



Cambridge International AS & A Level

PHYSICS

9702/11

Paper 1 Multiple Choice

October/November 2025

1 hour 15 minutes

You must answer on the multiple choice answer sheet.

You will need: Multiple choice answer sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

INSTRUCTIONS

- There are **forty** questions on this paper. Answer **all** questions.
- For each question there are four possible answers **A**, **B**, **C** and **D**. Choose the **one** you consider correct and record your choice in soft pencil on the multiple choice answer sheet.
- Follow the instructions on the multiple choice answer sheet.
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- Do **not** use correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.

INFORMATION

- The total mark for this paper is 40.
- Each correct answer will score one mark.
- Any rough working should be done on this question paper.

This document has **20** pages. Any blank pages are indicated.



Data

acceleration of free fall	$g = 9.81 \text{ m s}^{-2}$
speed of light in free space	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
elementary charge	$e = 1.60 \times 10^{-19} \text{ C}$
unified atomic mass unit	$1 \text{ u} = 1.66 \times 10^{-27} \text{ kg}$
rest mass of proton	$m_p = 1.67 \times 10^{-27} \text{ kg}$
rest mass of electron	$m_e = 9.11 \times 10^{-31} \text{ kg}$
Avogadro constant	$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$
molar gas constant	$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
Boltzmann constant	$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$
gravitational constant	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
permittivity of free space	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$ $(\frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 \text{ m F}^{-1})$
Planck constant	$h = 6.63 \times 10^{-34} \text{ J s}$
Stefan–Boltzmann constant	$\sigma = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$

Formulae

uniformly accelerated motion	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
hydrostatic pressure	$\Delta p = \rho g \Delta h$
upthrust	$F = \rho g V$
Doppler effect for sound waves	$f_o = \frac{f_s v}{v \pm v_s}$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \dots$
resistors in parallel	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$

- 1 The table shows some physical quantities.

Which row correctly identifies the quantities as scalars or vectors?

	acceleration	charge	kinetic energy	wavelength
A	scalar	vector	vector	scalar
B	vector	vector	scalar	scalar
C	scalar	scalar	scalar	vector
D	vector	scalar	scalar	scalar

- 2 Two quantities are measured.

$$L = 6.8 \pm 0.1 \text{ cm}$$

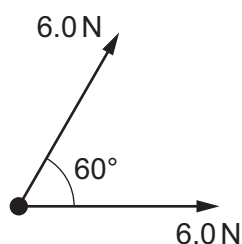
$$T = 2.42 \pm 0.08 \text{ s}$$

L and T are related to X by the equation shown.

$$X = \frac{4\pi^2 L}{T^2}$$

What is the calculated value and uncertainty of X ?

- A** $45.8 \pm 0.2 \text{ cm s}^{-2}$
B $45.8 \pm 0.3 \text{ cm s}^{-2}$
C $46 \pm 2 \text{ cm s}^{-2}$
D $46 \pm 4 \text{ cm s}^{-2}$
- 3 What are the SI base units of the watt?
- A** Js^{-1} **B** $\text{kg m}^2 \text{s}^{-3}$ **C** $\text{kg m}^2 \text{s}^{-1}$ **D** Nm s^{-1}
- 4 The diagram shows two forces of 6.0 N acting on an object. The angle between the lines of action of the two forces is 60° .



What is the magnitude of the resultant force?

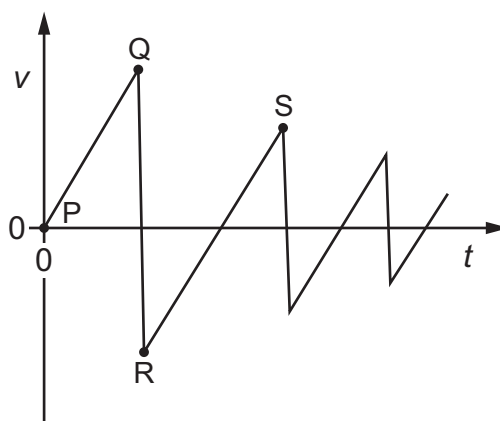
- A** 6.0 N **B** 7.9 N **C** 10 N **D** 12 N

- 5 A goods train passes through a station at a constant speed of 10 m s^{-1} at time $t = 0$. An express train is at rest at the station. The express train leaves the station with a uniform acceleration of 0.5 m s^{-2} just as the goods train goes past. Both trains move in the same direction on straight, parallel tracks.

At which time t does the express train overtake the goods train?

- A 6 s B 10 s C 20 s D 40 s
- 6 A ball is held above the ground and released. It falls to the ground and bounces several times.

The graph shows the variation with time t of the velocity v of the ball.

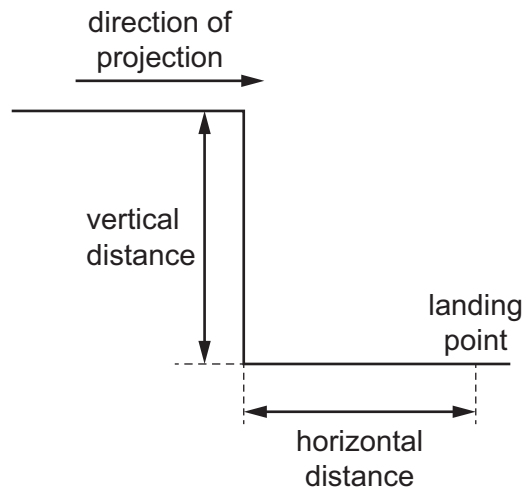


Four points on the graph are labelled P, Q, R and S.

Which statement is **not** correct?

- A The area under line PQ represents the initial height of the ball.
- B The collisions of the ball with the ground are inelastic.
- C The gradient of the line RS represents the acceleration due to free fall.
- D The maximum upwards velocity of the ball is reached at point P.

- 7 An object is projected horizontally. The object falls a vertical distance y and travels a horizontal distance x before landing on the ground.



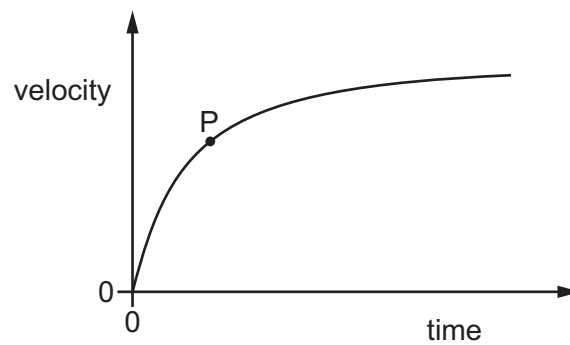
A second object is projected horizontally with the same initial velocity and falls a vertical distance $4y$ before landing on the ground.

Assume that air resistance is negligible.

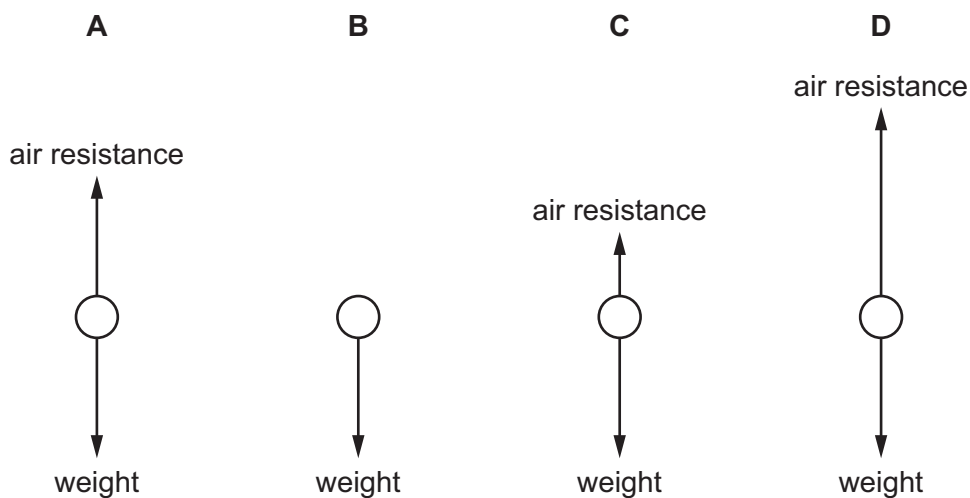
Which horizontal distance does the second object travel?

- A** x **B** $2x$ **C** $4x$ **D** $16x$

- 8 A sphere falls from rest through the air. The graph shows the variation with time of the sphere's velocity.



Which diagram shows the forces acting on the sphere when it is at the velocity corresponding to point P on the graph?



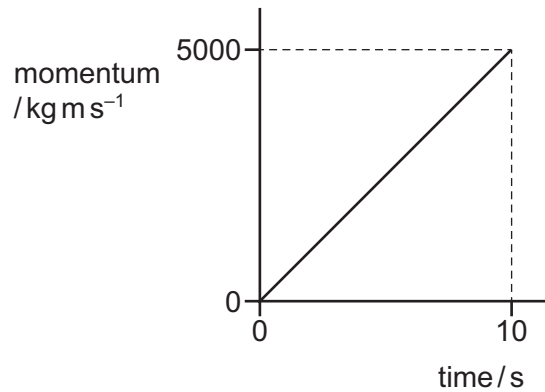
- 9 In which situation is total linear momentum **always** conserved?
- A in all collisions between two objects
 - B in collisions between two objects moving at equal and opposite velocity
 - C in collisions between two objects that form an isolated system
 - D in collisions between two objects with the same mass
- 10 An object of mass m moving with velocity 9.0 ms^{-1} has a head-on elastic collision with a stationary object of mass $2m$.

After the collision, both objects are moving. No external forces act on the system.

What is the velocity of the object of mass $2m$ after the collision?

- A -6.0 ms^{-1} B -3.0 ms^{-1} C 4.5 ms^{-1} D 6.0 ms^{-1}

- 11 The graph shows how the momentum of a motorcycle changes with time.



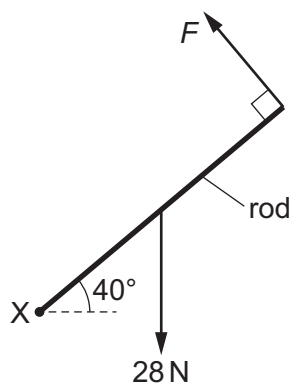
What is the resultant force on the motorcycle?

- A** 500 N **B** 5000 N **C** 25 000 N **D** 50 000 N
- 12 A rocket has a weight of W and an initial acceleration of a as the rocket leaves the ground vertically. The acceleration of free fall is g .

Which expression gives the initial upward force exerted on the rocket due to the engine?

- A** $\frac{Wa}{g} + W$ **B** $\frac{Wa}{g}$ **C** $\frac{Wa}{g} - W$ **D** $Wa + W$
- 13 A uniform rod of weight 28 N is supported at one end by force F .

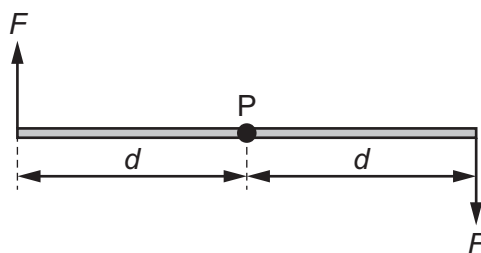
The rod is in equilibrium and attached to a frictionless hinge at end X.



What is the magnitude of F ?

- A** 9.0 N **B** 11 N **C** 18 N **D** 21 N

- 14 Two forces, each of magnitude F , act in opposite directions on a rod.



Each force acts on the rod at a distance d from the pivot P.

What is the torque of this couple about P?

- A** 0 **B** $F \times d$ **C** $2F \times d$ **D** $2F \times 2d$

- 15 A man of weight 600 N stands with both feet flat on the ground.

What is a reasonable estimate of the pressure exerted on the ground by the weight of the man?

- A** $1 \times 10^0 \text{ Pa}$ **B** $1 \times 10^2 \text{ Pa}$ **C** $1 \times 10^4 \text{ Pa}$ **D** $1 \times 10^6 \text{ Pa}$

- 16 The formula for the upthrust on a block of wood partially submerged in water is shown.

$$F = \rho g V$$

What do the symbols ρ and V represent?

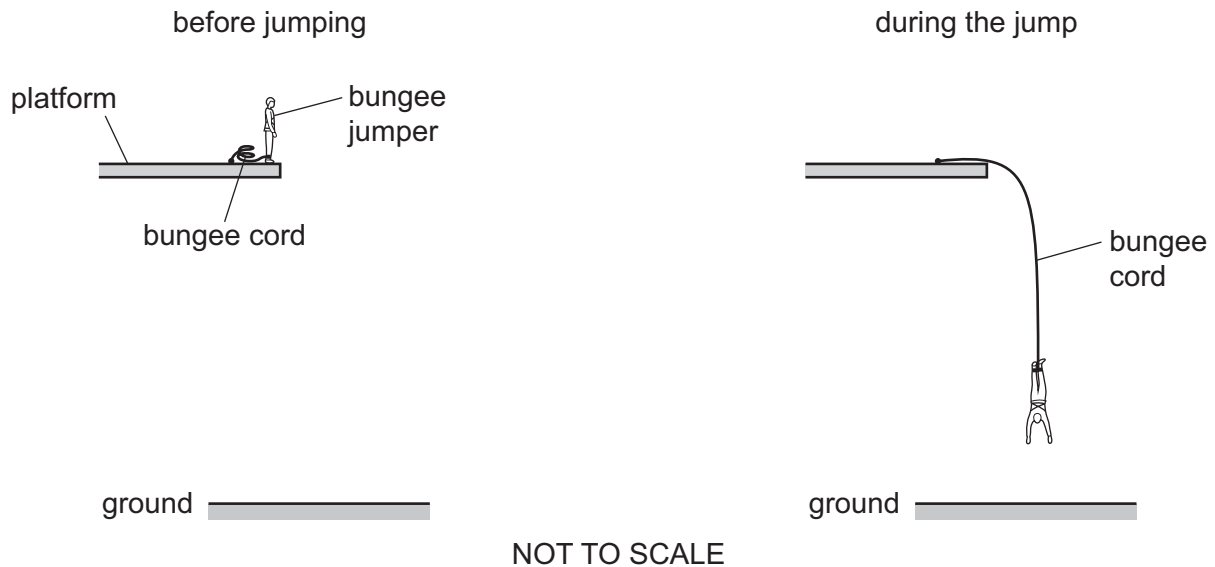
	ρ	V
A	density of water	volume of whole block
B	density of water	volume of block below surface of water
C	density of wood	volume of whole block
D	density of wood	volume of block below surface of water

- 17 An object with a mass of 100 g falls a vertical distance of 10 m.

