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

Cambridge Pre-U

CANDIDATE
NAME

CENTRE
NUMBER

CANDIDATE
NUMBER
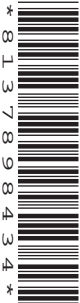
PHYSICS **9792/02**

Paper 2 Part A Written Paper **May/June 2010**

2 hours

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions.
You are advised to spend about 1 hour 30 minutes on this section.

Section B
Answer the **one** question.
You are advised to spend about 30 minutes on this section.
The question is based on the material in the Insert.

You may lose marks if you do not show your working or if you do not use
appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question
or part question.

For Examiner's Use	
1	
2	
3	
4	
5	
6	
7	
8	
Total	

This document consists of **18** printed pages, **2** blank pages and **1** insert.

UNIVERSITY *of* CAMBRIDGE
International Examinations

[Turn over

Data

gravitational field strength close to Earth's surface	g	$= 9.81 \, \text{N} \, \text{kg}^{-1}$
elementary charge	e	$= 1.60 \times 10^{-19} \, \text{C}$
speed of light in vacuum	c	$= 3.00 \times 10^{8} \, \text{m} \, \text{s}^{-1}$
Planck constant	h	$= 6.63 \times 10^{-34} \, \text{J} \, \text{s}$
permittivity of free space	ε_0	$= 8.85 \times 10^{-12} \, \text{F} \, \text{m}^{-1}$
gravitational constant	G	$= 6.67 \times 10^{-11} \, \text{N} \, \text{m}^2 \, \text{kg}^{-2}$
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	$= 8.31 \, \text{J} \, \text{K}^{-1} \, \text{mol}^{-1}$
Avogadro constant	N_A	$= 6.02 \times 10^{23} \, \text{mol}^{-1}$
Boltzmann constant	k	$= 1.38 \times 10^{-23} \, \text{J} \, \text{K}^{-1}$
Stefan-Boltzmann constant	σ	$= 5.67 \times 10^{-8} \, \text{W} \, \text{m}^{-2} \, \text{K}^{-4}$

Formulae

uniformly accelerated motion	$s = ut + \frac{1}{2}at^2$
	$v^2 = u^2 + 2as$
	$s = \left(\dfrac{u+v}{2}\right)t$
heating	$\Delta E = mc\Delta\theta$
change of state	$\Delta E = mL$
refraction	$n = \dfrac{\sin\theta_1}{\sin\theta_2}$
	$n = \dfrac{v_1}{v_2}$
photon energy	$E = hf$
de Broglie wavelength	$\lambda = \dfrac{h}{p}$
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	$F = \dfrac{Q_1 Q_2}{4\pi\varepsilon_0 r^2}$
electrostatic potential energy	$W = \dfrac{Q_1 Q_2}{4\pi\varepsilon_0 r}$
gravitational force	$F = \dfrac{-Gm_1 m_2}{r^2}$
gravitational potential energy	$E = \dfrac{-Gm_1 m_2}{r}$

magnetic force	$F = BIl\sin\theta$
	$F = BQv\sin\theta$
electromagnetic induction	$E = \dfrac{-\mathrm{d}(N\Phi)}{\mathrm{d}t}$
Hall effect	$V = Bvd$
time dilation	$t' = \dfrac{t}{\sqrt{1 - \dfrac{v^2}{c^2}}}$
kinetic theory	$\frac{1}{2}m<c^2> = \frac{3}{2}kT$
work done on/by a gas	$W = p\Delta V$
radioactive decay	$\dfrac{\mathrm{d}N}{\mathrm{d}t} = -\lambda N$
	$N = N_0 e^{-\lambda t}$
	$t_{\frac{1}{2}} = \dfrac{\ln 2}{\lambda}$
attenuation losses	$I = I_0 e^{-\mu x}$
mass-energy equivalence	$\Delta E = c^2 \Delta m$
hydrogen energy levels	$E_n = \dfrac{-13.6\,\mathrm{eV}}{n^2}$
Heisenberg uncertainty principle	$\Delta p\,\Delta x \geqslant \dfrac{h}{2\pi}$
	$\Delta E\,\Delta t \geqslant \dfrac{h}{2\pi}$
Wien's law	$\lambda_{\max} \propto \dfrac{1}{T}$
Stefan's law	$L = 4\pi\sigma r^2 T^4$
electromagnetic radiation from a moving source	$\dfrac{\Delta\lambda}{\lambda} \approx \dfrac{\Delta f}{f} \approx \dfrac{v}{c}$

Section A

Answer **all** the questions in this section.
You are advised to spend about 1 hour 30 minutes on this section.

