



Cambridge International AS & A Level

PHYSICS

9702/11

Paper 1 Multiple Choice

October/November 2024

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 **16** 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 are the SI base units for the moment of a force?

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

2 Which statement about vector quantities is correct?

- A Acceleration of free fall is a vector quantity because it has a constant magnitude.
 B Temperature in $^{\circ}\text{C}$ is a vector quantity because it can be positive or negative.
 C Time is a vector quantity because it can only go in the forwards direction.
 D Weight is a vector quantity because it has a direction.

3 The density of the material of a rectangular block is determined by measuring the mass and linear dimensions of the block. The list shows the results obtained, together with their uncertainties.

$$\text{mass} = (25.0 \pm 0.1) \text{g}$$

$$\text{length} = (5.00 \pm 0.01) \text{cm}$$

$$\text{width} = (2.00 \pm 0.01) \text{cm}$$

$$\text{height} = (1.00 \pm 0.01) \text{cm}$$

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

What is the uncertainty in this result?

- A $\pm 0.01 \text{ g cm}^{-3}$ B $\pm 0.02 \text{ g cm}^{-3}$ C $\pm 0.05 \text{ g cm}^{-3}$ D $\pm 0.13 \text{ g cm}^{-3}$

4 What is a reasonable estimate of the volume of one page from this examination paper?

- A 60 mm^3 B 600 mm^3 C 6000 mm^3 D $60\,000 \text{ mm}^3$

5 An object is projected from horizontal ground at a velocity of magnitude u and angle θ to the horizontal. It hits the ground at a time t after it is projected. Assume air resistance is negligible.



Which statement does **not** describe the motion of this object?

- A The horizontal component of the object's velocity is constant and has the value $u \cos \theta$.
 B The horizontal distance travelled by the object is $t u \cos \theta$.
 C The time taken for the object to reach maximum height is $\frac{t}{2}$.
 D The vertical component of the object's velocity is constant and has the value $u \sin \theta$.

- 6 A person, travelling on a motorway a total distance of 200 km, travels the first 90 km at an average speed of 80 km h^{-1} .

Which average speed must be obtained for the rest of the journey if the person is to reach the destination in a total time of 2 hours 0 minutes?

- A** 110 km h^{-1} **B** 120 km h^{-1} **C** 122 km h^{-1} **D** 126 km h^{-1}

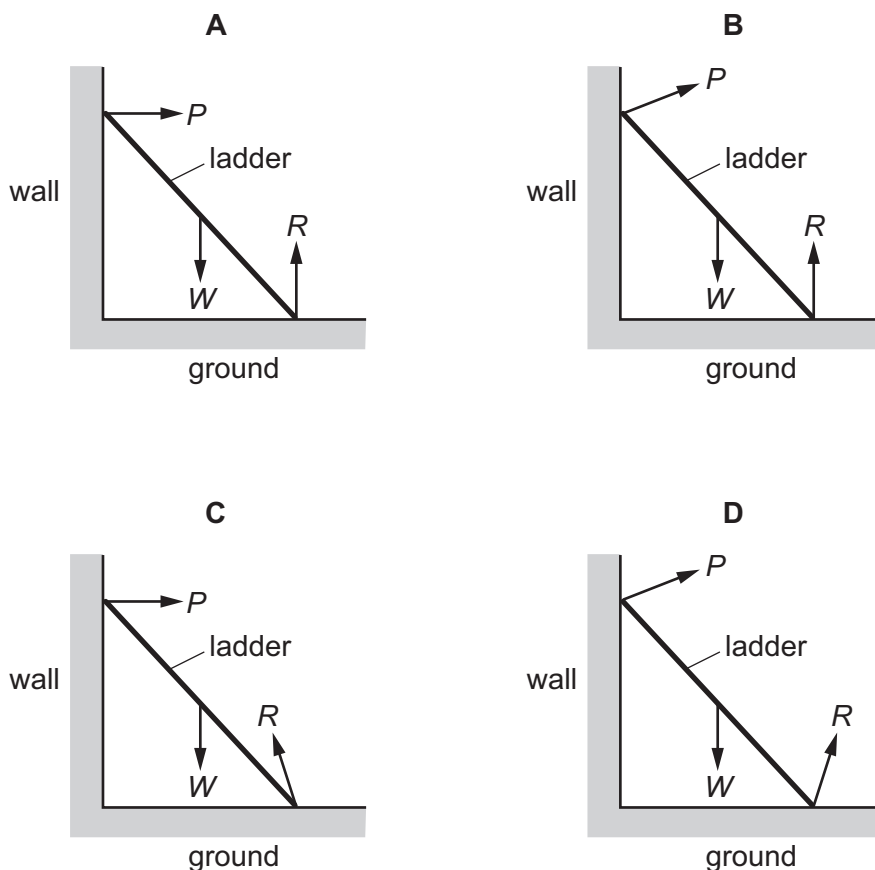
- 7 A car of mass 1200 kg has momentum $18\,000 \text{ kg m s}^{-1}$.

What is the kinetic energy of the car?

- A** 4.65 kJ **B** 6.57 kJ **C** 135 kJ **D** 270 kJ

- 8 A ladder is positioned on icy (frictionless) ground and is leant against a rough wall. At the instant of release it begins to slide.

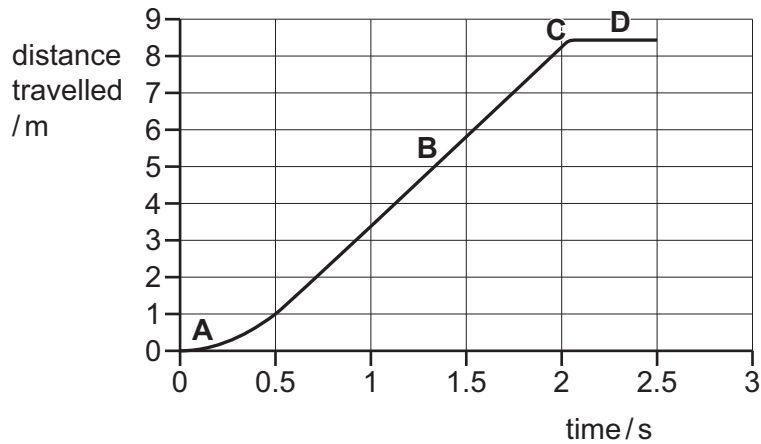
Which diagram shows the directions of the forces P , W and R acting on the ladder as it slides?



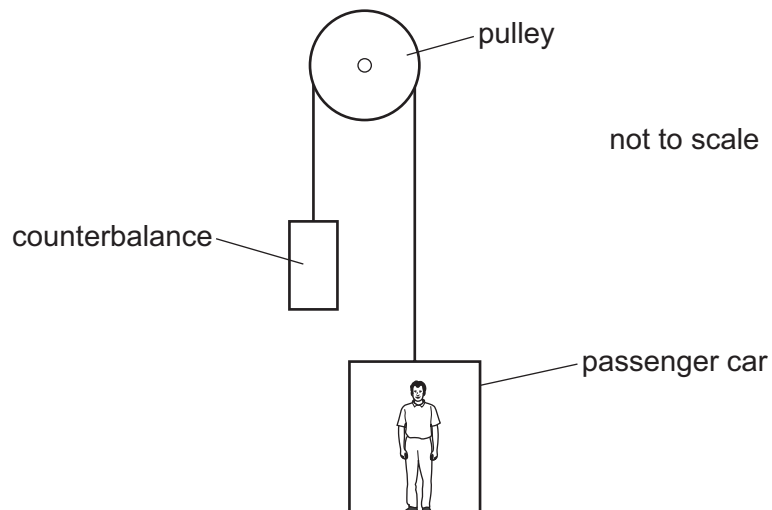
- 9 A toy parachute is dropped from a bridge and falls vertically through the air.

The graph shows the distance travelled by the parachute against time.

Which region of the graph shows when the parachute is at terminal velocity?



- 10 A lift (elevator) consists of a passenger car supported by a cable that runs over a light, frictionless pulley to a counterbalance. The counterbalance falls as the passenger car rises.



Some masses are shown in the table.

	mass / kg
passenger car	520
counterbalance	640
passenger	80

What is the magnitude of the acceleration of the car when carrying just one passenger and when the pulley is free to rotate?

- A** 0.032 ms^{-2} **B** 0.32 ms^{-2} **C** 0.61 ms^{-2} **D** 0.65 ms^{-2}

- 11 A stationary ball of mass m is hit by a bat. The ball leaves the bat with velocity v .

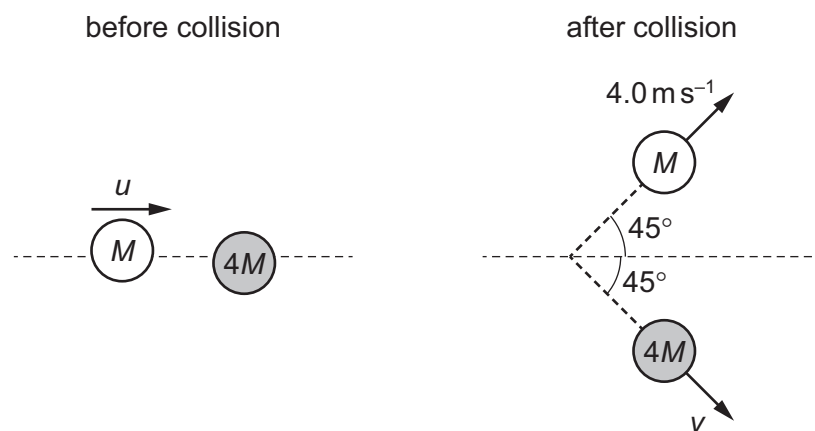
The bat is in contact with the ball for a short time Δt .

What is the average force of the bat on the ball?

- A $mv\Delta t$ B $\frac{mv}{\Delta t}$ C $\frac{1}{2}mv^2\Delta t$ D $\frac{\frac{1}{2}mv^2}{\Delta t}$

- 12 A disc of mass M is moving across a horizontal frictionless surface with constant velocity u . It collides with a stationary disc of mass $4M$.

The diagram shows the view from above of the motion of the two discs before and after the collision.



What is the initial velocity u of the disc of mass M ?

- A 1.1 ms^{-1} B 1.4 ms^{-1} C 3.5 ms^{-1} D 5.7 ms^{-1}

- 13 An object is dropped from rest on the Earth from a height of 2.0 m.

The same object is dropped from rest on the Moon from twice the height.

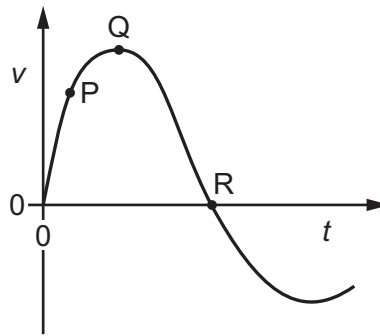
The acceleration of free fall on the Moon is approximately 16% of the value on the Earth.

Assume that there are no resistive forces acting on the object.

What is the ratio $\frac{\text{speed of the object just before hitting the surface on the Earth}}{\text{speed of the object just before hitting the surface on the Moon}}$?

