UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
Cambridge International Level 3 Pre-U Certificate
Principal Subject

PHYSICS **9792/01**

Paper 1 Part A Multiple Choice **May/June 2010**

1 hour 15 minutes

0564610977

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 working should be done in this booklet.

This document consists of **23** printed pages and **1** blank page.

IB10 06_9792_01/4RP

UNIVERSITY of CAMBRIDGE International Examinations

[Turn over

Data

gravitational field strength close to Earth's surface	$g = 9.81\,\mathrm{N\,kg^{-1}}$
elementary charge	$e = 1.60 \times 10^{-19}\,\mathrm{C}$
speed of light in vacuum	$c = 3.00 \times 10^{8}\,\mathrm{m\,s^{-1}}$
Planck constant	$h = 6.63 \times 10^{-34}\,\mathrm{J\,s}$
permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\,\mathrm{F\,m^{-1}}$
gravitational constant	$G = 6.67 \times 10^{-11}\,\mathrm{N\,m^{2}\,kg^{-2}}$
electron mass	$m_e = 9.11 \times 10^{-31}\,\mathrm{kg}$
proton mass	$m_p = 1.67 \times 10^{-27}\,\mathrm{kg}$
unified atomic mass constant	$u = 1.66 \times 10^{-27}\,\mathrm{kg}$
molar gas constant	$R = 8.31\,\mathrm{J\,K^{-1}\,mol^{-1}}$
Avogadro constant	$N_A = 6.02 \times 10^{23}\,\mathrm{mol^{-1}}$
Boltzmann constant	$k = 1.38 \times 10^{-23}\,\mathrm{J\,K^{-1}}$
Stefan-Boltzmann constant	$\sigma = 5.67 \times 10^{-8}\,\mathrm{W\,m^{-2}\,K^{-4}}$

Formulae

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

$v^2 = u^2 + 2as$

$s = \left(\frac{u+v}{2}\right)t$

heating $\Delta E = mc\Delta\theta$

change of state $\Delta E = mL$

refraction $n = \frac{\sin\theta_1}{\sin\theta_2}$

$n = \frac{v_1}{v_2}$

photon energy $E = hf$

de Broglie wavelength $\lambda = \frac{h}{p}$

simple harmonic motion $x = A\cos\omega t$

$v = -A\omega\sin\omega t$

$a = -A\omega^2\cos\omega t$

$F = -m\omega^2 x$

$E = \frac{1}{2}mA^2\omega^2$

energy stored in a capacitor $W = \frac{1}{2}QV$

electric force $F = \frac{Q_1Q_2}{4\pi\varepsilon_0 r^2}$

electrostatic potential energy $W = \frac{Q_1Q_2}{4\pi\varepsilon_0 r}$

gravitational force $F = \frac{-Gm_1m_2}{r^2}$

gravitational potential energy $E = \frac{-Gm_1m_2}{r}$

magnetic force $F = BIl\sin\theta$

$F = BQv\sin\theta$

electromagnetic induction $E = \frac{-\mathrm{d}(N\Phi)}{\mathrm{d}t}$

Hall effect $V = Bvd$

time dilation $t' = \frac{t}{\sqrt{1-\frac{v^2}{c^2}}}$

kinetic theory $\frac{1}{2}m\langle c^2\rangle = \frac{3}{2}kT$

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

radioactive decay $\frac{\mathrm{d}N}{\mathrm{d}t} = -\lambda N$

$N = N_0 e^{-\lambda t}$

$t_{\frac{1}{2}} = \frac{\ln 2}{\lambda}$

attenuation losses $I = I_0 e^{-\mu x}$

mass-energy equivalence $\Delta E = c^2\Delta m$

hydrogen energy levels $E_n = \frac{-13.6\,\mathrm{eV}}{n^2}$

Heisenberg uncertainty principle $\Delta p\,\Delta x \geqslant \frac{h}{2\pi}$

$\Delta E\,\Delta t \geqslant \frac{h}{2\pi}$

Wien's law $\lambda_{max} \propto \frac{1}{T}$

Stefan's law $L = 4\pi\sigma r^2T^4$

electromagnetic radiation from a moving source $\frac{\Delta\lambda}{\lambda} \approx \frac{\Delta f}{f} \approx \frac{v}{c}$

