



**PHYSICS**

**9792/01**

Paper 1 Part A Multiple Choice

**October/November 2013**

**1 hour 15 minutes**

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.

Electronic calculators may be used.

This document consists of **22** printed pages and **2** blank pages.



**Data**

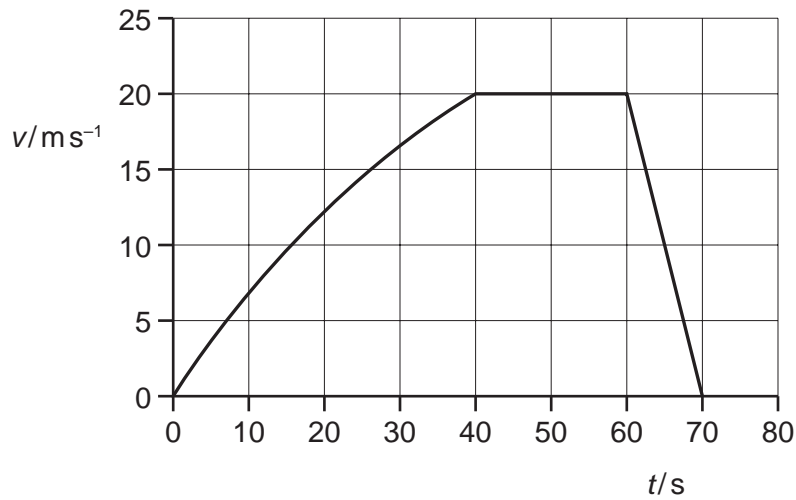
gravitational field strength close to Earth's surface	$g = 9.81 \text{ N kg}^{-1}$
elementary charge	$e = 1.60 \times 10^{-19} \text{ C}$
speed of light in vacuum	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
Planck constant	$h = 6.63 \times 10^{-34} \text{ J s}$
permittivity of free space	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$
gravitational constant	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
electron mass	$m_e = 9.11 \times 10^{-31} \text{ kg}$
proton mass	$m_p = 1.67 \times 10^{-27} \text{ kg}$
unified atomic mass constant	$u = 1.66 \times 10^{-27} \text{ kg}$
molar gas constant	$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
Avogadro constant	$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$
Boltzmann constant	$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$
Stefan-Boltzmann constant	$\sigma = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$

**Formulae**

uniformly accelerated motion	$s = ut + \frac{1}{2}at^2$	change of state	$\Delta E = mL$	
	$v^2 = u^2 + 2as$		refraction	$n = \frac{\sin\theta_1}{\sin\theta_2}$
	$s = \left(\frac{u+v}{2}\right)t$			$n = \frac{v_1}{v_2}$
heating	$\Delta E = mc\Delta\theta$			

diffraction		electromagnetic induction	$E = -\frac{d(N\Phi)}{dt}$
single slit, minima	$n\lambda = b \sin \theta$	Hall effect	$V = Bvd$
grating, maxima	$n\lambda = d \sin \theta$	time dilation	$t' = \frac{t}{\sqrt{1 - \frac{v^2}{c^2}}}$
double slit interference	$\lambda = \frac{ax}{D}$	kinetic theory	$\frac{1}{2}m\langle c^2 \rangle = \frac{3}{2}kT$
Rayleigh criterion	$\theta \approx \frac{\lambda}{b}$	work done on/by a gas	$W = p\Delta V$
photon energy	$E = hf$	radioactive decay	$\frac{dN}{dt} = -\lambda N$ $N = N_0 e^{-\lambda t}$ $t_{\frac{1}{2}} = \frac{\ln 2}{\lambda}$
de Broglie wavelength	$\lambda = \frac{h}{p}$	attenuation losses	$I = I_0 e^{-\mu x}$
simple harmonic motion	$x = A \cos \omega t$ $v = -A\omega \sin \omega t$ $a = -A\omega^2 \cos \omega t$ $F = -m\omega^2 x$ $E = \frac{1}{2}mA^2\omega^2$	mass-energy equivalence	$\Delta E = c^2 \Delta m$
energy stored in a capacitor	$W = \frac{1}{2}QV$	hydrogen energy levels	$E_n = \frac{-13.6 \text{ eV}}{n^2}$
electric force	$F = \frac{Q_1 Q_2}{4\pi\epsilon_0 r^2}$	Heisenberg uncertainty principle	$\Delta p \Delta x \geq \frac{h}{2\pi}$ $\Delta E \Delta t \geq \frac{h}{2\pi}$
electrostatic potential energy	$W = \frac{Q_1 Q_2}{4\pi\epsilon_0 r}$	Wien's displacement law	$\lambda_{\text{max}} \propto \frac{1}{T}$
gravitational force	$F = -\frac{Gm_1 m_2}{r^2}$	Stefan's law	$L = 4\pi\sigma r^2 T^4$
gravitational potential energy	$E = -\frac{Gm_1 m_2}{r}$	electromagnetic radiation from a moving source	$\frac{\Delta\lambda}{\lambda} \approx \frac{\Delta f}{f} \approx \frac{v}{c}$
magnetic force	$F = BIL \sin \theta$ $F = BQv \sin \theta$		

