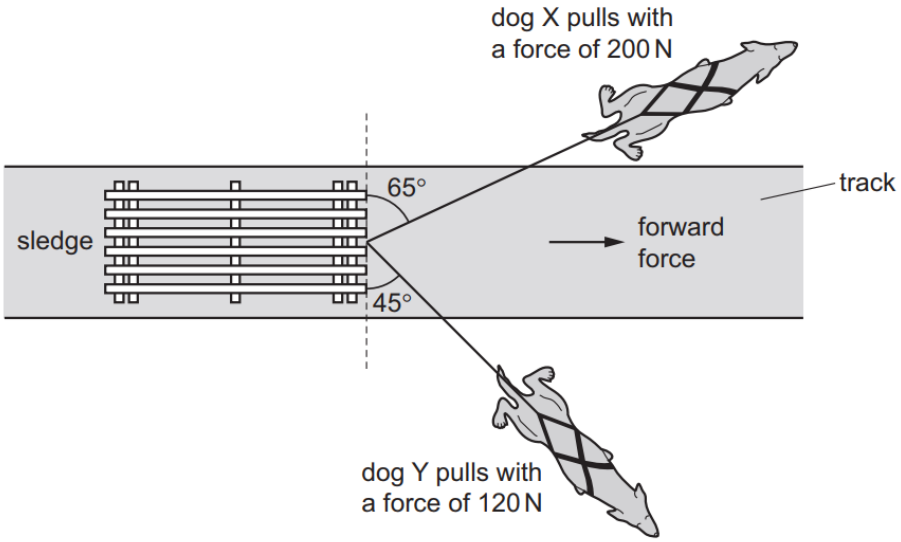
A kinetic energy and force

B momentum and time

C velocity and electric field strength

D weight and temperature

3 Two dogs pull a sledge along an icy track, as shown.

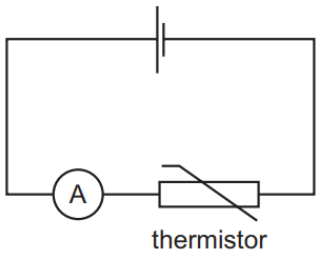


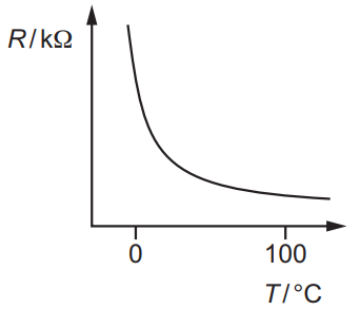
Dog X pulls with a force of 200 N at an angle of 65° to the front edge of the sledge. Dog Y pulls with a force of 120 N at an angle of 45° to the front edge of the sledge.

What is the resultant forward force on the sledge exerted by the two dogs?

A 80 N **B** 170 N **C** 270 N **D** 320 N

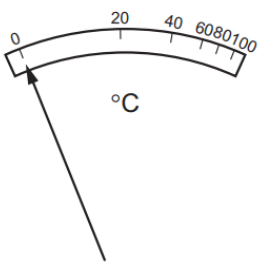
4 In the circuit shown, an analogue ammeter is to be recalibrated as a thermometer. The ammeter is connected in series with a thermistor. The thermistor is a component with a resistance that varies with temperature. The graph shows how the resistance R of the thermistor changes with temperature T.





Which diagram could represent the temperature scale on the ammeter?

A



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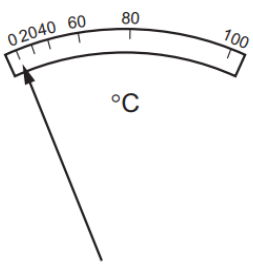

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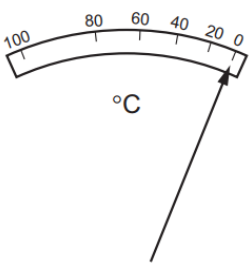

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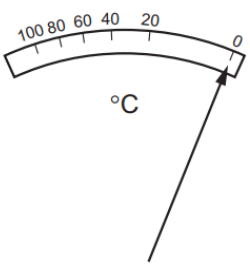

5 The sides of a cube are measured with calipers.

The measured length of each side is (30.0 ± 0.1) mm.

The measurements are used to calculate the volume of the cube.

