UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

PHYSICS **9702/01**

Paper 1 Multiple Choice

May/June 2004

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.

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 separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

Data

speed of light in free space,	$c = 3.00 \text{ x } 10^{8} \text{ m s}^{-1}$
permeability of free space,	$\mu_0 = 4\pi \text{ x } 10^{-7} \text{ H m}^{-1}$
permittivity of free space,	$\varepsilon_0 = 8.85 \text{ x } 10^{-12} \text{ F m}^{-1}$
elementary charge,	$e = 1.60 \text{ x } 10^{-19} \text{ C}$
the Planck constant,	$h = 6.63 \text{ x } 10^{-34} \text{ J s}$
unified atomic mass constant,	$u = 1.66 \text{ x } 10^{-27} \text{ kg}$
rest mass of electron,	$m_e = 9.11 \text{ x } 10^{-31} \text{ kg}$
rest mass of proton,	$m_p = 1.67 \text{ x } 10^{-27} \text{ kg}$
molar gas constant,	$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
the Avogadro constant,	$N_A = 6.02 \text{ x } 10^{23} \text{ mol}^{-1}$
the Boltzmann constant,	$k = 1.38 \text{ x } 10^{-23} \text{ J K}^{-1}$
gravitational constant,	$G = 6.67 \text{ x } 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
acceleration of free fall,	$g = 9.81 \text{ m s}^{-2}$

Formulae

uniformly accelerated motion, $s = ut + \frac{1}{2}at^2$
$v^2 = u^2 + 2as$

work done on/by a gas, $W = p\Delta V$

gravitational potential, $\phi = -\frac{Gm}{r}$

simple harmonic motion, $a = -\omega^2 x$

velocity of particle in s.h.m., $v = v_0 \cos \omega t$
$v = \pm \omega \sqrt{(x_0^2 - x^2)}$

resistors in series, $R = R_1 + R_2 + \ldots$

resistors in parallel, $1/R = 1/R_1 + 1/R_2 + \ldots$

electric potential, $V = \frac{Q}{4\pi\varepsilon_0 r}$

capacitors in series, $1/C = 1/C_1 + 1/C_2 + \ldots$

capacitors in parallel, $C = C_1 + C_2 + \ldots$

energy of charged capacitor, $W = \frac{1}{2}QV$

alternating current/voltage, $x = x_0 \sin \omega t$

hydrostatic pressure, $p = \rho gh$

pressure of an ideal gas, $p = \frac{1}{3}\frac{Nm}{V}\langle c^2 \rangle$

radioactive decay, $x = x_0 \exp(-\lambda t)$

decay constant, $\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

critical density matter of the Universe, $\rho_0 = \frac{3H_0^2}{8\pi G}$

equation of continuity, $Av = \text{constant}$

Bernoulli equation (simplified) $p_1 + \frac{1}{2}\rho v_1^2 = p_2 + \frac{1}{2}\rho v_2^2$

Stokes' law, $F = Ar\eta v$

Reynolds' number, $R_e = \frac{\rho v r}{\eta}$

drag force in turbulent flow, $F = Br^2 \rho v^2$

1 Which pair contains one vector and one scalar quantity?

A displacement : acceleration

B force : kinetic energy

C momentum : velocity

D power : speed

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

A energy / distance

B energy x distance

C energy / time

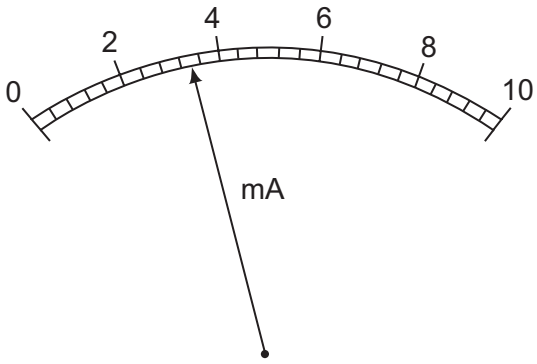
D momentum x distance

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

What is the name and value of this unit?