1 Which quantity is a vector?

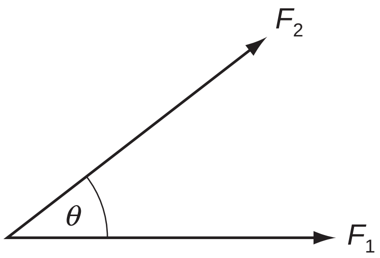
A kinetic energy

B speed

C weight

D work

2 Two forces F_1 and F_2 act with an angle θ between them.



Which combination could produce a resultant force of magnitude 1 N?

	F_1 / N	F_2 / N	θ
A	1	1	less than 90°
B	1	1	more than 90° but less than 180°
C	2	1	less than 90°
D	2	1	more than 90° but less than 180°

Space for working

3 A racing driver enters the home straight at 50 m s^{-1}. He then accelerates uniformly until he passes the finish line, 432 m away. At this time he is moving at 70 m s^{-1}.

Which statement is correct?

A The acceleration is 20 m s^{-2}.

B The time taken to reach the finish line is 2.0 s.

C The time taken to reach the finish line is 7.2 s.

D When the driver's speed is 60 m s^{-1}, he is 216 m from the finish line.

4 A ball is thrown with kinetic energy K from ground level at an angle of 45° to the horizontal.

Which statement is **not** correct?

A The kinetic energy of the ball is $\frac{K}{2}$ at the maximum height.

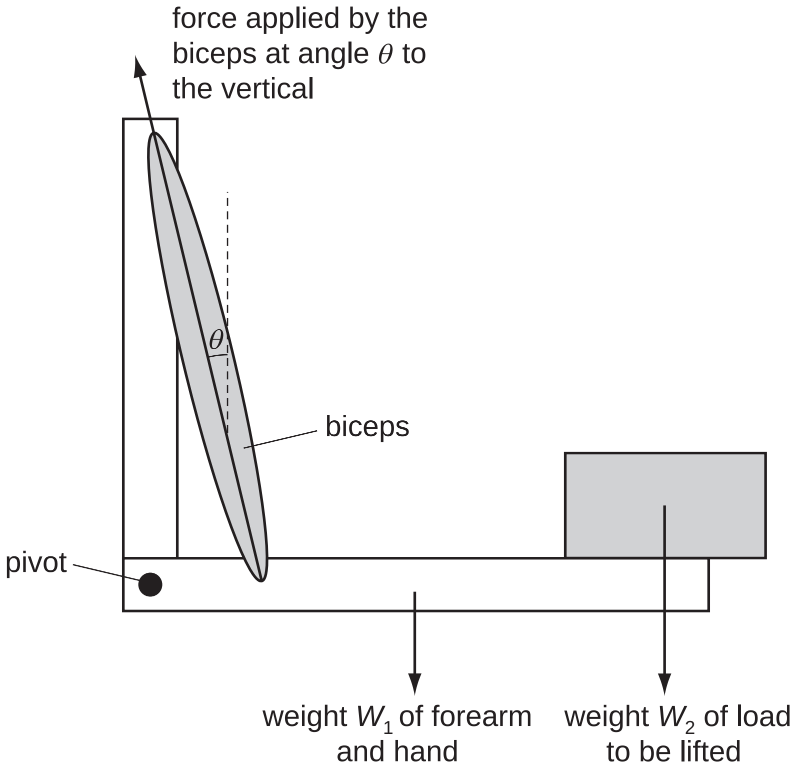
B The kinetic energy of the ball is $\frac{K}{2}$ when the ball reaches a height equal to half the maximum height.

C The potential energy of the ball is $\frac{K}{2}$ at the maximum height.