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

A 0.01% **B** 0.3% **C** 1% **D** 3%

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1 A sheet of gold leaf has a thickness of 0.125 μm. A gold atom has a radius of 174 pm.

Approximately how many layers of atoms are there in the sheet?

A 4 **B** 7 **C** 400 **D** 700

2 The drag coefficient C_d is a number with no units. It is used to compare the drag on different cars at different speeds. C_d is given by the equation

$$C_d = \frac{2F}{v^n \rho A}$$

where F is the drag force on the car, ρ is the density of the air, A is the cross-sectional area of the car and v is the speed of the car.

What is the value of n?

A 1 **B** 2 **C** 3 **D** 4

3 A student measures the current through a resistor and the potential difference (p.d.) across it. There is a 4% uncertainty in the current reading and a 1% uncertainty in the p.d. reading. The student calculates the resistance of the resistor.

What is the percentage uncertainty in the calculated resistance?

A 0.25% **B** 3% **C** 4% **D** 5%

4 A student applies a potential difference V of (4.0 ± 0.1) V across a resistor of resistance R of $(10.0 \pm 0.3)\,\Omega$ for a time t of (50 ± 1) s.

The student calculates the energy E dissipated using the equation below.

$$E = \frac{V^2 t}{R} = \frac{4.0^2 \times 50}{10.0} = 80\,\text{J}$$

What is the absolute uncertainty in the calculated energy value?

A 1.5 J **B** 3 J **C** 6 J **D** 8 J

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1 What is the best way of describing a physical quantity?

A a quantity with a magnitude and a direction but no unit

B a quantity with a magnitude and a unit

C a quantity with a magnitude but no direction

D a quantity with a unit but no magnitude

2 Which pair includes a vector quantity and a scalar quantity?

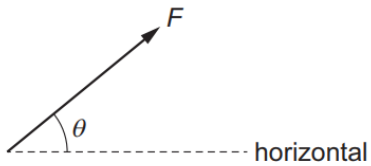
A displacement and acceleration

B force and kinetic energy

C power and speed

D work and potential energy

3 A force F acts at an angle θ to the horizontal.



What are the horizontal and the vertical components of the force?

	horizontal component	vertical component
A	$F\cos\theta$	$F\cos(90° - \theta)$
B	$F\cos\theta$	$F\sin(90° - \theta)$
C	$F\sin\theta$	$F\cos\theta$
D	$F\sin\theta$	$F\cos(90° - \theta)$

4 What will reduce the systematic errors when taking a measurement?

A adjusting 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 parallax effects by using a marker and a mirror when measuring the amplitude of oscillation of a pendulum

D timing 20 oscillations, rather than a single oscillation, when finding the period of a pendulum

5 In an experiment to determine the Young modulus E of the material of a wire, the measurements taken are shown.

mass hung on end of wire	$m = 2.300 \pm 0.002\,\text{kg}$
original length of wire	$l = 2.864 \pm 0.005\,\text{m}$
diameter of wire	$d = 0.82 \pm 0.01\,\text{mm}$
extension of wire	$e = 7.6 \pm 0.2\,\text{mm}$

The Young modulus is calculated using

$$E = \frac{4mgl}{\pi d^2 e}$$

where g is the acceleration of free fall.

The calculated value of E is $1.61 \times 10^{10}\,\text{N m}^{-2}$.

How should the calculated value of E and its uncertainty be expressed?

A $(1.61 \pm 0.04) \times 10^{10}\,\text{N m}^{-2}$

B $(1.61 \pm 0.05) \times 10^{10}\,\text{N m}^{-2}$

C $(1.61 \pm 0.07) \times 10^{10}\,\text{N m}^{-2}$

D $(1.61 \pm 0.09) \times 10^{10}\,\text{N m}^{-2}$

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1 The radius of the Earth is approximately 6.4×10^6 m, and the radius of the Moon is approximately 1.7×10^6 m. A student wishes to build a scale model of the Solar System in the classroom, using a football of radius 0.12 m to represent the Earth.

Which object would best represent the Moon?

A basketball

B cherry

C golf ball

D tennis ball

2 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}

3 A ship is travelling with a velocity of 8.0 km h^{-1} in a direction 30° east of north.

What are the components of the ship's velocity in the east and north directions?

	component of velocity in east direction / km h^{-1}	component of velocity in north direction / km h^{-1}
A	4.0	4.0
B	4.0	6.9
C	4.6	6.9
D	6.9	4.0

4 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.