What is the change in the gravitational potential energy of the object?

- A** 1 J **B** 10 J **C** 100 J **D** 10 000 J

- 18 A bungee jumper jumps from a platform and is decelerated by an elastic bungee cord, as shown.



When the jumper makes the jump, his initial gravitational potential energy relative to the ground is converted into his kinetic energy and into elastic potential energy in the cord.

At which part of the jump are all three types of energy non-zero?

- A on the platform before the jump
 - B on the way down before the cord has started to extend
 - C on the way down as he decelerates
 - D at the bottom of the jump when he is stationary
- 19 A sailboat is pushed by the wind at a constant velocity v across a lake.

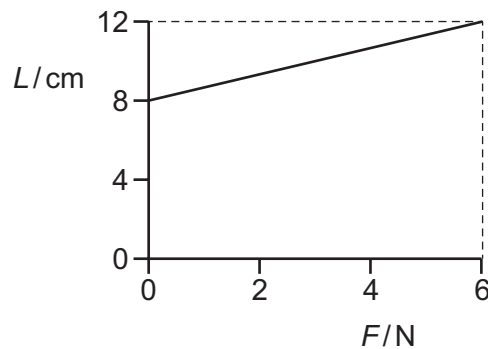
The force of the wind and the velocity of the sailboat are in the same direction.

Which additional information is required to determine the work done per unit time by the wind acting on the sailboat?

- A the force exerted by the wind
- B the distance travelled by the sailboat per unit time
- C the total energy input to the sailboat by the wind
- D the weight of the sailboat

- 20** A spring is fixed at one end. The length L of the spring is increased by applying a tensile force F to the other end.

The graph shows the variation of L with F .

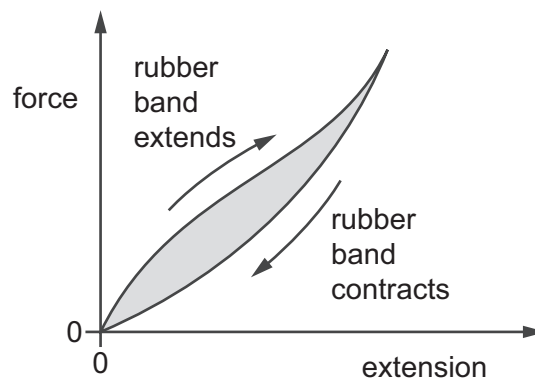


What is the elastic potential energy of the spring when F is 6.0 N?

- A** 0.12 J **B** 0.24 J **C** 0.36 J **D** 0.60 J
- 21** A wire has an unstretched length of 2.00 m.
- A stress of 1.6×10^5 Pa is applied to the wire, and the new length of the wire is 2.10 m.
- The wire obeys Hooke's law.
- What is the Young modulus of the wire?
- A** 8.0×10^3 Pa **B** 7.8×10^4 Pa **C** 1.5×10^5 Pa **D** 3.2×10^6 Pa
- 22** What are the SI base units of stress?

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

- 23 The diagram shows a force–extension graph for a rubber band as the band is extended and then the stretching force is decreased to zero.



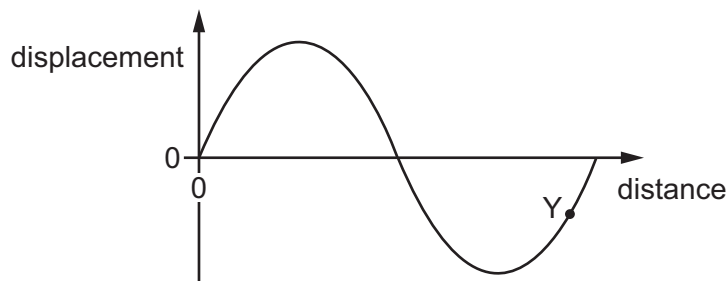
What can be deduced from the graph?

- A The rubber band does **not** return to its original length when the force is decreased to zero.
 - B The rubber band obeys Hooke's law for the extensions shown.
 - C The rubber band remains elastic for the extensions shown.
 - D The shaded area represents the work done in extending the rubber band.
- 24 Which row is correct for sound waves?

	can travel in a vacuum	can be polarised	can diffract through a gap
A	no	no	yes
B	yes	no	no
C	no	yes	no
D	no	yes	yes

- 25** A source emits a progressive sound wave in the horizontal direction. The wave travels away from the source in a direction towards the right.

The graph shows the variation of the displacement of the particles from their equilibrium positions with distance from the source at a particular instant in time. Displacements to the right of the equilibrium positions are shown as positive.



Position Y represents the displacement of a particle in the sound wave at a particular distance from the source at this instant.

Which statement about the motion of this particle is correct?

- A** The particle is moving away from the source.
 - B** The particle is moving towards the source.
 - C** The particle is moving upwards.
 - D** The particle is moving downwards.
- 26** Two polarising filters are placed next to each other so that their planes are parallel.

The first polarising filter has its transmission axis at an angle of 50° to the vertical.

The second polarising filter has its transmission axis at an angle of 20° to the vertical. The angle between the transmission axes of the two polarising filters is 30° .

A beam of vertically polarised light of intensity 8.0 W m^{-2} is incident normally on the first polarising filter.

What is the intensity of the light that is transmitted from the second polarising filter?

- A** zero
 - B** 2.5 W m^{-2}
 - C** 2.9 W m^{-2}
 - D** 6.0 W m^{-2}
- 27** A dolphin is swimming at a speed of 16.0 m s^{-1} directly towards a stationary underwater microphone.

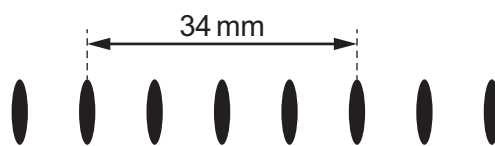
The dolphin emits a sound of frequency 122 kHz . The speed of sound in water is 1480 m s^{-1} .

What is the frequency of sound detected by the microphone?

- A** 1300 Hz
- B** 1330 Hz
- C** 121 kHz
- D** 123 kHz

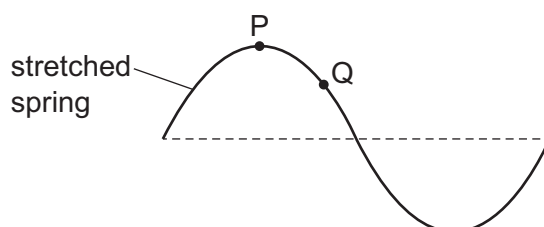
- 28 A student carries out a double-slit experiment using a laser emitting red light of wavelength of 680 nm. The light is incident normally on a double slit.

The diagram shows part of the pattern of bright fringes visible on a screen at a distance of 2.4 m from the slits. The distance across five bright fringes is measured as 34 mm.



What is the slit separation?

- A 8.5×10^{-3} m B 2.4×10^{-4} m C 1.9×10^{-4} m D 4.8×10^{-5} m
- 29 The diagram shows a stationary wave on a stretched spring at an instant in time.



Two particles on the spring, P and Q, are shown.

Which statement about the vibrations of P and Q is correct?

- A They have different frequencies.
 B They have the same amplitudes.
 C They have different periods.
 D They are always in phase.
- 30 Green laser light passes through a diffraction grating and forms an interference pattern.

The diffraction grating contains 400 lines per mm.

The wavelength of the laser light is 550 nm.

What is the highest order diffraction maximum produced by the grating?

- A 4 B 5 C 8 D 9
- 31 There is a potential difference V across a resistor of resistance R . The current in the resistor is I .

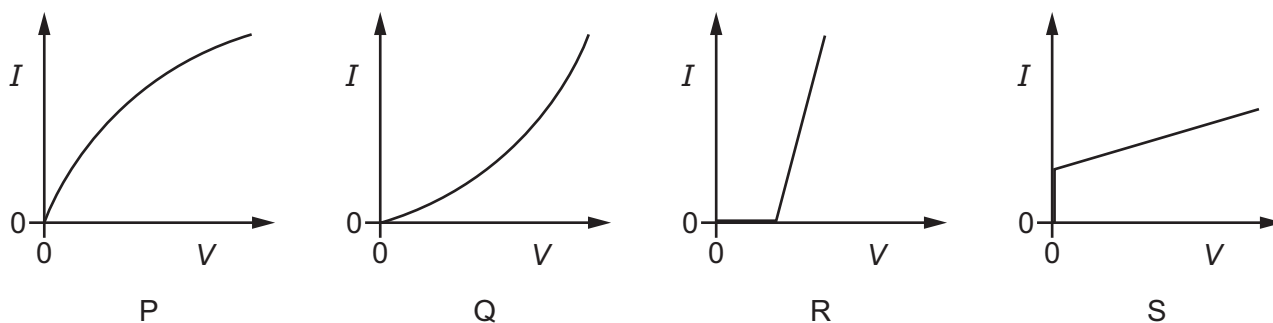
Which equation gives the power P dissipated by the resistor?

- A $P = V^2 I$ B $P = \frac{V^2}{I}$ C $P = V^2 R$ D $P = \frac{V^2}{R}$

32 What is a possible charge on a particle?

- A $6.40 \times 10^{-20} \text{ C}$
- B $4.00 \times 10^{-19} \text{ C}$
- C $1.12 \times 10^{-18} \text{ C}$
- D $9.11 \times 10^{-18} \text{ C}$

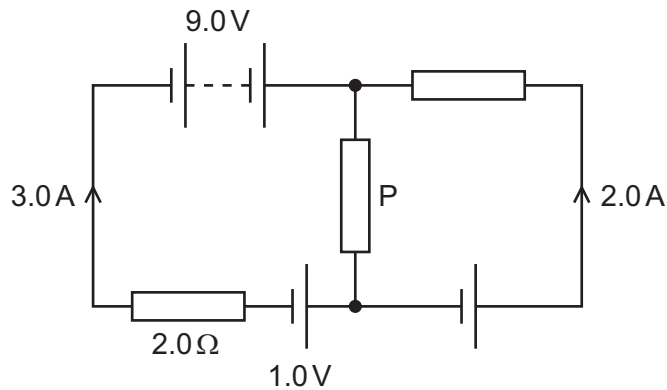
33 The graphs show possible current–voltage (I – V) characteristics for a filament lamp and for a semiconductor diode.



Which row identifies the I – V graphs for the lamp and for the diode?

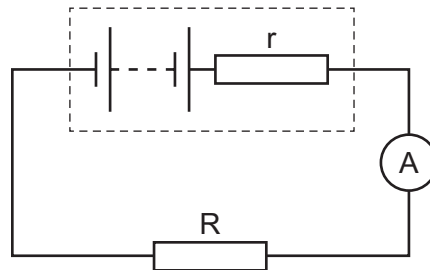
	filament lamp	semiconductor diode
A	P	R
B	P	S
C	Q	R
D	Q	S

- 34** The diagram shows a circuit containing a battery and cells with negligible internal resistance. Some values of current, electromotive force (e.m.f.) and resistance are shown. One resistor is labelled P.



What is the resistance of resistor P?

- A** 0.40Ω **B** 0.80Ω **C** 2.0Ω **D** 2.8Ω
- 35** The diagram shows a circuit with a battery connected to a resistor R. The battery has an internal resistance represented by resistor r.

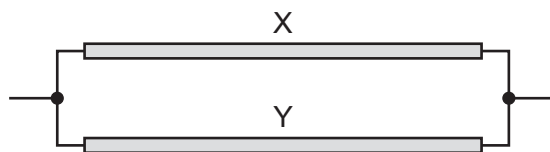


A second resistor, identical to R, is connected in parallel with R.

Which row describes the changes to the potential difference (p.d.) across r and the current shown on the ammeter when the second resistor is connected?

	p.d. across r	current shown on ammeter
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

- 36 Two identical wires X and Y, each of length L and radius r , are connected in parallel as shown.



The total resistance of this combination is R_1 .

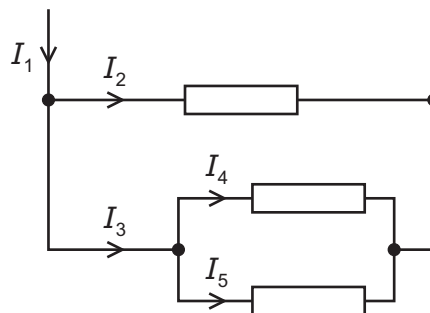
Wire X is replaced with a wire of the same material with length L and radius $2r$.

The total resistance of the new combination is R_2 .

What is the ratio $\frac{R_1}{R_2}$?

- A $\frac{2}{5}$ B $\frac{2}{3}$ C $\frac{3}{2}$ D $\frac{5}{2}$

- 37 The diagram shows the currents in part of an electric circuit.

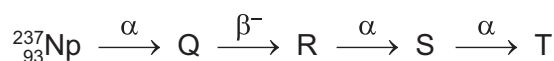


The resistors are identical.

Which equation is **not** correct?

- A $I_1 = I_2 + I_4 + I_5$
 B $I_2 = I_1 - I_3$
 C $I_2 = I_3 + I_4 + I_5$
 D $I_4 = I_3 - I_5$

- 38 The diagram shows a sequence of radioactive decays involving three α -particles and a β^- particle.



What is nuclide T?

- A ${}_{88}^{225}\text{Ra}$ B ${}_{88}^{231}\text{Ra}$ C ${}_{90}^{225}\text{Th}$ D ${}_{90}^{229}\text{Th}$

- 39** The number of electrons in a neutral atom of an isotope of plutonium, $^{239}_{94}\text{Pu}$, is changed to produce a charged atom (ion) W.

W has an overall charge of $+1.6 \times 10^{-19} \text{ C}$.

How many protons, neutrons and electrons are in W?

	protons	neutrons	electrons
A	94	145	93
B	94	145	95
C	238	94	239
D	239	94	238

- 40** Which particle is a lepton?

- A** meson
- B** positron
- C** proton
- D** quark

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Planck constant	$h = 6.63 \times 10^{-34} \text{ J s}$
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Doppler effect for sound waves	$f_o = \frac{f_s v}{v \pm v_s}$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \dots$
resistors in parallel	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$

1 What is a reasonable estimate of the weight of an adult human?

- A** $7 \times 10^0 \text{ N}$ **B** $7 \times 10^2 \text{ N}$ **C** $7 \times 10^4 \text{ N}$ **D** $7 \times 10^6 \text{ N}$

2 What describes a set of data with a high precision?

- A** data measured using equipment with small scale divisions
B data that is close to the accepted value
C data with each value having a low uncertainty
D data with repeats that are close to each other

3 Which physical quantity could have units of $\text{N s}^2 \text{ m}^{-1}$?

- A** acceleration
B force
C mass
D momentum

4 A ball is released from rest. The distance the ball falls and the time the ball takes to fall that distance are both measured.

