Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

PHYSICS **9702/12**

Paper 1 Multiple Choice **October/November 2015**

1 hour

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

4235130509

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, 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.
DO **NOT** WRITE IN ANY BARCODES.

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 working should be done in this booklet.
Electronic calculators may be used.

IB15 11_9702_12/2RP
© UCLES 2015

Data

speed of light in free space, $c = 3.00 \times 10^{8}\,\text{m s}^{-1}$

permeability of free space, $\mu_0 = 4\pi \times 10^{-7}\,\text{H m}^{-1}$

permittivity of free space, $\varepsilon_0 = 8.85 \times 10^{-12}\,\text{F m}^{-1}$

$\left(\dfrac{1}{4\pi\varepsilon_0} = 8.99 \times 10^{9}\,\text{m F}^{-1}\right)$

elementary charge, $e = 1.60 \times 10^{-19}\,\text{C}$

the Planck constant, $h = 6.63 \times 10^{-34}\,\text{J s}$

unified atomic mass constant, $u = 1.66 \times 10^{-27}\,\text{kg}$

rest mass of electron, $m_\text{e} = 9.11 \times 10^{-31}\,\text{kg}$

rest mass of proton, $m_\text{p} = 1.67 \times 10^{-27}\,\text{kg}$

molar gas constant, $R = 8.31\,\text{J K}^{-1}\,\text{mol}^{-1}$

the Avogadro constant, $N_\text{A} = 6.02 \times 10^{23}\,\text{mol}^{-1}$

the Boltzmann constant, $k = 1.38 \times 10^{-23}\,\text{J K}^{-1}$

gravitational constant, $G = 6.67 \times 10^{-11}\,\text{N m}^2\,\text{kg}^{-2}$

acceleration of free fall, $g = 9.81\,\text{m s}^{-2}$

© UCLES 2015

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

hydrostatic pressure, $p = \rho gh$

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

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

velocity of particle in s.h.m., $v = v_0 \cos \omega t$

$v = \pm \omega \sqrt{(x_0^2 - x^2)}$

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, $W = \frac{1}{2}QV$

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

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

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

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

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

© UCLES 2015

1 Which list shows increasing lengths from beginning to end?

A 1 cm 1 nm 1 mm 1 μm

B 1 μm 1 mm 1 nm 1 cm

C 1 nm 1 μm 1 mm 1 cm

D 1 mm 1 cm 1 μm 1 nm

2 Which equation contains only scalar quantities?

A $\text{acceleration} = \dfrac{\text{force}}{\text{mass}}$

B $\text{power} = \dfrac{\text{work}}{\text{time}}$

C $\text{pressure} = \dfrac{\text{force}}{\text{area}}$

D $\text{velocity} = \dfrac{\text{displacement}}{\text{time}}$

3 The time T taken for a satellite to orbit the Earth on a circular path is given by the equation

$$T^2 = \frac{kr^3}{M}$$

where r is the radius of the orbit, M is the mass of the Earth and k is a constant.

What are the SI base units of k?

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

4 Which row gives reasonable estimates for the mass and the speed of an adult running?

	mass / kg	speed / $\text{m}\,\text{s}^{-1}$
A	6×10^0	5×10^1
B	6×10^1	5×10^0
C	6×10^1	5×10^1
D	6×10^2	5×10^0

© UCLES 2015

5 A student measures the time T for one complete oscillation of a pendulum of length l.

Her results are shown in the table.

l / m	T / s
0.420 ± 0.001	1.3 ± 0.1

She uses the formula

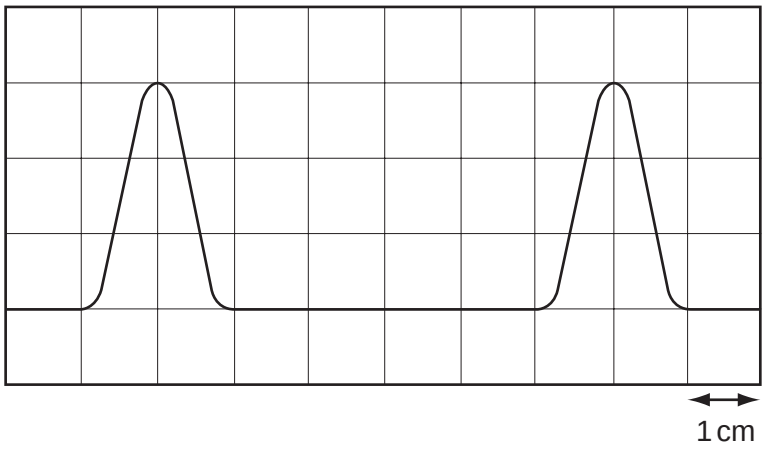
$$T = 2\pi\sqrt{\frac{l}{g}}$$

to calculate the acceleration of free fall g.

