



Cambridge International AS & A Level

PHYSICS

9702/11

Paper 1 Multiple Choice

May/June 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.
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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 **16** pages.



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 Which quantity is a vector?

- A pressure
- B temperature
- C weight
- D work

2 Four students, **A**, **B**, **C** and **D**, have completed an experiment to determine the acceleration of free fall, g . Each student repeated the experiment three times. The determined values of g are shown in the table.

Which set of results has a high precision and a low accuracy?

	acceleration of free fall / m s^{-2}		
	experiment 1	experiment 2	experiment 3
A	7.2	9.4	8.3
B	9.5	9.8	10.2
C	9.8	9.8	9.9
D	10.1	10.2	10.1

3 The diameter of a ball is measured as $(5.26 \pm 0.02) \text{ cm}$.

What is the absolute uncertainty in the volume of the ball?

- A 0.29 cm^3
- B 0.87 cm^3
- C 1.1 cm^3
- D 7.0 cm^3

- 4 Two vectors, X and Y , are shown.



What are the directions of $X + Y$ and $X - Y$?

	$X + Y$	$X - Y$
A		
B		
C		
D		

- 5 A ball is projected vertically downwards with an initial velocity of 20 m s^{-1} . Air resistance is negligible.

What is the displacement from its initial position of the ball after a time of 1.5 s?

- A 11 m B 19 m C 37 m D 41 m

- 6 A surveyor's device emits a pulse of light. The light is reflected from a wall 150 m away.

What is the total time taken for the pulse to travel from the device to the wall and then back to the device?

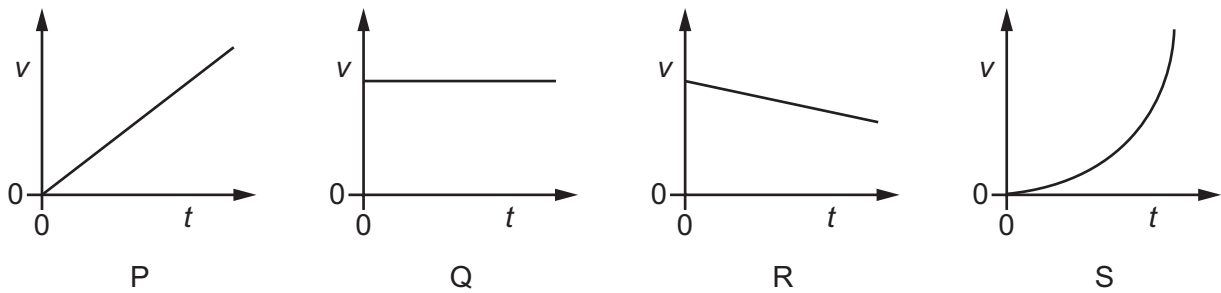
- A 0.05 ns B 0.10 ns C $0.50 \mu\text{s}$ D $1.0 \mu\text{s}$

- 7 Which equation of uniformly accelerated motion can be derived using only the gradient of a velocity–time graph?

- A** $s = \frac{1}{2}(u + v)t$
B $s = ut + \frac{1}{2}at^2$
C $v = u + at$
D $v^2 = u^2 + 2as$

- 8 An object is projected horizontally from a table at time $t = 0$. The object falls in a uniform gravitational field. Air resistance is negligible.

Graphs P, Q, R and S are velocity–time graphs.



Which graphs represent the horizontal and vertical components of the velocity of the object?

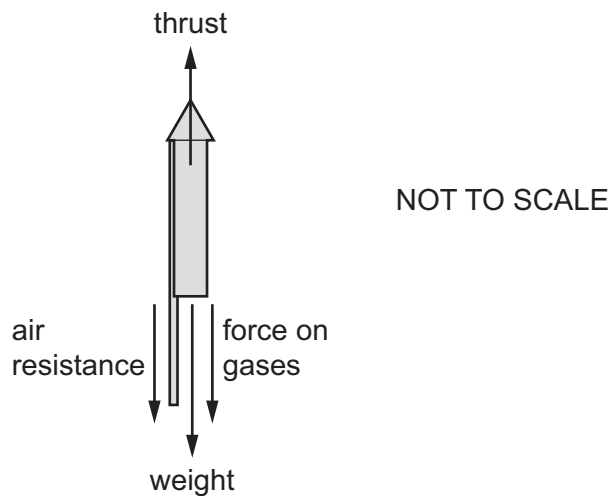
	horizontal	vertical
A	Q	P
B	Q	S
C	R	P
D	R	S

- 9 What is always conserved in elastic collisions?

	total kinetic energy	total velocity
A	yes	yes
B	yes	no
C	no	yes
D	no	no

- 10 A firework travels vertically upwards in air. Gases are pushed vertically downwards from the firework.

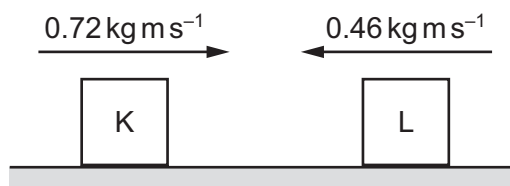
Several forces that act on the firework and gases are shown.



Which forces are a Newton's third law pair?

- A air resistance and force on gases
 - B air resistance and thrust
 - C force on gases and thrust
 - D thrust and weight
- 11 Two blocks K and L slide towards each other along a horizontal frictionless surface.

The diagram shows the momentum of the two blocks just before they collide.



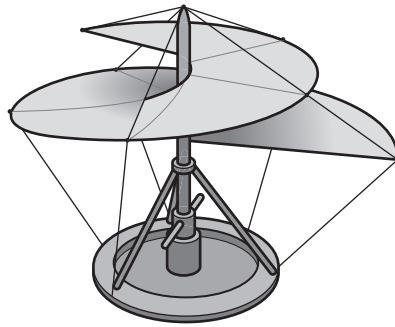
During the collision, the blocks are in contact with each other for a time of 0.084 s.

After the collision, the blocks separate and block L moves back along its original path with a momentum of 0.12 kg m s^{-1} .

What is the magnitude of the average force exerted on block L by block K during the collision?

- A 3.1 N
- B 4.0 N
- C 6.9 N
- D 7.1 N

- 12** Leonardo da Vinci proposed a flying machine that would work like a screw to lift the pilot into the air. The 'screw' is rotated by the pilot.



The machine and the pilot together have a total mass of 120 kg.

Which useful output power must the pilot provide to move vertically upwards at a constant speed of 2.5 m s^{-1} ?

- A** 48 W **B** 300 W **C** 470 W **D** 2900 W

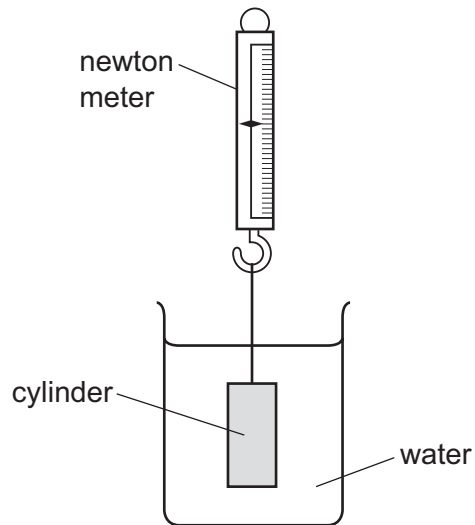
- 13** Which row describes a pair of forces that forms a couple?

	direction of the forces	magnitude of the forces
A	opposite	different
B	opposite	equal
C	same	different
D	same	equal

- 14 A uniform cylinder of weight 25.0 N is suspended from a newton meter.

The cylinder is fully submerged in water, as shown.

The reading on the newton meter is 10.0 N.



The water is replaced by a liquid with a density 10% greater than the density of water. The cylinder remains fully submerged.

What is the new reading on the newton meter?

- A 8.5 N B 9.0 N C 11.0 N D 11.5 N
- 15 A student balances a 30 cm ruler on a fulcrum set at the 15 cm mark. She then places a 50 g mass on the 23 cm mark and a 20 g mass on the 11 cm mark, as shown.



Which mass should she place on the 7 cm mark to restore the balance?

- A 30 g B 40 g C 47 g D 133 g
- 16 A submarine is at a depth of 130 m below the surface of the sea.

The pressure on the submarine due to the sea water is p .

The submarine sinks to a depth of 260 m below the surface.

Assume that the density of sea water is constant.

What is the **difference** between the pressures on the submarine due to the sea water at the two depths?

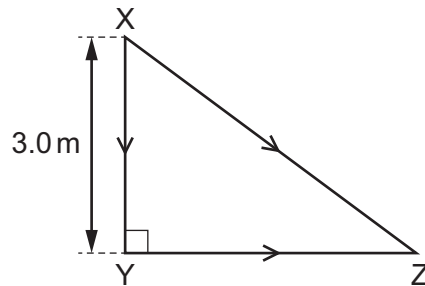
- A 0 B $0.5p$ C p D $2p$

- 17 An object is falling in a uniform gravitational field.

Which two quantities are sufficient to calculate the change in gravitational potential energy?

- A mass and acceleration of free fall
- B mass and change in vertical displacement
- C weight and acceleration of free fall
- D weight and change in vertical displacement

- 18 The points X, Y and Z are on a rough, horizontal surface.



A box P is pushed across the surface from X to Y and then from Y to Z.

The distance from X to Y is 3.0 m. The work done against the frictional force in moving the box from X to Y is 150 J.

The work done against the frictional force in moving the box from Y to Z is 200 J.

An identical box Q is pushed in a straight line from X to Z.

The magnitude of the frictional force between the boxes and the surface is constant.

How much extra work is done against the frictional force in moving P than Q?

- A 100 J
- B 250 J
- C 350 J
- D 600 J

- 19 The momentum of a car of mass m increases from p_1 to p_2 .

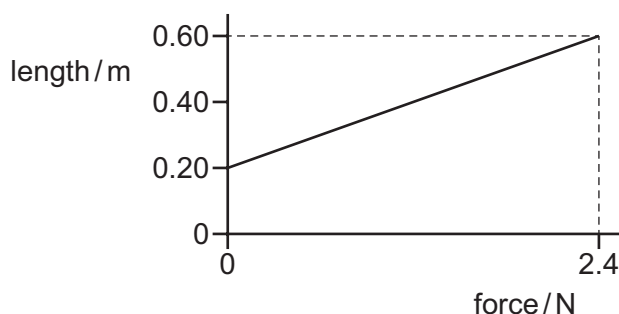
What is the increase in the kinetic energy of the car?

- A $\frac{(p_2^2 - p_1^2)}{2m}$
- B $\frac{(p_2 - p_1)^2}{2m}$
- C $\frac{p_2 - p_1}{2m}$
- D $\frac{p_1 - p_2}{2m}$

- 20 A parachutist is falling at constant (terminal) velocity.

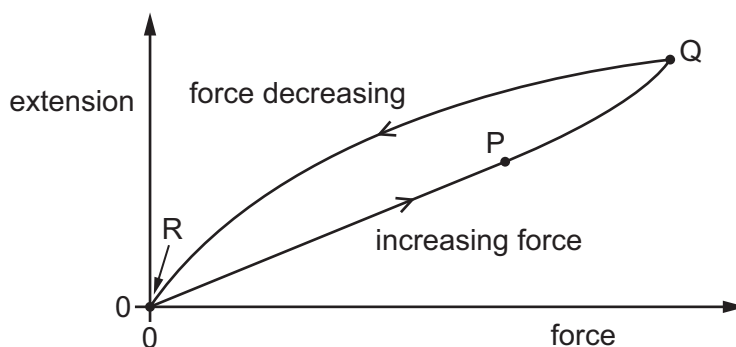
Which statement is **not** correct?

- A Gravitational potential energy is converted into kinetic energy of the air.
 - B Gravitational potential energy is converted into kinetic energy of the parachutist.
 - C Gravitational potential energy is converted into thermal energy of the air.
 - D Gravitational potential energy is converted into thermal energy of the parachutist.
- 21 A student investigates a spring. The variation of the length of the spring with the force applied to the spring is shown.



What is the spring constant of the spring?

- A 0.17 Nm^{-1}
 - B 0.25 Nm^{-1}
 - C 4.0 Nm^{-1}
 - D 6.0 Nm^{-1}
- 22 The graph shows the variation with force of the extension of a wire.



The force is gradually increased to a maximum at Q and then gradually decreased to zero at R.

Which statement is correct?

- A Along the line PQ, the wire obeys Hooke's law.
- B Along the line RP, the spring constant is equal to $\frac{\text{extension}}{\text{force}}$.
- C The wire has elastic deformation at point Q.
- D The work done in stretching the wire to P is equal to (force $\times$ extension) at point P.

- 23 A uniform metal wire of length L and diameter d has spring constant k .

What is the Young modulus of the metal?

- A $\frac{\pi d^2}{4kL}$ B $\frac{\pi d^2}{kL}$ C $\frac{kL}{\pi d^2}$ D $\frac{4kL}{\pi d^2}$

- 24 An aircraft produces a sound at a frequency of 30.0 Hz.

The speed of sound in air is 330 m s^{-1} .

The aircraft is directly in front of the stationary observer and travels in a straight line towards or away from the observer.

The observer hears the sound from the aircraft at a frequency of 20.0 Hz.

What is the speed and direction of the aircraft?

	speed / m s^{-1}	direction
A	110	away from observer
B	110	towards observer
C	165	away from observer
D	165	towards observer

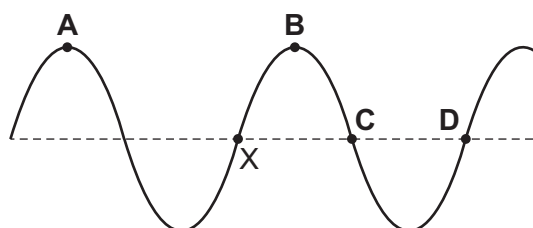
- 25 Which statement about longitudinal and transverse wave motion for a progressive wave is correct?