D The potential energy of the ball is $\frac{K}{4}$ when the ball reaches a height equal to half the maximum height.

Space for working

5 The diagram shows a model of an arm. A force applied by the biceps muscle can hold the arm in equilibrium while it supports a load.



Which statement is correct when the arm is in equilibrium in the position shown?

A The force at the pivot is zero.

B The force from the biceps is bigger when the load is moved nearer to the pivot.

C The force from the biceps is equal to $W_1 + W_2$.

D The resultant force on the biceps is zero.

Space for working

6 A man applies a horizontal force to a supermarket trolley and the trolley accelerates uniformly in the direction of the force.

Which statement is correct?

A The force applied by the man on the trolley equals the force applied by the trolley on the man.

B The force applied by the man on the trolley is greater than the force applied by the trolley on the man.

C The forces acting on the trolley are in equilibrium.

D The total frictional force acting on the trolley equals the force applied by the man on the trolley.

7 A body of mass 8.0 kg moving at 5.0 m s^{-1} collides with a stationary body of mass 12 kg. They both move off with the same velocity.

Which statement is correct?

A Kinetic energy is conserved and their common velocity is 2.0 m s^{-1}.

B Kinetic energy is conserved and their common velocity is 3.2 m s^{-1}.

C Momentum is conserved and their common velocity is 2.0 m s^{-1}.

D Momentum is conserved and their common velocity is 3.2 m s^{-1}.

8 A vehicle is used to explore under the sea. The force due to the water on its horizontal rectangular window, which measures 50.0 cm by 40.0 cm, is 8.24×10^6 N.

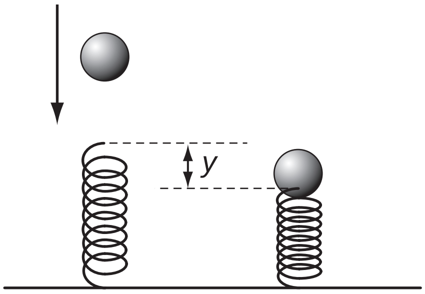
At what depth is the window? (Average density of sea water is 1.03×10^3 kg m^{-3}).

A 40.8 m **B** 163 m **C** 4.08×10^3 m **D** 4.00×10^4 m

Space for working

9 A ball of mass *m* falls freely from rest. When it has reached a speed *v*, it strikes a vertical spring.

The spring is compressed by a distance *y* before the ball begins to move upwards.



Assume that all the energy the ball loses becomes elastic potential energy in the spring.

What is the average force exerted by the spring during its compression?

A $\dfrac{mv^2}{2y}$

B $\dfrac{m}{2y}(v^2 - 2gy)$

C $\dfrac{mv^2}{y}$

D $\dfrac{m}{2y}(v^2 + 2gy)$

10 On the surface of Titan, Saturn's largest moon, a mass of 5.0 kg experiences a gravitational force of 6.8 N.

What is its speed of impact on the surface when released from rest at a height of 5.0 m?

A $3.7\,\text{m}\,\text{s}^{-1}$ **B** $8.2\,\text{m}\,\text{s}^{-1}$ **C** $9.9\,\text{m}\,\text{s}^{-1}$ **D** $13.5\,\text{m}\,\text{s}^{-1}$

Space for working

11 A scale model of a table is made so that all its linear dimensions are one tenth of those of the real table (scale 1 : 10). The model is made from the same wood as the table.

What is the value of $\dfrac{\text{stress in the legs of the model}}{\text{stress in the legs of the real table}}$?

A 0.001 **B** 0.01 **C** 0.1 **D** 1

12 When a force is applied to a metal wire, the wire can undergo elastic or plastic deformation.

Which statement is correct?

A In elastic deformation, stress is always proportional to strain.