What is the best estimate of the percentage uncertainty in the value of g?

A 0.02% **B** 4% **C** 8% **D** 16%

6 The diagram shows two complete pulses on the screen of a cathode-ray oscilloscope. A grid of 1 cm squares covers the screen. The time-base setting is $1\,\mu s\,cm^{-1}$.



How long does each pulse last?

A 2 μs **B** 3 μs **C** 4 μs **D** 6 μs

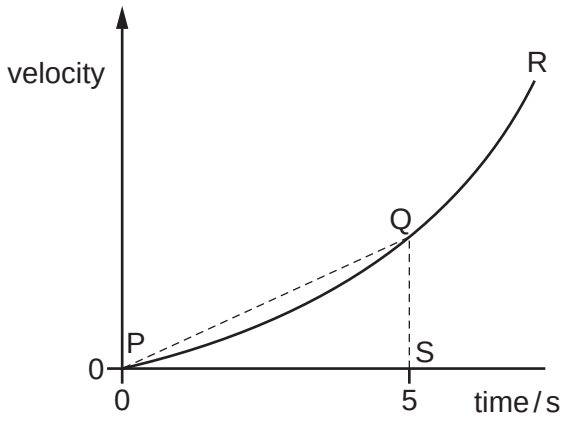
© UCLES 2015

7 A boy throws a ball vertically upwards. It rises to a maximum height, where it is momentarily at rest, and then falls back to his hands.

Which row gives the acceleration of the ball at various stages in its motion? (Take vertically upwards as positive. Ignore air resistance.)

	rising	at maximum height	falling
A	$-9.81\,m\,s^{-2}$	0	$+9.81\,m\,s^{-2}$
B	$-9.81\,m\,s^{-2}$	$-9.81\,m\,s^{-2}$	$-9.81\,m\,s^{-2}$
C	$+9.81\,m\,s^{-2}$	$+9.81\,m\,s^{-2}$	$+9.81\,m\,s^{-2}$
D	$+9.81\,m\,s^{-2}$	0	$-9.81\,m\,s^{-2}$

8 The curved line PQR is the velocity-time graph for a car starting from rest.



What is the average acceleration of the car over the first 5 s?

A the area below the curve PQ

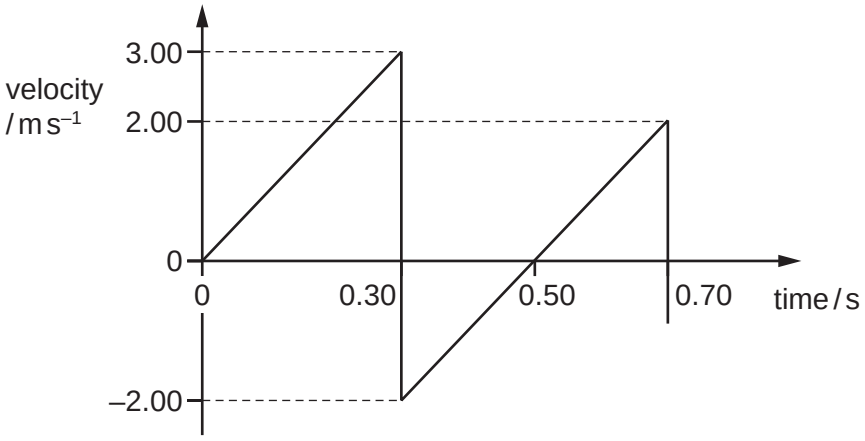
B the area of the triangle PQS

C the gradient of the straight line PQ

D the gradient of the tangent at Q

9 A ball is released from rest above a horizontal surface. It strikes the surface and bounces several times.

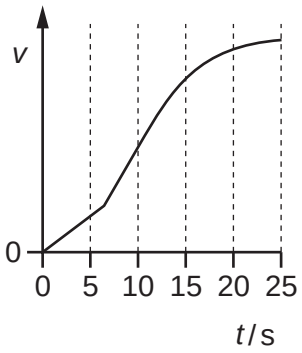
The velocity-time graph for the first two bounces is shown.



What is the maximum height of the ball after the first bounce?