- A All transverse and longitudinal waves require a medium for propagation.
- B All transverse waves travel at the same speed, but longitudinal waves can travel at different speeds.
- C In both transverse waves and longitudinal waves, a particle with zero displacement has a maximum speed.
- D In a longitudinal wave there is a net movement of particles in the direction of travel of the wave, but there is no net movement of particles in a transverse wave.

- 26 The diagram shows a progressive transverse wave on a stretched string at one instant in time.

One point on the string is labelled X.

Which point on the string is 270° out of phase with X?



27 Which wavelength of electromagnetic radiation in free space could be green light?

- A** $4.9 \times 10^{-9} \text{ m}$ **B** $6.6 \times 10^{-9} \text{ m}$ **C** $5.5 \times 10^{-7} \text{ m}$ **D** $8.6 \times 10^{-7} \text{ m}$

28 Which group contains only waves that can be polarised?

- A** infrared waves, radio waves, sound waves
B visible light waves, microwaves, radio waves
C visible light waves, radio waves, sound waves
D microwaves, visible light waves, sound waves

29 One wave has an amplitude of $2A$. A second wave has an amplitude of $\frac{A}{2}$. The waves are otherwise identical.

The two waves travel in opposite directions and overlap.

What is the ratio $\frac{\text{maximum amplitude of combined wave}}{\text{minimum amplitude of combined wave}}$?

- A** $\frac{3}{2}$ **B** $\frac{5}{3}$ **C** $\frac{5}{2}$ **D** 4

30 Light of wavelength 680 nm is incident normally on a diffraction grating with 450 lines mm^{-1} .

What is the angle of diffraction of the second-order maximum in the diffraction pattern that is produced?

- A** 1.8° **B** 3.5° **C** 18° **D** 38°

31 A hollow tube is closed at one end and open at the other.

A stationary sound wave of the lowest possible frequency, 820 Hz, is produced in the tube.

The speed of sound in air is 330 m s^{-1} .

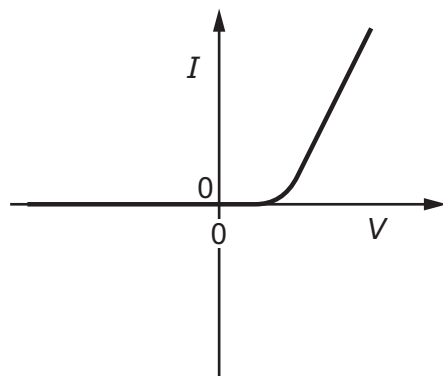
What is the length of the tube?

- A** 10 cm **B** 20 cm **C** 40 cm **D** 160 cm

32 Which expression gives the definition of resistance?

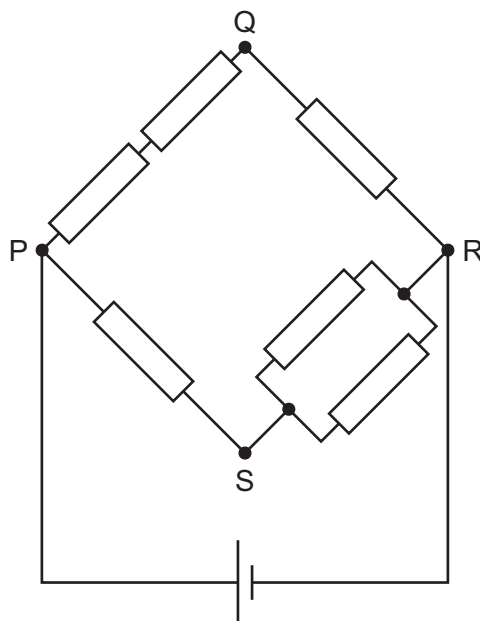
- A** current divided by potential difference
B current multiplied by potential difference
C potential difference divided by current
D resistivity multiplied by length

- 33 The graph shows the I – V characteristic of an electrical component.



What is the component?

- A** a filament lamp
 - B** a metallic conductor at constant temperature
 - C** a resistor
 - D** a semiconductor diode
- 34 The diagram shows six identical resistors connected in a circuit.

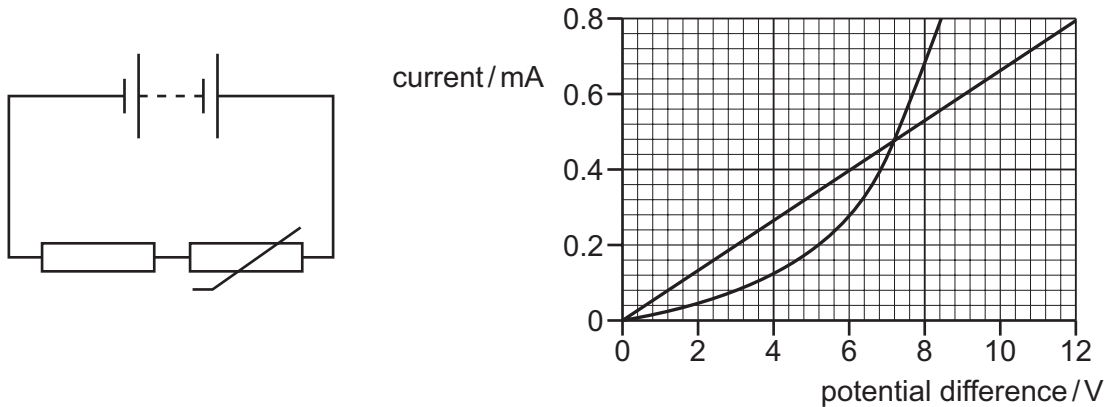


In which branch of the circuit is the most power dissipated?

- A** PQ
- B** QR
- C** RS
- D** SP

- 35 The diagram shows a circuit containing a thermistor, a fixed resistor and a battery.

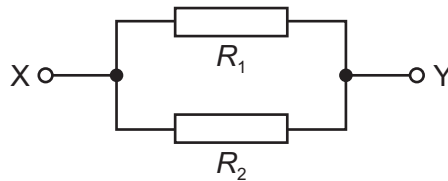
The graph shows the I - V characteristics of both components.



The battery has an e.m.f. of 12 V and negligible internal resistance.

What is the current in the fixed resistor?

- A 0.36 mA B 0.40 mA C 0.48 mA D 0.80 mA
- 36 Two resistors of resistances R_1 and R_2 are connected in parallel.

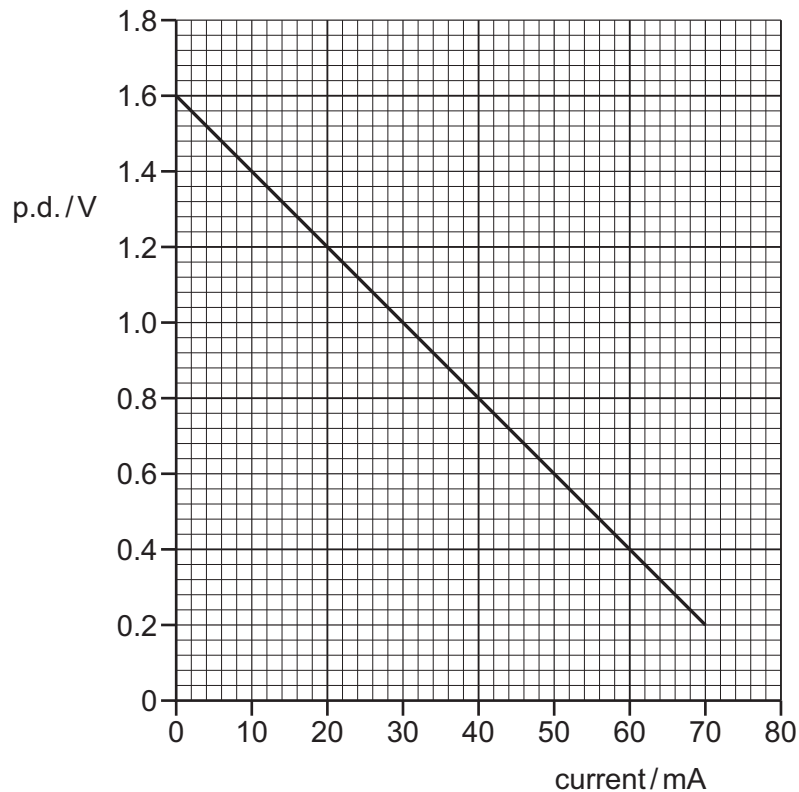


What is the combined resistance between X and Y?

- A $R_1 + R_2$ B $\frac{R_1 R_2}{R_1 + R_2}$ C $\frac{R_1 + R_2}{R_1 R_2}$ D $\frac{R_1}{R_2}$

- 37** A cell is connected in series with an ammeter and a variable resistor. A voltmeter is used to measure the p.d. across the variable resistor. The resistance of the variable resistor is varied, and the p.d. and the current are recorded.

The graph shows the variation with current of the p.d. across the variable resistor.



What is the internal resistance of the cell?

- A** $0.050\ \Omega$ **B** $1.6\ \Omega$ **C** $20\ \Omega$ **D** $23\ \Omega$

- 38** Which list contains only fundamental particles?

- A** antineutrinos, baryons, neutrons, electrons
B mesons, electrons, neutrinos, protons
C positrons, quarks, hadrons, protons
D quarks, positrons, neutrinos, leptons

- 39 Which statement explains why alpha-particles have discrete energies, but beta-particles have a continuous range of energies?
- A Beta-particles have a much smaller mass than alpha-particles which means beta-particles can be emitted with a larger range of velocities.
 - B Only alpha-particles experience repulsion from the nucleus which is dependent on the number of protons in the nucleus.
 - C Only beta-particles are emitted with another lepton and some energy is transferred to the other lepton.
 - D Only the energy of alpha-particles is discrete because the composition of alpha-particles is always the same.
- 40 A hadron consists of antiquarks that are all identical.

What is a possible value, in terms of the elementary charge e , for the charge on the hadron?

- A $0e$ B $+1e$ C $+2e$ D $+3e$

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1 What must all physical quantities have?

- A a direction and a magnitude
- B a direction and a unit
- C a magnitude and a prefix
- D a magnitude and a unit

2 What is 0.25 kN mm^{-2} expressed in N m^{-2} ?

- A 0.00025 N m^{-2}
- B 0.25 N m^{-2}
- C $250\,000 \text{ N m}^{-2}$
- D $250\,000\,000 \text{ N m}^{-2}$

3 A student calculates the density of a solid steel cube in an experiment.

The measured mass is $975 \text{ g} \pm 10 \text{ g}$ and the measured length of side is $50 \text{ mm} \pm 1 \text{ mm}$.

What is the density of the steel?

- A $7.8 \text{ g cm}^{-3} \pm 3.0\%$
- B $7.8 \text{ g cm}^{-3} \pm 7.0\%$
- C $7.8 \text{ g cm}^{-3} \pm 11\%$
- D $7.8 \text{ g cm}^{-3} \pm 13\%$

4 The time period T of a pendulum is given by

$$T = 2\pi \left(\frac{L}{g} \right)^n$$

where L is the length of the pendulum and g is the acceleration of free fall.

The equation is homogeneous.

What is the value of n ?

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

- 5 Radio waves can be used to measure the distance between Earth and the planet Jupiter.

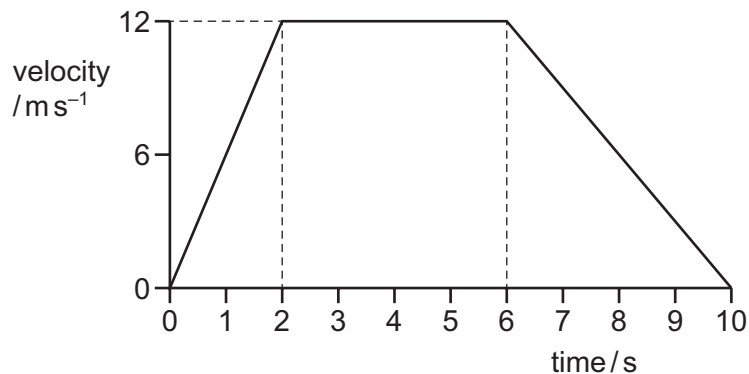
A pulse of radio waves is emitted from the surface of Earth. The pulse reflects from the surface of Jupiter and is detected again on Earth.

The time between emitting and receiving the pulse is 3960 s.

What is the distance between Earth and Jupiter?

- A $5.94 \times 10^8 \text{ km}$
- B $1.19 \times 10^9 \text{ km}$
- C $5.94 \times 10^{11} \text{ km}$
- D $1.19 \times 10^{12} \text{ km}$

- 6 The graph shows the variation with time of the velocity of a car.



Which statement is correct?

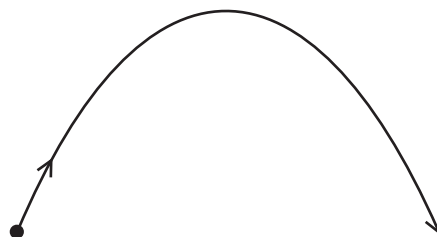
- A The car accelerates for 2 s, then stops for 4 s and then reverses.
 - B The car accelerates at 12 m s^{-2} for 2 s.
 - C The car travels a distance of 36 m in the first 4 s.
 - D The car travels a distance of 48 m in the last 4 s.
- 7 A solid object of mass 1.0 kg falls vertically downwards in a vacuum.

When the speed of the object is 60 m s^{-1} , an additional constant force of 50 N suddenly starts to act vertically upwards on the object.

What is the speed of the object 2.0 s after the additional force starts to act?