- 1 An object starts from rest at time  $t = 0$  and moves in a horizontal straight line. The graph shows how the velocity  $v$  of the object varies with time.



What is the distance travelled by the object during the time that its acceleration is zero?

- A** 300 m      **B** 400 m      **C** 800 m      **D** 1200 m
- 2 A body is initially at rest. Two forces are then applied to it; one is constant, the other acts in the opposite direction with a magnitude that is proportional to the velocity of the object.

Which statement best describes the motion of the object?

- A** The acceleration will increase from zero to a maximum.
- B** The acceleration will increase from zero to a maximum and then decrease.
- C** The velocity will increase from zero to a maximum.
- D** The velocity will increase from zero to a maximum and then decrease.

**Space for working**

- 3 In the 2009 World Championships in Berlin, Usain Bolt won the 100 m in a new world record time of 9.58 s. Bolt was so far in front of the other runners that he began to slow down and celebrate before the end of the race.

The table shows his times for each successive 20 m section of the race.

distance (m)	time (s)
0-20	2.74
20-40	1.75
40-60	1.67
60-80	1.61
80-100	1.66

Usain Bolt's reaction time at the start of the race was 0.15 s.

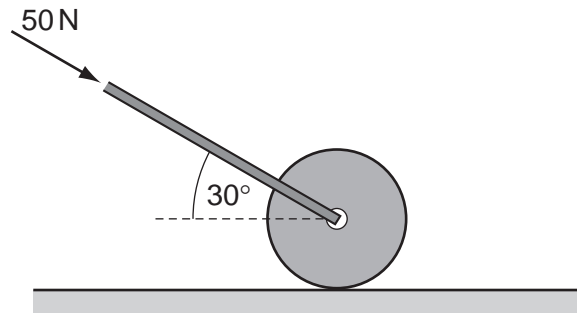
Which time would he have achieved if his reaction time had been 0.12 s **and** if he had not slowed down after reaching his maximum velocity?

- A** 9.50 s      **B** 9.51 s      **C** 9.53 s      **D** 9.56 s

**Space for working**

- 4 A heavy roller is pushed across a horizontal grass surface.

A force of 50 N is needed to push it at a steady velocity of  $0.50 \text{ m s}^{-1}$ .



How much work is done on the roller when it is pushed for 10 s?

- A** 130 J      **B** 220 J      **C** 250 J      **D** 870 J
- 5 A car pulls a trailer of mass 500 kg. The friction acting on the car is 1200 N and that on the trailer is 400 N. At first, the acceleration of the car and trailer system is  $2 \text{ m s}^{-2}$ .

What is the tension in the coupling between the car and trailer for this acceleration?