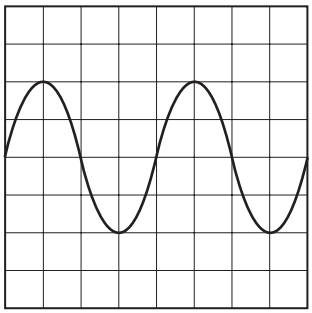
	name	value
A	microsecond	10^{-6} s
B	microsecond	10^{-3} s
C	millisecond	10^{-6} s
D	millisecond	10^{-3} s

4 What is the reading shown on this milliammeter?



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

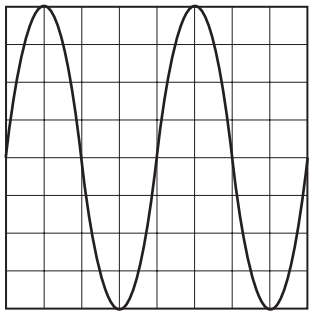
5 The following trace is seen on the screen of a cathode-ray oscilloscope.



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

Which trace is now seen on the screen?

A



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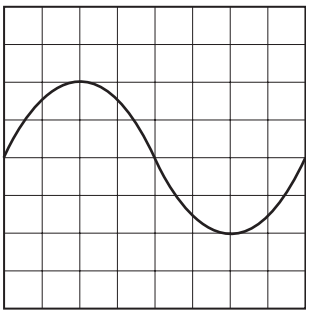

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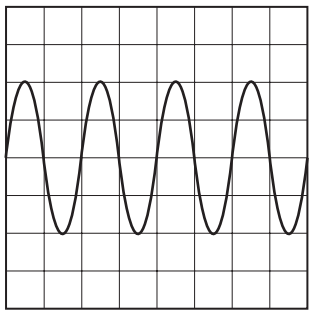
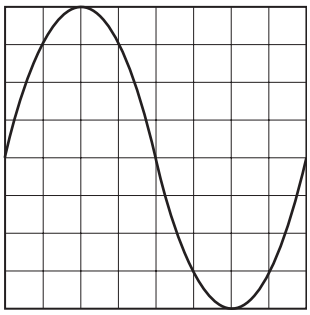


D



6 In a simple electrical circuit, the current in a resistor is measured as (2.50 ± 0.05) mA. The resistor is marked as having a value of 4.7 Ω ± 2 %.

If these values were used to calculate the power dissipated in the resistor, what would be the percentage uncertainty in the value obtained?

A 2 % **B** 4 % **C** 6 % **D** 8 %

[Turn over

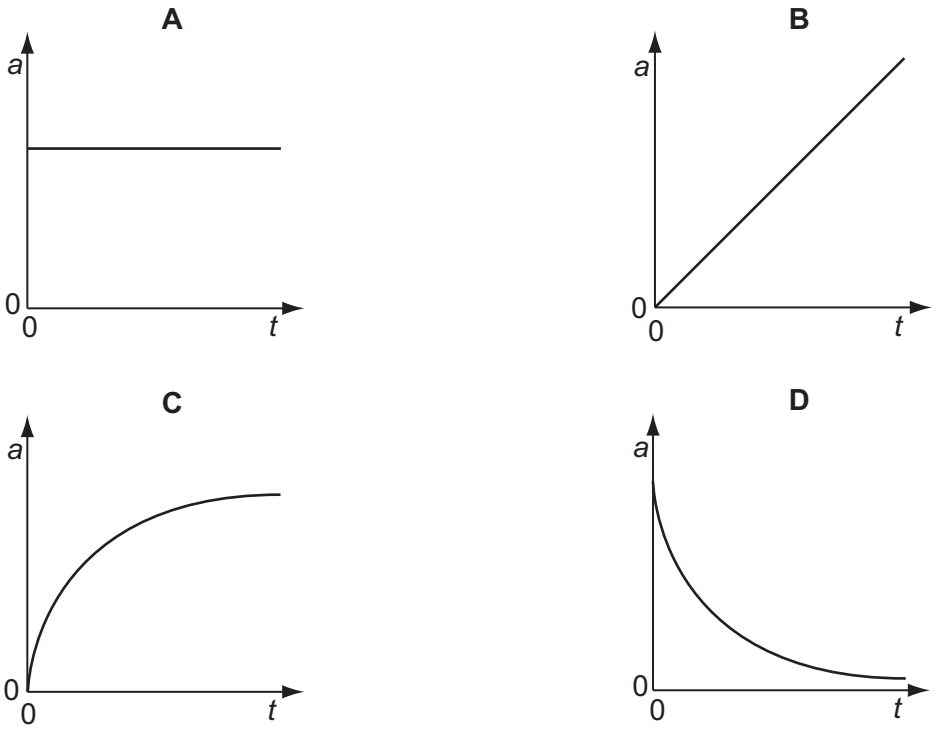
7 A car is travelling with uniform acceleration along a straight road. The road has marker posts every 100 m. When the car passes one post, it has a speed of $10\,m\,s^{-1}$ and, when it passes the next one, its speed is $20\,m\,s^{-1}$.