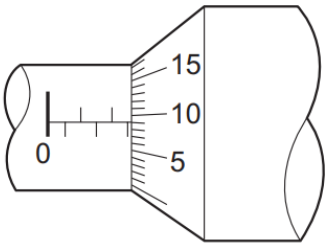

diagram 1

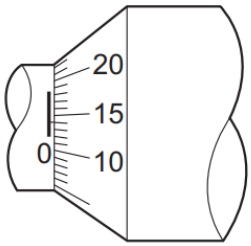

diagram 2

What is the diameter of the wire?

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

5 A digital meter has an accuracy of ±1%.

The meter is used to measure the current in an electrical circuit.

The reading on the meter varies between 3.04 A and 3.08 A.

What is the value of the current, with its uncertainty?

A (3.06 ± 0.02) A

B (3.06 ± 0.04) A

C (3.06 ± 0.05) A

D (3.06 ± 0.07) A

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1 A car is travelling at a speed of $20\,m\,s^{-1}$. The table contains values for the kinetic energy and the momentum of the car.

Which values are reasonable estimates?

	kinetic energy / J	momentum / kg m s^{-1}
A	3×10^5	3×10^4
B	3×10^5	5×10^6
C	2×10^7	3×10^4
D	2×10^7	5×10^6

2 What is the unit of resistance when expressed in SI base units?

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

B $kg\,m^2\,s^{-3}\,A^{-2}$

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

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

3 Which list contains both scalar and vector quantities?

A acceleration, momentum, velocity, weight

B area, current, force, work

C distance, kinetic energy, power, pressure

D mass, temperature, time, speed

4 Vectors P and Q are drawn to scale.

Which diagram represents the vector (P + Q)?

A

B

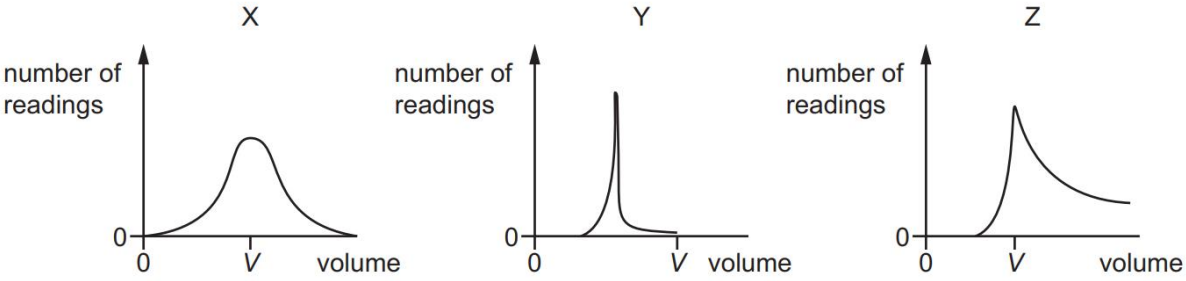
C

D

5 Students take readings of the volume of a liquid using three different pieces of measuring equipment X, Y and Z.

The true value of the volume of the liquid is *V*.

The students' results are shown.



How many pieces of equipment are precise and how many are accurate?

	number of precise pieces of equipment	number of accurate pieces of equipment
A	1	1
B	1	2
C	2	1
D	2	2

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1 Which statement is **not** a reasonable estimate?

A Atmospheric pressure at sea level is about 1×10^5 Pa.

B Light takes 5×10^2 s to reach us from the Sun.

C The frequency of ultraviolet light is 3×10^{12} Hz.

D The lifespan of a man is about 2×10^9 s.

2 Three of these quantities have the same unit.

Which quantity has a different unit?

A $\frac{\text{energy}}{\text{distance}}$

B force

C power × time

D rate of change of momentum

3 Which group of quantities contains only vectors?

A acceleration, displacement, speed

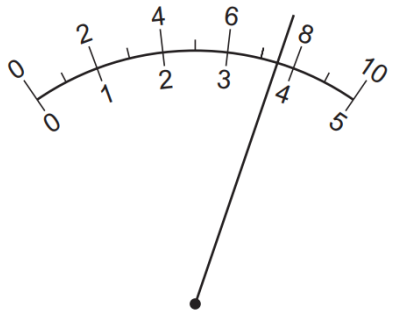
B acceleration, work, electric field strength

C displacement, force, velocity

D power, electric field strength, force

4 An ammeter is calibrated so that it shows a full-scale deflection when it measures a current of 2.0 A.

The diagram shows the display of this ammeter when it is measuring a current.



