UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

Pre-U Certificate

MARK SCHEME for the May/June 2010 question paper

for the guidance of teachers

9792 PHYSICS

9792/02 Paper 2 (Part A Written), maximum raw mark 100

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

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UNIVERSITY of CAMBRIDGE
International Examinations

c.a.o. correct answer only (including unit)
e.e.o.o. each error or omission
e.c.f. error carried forward:
it is usually awarded even where not specifically indicated.
i.e. subsequent working including a previous error is credited, if otherwise correct.

Incorrect units, errors in powers of 10 and unit multipliers are to be treated as arithmetical errors.

Correct numerical answers with incorrect units will normally gain preceding marks even when the working is not shown.

Do not penalise a sig. fig. fraction or a unit error more than once in the same question.

There is no penalty for taking g = 10 or 9.8 (ms^{-2}) unless specifically stated.

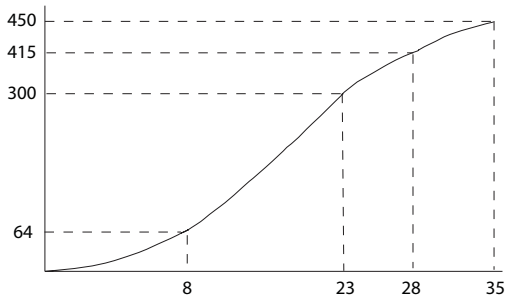
Sig. Fig. Answers must given to at least 2 sig. fig. except where the answer is exactly 0.6, 2 etc.

1 (a) (i) area under graph (award in either **(i)** or **(ii)**) (1)
½ × 8 × 16 = 64 (m) (1) [2]

(ii) ½ × 7 × 10 = 35 (m) [1]

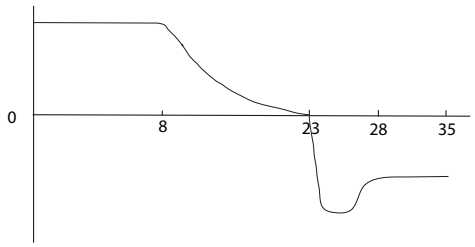
(b) estimates area of central section (1)
e.g. 700 ± 20 small squares **or** 15 × ~18.5 **and** 5 × ~15 (1)
equivalent to 350 m + 99 m = 450 ± 10 (m) (1) [3]

(c) (i)



curve with gradient increasing to 23 s (1)
distance increasing to 35 s and **candidate's** 450 m (1)
with gradient decreasing (1) [3]
Penalise: sudden change of gradient / more than one line

(ii)



horizontal to 8 s (1)
falling to zero at 23 s (1)
negative then rises to negative horizontal to 35 s (1) [3]

(d) at equal intervals along route (1)
position (student) with a stopwatch (at each point) (1)
some mechanism for starting together (1) max 3
record time as bus passes (1)

same point on bus (used for measurements) (1) [4]

[Total: 16]

2 **(a)** **(i)** volume = 53 × 32 × 1.3 = (2205 m^3) (1)
mass = 2205 × 2400 = 5.29 × 10^6 (kg) (1) [2]

(ii) weight = 5.29 × 10^6 × 9.81 = 5.19 × 10^7 (N) [1]

(iii) pressure = weight / area (1)
5.19 × 10^7 / 53 × 32 = 30 600 ($N\,m^{-2}$) (1) [2]

(b) building provides (70 – 30.6) = 39.4 ($kN\,m^{-2}$) (1)
mass of building is 39.4 × 5.29 × 10^6 / 30.6 = 6.81 × 10^6 (kg) (or the long way) (1) [2]

[Total: 7]

3 **(a)** acceleration of body (= a) = (–)F/m (1)
use of $v^2 = u^2 + 2as$ (condone use of signs wrongly and using u = v) (1)
Fs = work done = k.e. **and** substitution to get $mas = msv^2 / 2s = ½mv^2$ (1) [3]
(integration methods acceptable)

(b) **(i)** ½ × 1800 × 8500^2 = 6.5 × 10^{10} (J) [1]