- A 1.8 B 2.5 C 3.1 D 3.5

- 14 The graph shows how velocity v varies with time t for a bungee jumper.



At which point is the bungee jumper momentarily at rest and at which point does she have zero acceleration?

	jumper at rest	jumper with zero acceleration
A	Q	P
B	Q	R
C	R	Q
D	R	R

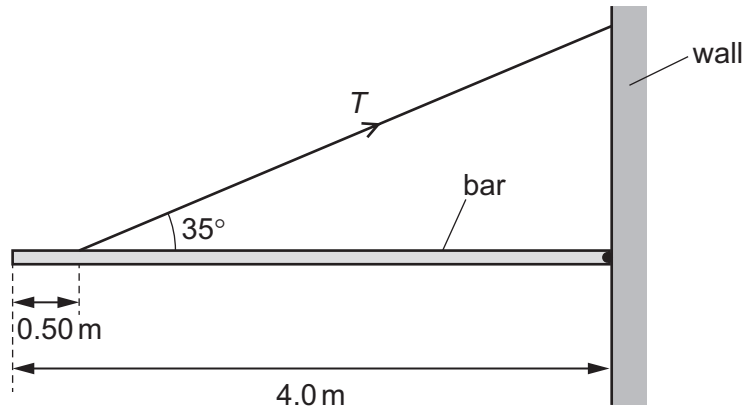
- 15 A solid sphere, which is less dense than water, is held completely immersed in water a few metres below the surface. The density of the water is uniform.

The sphere is released. Immediately after release, the sphere rises.

Which row describes the changes in the magnitudes of the upthrust on the sphere and the resultant force on the sphere as it rises?

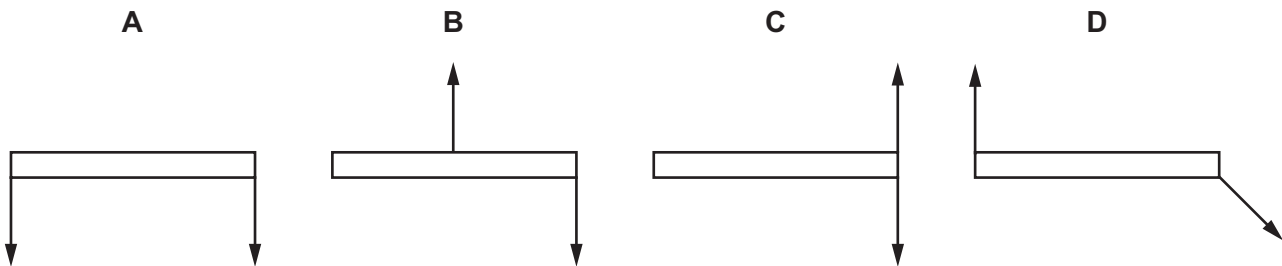
	upthrust on the sphere	resultant force on the sphere
A	constant	decreasing
B	constant	increasing
C	decreasing	decreasing
D	decreasing	increasing

- 16 A uniform bar of weight 200 N and length 4.0 m is freely hinged on a wall at one end. The bar is horizontal and is held in equilibrium by a cable attached at a distance of 0.50 m from the other end. The cable is at an angle of 35° to the horizontal.

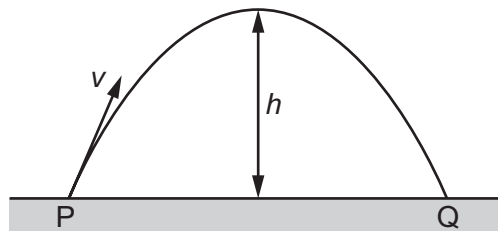


What is the tension T in the cable?

- A 140 N B 170 N C 200 N D 400 N
- 17 The diagrams all show a pair of equal forces acting on a metre rule.
- Which diagram shows forces that provide a couple and zero resultant force?



- 18 A ball of mass m is thrown up to height h in air with an initial velocity v , as shown.



Air resistance is negligible. The acceleration of free fall is g .

What is the **total** work done by the gravitational force on the ball during its flight from P to Q?

- A zero B $\frac{1}{2}mv^2$ C mgh D $2mgh$

- 19 A spring of spring constant 30 N m^{-1} is suspended vertically from its top. The spring obeys Hooke's law. Initially the spring is not compressed and not stretched. A mass of 0.50 kg is attached to the bottom of the spring. The mass is released from rest and falls.

Frictional effects are negligible.

In the motion that follows, what is the maximum extension of the spring?

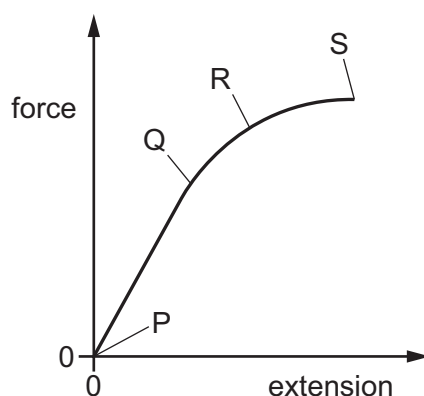
- A 0.017 m B 0.033 m C 0.16 m D 0.33 m

- 20 A wire has original length L and cross-sectional area A . A tensile force F is applied to the wire which causes it to have extension x . The wire obeys Hooke's law.

What is an expression for the Young modulus of the material from which the wire is made?

- A $\frac{\text{stress} \times x}{L}$ B $\frac{F}{A \times \text{strain}}$ C $\frac{F \times x}{A \times L}$ D $\frac{\text{strain}}{\text{stress}}$

- 21 A wire is stretched by a gradually increasing force. The force–extension graph for the wire is shown.



Which statement **must** be correct?

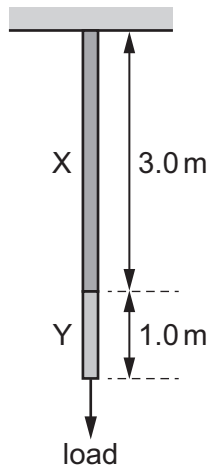
- A Point Q is the elastic limit.
 B Point R is the limit of proportionality.
 C The area under the graph from P to S is the elastic potential energy stored in the wire.
 D The area under the graph from P to S is the work done in stretching the wire.
- 22 A spring has an unstretched length of 0.30 m and a spring constant of 400 N m^{-1} . An object is suspended from the spring and the spring is deformed within its limit of proportionality. The new length of the spring is 0.50 m .

What is the elastic potential energy stored in the spring?

- A 8.0 J B 16 J C 40 J D 50 J

- 23** A wire consists of a 3.0 m length of metal X joined to a 1.0 m length of metal Y.

The cross-sectional area of the wire is uniform.



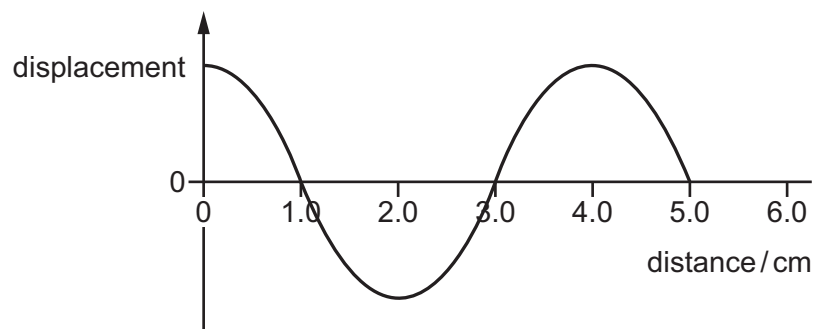
A load hung from the wire causes metal X to extend by 1.5 mm and metal Y to extend by 1.0 mm.

The same load is then hung from a second wire of the same cross-sectional area, consisting of a 1.0 m length of metal X and a 3.0 m length of metal Y.

Both wires are extended within their limit of proportionality.

What is the total extension of this second wire?

- A** 2.5 mm **B** 3.5 mm **C** 4.8 mm **D** 5.0 mm
- 24** The graph shows the variation of the displacement with distance for a progressive wave at one instant in time.



The period of the wave is 91 ms.

What can be determined about the wave?

- A** It has a velocity of 0.44 m s^{-1} and a frequency of 11 Hz.
B It has a velocity of 0.55 m s^{-1} and a wavelength of 5.0 cm.
C It is longitudinal and has a frequency of 11 Hz.
D It is transverse and has a wavelength of 4.0 cm.

25 Which group of electromagnetic waves is arranged in order from shortest wavelength to longest wavelength?

- A radio waves → visible light → gamma rays
- B visible light → microwaves → infrared
- C visible light → ultraviolet → X-rays
- D X-rays → infrared → microwaves

26 A wave has a frequency of 5 GHz.

What is the period of the wave?

- A 200 ps B 2 ns C 20 ns D 20 000 μ s

27 Three statements about two progressive waves are listed.

- 1 The waves have the same frequency.
- 2 The waves have the same amplitude.
- 3 The waves are emitted with a constant phase difference.

Which statements **must** be correct for the two waves to be coherent?

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

28 Waves P and Q have the same amplitude. The waves meet in phase at point X and interfere to give a resultant wave with intensity I .

The amplitude of wave P is doubled.

What is the new intensity of the resultant wave at X, in terms of I ?

- A $0.44I$ B $1.5I$ C $2.3I$ D $3.0I$

29 Radio waves can be polarised, but sound waves **cannot** be polarised.

Which statement gives the reason for this?

- A Radio waves are generally of a higher frequency than sound waves.
- B Radio waves are transverse waves, but sound waves are longitudinal waves.
- C Radio waves can travel through a vacuum, but sound waves **cannot** travel through a vacuum.
- D Radio waves travel at a much higher speed than sound waves.

- 30 Light of wavelength λ is incident normally on a diffraction grating with a total number of N lines in width w .

A second order maximum is observed at an angle of diffraction θ .

What is N ?

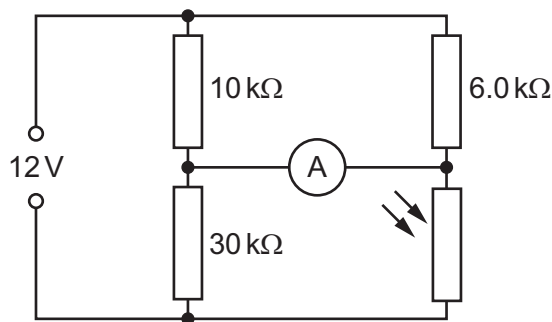
- A $\frac{w\lambda}{\sin\theta}$ B $\frac{2w\lambda}{\sin\theta}$ C $\frac{w\sin\theta}{2\lambda}$ D $\frac{w\sin\theta}{\lambda}$

- 31 Kirchhoff's second law is a consequence of a basic principle.

What is this principle?

- A The charge flowing in an electric circuit is conserved.
 B The energy in an electric circuit is conserved.
 C The sum of the electric currents entering a point in an electric circuit is equal to the sum of the electric currents leaving that point.
 D The sum of the potential differences in an electric circuit is equal to the sum of the products of the current and resistance.

- 32 The diagram shows a circuit with a light-dependent resistor (LDR).



The ammeter reads zero current.

What is the resistance of the LDR?