Which current is the ammeter measuring?

A 0.75 A **B** 1.5 A **C** 3.8 A **D** 7.5 A

5 The width of a table is measured as (50.3 ± 0.1) cm. Its length is measured as (1.40 ± 0.01) m.

What is the area of the table and its absolute uncertainty?

A $(0.7 \pm 0.1)\,m^2$

B $(0.704 \pm 0.006)\,m^2$

C $(0.704 \pm 0.011)\,m^2$

D $(70.4 \pm 0.6)\,m^2$

9702/11/M/J/19

1 Which unit can be expressed in base units as $kg\,m^2\,s^{-2}$?

A joule

B newton

C pascal

D watt

2 The luminosity L of a star is given by

$$L = 4\pi r^2 \sigma T^4$$

where

r is the radius of the star,

T is the temperature of the star and

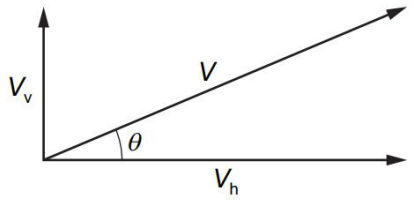
σ is a constant with units $W\,m^{-2}\,K^{-4}$.

What are the SI base units of L?

A $kg\,m^2\,s^{-1}$ **B** $kg\,m^2\,s^{-2}$ **C** $kg\,m^2\,s^{-3}$ **D** $kg\,m^2\,s^{-4}$

3 A particle has velocity V at an angle θ to the horizontal.

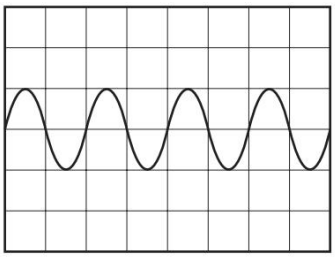
The components of the particle's velocity are V_v upwards in the vertical direction and V_h to the right in the horizontal direction, as shown.



What are expressions for the magnitude of V and for the angle θ?

	magnitude of V	θ
A	$\sqrt{(V_v^2 + V_h^2)}$	$\tan^{-1}\left(\frac{V_h}{V_v}\right)$
B	$\sqrt{(V_v^2 + V_h^2)}$	$\tan^{-1}\left(\frac{V_v}{V_h}\right)$
C	$\sqrt{(V_v^2 - V_h^2)}$	$\tan^{-1}\left(\frac{V_h}{V_v}\right)$
D	$\sqrt{(V_v^2 - V_h^2)}$	$\tan^{-1}\left(\frac{V_v}{V_h}\right)$

4 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?

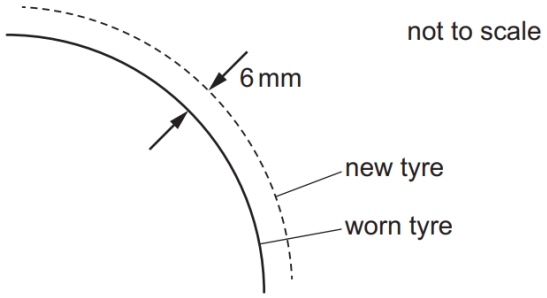
A $0.1\,\text{ms div}^{-1}$ **B** $1\,\text{ms div}^{-1}$ **C** $10\,\text{ms div}^{-1}$ **D** $100\,\text{ms div}^{-1}$

5 The speed shown on a car's speedometer is proportional to the rate of rotation of the tyres.

The variation of the diameter of a tyre as it wears introduces an error in the speed shown on the speedometer.

A car has new tyres of diameter 600 mm. The speedometer is accurately calibrated for this diameter.

The tyres wear as shown, with 6 mm of material being removed from the outer surface.



What is the error in the speed shown on the speedometer after this wear has taken place?

A The speed shown is too high by 1%.

B The speed shown is too high by 2%.

C The speed shown is too low by 1%.

D The speed shown is too low by 2%.

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1 What is equivalent to 2000 microvolts?

A $2\,\mu J\,C^{-1}$ **B** 2 mV **C** 2 pV **D** 2000 mV

2 What is the number of SI base units required to express electric field strength and power?

	electric field strength	power
A	3	3
B	3	2
C	4	2
D	4	3

3 The Planck constant h has SI units J s.

Which equation could be used to calculate the Planck constant?