- A** zero      **B** 1400 N      **C** 1800 N      **D** 2600 N

**Space for working**

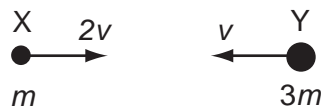
- 6 A helicopter is moving horizontally at  $60 \text{ m s}^{-1}$  at a height of  $80 \text{ m}$  above level ground. The pilot aims to land a parcel at position X shown in the diagram.



At what horizontal distance from X should the parcel be dropped? Ignore air resistance.

- A** 0 m      **B** 72 m      **C** 240 m      **D** 960 m
- 7 An object X, of mass  $m$ , is travelling to the right at speed  $2v$ .

A second object Y, of mass  $3m$ , is travelling to the left at speed  $v$ .



The two objects collide, head on, in an inelastic collision.

Which of the following is a possible outcome after the collision?

	X	Y
<b>A</b>	0	0
<b>B</b>	$\leftarrow \frac{v}{3}$	$\frac{v}{3} \rightarrow$
<b>C</b>	$\leftarrow \frac{v}{2}$	$v \rightarrow$
<b>D</b>	$\leftarrow 2v$	$\frac{v}{3} \rightarrow$

**Space for working**

- 8 A stationary nucleus of the radioactive isotope radon-220 emits an alpha-particle.

The speed of the emitted particle is  $1.60 \times 10^7 \text{ m s}^{-1}$ .

What is the speed of the daughter nucleus immediately after the decay?

- A  $3.44 \times 10^{-6} \text{ m s}^{-1}$   
B  $1.46 \times 10^5 \text{ m s}^{-1}$   
C  $2.96 \times 10^5 \text{ m s}^{-1}$   
D  $1.60 \times 10^7 \text{ m s}^{-1}$
- 9 On the asteroid Ceres, a stone dropped from rest from a height of 1.0 m would take 2.8 s to reach the surface of the asteroid.

What would be the weight of a 70 kg astronaut on Ceres?

- A 18 N                      B 70 N                      C 250 N                      D 700 N
- 10 What is the best estimate of the stress in your neck when it supports your head in a vertical position?
- A 0.3 Pa                      B 30 Pa                      C 3000 Pa                      D 300 000 Pa
- 11 Two wires, G and H, are made of the same metal. They are stretched by the same force without exceeding the limit of proportionality. G has twice the length and half the diameter of H.

What is the ratio:  $\frac{\text{extension of G}}{\text{extension of H}}$  ?

- A  $\frac{1}{8}$                       B  $\frac{1}{4}$                       C 4                      D 8

**Space for working**



- 12 In June 2009, it was reported that a 14-year old German boy had been hit by a pea-sized meteorite.

The meteorite was spherical, with diameter 15 mm and its density was  $7300 \text{ kg m}^{-3}$ .

The meteorite was travelling at  $350 \text{ km h}^{-1}$  when it hit the boy.

What was the approximate kinetic energy of the meteorite when it hit the boy? (The volume of a sphere of radius  $r$  is given by the formula  $V = \frac{4}{3}\pi r^3$ .)

- A 0.63 J            B 61 J            C 490 J            D 24 000 J

- 13 A storage heater is made up of several bricks each of mass 1.25 kg. They are warmed by an electric heater to  $75^\circ\text{C}$  in the night-time.

During the day, the bricks cool to  $18^\circ\text{C}$ , giving out  $4.2 \times 10^7 \text{ J}$  of their stored energy to the room.

The specific heat capacity of brick is  $840 \text{ J kg}^{-1} \text{ K}^{-1}$ . Approximately how many bricks are needed?

- A 530            B 700            C 880            D 2200

- 14 A vacuum flask of water contains 150 g of water at  $10^\circ\text{C}$ .

What mass of ice at  $0^\circ\text{C}$  must be added to the flask to reduce the temperature of the water to  $0^\circ\text{C}$ ?

Assume the heat transfer from the flask is negligible.