What is the car's acceleration?

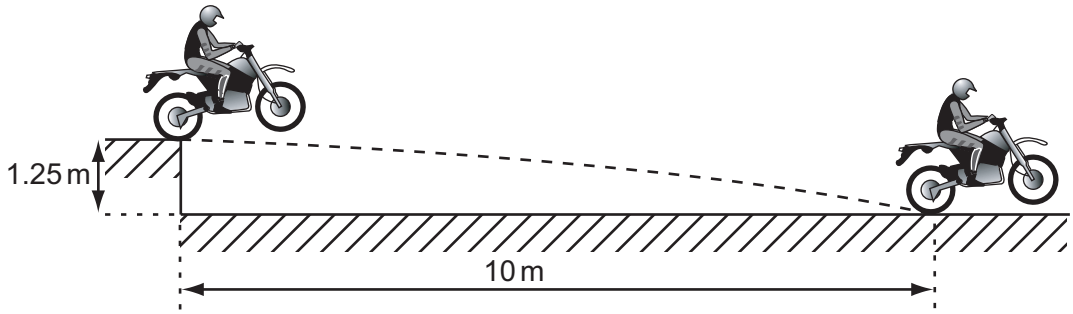
A $0.67\,m\,s^{-2}$ **B** $1.5\,m\,s^{-2}$ **C** $2.5\,m\,s^{-2}$ **D** $6.0\,m\,s^{-2}$

8 A tennis ball is released from rest at the top of a tall building.

Which graph best represents the variation with time t of the acceleration a of the ball as it falls, assuming that the effects of air resistance are appreciable?



9 A motorcycle stunt-rider moving horizontally takes off from a point 1.25 m above the ground, landing 10 m away as shown.



What was the speed at take-off?

A $5\,m\,s^{-1}$ **B** $10\,m\,s^{-1}$ **C** $15\,m\,s^{-1}$ **D** $20\,m\,s^{-1}$

10 A ball falls vertically and bounces on the ground.

The following statements are about the forces acting while the ball is in contact with the ground.

Which statement is correct?

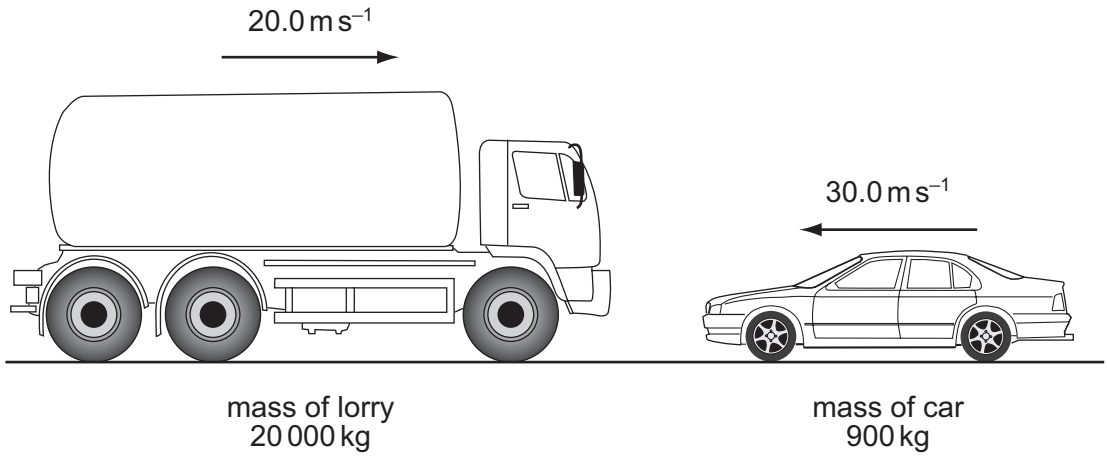
A The force that the ball exerts on the ground is always equal to the weight of the ball.

B The force that the ball exerts on the ground is always equal in magnitude and opposite in direction to the force the ground exerts on the ball.

C The force that the ball exerts on the ground is always less than the weight of the ball.

D The weight of the ball is always equal in magnitude and opposite in direction to the force that the ground exerts on the ball.