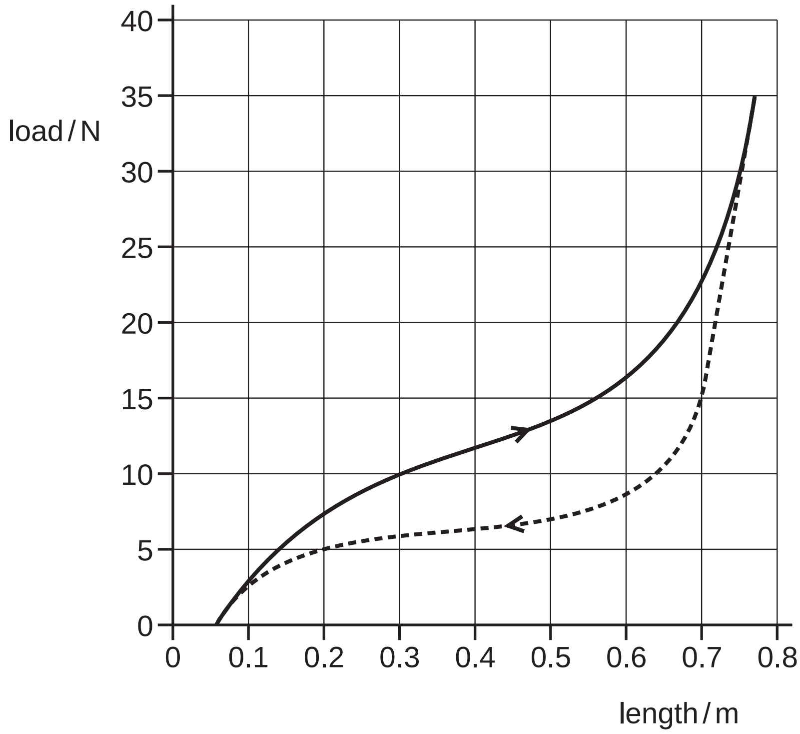
B In plastic deformation, the original length is regained when the load is removed.

C Plastic deformation always starts at the limit of proportionality.

D There is no elastic deformation past the yield point.

Space for working

13 The solid line on the graph shows how the length of a rubber band varies when an increasing load is applied. The dotted line shows how the length subsequently varies as the load is gradually decreased.



Which statement is correct?

A The energy recovered when the load is removed is about 10 J.

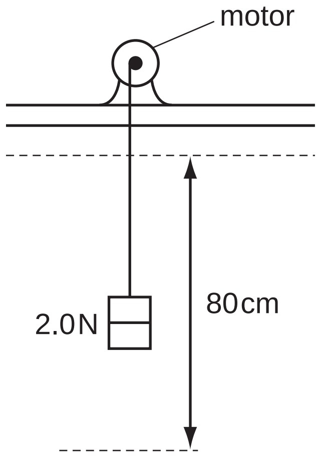
B The energy remaining in the rubber band after one cycle of loading and unloading is about 3 J.

C The total work done on the rubber band during one cycle of loading and unloading is about 14 J.

D The work done in stretching the rubber band is about 5 J.

Space for working

14 A small electric motor is used to raise a weight of 2.0 N at constant speed through a vertical height of 80 cm in 4.0 s.



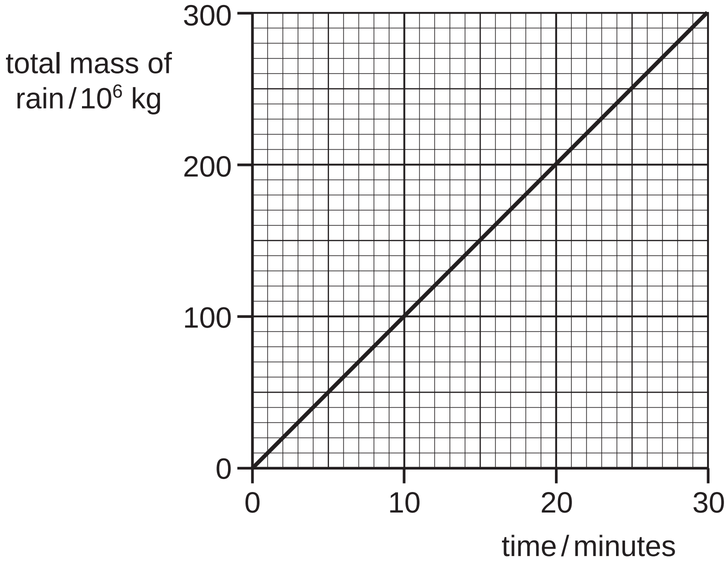
The efficiency of the motor is 20 %.