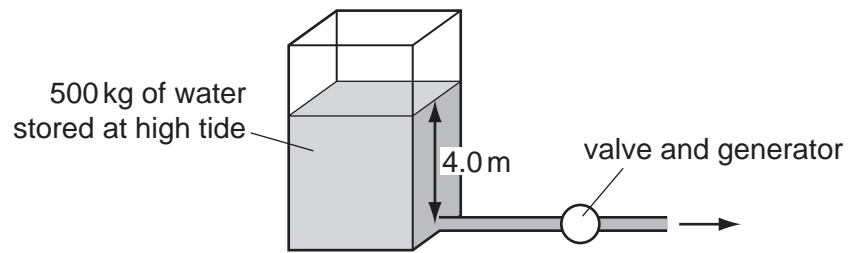
Specific heat capacity of water =  $4200 \text{ J kg}^{-1} \text{ K}^{-1}$ .

Latent heat of fusion of water =  $3.4 \times 10^5 \text{ J kg}^{-1}$ .

- A 1.9 g            B 19 g            C 1.9 kg            D 19 kg

**Space for working**

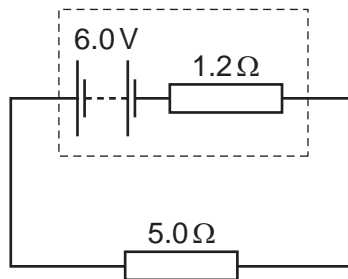
- 15 A simple idea for generating electricity from the tides allows water stored in a container at high tide to flow away through a generator at low tide.



At high tide 500 kg of water is stored to a height of 4.0 m. When the valve is opened the container empties in 5.0 s and the generator operates with an efficiency of 40%.

What is the average electrical power generated during the period of water flow?

- A 780 W      B 1600 W      C 2000 W      D 3900 W
- 16 The diagram shows a battery of e.m.f. 6.0 V and internal resistance  $1.2\ \Omega$  connected to a resistor of resistance  $5.0\ \Omega$ .



Another  $5.0\ \Omega$  resistor is connected in parallel to the original  $5.0\ \Omega$  resistor.

What is the ratio:  $\frac{\text{total current with two } 5.0\ \Omega \text{ resistors}}{\text{total current with one } 5.0\ \Omega \text{ resistor}}$  ?

- A 0.50      B 0.55      C 1.7      D 2.0

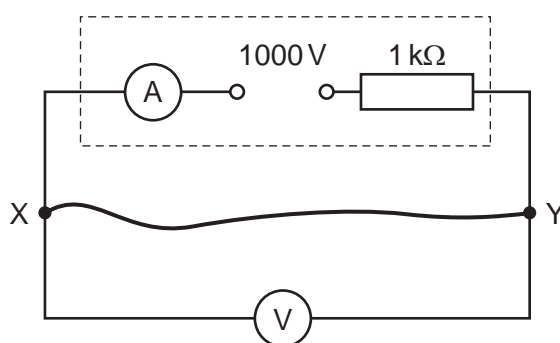
**Space for working**

- 17 The Large Hadron Collider (LHC) at CERN is designed to accelerate groups of protons around a large circular ring.

At any moment, there will be 3000 groups in the ring and each group will contain about  $10^{11}$  protons. All the protons go around the ring  $10^4$  times per second.

What is the best estimate of the current in the ring?

- A  $50\ \mu\text{A}$       B  $160\ \mu\text{A}$       C  $500\ \text{mA}$       D  $160\ \text{A}$
- 18 A power supply has an e.m.f. of  $1000\ \text{V}$  and an internal resistance of  $1\ \text{k}\Omega$ . It has a built-in ammeter.



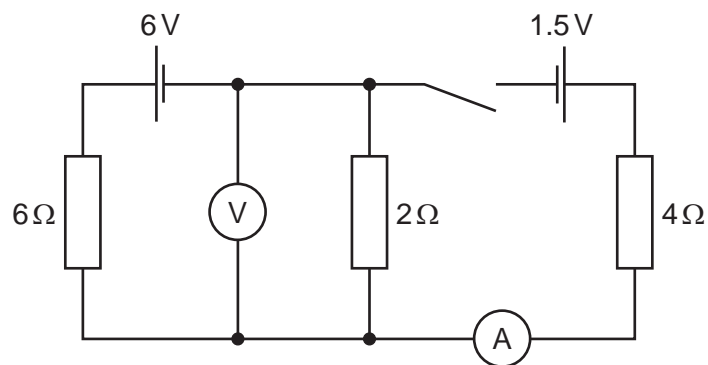
A connecting lead of negligible resistance is connected between points X and Y.