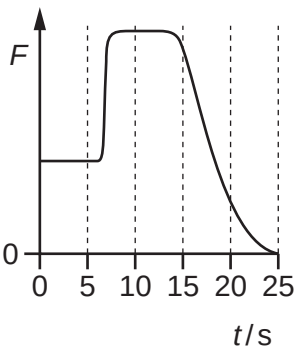
A 0.20 m **B** 0.25 m **C** 0.45 m **D** 0.65 m

10 A bus takes a time of 25 s to reach a constant speed while travelling in a straight line. A graph of speed *v* against time *t* is shown.

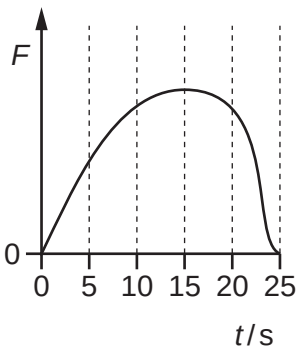


Which graph shows the variation with *t* of the resultant force *F* on the bus?

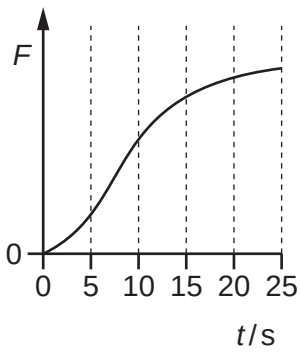
A



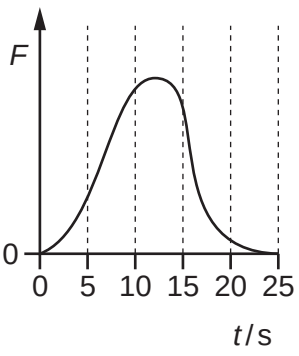
B



C

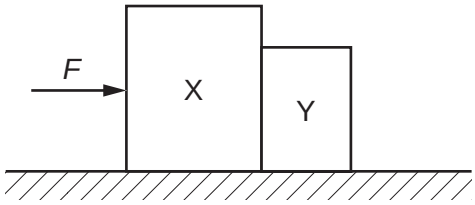


D



© UCLES 2015

11 A single horizontal force *F* is applied to a block X which is in contact with a separate block Y as shown.



The blocks remain in contact as they accelerate along a horizontal frictionless surface. Air resistance is negligible. X has a greater mass than Y.

Which statement is correct?

A The acceleration of X is equal to force *F* divided by the mass of X.

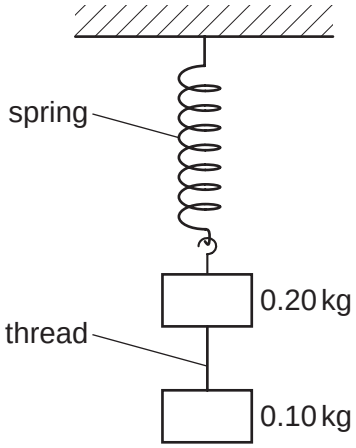
B The force that X exerts on Y is equal to *F*.

C The force that X exerts on Y is less than *F*.

D The force that X exerts on Y is less than the force that Y exerts on X.

© UCLES 2015

12 A mass of 0.20 kg is suspended from the lower end of a light spring. A second mass of 0.10 kg is suspended from the first mass by a thread. The arrangement is allowed to come into static equilibrium and then the thread is burned through.



At this instant, what is the upward acceleration of the 0.20 kg mass? (Assume $g = 10\,m\,s^{-2}$.)

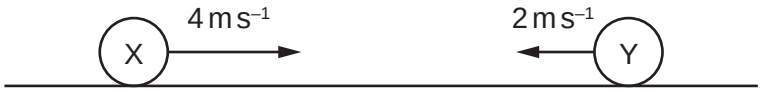
A $5.0\,m\,s^{-2}$ **B** $6.7\,m\,s^{-2}$ **C** $10\,m\,s^{-2}$ **D** $15\,m\,s^{-2}$

13 An object of mass m travelling with speed v has a head-on collision with another object of mass m travelling with speed v in the opposite direction. The two objects stick together after the collision.

What is the total loss of kinetic energy in the collision?