What is the electrical power supplied to the motor?

A 0.080 W **B** 0.80 W **C** 2.0 W **D** 200 W

Space for working

15 Rain from a thunderstorm reaches the ground at a speed of $12\,\text{m s}^{-1}$. The graph shows how the total mass of deposited rain increases with time.



What is the average power delivered by the rain as it hits the ground?

A 1.0×10^6 W **B** 1.2×10^7 W **C** 2.4×10^7 W **D** 7.2×10^8 W

16 A rocket is travelling away from Earth at a speed of $11\,\text{km s}^{-1}$ in a direction at 60° to the Earth's surface at a point where the gravitational field strength is $9.3\,\text{N kg}^{-1}$.

If the mass of the rocket at this moment is 4.0×10^6 kg, at what rate is the rocket gaining gravitational potential energy?

A 4.2×10^8 W

B 3.6×10^{10} W

C 2.1×10^{11} W

D 3.5×10^{11} W

Space for working

17 An object falling at terminal velocity through air is converting

A gravitational potential energy to kinetic energy.

B gravitational potential energy to thermal energy.

C kinetic energy to gravitational potential energy.

D kinetic energy to thermal energy.

18 A copper wire of length 3.0 m has a resistivity of $1.7 \times 10^{-8}\,\Omega\,\text{m}$ and resistance $15.9\,\Omega$.

What is the diameter of the wire? (Assume the wire has a uniform circular cross-section.)

A 3.2×10^{-4} m **B** 2.1×10^{-5} m **C** 3.2×10^{-5} m **D** 6.4×10^{-5} m

19 One type of charger for a mobile phone supplies a current of 240 mA for one hour.

How many electrons flow to the mobile phone?

A 1.5×10^{18} **B** 9.0×10^{19} **C** 5.4×10^{21} **D** 5.4×10^{24}

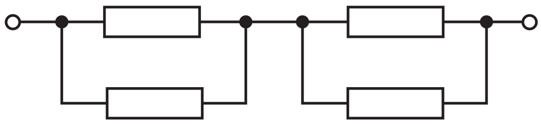
Space for working

20 In the diagrams, all resistors are identical.

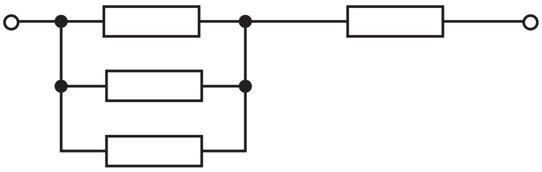
Which network has the lowest resistance?

A

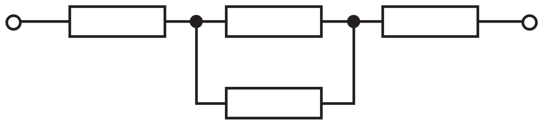
B



C



D



21 A high-resistance voltmeter connected directly across the terminals of a cell reads 1.50 V.

When a 2.0 Ω resistor is also connected across the cell the voltmeter reading drops to 1.20 V.

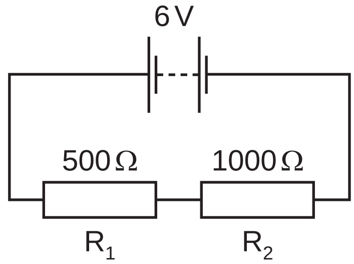
What is the internal resistance of the cell?

A 0.50 Ω **B** 1.6 Ω **C** 2.0 Ω **D** 2.5 Ω

Space for working

22 The diagram shows a 6 V battery, with negligible internal resistance, connected in series to two resistors R_1 and R_2.