What will be the readings of the voltmeter and ammeter?

	voltmeter reading / V	ammeter reading / A
<b>A</b>	0	0
<b>B</b>	0	1
<b>C</b>	1000	0
<b>D</b>	1000	1

**Space for working**

19 The diagram shows a circuit.



The switch is initially open and is then closed.

What are the meter readings?

	voltmeter <b>before</b> closing switch / V	ammeter <b>after</b> closing switch / A
<b>A</b>	6.0	0
<b>B</b>	1.5	0.75
<b>C</b>	6.0	0.75
<b>D</b>	1.5	0

20 A cable is constructed of 12 parallel strands of nichrome wire, each of length 6.0 m and cross-sectional area  $1.00 \text{ mm}^2$ .

What is the resistance of the cable?

Resistivity of nichrome =  $1.10 \times 10^{-6} \Omega \text{ m}$

- A**  $0.55 \Omega$       **B**  $6.6 \Omega$       **C**  $14 \Omega$       **D**  $79 \Omega$

Space for working

- 21 A cable of length  $l$  and diameter  $d$  is to be replaced by a new cable of the same length and the same total resistance, but made from a material whose resistivity is half as much as in the original cable.

What is the diameter of the new cable?

- A  $0.50d$       B  $0.71d$       C  $1.41d$       D  $2.00d$

- 22 The table lists some properties of longitudinal waves.

Which row is correct?

	direction of vibrations	polarisation
<b>A</b>	parallel to velocity of wave	can be polarised
<b>B</b>	parallel to velocity of wave	cannot be polarised
<b>C</b>	perpendicular to velocity of wave	can be polarised
<b>D</b>	perpendicular to velocity of wave	cannot be polarised