A 0 **B** $\frac{1}{2}mv^2$ **C** mv^2 **D** $2mv^2$

14 Two identical spheres X and Y approach each other with the speeds shown and undergo a head-on elastic collision.



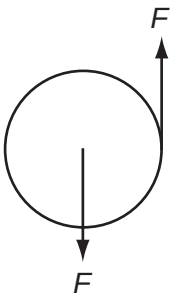
What are the velocities of the spheres after the collision?

	sphere X	sphere Y
A	$0\,m\,s^{-1}$	$2\,m\,s^{-1}$ →
B	$2\,m\,s^{-1}$ →	$4\,m\,s^{-1}$ →
C	$2\,m\,s^{-1}$ ←	$4\,m\,s^{-1}$ →
D	$4\,m\,s^{-1}$ ←	$2\,m\,s^{-1}$ →

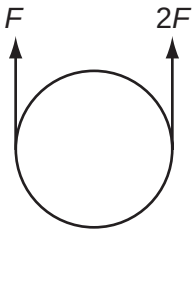
© UCLES 2015

15 Which pair of forces acts only as a couple on the circular object?

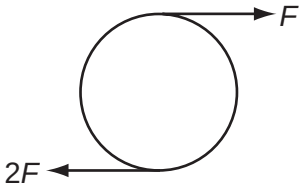
A



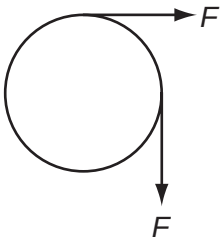
B



C

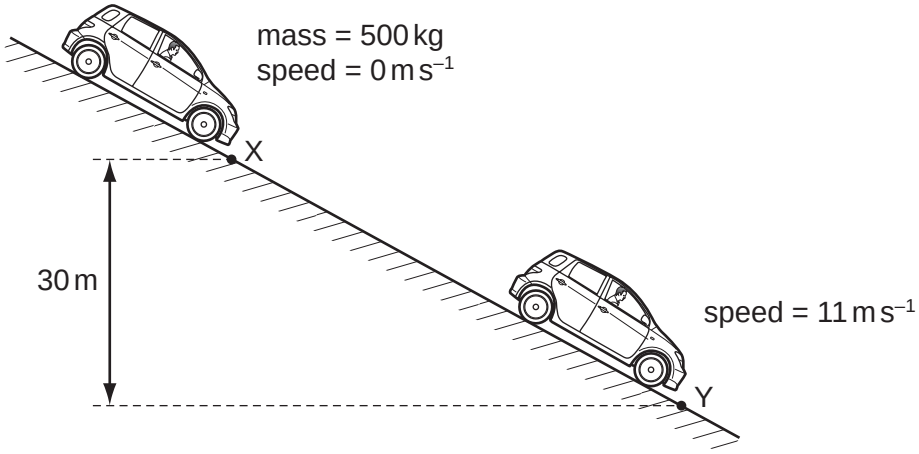


D



16 A car of mass 500 kg is at rest at point X on a slope, as shown.

The car's brakes are released and the car rolls down the slope with its engine switched off. At point Y the car has moved through a vertical height of 30 m and has a speed of 11 m s^{-1}.



What is the energy dissipated by frictional forces when the car moves from X to Y?

A 3.0×10^4 J **B** 1.2×10^5 J **C** 1.5×10^5 J **D** 1.8×10^5 J

17 In which situation is **no** work done?

A The air in a bicycle tyre is released because of a puncture.

B A ball is dropped and falls to the ground.

C A box moves at constant speed across a smooth horizontal surface.

D A crane lifts a steel girder at constant speed.

© UCLES 2015

18 An electric railway locomotive has a maximum mechanical output power of 4.0 MW. Electrical power is delivered at 25 kV from overhead wires. The overall efficiency of the locomotive in converting electrical power to mechanical power is 80 %.

What is the current from the overhead wires when the locomotive is operating at its maximum power?

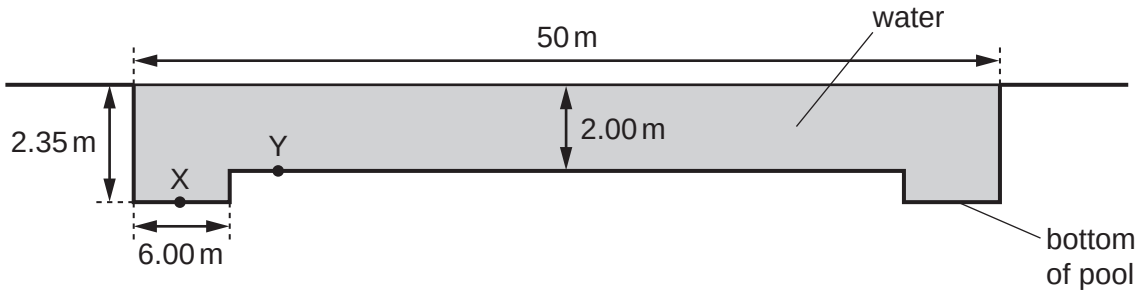
A 130 A **B** 160 A **C** 200 A **D** 250 A

19 The table summarises some descriptions of evaporation.

Which row of the table is correct?

	involves a change in state from liquid to vapour	occurs at a fixed temperature	involves a reduction in the average kinetic energy of the remaining atoms
A	true	true	true
B	true	false	true
C	true	false	false
D	false	true	false

20 The diagram shows the cross-section of an Olympic-size swimming pool filled with water. It is not drawn to scale. The density of the water is 1000 kg m^{-3}.



