INTERNATIONAL BACCALAUREATE
BACCALAURÉAT INTERNATIONAL
BACHILLERATO INTERNACIONAL

MARKSCHEME

November 2001

PHYSICS

Standard Level

Paper 2

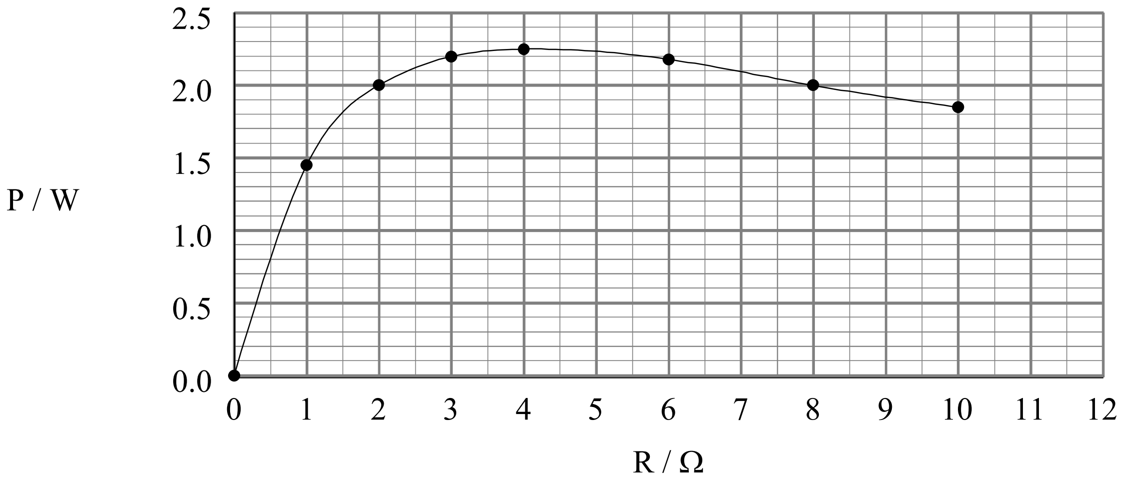
15 pages

SECTION A

A1. (a) recognise to use $P = I^2 R$; *[1]*
correct substitution to give P = 1.8 W; *[1]*
[2 max]

(b) error in $I^2 = 4\ \%$; *[1]*
error in $I^2 R = 14\ \%$; *[1]*
therefore absolute uncertainty = ± 0.3 W; *[1]*
[3 max]

(c)



labelled axes with correct units; *[1]*
suitable scale *(should fill at least half the grid)*; *[1]*
data points *(zero point must be included)*; *[1]*
best fit line; *[1]*
[4 max]

(d) 4 Ω (± 1Ω) ***[1 max]***

(e) yes; *[1]*
because of the large error in determining the actual maximum of the graph; *[1]*
OWTTE
[2 max]

A2. (a) (i) use $v = \sqrt{2gh}$ to get 4.0 m s^{-1} ***[1 max]***

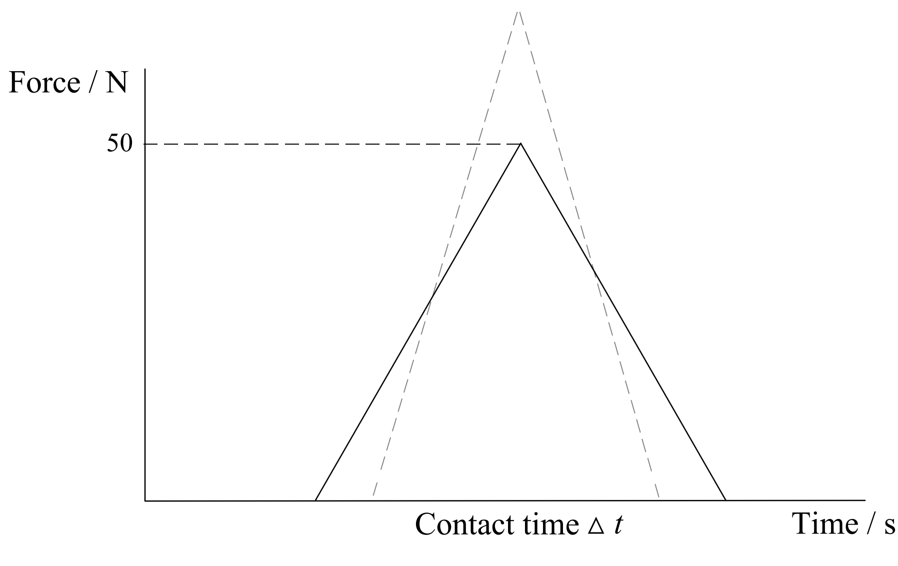
(ii) use $v = \sqrt{2gh}$ to get 3.5 m s^{-1} ***[1 max]***