R_1 has a resistance of 500 Ω and R_2 has a resistance of 1000 Ω.



A third resistor with a resistance of 500 Ω is placed in parallel across R_2.

Which statement about the new circuit is correct?

A The current in R_2 is larger than before.

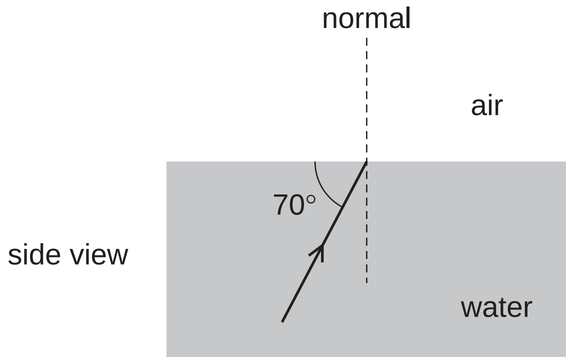
B The current through the battery is smaller than before.

C The potential difference (p.d.) across R_1 is larger than before.

D The p.d. across R_2 is now greater than the p.d. across R_1.

Space for working

23 The speed of light in air is $3.0 \times 10^{8}\,\mathrm{m\,s^{-1}}$ and the speed of light in water is $2.3 \times 10^{8}\,\mathrm{m\,s^{-1}}$. A laser beam strikes a water/air boundary at an angle of 70° to the boundary.



At which angle to the normal does the beam leave the surface?

A 15° **B** 20° **C** 26° **D** 46°

24 Why does white light passing through a glass prism split into a spectrum of colours?

A The frequency of the light changes as it passes into the prism.

B The light is refracted both on entering and leaving the prism.

C The refractive index of the glass depends on its density.

D The refractive index of the glass depends on the wavelength of the light.

Space for working

25 Which statements are correct for **all** transverse waves?

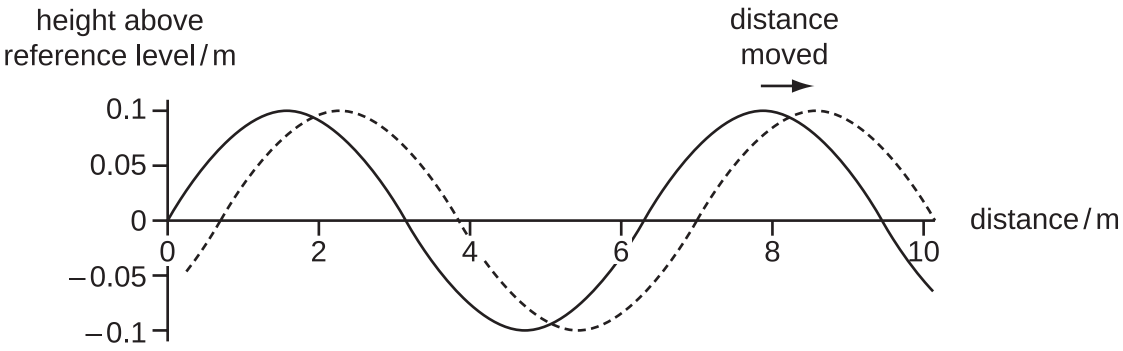
1 The waves are electromagnetic.

2 The waves can be polarised.

3 The waves can travel through a vacuum.

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

26 The solid line shows a diagram of a rope on which there is a progressive wave travelling to the right. The dotted line shows the same rope 0.2 s later.



Which statement is correct?

A The amplitude of the wave is about 0.2 m.

B The frequency of the wave is about 0.6 Hz.

C The speed of the wave is about 30 $m s^{-1}$.

D The wavelength of the portion shown is about 10 m.

Space for working

27 Which correctly shows regions of the electromagnetic spectrum in order of increasing wavelength?

A gamma → infra-red → visible → radio

B microwave → ultraviolet → visible → infra-red

C radio → microwave → infra-red → visible

D ultraviolet → visible → infra-red → microwave

28 Two waves are defined to be coherent if

A they are emitted by identical sources close together.