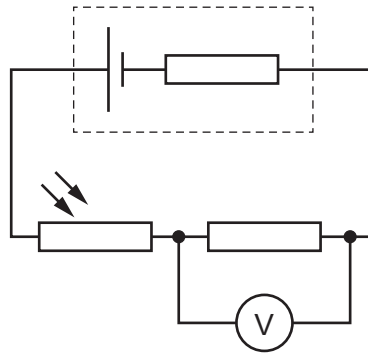
- A $6.0\text{ k}\Omega$ B $18\text{ k}\Omega$ C $26\text{ k}\Omega$ D $30\text{ k}\Omega$

- 33 A torch uses three lamps connected in parallel and is powered by a cell of electromotive force (e.m.f.) 3.0 V and negligible internal resistance. Each lamp dissipates 0.60 W of power.

What is the current in the cell?

- A 0.067 A B 0.20 A C 0.60 A D 0.83 A

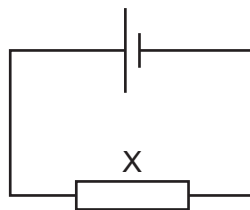
- 34 A cell with internal resistance is connected to a light-dependent resistor (LDR), a fixed resistor and a voltmeter, as shown.



The voltmeter reading increases.

Which quantity decreases as the voltmeter reading increases?

- A the charge moving through the cell per unit time
 - B the energy transferred to the fixed resistor per unit charge
 - C the intensity of the light incident on the LDR
 - D the terminal potential difference across the cell
- 35 The circuit shown contains a cell with negligible internal resistance.



The energy transferred per unit charge in driving charge around the complete circuit is E . The potential difference (p.d.) across X is V .

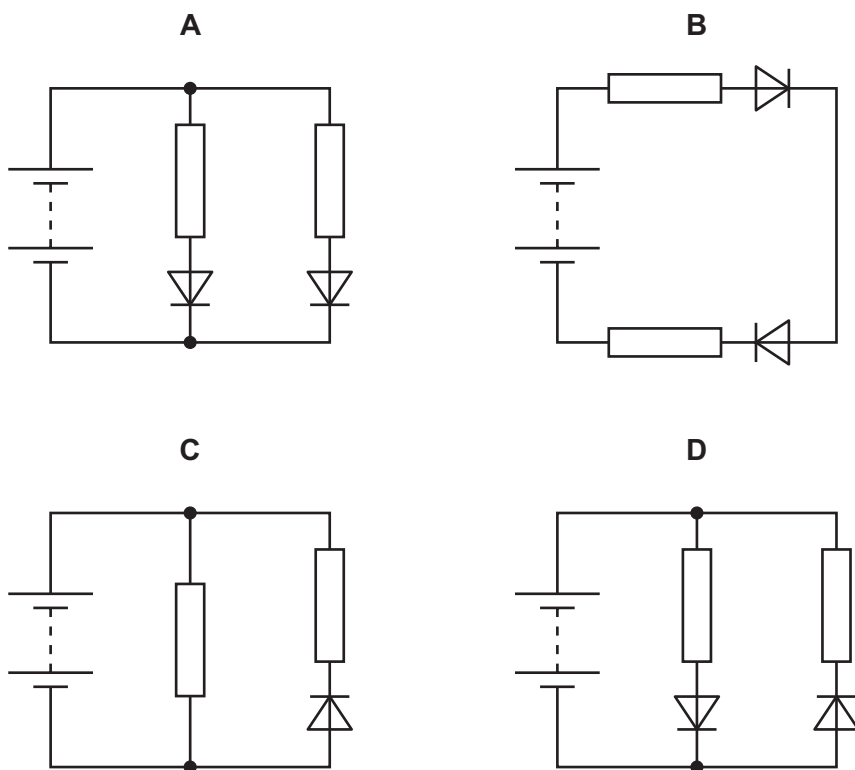
The cell is then replaced with a different cell of the same electromotive force (e.m.f.) that has significant internal resistance.

What is the effect on E and V of replacing the cell?

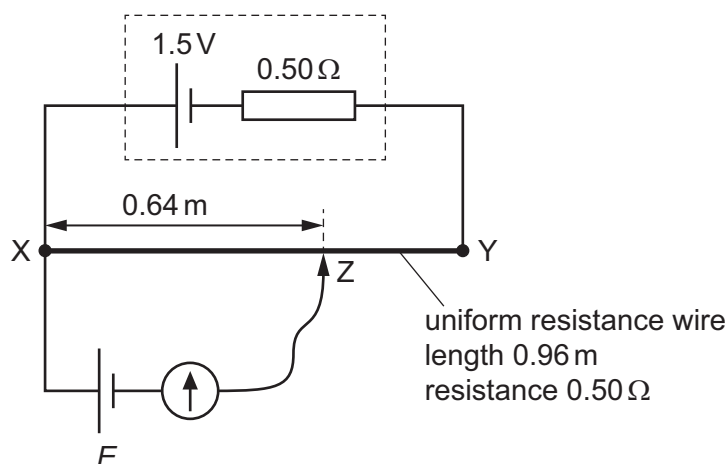
	effect on E	effect on V
A	decreases	decreases
B	decreases	increases
C	no change	decreases
D	no change	increases

- 36** In the circuits shown, the batteries are identical and all have negligible internal resistance. All of the resistors have the same resistance. The diodes have zero resistance when conducting and infinite resistance when not conducting.

In which circuit is the current in the battery greatest?



- 37 A potentiometer circuit is used to determine the electromotive force (e.m.f.) E of a cell. The circuit includes a second cell of e.m.f. 1.5 V and internal resistance $0.50\ \Omega$ that is connected to a uniform resistance wire XY , as shown.



The resistance wire XY has a length of 0.96 m and a resistance of $0.50\ \Omega$.

The movable connection Z is moved along wire XY . The galvanometer reading is zero when length XZ is 0.64 m .

What is the value of e.m.f. E ?

- A** 0.50 V **B** 0.75 V **C** 1.0 V **D** 1.1 V
- 38 Which particle is **not** a fundamental particle?
- A** charm quark
B electron
C neutrino
D neutron
- 39 The isotope fluorine-18, $^{18}_{9}\text{F}$, undergoes β^+ decay to form a stable isotope.
- How many neutrons are there in a nucleus of the stable isotope?
- A** 7 **B** 8 **C** 9 **D** 10
- 40 Which statement is correct?
- A** A baryon is a hadron and consists of 2 quarks.
B A meson is a hadron and consists of 3 quarks.
C An electron is a fundamental particle and is a lepton.
D A neutrino is a fundamental particle and is a hadron.

BLANK PAGE

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cambridgeinternational.org after the live examination series.

Cambridge Assessment International Education is part of Cambridge Assessment. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which is a department of the University of Cambridge.



Cambridge International AS & A Level

PHYSICS

9702/12

Paper 1 Multiple Choice

October/November 2024

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 A physical quantity consists of a magnitude and a unit.

Which row does **not** show a correct combination of a quantity and its unit?

	quantity	unit
A	mass	gram
B	length	metre
C	charge	ampere
D	temperature	kelvin

- 2 A small car travels in a town.

What is a reasonable estimate of the kinetic energy of the car?

- A** $5 \times 10^4 \text{ J}$ **B** $5 \times 10^7 \text{ J}$ **C** $5 \times 10^{10} \text{ J}$ **D** $5 \times 10^{13} \text{ J}$

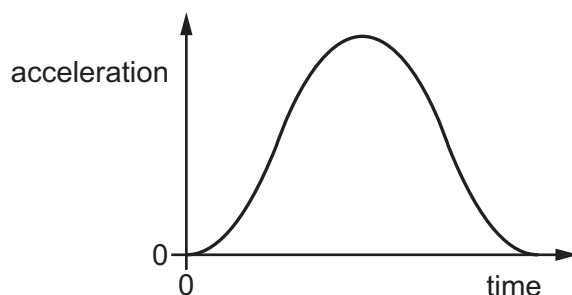
- 3 A solid bar has a square cross-section. Its length is measured as $50.0 \pm 0.2 \text{ cm}$ and its width is measured as $2.00 \pm 0.01 \text{ cm}$.

These values are used to calculate the volume of the bar.

What is the percentage uncertainty in the calculated volume?

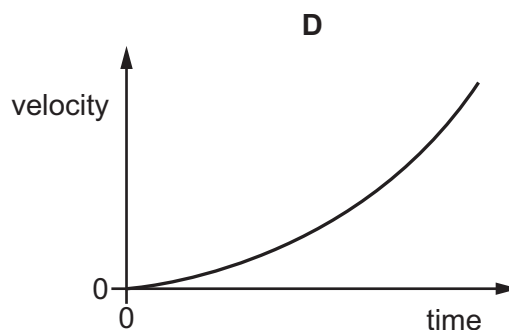
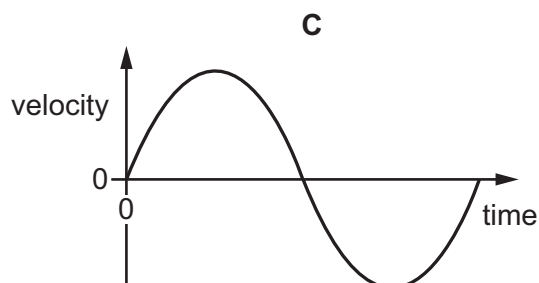
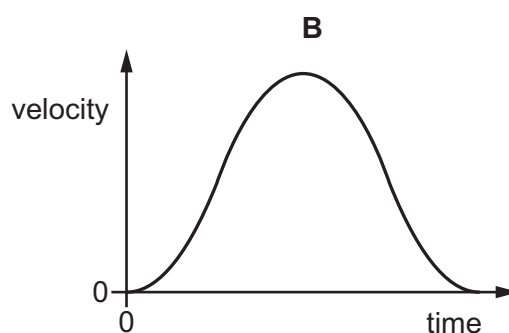
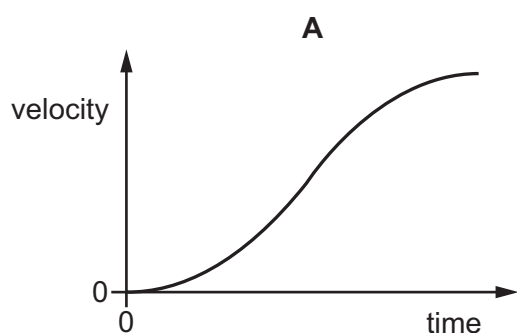
- A** $\pm 0.21\%$ **B** $\pm 0.22\%$ **C** $\pm 0.90\%$ **D** $\pm 1.4\%$

- 4 The graph shows how the acceleration of an object moving in a straight line varies with time.



The object starts from rest.

Which graph shows the variation with time of the velocity of the object over the same time interval?



- 5 A stone falls vertically from rest. Air resistance is negligible.

What is the speed of the stone when it has fallen through a distance of 0.40 m?

- A** 2.0 ms^{-1} **B** 2.8 ms^{-1} **C** 3.9 ms^{-1} **D** 7.8 ms^{-1}

- 6 A ball is thrown horizontally off a tall building. The ground is horizontal. Air resistance is negligible.