1 Fig. 1.1 shows a velocity-time graph for a bus travelling along a straight road between two bus stops. It is divided into four parts.

       a constant acceleration
       a further increase in velocity to $20 \, m \, s^{-1}$
       a decrease in velocity to $10 \, m \, s^{-1}$
       a constant deceleration to rest
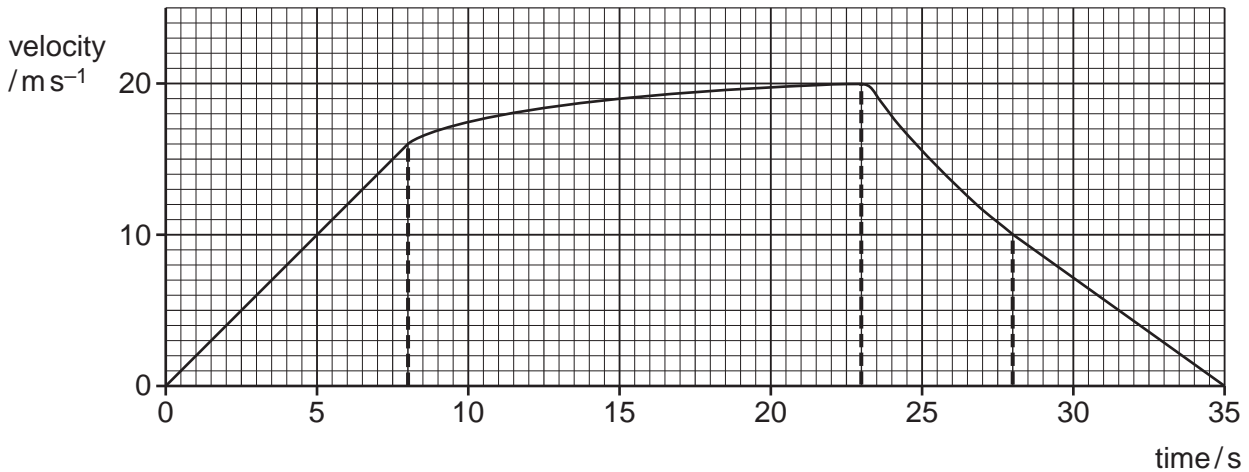
Fig. 1.1

(a) Calculate the distance travelled during

   (i) the first 8 seconds,

distance = ... m [2]

   (ii) the last 7 seconds.

distance = ... m [1]

(b) Estimate the total distance travelled.

distance = ... m [3]

(c) (i) On Fig.1.2, sketch the corresponding distance-time graph for the bus.

