Name:		Centre/Index Number:		Class:	

DUNMAN HIGH SCHOOL
Preliminary Examination
Year 6

H2 PHYSICS

9749/03

Paper 3 Longer Structured Questions

23 September 2021

2 hours

Candidates answer on the Question Paper

READ THESE INSTRUCTIONS FIRST

Write your centre number, index number, name and class at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer any **one** question.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
1	10
2	8
3	9
4	5
5	8
6	7
7	13
Section B	
8 / 9	20
Total	80

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

Data

speed of light in free space,	$c = 3.00 \times 10^{8}\ \mathrm{m\ s^{-1}}$
permeability of free space,	$\mu_o = 4\pi \times 10^{-7}\ \mathrm{H\ m^{-1}}$
permittivity of free space,	$\varepsilon_o = 8.85 \times 10^{-12}\ \mathrm{F\ m^{-1}}$
	$(1/(36\pi)) \times 10^{-9}\ \mathrm{F\ m^{-1}}$
elementary charge,	$e = 1.60 \times 10^{-19}\ \mathrm{C}$
the Planck constant,	$h = 6.63 \times 10^{-34}\ \mathrm{J\ s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27}\ \mathrm{kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31}\ \mathrm{kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27}\ \mathrm{kg}$
molar gas constant,	$R = 8.31\ \mathrm{J\ K^{-1}\ mol^{-1}}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23}\ \mathrm{mol^{-1}}$
the Boltzmann constant,	$k = 1.38 \times 10^{-23}\ \mathrm{J\ K^{-1}}$
gravitational constant,	$G = 6.67 \times 10^{-11}\ \mathrm{N\ m^{2}\ kg^{-2}}$
acceleration of free fall,	$g = 9.81\ \mathrm{m\ s^{-2}}$

Formulae

uniformly accelerated motion,	s =	$ut + \frac{1}{2}at^2$
	v^2 =	$u^2 + 2as$
work done on/by a gas,	W =	$p\Delta V$
hydrostatic pressure,	p =	ρgh
gravitational potential,	ϕ =	$-Gm/r$
temperature,	T/K =	T/°C + 273.15
pressure of an ideal gas,	p =	$\frac{1}{3}\frac{Nm}{V}\langle c^2 \rangle$
mean translational kinetic energy of an ideal gas molecule,	E =	$\frac{3}{2}kT$
displacement of particle in s.h.m.,	x =	$x_0 \sin \omega t$
velocity of particle in s.h.m.,	v =	$v_0 \cos \omega t$
	=	$\pm\omega\sqrt{x_0^2 - x^2}$
electric current,	I =	$Anvq$
resistors in series,	R =	$R_1 + R_2 + \ldots$
resistors in parallel,	$1/R$ =	$1/R_1 + 1/R_2 + \ldots$
electric potential,	V =	$\frac{Q}{4\pi\varepsilon_0 r}$
alternating current / voltage,	x =	$x_0 \sin \omega t$
magnetic flux density due to a long straight wire,	B =	$\frac{\mu_0 I}{2\pi d}$
magnetic flux density due to a flat circular coil,	B =	$\frac{\mu_0 NI}{2r}$
magnetic flux density due to a long solenoid,	B =	$\mu_0 nI$
radioactive decay,	x =	$x_0 \exp(-\lambda t)$
decay constant,	λ =	$\frac{\ln 2}{t_{\frac{1}{2}}}$

Section A

Answer **all** the questions in this section in the spaces provided.

1 **(a)** Explain what is meant by *acceleration*.

....[1]

(b) A ball is kicked from horizontal ground towards the top of a vertical wall, as shown in Fig. 1.1.

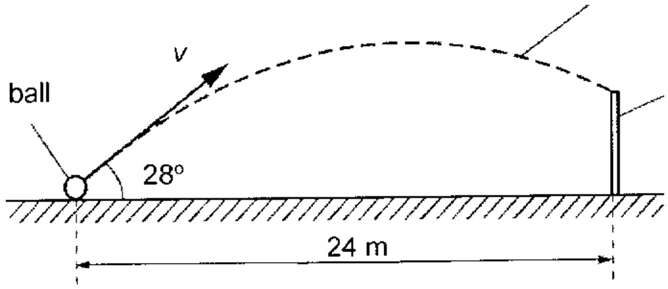


Fig. 1.1 (not to scale)

The horizontal distance between the initial position of the ball and the base of the wall is 24 m. The ball is kicked with an initial velocity v at an angle of 28° to the horizontal. The ball hits the top of the wall after a time of 1.5 s. Air resistance may be assumed to be negligible.

(i) Calculate the initial horizontal component v_X of the velocity of the ball.

v_X = ...m s^{-1} [1]

(ii) Show that the initial vertical component v_Y of the velocity of the ball is 8.5 m s^{-1}.

[1]

(iii) Calculate the time taken for the ball to reach its maximum height above the ground.

time = ... s [2]

(iv) The ball is kicked at time $t = 0$. On Fig. 1.2, sketch the variation with time t of the vertical component v_Y of the velocity of the ball until it hits the wall. It may be assumed that velocity is positive when in the upward direction. [2]