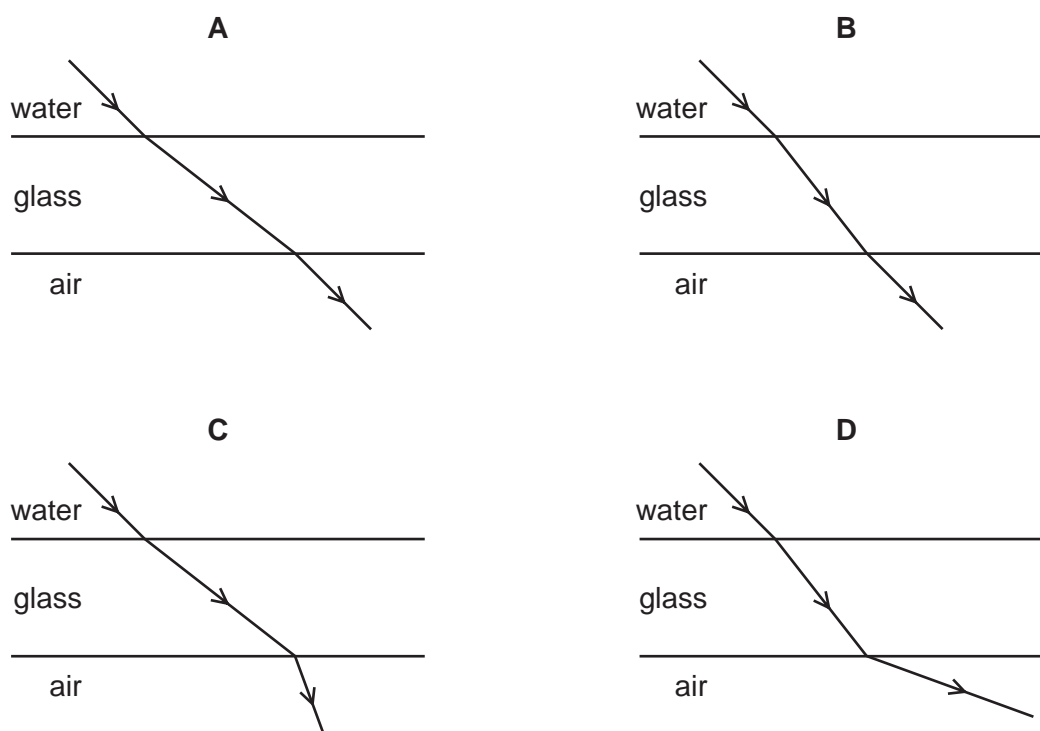
**Space for working**

- 23 Which row correctly lists the electromagnetic waves that correspond to wavelengths of 250 nm, 450 nm and 650 nm?

	wavelength 250 nm	wavelength 450 nm	wavelength 650 nm
<b>A</b>	infra-red	red light	blue light
<b>B</b>	infra-red	red light	ultraviolet
<b>C</b>	ultraviolet	blue light	infra-red
<b>D</b>	ultraviolet	blue light	red light

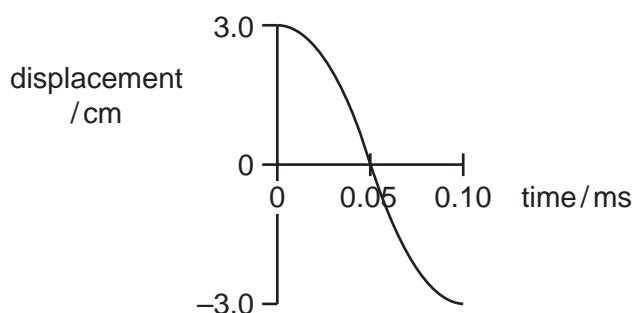
- 24 A glass table top has a small pool of spilled water on its surface.

Which diagram shows the path of the light beam from a laser pen as it passes through the water, the glass and into the air below?



Space for working

- 25 The graph below shows the variation in the displacement of a particle in a progressive wave with respect to time.



Which row gives the correct values of the frequency and amplitude of the vibration of the particle?

	frequency / kHz	amplitude / cm
<b>A</b>	5.0	6.0
<b>B</b>	10.0	6.0
<b>C</b>	5.0	3.0
<b>D</b>	10.0	3.0

- 26 Pre-natal scanners use ultrasound to create detailed images of developing babies while they are still inside their mother's womb. The finest details that can be resolved are about the same size as the wavelength of the ultrasound.

The speed of ultrasound in human flesh is about  $1500 \text{ m s}^{-1}$ .

Which frequency of ultrasound has a wavelength closest to 1.0 mm?

- A** 2 Hz                      **B** 2 kHz                      **C** 2 MHz                      **D** 2 GHz

**Space for working**

- 27 A vertically polarised beam of light of intensity  $I_0$  enters a polarising filter whose plane of polarisation is at  $45^\circ$  to the vertical.

What is the intensity of the transmitted beam?

- A zero                      B  $\frac{I_0}{\sqrt{2}}$                       C  $\frac{I_0}{2}$                       D  $I_0$

- 28 A standing wave is set up on a rope of length 1.0 m fixed at both ends.

Which statement is correct?

- A A harmonic of wavelength 0.4 m may be set up on the rope.  
B The fundamental mode has a wavelength of 1 m.  
C The midpoint of the rope is always stationary.  
D There are five nodes on the rope for the 5th harmonic.