distance
/ m

0

0   5   10   15   20   25   30   35

time / s
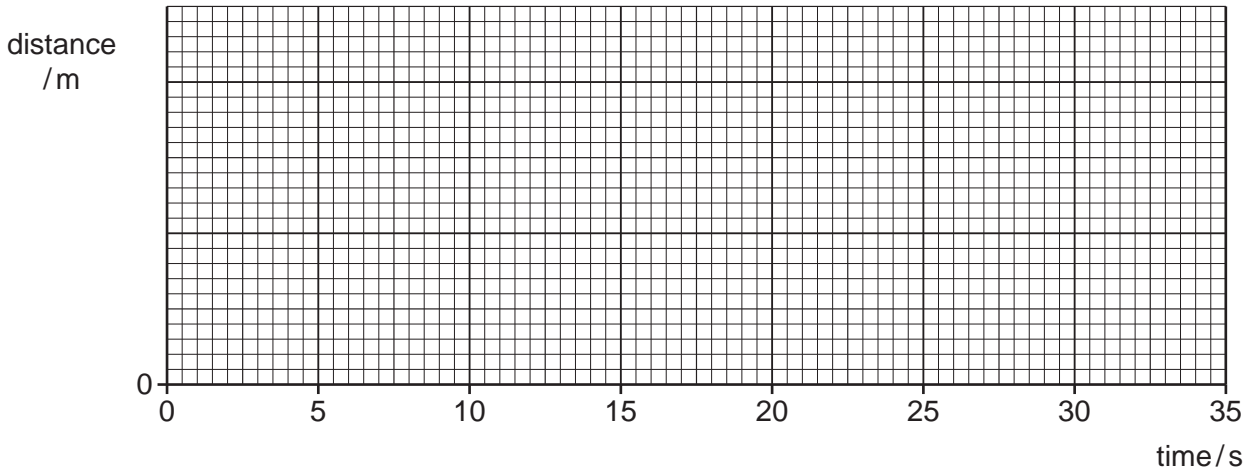
Fig. 1.2

[3]

(ii) On Fig. 1.3, sketch the shape of the corresponding acceleration-time graph for the bus.

acceleration
/ m s⁻²

0

0   5   10   15   20   25   30   35

time / s

Fig. 1.3

[3]

(d) For a group of about 10 students, each with a stopwatch and a 50 m tape measure, write an instruction sheet for them to enable them to carry out an exercise to obtain data to plot a distance-time graph for such a journey.

....

....

....
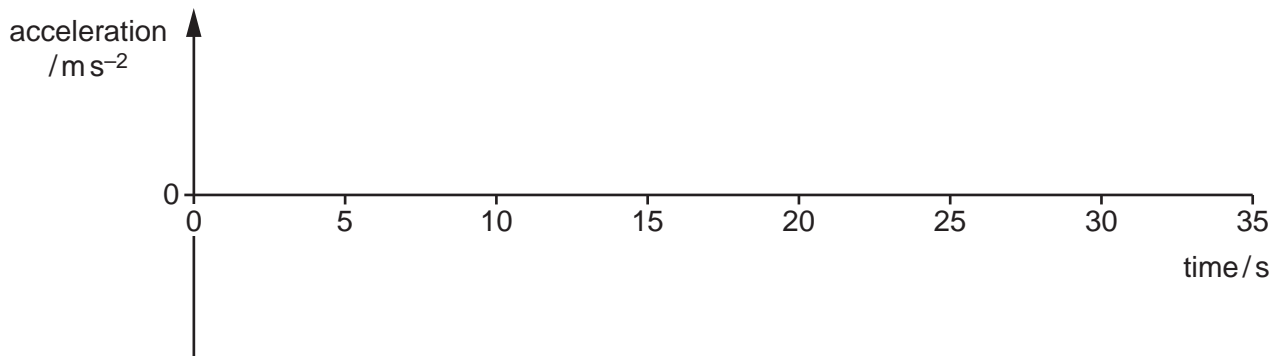
....

....

....

....

....

....

....

....[4]

2 A large hotel has a slab of concrete as its foundation, as shown in Fig. 2.1. The area of concrete is 53 m × 32 m and the depth of concrete is 1.3 m. The density of the concrete is 2400 kg m^{-3} (density = mass / volume).
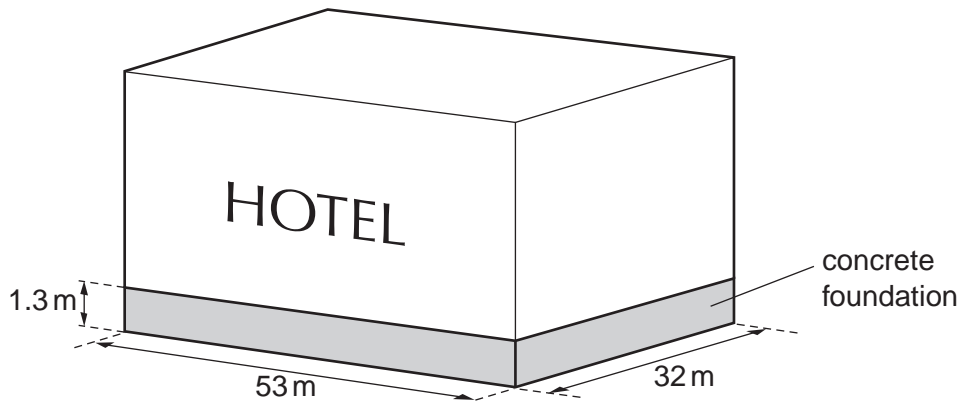
Fig. 2.1