What is the difference in pressure between X and Y?

A 0.35 kPa **B** 3.4 kPa **C** 21.3 kPa **D** 58.9 kPa

21 A force acts on a wire to produce extension *e*. The same force then acts on a second wire of the same material, but of half the diameter and three times the length of the first wire. Both wires obey Hooke's law.

What is the extension of the second wire?

A 3*e* **B** 4*e* **C** 6*e* **D** 12*e*

22 Which statement about elastic and plastic deformation is correct?

A Elastic deformation and plastic deformation are proportional to the applied force.

B Elastic deformation and plastic deformation cause no change in volume.

C Elastic deformation causes heating of the material but plastic deformation does not.

D Elastic deformation is reversible but plastic deformation is not.

23 What is meant by the *ultimate tensile stress* of a ductile metal?

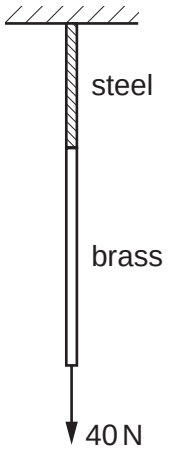
A It is the maximum stress at which the material deforms elastically.

B It is the maximum stress at which the material obeys Hooke's law.

C It is the maximum stress that the material can support without breaking.

D It is the Young modulus multiplied by the maximum possible strain of a material.

24 A 0.80 m length of steel wire and a 1.4 m length of brass wire are joined together. The combined wires are suspended from a fixed support and a force of 40 N is applied, as shown.



The Young modulus of steel is 2.0×10^{11} Pa.

The Young modulus of brass is 1.0×10^{11} Pa.

Each wire has a cross-sectional area of 2.4×10^{-6} m^2.

The wires extend without reaching their elastic limits.

What is the total extension? Ignore the weights of the wires.

A 1.7×10^{-4} m **B** 3.0×10^{-4} m **C** 3.9×10^{-4} m **D** 9.0×10^{-4} m

© UCLES 2015

25 Which of the following wave motions may be used to demonstrate the phenomenon of polarisation?

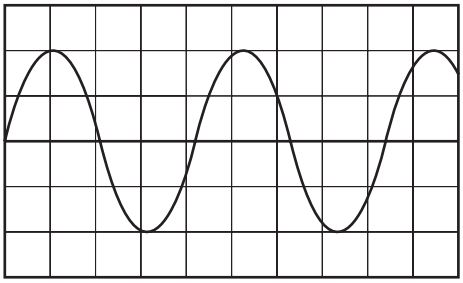
A a sound wave from a thunderclap

B a surface wave in a water ripple tank

C a stationary wave in an organ pipe

D a stationary wave on a stretched wire

26 The diagram shows the screen of a cathode-ray oscilloscope (c.r.o.) displaying a wave.



The time-base of the c.r.o. is set at 10 ms / div.

What is the frequency of the wave?

A 0.24 Hz **B** 4.2 Hz **C** 12 Hz **D** 24 Hz

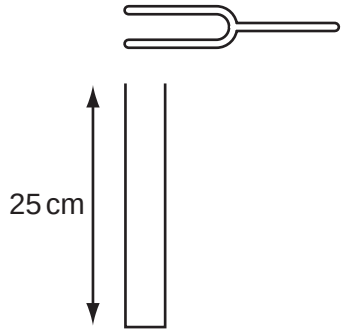
27 P is a source emitting infra-red radiation and Q is a source emitting ultra-violet radiation. The figures in the table are suggested values for the wavelengths emitted by P and Q.

Which row is correct?

	wavelength emitted by P / m	wavelength emitted by Q / m
A	5×10^{-5}	5×10^{-8}
B	5×10^{-5}	5×10^{-10}
C	5×10^{-7}	5×10^{-8}
D	5×10^{-7}	5×10^{-10}

© UCLES 2015

28 The diagram shows a tuning fork above a tube of air of length 25 cm.



A stationary wave is set up in the tube with the same frequency as the tuning fork. The lower end of the tube is sealed. This is the minimum length of tube with the lower end sealed that creates a stationary wave.