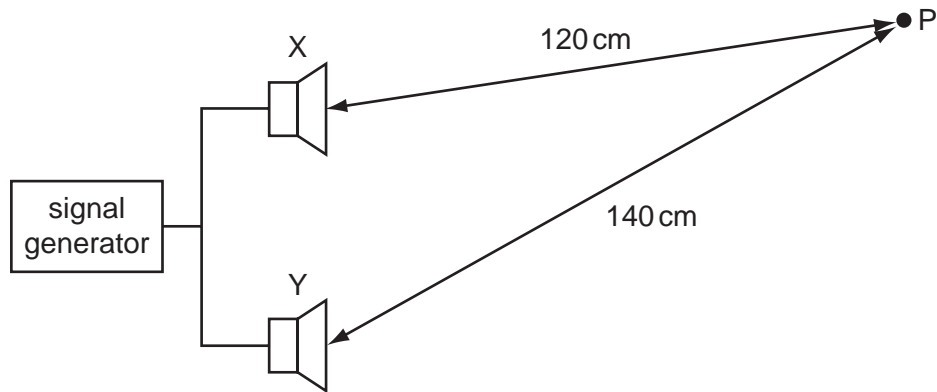
**Space for working**



- 29 The output from a single signal generator is connected to two speakers, X and Y, so that the sound waves produced by each speaker are in phase.

The wavelength of the sound is 30 cm.

P is a point near the speakers.

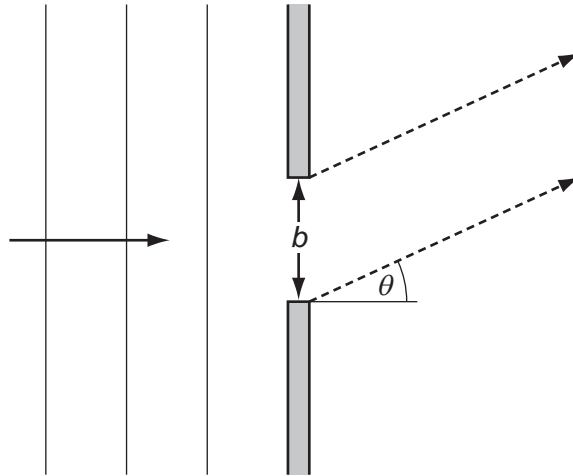


Which of the following is a way of expressing the phase difference between the waves arriving at P from X and Y?

- A 0 radians      B  $\frac{\pi}{3}$  radians      C  $\frac{2\pi}{3}$  radians      D  $\pi$  radians

**Space for working**

- 30 Light of wavelength  $\lambda$ , from a distant source to the left of the diagram, falls on a narrow slit of width  $b$ .



Light passing through the slit spreads out and is incident on a distant screen.

At which **small** angle  $\theta$  is it certain that there will be zero intensity?

- A 0                      B  $\frac{\lambda}{b}$                       C  $\frac{b}{\lambda}$                       D  $\frac{\lambda}{2b}$
- 31 A thin beam of monochromatic light falls on a diffraction grating at normal incidence. The third order diffracted beam occurs at an angle of  $50^\circ$  to the normal.

What is the highest order visible with this grating at this wavelength?

- A 3                      B 4                      C 5                      D 6

**Space for working**

32 Two phenomena P and Q are described.

P When ultraviolet light shines on zinc, electrons are emitted from the surface.

Q When electrons are passed through graphite, a pattern of rings may be observed on a screen.

Which different models are used to explain the phenomena?

	P	Q
<b>A</b>	particle	particle
<b>B</b>	particle	wave
<b>C</b>	wave	particle
<b>D</b>	wave	wave

33 In a laser beam, each photon has an energy of 1.9 eV.

What is the wavelength of the electromagnetic waves emitted by the laser?

**A**  $0.65 \times 10^{-6} \text{ m}$    **B**  $1.0 \times 10^{-6} \text{ m}$    **C**  $1.2 \times 10^{-6} \text{ m}$    **D**  $1.4 \times 10^{-6} \text{ m}$

34 In 2010 the Japanese launched the world's first interplanetary solar sail spacecraft, called IKAROS. This works because photons reflected from the sail, of area  $A$ , undergo a change of momentum and, by Newton's third Law, exert a forward force on the sail.

A beam of light of intensity  $I$  is reflected at right angles to a solar sail.

The momentum of a photon  $f$  is given by the expression  $\frac{hf}{c}$ , where  $f$  is the frequency of the light,  $h$  is the Planck constant and  $c$  is the speed of light.

What is the force exerted on the sail?