11 The diagram shows a situation just before a head-on collision. A lorry of mass 20 000 kg is travelling at 20.0 m s^{-1} towards a car of mass 900 kg travelling at 30.0 m s^{-1} towards the lorry.



What is the magnitude of the total momentum?

A 373 kN s **B** 427 kN s **C** 3600 kN s **D** 4410 kN s

12 An object, immersed in a liquid in a tank, experiences an upthrust.

What is the physical reason for this upthrust?

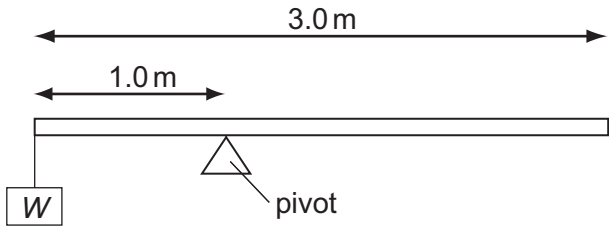
A The density of the body differs from that of the liquid.

B The density of the liquid increases with depth.

C The pressure in the liquid increases with depth.

D The value of *g* in the liquid increases with depth.

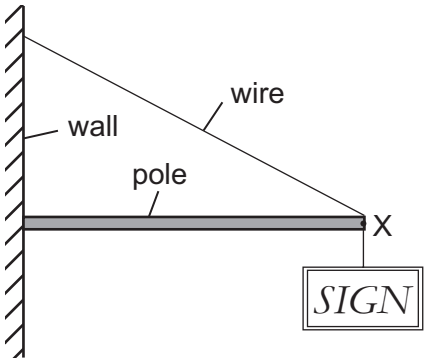
13 A uniform beam of weight 50 N is 3.0 m long and is supported on a pivot situated 1.0 m from one end. When a load of weight *W* is hung from that end, the beam is in equilibrium, as shown in the diagram.



What is the value of *W*?

A 25 N **B** 50 N **C** 75 N **D** 100 N

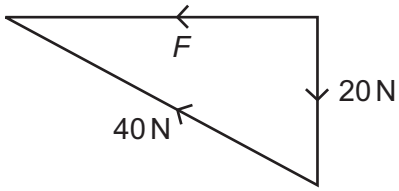
14 The diagram shows a sign of weight 20 N suspended from a pole, attached to a wall. The pole is kept in equilibrium by a wire attached at point X of the pole.



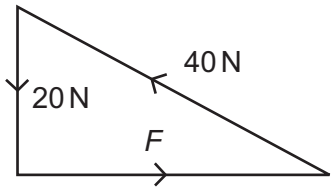
The force exerted by the pole at point X is *F*, and the tension in the wire is 40 N.

Which diagram represents the three forces acting at point X?

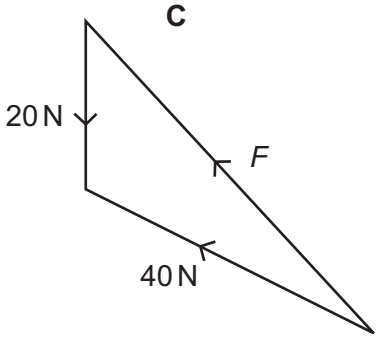
A



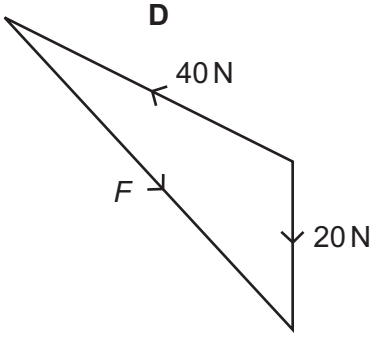
B



C



D



15 What is the expression used to **define** power?

A $\frac{\text{energy output}}{\text{energy input}}$

B energy x time taken

C force x velocity

D $\frac{\text{work done}}{\text{time taken}}$

16 A ball is thrown vertically upwards.

Neglecting air resistance, which statement is correct?

A The kinetic energy of the ball is greatest at the greatest height attained.

B By the principle of conservation of energy, the total energy of the ball is constant throughout its motion.

C By the principle of conservation of momentum, the momentum of the ball is constant throughout its motion.

D The potential energy of the ball increases uniformly with time during the ascent.

17 Car X is travelling at half the speed of car Y. Car X has twice the mass of car Y.

Which statement is correct?