(ii) 6.5 × 10^{10} = 1800 × 5300 × $\Delta\theta$ (1)
$\Delta\theta$ = 6820 (K) (1) [2]

(iii) (gravitational) **potential** (energy must be lost as well) [1]

(iv) heat/energy lost from spacecraft (1)
by conduction **to air**
or heat due to/WD against **air** resistance/atmosphere
or by radiation (1)
less (net) energy gain leads to (less temperature rise)
or net energy gain is less than actual energy gain (1) [3]

[Total: 10]

4

I / A	P / W
3.0	0
2.4	2.9
2.0	4.0
1.5	**4.5**
1.2	**4.3(2)**
1.0	**4.0**
0.86	3.7
0.75	3.4
0.60	2.9
0.50	2.5

(a) **both** currents correct (1)
all three powers correct from values of current (1) [2]

(b) **(i)** suitable smooth curve [1]

(ii) maximum at $R = 2 \pm 0.2$ (Ω) [1]

(iii) **all** the power (is wasted as heat) in the internal resistance (1)
no power/energy to external resistor (as its value is zero so) (1) [2]

(iv) 1. total power supplied = 6 V × 1.5 A = 9.0 (W) (1)
efficiency = 4.5 / 9.0 = 0.5 (or 50%) (1) [2]

2. R for maximum fraction = 10 (Ω) [1]

[Total: 9]

5 **(a)** **two** points from:
a wave in which nodes and antinodes are set up
a wave made of two waves (of the same type and) of the same frequency (or wavelength), travelling in opposite directions
a wave not transmitting/storing energy (1 each) (2) [2]

(b) source (e.g. of microwaves) (1)
reflector/fixed point to produce waves in opposite direction (1)
adjustment of distances to set up nodes and antinodes (1)
correct diagram of arrangement (1) [4]

(c) **(i)** the wavelength [1]

(ii) -sin wave; labelled/thick horizontal line; sin wave (amplitude~70%) (1 each) (3) [3]

[Total: 10]

6 **(a)** $^{28}_{14}\text{Si}$, $^{29}_{14}\text{Si}$ and $^{30}_{14}\text{Si}$ [1]

(b) **(i)** $^{27}_{12}\text{Mg} \rightarrow {}^{27}_{13}\text{A}l + {}^{0}_{-1}\beta$
beta particle correct (penalise β^-) (1)
equation balances (1) [2]

(ii) 12 protons become 13 protons **and** 15 neutrons become 14 neutrons (and an electron)
or a neutron changes into a proton (1)
a neutron changes into a proton and an electron/β-particle
(this scores both marks) (1) [2]

(c) $^{29}_{15}\text{P} \rightarrow {}^{0}_{1}\text{e} / \beta + {}^{29}_{14}\text{Si}$
correct symbol for positron (penalise β^+ but not as well as β^-) (1)
correct equation (1) [2]

(d) half life for aluminium-29 is 6.6 (min) (1)
time is 5 half lives so **or** 5 used correctly (1)
activity = $4.8 \times 10^5 / 2^5 = 1.5 \times 10^4$ (Bq) (1) [3]

[Total: 10]

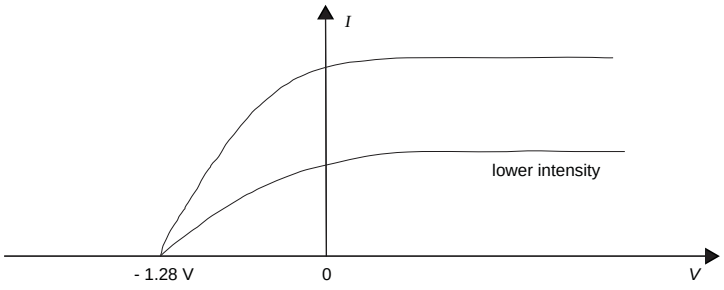
7 **(a)** photoelectric (effect) [1]