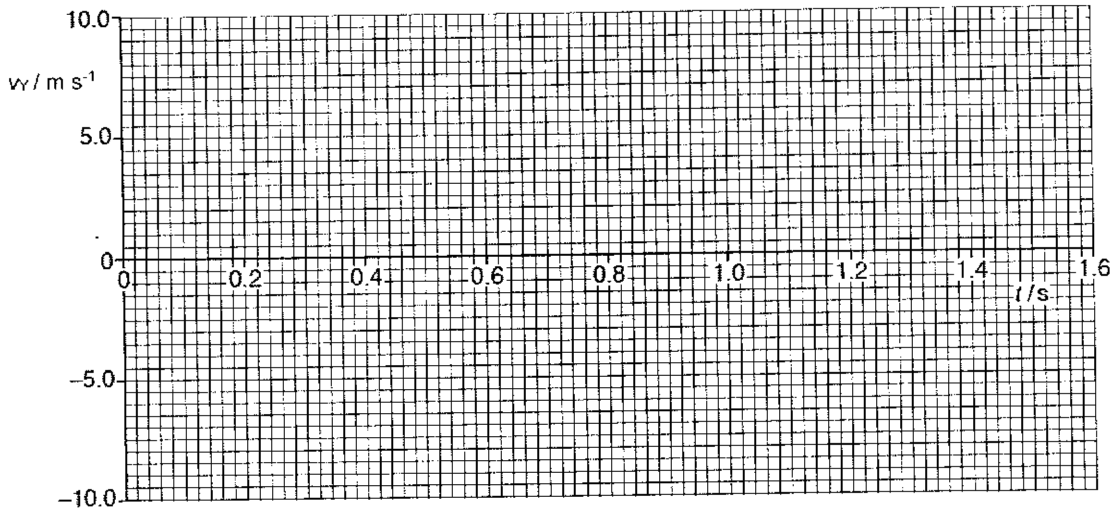


Fig. 1.2

(c) Determine the maximum height of the ball above the ground.

maximum height = ... m [2]

(d) A ball of greater mass is kicked with the same velocity as the ball in **(b)**.

State and explain the effect, if any, of the increased mass on the maximum height reached by the ball. Air resistance is still assumed to be negligible.

....

.... [1]

2 (a) Explain what is meant by *weight*.

....

.... [1]

(b) Fig. 2.1 shows a system of two pulleys with one pulley fixed to the ceiling but free to rotate. The other pulley is attached to a load.

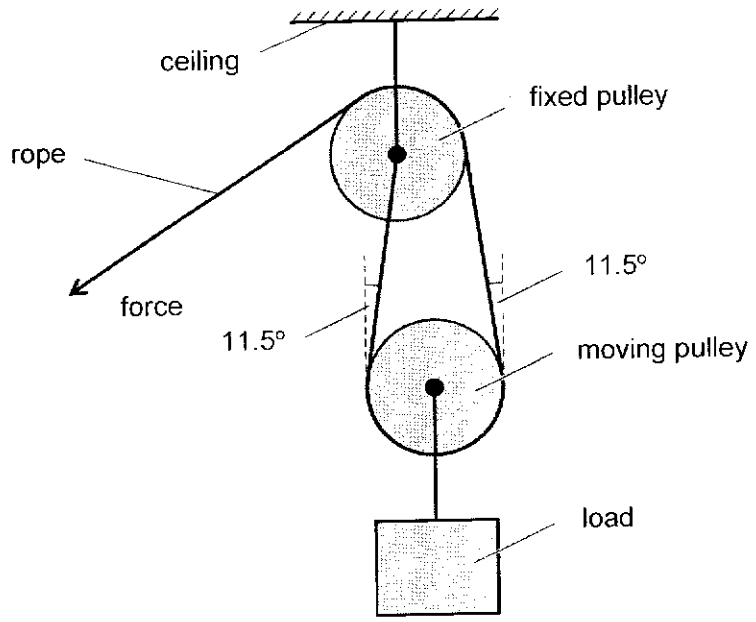


Fig. 2.1 (not to scale)

A force is used to pull the free end of the rope and this lifts the load at a constant speed. The air resistance and friction are negligible. The moving pulley has a mass of 2.40 kg and the load is a box of weight 960 N.

(i) The tension T in the rope is constant along its length. Calculate the tension T.

T = ... N [3]

(ii) As the rope moves upwards, the tension in the rope changes. Explain how the tension changes.

....

....[2]

(c) When the pulley system is used, the work done by the force is greater than the gravitational potential energy gained by the load.

(i) Suggest one reason for this.

....

....[1]

(ii) Suggest one advantage for using the pulley system.

....

....[1]

3 The volume of air in the cylinder of a car engine is 540 cm^3 at a pressure of 1.1×10^5 Pa and a temperature of 27 °C. The air is suddenly compressed to a volume of 30 cm^3. No heat energy enters or leaves the gas during the compression. The pressure then rises to 6.5×10^6 Pa. Assume that air behaves as an ideal gas.

(a) Determine the temperature of the gas after the compression.

temperature = ... K [2]

(b) **(i)** State the *first law of thermodynamics*.

....

.... [2]

(ii) Use the law to explain why the temperature of the air changes during compression.

....

....

....

....

.... [3]

(c) The temperature of a gas depends on the root-mean-square (r.m.s.) speed of its molecules. Calculate the ratio:

$$\frac{\text{r.m.s. speed of gas molecules at 350 K}}{\text{r.m.s. speed of gas molecules at 300 K}}$$

ratio = ... [2]

4 **(a)** A body undergoes simple harmonic motion.

The variation with displacement x of its velocity v is shown in Fig. 4.1.