(a) Calculate

(i) the mass of the concrete,

mass = ... kg [2]

(ii) the weight of the concrete,

weight = ... N [1]

(iii) the pressure the foundations exert on the ground beneath them before the hotel itself is built.

pressure = ... N m^{-2} [2]

(b) Building regulations state that the maximum pressure allowed on the ground under the foundations beneath the hotel is 70 kN m^{-2}. Deduce the maximum mass of the building and contents that can be allowed on top of the foundations.

mass = ... kg [2]

[Turn over

3 **(a)** A car of mass m is travelling with constant velocity v. It is then brought to rest in a distance s by a constant frictional force F. Show that its initial kinetic energy is $\frac{1}{2}mv^2$.

....

....

....

....

....[3]

(b) A spacecraft of mass 1800 kg, far out in space, is travelling towards the Earth with velocity 8500 m s^{-1}.

(i) Calculate its kinetic energy.

kinetic energy = ... J [1]

(ii) The average specific heat capacity of the spacecraft is 5300 J kg^{-1} K^{-1}. Calculate the rise in the temperature of the spacecraft should all its kinetic energy be used in raising its temperature.

rise in temperature = ... K [2]

(iii) Kinetic energy is transformed to thermal energy as the spacecraft moves closer to the Earth. State the other form of energy that is transformed between the time when it was far out in space and landing.

....

....[1]

(iv) Describe why, in practice, the spacecraft does not experience the rise in temperature calculated in **(ii)**.

....

....

....

....

....[3]

BLANK PAGE

Please turn over for Question 4.

4   A battery is connected to a variable resistor of resistance R, as shown in Fig. 4.1. The battery has an e.m.f. of 6.0 V and an internal resistance r of 2.0 Ω.

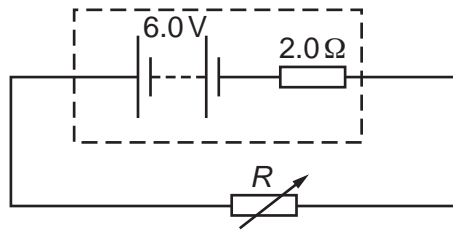**Fig. 4.1**

Some values are given in Fig. 4.2 for total resistance $(R + r)$, current I and power P dissipated in R.

R/Ω	$(R + r)$/Ω	I/A	P/W
0	2.0	3.0	0
0.5	2.5	2.4	2.9
1.0	3.0	2.0	4.0
2.0	4.0	1.5	
3.0	5.0		
4.0	6.0		
5.0	7.0	0.86	3.7
6.0	8.0	0.75	3.4
8.0	10.0	0.60	2.9
10.0	12.0	0.50	2.5

Fig. 4.2

(a) Complete the table of Fig. 4.2.   [2]