(iii) $\Delta p = m\Delta v = 0.2 \times 7.5$; ***[1]***
$= 1.5$ N s; ***[1]***
*(Award **[1]** for 0.1 N s and use e.c.f. in (b) below.)*
[2 max]

(b) (i) the total change in momentum *(accept impulse)* ***[1 max]***

(ii) total momentum = $\frac{1}{2}50 \times \Delta t = 1.5$ N s; ***[1]***
to give $\Delta t = 0.06$ s; ***[1]***
e.c.f. from above gives $\Delta t = 0.004$ s;
[2 max]

(c) (i)



smaller contact time; ***[1]***
greater maximum force; ***[1]***
[2 max]

A3. (a) $^{14}_{7}N + ^{1}_{0}n = ^{14}_{6}C + ^{1}_{1}H$ ***[1 max]***

(b) (i) since C-14 is radioactive it will transmute to another element OWTTE; ***[1 max]***

(ii) recognise that this is 2 half-lives; ***[1]***
age $= 2 \times 5600 = 11200$ years; ***[1]***
[2 max]

SECTION B

B1. Part 1.

(a) *look for an answer along the following lines:*
temperature is a measure of the average KE of the molecules so if the temperature is constant the average KE will not change; ***[1]***
if energy is being supplied and the KE is not changing the PE must be increasing; ***[1]***
[2 max]

(b) (i) 400 g ***[1 max]***

(ii) $Q = m\mathrm{L} = 0.4 \times 2.3 \times 10^6$ (*i.e.* formula and correct substitution); ***[1]***
$= 9.2 \times 10^5$ J ; ***[1]***
[2 max]

(iii) rate $= \dfrac{\text{energy}}{\text{time}}$; ***[1]***
$= \dfrac{9.2 \times 10^5}{900}$; ***[1]***
$\simeq 1000$ W
[2 max]

(iv) because of all the energy losses to the surroundings ***[1 max]***
OWTTE;

(c) use $\dfrac{dQ}{dt} = -kA\dfrac{d\theta}{dx}$; ***[1]***
correct substitution $1000 = \dfrac{200 \times 5 \times 10^{-2} \times d\theta}{6 \times 10^{-3}}$; ***[1]***
to give $d\theta = 0.6\ ^\circ\mathrm{C}$; ***[1]***
[3 max]

(d) Any sensible discussion of appropriate physics *e.g.* ***[2]***
only a small amount of the base is actually in contact with the burner;
so there will be a layer of air between the burner and the base that accounts for most of the temperature drop (*or air is a poor conductor*)
aluminium is a good conductor
flame has to be a higher temperature than base for energy transfer to take place;
[2 max]

(e) energy supplied to water $= 1000 \times 315$ J ; ***[1]***
energy used to heat water $= 4200 \times 70$; ***[1]***
and aluminium $= 0.25 \times s \times 70$; ***[1]***
therefore $s = \dfrac{(1000 \times 315 - 4200 \times 70)}{(0.25 \times 70)} = 1200\ \mathrm{J\,kg^{-1}\,K^{-1}}$; ***[1]***
[4 max]