The percentage uncertainty in the measured distance is negligible. The percentage uncertainty in the measured time is 4%.

The distance and the time are then used to calculate the acceleration of free fall.

Air resistance is negligible.

What is the percentage uncertainty in the calculated value of the acceleration of free fall?

- A** 2% **B** 4% **C** 8% **D** 16%

5 A car has an initial velocity u . The car then moves with constant acceleration a in a straight line through a displacement d . The car reaches a final velocity v .

Which expression gives the initial velocity u of the car?

- A** $v - ad$ **B** $\sqrt{v^2 - 2ad}$ **C** $v + ad$ **D** $v - \frac{1}{2}ad^2$

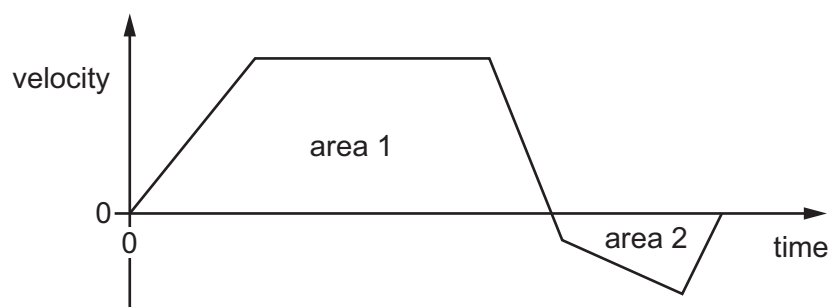
6 A bicycle brakes so that it undergoes uniform deceleration from a speed of 8 m s^{-1} to 6 m s^{-1} over a distance of 7 m.

The deceleration of the bicycle remains constant.

Which further distance will the bicycle travel before coming to rest?

- A** 7 m **B** 9 m **C** 16 m **D** 21 m

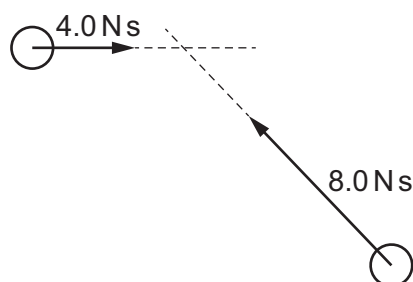
- 7 The velocity–time graph for an object is shown.



Which expression gives the total displacement of the object?

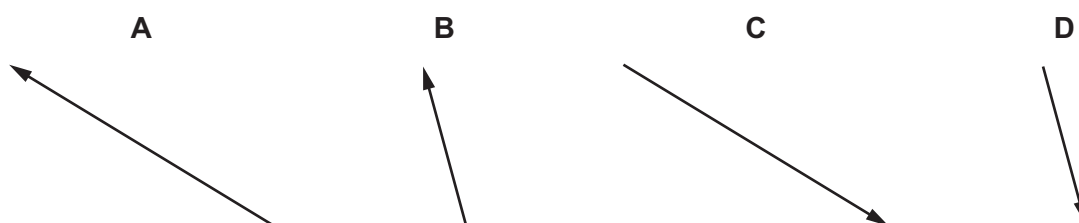
- A** area 1 – area 2
- B** $\frac{(\text{area 1} + \text{area 2})}{2}$
- C** area 1 + area 2
- D** area 2 – area 1
- 8 Which statement describes the weight of an object?
- A** It is equal to the mass of the object multiplied by its acceleration.
- B** It is equal to the resultant force when the object falls at terminal (constant) velocity.
- C** It is the force acting on the object due to a gravitational field.
- D** It is the property of the object that resists change in motion.
- 9 What is a statement of the principle of conservation of momentum?
- A** In an elastic collision, momentum is constant.
- B** Momentum is the product of mass and velocity.
- C** The force acting on a body is proportional to its rate of change of momentum.
- D** The momentum of an isolated system is constant.

- 10 The diagram shows the view from above of two balls moving along a horizontal frictionless surface before they collide. The momentum of each ball is also shown.

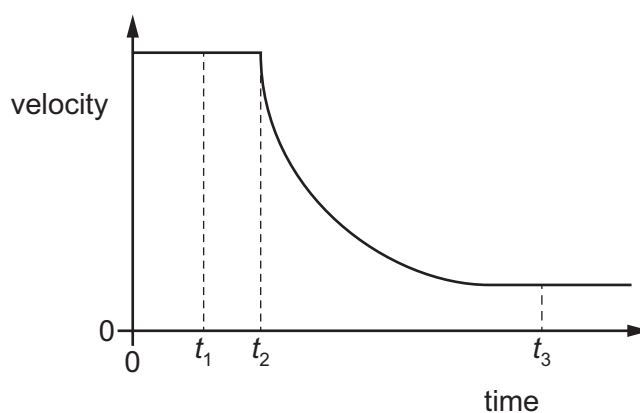


The balls stick together during the collision.

Which vector diagram represents the combined momentum of the balls after the collision?



- 11 A skydiver is falling at constant velocity. She then opens her parachute. The graph shows the variation with time of her velocity.



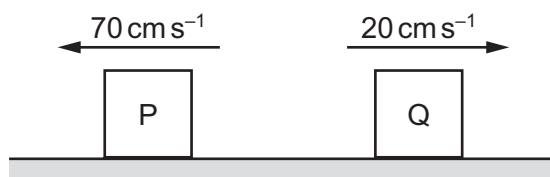
Which statements about the motion of the skydiver are correct?

- 1 The magnitude of the acceleration is maximum at time t_2 .
- 2 The magnitude of the drag force at time t_1 equals the magnitude of the drag force at time t_3 .
- 3 The magnitude of the drag force is maximum at time t_1 .

- A** 1 and 2 **B** 1 and 3 **C** 2 only **D** 3 only

- 12 Two different blocks, P and Q, slide towards each other on a horizontal frictionless surface. The blocks have an elastic collision.

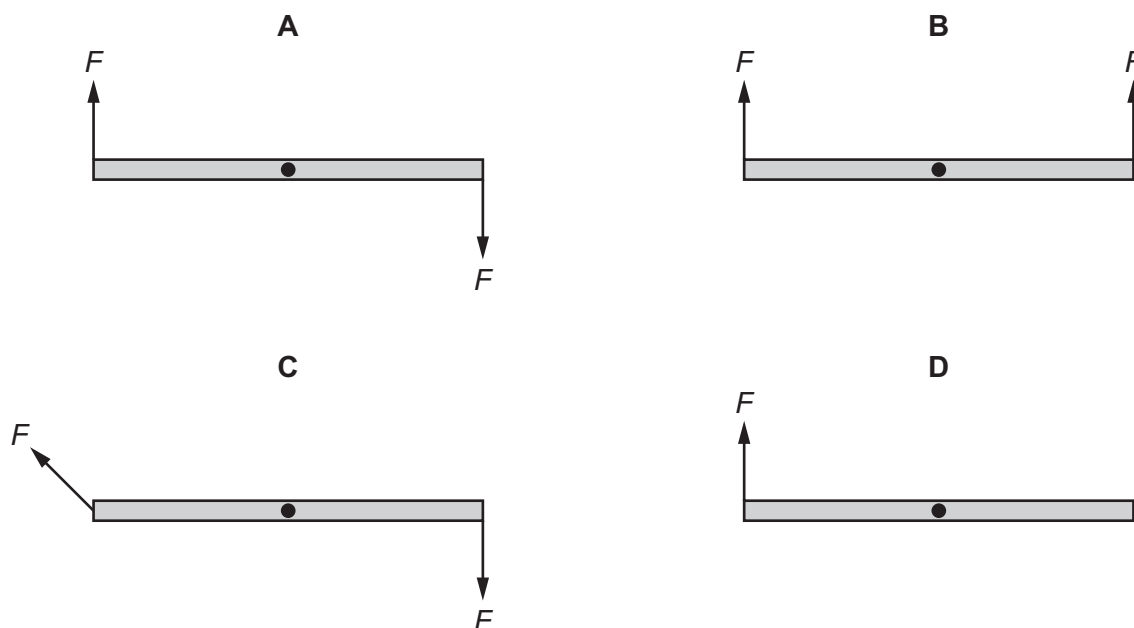
The diagram shows the velocities of the two blocks immediately after the collision.



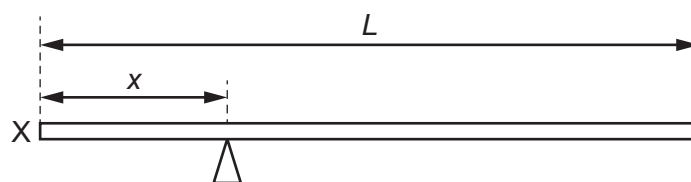
Which row gives possible velocities of the two blocks immediately before the collision?

	velocity of P	velocity of Q
A	10 cm s^{-1} to the right	60 cm s^{-1} to the left
B	50 cm s^{-1} to the right	zero
C	20 cm s^{-1} to the left	70 cm s^{-1} to the right
D	60 cm s^{-1} to the right	30 cm s^{-1} to the left

- 13 Which diagram shows a couple?



- 14 The diagram shows a uniform bar of mass M and length L resting on a pivot at a distance x from end X.



An object of mass m is placed on the bar at distance y from the pivot so that the bar is in equilibrium.

What is an expression for y ?

- A $\frac{xM}{m}$ B $\frac{M}{m}(L - x)$ C $\frac{M}{2m}(L - 2x)$ D $\frac{1}{m}(Lm - xM)$

- 15 The mass and volume of an object are varied.

Which two changes, when made together, **must** increase the density of the object?

	mass	volume
A	decrease	decrease
B	decrease	increase
C	increase	decrease
D	increase	increase

- 16 On Earth, a solid object that is fully submerged in a liquid experiences an upthrust U_E .

On Mars, the same object, fully submerged in the same liquid, experiences an upthrust U_M .

The acceleration of free fall on Mars is 3.7 m s^{-2} .

Assume that the liquid's density and the object's volume have the same values on Earth and Mars.

What is the ratio $\frac{U_M}{U_E}$?

- A 0.38 B 1.0 C 2.7 D 3.6

- 17 A student attempts to derive the formula for kinetic energy E_K . She begins by considering an object of mass m that is initially at rest. A constant force F applied to the object causes it to accelerate to final velocity v in displacement s . The kinetic energy gained by the object is equal to the work done on the object by the force F .

Which equation does the student **not** need in order to derive the formula for E_K ?

- A $F = ma$ B $W = Fs$ C $E = \frac{1}{2}Fs$ D $v^2 = u^2 + 2as$

- 18** A ball falls towards the ground from point X. Point X is 2.4 m above the ground.

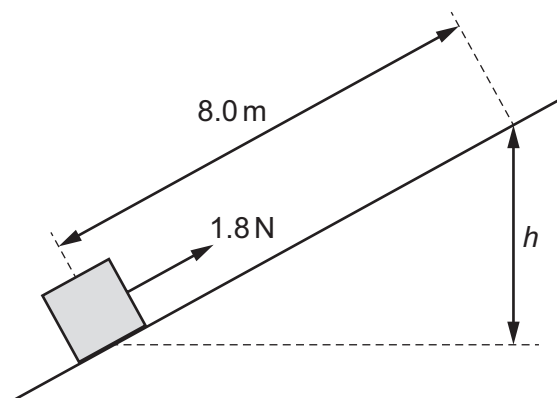
The ball rebounds from the ground and rises to point Y. Point Y is 1.8 m above the ground.

A single value of the change in height Δh is used to calculate the change in gravitational potential energy of the ball from X to Y.

What is the magnitude of Δh ?

- A** 0.6 m **B** 1.8 m **C** 2.4 m **D** 4.2 m

- 19** The diagram shows a block on a slope.



A constant force of 1.8 N in a direction parallel to the slope is exerted on the block. This causes the block to move along the slope at a constant speed.

The block moves a distance of 8.0 m along the slope and gains height h . The work done against the frictional force acting on the block is 4.8 J.

The weight of the block is 4.0 N.

What is the value of h ?

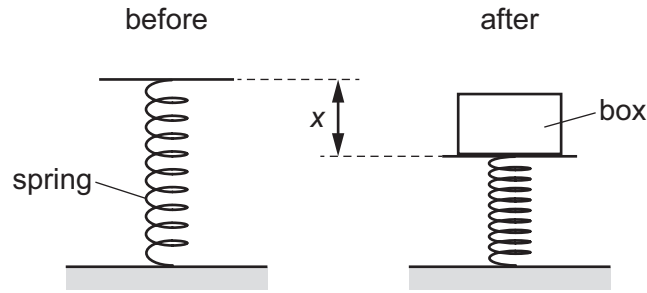
- A** 1.2 m **B** 2.4 m **C** 3.6 m **D** 4.8 m

- 20** The motor of a crane lifts a load of mass 600 kg. The load rises vertically at a constant speed of 12 m per minute.

What is the useful power output of the motor?

- A** 0.12 kW **B** 1.2 kW **C** 7.2 kW **D** 71 kW

- 21** A platform is supported by a spring. A box is placed onto the platform. The diagram shows the spring before and after the box is placed onto it.



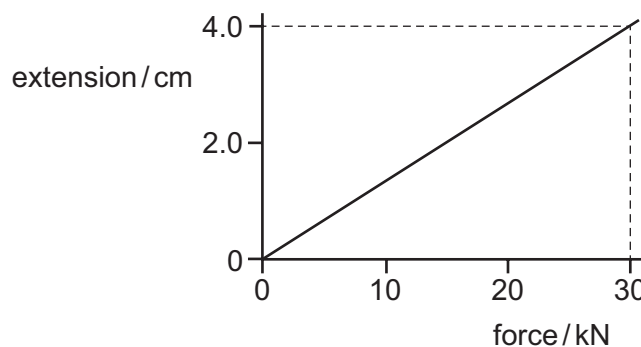
What is the term for the quantity marked as x ?

- A** compression
 - B** load
 - C** strain
 - D** stress
- 22** A copper wire has length 1.7 m and uniform diameter 0.64 mm.

The Young modulus of copper is 1.2×10^{11} Pa.

What is the spring constant of the wire?

- A** $2.3 \times 10^4 \text{ N m}^{-1}$
 - B** $9.1 \times 10^4 \text{ N m}^{-1}$
 - C** $4.5 \times 10^7 \text{ N m}^{-1}$
 - D** $7.1 \times 10^7 \text{ N m}^{-1}$
- 23** The graph shows how the extension of a spring varies with the force used to stretch it.