- A 20 m s^{-1}
- B 40 m s^{-1}
- C 80 m s^{-1}
- D 100 m s^{-1}

- 8 A stone is thrown upwards and follows a curved path.



Air resistance is negligible.

Why does the path have this shape?

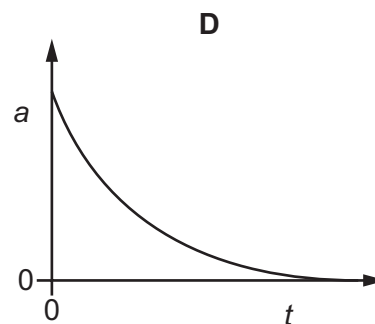
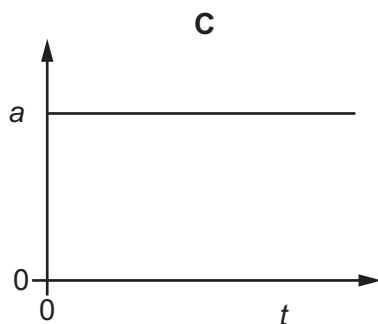
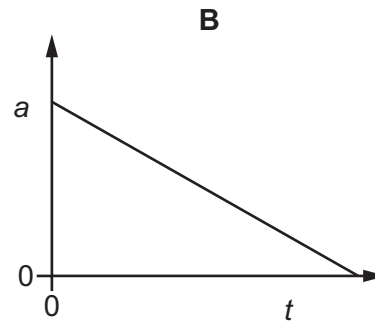
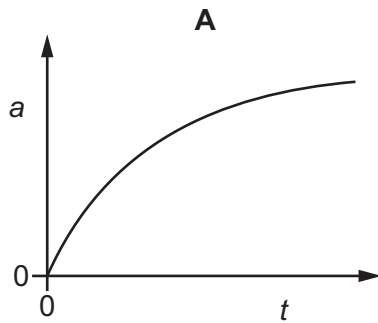
- A The stone has a constant horizontal acceleration and constant vertical velocity.
 - B The stone has a constant horizontal velocity and constant vertical acceleration.
 - C The stone has a constant upward acceleration followed by a constant downward acceleration.
 - D The stone has a constant upward velocity followed by a constant downward velocity.
- 9 A rocket engine ejects 90 kg of exhaust gas per second at a velocity of 190 m s^{-1} relative to the rocket.
- What is the force acting on the rocket due to the ejected gas?
- A 2.1 kN B 17 kN C 18 kN D 162 kN
- 10 Which statement does **not** describe an elastic collision between two objects?
- A The relative speed of approach of the two objects equals the relative speed of separation.
 - B The total kinetic energy of the objects is conserved.
 - C The total kinetic energy of the objects is reduced.
 - D The total linear momentum of the objects is conserved.
- 11 A cyclist is riding at a constant speed on a level road.

According to Newton's third law of motion, what is equal and opposite to the backward push of the back wheel on the road?

- A the force exerted by the cyclist on the pedals
- B the forward push of the road on the back wheel
- C the tension in the cycle chain
- D the total air resistance and friction force

- 12** A stone is released from rest and falls a long distance in air.

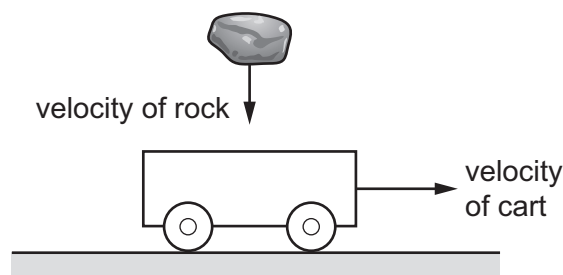
Which graph could show the variation with time t of the acceleration a of the stone?



- 13** An empty cart is moving along a horizontal track at a constant velocity.

Resistive forces acting on the cart are negligible.

A heavy rock is dropped vertically into the cart.

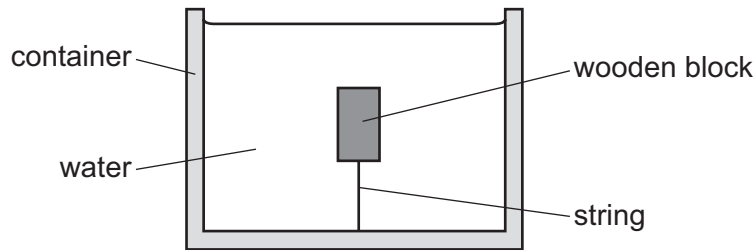


The cart continues to move horizontally with the rock inside.

How does the momentum and kinetic energy of the cart with the rock inside compare with the momentum and kinetic energy of the empty cart?

- A** The cart with the rock inside has a smaller momentum and a smaller kinetic energy.
- B** The cart with the rock inside has a smaller momentum and the same kinetic energy.
- C** The cart with the rock inside has the same momentum and a smaller kinetic energy.
- D** The cart with the rock inside has the same momentum and the same kinetic energy.

- 14** A wooden block is held stationary in a container of water using a string that is attached to both the wooden block and the bottom of the container.



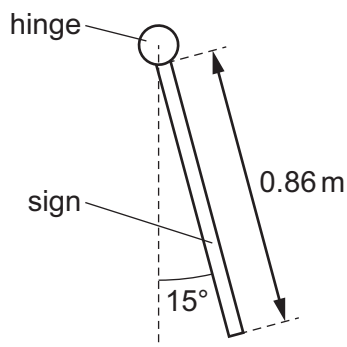
The wooden block has mass m and volume V . The water has density ρ . The acceleration of free fall is g .

What is the magnitude of the force acting on the block due to the tension in the string?

- A** ρgV **B** $mg + \rho gV$ **C** mg **D** $\rho gV - mg$
- 15** A square shop sign of uniform density has mass 2.4 kg and sides of length 0.86 m.

The sign is supported by a hinge along its top edge.

There is friction in the hinge so that the sign hangs from it in equilibrium at an angle of 15° to the vertical, as shown.

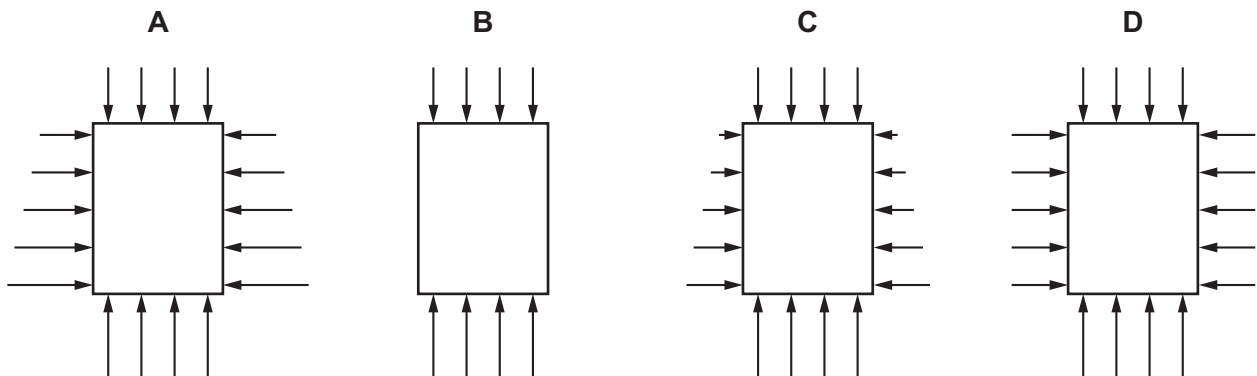


What is the moment about the hinge of the weight of the sign?

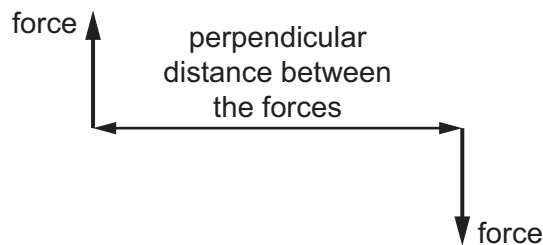
- A** 2.6 Nm **B** 4.0 Nm **C** 5.2 Nm **D** 9.8 Nm

- 16** A block is submerged vertically in a liquid. The four diagrams show the block viewed from the side.

Which diagram shows, to scale, the forces exerted on equal areas of the block by the liquid?



- 17** The diagram shows a couple.



How is the torque of the couple calculated?

- A** $\frac{1}{2} \times \text{perpendicular distance between the forces} \times \text{magnitude of one of the forces}$
- B** $\text{perpendicular distance between the forces} \times \text{magnitude of one of the forces}$
- C** $\text{perpendicular distance between the forces} \times \text{magnitude of the sum of the forces}$
- D** $2 \times \text{perpendicular distance between the forces} \times \text{magnitude of one of the forces}$
- 18** A ball of mass 1.2 kg travels horizontally at a speed of 3.0 m s^{-1} .

The ball hits a cushion and comes to rest over a horizontal distance of 0.020 m.

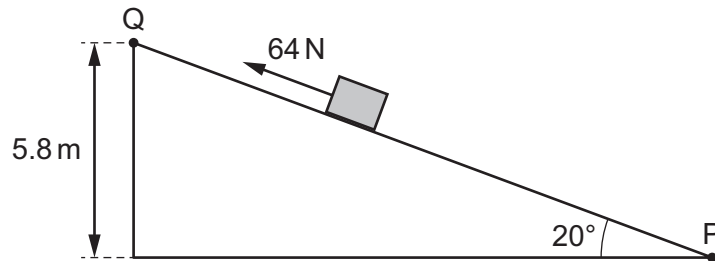
What is the work done by the cushion on the ball to bring the ball to rest?

- A** 0.24 J **B** 1.8 J **C** 5.4 J **D** 11 J

- 19** A box of mass 4.9 kg is pushed at a constant velocity from point P at the bottom of an inclined plane to point Q at the top.

The box is pushed by a force of 64 N acting parallel to the slope.

The slope is inclined at an angle of 20° to the horizontal and the box moves through a vertical height of 5.8 m.



What is the work done against the frictional force acting on the block between P and Q?

- A** 280 J **B** 810 J **C** 960 J **D** 1100 J

- 20** Which expression gives the efficiency of a system?

- A** $\frac{\text{total energy input}}{\text{useful energy output}}$
- B** $\frac{\text{useful energy output} + \text{wasted energy output}}{\text{total energy input}}$
- C** $\frac{\text{useful energy output}}{\text{total energy input}}$
- D** $\frac{\text{wasted energy output}}{\text{total energy input}}$

- 21** A student has a copper wire and a steel wire with equal lengths and cross-sectional areas.

The student hangs identical loads on the two wires.

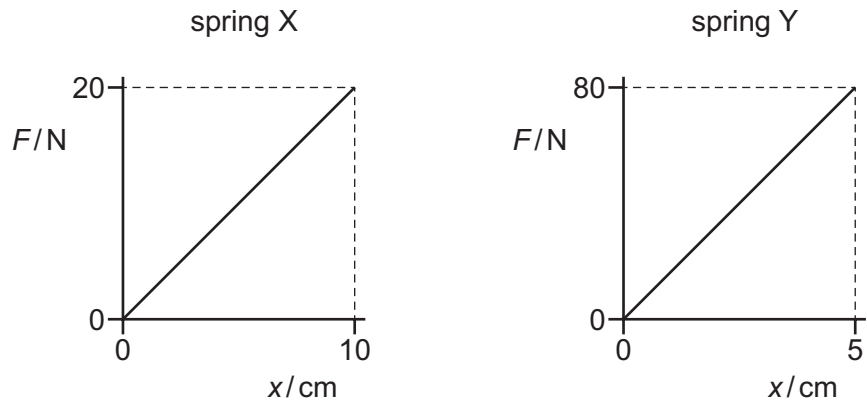
The extensions of the two wires are different.

The student calculates the stress, strain and Young modulus of each wire.

Which row identifies with a tick (✓) the calculated values that are equal for both wires?

	stress	strain	Young modulus
A	✓		
B		✓	
C		✓	✓
D	✓		✓

- 22 Two springs X and Y stretch elastically. The graphs show the variation with extension x of the force F applied to each spring.



Which statement is correct?

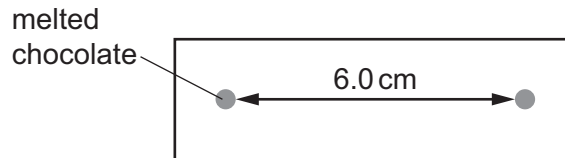
- A When each spring is given the same extension, the energy stored in Y is 4 times the energy stored in X.
 - B When each spring is given the same extension, the energy stored in Y is 8 times the energy stored in X.
 - C When the same force is applied to each spring, the energy stored in Y is 4 times the energy stored in X.
 - D When the same force is applied to each spring, the energy stored in Y is 8 times the energy stored in X.
- 23 Which phrase describes the strain at the elastic limit on a stress–strain graph?
- A the maximum strain below which Hooke's law is obeyed
 - B the maximum strain below which the deformation is plastic
 - C the minimum strain above which Hooke's law is obeyed
 - D the minimum strain above which the deformation is plastic

- 24** A teacher removes the turntable from a microwave oven and places a bar of chocolate in the oven. She then switches the oven on for a short time.

A stationary wave is formed in the oven.

When the chocolate is removed, the teacher observes that there are two small sections of melted chocolate 6.0 cm apart with unmelted chocolate in between.

Each section of melted chocolate is located at an antinode.



Assume that the speed of the microwaves is $3.0 \times 10^8 \text{ m s}^{-1}$.