B1. Part 2

(a)

electric; ***[1]***
magnetic; ***[1]***
[2 max]

(b) (i) electric force $F_E = qE$ ***[1 max]***

(ii) magnetic force $F_B = Bqv$ ***[1 max]***

(c) for no deflection $F_E = F_B$; ***[1]***

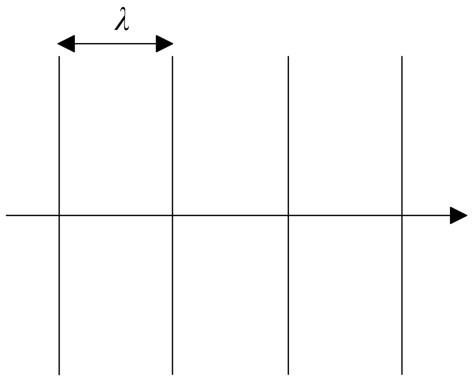
to give $v = \frac{E}{B}$; ***[1]***

[2 max]

(d) at any point along the path the magnetic force is at right angles to the velocity of the ion; ***[1]***
and the speed of the ion is constant; ***[1]***
OWTTE;
e.g. 'there is a force acting at right angles to the velocity of the ion and this will produce a constant centripetal acceleration since the velocity is constant'.
An answer such as 'the force is at right angles' would be worth ***[1]****. Look for a bit more detail for* ***[2]****.*

[2 max]

B2. (a)



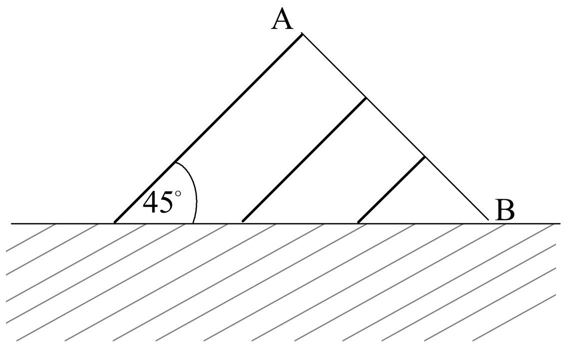
λ on diagram ***[1 max]***

(b) $\lambda = 3$ cm ***[1 max]***

(c) (i) period = 0.1 s; ***[1]***
so in 0.05 s wave front will move 1.5 cm (half a wavelength); ***[1]***
[2 max]

(ii) negative cosine graph ***[1 max]***

(d)



Boundary

correct position of A and B ***[1 max]***

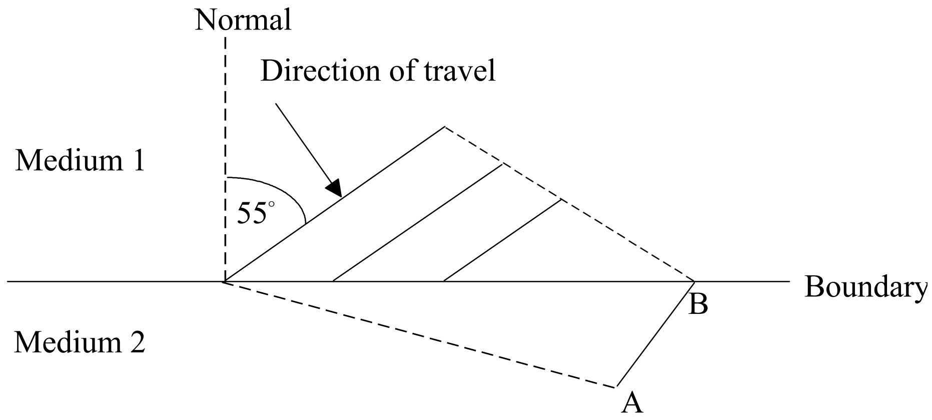
(e) (i) 10 Hz **[1 max]**

(ii) $\lambda = \frac{c}{f}$; **[1]**

$= 4.5\ \text{cm}$; **[1]**

[2 max]