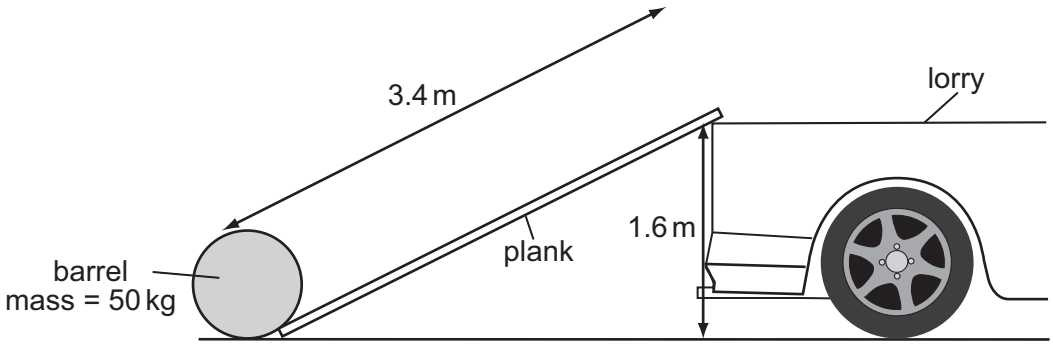
A Car X has half the kinetic energy of car Y.

B Car X has one quarter of the kinetic energy of car Y.

C Car X has twice the kinetic energy of car Y.

D The two cars have the same kinetic energy.

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



What is the minimum work done?

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

19 Comparing the properties of solids, liquids and gases, which option is correct?

	property	solids	liquids	gases
A	ordering of molecules	high	not so high	random
B	spacing of molecules	close	far	far
C	translation of molecules	no	no	yes
D	vibration of molecules	no	yes	yes

20 Particles of dust, suspended in water, are viewed through a microscope. The particles can be seen to move irregularly.

This movement is due to

A convection currents in the water.

B evaporation of the water near the dust particles.

C gravitational forces acting on the particles of dust.

D water molecules hitting the dust particles in a random way.

21 Two solid substances P and Q have atoms of mass M_P and M_Q respectively. They have N_P and N_Q atoms per unit volume.

It is found by experiment that the density of P is greater than that of Q.

Which of the following deductions from this experiment must be correct?

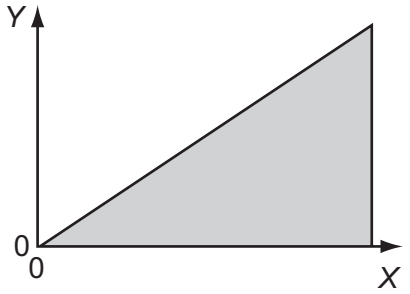
A $M_P > M_Q$

B $N_P > N_Q$

C $M_P N_P > M_Q N_Q$

D $\frac{M_P}{N_P} > \frac{M_Q}{N_Q}$

22 The graph shown was plotted in an experiment on a metal wire.



The shaded area represents the total strain energy stored in stretching the wire.

How should the axes be labelled?

	Y	*X*
A	force	extension
B	mass	extension
C	strain	energy
D	stress	strain

23 Nylon breaks when the stress within it reaches 1×10^9 Pa.

Which range includes the heaviest load that could be lifted by a nylon thread of diameter 1 mm?

A 2 N to 20 N

B 20 N to 200 N

C 200 N to 2000 N

D 2000 N to 20 000 N

24 Which observation indicates that sound waves are longitudinal?

A Sound can be reflected from a solid surface.

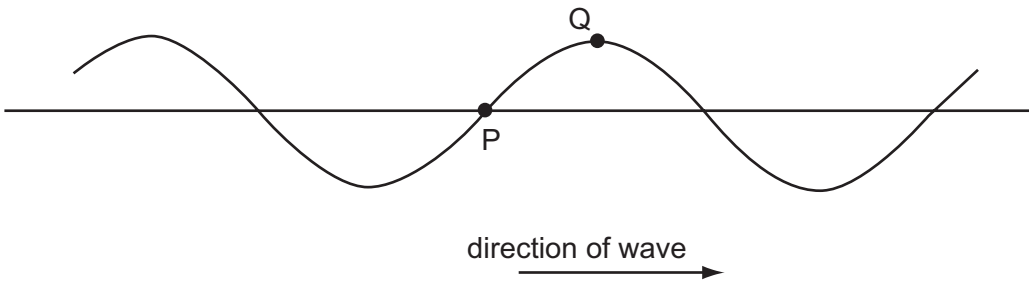
B Sound cannot be polarised.