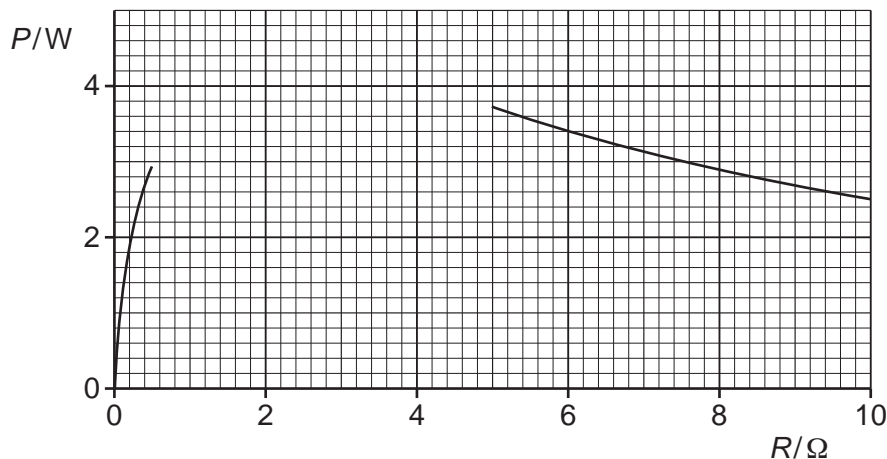**(b)** The graph of Fig. 4.3 shows how the power P dissipated in R varies as R changes.

Fig. 4.3

(i) Complete the graph. [1]

(ii) State the value of R at which the power has its maximum value.

resistance for maximum power = ... Ω [1]

(iii) Explain what happens to the power supplied by the 6.0 V battery when the current is 3.0 A.

....

....

....[2]

(iv) The efficiency of the circuit is defined by the equation

$$\text{efficiency} = \frac{\text{power dissipated in } R}{\text{power supplied by battery}}.$$

1. Determine the efficiency of the circuit when $R = 2.0\,\Omega$.

efficiency = ... [2]

2. State the value of R in the table that gives the greatest efficiency.

value = ... Ω [1]

 [Turn over

5 (a) Explain what is meant by a *standing wave*.

....

....

....

....[2]

(b) Describe one method of setting up a standing wave. Use a diagram with your answer and state the source of waves you are suggesting.

....

....

....

....

....

....

....   [4]

(c) The pattern in Fig. 5.1 shows how the displacement of a standing wave of amplitude A varies with the distance x along the wave at a time $t = 0$.
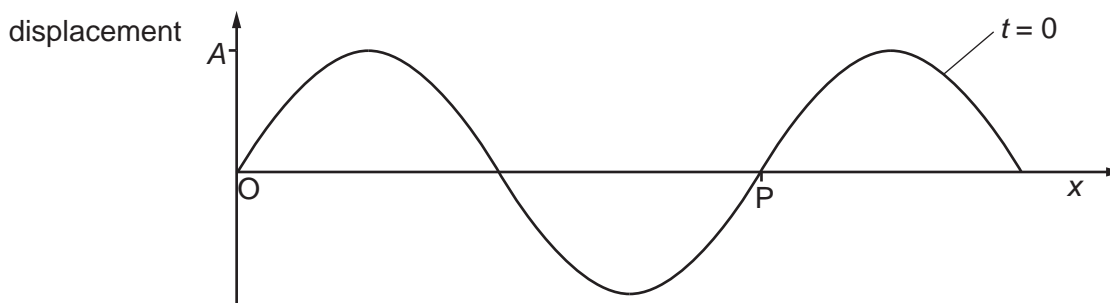

Fig. 5.1

(i) What does the distance OP represent?

....[1]

(ii) On Fig. 5.1, sketch and label graphs to show the pattern at times

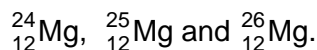$$t = \frac{T}{2} \text{ and } t = \frac{T}{4} \text{ and } t = \frac{7T}{8}$$

where T is the time period of the oscillation.   [3]

6 Fig. 6.1 shows some of the isotopes of the elements of proton numbers 11 to 15. For example, magnesium (Mg) has proton number 12 and has three stable isotopes. A stable nucleus of magnesium may contain 12, 13 or 14 neutrons to give three isotopes

$$^{24}_{12}\text{Mg}, \quad ^{25}_{12}\text{Mg and } ^{26}_{12}\text{Mg}.$$

The table also shows a few unstable isotopes together with their half-lives. The symbol β^- indicates that the isotope decays with the emission of a beta-particle.

number of neutrons	Na 11	Mg 12	A*l* 13	Si 14	P 15
12	stable	stable			
13	β^- 15 h	stable			
14	β^- 60 s	stable	stable	stable	β^+ 4.3 s
15		β^- 9.5 min	β^- 2.3 min	stable	
16			β^- 6.6 min	stable	stable
17				β^- 157 min	
18					
19					
20					

Fig. 6.1

Use the information in Fig. 6.1 to answer the following.