B they have a constant phase difference between them.

C they have the same amplitude and frequency.

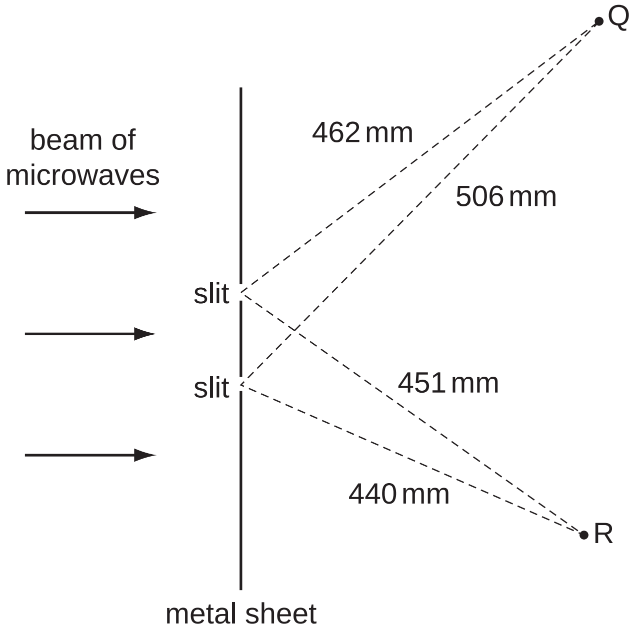
D they have the same wavelength and speed.

29 What is the relationship between phase difference $\Delta\phi$ in radians, path difference x and wavelength λ?

A $\Delta\phi = \frac{x}{\lambda}$ **B** $\Delta\phi = \frac{\lambda}{x}$ **C** $\Delta\phi = \frac{2\pi x}{\lambda}$ **D** $\Delta\phi = \frac{2\pi\lambda}{x}$

Space for working

30 A beam of microwaves, with wavelength 22 mm, passes through two slits in a metal sheet. Q and R are microwave detectors.



When Q and R are at the distances shown, what are their readings?

	Q	R
A	maximum	maximum
B	maximum	zero
C	zero	maximum
D	zero	zero

Space for working

31 A loudspeaker is placed facing a wall. It emits a continuous note of constant frequency. A standing wave is set up between the loudspeaker and the wall. At the wall, the standing wave has a node of displacement and an antinode of pressure.

The frequency of the note is now doubled and a standing wave is again formed.

What will there now be at the wall?

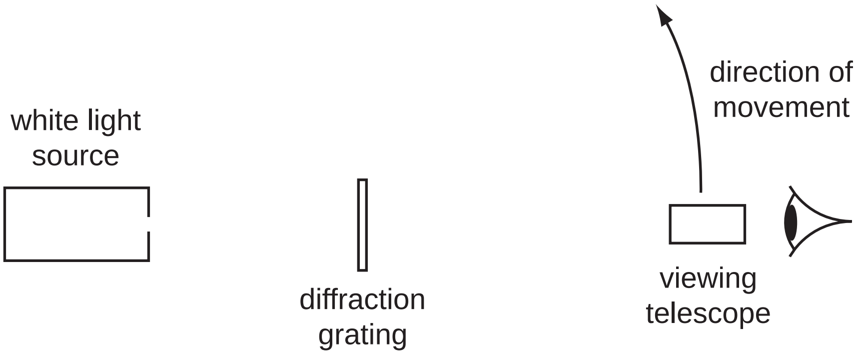
A an antinode of displacement and an antinode of pressure

B an antinode of displacement and a node of pressure

C a node of displacement and an antinode of pressure

D a node of displacement and a node of pressure

32 The diagram shows a source of white light. The light is incident on a diffraction grating.



Which diagram represents the spectrum observed when the viewing telescope is moved from the position shown and in the direction shown on the diagram?