Which statement about the motion of the ball is correct?

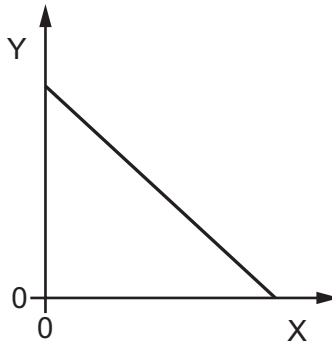
- A** The acceleration of the ball is always at right angles to the path of the ball.
- B** The ball follows a circular path until it hits the ground.
- C** The ball has constant acceleration.
- D** The ball's time in the air is proportional to the velocity at which the ball is thrown.
- 7 A moving object strikes a stationary object. The collision is inelastic. The objects move off together.

Assume that the two objects form an isolated system.

Which row shows the possible values of total momentum and total kinetic energy for the system before and after the collision?

	total momentum before collision / kg m s ⁻¹	total momentum after collision / kg m s ⁻¹	total kinetic energy before collision / J	total kinetic energy after collision / J
A	6	2	90	30
B	6	6	30	90
C	6	6	90	30
D	6	6	90	90

- 8 The graph shows how a quantity Y varies with a quantity X for an object falling vertically at its terminal velocity towards the surface of the Earth.



Which quantities could X and Y represent?

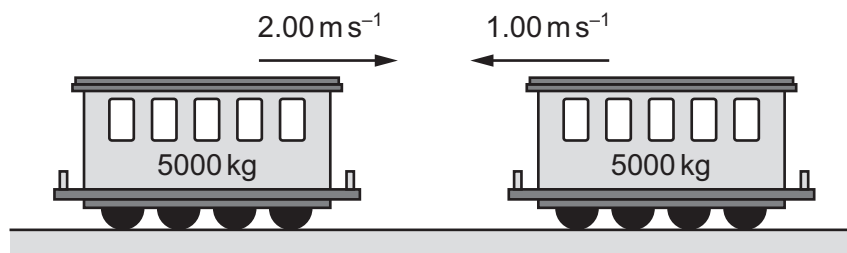
	X	Y
A	time	acceleration
B	time	height above surface
C	distance moved	kinetic energy
D	distance moved	velocity

- 9 A ball of mass 2.0 kg travels horizontally with a speed of 4.0 m s^{-1} . The ball collides with a wall and rebounds in the opposite direction with a speed of 2.8 m s^{-1} . The time of the collision is 150 ms .

What is the average force exerted on the wall?

- A** 16 N **B** 37 N **C** 53 N **D** 91 N

- 10 Two train carriages each of mass 5000 kg roll toward one another on a horizontal frictionless track. One is travelling at a speed of 2.00 m s^{-1} and the other at a speed of 1.00 m s^{-1} , as shown.



They collide and join together.

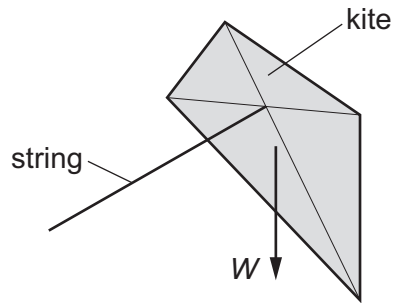
What is the kinetic energy lost during the collision?

- A** 1250 J **B** 7500 J **C** 11 250 J **D** 12 500 J

11 Which single condition **must** apply for an object to be in equilibrium?

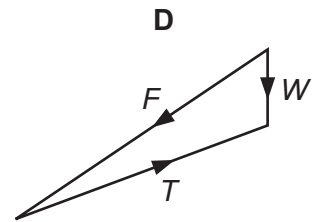
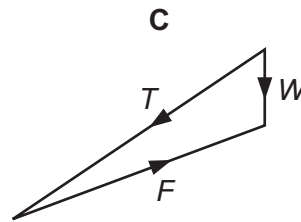
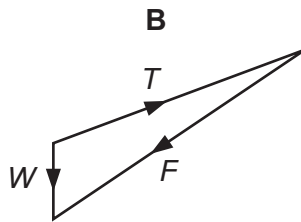
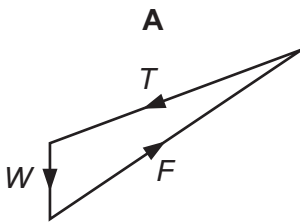
- A The object has a constant non-zero acceleration.
- B The object is stationary.
- C There are no forces acting on the object.
- D The resultant force acting on the object is zero.

12 A kite is in equilibrium at the end of a string, as shown.

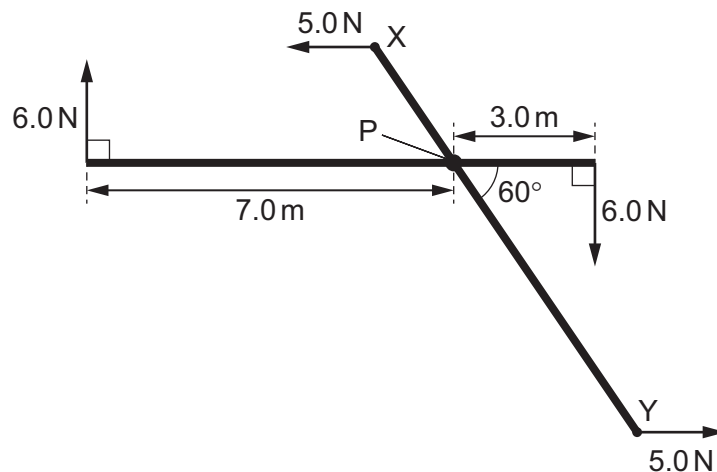


The kite has three forces acting on it: the weight W , the tension T in the string, and the force F from the wind.

Which vector diagram represents the forces acting on the kite?



- 13 Four forces act about a point P, as shown.



The forces act in the same plane and produce no resultant moment about point P.

What is the length XY?

- A** 6.9 m **B** 12 m **C** 14 m **D** 24 m
- 14 A rectangular block of lead of density $1.13 \times 10^4 \text{ kg m}^{-3}$ has sides of length 12.0 cm, 15.0 cm and 10.0 cm.
- What is the maximum pressure the block can exert when resting on a table?
- A** 1.13 kPa **B** 1.70 kPa **C** 11.1 kPa **D** 16.6 kPa
- 15 What is the definition of power?
- A** work done in one second
B work done in unit time
C work done per second
D work done per unit time
- 16 A model car travels at a constant velocity of 12 m s^{-1} in a straight horizontal line. The input power to the engine of the car is 800 W. The efficiency of the engine is 60%.

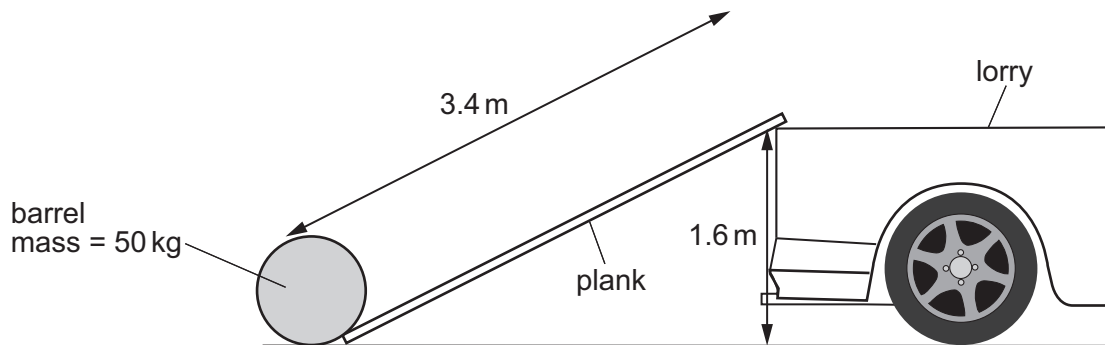
What is the total horizontal resistive force on the car?

- A** 27 N **B** 40 N **C** 67 N **D** 110 N

17 Which statement represents the principle of conservation of energy?

- A Energy cannot be used faster than it is created.
- B The supply of energy is limited, so energy must be conserved.
- C The total energy in a closed system is constant.
- D The total energy input to a system is equal to the useful energy output.

18 A barrel of mass 50 kg is loaded onto the back of a lorry 1.6 m high by pushing it up a frictionless plank 3.4 m long.



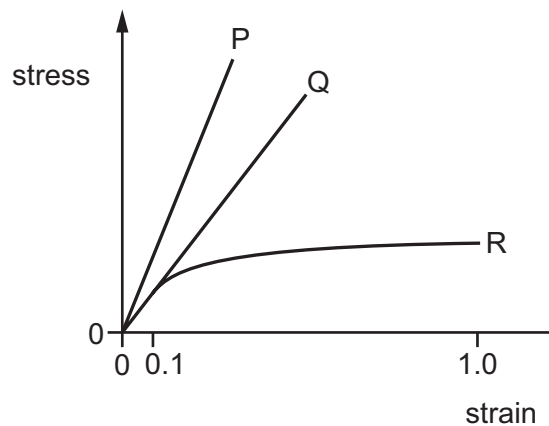
What is the minimum work done?

- A 80 J
- B 170 J
- C 780 J
- D 1700 J

19 What is a unit for stress?

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

- 20 The graph shows the relationship between stress and strain for three wires of the same linear dimensions but made from different materials.



Which statements are correct?

- 1 The extension of P is approximately twice that of Q for the same stress.
- 2 The ratio of the Young modulus for P to that of Q is approximately two.
- 3 For strain less than 0.1, R obeys Hooke's law.

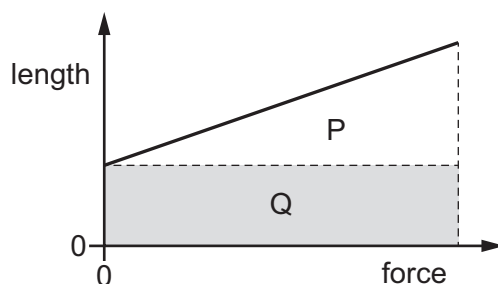
A 1, 2 and 3 **B** 1 and 3 only **C** 2 and 3 only **D** 2 only

- 21 Four solid steel rods equally support an object weighing 10 kN. Each rod is of length 2.0 m and cross-sectional area 250 mm^2 . The weight of the object causes the rods to contract by 0.10 mm. The rods obey Hooke's law.

What is the Young modulus of steel?

- A** $2.0 \times 10^8 \text{ Nm}^{-2}$
B $2.0 \times 10^{11} \text{ Nm}^{-2}$
C $8.0 \times 10^8 \text{ Nm}^{-2}$
D $8.0 \times 10^{11} \text{ Nm}^{-2}$

- 22** The graph shows how the length of a spring varies with the force applied to it. Two areas P and Q are labelled.



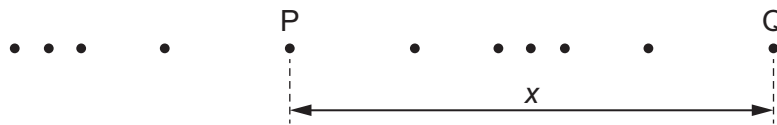
Which area represents the work done in stretching the spring?