(a) Give the symbols for the three stable isotopes of silicon (Si).

.... [1]

(b) (i) Write a balanced nuclear transformation, using standard notation, for the decay of magnesium-27.

....[2]

(ii) By counting the number of protons and neutrons on both sides of the equation in **(i)**, deduce what change has taken place in one nuclear particle to produce other particles.

....[2]

(c) Suggest a nuclear transformation equation for the decay of phosphorus(P)-29 in which a positive electron, called a positron, is emitted.

....[2]

(d) The activity of a sample of aluminium(A*l*)-29 is 4.8×10^5 Bq at time $t = 0$. Calculate its activity at time $t = 33$ min.

activity = ... Bq [3]

7 A clean magnesium plate is placed in an evacuated glass container and illuminated with ultra-violet radiation of wavelength 250 nm, as shown in Fig. 7.1. Another metal plate is at the opposite end of the container and the two plates are connected through a microammeter to a variable d.c. supply. The polarity of the variable d.c. supply can be reversed.
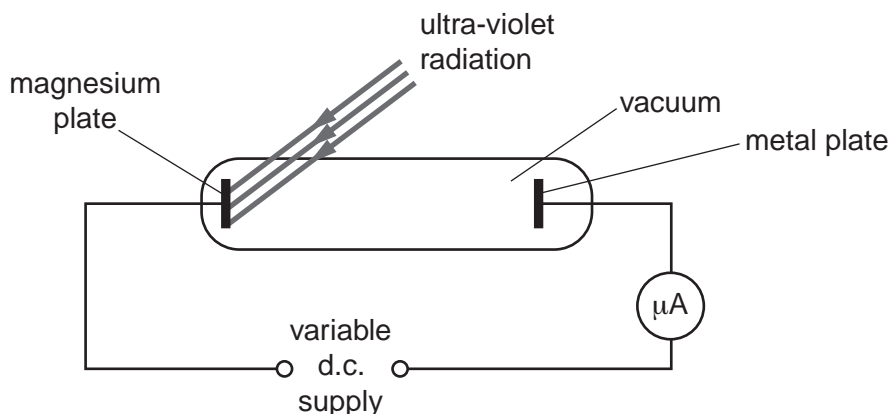
Fig. 7.1

(a) State the name of the effect that causes electrons to be emitted from the magnesium plate.

....[1]

(b) Calculate the photon energy of the ultra-violet radiation

    (i) in joules,

energy = ... J [2]

    (ii) in electron-volts.

energy = ... eV [1]

(c) The work function of magnesium is 3.69 eV. Calculate the maximum energy, in eV, of electrons emitted from the magnesium plate.

energy = ... eV [1]

(d) Sketch a graph on the axes of Fig 7.2 to show how the current *I* in the microammeter will vary with the potential difference *V* between the two metal plates.
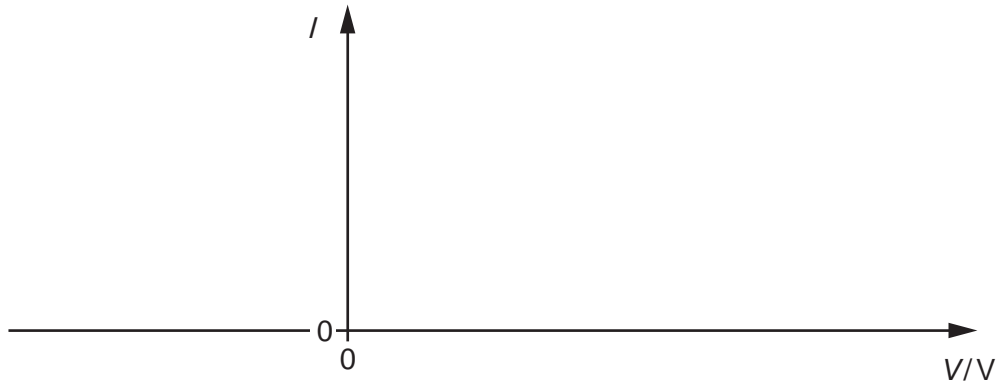