(iii)



correct position of B at the boundary; **[1]**

position of A showing that the wave is refracted away from the normal; **[1]**

[2 max]

(iv) recognise that the refractive index is ratio of the speeds; **[1]**

to give n=1.5; **[1]**

use $1.5 = \frac{\sin r}{\sin 35^\circ}$; **[1]**

to give $r = 59^\circ$; **[1]**

[4 max]

(v) the wave fronts will be totally reflected at the boundary; **[1]**

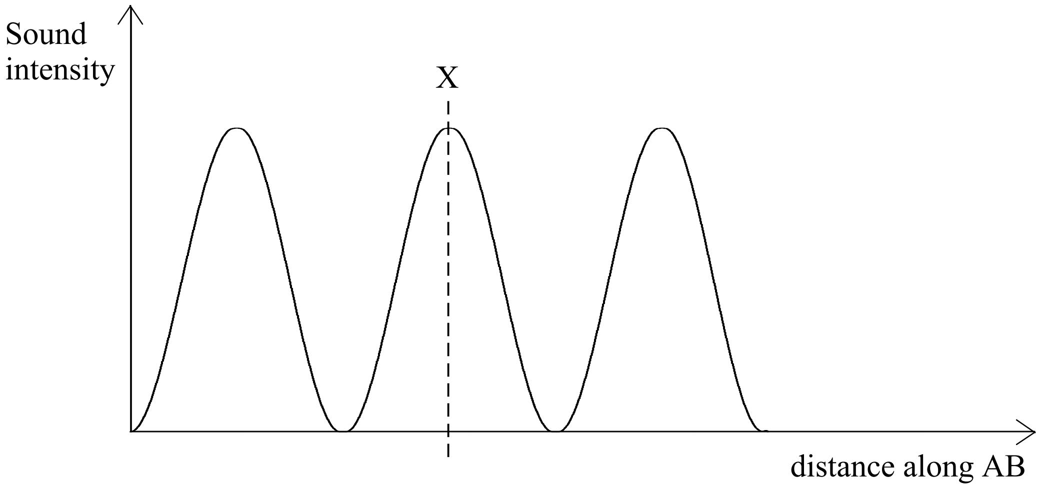
since critical angle $= \sin^{-1}\left(\frac{1}{n}\right)$; **[1]**

$r = 42^\circ$; **[1]**

hence waves are incident at an angle greater that critical angle; **[1]**

[4 max]

(f) (i)



correct shape; ***[1]***
position of X coincident with a central maxima; ***[1]***
[2 max]

(ii) when two or more waves meet at a point; ***[1]***
the resulting amplitude at that point is the vector sum of the individual amplitudes of the separate waves; ***[1]***
OWTTE;
i.e. look for an understanding of how the resultant amplitude is produced

Argument should go something like this:
waves from S_1 and S_2 travel different distances to different points on AB they will therefore be out of phase at a particular point; ***[1]***
if the phase difference is such that a trough meets a crest then the individual wave amplitudes will add to cancel out-minimum; ***[1]***
if a crest meets crest (trough meets trough) then they will add to a maximum; ***[1]***
[4 max]

B3. (a) let $d = \mathrm{k}v^2$; *[1]*
choose $v = 20,\ d = 60$ to give $\mathrm{k} = 0.15$; *[1]*
choose $v = 30,\ d = 135$ to give $\mathrm{k} = 0.15$; *[1]*
since k is the same *d* is proportional to v^2; *[1]*
*(i.e. they should show that they understand the proportionality and then use **two** points to verify this proportionality.)*

[4 max]

(b) candidates could use a KE – work done argument or kinematic argument
e.g. $\Delta(\mathrm{KE}) = \frac{1}{2}mv^2 = Fd$; *[1]*
where *F* is the braking force; *[1]*
if the braking force *F* is constant then $d \propto v^2$; *[1]*

or

if *F* is constant than *a* is constant; *[1]*
so $v^2 = u^2 + 2ad$; *[1]*
$v = 0$ therefore $d \propto u^2$; *[1]*
[3 max]