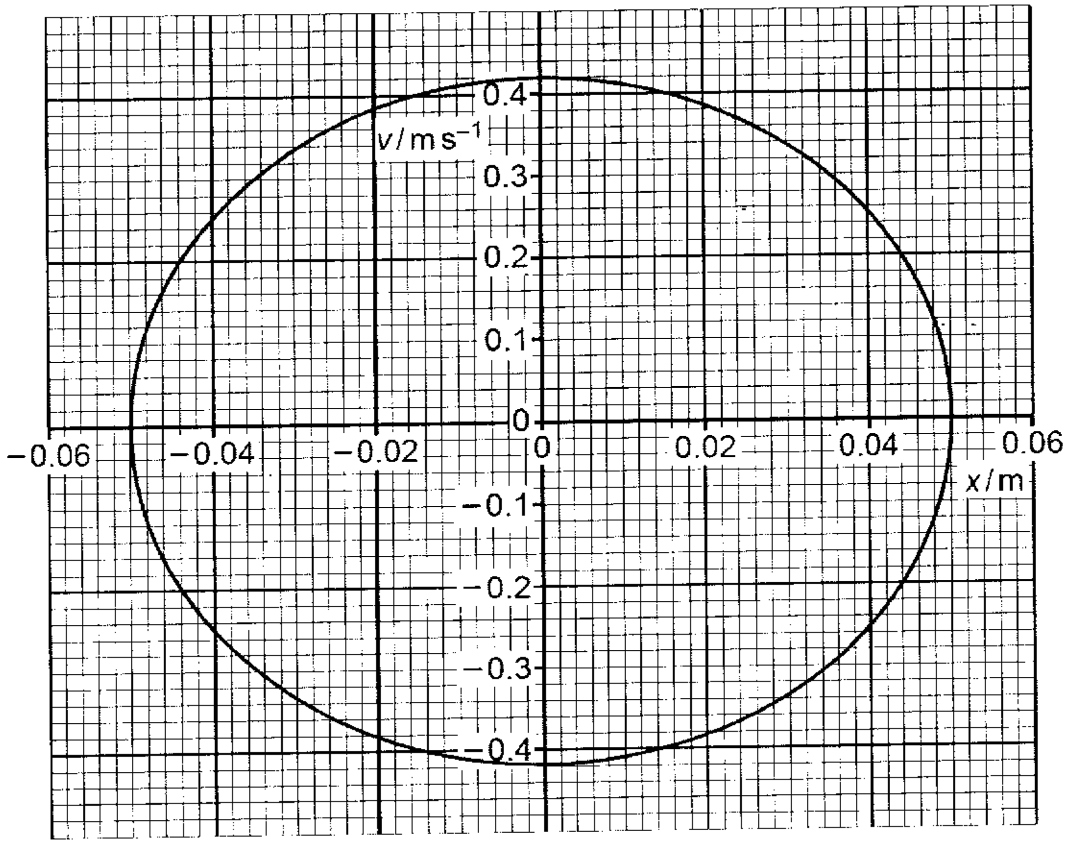


Fig. 4.1

(i) State the amplitude, x_o, of the oscillations.

x_o = ... m [1]

(ii) Calculate the period, T, of the oscillations.

T = ... s [3]

(b) On Fig. 4.1, label a point with letter P where the body has maximum potential energy. [1]

5 **(a)** Explain what is meant by the *principle of superposition.*

....

....

.... [2]

(b) Two identical loudspeakers are driven by the same oscillator of frequency 200 Hz. The loudspeakers are located on a vertical pole, a distance of 4.0 m from each other. A man walks straight towards the lower loudspeaker in a direction perpendicular to the pole, as shown in Fig. 5.1.

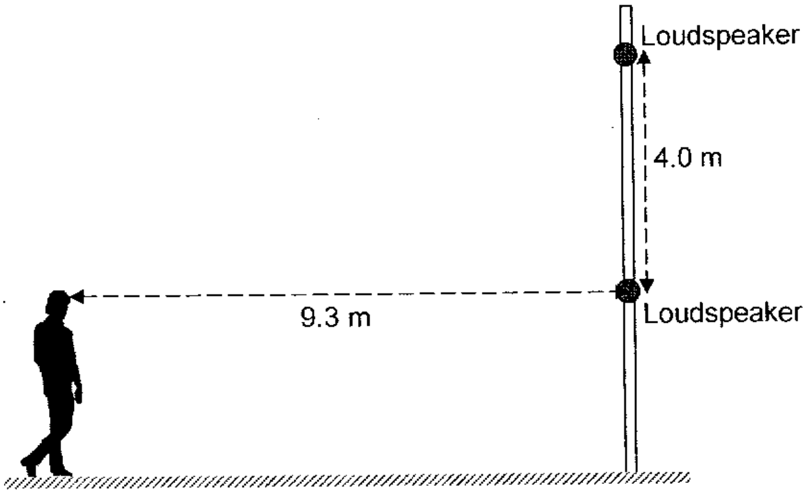


Fig. 5.1 (not to scale)

(i) Calculate the wavelength, λ, of the sound emitted by the loudspeaker, if the speed of sound in air is 330 m s^{-1}.

λ = ... m [1]

(ii) Determine whether the man will hear a maximum or minimum in sound intensity when he is 9.3 m from the pole. You may ignore any sound reflection from the ground.

[3]

(iii) State two changes that can be made to the set-up in Fig. 5.1 in order to increase the number of intensity fluctuations detected by the man as he walks towards the pole.

1. ....

....

2. ....

....[2]

6 **(a)** Define *electric field strength.*

....

.... [1]

(b) An electron is travelling in a straight line through a vacuum with a constant speed of 1.5×10^7 m s^{-1}. The electron enters a uniform electric field at point A, as shown in Fig. 6.1.

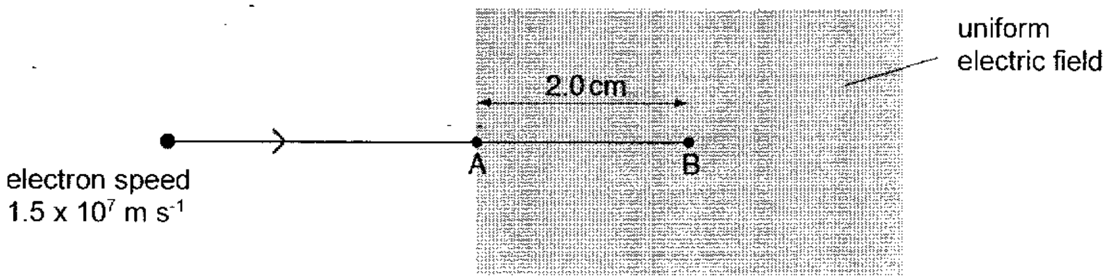


Fig. 6.1

The electron continues to move in the same direction until it is brought to rest by the electric field at point B. Distance AB is 2.0 cm.