Fig. 7.2

[3]

(e) Add another line on your sketch graph to show the effect of reducing the intensity of the ultra-violet radiation. Label this line 'lower intensity'. [2]

(f) Explain why the answer to **(e)** was so unexpected when the experiment was first performed.

....

....

....

....

....

....

....[3]

Section B

You are advised to spend about 30 minutes on this section.
Your answers should, where possible, make use of any relevant Physics.

8 **(a)** **(i)** Extract 1 states that a pilot ejecting from an aircraft usually experiences a maximum acceleration of between 5*g* and 20*g*.

1. Explain what is meant by *acceleration*.

....

....[1]

2. Calculate the range of the pilot's acceleration.

range = ... m s^{-2} to .... m s^{-2} [1]

(ii) An ejecting pilot does not reach the maximum upwards acceleration immediately. In Extract 2, the onset rate of one ejector seat is such that the acceleration takes 0.020 s to increase from 0 to 16*g*. At 0.020 s, the velocity of the pilot is 1.5 m s^{-1}.

Sketch a velocity-time graph for this period, paying particular attention to its gradient at time = 0 and at time = 0.020 s.

velocity
/ m s^{-1}

1.5 ┐

0 ┴────────────────────────────────
0   0.020
                                time / s

[3]

(b) Extract 3 explains how an explosive cartridge in a catapult gun accelerates the seat up guide rails. Within 150 ms, a pilot using an ejector seat such as this is clear of the guide rails and has travelled more than 1.60 m upwards. Extract 4 mentions pilots who have ejected safely from aeroplanes travelling at more than $360 \, m \, s^{-1}$.

   (i) Calculate the distance travelled by an aircraft travelling at $360 \, m \, s^{-1}$ in 150 ms.

distance = ... [1]

   (ii) The large acceleration experienced during ejection may seriously injure the pilot. Explain why such large accelerations are necessary.

....

....

....[2]

(c) Extract 5 refers to the use of rocket propulsion in modern ejector seats. When the rockets fire, a large mass of extremely hot gas is expelled downwards at an extremely high speed. Explain, in detail, how this causes the ejector seat to move upwards.

....

....

....

....[3]

(d) Extract 4 mentions one design of ejector seat, in which the aircraft floor is jettisoned and the seat is ejected downwards through the gap.

   (i) State why it is this type of ejector seat that is used in many helicopters.

....

....[1]

   (ii) Explain the problems encountered when ejector seats of this design are to be used at low altitude.

....

....

....[2]

(e) (i) A pilot of mass 80 kg is strapped into an ejector seat of mass 300 kg. The pilot ejects and an explosive cartridge exerts an 1800 N s impulse on the seat. The seat and pilot accelerate upwards at rate of 10*g*.

Assuming that the force that the explosive cartridge exerts on the seat remains constant as it is being fired, calculate the time for which the force is acting.

time = ... [3]

(ii) Fig. E3.3 in Extract 3 refers to a rocket with a burn time of 0.30 s. Explosive cartridges, however, exert a force for a much shorter period of time.

Suggest one advantage of using this rocket to propel an ejector seat rather than an explosive cartridge.

....

....[1]

(f) Since their introduction, ejector seats in military aircraft have saved the lives of several thousand crew members. No commercial airliners, however, are fitted with ejector seats for use by either the passengers or the crew. By considering

- the financial consequences,
- the hazards,
- the operational practicality

of such a system, suggest why this is so.

You may use information from any of the extracts.

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....[7]

www.theallpapers.com

20

BLANK PAGE