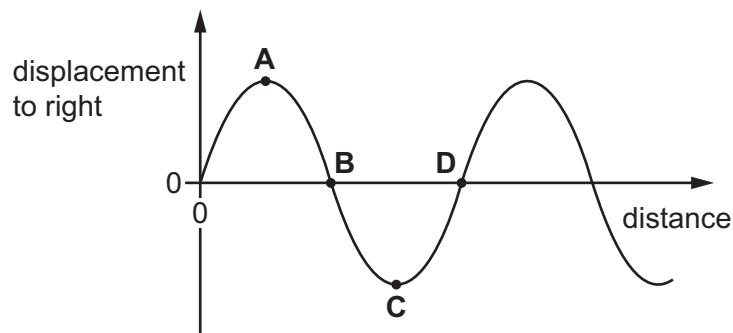
What is the frequency of the microwaves emitted by the oven?

- A** 25 MHz **B** 50 MHz **C** 2.5 GHz **D** 5.0 GHz

- 25** A sound wave travels from the left to the right.

The graph shows the variation of the displacement to the right of particles in the sound wave with distance, at one instant.

Which letter represents the centre of a compression?



- 26 A buzzer emitting sound of frequency 846 Hz is attached to a string and rotated in a horizontal circle. The linear speed of the buzzer is 25.0 m s^{-1} .



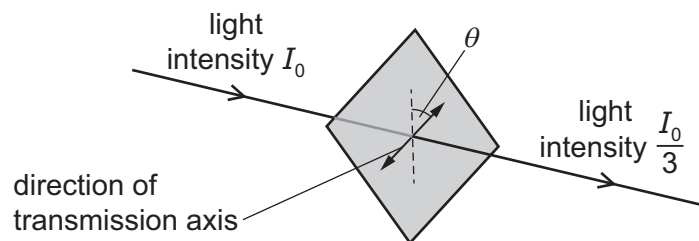
The speed of sound is 340 m s^{-1} .

What is the maximum frequency heard by the observer?

- A 783 Hz B 788 Hz C 908 Hz D 913 Hz
- 27 Vertically polarised light of intensity I_0 is incident normally on a polarising filter.

The transmission axis of the filter is at an angle θ to the plane of polarisation of the light.

The intensity of the light after passing through the filter is $\frac{I_0}{3}$.

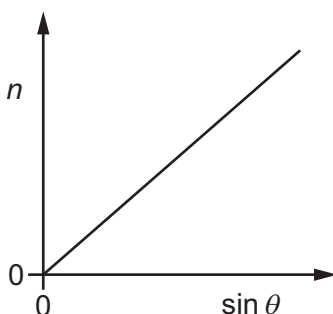


What is θ ?

- A 8.4° B 55° C 71° D 84°
- 28 Which statement compares the behaviour of transverse and longitudinal waves?
- A Only longitudinal waves can be diffracted.
- B Only longitudinal waves can travel in free space.
- C Only transverse waves can be coherent.
- D Only transverse waves can be polarised.

- 29 A student uses a diffraction grating to determine the wavelength of visible light from a source.

The diffraction grating has 300 lines per mm. The student measures the angle θ of each order n of the intensity maxima. A graph of n against $\sin \theta$ is plotted. The line of best fit for the plotted points is shown and has gradient G .



Which expression represents the wavelength, in m, of the visible light in terms of G ?

- A $3 \times 10^5 G$ B $3.3 \times 10^{-6} G$ C $\frac{3.3 \times 10^{-6}}{G}$ D $\frac{300}{G}$

- 30 Two waves meet.

What is **not** a necessary condition for the waves to produce a stationary wave?

- A They must be of the same type.
B They must have the same period.
C They must have the same wavelength.
D They must travel in the same direction.

- 31 Light of a single wavelength is incident normally on a double slit. Interference fringes are observed on a screen.

The distance from the double slit to the screen is 0.60 m and the fringe separation is 1.8 mm.

The distance from the double slit to the screen increases by 0.90 m.

What is the new fringe separation?

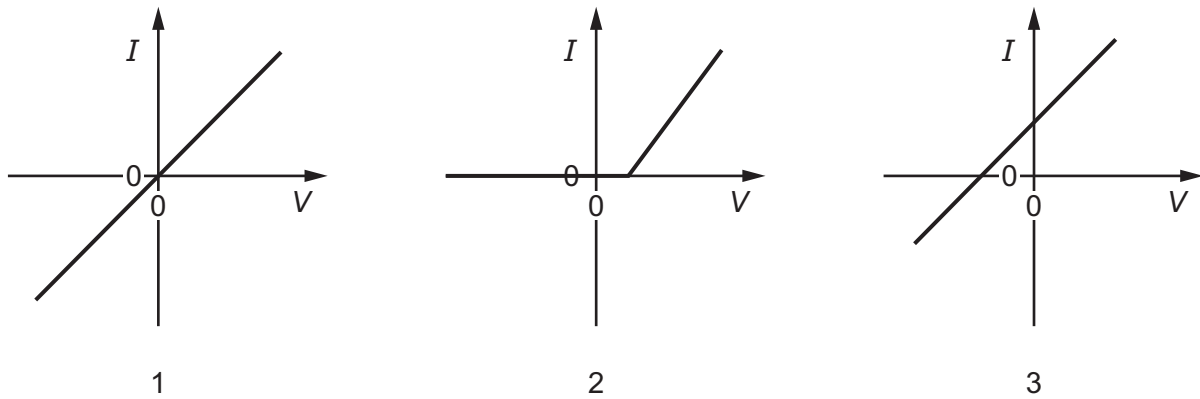
- A 1.2 mm B 2.7 mm C 4.5 mm D 5.4 mm

- 32 A wire is made from a metal of constant resistivity. There is a constant current in the wire.

Which statement about the potential difference across the wire is correct?

- A It is directly proportional to the length of the wire.
B It is inversely proportional to the length of the wire.
C It is directly proportional to the diameter of the wire.
D It is inversely proportional to the diameter of the wire.

33 The I – V characteristics for three electrical components are shown.



Which components obey Ohm's law?

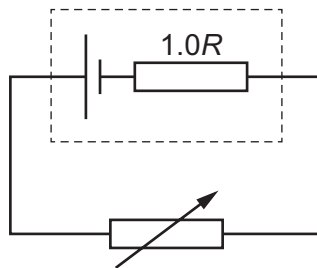
- A** 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 1 only

34 A resistor of resistance $200\ \Omega$ is connected to a supply that has a p.d. of $4.00\ \text{V}$.

How many electrons enter the resistor in $4.00\ \text{s}$?

- A** 3.13×10^{16} **B** 1.25×10^{17} **C** 5.00×10^{17} **D** 1.25×10^{21}

35 The diagram shows a cell of internal resistance $1.0R$ connected to a variable resistor.



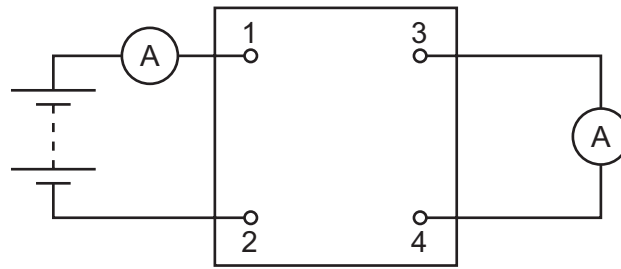
When the variable resistor has an initial resistance of $2.0R$, the current in the cell is I_1 and the terminal potential difference (p.d.) across the cell is V_1 .

The variable resistor is now adjusted to a new resistance of $4.0R$.

What is the new current in the cell and the new terminal p.d. across the cell?

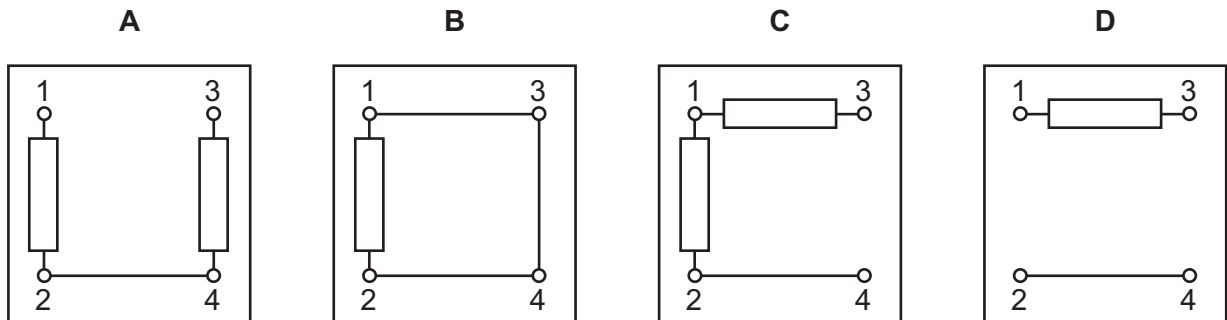
	current	terminal p.d.
A	$0.50I_1$	$1.0V_1$
B	$0.50I_1$	$1.2V_1$
C	$0.60I_1$	$1.0V_1$
D	$0.60I_1$	$1.2V_1$

- 36 The diagram shows a four-terminal box connected to a battery and two ammeters.



The currents in the two ammeters are identical.

Which circuit, within the box, gives this result?



- 37 Each of Kirchhoff's two laws presumes that some quantity is conserved.

Which row states Kirchhoff's **first** law and names the quantity that is conserved?

	statement	quantity
A	The algebraic sum of currents at a junction is zero.	charge
B	The algebraic sum of currents at a junction is zero.	energy
C	The e.m.f. in a loop is equal to the algebraic sum of the product of current and resistance round the loop.	charge
D	The e.m.f. in a loop is equal to the algebraic sum of the product of current and resistance round the loop.	energy

38 Two neutral atoms are isotopes of the same element.

Which statement about the atoms is correct?

- A** They have a different number of neutrons and a different number of electrons.
- B** They have a different number of neutrons and the same number of protons.
- C** They have the same number of neutrons and a different number of electrons.
- D** They have the same number of neutrons and the same number of protons.

39 What is the composition of a meson?

- A** 1 quark and 1 antiquark
- B** 1 quark and 2 antiquarks
- C** 2 quarks and 1 antiquark
- D** 3 quarks

40 A nucleus of carbon-11 contains 6 protons and 5 neutrons.

The nucleus of carbon-11 decays by β^+ emission.

What is the total number of up and down quarks in the product of the decay of this nucleus?

	up quarks	down quarks
A	15	18
B	16	17
C	17	16
D	18	15

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Cambridge International AS & A Level

PHYSICS

9702/13

Paper 1 Multiple Choice

May/June 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 represents a vector quantity?
- A 1 N upwards
B 2 kg decrease
C 3 K cooler
D 4 s later
- 2 What is a reasonable estimate of the current in an electric kettle that is in use?
- A $8\text{ }\mu\text{A}$ B 8 mA C 8 A D 8 kA
- 3 Which statement about errors in measurements is correct?
- A An accurate set of measurements always has a small random error.
B A precise set of measurements always has a small systematic error.
C A random error can be reduced by taking an average of several measurements.
D A systematic error creates a random set of measurements spread out about the true value.
- 4 A sample of material has cross-sectional area A and length L . The temperatures at the two sides of the sample are T_1 and T_2 . Thermal energy Q is transferred through the sample in time t .

These quantities are related by

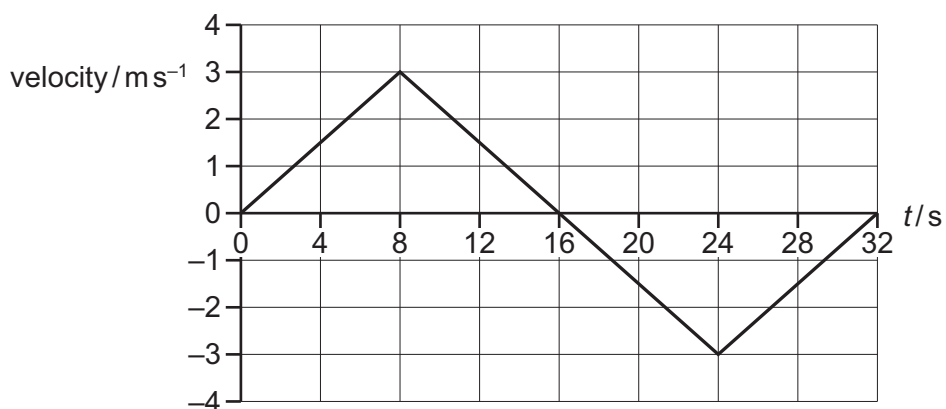
$$\frac{Q}{t} = \frac{k \times A \times (T_1 - T_2)}{L}$$

where k is a constant.

What are the SI base units of k ?

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

- 5 The graph shows the variation of velocity with time t of an object moving in a straight line.



At $t = 0$, the displacement of the object is zero.

What is the displacement of the object at $t = 20$ s?

- A** -3 m **B** 21 m **C** 24 m **D** 27 m
- 6 A science museum designs an experiment to show the fall of a feather in a vertical glass vacuum tube.

The time of fall from rest in the vacuum is to be close to 0.5 s.

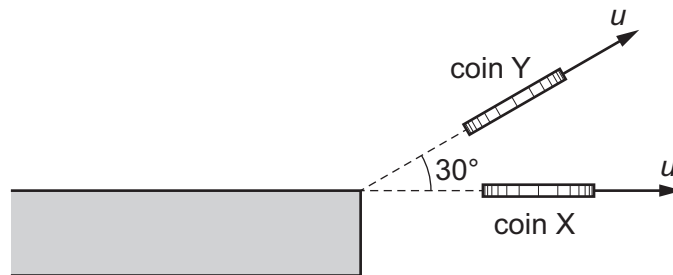
Which length of tube is required?

- A** 1.2 m **B** 2.5 m **C** 4.9 m **D** 9.8 m

- 7 Two coins are projected from a horizontal table at the same initial speed u .

Coin X is projected horizontally.

Coin Y is projected upwards at an angle of 30° to the horizontal.