C Sound is diffracted around corners.

D Sound is refracted as it passes from hot air to cold air.

25 The diagram shows a transverse wave on a rope. The wave is travelling from left to right.

At the instant shown, the points P and Q on the rope have zero displacement and maximum displacement respectively.



Which of the following describes the direction of motion, if any, of the points P and Q at this instant?

	point P	point Q
A	downwards	stationary
B	stationary	downwards
C	stationary	upwards
D	upwards	stationary

26 A plane wave of amplitude A is incident on a surface of area S placed so that it is perpendicular to the direction of travel of the wave. The energy per unit time reaching the surface is E.

The amplitude of the wave is increased to $2A$ and the area of the surface is reduced to $\frac{1}{2}S$.

How much energy per unit time reaches this smaller surface?

A $4E$ **B** $2E$ **C** E **D** $\frac{1}{2}E$

27 What is the approximate range of frequencies of infra-red radiation?

A 1×10^3 Hz to 1×10^9 Hz

B 1×10^9 Hz to 1×10^{11} Hz

C 1×10^{11} Hz to 1×10^{14} Hz

D 1×10^{14} Hz to 1×10^{17} Hz

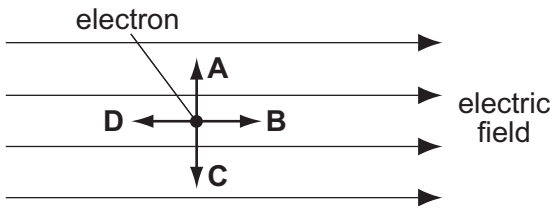
28 The lines of a diffraction grating have a spacing of 1.6×10^{-6} m. A beam of light is incident normally on the grating. The first order maximum makes an angle of 20° with the undeviated beam.

What is the wavelength of the incident light?

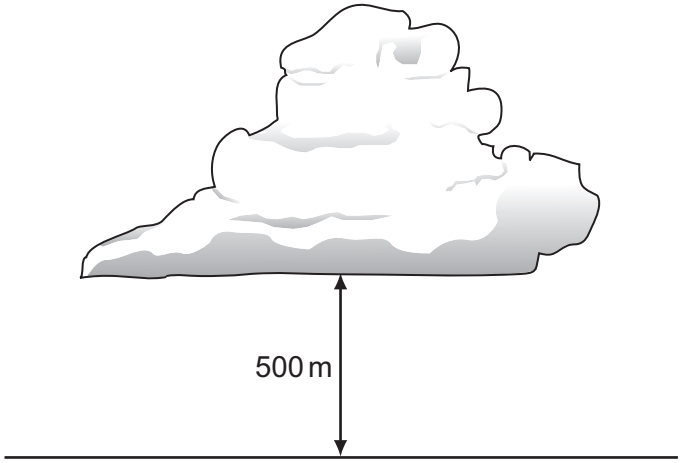
A 210 nm **B** 270 nm **C** 420 nm **D** 550 nm

29 The diagram shows an electron in a uniform electric field.

In which direction will the field accelerate the electron?



30 The diagram shows a thundercloud whose base is 500 m above the ground.



The potential difference between the base of the cloud and the ground is 200 MV. A raindrop with a charge of 4.0×10^{-12} C is in the region between the cloud and the ground.

What is the electrical force on the raindrop?

A 1.6×10^{-6} N **B** 8.0×10^{-4} N **C** 1.6×10^{-3} N **D** 0.40 N

31 Two wires made of the same material and of the same length are connected in parallel to the same voltage supply. Wire P has a diameter of 2 mm. Wire Q has a diameter of 1 mm.

What is the ratio $\frac{\text{current in P}}{\text{current in Q}}$?

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

32 What is an equivalent unit to 1 volt?

A $1\,\text{J A}^{-1}$ **B** $1\,\text{J C}^{-1}$ **C** $1\,\text{W C}^{-1}$ **D** $1\,\text{W s}^{-1}$

33 The terminal voltage of a battery is observed to fall when the battery supplies a current to an external resistor.

What quantities are needed to calculate the fall in voltage?