(c) (i) from the graph *d* = 60 m; *[1]*
average speed = $10\ \mathrm{m\,s^{-1}}$; *[1]*
$t = \frac{60}{10} = 6.0\,\mathrm{s}$; *[1]*

or

from the graph *d*=60 m; *[1]*
use $v^2 = u^2 + 2ad$ to give $a = 3.3\ \mathrm{m\ s^{-2}}$; *[1]*
use $v = u + at$ to give $t = 6.1$ s (6.0 s); *[1]*
[3 max]

(ii) use $v^2 = u^2 + 2ad$ to find a; *[1]*
to give $a = 3.3\ \mathrm{m\ s^{-2}}$; *[1]*
use $F = m\,a$ to give $F = 5000\ \mathrm{N}$; *[1]*
If they have calculated a in (i) then this is easier for them!

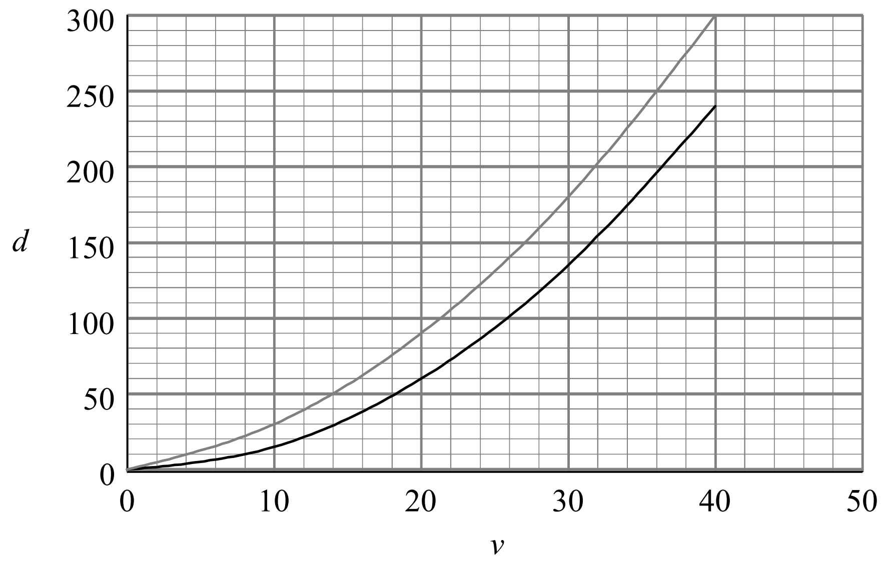
or

use $Fd = \frac{1}{2}mv^2$; *[1]*
$= \frac{1}{2}(1500)\times(20)^2$; *[1]*
to give $F = 5000\ \mathrm{N}$; *[1]*
[3 max]

(d) reaction time or thinking time; ***[1]***
explanation of what this is; ***[1]***
*(i.e. something like 'when a driver sees an incident that causes him to brake it takes some time before he reacts' receives **[2]** but just 'reaction time' receives **[1]**)*

[2 max]

(e)



rough correct shape; ***[1]***
explanation: reaction time is constant; ***[1]***
therefore each point on the braking distance graph will be increased by an amount proportional to the speed; ***[1]***
OWTTE

[3 max]

(f) greater; ***[1]***
there is now a component of weight acting against the braking force; ***[1]***
[2 max]

(g) time to travel 12 km $= \frac{12000}{40} = 300\,\text{s}$; ***[1]***
therefore rate at which fuel is used $= 0.0033\,\text{l}\,\text{s}^{-1}$; ***[1]***
[2 max]

(h) energy released per second by the fuel $= 35 \times 10^6 \times 0.0033$
$= 1.2 \times 10^5\,\text{W}$; ***[1]***
25 % of this $= 3 \times 10^4$;
therefore power output $= 30\,\text{kW}$; ***[1]***
[2 max]

(i) drag force $= \frac{P}{v} = 7.5 \times 10^2\ \text{N}$ ***[1 max]***