Both coins hit the horizontal ground without bouncing.

Assume the air resistance on each coin is negligible.

Which statement about the motion of the coins is correct?

- A Both coins hit the ground with the same speed.
 - B Both coins travel the same vertical distance.
 - C Coin Y hits the ground before coin X.
 - D Coin Y has a smaller vertical acceleration.
- 8 Two spheres are released from rest at equal heights above the ground.

Both spheres reach terminal velocity.

One sphere has a larger density than the other sphere.

Both spheres have equal volumes.

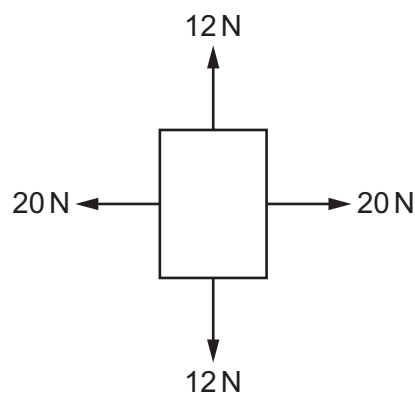
Which statement is correct while both spheres are at terminal velocity?

- A The drag forces on the spheres are equal.
- B The resultant forces on the spheres are equal.
- C The velocities of the spheres are equal.
- D The weights of the spheres are equal.

9 Which statement **defines** force?

- A When a force acts on a body that is free to move, the force is the product of the mass of the body and its acceleration.
- B When a force acts on a body that is free to move, the force is the rate of change of momentum of the body.
- C When a force acts on a body that is free to move, the force is the work done by the force divided by the distance moved by the body.
- D When a force acts on a lever and causes a moment, the force is the moment divided by the perpendicular distance of the force from the pivot.

10 Four forces, all in the same plane, act on an object.



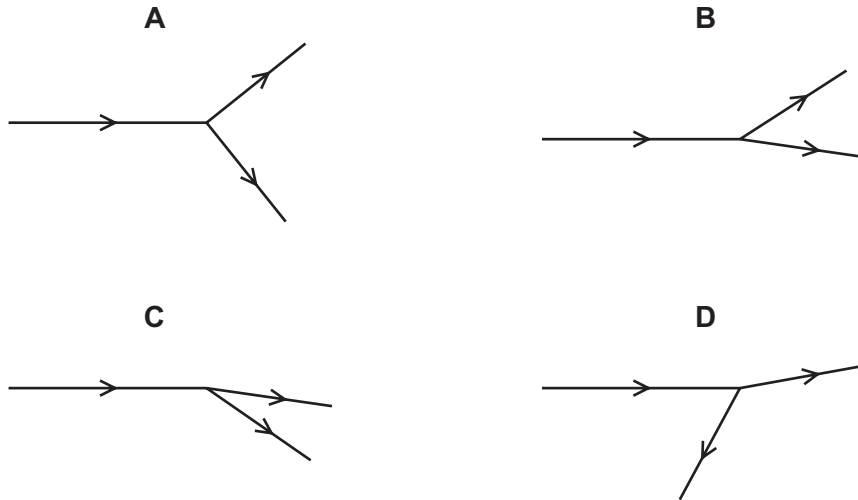
What could describe the motion of the object?

- A It is accelerating.
- B It is moving in a straight line.
- C It is moving with decreasing speed.
- D It is moving with increasing momentum.

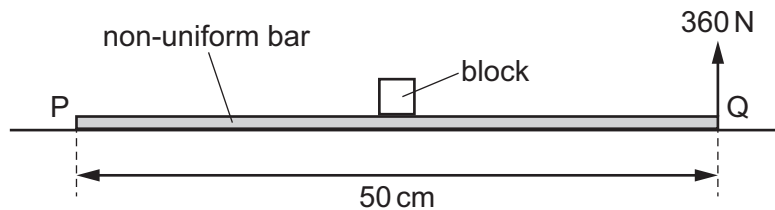
- 11 A nucleus collides with a stationary nucleus in a vacuum. The diagrams show the paths of the nuclei before and after the collision.

No other particles are involved in the collision.

Which diagram is **not** possible?



- 12 A non-uniform bar PQ has length 50 cm and weight 200 N.



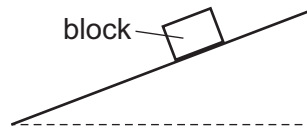
A block of weight 400 N is attached to the top of the bar at its centre. The bar rests on horizontal ground.

A vertical force of 360 N is now exerted upwards on the bar at end Q and is just sufficient to lift end Q from the ground.

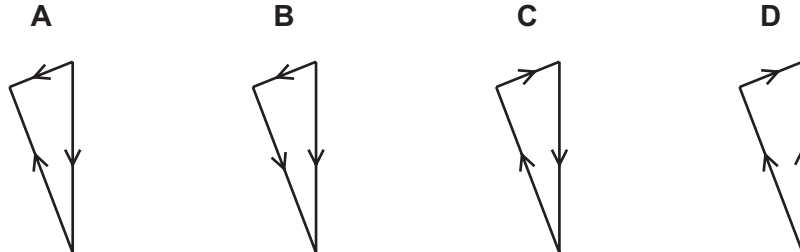
What is the distance from the centre of gravity of the bar to end P?

- A 0.050 m B 0.10 m C 0.25 m D 0.40 m
- 13 What is the definition of density?
- A mass of one cubic metre
 B mass of a unit volume
 C mass per cubic metre
 D mass per unit volume

- 14 A block is in equilibrium on a slope.



Which vector triangle represents the three forces acting on the block?



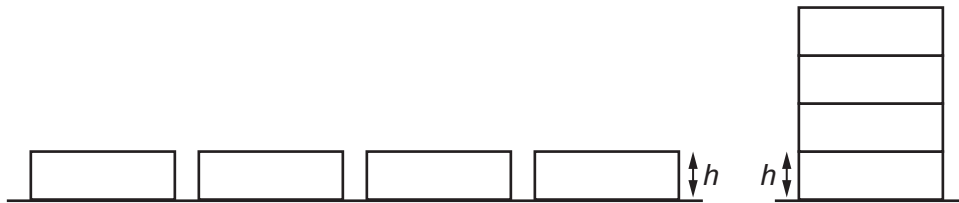
- 15 A measuring cylinder contains 80 cm^3 of a liquid.

The pressure due to the liquid at the 60 cm^3 mark is 1200 Pa .

What is the pressure due to the liquid at the base of the measuring cylinder?

- A** 1200 Pa **B** 1600 Pa **C** 3600 Pa **D** 4800 Pa

- 16 Four identical uniform blocks are spread on a table. Each block has mass m and thickness h .



The acceleration of free fall is g .

How much work is done on the blocks in stacking them on top of one another?

- A** $3mgh$ **B** $6mgh$ **C** $8mgh$ **D** $10mgh$

- 17 An electric motor uses 1.7 kW of power when operating normally.

The efficiency of the motor is 53% .

What is the useful output power of the motor?

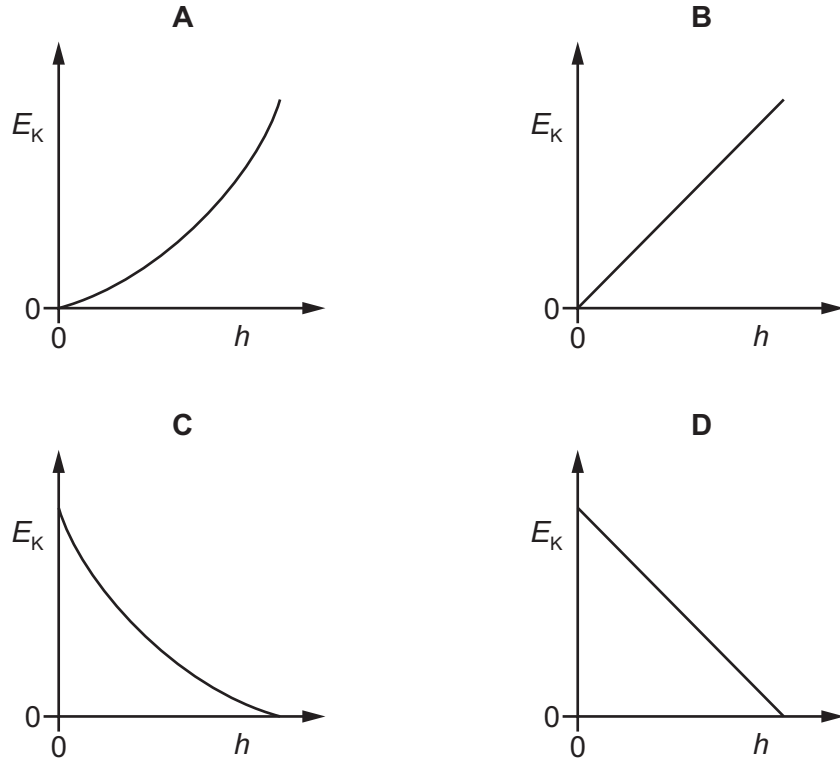
- A** 0.032 kW **B** 0.90 kW **C** 3.2 kW **D** 90 kW

- 18** A ball is released from rest and falls vertically to the ground.

The kinetic energy E_K of the ball varies as the height h of the ball above the ground changes.

Air resistance is negligible.

Which graph shows the variation of E_K with h ?



- 19** An object travelling with a speed of 10 m s^{-1} has kinetic energy of 1500 J.

The speed of the object is increased to 40 m s^{-1} .

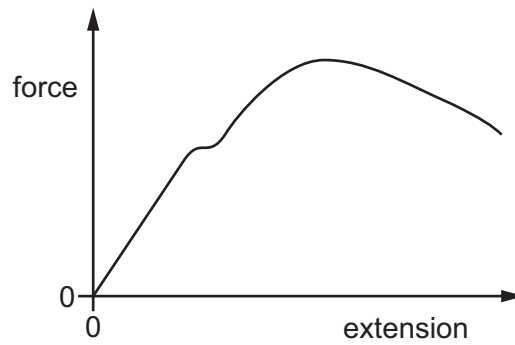
What is the new kinetic energy of the object?

- A** 4500 J **B** 6000 J **C** 24 000 J **D** 1 350 000 J

- 20** What are the units of stress, strain and the Young modulus?

	stress	strain	Young modulus
A	newton	metre	pascal
B	newton	no unit	newton
C	pascal	metre	newton
D	pascal	no unit	pascal

- 21 The force–extension graph for a metal wire is shown.



Which quantity is represented by the area under the graph?

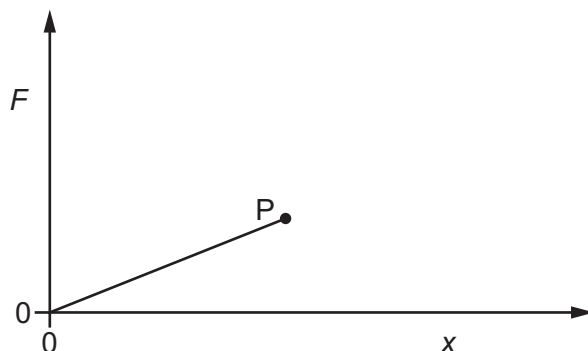
- A power transferred to the wire
 - B temperature increase in the wire
 - C time taken for the wire to extend
 - D work done on the wire
- 22 A wire of length L_0 is attached at one end to a fixed point. A tensile force is applied to the other end so that the wire extends and has a new length L_1 .

What is the strain of the wire?

- A $\left(\frac{L_1}{L_0}\right) - 1$
 B $L_1 - L_0$
 C $\left(\frac{L_1}{L_0}\right) + 1$
 D $L_1 + L_0$

- 23 A wire of length L is stretched to determine its limit of proportionality.

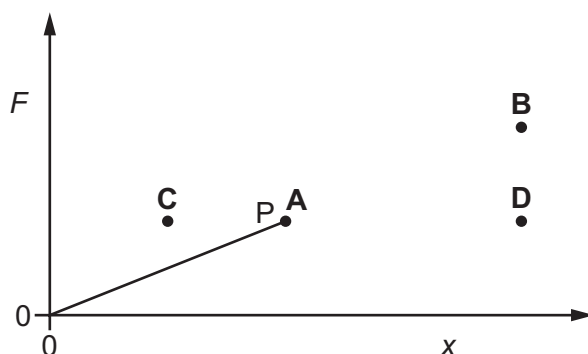
The graph shows the variation of the extension x with the force F applied to the wire.



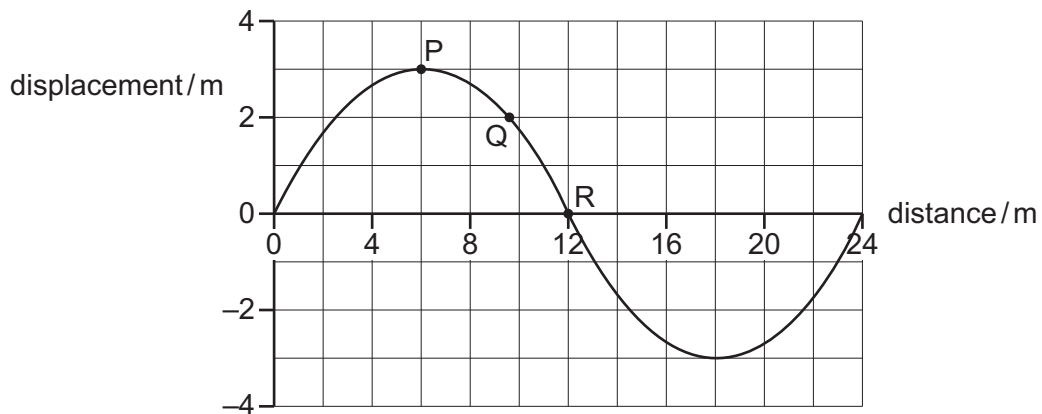
The limit of proportionality is shown by point P on the graph.