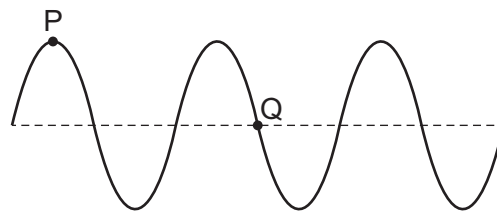
What is the elastic potential energy of the spring when the extension is 4.0 cm?

- A** 60 J
- B** 120 J
- C** 600 J
- D** 1200 J

24 Which row describes a progressive longitudinal wave?

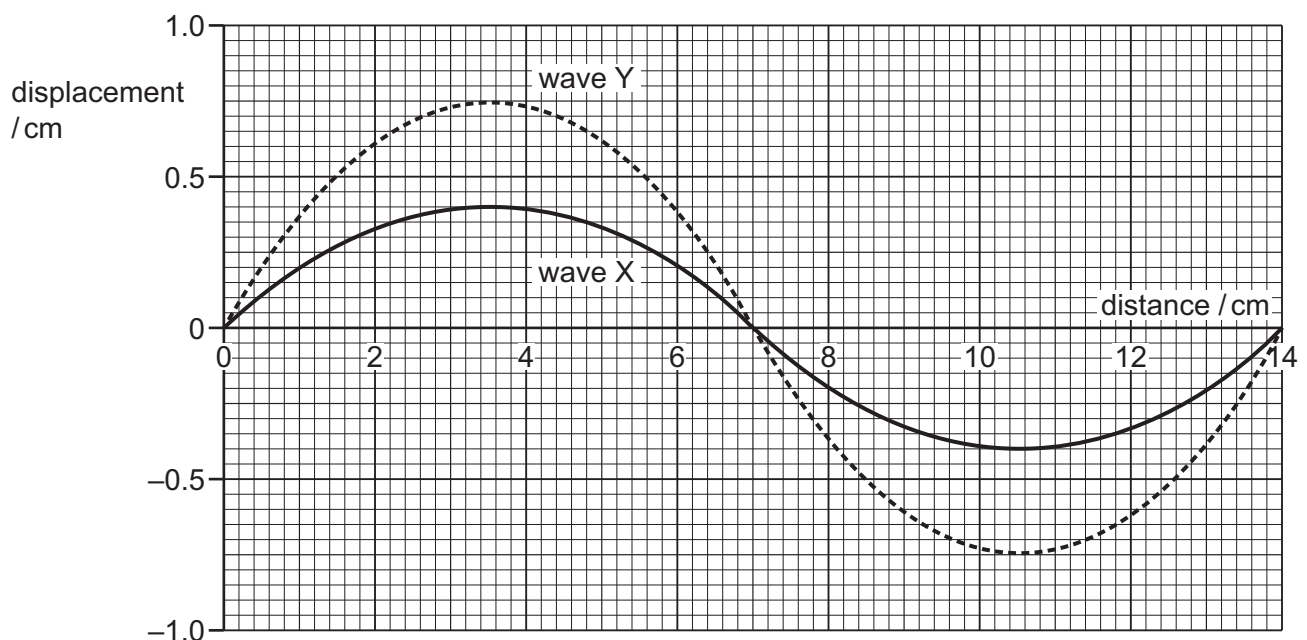
	transfers energy in a direction parallel to the oscillations	requires a medium to travel through	always travels at the same speed
A	false	false	true
B	false	true	true
C	true	false	false
D	true	true	false

25 What is the phase difference between points P and Q on the progressive wave shown in the diagram?



- A** 180° **B** 450° **C** 540° **D** 720°

26 The graph shows the variation of displacement with distance for two progressive waves X and Y of the same type in the same medium.



The intensity of wave X is I .

What is the intensity of wave Y?

- A** $0.28I$ **B** $0.53I$ **C** $1.9I$ **D** $3.5I$

- 27 A moving source emits sound of frequency 1200 Hz.

A stationary observer hears sound of frequency 960 Hz. The speed of the sound is 340 m s^{-1} .

What could be the velocity of the source?

- A 68 m s^{-1} directly away from the observer
- B 68 m s^{-1} directly towards the observer
- C 85 m s^{-1} directly away from the observer
- D 85 m s^{-1} directly towards the observer

- 28 A light wave passes through a single slit and a diffraction pattern forms.

What happens to the frequency and the speed of the wave when it is diffracted?

	frequency	speed
A	decreases	increases
B	increases	decreases
C	no change	decreases
D	no change	no change

- 29 The equation $n\lambda = d \sin \theta$ can be used with a diffraction grating to find the wavelength of visible light.

Which quantity is **not** correct for use in this equation?

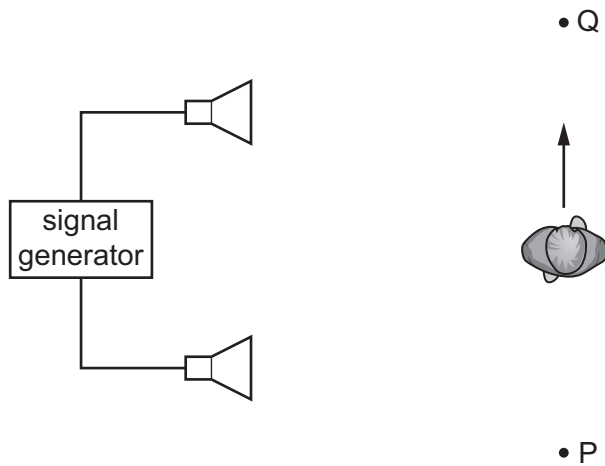
	symbol	quantity
A	d	distance from grating to screen
B	λ	wavelength of light
C	n	order of intensity maximum
D	θ	diffraction angle of intensity maximum

- 30 Two progressive sound waves move in opposite directions and superpose to form a stationary wave.

Which statement describes an antinode of this stationary wave?

- A a position where the phase difference between the two waves is always 0°
- B a position where the phase difference between the two waves is always 180°
- C a position where the stationary wave has maximum amplitude
- D a position where the stationary wave has minimum amplitude

- 31 A student connects two loudspeakers to a signal generator.



As the student walks from P to Q, he notices that the loudness of the sound rises and falls repeatedly.

What causes the loudness of the sound to vary?

- A diffraction of the sound waves
 - B Doppler shift of the sound waves
 - C interference of the sound waves
 - D reflection of the sound waves
- 32 The current in a resistor of constant resistance is 8.0 mA. The power dissipated by the resistor is P .

The current in the resistor is increased to 12.0 mA.

What is the new power dissipated by the resistor?

- A $0.44P$
- B $0.67P$
- C $1.5P$
- D $2.3P$

- 33** A piece of wire X has resistivity ρ , length L and cross-sectional area A . Wire X has a resistance R .

A second piece of wire Y is made of a different metal. It has the same resistance as X but has twice the length of X.

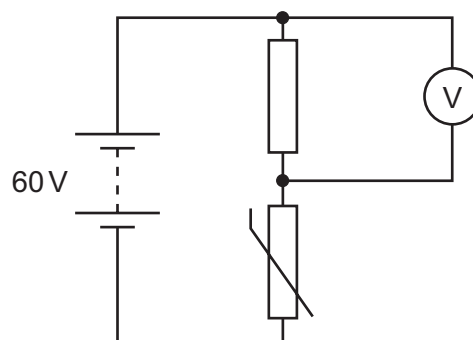
Which row gives possible values for the resistivity and the cross-sectional area of Y?

	resistivity	cross-sectional area
A	$\frac{1}{2}\rho$	$\frac{1}{2}A$
B	$\frac{1}{2}\rho$	A
C	ρ	$\frac{1}{2}A$
D	2ρ	A

- 34** A cell of electromotive force (e.m.f.) E delivers a charge Q to an external circuit.

Which statement is correct?

- A** The energy dissipated in the external circuit is EQ .
- B** The energy dissipated within the cell is EQ .
- C** The external resistance is EQ .
- D** The total energy dissipated in the cell and the external circuit is EQ .
- 35** The diagram shows a circuit with a battery of electromotive force (e.m.f.) 60 V and negligible internal resistance, a $20\text{ k}\Omega$ resistor, a thermistor and a voltmeter. The resistance of the thermistor is $20\text{ k}\Omega$.



The temperature of the thermistor decreases, and this causes its resistance to change by 50%.

After this change, what is the reading on the voltmeter?

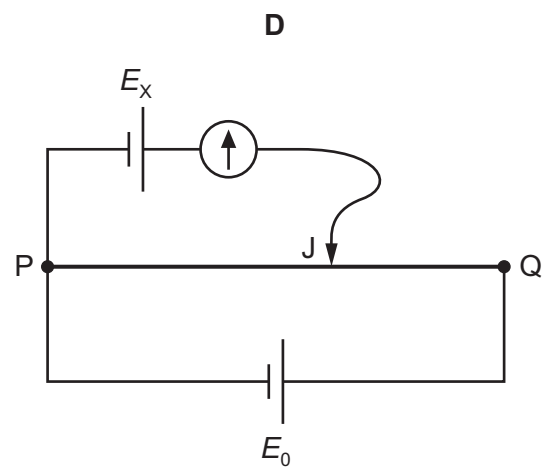
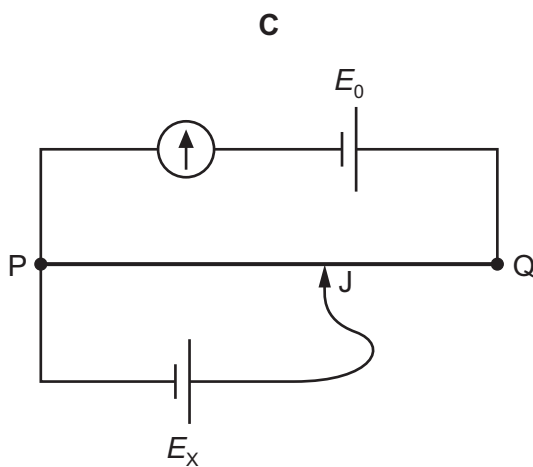
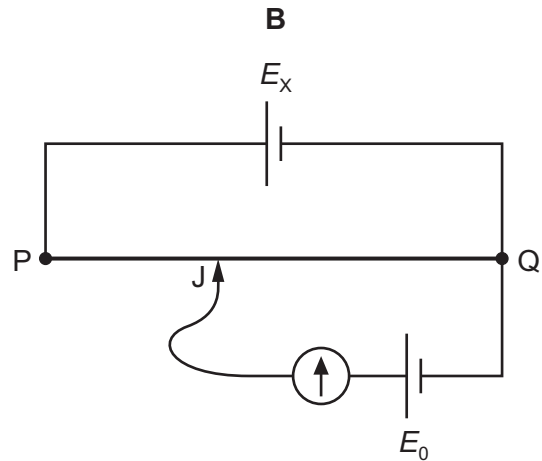
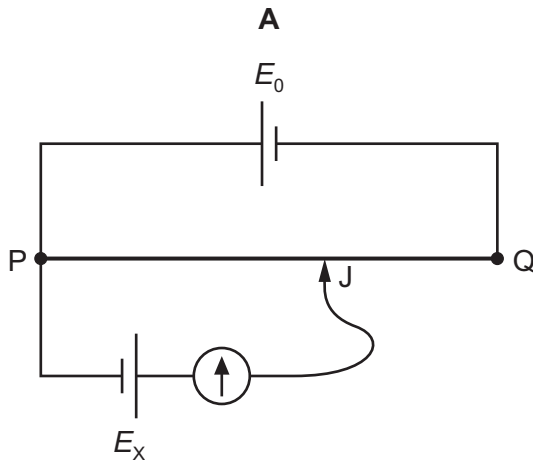
- A** 20 V **B** 24 V **C** 36 V **D** 40 V

- 36** A potentiometer circuit is used to determine the electromotive force (e.m.f.) E_x of a cell. The circuit includes a second cell of known e.m.f. E_0 and negligible internal resistance, and a uniform resistance wire PQ of known length.

E_x is less than E_0 .

The movable connection J can be positioned anywhere along the length of the resistance wire.

Which circuit is suitable for determining E_x ?



- 37** The principles of conservation of which two quantities are associated with Kirchhoff's first and second laws?

	first law	second law
A	charge	energy
B	charge	voltage
C	energy	charge
D	voltage	charge

- 38 An up quark in a hadron changes to a down quark.

The elementary charge is e .

What is the magnitude of the change in the charge of the hadron?

- A** $\frac{1}{3}e$ **B** $\frac{2}{3}e$ **C** e **D** zero

- 39 A nucleus of magnesium-23 decays to form a nucleus of sodium-23, emitting a β^+ particle and particle X.

What is particle X?

- A** an antineutrino
B an electron
C a neutron
D a neutrino

- 40 A nucleus of ${}_{92}^{238}\text{U}$ decays in stages by emitting α -particles and β^- particles, eventually forming a nucleus of ${}_{82}^{206}\text{Pb}$.

How many α -particles and how many β^- particles are emitted during the decay chain?

	α -particles	β^- particles
A	8	6
B	8	10
C	16	6
D	16	22

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Cambridge International AS & A Level

PHYSICS

9702/13

Paper 1 Multiple Choice

October/November 2025

1 hour 15 minutes

You must answer on the multiple choice answer sheet.

You will need: Multiple choice answer sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

INSTRUCTIONS

- There are **forty** questions on this paper. Answer **all** questions.
- For each question there are four possible answers **A**, **B**, **C** and **D**. Choose the **one** you consider correct and record your choice in soft pencil on the multiple choice answer sheet.
- Follow the instructions on the multiple choice answer sheet.
- Write in soft pencil.
- Write your name, centre number and candidate number on the multiple choice answer sheet in the spaces provided unless this has been done for you.
- Do **not** use correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.

INFORMATION

- The total mark for this paper is 40.
- Each correct answer will score one mark.
- Any rough working should be done on this question paper.

This document has **20** pages. Any blank pages are indicated.



Data

acceleration of free fall	$g = 9.81 \text{ m s}^{-2}$
speed of light in free space	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
elementary charge	$e = 1.60 \times 10^{-19} \text{ C}$
unified atomic mass unit	$1 \text{ u} = 1.66 \times 10^{-27} \text{ kg}$
rest mass of proton	$m_p = 1.67 \times 10^{-27} \text{ kg}$
rest mass of electron	$m_e = 9.11 \times 10^{-31} \text{ kg}$
Avogadro constant	$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$
molar gas constant	$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
Boltzmann constant	$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$
gravitational constant	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
permittivity of free space	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$ $(\frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 \text{ m F}^{-1})$
Planck constant	$h = 6.63 \times 10^{-34} \text{ J s}$
Stefan–Boltzmann constant	$\sigma = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$

Formulae

uniformly accelerated motion	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
hydrostatic pressure	$\Delta p = \rho g \Delta h$
upthrust	$F = \rho g V$
Doppler effect for sound waves	$f_o = \frac{f_s v}{v \pm v_s}$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \dots$
resistors in parallel	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$

- 1 The table shows some physical quantities.