A the battery's e.m.f. and its internal resistance

B the battery's e.m.f. and the current

C the current and the battery's internal resistance

D the current and the external resistance

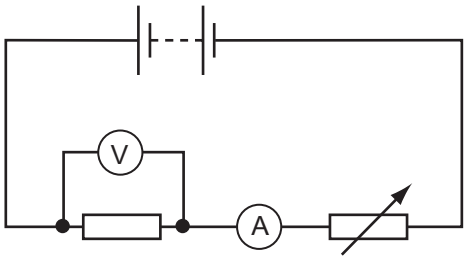
34 The potential difference between point X and point Y is 20 V. The time taken for charge carriers to move from X to Y is 15 s, and, in this time, the energy of the charge carriers changes by 12 J.

What is the current between X and Y?

A 0.040 A **B** 0.11 A **C** 9.0 A **D** 25 A

35 The diagram shows a battery, a fixed resistor, an ammeter and a variable resistor connected in series.

A voltmeter is connected across the fixed resistor.



The value of the variable resistor is reduced.

Which correctly describes the changes in the readings of the ammeter and of the voltmeter?

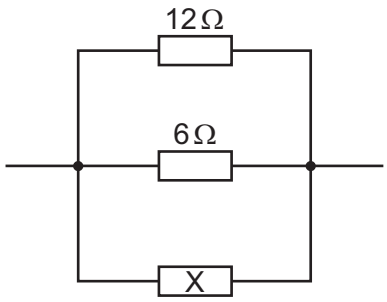
	ammeter	voltmeter
A	decrease	decrease
B	decrease	increase
C	increase	decrease
D	increase	increase

36 Kirchhoff's two laws for electric circuits can be derived by using conservation laws.

On which conservation laws do Kirchhoff's laws depend?

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

37 The diagram shows a parallel combination of three resistors. The total resistance of the combination is $3\,\Omega$.



What is the resistance of resistor X?

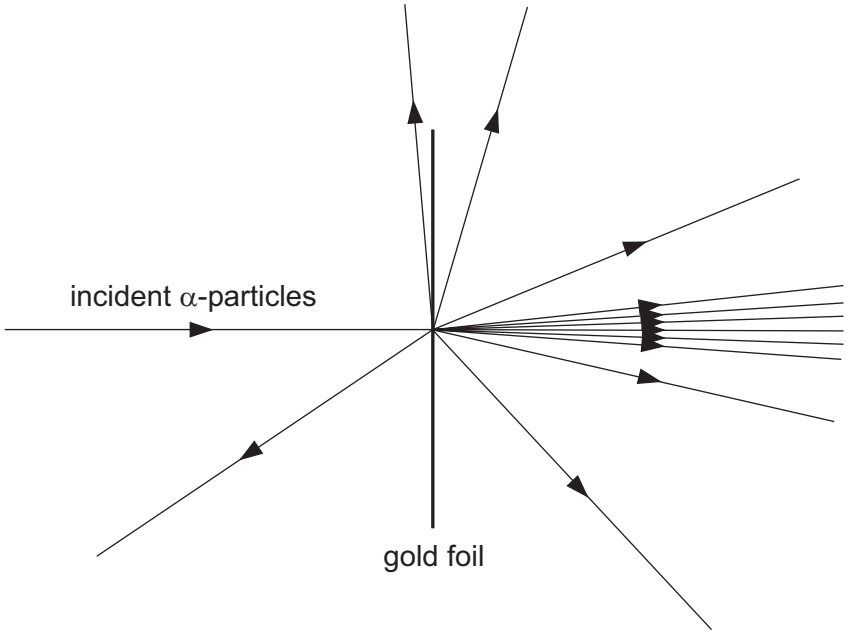
A $2\,\Omega$ **B** $3\,\Omega$ **C** $6\,\Omega$ **D** $12\,\Omega$

38 A nucleus of the nuclide $^{241}_{94}\text{Pu}$ decays by emission of a β-particle followed by the emission of an α-particle.

Which of the nuclides shown is formed?

A $^{239}_{93}\text{Np}$ **B** $^{239}_{91}\text{Pa}$ **C** $^{237}_{93}\text{Np}$ **D** $^{237}_{92}\text{U}$

39 A thin gold foil is bombarded with α-particles as shown.



The results of this experiment provide information about the

A binding energy of a gold nucleus.

B energy levels of electrons in gold atoms.

C size of a gold nucleus.

D structure of a gold nucleus.

40 Isotopes of a given element all have the same

A charge / mass ratio.

B neutron number.

C nucleon number.

D proton number.