Which other lengths of tubes, sealed at their lower end, will also create a stationary wave?

A 37.5 cm and 50 cm

B 50 cm and 75 cm

C 75 cm and 100 cm

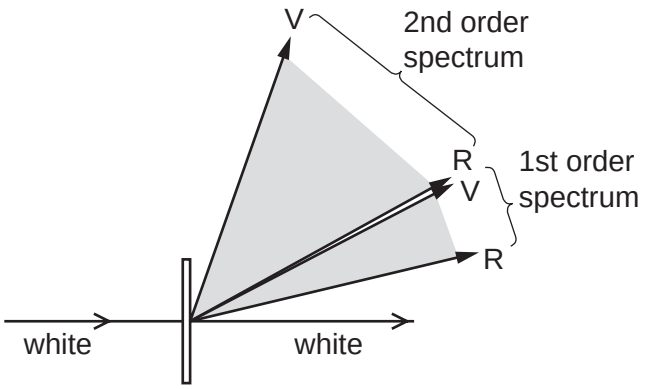
D 75 cm and 125 cm

© UCLES 2015

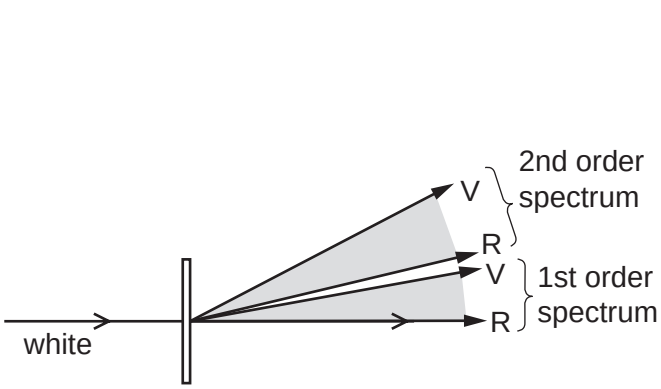
29 White light consists of many wavelengths. The wavelength of red light R is approximately twice the wavelength of violet light V. When white light is incident normally on a diffraction grating, several spectra can be formed.

Which diagram shows the possible distributions of light in the first order and the second order spectra?

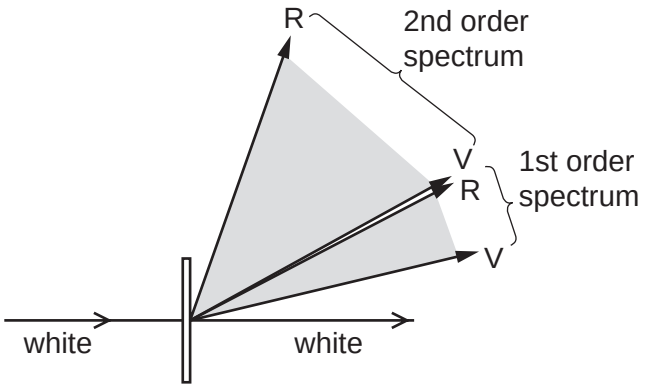
A



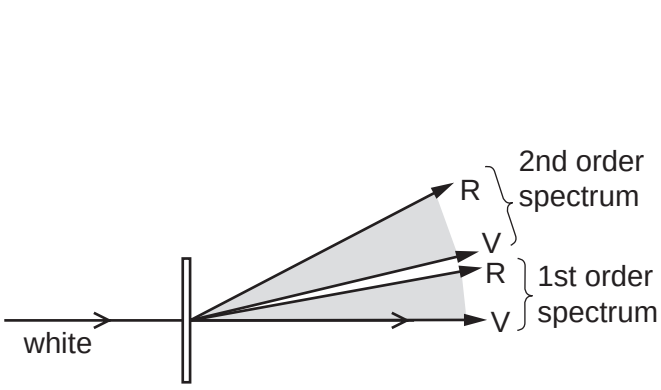
B



C



D



30 To produce a stationary wave, two waves must travel in opposite directions through the same space.

Which statement about the properties of the two waves must also be true?

A The waves must have equal frequency, but a different speed and wavelength.

B The waves must have equal speed, but a different wavelength and frequency.

C The waves must have equal speed, frequency and wavelength.

D The waves must have equal wavelength, but a different speed and frequency.