Which row correctly identifies the quantities as scalars or vectors?

	acceleration	charge	kinetic energy	wavelength
A	scalar	vector	vector	scalar
B	vector	vector	scalar	scalar
C	scalar	scalar	scalar	vector
D	vector	scalar	scalar	scalar

- 2 Two quantities are measured.

$$L = 6.8 \pm 0.1 \text{ cm}$$

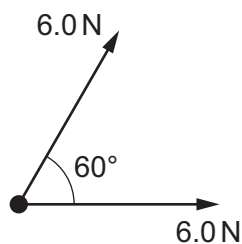
$$T = 2.42 \pm 0.08 \text{ s}$$

L and T are related to X by the equation shown.

$$X = \frac{4\pi^2 L}{T^2}$$

What is the calculated value and uncertainty of X ?

- A** $45.8 \pm 0.2 \text{ cm s}^{-2}$
B $45.8 \pm 0.3 \text{ cm s}^{-2}$
C $46 \pm 2 \text{ cm s}^{-2}$
D $46 \pm 4 \text{ cm s}^{-2}$
- 3 What are the SI base units of the watt?
- A** Js^{-1} **B** $\text{kg m}^2 \text{s}^{-3}$ **C** $\text{kg m}^2 \text{s}^{-1}$ **D** Nm s^{-1}
- 4 The diagram shows two forces of 6.0 N acting on an object. The angle between the lines of action of the two forces is 60° .



What is the magnitude of the resultant force?

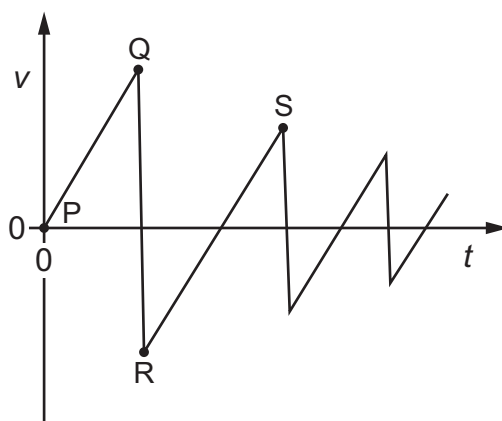
- A** 6.0 N **B** 7.9 N **C** 10 N **D** 12 N

- 5 A goods train passes through a station at a constant speed of 10 m s^{-1} at time $t = 0$. An express train is at rest at the station. The express train leaves the station with a uniform acceleration of 0.5 m s^{-2} just as the goods train goes past. Both trains move in the same direction on straight, parallel tracks.

At which time t does the express train overtake the goods train?

- A 6 s B 10 s C 20 s D 40 s
- 6 A ball is held above the ground and released. It falls to the ground and bounces several times.

The graph shows the variation with time t of the velocity v of the ball.

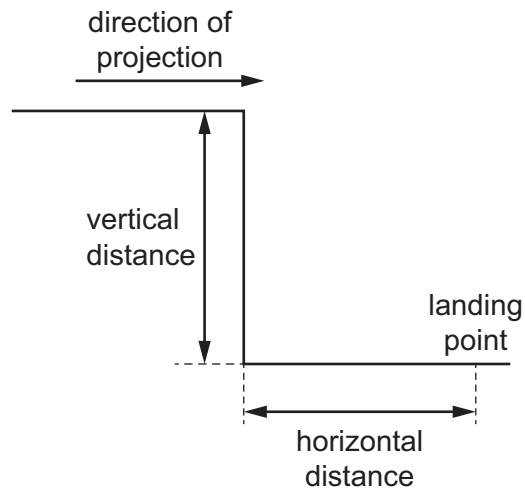


Four points on the graph are labelled P, Q, R and S.

Which statement is **not** correct?

- A The area under line PQ represents the initial height of the ball.
- B The collisions of the ball with the ground are inelastic.
- C The gradient of the line RS represents the acceleration due to free fall.
- D The maximum upwards velocity of the ball is reached at point P.

- 7 An object is projected horizontally. The object falls a vertical distance y and travels a horizontal distance x before landing on the ground.



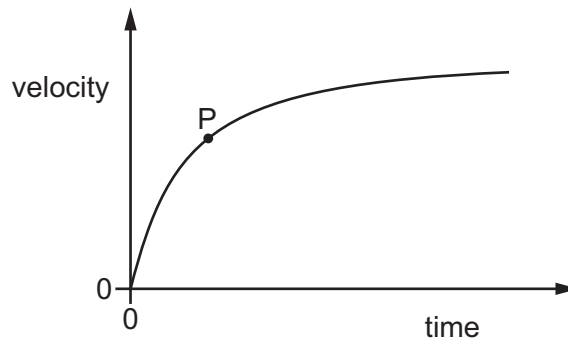
A second object is projected horizontally with the same initial velocity and falls a vertical distance $4y$ before landing on the ground.

Assume that air resistance is negligible.

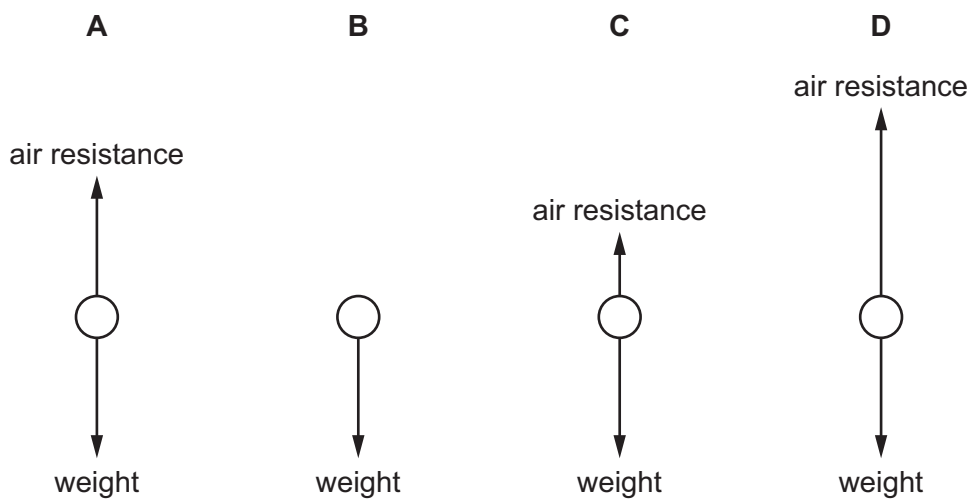
Which horizontal distance does the second object travel?

- A** x **B** $2x$ **C** $4x$ **D** $16x$

- 8 A sphere falls from rest through the air. The graph shows the variation with time of the sphere's velocity.



Which diagram shows the forces acting on the sphere when it is at the velocity corresponding to point P on the graph?



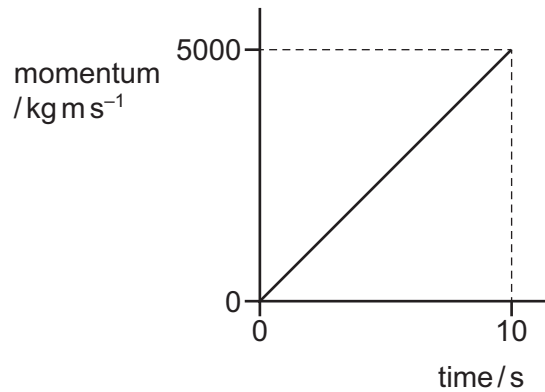
- 9 In which situation is total linear momentum **always** conserved?
- A in all collisions between two objects
 - B in collisions between two objects moving at equal and opposite velocity
 - C in collisions between two objects that form an isolated system
 - D in collisions between two objects with the same mass
- 10 An object of mass m moving with velocity 9.0 ms^{-1} has a head-on elastic collision with a stationary object of mass $2m$.

After the collision, both objects are moving. No external forces act on the system.

What is the velocity of the object of mass $2m$ after the collision?

- A -6.0 ms^{-1} B -3.0 ms^{-1} C 4.5 ms^{-1} D 6.0 ms^{-1}

- 11 The graph shows how the momentum of a motorcycle changes with time.



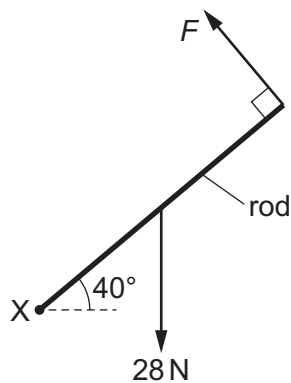
What is the resultant force on the motorcycle?

- A** 500 N **B** 5000 N **C** 25 000 N **D** 50 000 N
- 12 A rocket has a weight of W and an initial acceleration of a as the rocket leaves the ground vertically. The acceleration of free fall is g .

Which expression gives the initial upward force exerted on the rocket due to the engine?

- A** $\frac{Wa}{g} + W$ **B** $\frac{Wa}{g}$ **C** $\frac{Wa}{g} - W$ **D** $Wa + W$
- 13 A uniform rod of weight 28 N is supported at one end by force F .

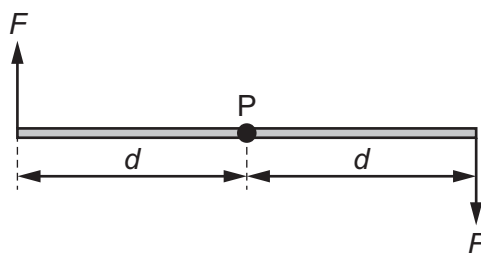
The rod is in equilibrium and attached to a frictionless hinge at end X.



What is the magnitude of F ?

- A** 9.0 N **B** 11 N **C** 18 N **D** 21 N

- 14 Two forces, each of magnitude F , act in opposite directions on a rod.



Each force acts on the rod at a distance d from the pivot P.

What is the torque of this couple about P?

- A** 0 **B** $F \times d$ **C** $2F \times d$ **D** $2F \times 2d$

- 15 A man of weight 600 N stands with both feet flat on the ground.

What is a reasonable estimate of the pressure exerted on the ground by the weight of the man?

- A** $1 \times 10^0 \text{ Pa}$ **B** $1 \times 10^2 \text{ Pa}$ **C** $1 \times 10^4 \text{ Pa}$ **D** $1 \times 10^6 \text{ Pa}$

- 16 The formula for the upthrust on a block of wood partially submerged in water is shown.

$$F = \rho g V$$

What do the symbols ρ and V represent?

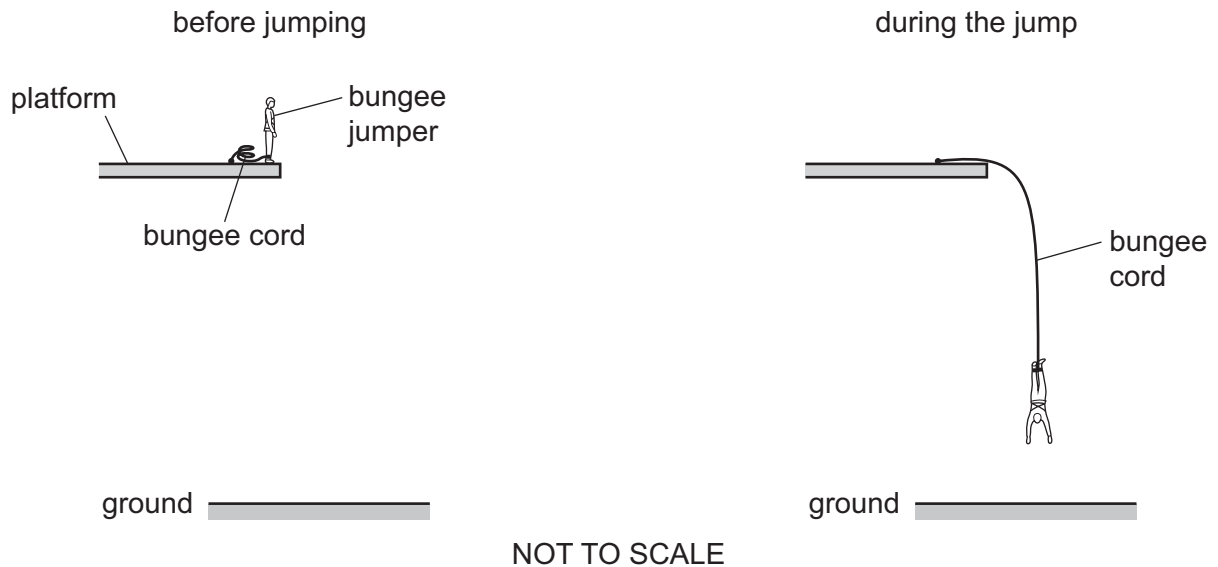
	ρ	V
A	density of water	volume of whole block
B	density of water	volume of block below surface of water
C	density of wood	volume of whole block
D	density of wood	volume of block below surface of water

- 17 An object with a mass of 100 g falls a vertical distance of 10 m.

What is the change in the gravitational potential energy of the object?

- A** 1 J **B** 10 J **C** 100 J **D** 10000 J

- 18** A bungee jumper jumps from a platform and is decelerated by an elastic bungee cord, as shown.



When the jumper makes the jump, his initial gravitational potential energy relative to the ground is converted into his kinetic energy and into elastic potential energy in the cord.

At which part of the jump are all three types of energy non-zero?

- A** on the platform before the jump
 - B** on the way down before the cord has started to extend
 - C** on the way down as he decelerates
 - D** at the bottom of the jump when he is stationary
- 19** A sailboat is pushed by the wind at a constant velocity v across a lake.

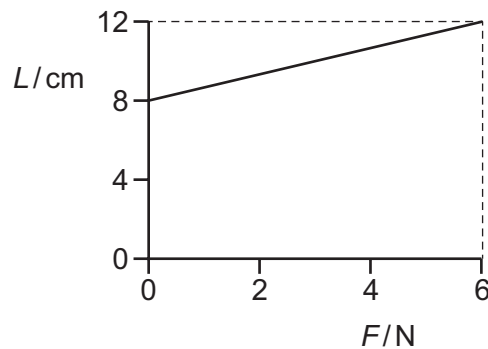
The force of the wind and the velocity of the sailboat are in the same direction.

Which additional information is required to determine the work done per unit time by the wind acting on the sailboat?