- A** area P
 - B** area Q
 - C** area P + area Q
 - D** area Q – area P
- 23** A horizontal beam of vertically polarised light of amplitude A is incident normally on a polarising filter. The transmission axis of the filter is at an angle of 50° to the vertical.

What is the amplitude of the light in the beam after it has passed through the filter?

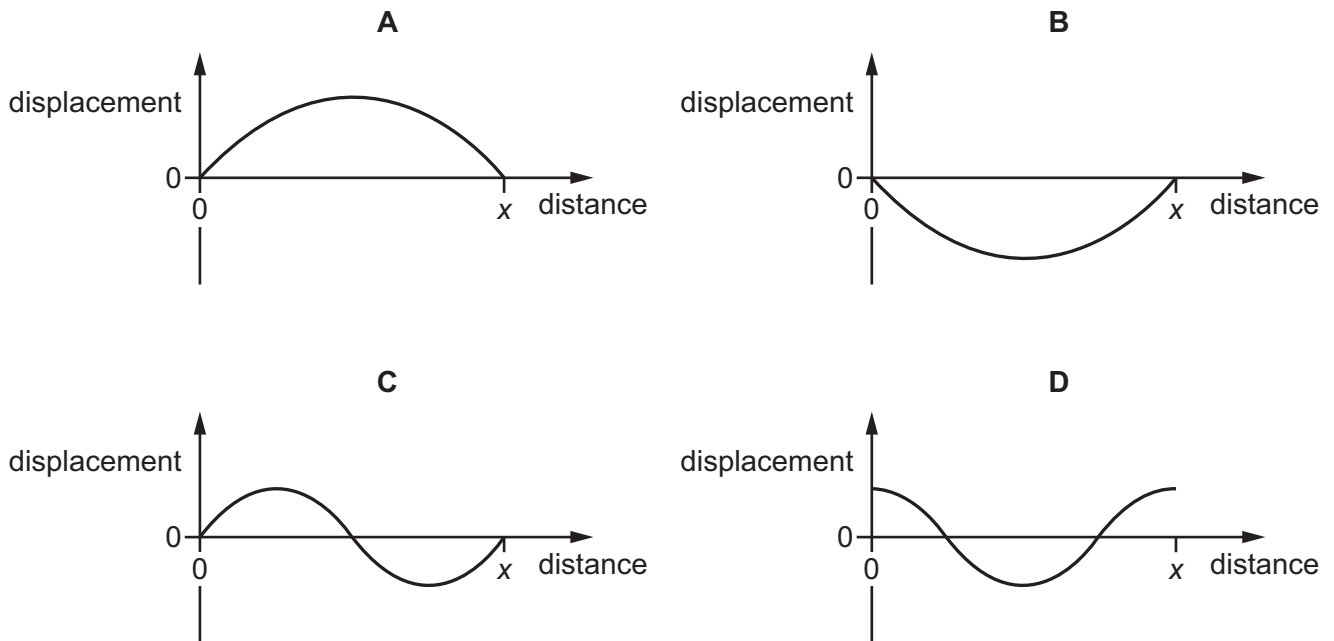
- A** $0.17A$ **B** $0.41A$ **C** $0.64A$ **D** $0.80A$

- 24** A progressive longitudinal sound wave moves through air. The diagram shows the positions of the air particles along part of the wave at one instant.



Point Q is a distance x from point P.

Which graph shows the variation of the displacement of the air particles with distance from P along the wave?



- 25** An electromagnetic wave in free space has a frequency of 3.0×10^{16} Hz.

Which row gives the principal region of this wave and an example of an electromagnetic wave with a lower frequency?

	principal region	wave with lower frequency
A	infrared	visible light
B	infrared	X-rays
C	ultraviolet	visible light
D	ultraviolet	X-rays

- 26** A source of sound emits waves of a constant frequency. The source moves at a constant speed in a straight line relative to a stationary observer.

Which velocity of the source gives the smallest observed frequency?

	speed / ms ⁻¹	direction
A	5	away from observer
B	10	away from observer
C	15	towards observer
D	20	towards observer

- 27** What could describe the time-base of a cathode-ray oscilloscope (CRO)?

- A** the frequency per division on the screen
- B** the number of divisions on the screen per unit frequency
- C** the number of divisions on the screen per unit time
- D** the time per division on the screen

- 28** What happens when two waves superpose at a point?

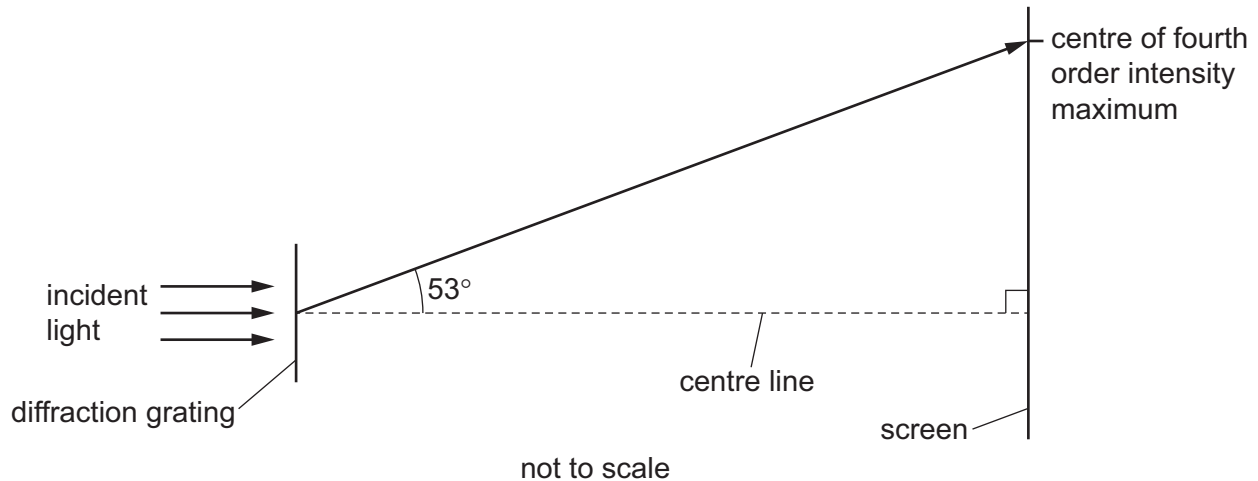
- A** Their amplitudes are added together.
- B** Their displacements are added together.
- C** Their frequencies are added together.
- D** Their velocities are added together.

- 29** An electromagnetic wave is diffracted as it passes through a single slit. The width of the slit is larger than the wavelength of the wave.

Which change will decrease the amount of diffraction of the wave?

- A** Decrease the frequency of the wave.
- B** Decrease the time period of the wave.
- C** Decrease the width of the slit.
- D** Increase the wavelength of the wave.

- 30 The diagram shows visible light incident normally on a diffraction grating.



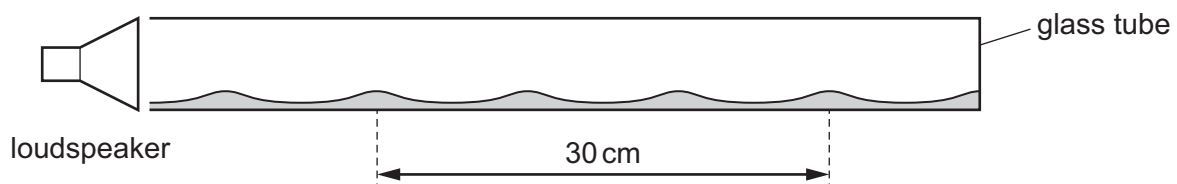
A pattern of intensity maxima forms on the screen. A line connecting the centre of the fourth order intensity maximum with the centre of the diffraction grating forms an angle of 53° with the centre line. The grating has a line spacing of $2.7 \times 10^{-6} \text{ m}$.

What is the wavelength of the incident light?

- A** $4.1 \times 10^{-7} \text{ m}$ **B** $5.4 \times 10^{-7} \text{ m}$ **C** $1.6 \times 10^{-6} \text{ m}$ **D** $2.2 \times 10^{-6} \text{ m}$
- 31 A horizontal glass tube, closed at one end, has a layer of dust laid inside it on its lower side. Sound is emitted from a loudspeaker that is placed near the open end of the tube.

The frequency of the sound is varied and, at one frequency, a stationary wave is formed inside the tube so that the dust forms small heaps.

The distance between four heaps of dust is 30 cm.



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

What is the frequency of the sound emitted by the loudspeaker?

- A** 1650 Hz **B** 2200 Hz **C** 3300 Hz **D** 6600 Hz

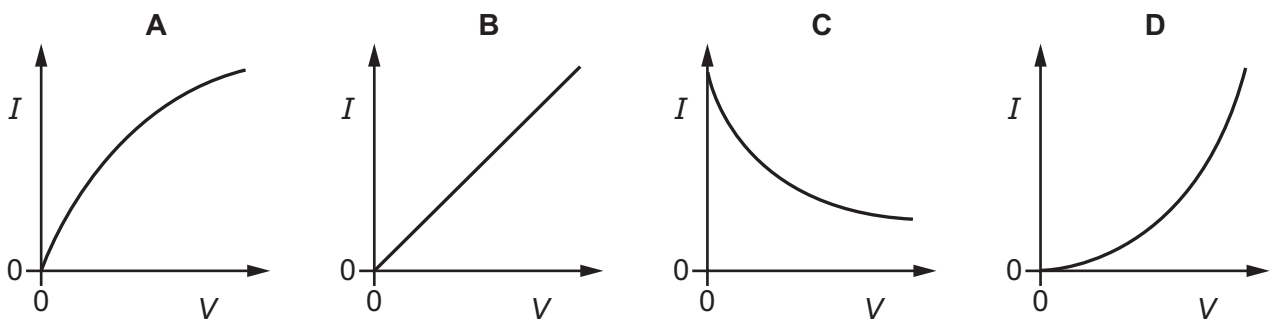
- 32** There is a current in a resistor for a short time interval.

Which statement about the total charge that passes through the resistor is correct?

- A** It can take any value.
- B** It is an integer multiple of the elementary charge.
- C** It is the elementary charge.
- D** It is the rate of flow of the current.

- 33** The potential difference V across a filament lamp is slowly raised from zero to its normal operating value.

Which graph represents the variation with V of the current I in the lamp?



- 34** An electric current of 12 A is in a wire of length 0.35 m .