The experiment is repeated with another wire of length $2L$ but of the same material and same diameter as the first wire.

Which point on the graph shows the limit of proportionality for the new wire?



- 24** The graph shows the variation with distance along the wave of the displacement of water particles at a particular instant in time for a transverse water wave.

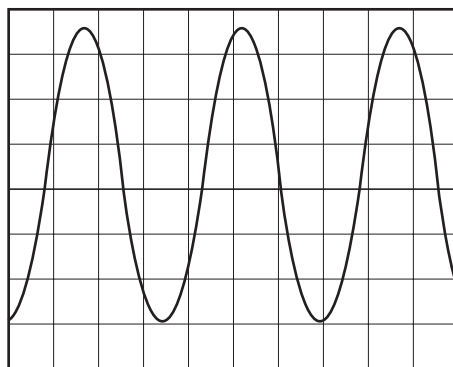


P, Q and R show the positions of three water particles in the wave.

Which particle has the greatest speed at the instant shown?

- A** all have the same speed
 - B** particle P
 - C** particle Q
 - D** particle R
- 25** Which phenomenon is only associated with transverse waves?
- A** diffraction
 - B** interference
 - C** polarisation
 - D** reflection

- 26 A wave is displayed on an oscilloscope.



The oscilloscope settings are:

time-base: $300 \mu\text{s div}^{-1}$

y-gain: $40 \mu\text{V div}^{-1}$.

What is the frequency of the wave?

- A** 130 Hz **B** 950 Hz **C** 1100 Hz **D** 7100 Hz
- 27 An electromagnetic wave travelling in free space is **not** visible to the human eye.

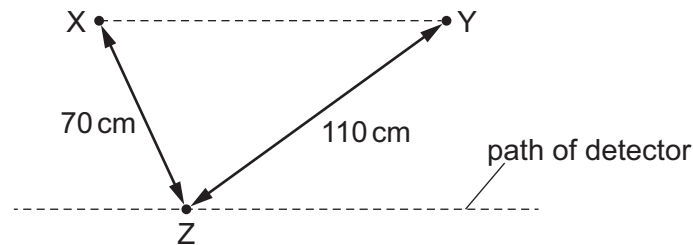
What is a possible wavelength of the wave?

- A** $4.5 \times 10^{-10} \text{ km}$
B $6.2 \times 10^{-7} \text{ m}$
C $5.4 \times 10^{-6} \text{ cm}$
D $4.2 \times 10^{-4} \text{ mm}$

- 28** Electromagnetic waves of equal wavelengths are emitted from two sources, X and Y. The waves are emitted from X and Y with a phase difference of 180° .

A detector moves along a path that is parallel to the line XY and detects a pattern of intensity maxima and minima.

The diagram shows the arrangement of the sources and the path of the detector.



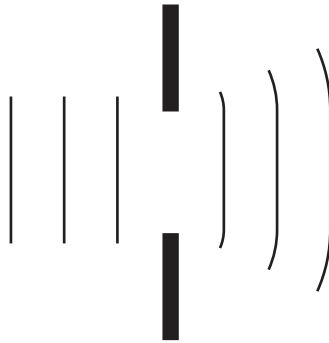
An intensity maximum is detected at point Z. Length XZ is 70 cm and length YZ is 110 cm.

What is a possible wavelength of the waves?

- A** 10 cm **B** 16 cm **C** 20 cm **D** 40 cm
- 29** Two waves of the same type overlap.
- When does the principle of superposition apply?
- A** always
- B** only when the waves have the same amplitude
- C** only when the waves travel in opposite directions
- D** only when the waves have the same frequency

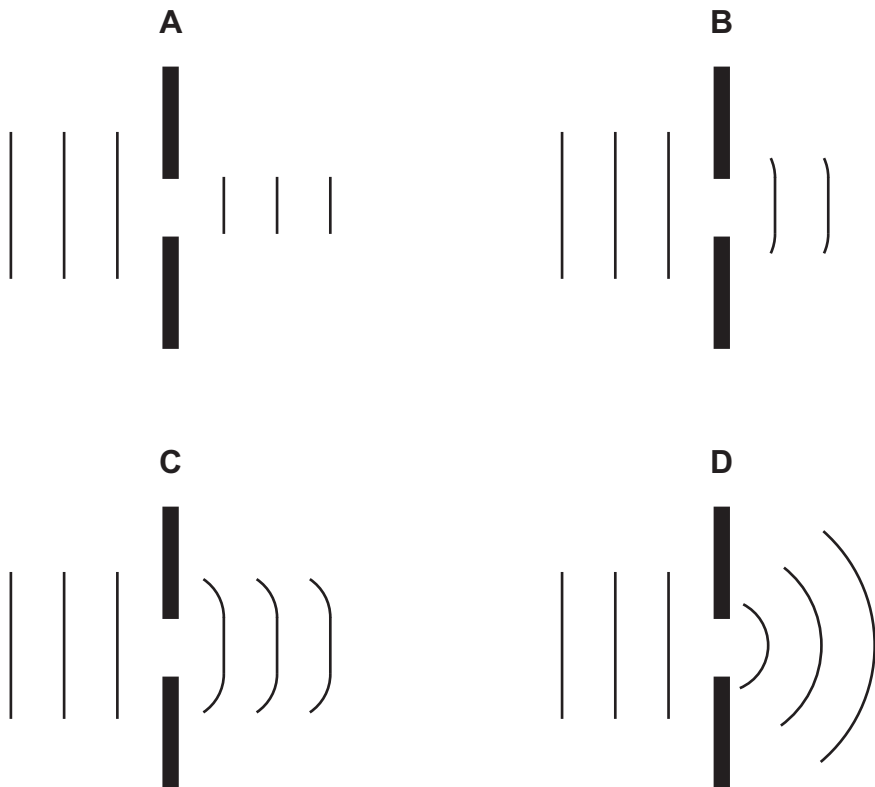
- 30** A ripple tank contains water at a constant depth.

A water wave of constant frequency travels towards a gap in a barrier placed in the ripple tank.



The gap is made smaller.

Which diagram represents the wave before and after the barrier?



- 31** Light of a single frequency from two coherent sources interferes to produce a pattern of bright and dark fringes on a screen.

Which change results in a larger fringe separation?

- A** increasing the distance between the sources and the screen
- B** increasing the distance between the two sources
- C** increasing the frequency of the light
- D** increasing the intensity of the light

- 32 The current I in a metallic conductor of cross-sectional area A is given by

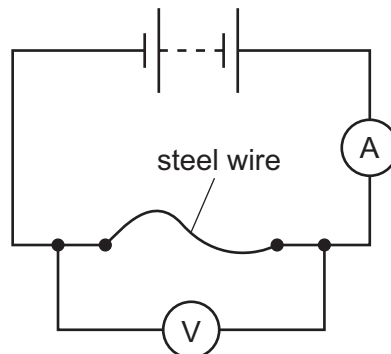
$$I = Anve$$

where e is the elementary charge and v is the mean drift velocity of the conduction electrons.

What is represented by the letter n in the equation?

- A density of conduction electrons
 - B number of conduction electrons per unit time
 - C number of conduction electrons per unit volume
 - D volume of conduction electrons
- 33 What **cannot** be the charge on a charge carrier?
- A $-4.8 \times 10^{-19} \text{ C}$
 - B $-3.2 \times 10^{-19} \text{ C}$
 - C $-2.4 \times 10^{-19} \text{ C}$
 - D $+3.2 \times 10^{-19} \text{ C}$

- 34 A steel wire with a length of 2.20 m is connected to a battery as shown.



The reading on the voltmeter is 1.50 V and the reading on the ammeter is 4.90 A.

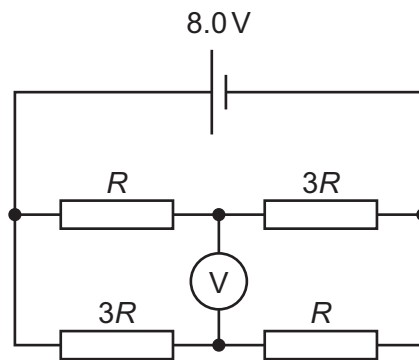
The resistivity of steel is $6.90 \times 10^{-7} \Omega \text{ m}$.

What is the diameter of the steel wire?

- A $1.76 \times 10^{-4} \text{ m}$
- B $3.52 \times 10^{-4} \text{ m}$
- C $1.26 \times 10^{-3} \text{ m}$
- D $2.51 \times 10^{-3} \text{ m}$

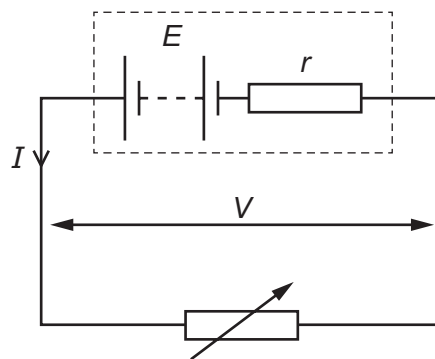
- 35 Two resistors of resistance R and two resistors of resistance $3R$ are connected to a cell of e.m.f. 8.0 V as shown.

The cell has negligible internal resistance.



What is the reading on the voltmeter?

- A** 0.0 V **B** 2.0 V **C** 4.0 V **D** 6.0 V
- 36 A battery has an e.m.f. E and internal resistance r . The battery delivers a current I to a variable resistor and the p.d. across its terminals is V .

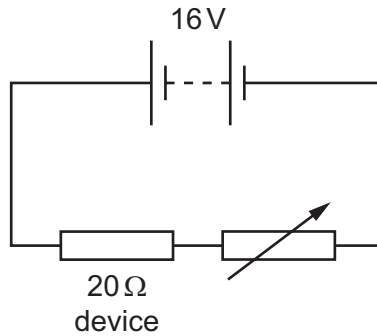


The variable resistor is adjusted so that I increases.

Why does V decrease?

- A** The e.m.f. E decreases.
B The internal resistance r increases.
C The p.d. across r increases.
D The resistance of the variable resistor increases.

- 37 An electrical device of fixed resistance $20\ \Omega$ is connected in series with a variable resistor and a battery of e.m.f. $16\ \text{V}$ and negligible internal resistance.



The power dissipated in the electrical device is $4.0\ \text{W}$.

What is the resistance of the variable resistor?

- A** $16\ \Omega$ **B** $36\ \Omega$ **C** $44\ \Omega$ **D** $64\ \Omega$
- 38 A nucleus decays by emitting a β^+ particle.
- Which particle **must** also be emitted from the nucleus?
- A** antineutrino
B β^- particle
C α -particle
D neutrino
- 39 What are the charges on an antidown quark and on an antistrange quark?

	antidown quark	antistrange quark
A	$+\frac{1}{3}e$	$+\frac{1}{3}e$
B	$+\frac{1}{3}e$	$-\frac{1}{3}e$
C	$-\frac{1}{3}e$	$+\frac{1}{3}e$
D	$-\frac{1}{3}e$	$-\frac{1}{3}e$

- 40** The nucleus of a radioactive isotope of an element emits an α -particle. The daughter nucleus then emits a β^- particle and then the daughter nucleus of that reaction emits another β^- particle.

Which statement describes the final nuclide that is formed?

- A** It is a different isotope of the original element.
- B** It is a nuclide of a different element of higher proton number.
- C** It is a nuclide of the same element but with different proton number.
- D** It is identical to the original nuclide.

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Cambridge International AS & A Level

PHYSICS

9702/14

Paper 1 Multiple Choice

May/June 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 number of atoms in a mobile phone handset may be estimated by dividing the approximate volume of the handset by the approximate volume of an atom.

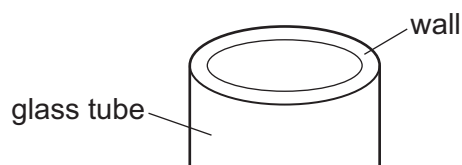
What is a reasonable estimate of the number of atoms in a mobile phone handset?

- A 10^{17} B 10^{26} C 10^{32} D 10^{37}

- 2 Which unit is **not** equivalent to a unit of energy?

- A Nm B VC C Ws D kg m s^{-2}

- 3 Calipers are used to determine the thickness of the wall of a glass tube.



The following measurements are made.

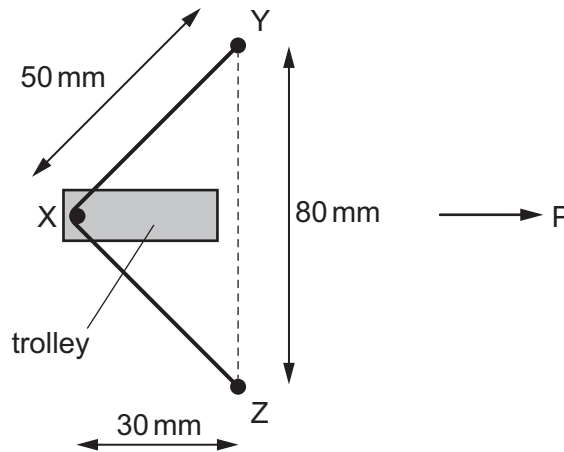
internal diameter of the tube = (10.0 ± 0.1) mm

external diameter of the tube = (12.0 ± 0.1) mm

What is the thickness of the wall of the tube?

- A (1.0 ± 0.1) mm
B (1.0 ± 0.2) mm
C (2.0 ± 0.1) mm
D (2.0 ± 0.2) mm

- 4 The diagram shows two fixed pins, Y and Z. A length of elastic is stretched between Y and Z and around pin X, which is attached to a trolley.