(i) State the direction of the electric field.

....[1]

(ii) Calculate the magnitude of the deceleration of the electron in the field.

deceleration = ... m s^{-2} [2]

(iii) Calculate the electric field strength of the uniform electric field.

electric field strength = ... V m^{-1} [2]

(c) The electron is at point A at time $t = 0$.

On Fig. 6.2, sketch the variation with time t of the velocity v of the electron until it reaches point B. Numerical values of v and t do not need to be shown.

[1]

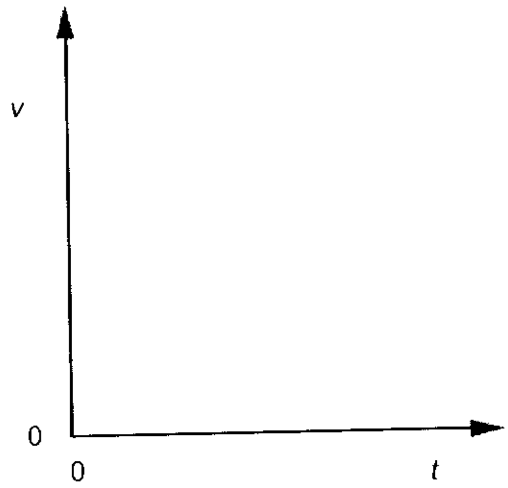


Fig. 6.2

7 **(a)** State what is meant by *angular velocity*.

....

.... [1]

(b) A binary star system consists of two stars S_1 and S_2, each in a circular orbit about a point P, as shown in Fig. 7.1. The two stars rotate with the same angular velocity ω.

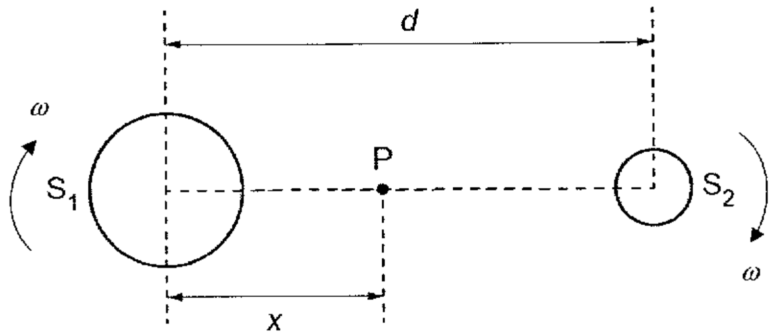


Fig. 7.1

The separation d of the centres of S_1 and S_2 is 1.8×10^{12} m. Point P is at a distance x from the centre of star S_1. The period of rotation of the stars is 44.2 years.

(i) Calculate ω.

ω = ... rad s^{-1} [2]

(ii) Show that the ratio of the masses of the stars is given by

$$\frac{\text{mass of } S_1}{\text{mass of } S_2} = \frac{d - x}{x}$$

[2]

(iii) The ratio in **(ii)** is 1.5. Determine the mass of S_1.

mass of S_1 = ... kg [4]

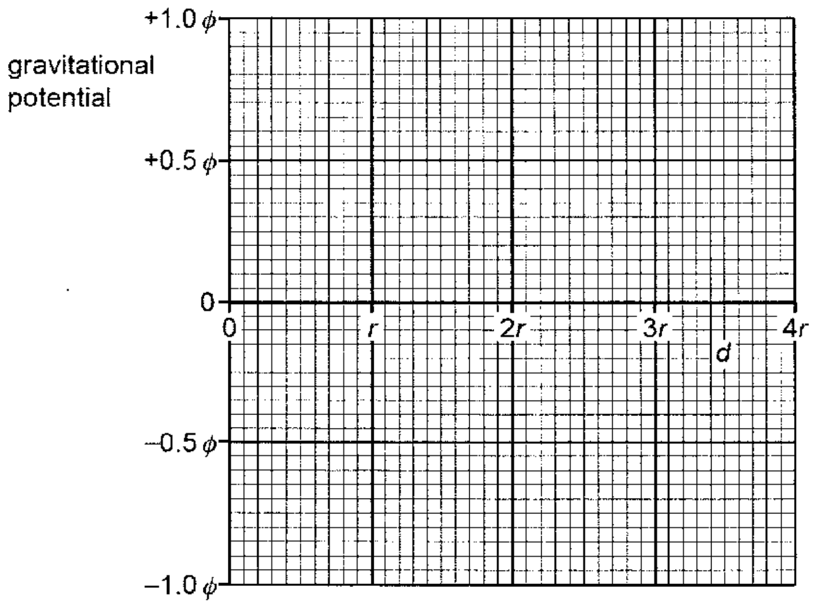
(c) (i) Define *gravitational potential* at a point.

....

.... [2]

(ii) An isolated solid sphere of radius r may be assumed to have its mass M concentrated at its centre. The magnitude of the gravitational potential at the surface of the sphere is ϕ.

On Fig. 7.2, show the variation of the gravitational potential with distance d from the centre of the sphere for values of d from r to $4r$.



[2]

Fig. 7.2

Section B

Answer **one** question from this section in the spaces provided.

8 **(a)** The photoelectric effect may be represented by the equation

photon energy = work function energy + maximum kinetic energy of electron.

State what is meant by

(i) *a photon*,

....

.... [1]

(ii) the *work function energy*.

....

.... [1]

(b) Fig. 8.1 shows how the maximum kinetic energy of the electrons varies with the frequency of the light shining on a metal surface.