- A** the force exerted by the wind
- B** the distance travelled by the sailboat per unit time
- C** the total energy input to the sailboat by the wind
- D** the weight of the sailboat

- 20** A spring is fixed at one end. The length L of the spring is increased by applying a tensile force F to the other end.

The graph shows the variation of L with F .

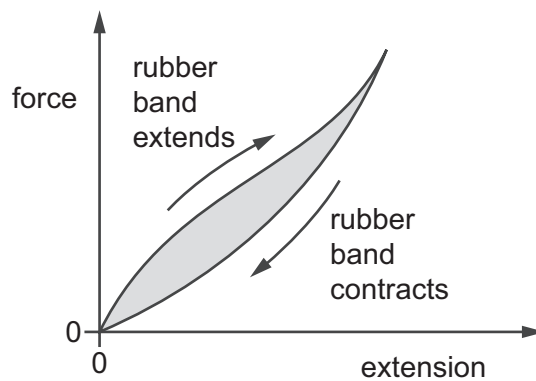


What is the elastic potential energy of the spring when F is 6.0 N?

- A** 0.12 J **B** 0.24 J **C** 0.36 J **D** 0.60 J
- 21** A wire has an unstretched length of 2.00 m.
- A stress of 1.6×10^5 Pa is applied to the wire, and the new length of the wire is 2.10 m.
- The wire obeys Hooke's law.
- What is the Young modulus of the wire?
- A** 8.0×10^3 Pa **B** 7.8×10^4 Pa **C** 1.5×10^5 Pa **D** 3.2×10^6 Pa
- 22** What are the SI base units of stress?

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

- 23 The diagram shows a force–extension graph for a rubber band as the band is extended and then the stretching force is decreased to zero.



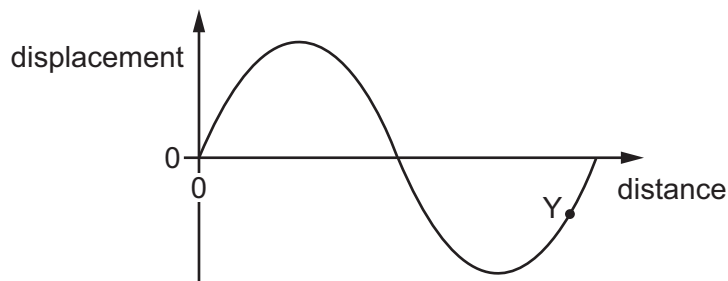
What can be deduced from the graph?

- A The rubber band does **not** return to its original length when the force is decreased to zero.
 - B The rubber band obeys Hooke's law for the extensions shown.
 - C The rubber band remains elastic for the extensions shown.
 - D The shaded area represents the work done in extending the rubber band.
- 24 Which row is correct for sound waves?

	can travel in a vacuum	can be polarised	can diffract through a gap
A	no	no	yes
B	yes	no	no
C	no	yes	no
D	no	yes	yes

- 25** A source emits a progressive sound wave in the horizontal direction. The wave travels away from the source in a direction towards the right.

The graph shows the variation of the displacement of the particles from their equilibrium positions with distance from the source at a particular instant in time. Displacements to the right of the equilibrium positions are shown as positive.



Position Y represents the displacement of a particle in the sound wave at a particular distance from the source at this instant.

Which statement about the motion of this particle is correct?

- A** The particle is moving away from the source.
 - B** The particle is moving towards the source.
 - C** The particle is moving upwards.
 - D** The particle is moving downwards.
- 26** Two polarising filters are placed next to each other so that their planes are parallel.

The first polarising filter has its transmission axis at an angle of 50° to the vertical.

The second polarising filter has its transmission axis at an angle of 20° to the vertical. The angle between the transmission axes of the two polarising filters is 30° .

A beam of vertically polarised light of intensity 8.0 W m^{-2} is incident normally on the first polarising filter.

What is the intensity of the light that is transmitted from the second polarising filter?

- A** zero
 - B** 2.5 W m^{-2}
 - C** 2.9 W m^{-2}
 - D** 6.0 W m^{-2}
- 27** A dolphin is swimming at a speed of 16.0 m s^{-1} directly towards a stationary underwater microphone.

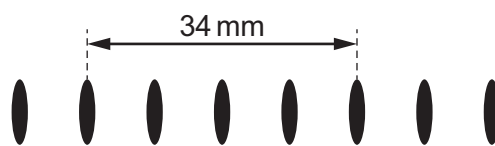
The dolphin emits a sound of frequency 122 kHz . The speed of sound in water is 1480 m s^{-1} .

What is the frequency of sound detected by the microphone?

- A** 1300 Hz
- B** 1330 Hz
- C** 121 kHz
- D** 123 kHz

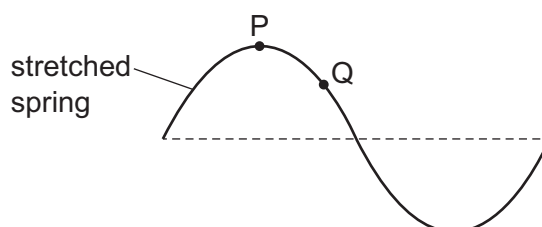
- 28 A student carries out a double-slit experiment using a laser emitting red light of wavelength of 680 nm. The light is incident normally on a double slit.

The diagram shows part of the pattern of bright fringes visible on a screen at a distance of 2.4 m from the slits. The distance across five bright fringes is measured as 34 mm.



What is the slit separation?

- A $8.5 \times 10^{-3} \text{ m}$ B $2.4 \times 10^{-4} \text{ m}$ C $1.9 \times 10^{-4} \text{ m}$ D $4.8 \times 10^{-5} \text{ m}$
- 29 The diagram shows a stationary wave on a stretched spring at an instant in time.



Two particles on the spring, P and Q, are shown.

Which statement about the vibrations of P and Q is correct?

- A They have different frequencies.
 B They have the same amplitudes.
 C They have different periods.
 D They are always in phase.
- 30 Green laser light passes through a diffraction grating and forms an interference pattern.

The diffraction grating contains 400 lines per mm.

The wavelength of the laser light is 550 nm.

What is the highest order diffraction maximum produced by the grating?

- A 4 B 5 C 8 D 9
- 31 There is a potential difference V across a resistor of resistance R . The current in the resistor is I .

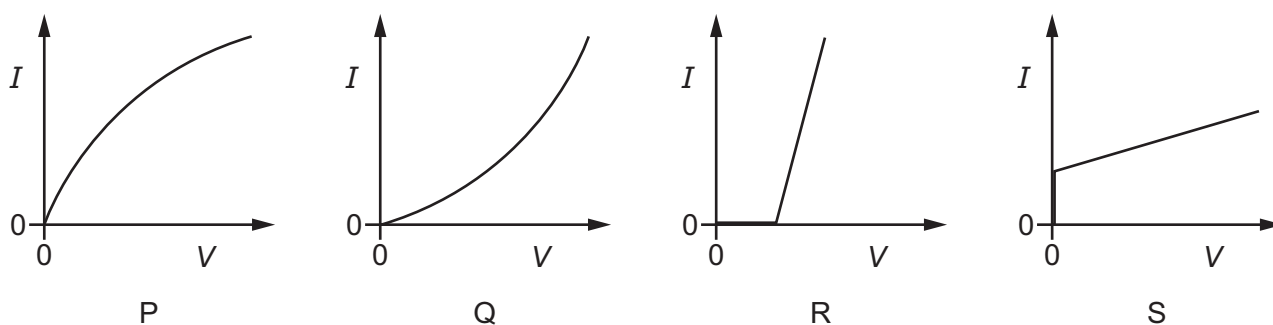
Which equation gives the power P dissipated by the resistor?

- A $P = V^2 I$ B $P = \frac{V^2}{I}$ C $P = V^2 R$ D $P = \frac{V^2}{R}$

32 What is a possible charge on a particle?

- A $6.40 \times 10^{-20} \text{ C}$
- B $4.00 \times 10^{-19} \text{ C}$
- C $1.12 \times 10^{-18} \text{ C}$
- D $9.11 \times 10^{-18} \text{ C}$

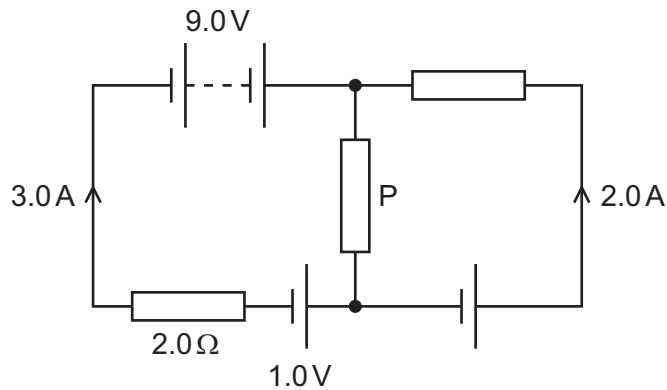
33 The graphs show possible current–voltage (I – V) characteristics for a filament lamp and for a semiconductor diode.



Which row identifies the I – V graphs for the lamp and for the diode?

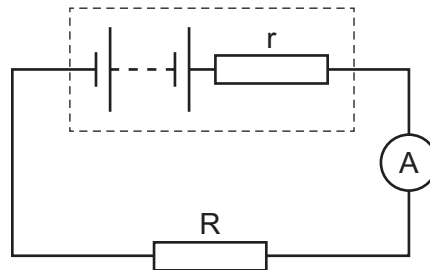
	filament lamp	semiconductor diode
A	P	R
B	P	S
C	Q	R
D	Q	S

- 34** The diagram shows a circuit containing a battery and cells with negligible internal resistance. Some values of current, electromotive force (e.m.f.) and resistance are shown. One resistor is labelled P.



What is the resistance of resistor P?

- A** 0.40Ω **B** 0.80Ω **C** 2.0Ω **D** 2.8Ω
- 35** The diagram shows a circuit with a battery connected to a resistor R. The battery has an internal resistance represented by resistor r.

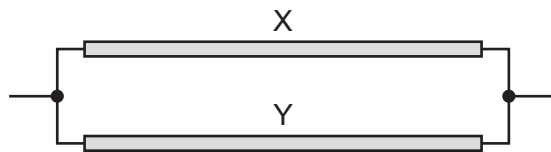


A second resistor, identical to R, is connected in parallel with R.

Which row describes the changes to the potential difference (p.d.) across r and the current shown on the ammeter when the second resistor is connected?

	p.d. across r	current shown on ammeter
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

- 36 Two identical wires X and Y, each of length L and radius r , are connected in parallel as shown.



The total resistance of this combination is R_1 .

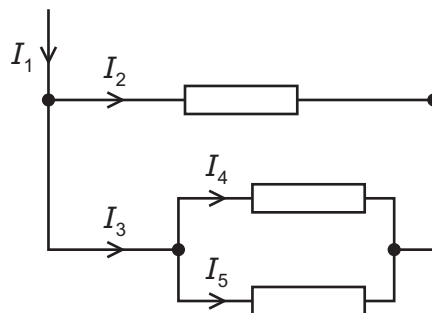
Wire X is replaced with a wire of the same material with length L and radius $2r$.

The total resistance of the new combination is R_2 .

What is the ratio $\frac{R_1}{R_2}$?

- A $\frac{2}{5}$ B $\frac{2}{3}$ C $\frac{3}{2}$ D $\frac{5}{2}$

- 37 The diagram shows the currents in part of an electric circuit.

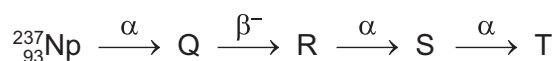


The resistors are identical.

Which equation is **not** correct?

- A $I_1 = I_2 + I_4 + I_5$
 B $I_2 = I_1 - I_3$
 C $I_2 = I_3 + I_4 + I_5$
 D $I_4 = I_3 - I_5$

- 38 The diagram shows a sequence of radioactive decays involving three α -particles and a β^- particle.



What is nuclide T?

- A ${}_{88}^{225}\text{Ra}$ B ${}_{88}^{231}\text{Ra}$ C ${}_{90}^{225}\text{Th}$ D ${}_{90}^{229}\text{Th}$

- 39** The number of electrons in a neutral atom of an isotope of plutonium, ${}^{239}_{94}\text{Pu}$, is changed to produce a charged atom (ion) W.

W has an overall charge of $+1.6 \times 10^{-19} \text{ C}$.

How many protons, neutrons and electrons are in W?

	protons	neutrons	electrons
A	94	145	93
B	94	145	95
C	238	94	239
D	239	94	238

- 40** Which particle is a lepton?

- A** meson
- B** positron
- C** proton
- D** quark

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Cambridge International AS & A Level

PHYSICS

9702/14

Paper 1 Multiple Choice

October/November 2025

1 hour 15 minutes

You must answer on the multiple choice answer sheet.

You will need: Multiple choice answer sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

INSTRUCTIONS

- There are **forty** questions on this paper. Answer **all** questions.
- For each question there are four possible answers **A**, **B**, **C** and **D**. Choose the **one** you consider correct and record your choice in soft pencil on the multiple choice answer sheet.
- Follow the instructions on the multiple choice answer sheet.
- Write in soft pencil.
- Write your name, centre number and candidate number on the multiple choice answer sheet in the spaces provided unless this has been done for you.
- Do **not** use correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.

INFORMATION

- The total mark for this paper is 40.
- Each correct answer will score one mark.
- Any rough working should be done on this question paper.

This document has **20** pages. Any blank pages are indicated.



Data

acceleration of free fall	$g = 9.81 \text{ m s}^{-2}$
speed of light in free space	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
elementary charge	$e = 1.60 \times 10^{-19} \text{ C}$
unified atomic mass unit	$1 \text{ u} = 1.66 \times 10^{-27} \text{ kg}$
rest mass of proton	$m_p = 1.67 \times 10^{-27} \text{ kg}$
rest mass of electron	$m_e = 9.11 \times 10^{-31} \text{ kg}$
Avogadro constant	$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$
molar gas constant	$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
Boltzmann constant	$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$
gravitational constant	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
permittivity of free space	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$ $(\frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 \text{ m F}^{-1})$
Planck constant	$h = 6.63 \times 10^{-34} \text{ J s}$
Stefan–Boltzmann constant	$\sigma = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$

Formulae

uniformly accelerated motion	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
hydrostatic pressure	$\Delta p = \rho g \Delta h$
upthrust	$F = \rho g V$
Doppler effect for sound waves	$f_o = \frac{f_s v}{v \pm v_s}$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \dots$
resistors in parallel	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$

1 What is essential to accurately represent all physical quantities?

- A a base unit and a number
- B a unit and a number expressed in standard form (scientific notation)
- C a unit and a numerical magnitude
- D an SI unit and a numerical magnitude

2 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

3 A stone is released from rest and falls vertically to the ground.

The time taken to fall to the ground and the distance travelled are measured. The measurements are used to determine the acceleration of free fall.