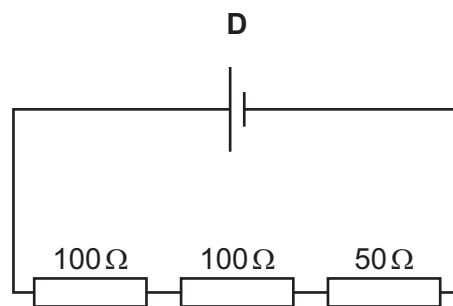
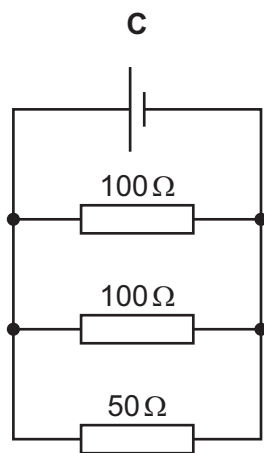
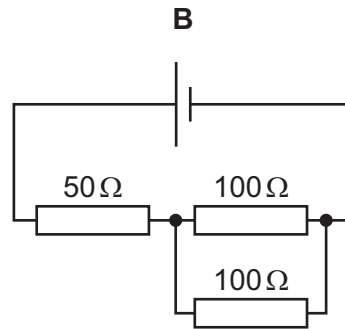
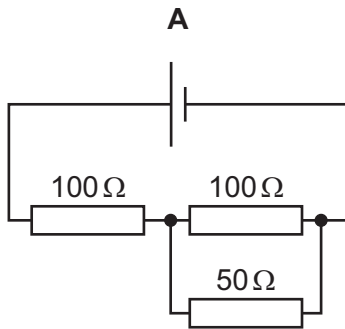
The average drift speed of the free electrons (charge carriers) in the wire is $5.0 \times 10^{-4}\text{ ms}^{-1}$.

How many free electrons are in the wire?

- A** 1.3×10^{16}
- B** 5.3×10^{22}
- C** 1.5×10^{23}
- D** 4.3×10^{23}

35 Three resistors are connected to a cell of negligible internal resistance.

Which circuit has a combined resistance of $100\ \Omega$?



36 Each of Kirchhoff's laws is a statement based on the conservation of a physical quantity.

Which quantity is conserved in each law?

	Kirchhoff's first law	Kirchhoff's second law
A	charge	energy
B	energy	current
C	power	charge
D	resistance	power

37 A cell with electromotive force (e.m.f.) 1.50 V delivers a current of 0.26 A to a resistor of resistance $5.0\ \Omega$ connected between its terminals.

What is the internal resistance of the cell?

A $0.04\ \Omega$

B $0.20\ \Omega$

C $0.39\ \Omega$

D $0.77\ \Omega$

38 What is **not** a quark flavour?

- A charm
- B meson
- C strange
- D up

39 How many down quarks are in a nucleus of hydrogen-3, ${}^3_1\text{H}$?

- A 2 B 3 C 4 D 5

40 An isotope of boron decays to beryllium by β^+ emission.

Which particle is emitted in addition to the β^+ particle?

- A antineutrino
- B electron
- C neutrino
- D neutron

BLANK PAGE

BLANK PAGE

BLANK PAGE

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cambridgeinternational.org after the live examination series.

Cambridge Assessment International Education is part of Cambridge Assessment. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which is a department of the University of Cambridge.



Cambridge International AS & A Level

PHYSICS

9702/13

Paper 1 Multiple Choice

October/November 2024

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 **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 statement about physical quantities is correct?
- A** A physical quantity does **not** always have a magnitude or a unit.
- B** A physical quantity must always have a magnitude but does **not** always have a unit.
- C** A physical quantity must always have a unit but does **not** always have a magnitude.
- D** A physical quantity must always have a magnitude and a unit.
- 2 What is a reasonable estimate of the mass of a solid sphere of copper that has a diameter of 60 cm?
- A** 0.1 kg **B** 10 kg **C** 1000 kg **D** 100 000 kg

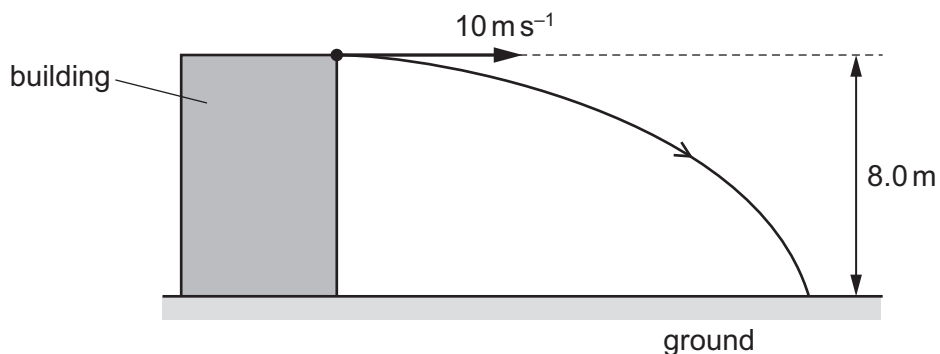
- 3 The power output P of a star can be modelled with the equation

$$P = \sigma AT^4$$

where σ is a constant, A is the surface area of the star and T is the surface temperature of the star.

What are the SI base units of σ ?

- A** $\text{kg s}^{-2} \text{K}^{-4}$
- B** $\text{kg s}^{-3} \text{K}^{-4}$
- C** $\text{kg m}^{-1} \text{s}^{-2} \text{K}^{-4}$
- D** $\text{kg m}^{-1} \text{s}^{-3} \text{K}^{-4}$
- 4 A boy throws a stone with a horizontal velocity of 10 m s^{-1} from the top of a building. The height of the building is 8.0 m. The stone travels along a curved path until it hits the horizontal ground, as shown.

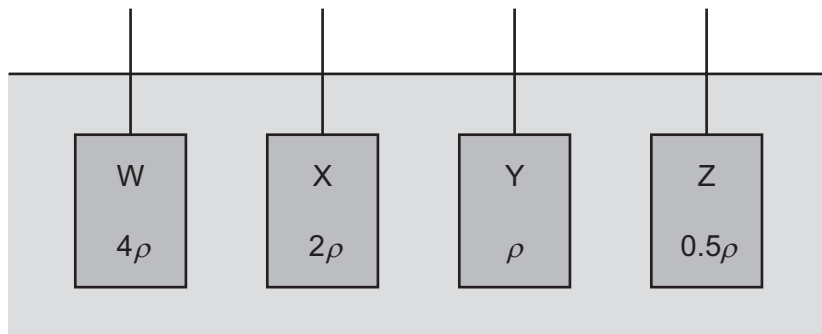


Air resistance is negligible.

How long does it take the stone to reach the ground?

- A** 0.61 s **B** 0.80 s **C** 1.3 s **D** 1.6 s

- 5 Four cuboids with identical lengths, breadths and heights are immersed in water. The cuboids are held at the same depth and in identical orientations by vertical rods, as shown.



Water has density ρ .

Cuboid W is made of material of density 4ρ .

Cuboid X is made of material of density 2ρ .

Cuboid Y is made of material of density ρ .

Cuboid Z is made of material of density 0.5ρ .

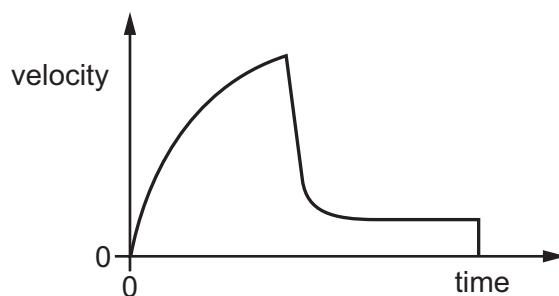
Which statement is correct?

- A The upthrust of the water on each of the cuboids is the same.
 - B The upthrust of the water on W is twice the upthrust of the water on X.
 - C The upthrust of the water on X is twice the upthrust of the water on W.
 - D The upthrust of the water on Y is zero.
- 6 In which example is it **not** possible for the underlined object to be in equilibrium?
- A An aeroplane climbs at a steady rate.
 - B An aeroplane tows a glider at a constant altitude.
 - C A speedboat changes direction at a constant speed.
 - D Two boats tow a ship into harbour.
- 7 Two identical balls are projected vertically upwards from ground level with the same initial velocity. Ball X is in a vacuum and ball Y is in air.

Which statement about the motion of the balls is correct?

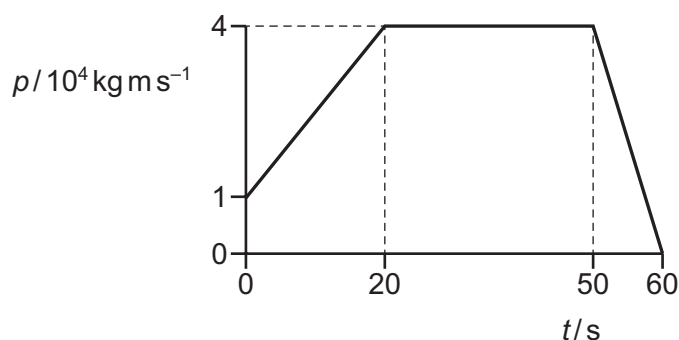
- A Ball X reaches a greater maximum height and in a longer time than ball Y.
- B Ball X reaches a greater maximum height and in a shorter time than ball Y.
- C Ball Y reaches a greater maximum height and in a longer time than ball X.
- D Ball Y reaches a greater maximum height and in a shorter time than ball X.

- 8 The graph shows the variation of velocity with time for a stone that falls from a bridge into a lake and sinks to the bottom of the lake.



What can be deduced about the motion of the stone?

- A** Terminal velocity was reached in air.
B The acceleration in air was decreasing with increasing time.
C The distance travelled in water was greater than the distance travelled in air.
D The rate of change of velocity in air was constant.
- 9 The graph shows the variation of the momentum p with time t for a car.



What is the resultant force on the car at $t = 10$ s?

- A** 0 **B** 1500 N **C** 2000 N **D** 4000 N
- 10 Two objects X and Y form an isolated system. X and Y collide and then separate. The mass of X is greater than the mass of Y.

Which statement about the collision is correct?

- A** The change of momentum of Y is greater than the change of momentum of X.
B The force on Y is greater than the force on X.
C The forces that X and Y exert on each other act for the same length of time.
D The forces that X and Y exert on each other are gravitational forces only.

- 11 Which row states whether total momentum and total kinetic energy are conserved in an inelastic collision in which there are no external forces?

	total momentum	total kinetic energy
A	conserved	conserved
B	conserved	not conserved
C	not conserved	conserved
D	not conserved	not conserved

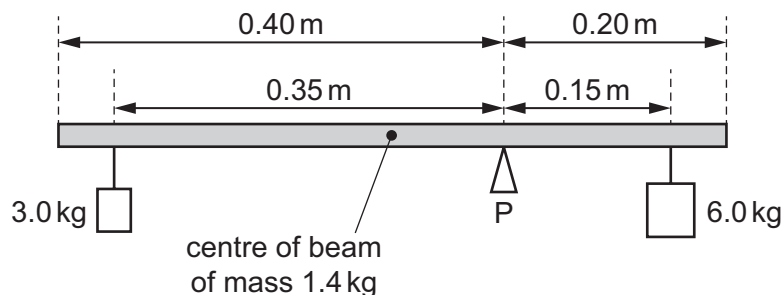
- 12 A tennis ball is thrown vertically upwards. The tennis ball reaches its highest point and then falls back down to the point from which it was thrown.

Air resistance is significant.

At which position on the path of the tennis ball is the resultant force on the tennis ball greatest?

- A** at the start just after the tennis ball is released
B when the tennis ball is halfway to its highest point on the way up
C when the tennis ball is at its highest point
D when the tennis ball is halfway from its highest point on the way down
- 13 Which statement correctly describes a couple?
- A** A couple is a pair of forces that act in the same direction.
B A couple is a pair of forces that act on the centre of gravity of an object.
C A couple is a pair of forces that act to produce a resultant force.
D A couple is a pair of forces that act to produce rotation only.