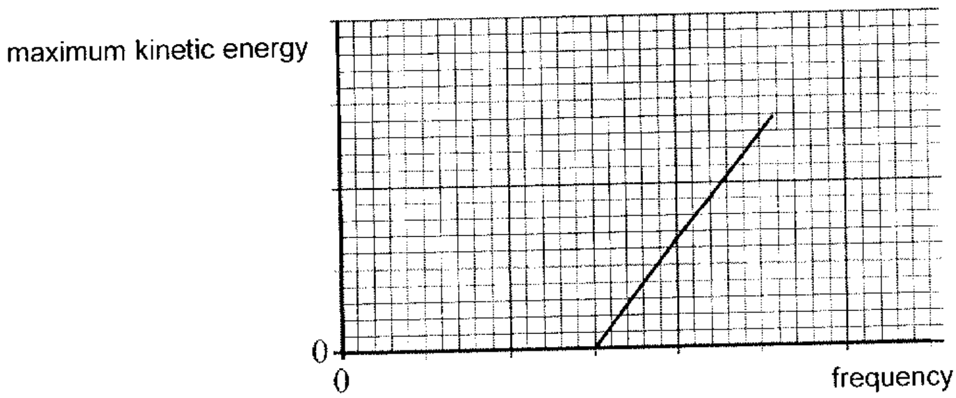


Fig. 8.1

(i) On Fig. 8.1,

1. mark the threshold frequency and label it f_0, [1]

2. draw a line for a metal which has a higher work function energy. [1]

(ii) State what information is provided by the gradient of the graph.

....[1]

(iii) Explain why the kinetic energy of the emitted electrons varies up to a maximum value.

....

.... [1]

(iv) Explain why the graphs on Fig. 8.1 do not depend on the intensity of the incident radiation.

....

.... [2s]

(c) Fig. 8.2 shows part of an energy level diagram for a hydrogen atom.

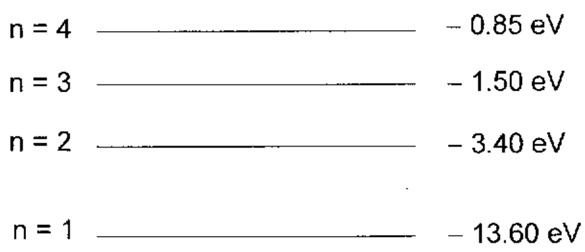


Fig. 8.2 (not to scale)

(i) State the ionisation energy of the atom.

ionisation energy = ... eV [1]

(ii) When an electron of energy 12.1 eV collides with the atom (initially at the ground state), photons of three different energies are emitted.

1. On Fig. 8.2, draw arrows to show the transitions responsible for these photons. [2]

2. Calculate the wavelength of the photon with the smallest energy and state the region of the electromagnetic spectrum this wavelength corresponds to.

wavelength = ... m

region of the electromagnetic spectrum = ... [3]

(d) Electrons having a *de Broglie* wavelength 1.2×10^{-10} m are required to investigate the crystal structure of a certain solid.

(i) State what is meant by the *de Broglie wavelength.*

....

.... [1]

(ii) Calculate the speed of the electron.

speed = ... m s^{-1} [3]

(iii) Suggest how such electrons may assist with an understanding of the crystal structure.

....

....

.... [2]

9 **(a)** An isotope of Americium, $^{241}_{95}Am$, has a half-life of 432.2 years. It undergoes spontaneous nuclear decay and may be represented by the equation

$$^{241}_{95}Am \rightarrow ^{237}_{93}Np + ^{4}_{2}He$$

where Neptunium $^{237}_{93}Np$ is a daughter nuclide.

(i) Define *half-life.*

....

.... [2]

(ii) Explain what is meant by *spontaneous decay.*

....

.... [1]

(iii) Calculate the decay constant of $^{241}_{95}Am$.

decay constant = ... s^{-1} [1]

(iv) Calculate the activity of 1.00 g of $^{241}_{95}Am$.

activity = ... Bq [3]

(v) Calculate in MeV the total kinetic energy of the decay products, given the following data:

Nuclide	Atomic mass / u

$^{241}_{95}Am$	241.0568229
$^{237}_{93}Np$	237.0481673
$^{4}_{2}He$	4.0026032

total kinetic energy = ... MeV [3]

(b) The variation with nucleon number A of the binding energy per nucleon B_E is shown in Fig. 9.1.

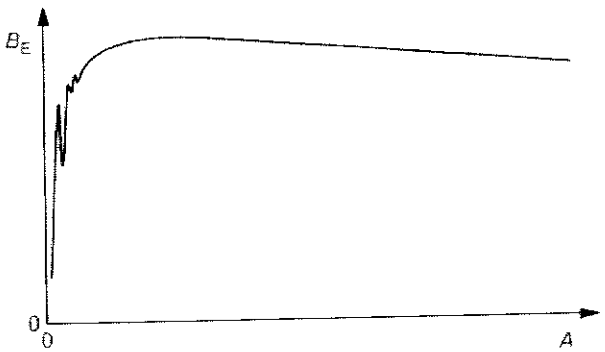


Fig. 9.1

Using Fig. 9.1, explain why fusion of nuclei having high nucleon numbers is not associated with a release of energy.

....

....

....

.... [3]

(c) One possible nuclear reaction involves the bombardment of a stationary nitrogen-14 nucleus by an α-particle to form oxygen-17 and another particle.

(i) Complete the nuclear equation for this reaction.

$$^{14}_{7}N + {}^{\cdots\cdots}_{\cdots\cdots}\alpha \rightarrow {}^{17}_{8}O + \ldots\ldots\ldots\ldots\ldots\ldots$$ [2]

(ii) The total mass-energy of the nitrogen-14 nucleus and the α-particle is less than that of the particles resulting from the reaction. This mass-energy difference is 1.1 MeV.