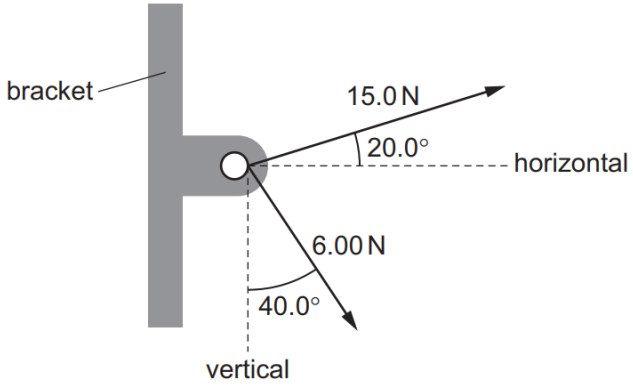
A $h = \frac{DE}{v}$ where D is distance, E is energy and v is velocity

B $h = \frac{v}{D}$ where v is velocity and D is distance

C $h = \frac{1}{4\pi E}$ where E is electric field strength

D $h = \frac{Fr^2}{m}$ where F is force, r is radius and m is mass

4 Two cables are attached to a bracket and exert forces as shown.



What are the magnitudes of the horizontal and vertical components of the resultant of the two forces?

	horizontal component / N	vertical component / N
A	9.73	0.534
B	9.73	10.2
C	18.0	0.534
D	18.0	10.2

5 A student wishes to determine the density ρ of lead. She measures the mass and diameter of a small sphere of lead:

$$\text{mass} = (0.506 \pm 0.005)\,\text{g}$$

$$\text{diameter} = (2.20 \pm 0.02)\,\text{mm}.$$

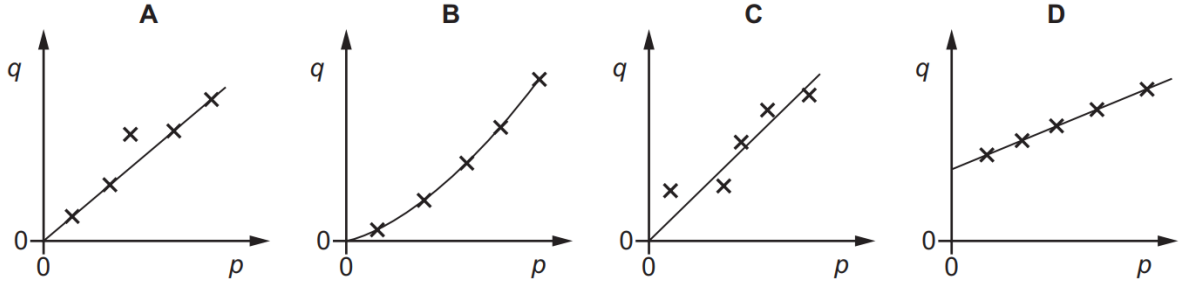
What is the best estimate of the percentage uncertainty in her calculated value of ρ?

A 1.7% **B** 1.9% **C** 2.8% **D** 3.7%

6 Two quantities p and q are directly proportional to each other.

Experimental results are taken and plotted in a graph of q against p.

Which graph shows there were random errors in the measurements of p and q?



7 A man of mass 75.2 kg uses a set of weighing scales to measure his mass three times. He obtains the following readings.

	mass / kg
reading 1	80.2
reading 2	80.1
reading 3	80.2

Which statement best describes the precision and accuracy of the weighing scales?

A not precise to ± 0.1 kg and accurate to ± 0.1 kg

B not precise to ± 0.1 kg and not accurate to ± 0.1 kg

C precise to ± 0.1 kg and accurate to ± 0.1 kg

D precise to ± 0.1 kg and not accurate to ± 0.1 kg

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1 Which is an SI base unit?

A current

B gram

C kelvin

D volt

2 Osmium, a naturally occurring element, has a density of 23 000 kg m^{-3}.

What is also a value of the density of osmium?