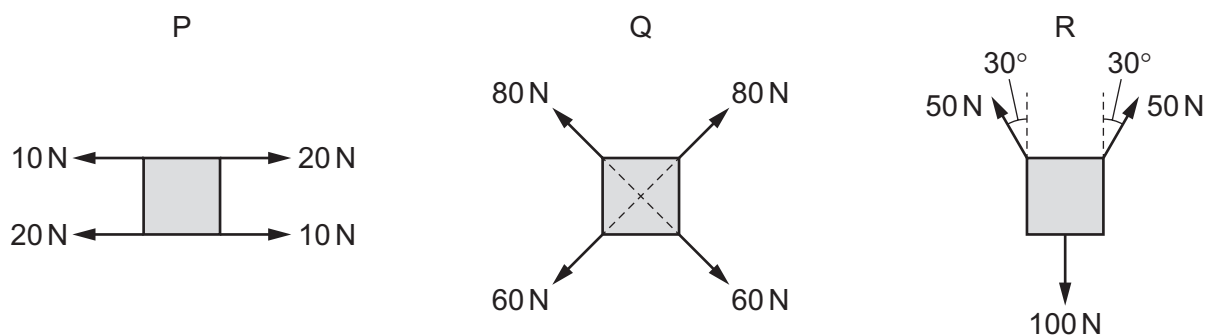
- 14 A uniform beam of mass 1.4 kg is pivoted at P, as shown. The beam has a length of 0.60 m and P is a distance of 0.20 m from one end. Loads of 3.0 kg and 6.0 kg are suspended at distances of 0.35 m and 0.15 m from the pivot, as shown.



What is the torque that must be applied to the beam in order to maintain it in equilibrium?

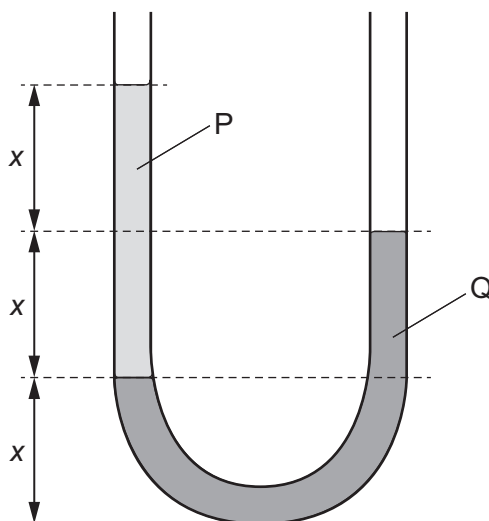
- A** 0.010 Nm **B** 0.10 Nm **C** 0.29 Nm **D** 2.8 Nm

- 15 The diagrams show three rigid objects P, Q and R being subjected to different combinations of forces.



Which objects are in equilibrium?

- A P and Q
 B P and R
 C Q and R
 D none of them
- 16 The diagram shows two liquids, labelled P and Q, that do **not** mix. The liquids are in equilibrium in an open U-tube. Three equal distances x are labelled.



What is the ratio $\frac{\text{density of P}}{\text{density of Q}}$?

- A $\frac{1}{2}$ B $\frac{2}{3}$ C $\frac{3}{2}$ D 2
- 17 A stone of mass 0.30 kg is thrown vertically downwards with a speed of 20 m s^{-1} from a height of 12 m above the ground. It falls vertically until it hits the ground. Air resistance is negligible.

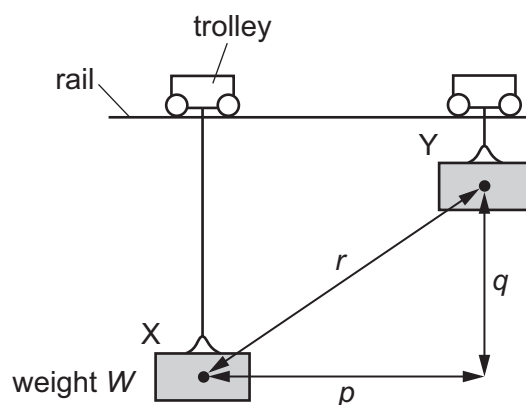
What is the kinetic energy of the stone just before it hits the ground?

- A 25 J B 35 J C 60 J D 95 J

- 18 A student can run or walk up the stairs to her classroom.

Which statement describes the power required and the gravitational potential energy gained while running up the stairs compared to walking up them?

- A Running provides more gravitational potential energy and uses more power.
 - B Running provides more gravitational potential energy and uses the same power.
 - C Running provides the same gravitational potential energy and uses more power.
 - D Running provides the same gravitational potential energy and uses the same power.
- 19 A weight W hangs from a trolley that runs along a rail. The trolley moves horizontally through a distance p and simultaneously raises the weight through a height q .



As a result, the weight moves through a distance r from X to Y. It starts and finishes at rest.

How much work is done on the weight during this process?

- A Wp
 - B $W(p + q)$
 - C Wq
 - D Wr
- 20 The equation for kinetic energy E_K can be derived using the equations of motion.

Four equations relating to motion are listed.

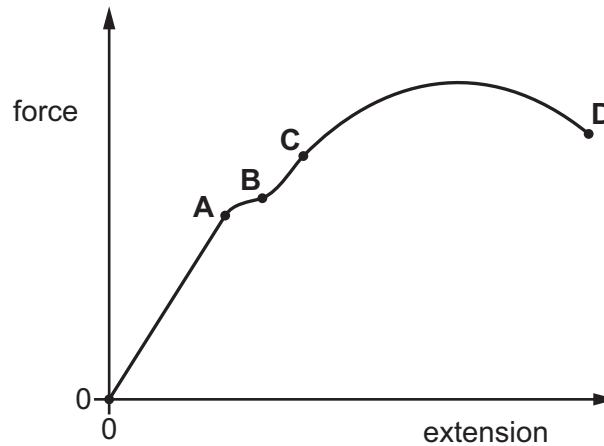
- 1 $W = Fs$
- 2 $F = ma$
- 3 $v^2 = u^2 + 2as$
- 4 $P = \frac{W}{t}$

Which three equations can be used to derive the equation for E_K ?

- A 1, 2 and 3
- B 1, 2 and 4
- C 1, 3 and 4
- D 2, 3 and 4

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

At which point on the graph does the metal wire stop obeying Hooke's law?

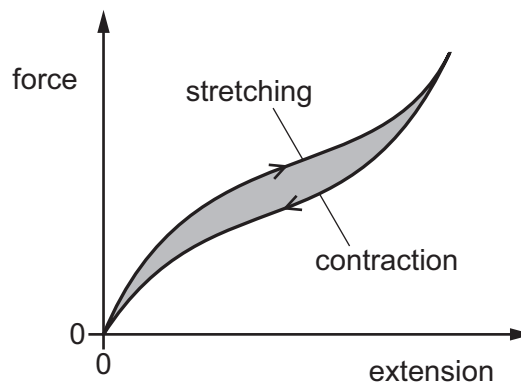
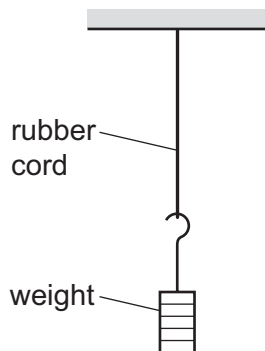


- 22 A uniform wire is made of a metal that has a Young modulus of $1.3 \times 10^{11} \text{ Pa}$.

The wire is 2.4 m long and has a spring constant of $2.7 \times 10^4 \text{ N m}^{-1}$.

What is the volume of the wire?

- A $2.6 \times 10^{-8} \text{ m}^3$ B $6.3 \times 10^{-8} \text{ m}^3$ C $5.0 \times 10^{-7} \text{ m}^3$ D $1.2 \times 10^{-6} \text{ m}^3$
- 23 A rubber cord hangs from a rigid support. A weight attached to its lower end is gradually increased from zero, and then gradually reduced to zero.



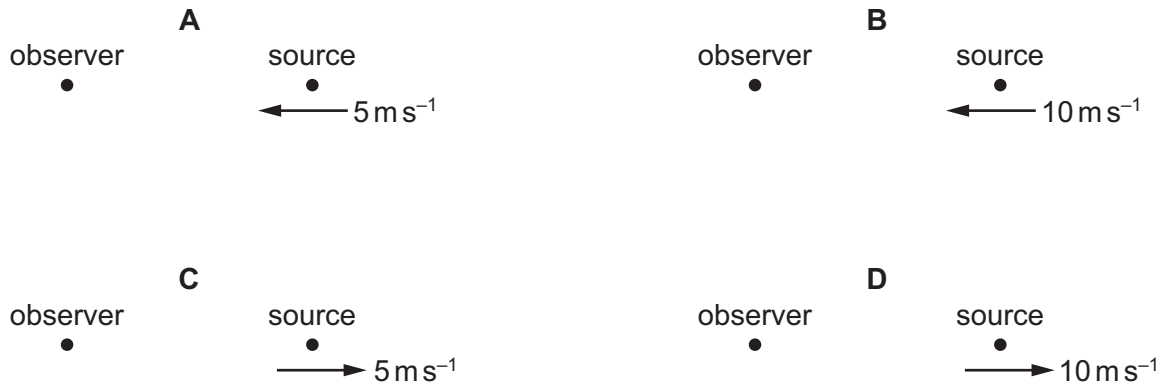
The force–extension curve for contraction is below the force–extension curve for stretching.

What does the shaded area between the curves represent?

- A the elastic potential energy stored in the rubber cord
 B the thermal energy dissipated in the rubber cord
 C the work done by the rubber cord during contraction
 D the work done on the rubber cord during stretching

- 24** A source of sound waves of constant frequency is travelling as shown.

In which situation would the stationary observer detect a sound with the lowest frequency?



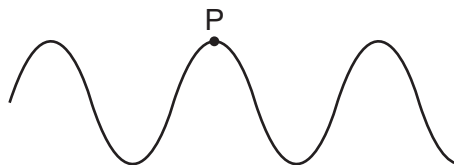
- 25** Each of the principal radiations of the electromagnetic spectrum has a range of wavelengths.

Which wavelength is correctly linked to its radiation?

	wavelength / m	radiation
A	10^{-9}	gamma ray
B	10^{-5}	microwave
C	10^{-8}	ultraviolet
D	10^{-14}	X-ray

- 26** A transverse water wave has a frequency of 15 Hz, a wavelength of 0.12 m and an amplitude of 4.0 mm.

P is a water particle that is initially at the peak of the wave, as shown.



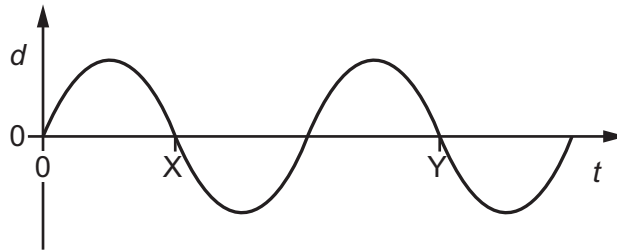
What is the total vertical distance travelled by P in a time of 0.5 s?