1. Suggest how it is possible for mass-energy to be conserved in this reaction.

....

.... [1]

2. Calculate the speed of an α-particle having kinetic energy of 1.1 MeV.

speed = ... m s^{-1} [4]

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2021 DHS H2 Physics Prelim Paper 3 Suggested Solutions

Section A

1 (a) change in velocity / time (taken) or rate of change of velocity **B1**

(b) (i) $v_X = (24 / 1.5) = 16$ m s^{-1} **A1**

(ii) $\tan 28° = v_Y / v_X$ or $v_X = v \cos 28°$ and $v_Y = v \sin 28°$ **M1**

$v_Y = 16 \tan 28°$ or $v_Y = 16 \times (\sin 28° / \cos 28°)$ so $v_Y = 8.5$ m s^{-1} **A0**

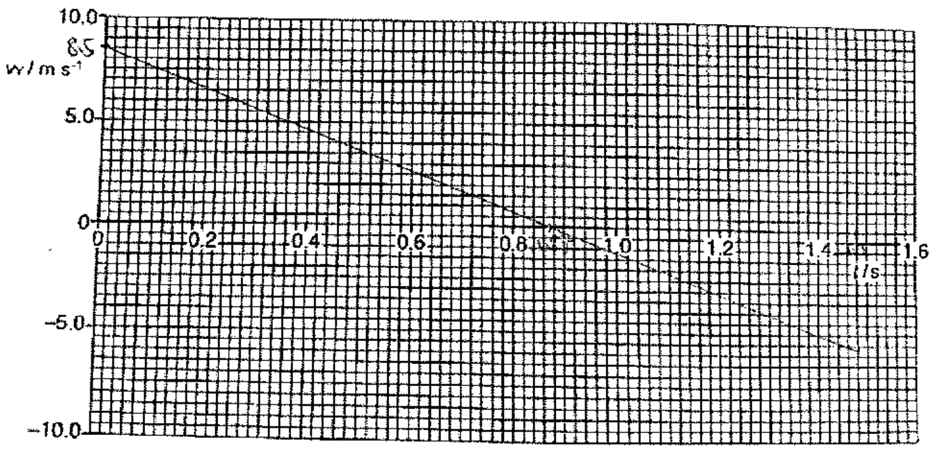
(iii) $v = u + at$ **C1**

$t = (0 - 8.5) / (-9.81)$

$= 0.87$ s **A1**

(iv) straight line from positive v_Y at t = 0 to negative v_Y at t =1.5 s **M1**

line starts at (0, 8.5) and crosses t-axis at (0.87, 0) and does not go beyond t = 1.5 s. **A1**



(c) $v^2 = u^2 + 2as$

$0 = 8.5^2 + 2(-9.81)s$

or ($s = ut + ½at^2$) $s = 8.5 \times 0.87 + ½ \times (-9.81) \times 0.87^2$

or ($s = vt - ½at^2$) $s = 0 - ½ \times (-9.81) \times 0.87^2$

or ($s = ½ (u + v)t$ or area under graph) $s = 0.5 \times 8.5 \times 0.87$ **C1**

$s = 3.7$ m **A1**

(d) acceleration (of freefall) is unchanged / not dependent on mass, and so no effect (on maximum height)

OR explanation in terms of energy:

(initial) KE $\propto$ mass, (Δ)KE = (Δ)PE, (max) PE $\propto$ mass, and so

no effect (on maximum height) **B1**

2 (a) Force experienced by a mass in a gravitational field **B1**

(b) (i) total downward force on the moving pulley

= 960 + (2.4 x 9.81) = 984 N **C1**

As the moving pulley is moving upwards at a constant speed,

net force = 0

$2T \cos 11.5° = 984$ **C1**

T = 502 N **A1**

(ii) Cosine of angle (with vertical) decreases

OR angle of rope (with vertical) increase **M1**

Hence tension increases **A1**

(c) (i) rope / lower pulley has to be lifted up

OR load has kinetic energy (any one) **B1**

(ii) force applied is less than weight of load **B1**

3 (a) pV / T = constant

$T = (6.5 \times 10^6 \times 30 \times 300) / (1.1 \times 10^5 \times 540)$ **C1**

= 985 K **A1**

(b) (i) The increase in the internal energy of a system is equal to the **B1**

sum of the thermal energy supplied to the system and work done on

the system. **B1**

(ii) no thermal energy supplied to system, thus increase in internal energy = work done on system **B1**

so U increases **B1**

U increases so kinetic energy of atoms increases

and hence T increases **B1**

(c) $KE \propto T$, hence $v \propto \sqrt{T}$, and so **C1**

ratio = $\sqrt{\frac{350}{300}} = 1.1$ **A1**

4 (a) (i) 0.050 m **A1**

(ii) $\omega = \frac{v_0}{x_0}$ **C1**

$T = \frac{2\pi}{\omega}$

$0.42 = \frac{2\pi \times 0.050}{T}$ **C1**

$T = 0.75$ s **A1**

(b) one point labelled P where ellipse crosses displacement axis **B1**

5 (a) When two or more waves of the same kind meet at a point at the same time, **B1**

the displacement of the resultant wave is the vector sum of the displacements of the individual waves at that point at that time. **B1**

(b) (i) $\lambda = \frac{v}{f} = \frac{330}{200} = 1.65$ m **A1**

(ii) The distance of the upper loudspeaker from the man is

$\sqrt{9.3^2 + 4.0^2} = 10.124\,m$

$\therefore$ *the path difference between the waves reaching the man is* **C1**

$10.124 - 9.3 = 0.8237\,m$

the path difference is $\frac{0.8237}{1.65} = 0.50\lambda$ **C1**

This means that the waves interfere destructively and the man will hence detect a **minimum** of sound intensity. **A1**