The percentage uncertainty in the measured time is 0.05%. The percentage uncertainty in the measured distance fallen is 0.6%.

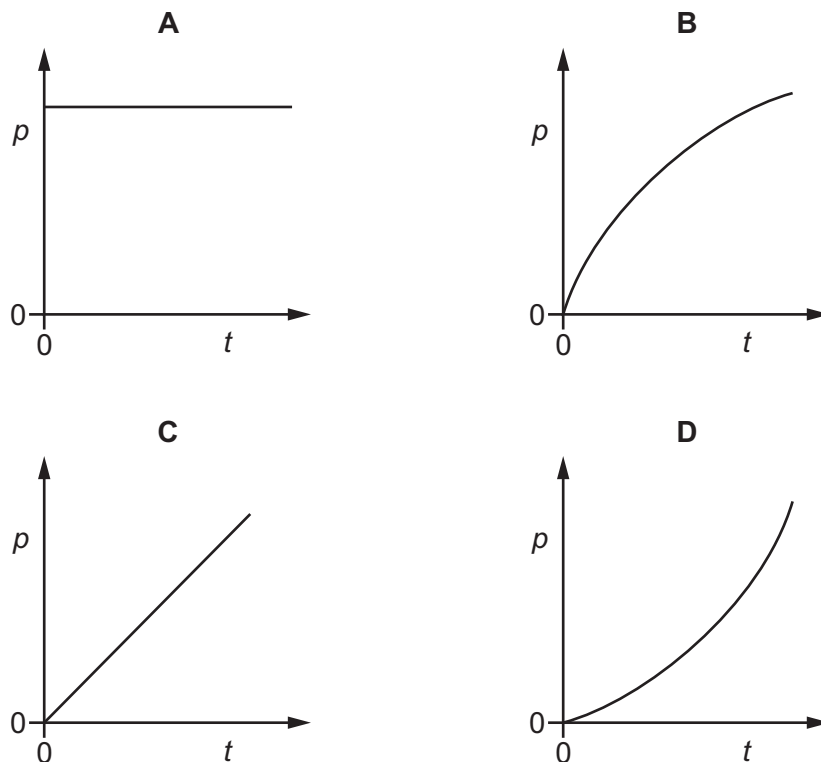
What is the percentage uncertainty in the calculated value of the acceleration of free fall?

- A** 0.5%
- B** 0.7%
- C** 1.1%
- D** 1.3%

- 4 An object falls from rest towards the ground.

Air resistance is negligible.

Which graph shows the variation of the momentum p of the object with time t until it hits the ground?



- 5 A projectile is fired at an angle of 45° upwards from horizontal ground. Air resistance is negligible.

Which row describes the horizontal motion and the vertical motion of the projectile after it is fired until immediately before it reaches the ground again?

	horizontal motion	vertical motion
A	constant velocity	constant acceleration
B	constant velocity	varying acceleration
C	varying velocity	constant acceleration
D	varying velocity	varying acceleration

- 6 An aircraft on a runway accelerates uniformly from rest to its take-off speed of 58 m s^{-1} .

The acceleration of the aircraft is 4.2 m s^{-2} , and the aircraft uses 74% of the length of the runway to reach its take-off speed.

What is the length of the runway?

- A** 300 m **B** 540 m **C** 590 m **D** 800 m

7 How can the acceleration of an object be determined?

- A from the area under a displacement–time graph
- B from the area under a velocity–time graph
- C from the gradient of a displacement–time graph
- D from the gradient of a velocity–time graph

8 The acceleration of free fall on the Earth is different to the acceleration of free fall on the Moon.

How do the mass and weight of an object on the Earth compare to its mass and weight on the Moon?

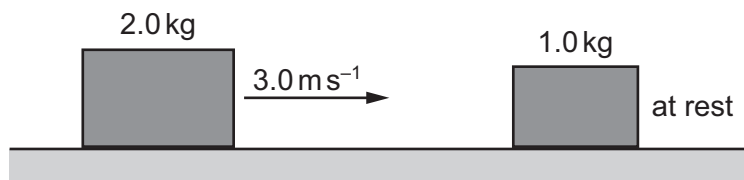
	mass	weight
A	different	different
B	different	same
C	same	different
D	same	same

9 A sphere moves vertically downwards at terminal (constant) velocity in a liquid.

Which statement about the magnitude of the upthrust acting on the sphere is correct?

- A It is proportional to the acceleration of free fall.
- B It is equal to the weight of the sphere.
- C It is proportional to the density of the sphere.
- D It is proportional to the square of the radius of the sphere.

10 An object of mass 2.0 kg is travelling at a speed of 3.0 ms^{-1} on a horizontal frictionless surface. This object collides head-on with a stationary object of mass 1.0 kg . The two objects stick together on impact.



How much kinetic energy is lost on impact?

- A zero
- B 2.0 J
- C 2.4 J
- D 3.0 J

- 11 A moving object X collides with a stationary object Y.

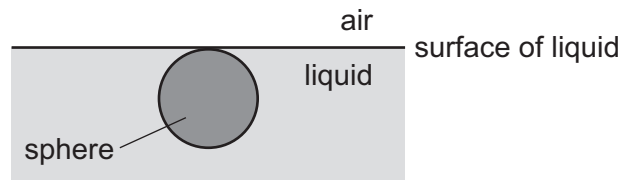
The objects separate after the collision.

The collision is perfectly elastic and there are no external forces acting.

Which word equation is **not** correct?

- A during the collision, (force acting on object X) + (force acting on object Y) = zero
 - B (relative speed of approach of X and Y) + (relative speed of separation of X and Y) = zero
 - C (total kinetic energy before collision) = (total kinetic energy after collision)
 - D (total momentum before collision) = (total momentum after collision)
- 12 The diagram shows a stationary sphere that is just fully submerged in a liquid. The radius of the sphere is r and the density of the liquid is ρ . The acceleration of free fall is g .

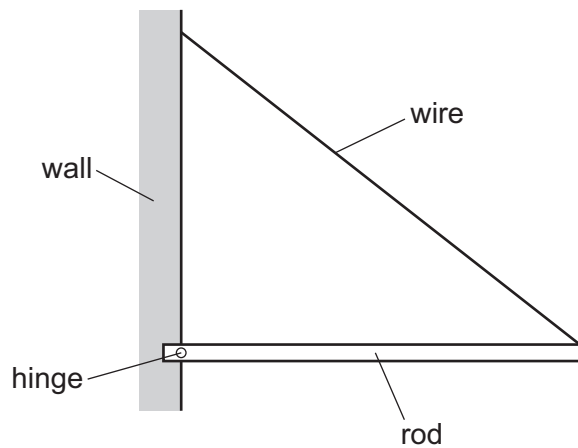
The air exerts pressure P_A on the surface of the liquid.



What is the pressure at the lowest point of the sphere?

- A $P_A + \frac{4}{3}\pi r^3 \rho g$
- B $P_A - \frac{4}{3}\pi r^3 \rho g$
- C $2r\rho g + P_A$
- D $2r\rho g - P_A$

- 13 A uniform rod is attached by a hinge at one end to a wall. The other end of the rod is supported by a wire so that the rod is horizontal and in equilibrium.



Which arrow shows the direction of the force on the rod from the hinge?

A



B



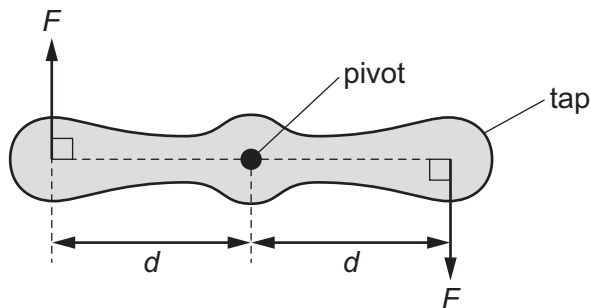
C



D



- 14 A couple is applied to a tap, as shown.



What is the torque of the couple?

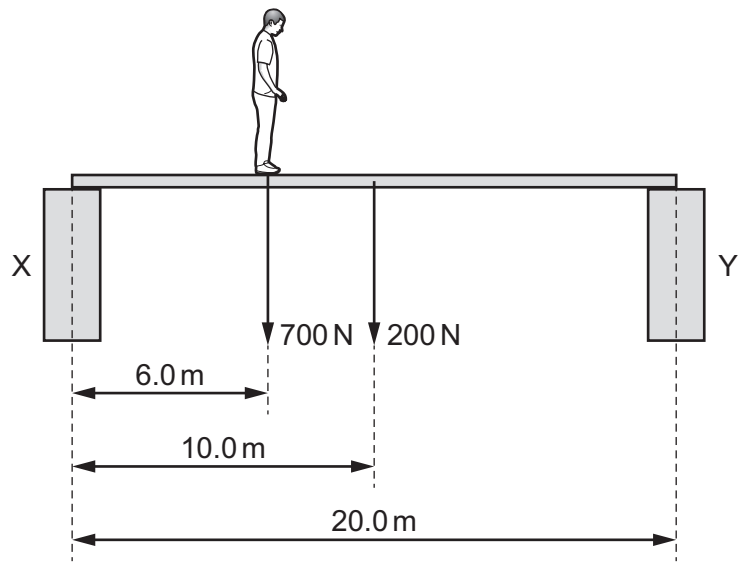
A $\frac{Fd}{2}$

B Fd

C $2Fd$

D $4Fd$

15 A uniform beam rests on two supports, X and Y, as shown.



not to scale

The beam has length 20.0 m and weight 200 N.

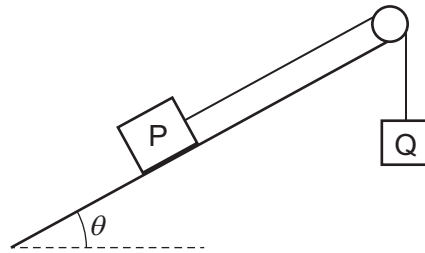
A man of weight 700 N stands on the beam at a distance of 6.0 m from support X.

The beam is in equilibrium.

What is the contact force of support X on the beam?

- A** 310 N **B** 450 N **C** 590 N **D** 900 N

- 16 The diagram shows a block P of mass M connected by a string over a frictionless pulley to a block Q of mass m .



Block P moves up the slope with a constant velocity v . The slope is at angle θ to the horizontal.

The acceleration of free fall is g .

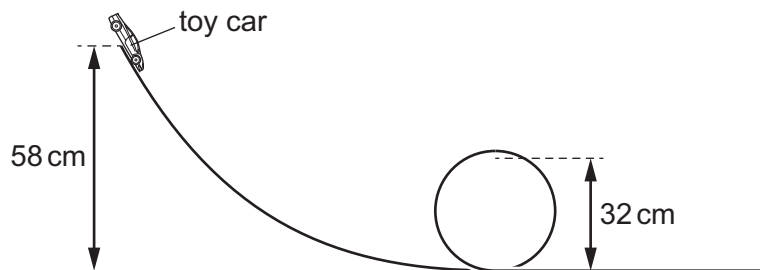
The resistive forces on the blocks are negligible.

Which expressions give the energy transferred per unit time to block P?

- 1 mgv
- 2 $Mgv \sin \theta$
- 3 $(M + m)gv$

- A** 1 and 2 **B** 1 only **C** 2 and 3 **D** 2 only

- 17 A toy car travels around a vertical loop track.



The toy car is released from rest at a height of 58 cm above the bottom of the vertical loop.

The car is at a height of 32 cm when it is at the top of the vertical loop.

Assume that no resistive forces act on the car.

What is the speed of the car at the top of the vertical loop?

- A** 0.87 ms^{-1} **B** 2.3 ms^{-1} **C** 2.5 ms^{-1} **D** 3.4 ms^{-1}

- 18 The total energy supplied to an electric motor is E . Energy Q is wasted and the remaining energy does useful work.

What is the efficiency of the motor?

- A $\frac{Q}{E}$ B $\left(\frac{Q}{E}\right) - 1$ C $1 - \left(\frac{Q}{E}\right)$ D $\frac{(1-Q)}{E}$

- 19 An object travels between two points. The change in gravitational potential energy ΔE_p of the object is given by

$$\Delta E_p = mg\Delta h$$

where m is the mass of the object, Δh is its change in height and g is the acceleration of free fall.

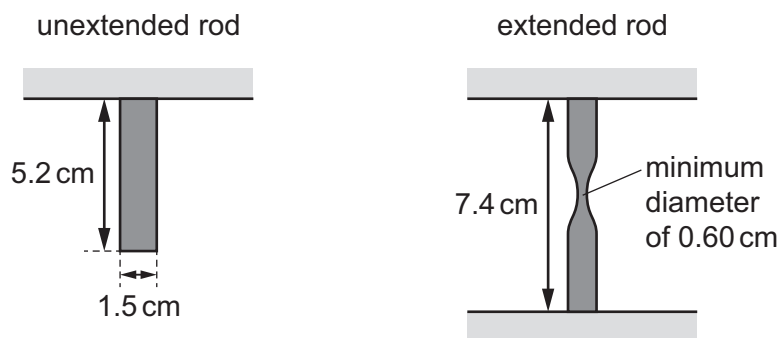
What is a necessary condition in order for the above equation to be valid?

- A The object must have a constant acceleration of 9.81 m s^{-2} .
 B The object must be travelling in a uniform gravitational field.
 C The object must be travelling only in a vertical direction.
 D The resultant force on the object must be equal to its weight.
- 20 A cylindrical steel rod with negligible weight has a diameter of 1.5 cm and a length of 5.2 cm.

The rod is firmly attached at the top end.

The rod is firmly attached to a machine at the other end that applies a constant force of 363 N to the rod.

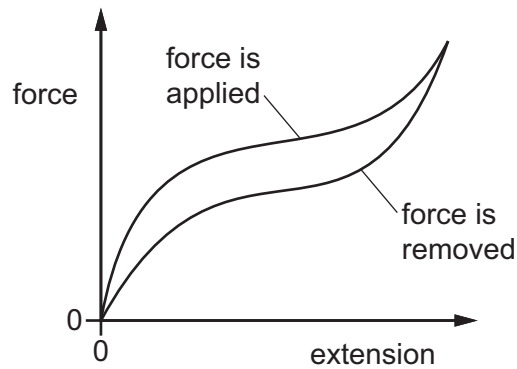
This causes the rod to extend to a length of 7.4 cm and to have a minimum diameter of 0.60 cm in the position shown.