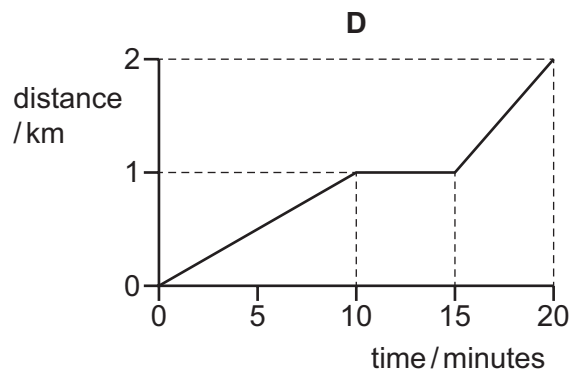
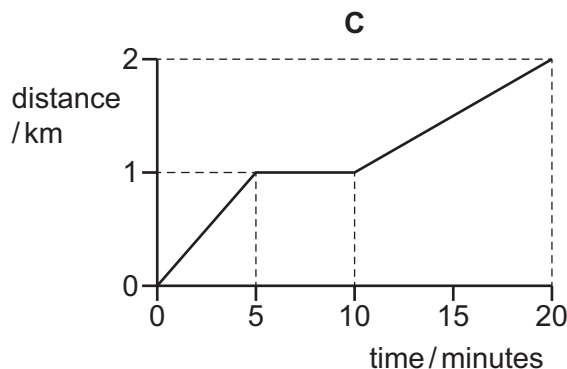
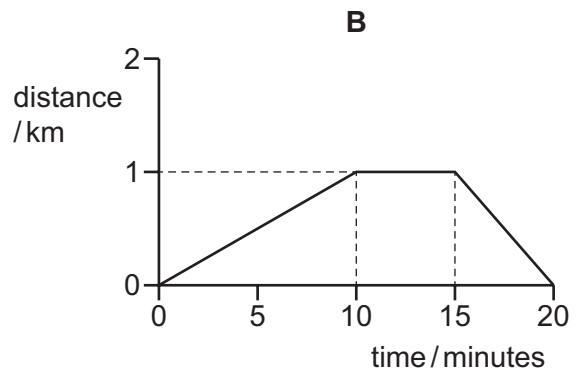
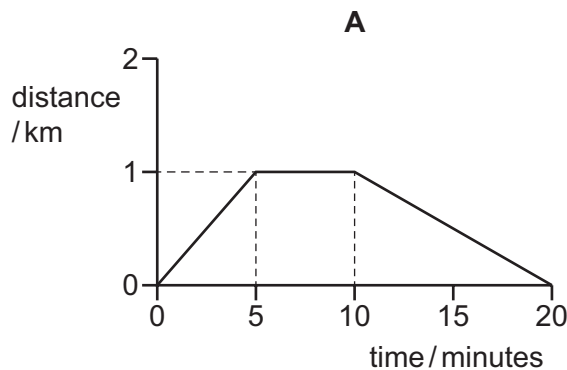
X is at the centre of the elastic and the trolley is to be propelled in the direction P at right angles to YZ. The tension in the elastic is 4.0 N.

What is the force accelerating the trolley in the direction P when the trolley is released?

- A** 2.4 N **B** 3.2 N **C** 4.8 N **D** 6.4 N

- 5 A student cycles uphill from home to a shop, taking 10 minutes. The student then spends 5 minutes in the shop before cycling home downhill at twice the initial speed.

Which graph could show the variation with time of the distance travelled by the student?



- 6 A ball is released from rest from a window at a height of 12 m above the ground. Air resistance is negligible.

What is the time taken after release for the ball to reach the ground?

- A 1.1 s B 1.2 s C 1.6 s D 2.4 s

- 7 Which word equation is **not** correct?

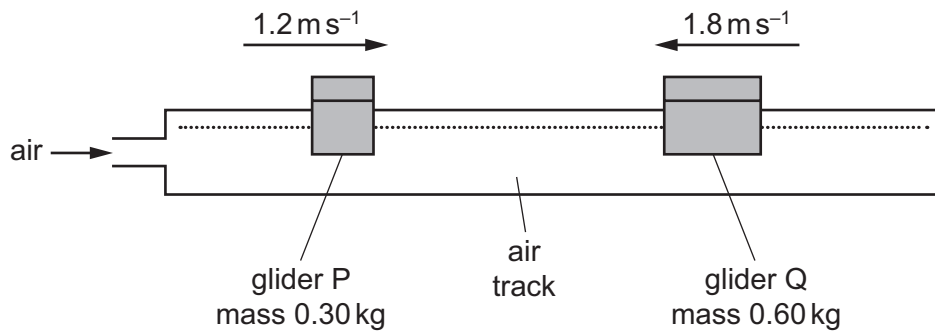
- A force = change of momentum
- B force = mass $\times$ acceleration
- C force = $\frac{\text{moment}}{\text{perpendicular distance from the pivot}}$
- D force = $\frac{\text{work done}}{\text{displacement in the direction of the force}}$

- 8 A skydiver is falling vertically with terminal velocity when their parachute opens fully.

Which statement describes the motion of the skydiver for the first few seconds after the parachute opens fully?

- A falling with non-uniform acceleration and increasing speed
- B falling with non-uniform acceleration and decreasing speed
- C falling with uniform acceleration and increasing speed
- D falling with uniform acceleration and decreasing speed

- 9 Two gliders are travelling towards each other on a horizontal air track. Glider P has mass 0.30 kg and is moving with a constant speed of 1.2 m s^{-1} . Glider Q has mass 0.60 kg and is moving with a constant speed of 1.8 m s^{-1} .



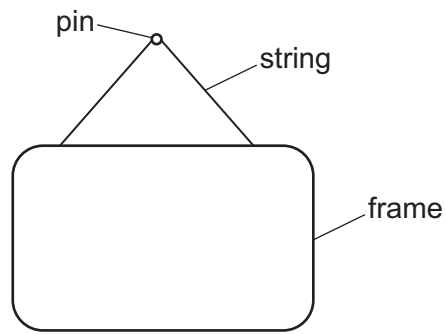
The gliders have a perfectly elastic collision.

What are the speeds of the two gliders after the collision?

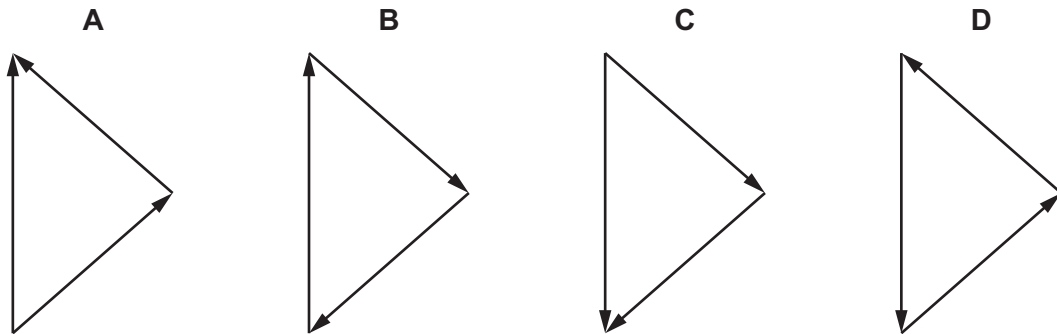
	speed of P $/\text{m s}^{-1}$	speed of Q $/\text{m s}^{-1}$
A	1.2	0.6
B	2.0	1.4
C	2.8	0.2
D	3.6	0.6

- 10 Which statement about a couple is correct?
- A** It acts to produce both translational motion and rotation.
 - B** It acts to produce rotation only.
 - C** It acts to produce translational motion only.
 - D** It acts to produce neither rotation nor translational motion.

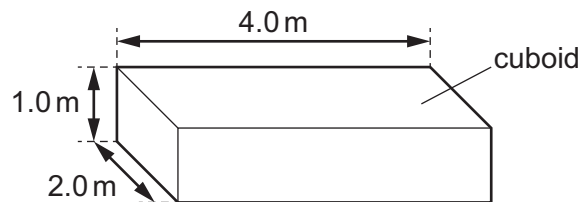
- 11 A picture frame hangs from a string. The string is supported by a pin. The frame is in equilibrium.



Which diagram shows the vector triangle of forces acting on the picture frame?



- 12 A solid metal cuboid of density 2700 kg m^{-3} has sides of lengths 1.0 m, 2.0 m and 4.0 m.

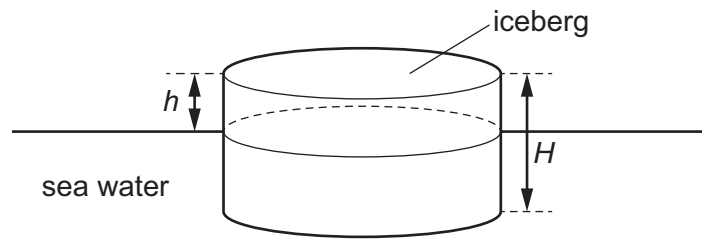


The cuboid can be placed on a horizontal surface so that it rests on any one of its six faces.

What is the largest pressure that the cuboid can exert on the surface due to its weight when it rests on one of its six faces?

- A** 11 kPa **B** 26 kPa **C** 53 kPa **D** 110 kPa

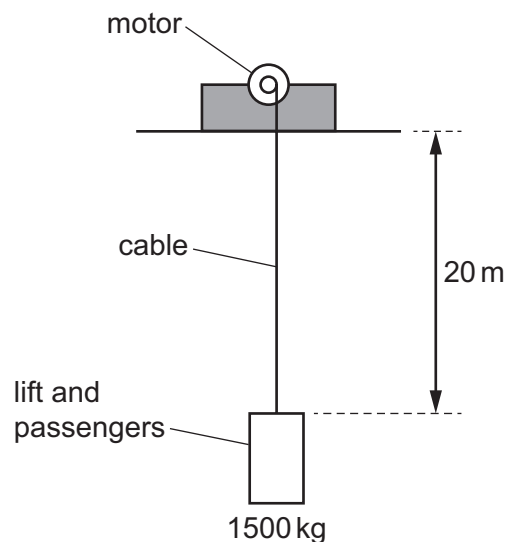
- 13 A cylindrical iceberg of height H floats in sea water. The top of the iceberg is at height h above the surface of the water.



The density of ice is ρ_i and the density of sea water is ρ_w .

What is the height h of the iceberg above the sea water?

- A $\left(1 - \frac{\rho_i}{\rho_w}\right)H$ B $\left(\frac{\rho_i}{\rho_w} - 1\right)H$ C $\frac{\rho_w}{\rho_i}H$ D $\frac{\rho_i}{\rho_w}H$
- 14 In which situation is work done on an object?
- A The object slides with a constant velocity along a horizontal frictionless surface in a vacuum.
- B A person holds the object at arm's length and at a fixed height above the ground.
- C A person pushes the object up a frictionless ramp.
- D The stationary object floats partially submerged in water.
- 15 An electric motor operating a lift has an output power of 20 kW.



The lift and passengers have a combined mass of 1500 kg. The motor raises the lift at constant speed through a distance of 20 m.

How long does it take?

- A 6 s B 15 s C 30 s D 60 s

16 In which situation is the least amount of energy transferred?

- A A student and a motorcycle of total mass 80 kg come to rest from a speed of 2.0 m s^{-1} .
- B A student of mass 50 kg falls a vertical distance of 2.0 m.
- C A student pushes a car with a horizontal force of 70 N for a horizontal distance of 2.0 m.
- D A student switches on a 70 W lamp for 20 s.

17 What is the definition of strain?

- A extension per unit cross-sectional area
- B extension per unit original length
- C force per unit cross-sectional area
- D force per unit extension

18 A spring of unstretched length 0.10 m is suspended vertically from a support.

A weight of 2.0 N is attached to the bottom of the spring and its length increases to 0.15 m.

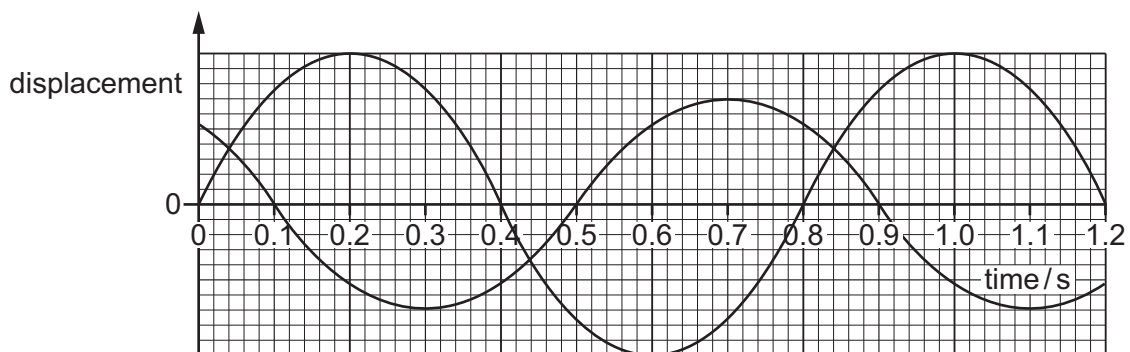
An additional weight of 4.0 N is then added to the bottom of the spring.

The spring obeys Hooke's law.

How much extra elastic potential energy is stored in the spring due to the addition of the 4.0 N weight?

- A 0.067 J
- B 0.13 J
- C 0.20 J
- D 0.40 J

19 Two progressive waves meet at a fixed point P. The variation with time of the displacement of each wave at point P is shown in the graph.

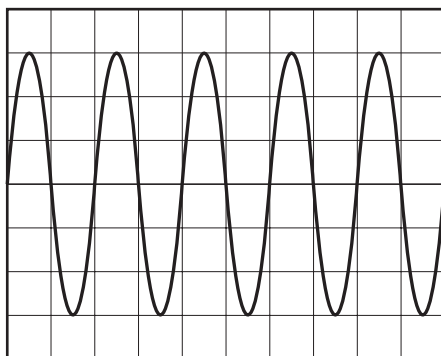


What is the phase difference between the two waves at point P?