(iii) 1. increase the frequency of the sound **B1**

2. increase the separation between the two loudspeakers **B1**

6 (a) The electric force per unit positive charge experienced by a small stationary test charge placed at that point. **B1**

(b)(i) to the right / from the left / from A to B / in the same direction as electron velocity **B1**

(ii) $v^2 = u^2 + 2as$

$a = (1.5 \times 10^7)^2 / (2 \times 2.0 \times 10^{-2})$ **C1**

Other alternative calculations for the C1 mark:

e.g. $a = 1.5\times10^7 / 2.67\times10^{-9}$

e.g. $a = [(1.5\times10^7 \times 2.67\times10^{-9}) - 2.0\times10^{-2}] \times [2 / (2.67\times10^{-9})^2]$

e.g. $a = (2.0\times10^{-2} \times 2) / (2.67\times10^{-9})^2$

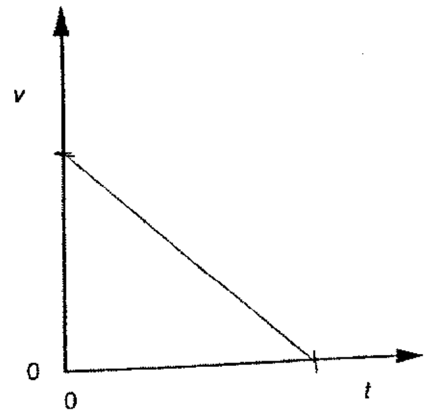
$= 5.6 \times 10^{15}$ m s^{-2} **A1**

(iii) $E = F / Q$

$= (9.11 \times 10^{-31} \times 5.6 \times 10^{15}) / 1.6 \times 10^{-19}$ **C1**

$= 3.2 \times 10^4$ V m^{-1} **A1**

(c) straight line with negative gradient starting at an intercept on the *v*-axis and ending at an intercept on the *t*-axis. **B1**



7 (a) Angular velocity is the rate of change of angular displacement of a radius joining the body to the axis of rotation. **B1**

(b)(i)

$\omega = \frac{2\pi}{T}$

$= \frac{2\pi}{(44.2 \times 365 \times 24 \times 3600)}$ C1

$= 4.5 \times 10^{-9}$ rad s^{-1} A1

(ii) magnitude of the centripetal force about P is the same **M1**

$M_1 x\omega^2 = M_2(d-x)\omega^2$

$\frac{M_1}{M_2} = \frac{(d-x)}{x}$ **A1**

(iii) $x = 0.4d$ **C1**

Consider S_2, gravitational force provides centripetal force

$\frac{GM_1M_2}{d^2} = M_2(d-x)\omega^2$ C1

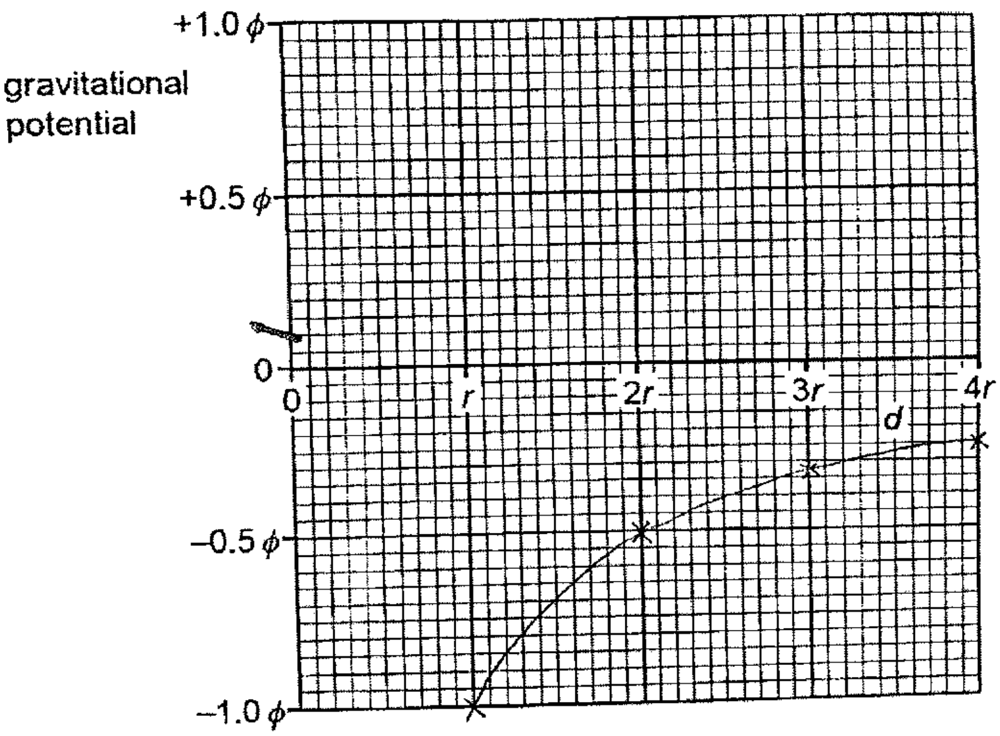
$GM_1 = d^2(d-x)\omega^2$

$(6.67\times10^{-11})M_1 = (1.0-0.4)(1.8\times10^{12})^3(4.5\times10^{-9})^2$ C1

$M_1 = 1.1\times10^{30}$ kg A1

(c)(i) The work done per unit mass in bringing a small test mass **B1**
from infinity to that point. **B1**

(ii) curve from r to $4r$, with gradient of decreasing magnitude and line showing potential is negative throughout **B1**
line passing through $(2r, -0.5\phi)$ and $(4r, -0.25\phi)$ **B1**