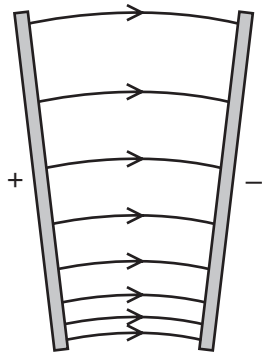
© UCLES 2015

[Turn over

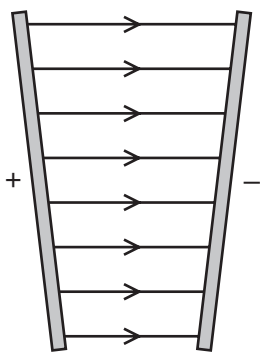
31 A potential difference is applied between two metal plates that are **not** parallel.

Which diagram shows the electric field between the plates?

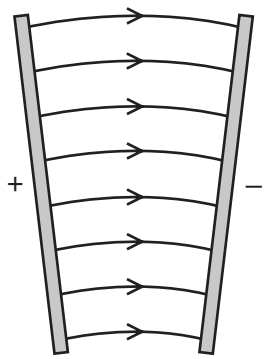
A



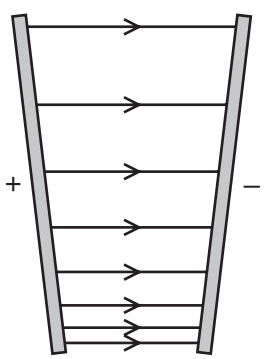
B



C



D



32 A particle situated between two parallel metal plates carries a charge of 8×10^{-19} C.

The potential difference (p.d.) between the plates is 2000 V. A force of 3.2×10^{-13} N due to the electric field acts on the particle.

What is the distance between the plates?

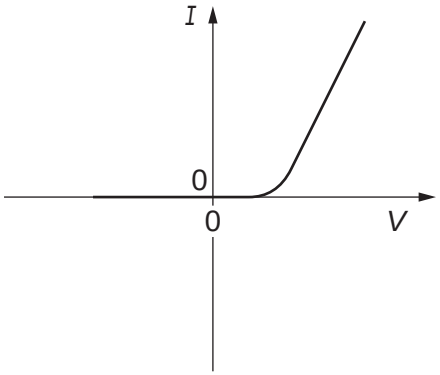
A 5 mm **B** 8 mm **C** 5 cm **D** 8 cm

33 Which unit is equivalent to a coulomb (C)?

A A s **B** Ω s **C** V s **D** W s

© UCLES 2015

34 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 semiconductor diode

D a thermistor

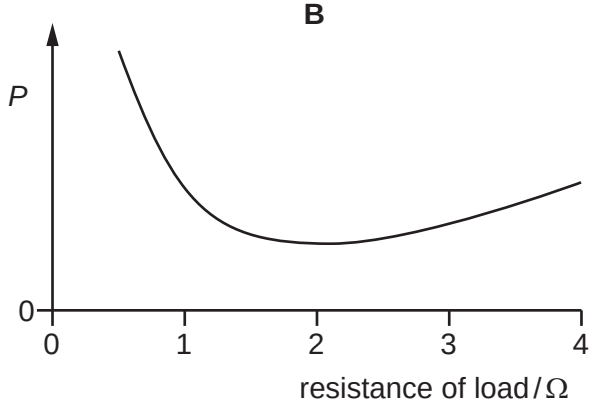
35 A power supply of electromotive force (e.m.f.) 12 V and internal resistance 2 Ω is connected in series with a load resistor. The resistance of the load resistor is varied from 0.5 Ω to 4 Ω.

Which graph shows how the power P dissipated in the load resistor varies with the resistance of the load resistor?