- A 45°
- B 90°
- C 135°
- D 180°

- 20** A microphone is connected to a cathode-ray oscilloscope (CRO). The diagram shows the waveform on the display of the CRO when the microphone detects a sound.

The y -gain is set to 1 V div^{-1} . The time-base is set to 2.0 ms div^{-1} .

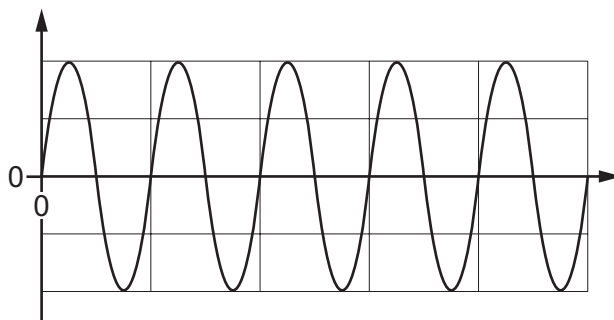


Which row gives the amplitude and frequency of the waveform?

	amplitude / V	frequency / Hz
A	3	125
B	3	250
C	6	125
D	6	250

- 21 A progressive longitudinal wave is travelling horizontally from left to right.

A graphical representation of the wave at one instant in time is shown.



Which row could give the correct labels for the x -axis and y -axis of this graph?

	x -axis	y -axis
A	distance	displacement of particles to the right
B	distance	displacement of particles upwards
C	time	displacement of particles to the right
D	time	displacement of particles upwards

- 22 A vehicle is moving with a speed of 30.0 m s^{-1} directly towards a stationary observer. The horn of the vehicle emits sound of frequency 440 Hz . The speed of sound in air is 340 m s^{-1} .

What is the frequency of the sound heard by the observer?

- A** 401 Hz **B** 404 Hz **C** 479 Hz **D** 483 Hz

- 23 Which row could describe electromagnetic waves?

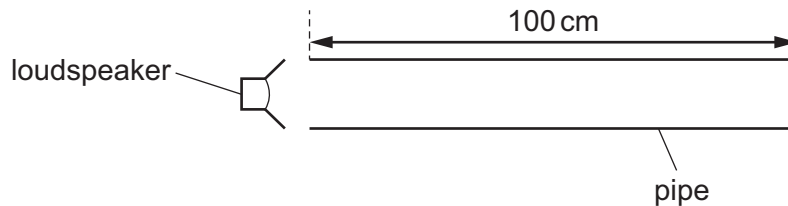
	type of wave	speed in free space
A	longitudinal	faster for shorter wavelengths
B	longitudinal	the same for all wavelengths
C	transverse	faster for shorter wavelengths
D	transverse	the same for all wavelengths

- 24** A horizontal beam of light is incident normally on a polarising filter. The incident light is vertically polarised and has an intensity of 24 W m^{-2} . The direction of the transmission axis of the filter is at an angle of 30° to the vertical.

What is the intensity of the light in the transmitted beam?

- A** 18 W m^{-2} **B** 21 W m^{-2} **C** 28 W m^{-2} **D** 32 W m^{-2}

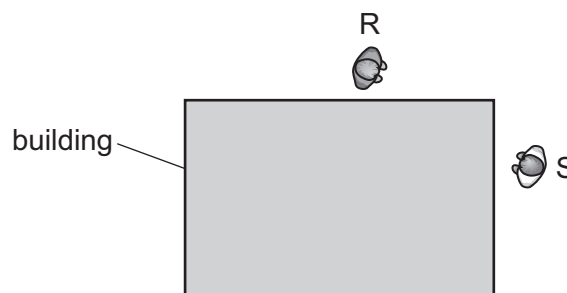
- 25** A pipe of length 100 cm is open at both ends. A loudspeaker situated at one end of the pipe can emit sound of different wavelengths.



Which wavelength can produce a stationary wave in the pipe?

- A** 50 cm **B** 75 cm **C** 150 cm **D** 300 cm

- 26** A student makes a sound at point R near a building. A second student, standing at point S around the corner of the building, hears the sound. The building is a solid structure and there are no other structures nearby.



Which effect best explains how the student at point S is able to hear the student at point R?

- A** diffraction
B interference
C polarisation
D reflection

- 27** Red light of a single wavelength from a laser is incident on a double slit.

A pattern of interference fringes is observed on a flat screen that is placed parallel to the double slit.

Which change increases the separation of the interference fringes on the screen?

- A** Decrease the distance from the double slit to the screen.
- B** Decrease the separation of the slits.
- C** Replace the red light with blue light.
- D** Replace the red light with green light.

- 28** An electromagnetic wave is incident normally on a diffraction grating.

A second-order maximum is produced at an angle of 30° to the direction of the incident light.

The grating has 5000 lines per cm.

What is the wavelength of the wave?

- A** $2.5 \times 10^{-7} \text{ m}$ **B** $5.0 \times 10^{-7} \text{ m}$ **C** $1.0 \times 10^{-6} \text{ m}$ **D** $5.0 \times 10^{-5} \text{ m}$

- 29** The resistance of a lamp is 10Ω and the potential difference across it is 6.0 V.

How many electrons pass through the lamp in a time of 24 hours?

- A** 5.2×10^4 **B** 9.0×10^{19} **C** 5.4×10^{21} **D** 3.2×10^{23}

- 30** What is equivalent to one volt?

- A** one coulomb per second
- B** one joule per coulomb
- C** one joule per second
- D** one joule second per coulomb squared

- 31** The resistance of some electrical components may change with changing conditions.

Which component's resistance increases?

- A** a filament lamp as the potential difference (p.d.) across it increases
- B** a light-dependent resistor (LDR) as the intensity of the light incident on it increases
- C** a metallic conductor at constant temperature as the current through it increases
- D** a thermistor as its temperature increases

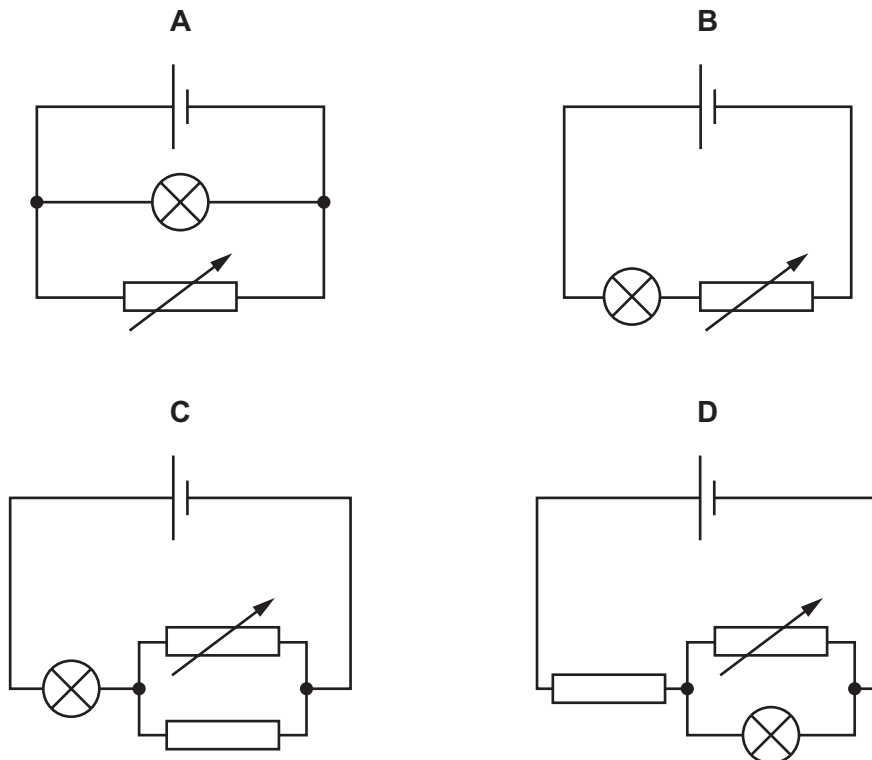
- 32** Gold is sometimes used to make very small connecting wires in electronic circuits.

A particular gold wire has length $2.50 \times 10^{-3} \text{ m}$ and cross-sectional area $6.25 \times 10^{-8} \text{ m}^2$. Gold has resistivity $2.3 \times 10^{-8} \Omega \text{ m}$.

What is the resistance of the wire?

- A** $3.6 \times 10^{-18} \Omega$
B $5.8 \times 10^{-13} \Omega$
C $9.2 \times 10^{-4} \Omega$
D $6.8 \times 10^{-3} \Omega$
- 33** A cell of constant electromotive force (e.m.f.) and negligible internal resistance is separately connected into four different circuits.

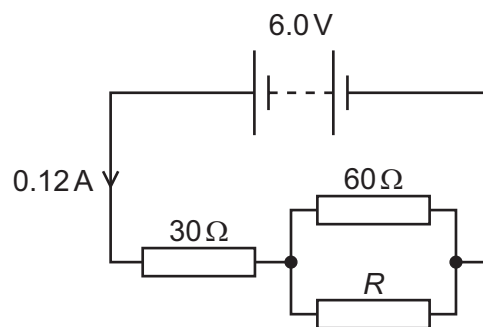
In which circuit does the power dissipated by the lamp stay the same as the variable resistor is adjusted?



- 34** The sum of the electrical currents into a point in a circuit is equal to the sum of the currents out of the point.

Which statement is correct?

- A** This is Kirchhoff's first law, which results from the conservation of charge.
 - B** This is Kirchhoff's first law, which results from the conservation of energy.
 - C** This is Kirchhoff's second law, which results from the conservation of charge.
 - D** This is Kirchhoff's second law, which results from the conservation of energy.
- 35** A battery of electromotive force (e.m.f.) 6.0 V and negligible internal resistance is connected to three resistors, as shown.



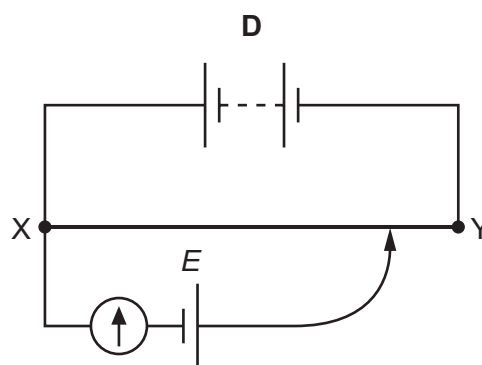
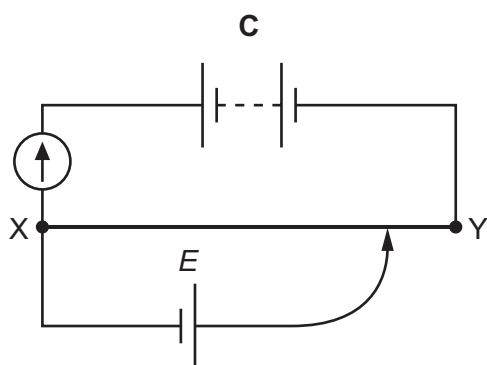
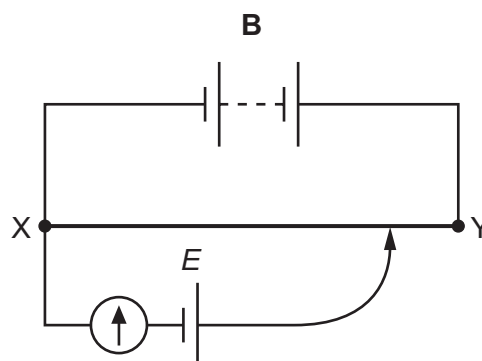
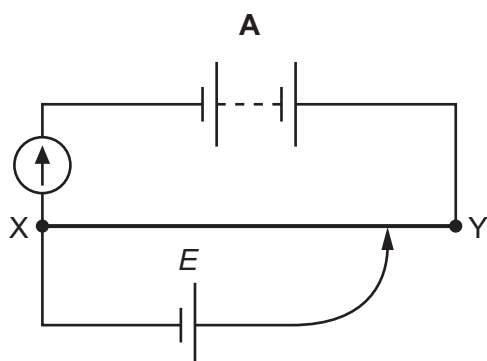
The current in the battery is 0.12 A .

What is resistance R ?

- A** $12\ \Omega$ **B** $30\ \Omega$ **C** $50\ \Omega$ **D** $60\ \Omega$

- 36** A potentiometer circuit may be used to determine the unknown electromotive force (e.m.f.) E of a cell. The circuit diagrams shown include a battery of known e.m.f. and negligible internal resistance, a uniform resistance wire XY and a galvanometer.

Which circuit diagram shows a suitable arrangement for determining E ?



- 37** A uranium atom with a charge of $+2e$ has a nucleon number of 235 and a proton number of 92.
 e is the elementary charge.

What is the total number of protons, neutrons and electrons in this charged atom?

- A** 235 **B** 325 **C** 327 **D** 329

- 38** A nucleus W of a radioactive isotope emits a β^- particle and forms nucleus X.

Nucleus X emits an α -particle to form nucleus Y.

Nucleus Y emits a β^- particle to form nucleus Z.

Which statement about Z is correct?

- A** Z is a nucleus of a different element from W and has a higher nucleon number.
B Z is a nucleus of a different element from W and has a lower nucleon number.
C Z is a nucleus of the same element as W and has a higher nucleon number.
D Z is a nucleus of the same element as W and has a lower nucleon number.

39 Which particle is **not** a lepton?

- A** electron
- B** neutrino
- C** neutron
- D** positron

40 How many flavours (types) of antiquark are there?

- A** 3
- B** 4
- C** 5
- D** 6

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