What is the maximum stress acting on the steel rod when the length is 7.4 cm?

- A $2.1 \times 10^6 \text{ Pa}$ B $3.2 \times 10^6 \text{ Pa}$ C $5.7 \times 10^6 \text{ Pa}$ D $1.3 \times 10^7 \text{ Pa}$

- 21 The graph shows the variation in extension with force for a sample of rubber.



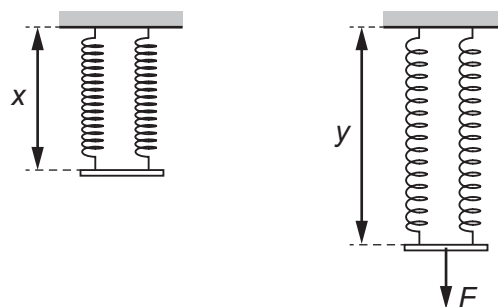
The top line shows the variation in extension as a force is applied.

The bottom line shows the variation in extension as the force is removed.

What is represented by the area between the two lines?

- A the work done as the force is applied
 - B the work done as the force is applied minus the work done as the force is removed
 - C the work done as the force is removed
 - D the work done as the force is removed plus the work done as the force is applied
- 22 Two identical springs have the same spring constant k . The springs are connected in parallel. The length of the unstretched springs is x .

A force F is applied to the spring combination. The length of the springs is now y .



Both springs are deformed within their limits of proportionality.

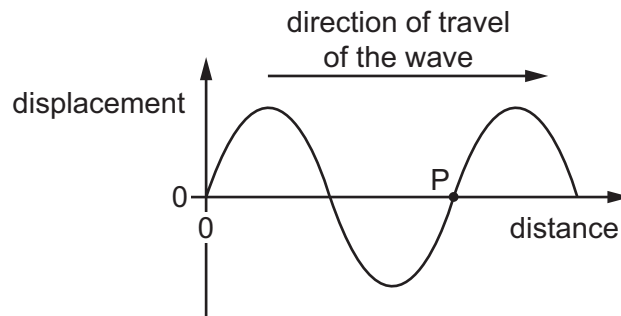
Which expression gives the elastic potential energy stored in **one** of the springs?

- A $\frac{1}{4}F(y - x)$
 - B $\frac{1}{2}F(y - x)$
 - C $\frac{1}{4}k(y - x)^2$
 - D $k(y - x)^2$
- 23 Which expression gives the formula for the spring constant?

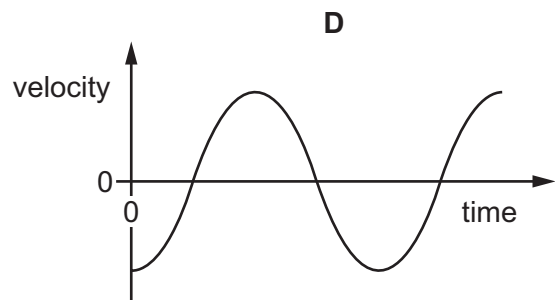
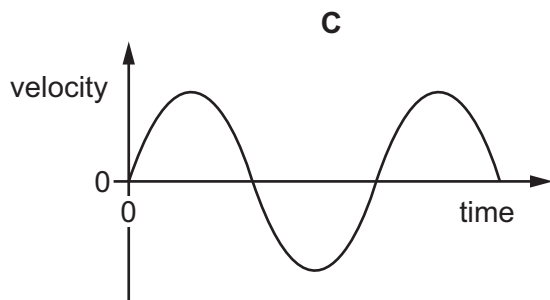
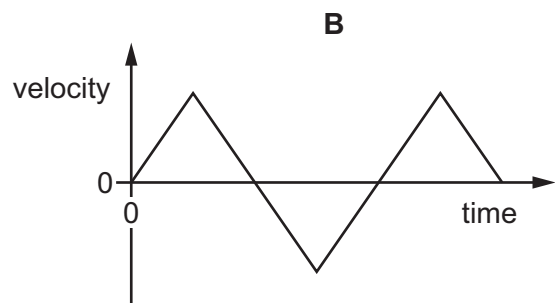
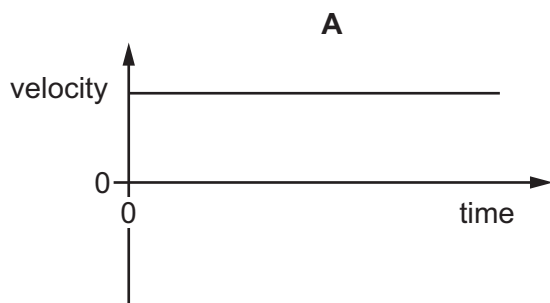
- A Fx
- B $2Fx^2$
- C $\frac{F}{x}$
- D $\frac{F}{x^2}$

24 A transverse progressive wave travels along a string.

The graph shows the variation with distance of the displacement of the string at time $t = 0$.



Which graph represents the variation with time of the velocity of point P on the string?



25 Which statement about electromagnetic waves is correct?

- A** A wave of wavelength $5.0 \times 10^{-6} \text{ m}$ is invisible to the human eye.
- B** They can all travel at different speeds in free space.
- C** They **cannot** be polarised.
- D** They consist of vibrating atoms.

- 26 For a progressive transverse wave, what describes the term diffraction?
- A the change in observed frequency of a wave due to a movement of the wave source
 - B the spreading of a wave as it passes through a gap or around an obstacle
 - C when oscillations of a wave are confined to one plane
 - D the resultant displacement of two waves is equal to the sum of the displacements of the individual waves when the waves meet

- 27 An aircraft flies at a velocity v_s directly away from a stationary observer.

The aircraft emits a sound of constant frequency.

The speed of sound in air is v .

The frequency of the sound heard by the observer on the ground is 500 Hz.

The speed of the aircraft is increased so that it flies away from the observer at a greater velocity.

The observer now hears a sound of frequency 250 Hz.

Which expression gives the new velocity of the aircraft?

- A $2(v + v_s)$ B $\frac{v + v_s}{2}$ C $2v_s + v$ D $2v_s - v$

- 28 What may be observed with light waves but **not** with sound waves?

- A diffraction
- B interference
- C polarisation
- D reflection

- 29 A wire is fixed at both ends and is vibrated by a source of frequency f . A stationary wave is formed on the wire with a total of two antinodes.

The frequency of the source is increased to $3f$ and a new stationary wave is formed.

What is the total number of antinodes on the new wave?

- A 4 B 5 C 6 D 9

- 30 A parallel beam of red light of wavelength 700 nm is incident normally on a diffraction grating that has 400 lines per millimetre.

What is the total number of intensity maxima from the grating?

- A 6 B 7 C 8 D 9

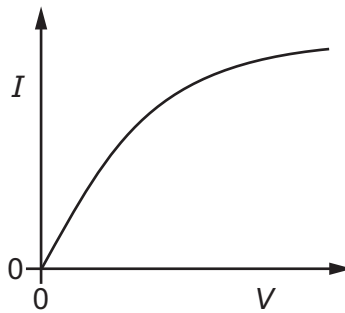
- 31 Two light sources are used to produce an interference pattern.

Interference fringes appear when the two sources emit waves that are coherent.

What is meant by coherent waves?

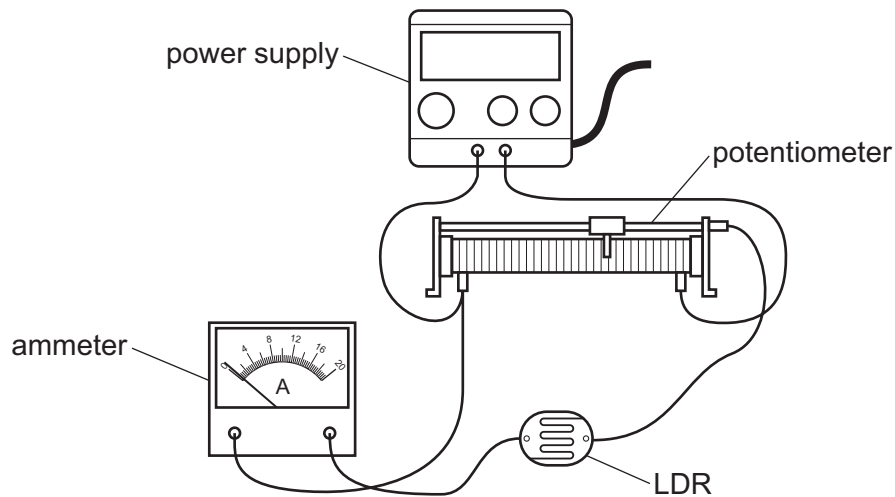
- A The two waves are emitted with the same frequency.
- B The two waves are emitted with constant phase difference.
- C The two waves are emitted with the same intensity.
- D The two waves are emitted with zero phase difference.

- 32 Which component has the I – V graph shown?

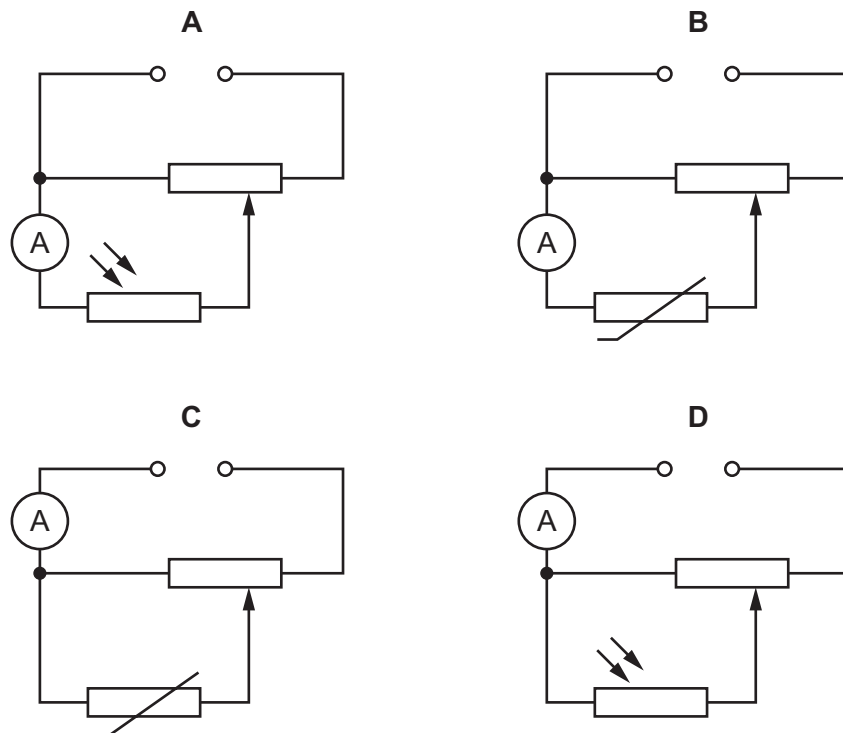


- A filament lamp
- B metallic conductor at constant temperature
- C resistor of fixed resistance
- D semiconductor diode

- 33 The diagram shows an electrical circuit containing a light-dependent resistor (LDR).



What is the circuit diagram for this circuit?



- 34 A copper wire of length 2 m has a circular cross-section. There is a constant current in the wire when it is connected to a mobile phone in order to charge the battery.

The wire has a fault. A 1 m length of the wire has half the diameter of the other 1 m length.

The power dissipated in the thicker length of wire is P .

What is the power dissipated in the thinner length of wire?

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

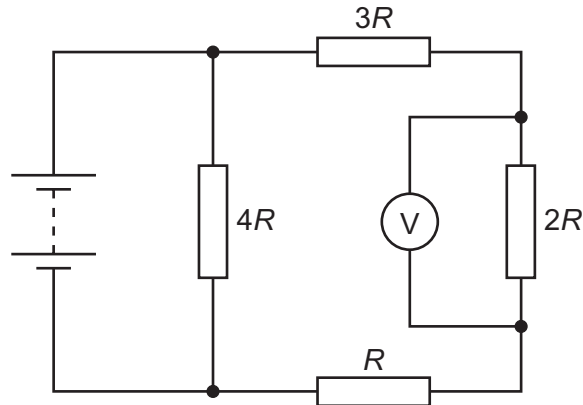
- 35** A wire carries a current of 5.6 A.

What is the number of conduction electrons that pass a point on the wire in a time of 20 s?

- A** 1.8×10^{18} **B** 2.2×10^{19} **C** 3.5×10^{19} **D** 7.0×10^{20}

- 36** Four resistors of resistance R , $2R$, $3R$ and $4R$ are connected to form a network.

A battery of negligible internal resistance and a voltmeter are connected to the resistor network as shown.

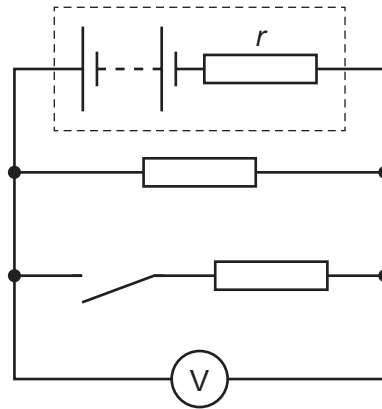


The voltmeter reading is 2 V.

What is the electromotive force (e.m.f.) of the battery?

- A** 2 V **B** 4 V **C** 6 V **D** 10 V

- 37 The circuit diagram shows a battery with internal resistance r , two resistors, a switch and a voltmeter. The switch is open.



The switch is now closed.

What happens to the current in the battery, and what happens to the reading on the voltmeter, when the switch is closed?

	current in battery	reading on voltmeter
A	increases	decreases
B	increases	remains the same
C	remains the same	decreases
D	remains the same	remains the same

- 38 What is the correct equation for β^+ decay?

- A** neutron $\rightarrow$ proton + electron + electron antineutrino
B neutron $\rightarrow$ proton + electron + electron neutrino
C proton $\rightarrow$ neutron + positron + electron antineutrino
D proton $\rightarrow$ neutron + positron + electron neutrino

- 39 A nucleus of polonium, $^{214}_{84}\text{Po}$, decays by emitting an α -particle to become a nucleus of lead.

The nucleus of lead is also unstable and decays by emitting a β^- particle to form a nucleus of bismuth which then decays by emitting a β^- particle to produce a nucleus X.

What is the number of neutrons in nucleus X?

- A** 126 **B** 128 **C** 130 **D** 210

40 Which combination of three quarks has no overall charge?

- A** down, strange, strange
- B** up, charm, strange
- C** up, charm, top
- D** up, down, strange

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