A 2.3×10^4 µg cm^{-3}

B 2.3×10^4 g cm^{-3}

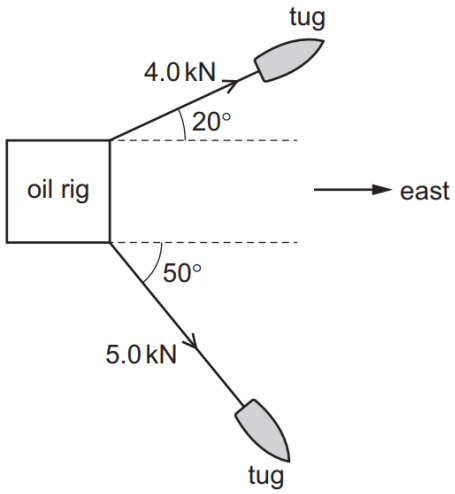
C 2.3 kg cm^{-3}

D 2.3×10^{-2} kg cm^{-3}

4 What is the approximate kinetic energy of an Olympic athlete when running at maximum speed during a 100 m race?

A 400 J **B** 4000 J **C** 40 000 J **D** 400 000 J

3 Two tugs are towing an oil rig as shown.

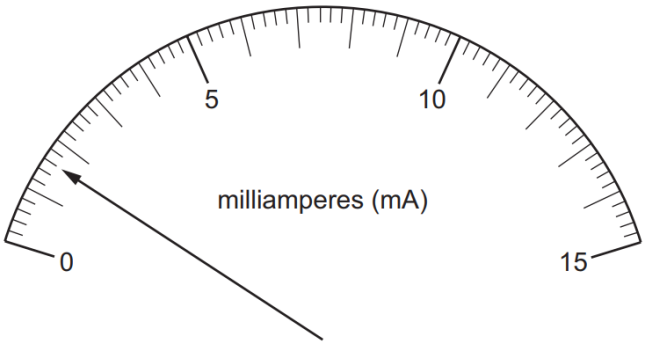


The tensions in the towing cables are 4.0 kN and 5.0 kN.

What is the total force acting on the rig due to the cables, in the direction to the east?

A 3.1 kN **B** 5.2 kN **C** 7.0 kN **D** 7.3 kN

5 The diagram shows the reading on an analogue ammeter.



Which digital ammeter reading is the same as the reading on the analogue ammeter?

	display units	display reading
A	μA	1600
B	μA	160
C	mA	16.0
D	A	1.60

6 A micrometer screw gauge is used to measure the diameter of a small uniform steel sphere. The micrometer reading is 5.00 mm ± 0.01 mm.

What will be the percentage uncertainty in a calculation of the volume of the sphere, using these values?

A 0.2% **B** 0.4% **C** 0.6% **D** 1.2%

9702/11/O/N/19

1 For which quantity is the magnitude a reasonable estimate?

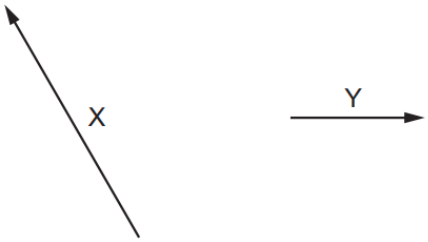
A	frequency of a radio wave	500 pHz
B	mass of an atom	500 μg
C	the Young modulus of a metal	500 kPa
D	wavelength of green light	500 nm

2 The speed of a wave in deep water depends on its wavelength L and the acceleration of free fall g.

What is a possible equation for the speed v of the wave?

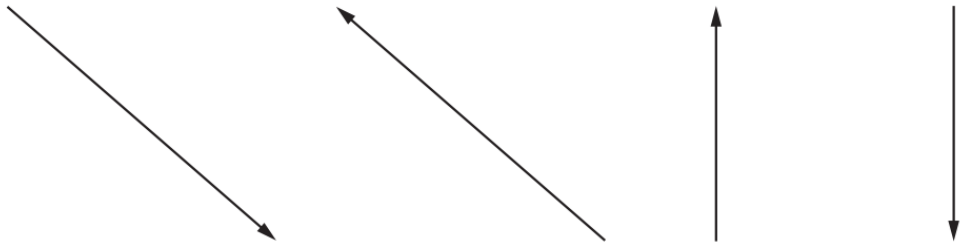
A $v = \sqrt{\left(\frac{gL}{2\pi}\right)}$ **B** $v = \frac{gL}{4\pi^2}$ **C** $v = 2\pi\sqrt{\left(\frac{g}{L}\right)}$ **D** $v = \frac{2\pi g}{L}$

3 The diagram shows two vectors X and Y, drawn to scale.



If X = Y – Z, which diagram best represents the vector Z?