(b) **(i)** $E = hc/\lambda$ **and** knowing what the symbols stand for (1)
$6.63 \times 10^{-34} \times 3.00 \times 10^8 / 250 \times 10^{-9} = 7.96 \times 10^{-19}$ (J) (1) [2]

(ii) $7.96 \times 10^{-19} / 1.60 \times 10^{-19} = 4.97$ (eV) [1]

(c) 4.97 eV – 3.69 eV = 1.28 (eV) [1]

(d)



graph/line for positive **and** negative values of V (1)
constant current for most but not all positive values of V (1)
becoming zero at –1.28 V **or** candidate's value from **(c)** (1) [3]

(e) lower intensity line with smaller values of current (1)
but becoming zero at same point (1) [2]

(f) any **three** of these four comments:
the wave theory makes intensity proportional to amplitude squared (1)
so it was expected that a brighter lamp would give higher energy photoelectrons (1)
here dim light is giving just as energetic photoelectrons as bright light (1) max 3
this cast doubt on the wave theory for electromagnetic radiation (1) [3]

[Total: 13]

8 (a) (i) 1. velocity/speed increases with **time** / **rate** of change of velocity/speed (1)
2. 49(.0/1) **and** 200(196) (**n.b.** unit given in question) (1)

(ii) increasing gradient (1)
initial gradient zero (1)
clear **attempt** at correct final gradient **or** angle to vertical ≤ 20° (1) [5]

(b) (i) 54(.0) m **cao.** (1)

(ii) the aeroplane is travelling **very/extremely** fast
or (large distance in) short time
or time (for given distance) is inversely related to acceleration
or the pilot has a short time (to clear the tailplane) (1)
pilot must miss the empennage/tailplane/clear the aeroplane etc. (1) [3]

(c)

Momentum Conservation Method:	**Newton's Third Law Method:**	
gas (emerges with) downwards momentum	downwards force on gas	(1)
conservation of momentum	upwards force (on cylinder/seat)	(1)
(rest of) seat/cylinders gains upwards momentum	force upwards greater than weight	(1) [3]

(d) (i) the pilot does not collide with/problem with the rotor blades (1)

(ii) (the parachute has to) slow down a fast/downwards moving object
or slow down in a short time (1)
before the pilot hits the ground / pilot too low (1) [3]

(e) (i)

Force, Impulse Method:	**Velocity, Acceleration Method:**	
(F =) 380 × 10 × 9.81/3.7(297) × 10^4	(v =) 1800/380 **or** 4.7(36842105)	(1)
I = Ft **or** 1800 / (380 × 10 × 9.81)	(t =) v/a	
or (t =) I/F **or** 1800/3.7(278) × 10^4	**or** 4.7(36842105)/(10 × 9.81)	(1)
0.048(28585225) s (allowing for weight of pilot and seat) (0.0439 s scores 2/3)		(1)

(ii) smaller acceleration/onset rate/force **not** jerk (1) [4]

(f) financial consequences:

seats/helmets/parachutes/training expensive (to buy/install/maintain etc.) / not economically viable	(1)
seats heavy (much heavier than a passenger) **or** bulkier	(1)
fewer passengers/less income **or** more fuel	(1)

hazards:

passengers untrained/unaware of danger / hull needs to be breached	(1)
accidental operation possible	(1)
rocket fuel highly flammable	(1)
bolts/rocket ejecta etc hot/fast moving/dangerous	(1)
forces/acceleration causes injury	(1)
low oxygen pressure / cabin depressurized / low temperature	(1)
some passengers elderly/unfit/sick/children/babies/disabled/obese	(1)
flailing limbs/possessions/collisions cause injury	(1)

practicality:

entire aeroplane roof needs to be removed first	(1)
many passengers ejecting at once	(1)
most accidents occur on take-off/landing/low altitude	(1)
does not protect against all risks	(1)
civilian airliner less likely to be target/in danger/less likely to crash	(1)
delay before ejection	(1)
tail fin higher (in commercial jet)	(1)
seats designed for a particular weight / seats need to be adjusted for weight	(1)
passengers belted up for the entire journey	(1)
no hand luggage / no overhead lockers	(1) [max 7]