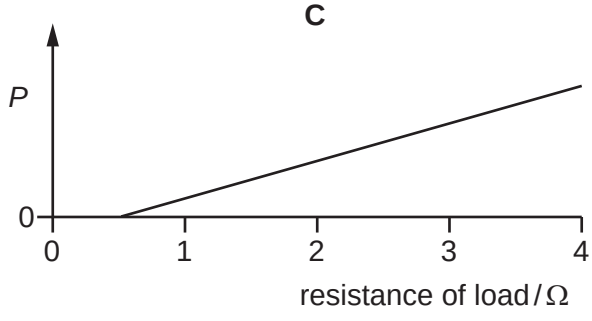
A



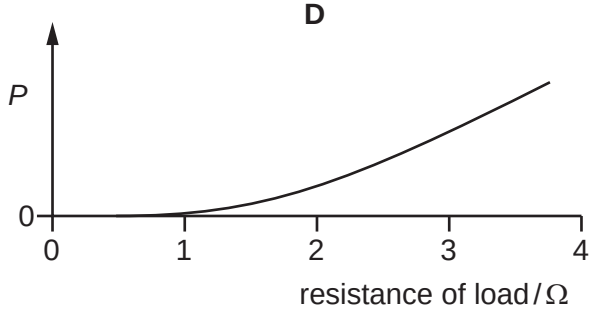
B



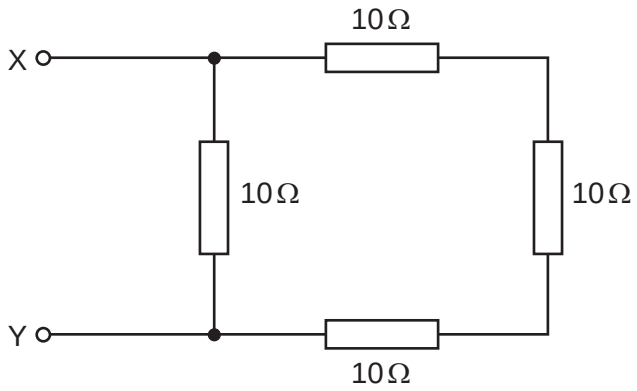
C



D



36 The diagram shows an arrangement of resistors.



What is the total electrical resistance between X and Y?

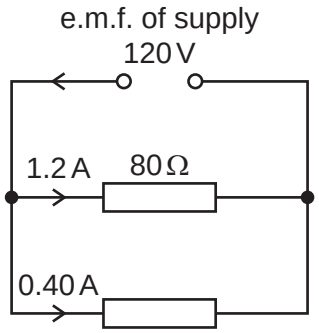
A less than 1 Ω

B between 1 Ω and 10 Ω

C between 10 Ω and 30 Ω

D 40 Ω

37 The electromotive force of a power supply is 120 V. It delivers a current of 1.2 A to a resistor of resistance 80 Ω and a current of 0.40 A to another resistor, as shown.

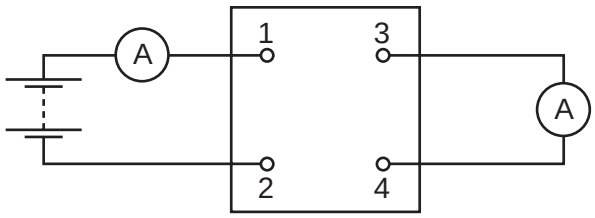


What is the internal resistance of the power supply?

A 15 Ω **B** 20 Ω **C** 60 Ω **D** 75 Ω

© UCLES 2015

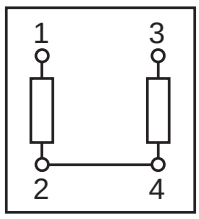
38 The diagram shows a four-terminal box connected to a battery and two ammeters.



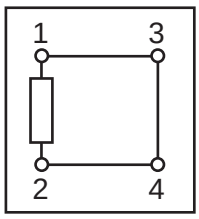
The currents in the two meters are identical.

Which circuit, within the box, will give this result?

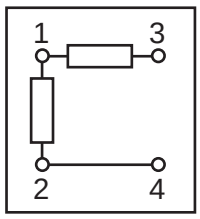
A



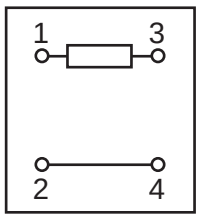
B



C



D



39 A material contains a radioactive isotope that disintegrates solely by the emission of α-particles at a rate of $100\,s^{-1}$.

Which statement about this material is correct?

A The number of atoms in the material diminishes at a rate of $100\,s^{-1}$.

B The number of neutrons in the material diminishes at a rate of $100\,s^{-1}$.

C The number of nucleons in the material diminishes at a rate of $400\,s^{-1}$.

D The number of protons in the material diminishes at a rate of $100\,s^{-1}$.

40 A radioactive nucleus emits an α-particle or a β-particle, creating a product nucleus.

Which decay process could create the product nucleus stated?

	radioactive nucleus	decay	product nucleus
A	$^{226}_{88}Ra$	α	$^{224}_{86}Rn$
B	$^{238}_{92}U$	α	$^{242}_{94}Pu$
C	$^{228}_{88}Ra$	β	$^{228}_{87}Fr$
D	$^{231}_{90}Th$	β	$^{231}_{91}Pa$

© UCLES 2015

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 International Examinations Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cie.org.uk after the live examination series.

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