A **B** **C** **D**



4 A student intends to measure accurately the diameter of a wire (known to be approximately 1 mm) and the internal diameter of a pipe (known to be approximately 2 cm).

What are the most appropriate instruments for the student to use to make these measurements?

	wire	pipe
A	calipers	calipers
B	calipers	micrometer
C	micrometer	calipers
D	micrometer	micrometer

5 The power P dissipated in a resistor of resistance R is calculated using the expression

$$P = \frac{V^2}{R}$$

where V is the potential difference (p.d.) across the resistor. The percentage uncertainty in V is 5% and in R is 2%.

What is the percentage uncertainty in P?

A 3% **B** 7% **C** 8% **D** 12%

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1 A cyclist has a speed of $5\,m\,s^{-1}$ and a small car has a speed of $12\,m\,s^{-1}$.

Which statement does **not** give a reasonable estimate?

A The kinetic energy of the cyclist is 1×10^3 J.

B The kinetic energy of the car is 7×10^4 J.

C The momentum of the cyclist is $4 \times 10^2\,kg\,m\,s^{-1}$.

D The momentum of the car is $2 \times 10^5\,kg\,m\,s^{-1}$.

2 Which expression gives an SI base quantity?

A charge per unit time

B force per unit area

C mass per unit volume

D work done per unit distance

3 Which list contains only scalar quantities?

A area, length, displacement

B kinetic energy, speed, power

C potential energy, momentum, time

D velocity, distance, temperature

4 A micrometer is used to measure the 28.50 mm width of a plastic ruler. The micrometer reads to the nearest 0.01 mm.

What is the correct way to record this reading?

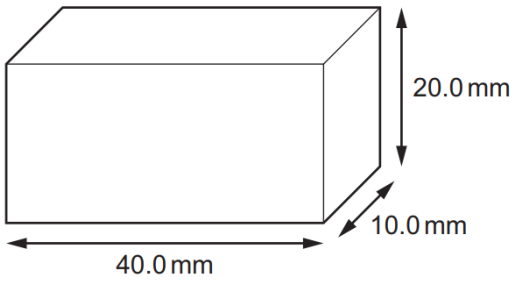
A 0.02850 ± 0.01 m

B 0.0285 ± 0.001 m

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

D $(2.850 \pm 0.001) \times 10^{-3}$ m

5 The sides of a wooden block are measured with calipers. The lengths of the sides are measured as 20.0 mm, 40.0 mm and 10.0 mm.



The calipers can measure with an absolute uncertainty of ± 0.1 mm.

What is the percentage uncertainty in the calculated volume of the block?

A 0.3% **B** 1.8% **C** 3.8% **D** 30%

9702/13/O/N/19

1 Which quantity with its unit is correct?

A acceleration of a bicycle = $1.4\,m\,s^{-1}$

B electric current in a lamp = $0.25\,A\,s^{-1}$

C electric potential difference across a battery = $8.0\,J\,C^{-1}$

D kinetic energy of a car = $4500\,N\,m^{-1}$

2 Which two units are **not** equivalent to each other?

A N m and $kg\,m^2\,s^{-2}$

B N s and $kg\,m\,s^{-1}$

C $J\,s^{-1}$ and $kg\,m^2\,s^{-3}$

D Pa and $kg\,m\,s^{-2}$

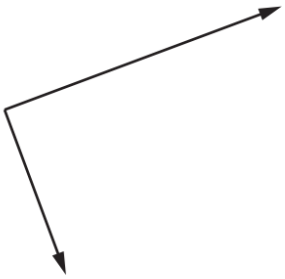
3 The arrow represents a vector R.

Which diagram does **not** represent R as two perpendicular components?

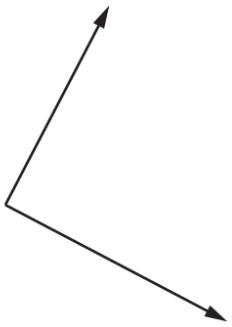
A

B

C



D



4 What could reduce systematic errors?

A averaging a large number of measurements

B careful calibration of measuring instruments

C reducing the sample size

D repeating measurements

5 The power loss P in a resistor is calculated using the formula $P = \frac{V^2}{R}$.

The percentage uncertainty in the potential difference V is 3% and the percentage uncertainty in the resistance R is 2%.

What is the percentage uncertainty in P?

A 4% **B** 7% **C** 8% **D** 11%