A


B


C


D


key
w = white
r = red
v = violet

Space for working

33 Hydrogen bombs operate with tritium, a radioactive isotope of hydrogen with a half-life of 1.7×10^8 s.

It has been proposed that if the production of tritium were halted, countries storing hydrogen bombs would have to replenish supplies from existing bombs. Eventually there would not be enough tritium to make any bombs.

A country has a stockpile of 2000 hydrogen bombs.

After how many years would it be unable to make a single bomb?

A 54 years

B 59 years

C 10 800 years

D 1.7×10^9 years

34 In an alpha-particle scattering experiment, which factors could be increased so as to increase the number of alpha-particles scattered through large angles by a thin metal foil?

1 alpha-particle energy

2 thickness of foil

3 the atomic number of the metal of the foil

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

Space for working

35 From which nuclide is $^{216}_{84}\text{Po}$ the product of an alpha-particle emission?

A $^{214}_{80}\text{Hg}$ **B** $^{212}_{82}\text{Pb}$ **C** $^{220}_{86}\text{Rn}$ **D** $^{218}_{88}\text{Ra}$

36 Which statement about radioactive nuclides is correct?

A The half-life is proportional to the probability of decay per unit time of each nucleus.

B The higher the temperature, the larger the probability of decay per unit time of each nucleus.

C The probability of decay per unit time of each nucleus decreases with time.

D The smaller the probability of decay per unit time, the longer the half-life.

37 What is the de Broglie wavelength of an electron having an energy of 54 eV?

A 3.7×10^{-27} m

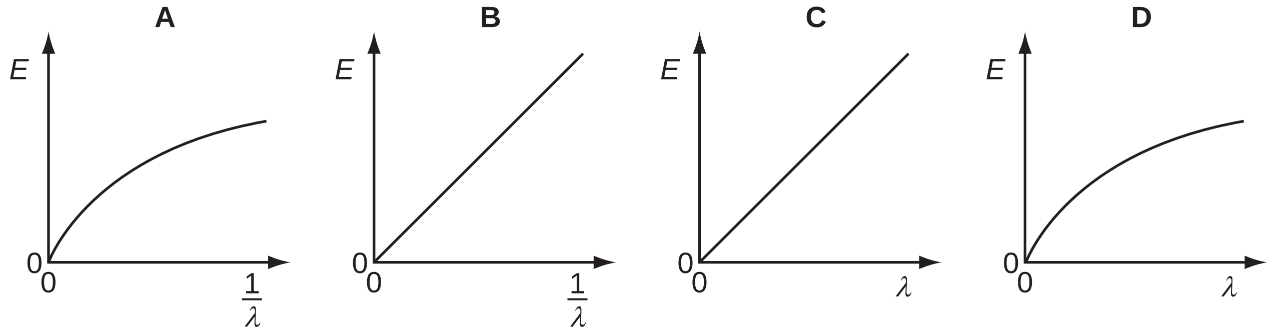
B 6.7×10^{-20} m

C 1.7×10^{-10} m

D 2.3×10^{-8} m

Space for working

38 Which graph shows the relationship between photon energy E and wavelength λ of electromagnetic waves?



39 Monochromatic light of wavelength 650 nm is incident on a clean potassium surface.

The work function of potassium is 1.81 eV.

What is the maximum velocity of the electrons emitted?

A $1.3 \times 10^5\,\mathrm{m\,s^{-1}}$

B $1.9 \times 10^5\,\mathrm{m\,s^{-1}}$

C $5.2 \times 10^5\,\mathrm{m\,s^{-1}}$

D $8.2 \times 10^5\,\mathrm{m\,s^{-1}}$

40 Which piece of evidence about the photoelectric effect **cannot** be explained using a wave model?

A Increasing the intensity of the illumination increases the rate at which electrons are ejected.

B Shining ultraviolet radiation onto a zinc surface ejects electrons.

C Shining visible light onto a potassium surface ejects electrons.

D There is a threshold frequency below which no electrons are ejected from a metal surface.

Space for working

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