- A** 30 mm **B** 60 mm **C** 120 mm **D** 900 mm

27 A wave is formed on a string.

A student plots a graph of the variation of displacement d with time t for a point on the string.

The student marks two points, X and Y, on the graph.



Which property of the wave is represented by the distance along the horizontal axis between X and Y?

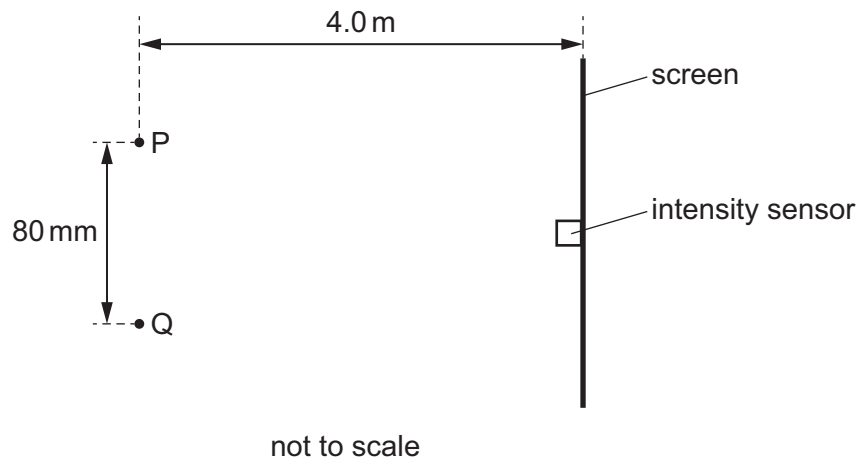
- A** amplitude
- B** frequency
- C** period
- D** wavelength

28 A stationary wave is set up in a stretched string.

Which distance is equal to the wavelength of the wave?

- A** double the distance between adjacent antinodes
- B** half the distance between adjacent nodes
- C** the distance between adjacent antinodes
- D** the distance between a node and an adjacent antinode

- 29** A source of coherent light is incident on two slits, P and Q, which are placed 80 mm apart. The light has a single frequency of 1.5×10^{12} Hz. The light from the slits meets on a screen that is a distance of 4.0 m from the slits. The screen is parallel to a line joining the slits.



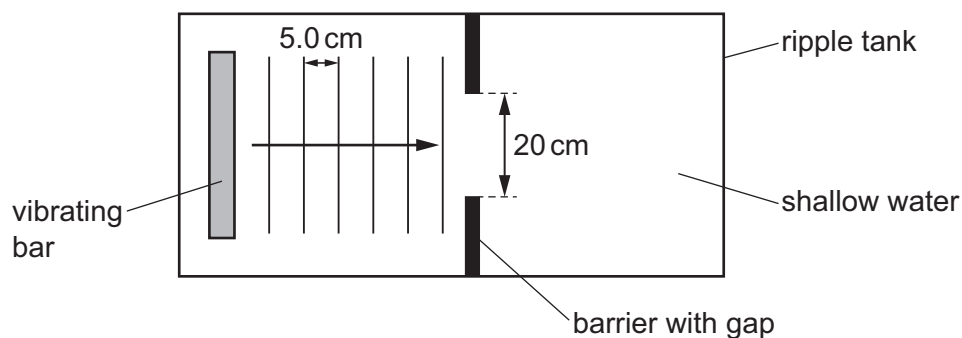
An intensity sensor is placed on the screen at the midpoint of the interference pattern such that the intensity reading is a maximum. The intensity sensor is moved along the screen.

The sensor travels through two intensity minima, two intensity maxima and stops in the middle of the third intensity minimum.

Which distance does the sensor move through?

- A** 4.0 mm **B** 10 mm **C** 25 mm **D** 50 mm
- 30** A vibrating bar produces surface water waves in a ripple tank.

The wavelength of the waves is 5.0 cm and they pass through a gap of width 20 cm.



Which change will increase the amount of diffraction that is observed?

- A** decreasing the distance between the bar and the gap
B decreasing the frequency of the wave
C increasing the amplitude of the wave
D increasing the width of the gap

31 What is an electric current?

- A a flow of charge carriers
- B a flow of energy
- C an electron
- D the charge on a particle

32 A wire of diameter d is connected into an electric circuit. There is a current I in the wire and the charge carriers have an average drift speed v .

The wire is replaced with a new wire of the same material but with a diameter $0.5d$.

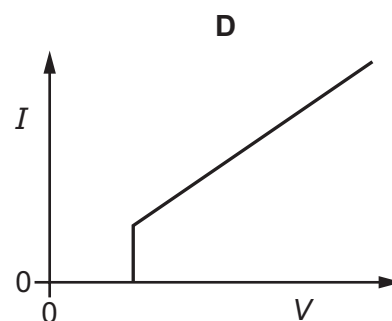
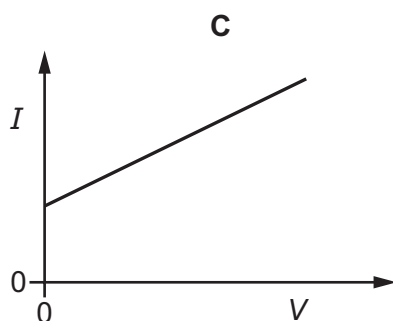
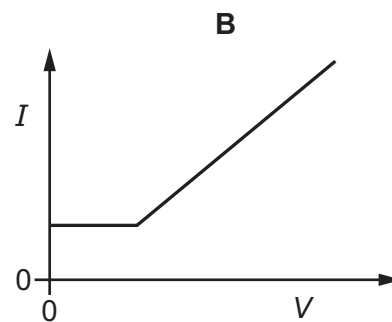
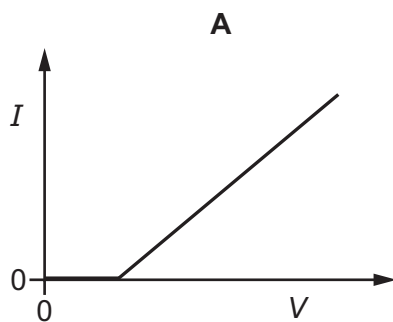
The current is adjusted so that the charge carriers in the new wire have an average drift speed $3v$.

What is the current in the new wire?

- A $0.75I$ B $1.5I$ C $6I$ D $12I$

33 A fixed resistor and a diode are combined by connecting them in series. The total potential difference V across the combination is varied and the corresponding current I is measured.

Which graph could represent the variation of I with V ?



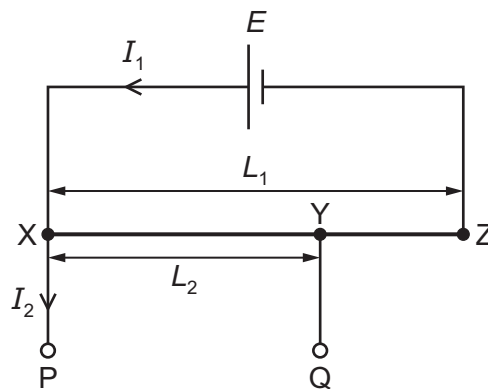
- 34 The potential difference (p.d.) across a fixed resistor is V . The power dissipated in the resistor is 5.0 W .

The p.d. across the resistor then changes to a new value. With the new p.d. the energy transferred to the resistor in a time of 2.25 s is 45.0 J .

What is the new p.d. across the resistor?

- A $\frac{1}{2}V$ B $2V$ C $3V$ D $4V$

- 35 The diagram shows part of a circuit that uses a potentiometer wire to measure a potential difference (p.d.) in an external circuit.



The potentiometer wire XZ has length L_1 . It is connected to a cell of known electromotive force (e.m.f.) E that has negligible internal resistance.

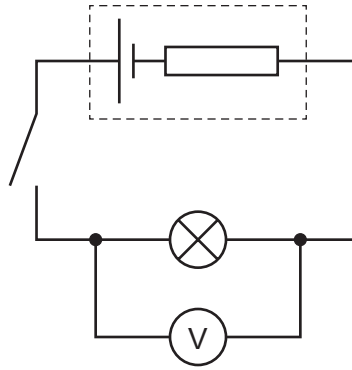
Terminals P and Q are connected to the external p.d. to be measured. The length of the potentiometer wire between points X and Y is L_2 .

The ratio of the lengths L_1 and L_2 is used to determine the p.d. between P and Q in terms of E .

Which condition must be met in order to determine this p.d.?

- A The current I_1 must be zero.
 B The current I_2 must be zero.
 C The p.d. across YZ must be zero.
 D The resistance of the external circuit must be zero.

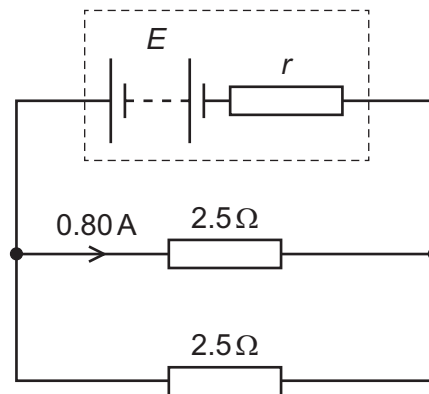
36 The diagram shows a circuit.



Which statement about the circuit is **not** correct?

- A** Electromotive force is the energy transferred per unit charge.
 - B** Energy is transferred from chemical potential energy in the cell to other forms when the switch is closed.
 - C** The electromotive force of the cell is greater than the terminal potential difference when the switch is closed.
 - D** When the switch is open, the voltmeter measures the electromotive force of the cell.
- 37 A circuit contains a battery of electromotive force E and internal resistance r connected to two resistors each of resistance 2.5Ω .

The resistors are connected in parallel as shown.



The current in one of the resistors is 0.80 A .

Which expression, where E is in volts and r is in ohms, gives the internal resistance r ?

- A** $\frac{E - 4.0}{1.6}$
- B** $\frac{E - 4.0}{0.80}$
- C** $\frac{E - 2.0}{1.6}$
- D** $\frac{E - 2.0}{0.80}$

38 What is the rest mass of a beta-particle?

- A 0
- B $9.11 \times 10^{-31} \text{ kg}$
- C $1.66 \times 10^{-27} \text{ kg}$
- D $1.67 \times 10^{-27} \text{ kg}$

39 What is the name of the group (class) of particles containing mesons, and the name of the group (class) of particles containing baryons?

	group (class) of particles containing mesons	group (class) of particles containing baryons
A	hadrons	hadrons
B	hadrons	leptons
C	leptons	hadrons
D	leptons	leptons

40 A magnesium nucleus ${}^{23}_{12}\text{Mg}$ decays by emitting two particles.

The resulting nucleus is sodium ${}^{23}_{11}\text{Na}$.

Which two particles are emitted?

- A α -particle, antineutrino
- B β^+ particle, antineutrino
- C β^- particle, neutrino
- D β^+ particle, neutrino

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cambridgeinternational.org after the live examination series.

Cambridge Assessment International Education is part of Cambridge Assessment. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which is a department of the University of Cambridge.