**A**  $\frac{IA}{hf}$    **B**  $\frac{2hf}{c}$    **C**  $\frac{I}{c}$    **D**  $\frac{2IA}{c}$

**Space for working**

- 35 The Sun has a power output of  $3.8 \times 10^{26}$  W. Approximately 10% of this is given out in the form of visible light. Take the average wavelength of visible light to be 500 nm.

What is the approximate number of photons of visible light that are given out per day by the Sun?

- A  $10^{44}$                       B  $10^{45}$                       C  $10^{49}$                       D  $10^{50}$

- 36 An isotope of cobalt-60 is  ${}_{27}^{60}\text{Co}$ .

What are the proton and neutron numbers for this isotope?

	protons	neutrons
A	27	33
B	27	60
C	33	27
D	60	27

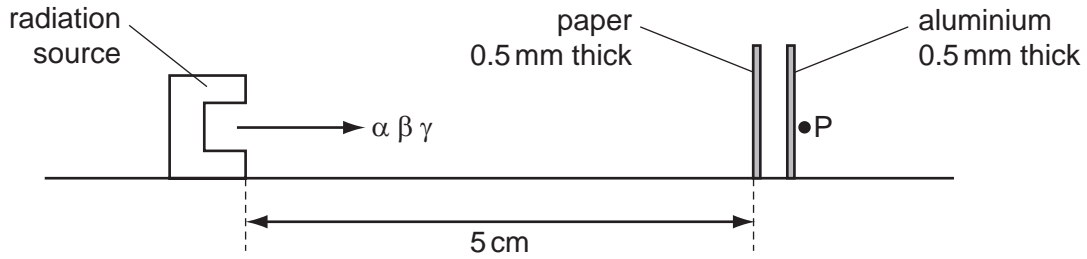
- 37 A radioactive nucleus emits a negative beta-particle. The daughter nucleus formed then decays, emitting an alpha-particle. The daughter nucleus of this decay then emits a negative beta-particle.

How does the final nucleus compare with the original nucleus?

- A It is a nucleus of a different element of higher proton number.  
 B It is a nucleus of a different element of lower proton number.  
 C It is a nucleus of an isotope of the original element.  
 D It is a nucleus identical to the original nucleus.

**Space for working**

- 38 A radioactive source emits  $\alpha$ ,  $\beta$  and  $\gamma$  radiation. It is placed on a laboratory bench with two absorbers about 5 cm away. One of the absorbers is paper of thickness 0.5 mm and the other is aluminium of thickness 0.5 mm.



Which radiations will be detected at point P?

- A  $\alpha$ ,  $\beta$  and  $\gamma$       B  $\alpha$  and  $\gamma$  only      C  $\beta$  and  $\gamma$  only      D  $\gamma$  only
- 39 The induced nuclear fission of uranium-235 can create many different pairs of daughter nuclei.

Which nuclear transformation correctly represents such an induced fission?

- A  ${}_{92}^{235}\text{U} \rightarrow {}_{56}^{144}\text{X} + {}_{36}^{90}\text{Y} + 3{}_0^1\text{n}$
- B  ${}_{92}^{235}\text{U} \rightarrow {}_0^1\text{n} \rightarrow {}_{56}^{144}\text{X} + {}_{36}^{90}\text{Y} + 2{}_0^1\text{n}$
- C  ${}_{92}^{235}\text{U} + {}_0^1\text{n} \rightarrow {}_{56}^{144}\text{X} + {}_{36}^{90}\text{Y} + 2{}_0^1\text{n}$
- D  ${}_{92}^{235}\text{U} \rightarrow {}_{56}^{145}\text{X} + {}_{36}^{91}\text{Y}$

Space for working

40 Nuclide X is radioactive with a half-life of 300 million years. It decays to form the stable nuclide Y.

A sample of rock is thought to have contained none of nuclide Y when it was formed, but now contains 15 atoms of Y to every atom of X.

How old are the rocks in this sample?

- A much less than 300 million years
- B 1200 million years
- C 2400 million years
- D 4500 million years

**Space for working**



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