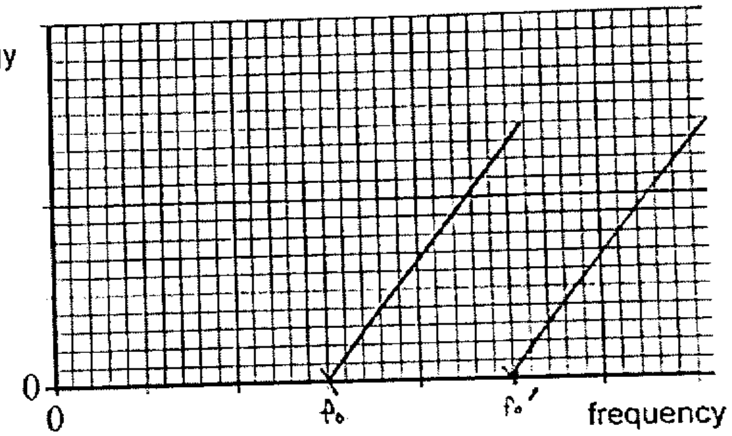


Section B

8 **(a)(i)**A photon is a discrete packet (quantum) of energy of electromagnetic radiation. **B1**

(ii) The work function energy of a metal is the minimum energy of photon to cause emission of electron from the surface of a metal. **B1**

(b)(i)



1. f_0 correctly labelled **B1**
2. parallel line with same gradient and higher horizontal intercept **B1**

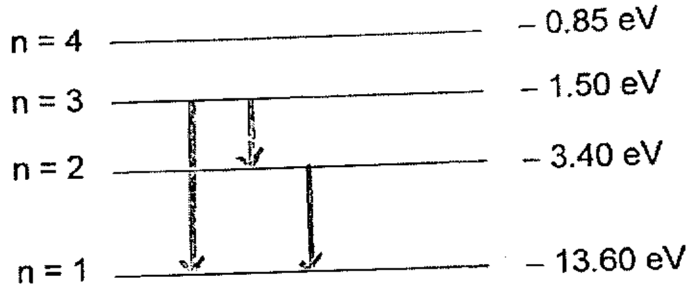
(ii) Planck constant **B1**

(iii) Max KE corresponds to electrons emitted from surface
Energy is required to bring electron to surface **B1**

(iv) intensity determines number of photons arriving per unit time **B1**
Hence determines number of electrons emitted per unit time,
and not energy. **B1**

(c)(i) 13.60 eV **B1**

(ii)1.



correct energy levels **B1**

correct direction of arrows **B1**

2. energy in Joules = 1.90 x 1.6 x 10^{-19} = 3.04 x 10^{-19} **C1**

$E = hc/\lambda$

$\lambda = (6.63 \times 10^{-34})(3 \times 10^{8}) / (3.04 \times 10^{-19})$

$= 6.54 \times 10^{-7}$ m **A1**

Visible light region (red) **B1**

(d)(i) Wavelength that is associated with a particle that is moving. **B1**

(ii) $\lambda = h/mv$ **C1**

$v = (6.63 \times 10^{-34}) / (9.11 \times 10^{-31})(1.2 \times 10^{-10})$ **C1**

$= 6.1 \times 10^{6}$ m s^{-1} **A1**

(iii) wavelength is about the separation of atoms in a crystal **B1**

can be used in electron diffraction **B1**

9 **(a)(i)** The average time taken for the initial number of nuclei (or activity) of **B1**

a particular radioactive nuclide to reduce to half its original value. **B1**

(ii) Decay is not affected by external or environmental factors (such as pressure, temperature etc) **B1**

(iii)

$$\lambda = \frac{\ln 2}{t_{1/2}} = \frac{\ln 2}{432.2 \text{ yrs}} = \frac{\ln 2}{432.2 \times 365 \times 24 \times 3600 \text{ s}} = 5.086 \times 10^{-11} \text{ s}^{-1}$$ **A1**

(iv) Number of undecayed atoms,

$$N = \left(\frac{1.00 \text{ g}}{241 \text{ g mol}^{-1}}\right)(6.02 \times 10^{23} \text{ mol}^{-1}) = 2.4979 \times 10^{21}$$ C1

$$A = \lambda N$$

$$= (5.086 \times 10^{-11} \text{ s}^{-1})(2.4979 \times 10^{21})$$ C1

$$= 1.27 \times 10^{11} \text{ s}^{-1}$$

$$= 1.27 \times 10^{11} \text{ Bq}$$ A1

(v) Loss of mass

= 241.0568229 – (237.0481673 + 4.0026032) **C1**

= 6.0236 × 10^{-3} u

Energy = (0.0060524 u x 1.66 x 10^{-27} x (3.00 x10^{8})^2 **C1**

= 9.0423 x 10^{-13} J

= 5.65 MeV **A1**

(b) For nuclei having high nucleon numbers, the binding energy per nucleon decreases with larger nucleon numbers. **B1**

When two such nuclei fuse together, they will produce a daughter nucleus which has an even larger nucleon number and smaller binding energy per nucleon. **B1**

The total binding energy of the products is less than that of the initial nuclei, hence there is an increase in the total mass of the system, and energy has to be supplied for such a reaction to take place. **B1**

(c) **(i)** ${}^{4}_{2}\alpha$ **B1**

${}^{1}_{1}H$ **B1**

(ii) 1. Initially alpha particle must have some kinetic energy. **B1**

2.

$1.1\ MeV = 1.1 \times 1.6 \times 10^{-13} = 1.76 \times 10^{-13}$ J C1

$E_k = \frac{1}{2}mv^2$ C1

$1.76 \times 10^{-13} = \frac{1}{2}(4 \times 1.66 \times 10^{-27} \times v^2)$ C1

$v = 7.3 \times 10^{6}$ m s^{-1} A1

~ THE END ~