MARKSCHEME

May 2006

PHYSICS

Standard Level

Paper 2

11 pages

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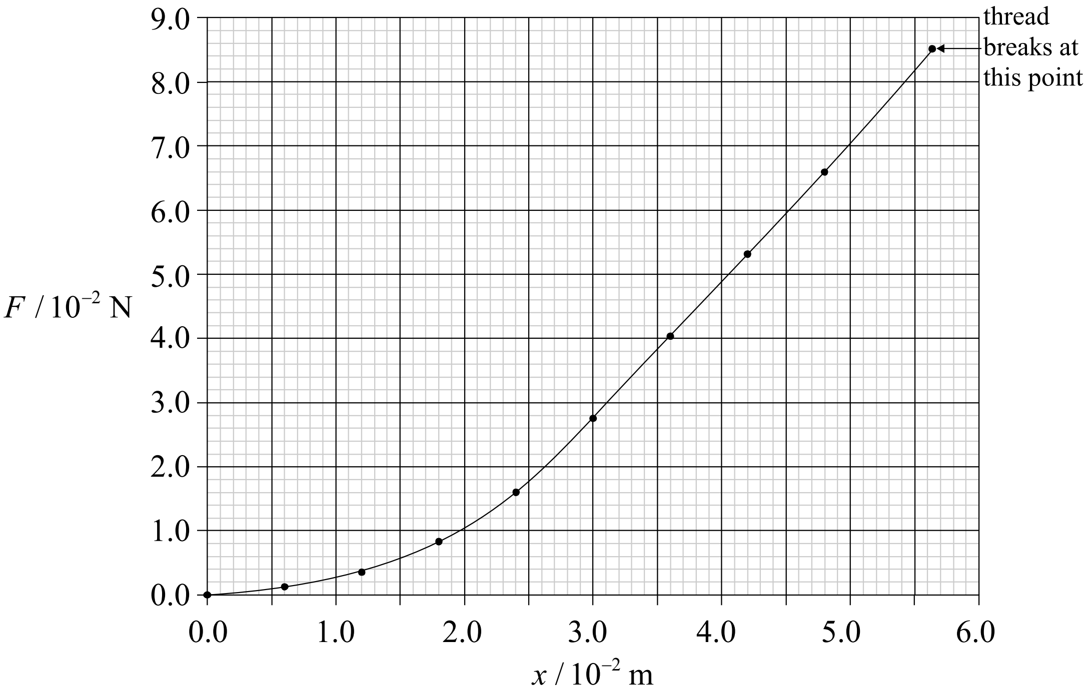
SECTION A

A1. (a)



correct line of best fit; ***[1]***

The line should go through a majority of the points.

(b) from the graph breaking load $= 8.5(\pm 0.1)\times 10^{-2}$ N ;

breaking stress $= \dfrac{8.5\times 10^{-2}}{3.14\times(4.5)^2\times 10^{-12}} = 1.3\times 10^9$ Pa ***or*** N m^{-2} ;

some statement of conclusion; ***[3]***

(c) (i) work = area under graph;

between $(2.4\times 10^{-2}, 1.6\times 10^{-2})$ and $(5.6\times 10^{-2}, 8.5\times 10^{-2})$;

$= (1.6\times 3.2)\times 10^{-4} + \frac{1}{2}(3.2\times 6.9)\times 10^{-4}$;

$= 1.6\times 10^{-3}$ J

If incorrect line of best fit in (a), allow first marking point only.

or

work = average force × distance/displacement/extension;

average force $= 5.1\times 10^{-2}$ N ;

extension $= 3.2\times 10^{-2}$ m ;

to give 1.6×10^{-3} J ***[3]***

(ii) KE of insect = work needed to break web $= 1.6 \times 10^{-3}$ J ;

$v = \sqrt{\frac{2\text{KE}}{m}}$;

$= \sqrt{\frac{3.2 \times 10^{-3}}{1.5 \times 10^{-4}}} = 4.6\,\text{m s}^{-1}$; ***[3]***

No ECF from (c)(i) i.e. the value 1.6×10^{-3} J *must be used.*

A2. (a) medium 1;
wavelength is greater than in medium 2;
and $c = f\lambda$ and frequency is same in both media; ***[3]***
*Award **[1]** if the candidate answers medium 2, because wavelength is greater. Award **[1]** for correct medium and mention of bending towards normal when entering medium 2. Award **[0]** for correct medium but incorrect or no explanation.*

(b) *measurement of wavelength*:

$\lambda_1 = 2.5\,\text{cm}$;

$\lambda_2 = 1.0\,\text{cm}$;

$\frac{c_1}{c_2} = \frac{\lambda_1}{\lambda_2} = 2.5\,(\pm 0.2)$;

or

measurement of incident and refraction angles:

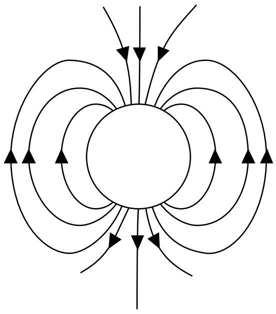
$\theta_1 = 60^\circ$;

$\theta_2 = 20^\circ$;

$\frac{c_1}{c_2} = \frac{\sin\theta_1}{\sin\theta_2} = 2.5$; ***[3]***

*Award **[2]** if the candidate gets it the wrong way round in either method, but they must have answered medium 2 in (a).*

A3. (a)

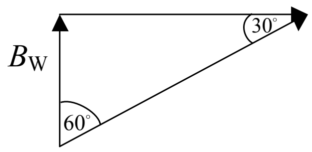


overall correct shape with no field lines touching;
direction of field; ***[2]***

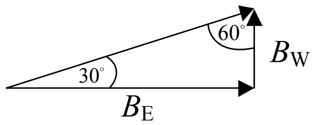
(b) <u>bar</u> magnet / solenoid; ***[1]***
Do not accept just "magnet".

(c) (i) upwards
the direction of the compass needle is the resultant of two fields / *OWTTE*;
the field must be into the plane of the (exam) paper to produce a resultant field in the direction shown / *OWTTE*; ***[2]***
*Award **[1]** for "upwards because of the right hand rule" / OWTTE.*

(ii)



or



vector addition with correct values of two angles shown $30^\circ, 60^\circ$ ***or*** 90°;

from diagrams $B_E = B_W \times \tan 60$ ***or*** $B_E = \dfrac{B_W}{\tan 30}$; ***[2]***

(iii) $B_W = \dfrac{\mu_0 I}{2\pi r} = \dfrac{2\times10^{-7}\times 4}{2\times10^{-2}} = 4.0\times10^{-5}$ T;
$B_E = B_W \times \tan 60 = 6.9\times10^{-5}$ T; ***[2]***

SECTION B

B1. Part 1 Travelling and standing waves

(a) no energy is propagated along a standing wave / *OWTTE*;
the amplitude of a standing wave varies along the wave / standing wave has nodes and antinodes;
in standing wave particles are either in phase or in antiphase / *OWTTE*; ***[2 max]***

(b) *Look for these main points.*
when the tube is vibrated, a wave travels along the tube and is reflected at B;
the wave is inverted on reflection;
the reflected wave interferes with the forward wave;
the maximum displacements occurs midway between A and B;
since there is always a node at A and B, then the pattern shown will be produced / *OWTTE*; ***[5]***
*Award **[1]** for essentially two waves in opposite directions, **[1]** for π out of phase, **[1]** for interference and **[2]** for condition to produce shape.*

(c) (i) $f = \frac{v}{\lambda}$;
to get $f = \text{constant}\sqrt{T}$ since λ constant;
therefore, a plot of f^2 against T ***or*** f against $\sqrt{T}$;
should produce a straight-line through the origin / *OWTTE*; ***[4]***

(ii) $\lambda = 4.8\,\text{m}$;
$v = f\lambda = 1.8 \times 4.8 = 8.6\,\text{m s}^{-1}$;
$k = \frac{v}{\sqrt{T}} \frac{8.6}{3} = 2.9$; ***[3]***
Ignore any unit.

B1. Part 2 Mechanical power

(a) the rate of working / work $\div$ time; *[1]*
If equation is given, then symbols must be defined.

(b) $P = \frac{W}{t} = \frac{F \times d}{t}$;
$v = \frac{d}{t}$ therefore, $P = Fv$; *[2]*

(c) (i) $t = \frac{d}{v}$;
$= \frac{4800}{16} = 300\,\text{s}$; *[2]*

(ii) $W = mgh = 1.2 \times 10^4 \times 300 = 3.6 \times 10^6\,\text{J}$; *[1]*

(iii) work done against friction $= 4.8 \times 10^3 \times 5.0 \times 10^2$;
total work done $= 2.4 \times 10^6 + 3.6 \times 10^6$;
total work done $= P \times t = 6.0 \times 10^6$;
to give $P = \frac{6 \times 10^6}{300} = 20\,\text{kW}$; *[4]*

(iv) the engine also has to overcome friction in the moving parts of the car / *OWTTE;* *[1]*

B2. (a) the energy required to assemble a nucleus / to separate the nucleus / *OWTTE*;
from its constituent parts / into its individual component / *OWTTE*; ***[2]***

(b) fission; ***[1]***

(c) (i) $\frac{1}{12}$th mass of ^{12}C atom/nuclide; ***[1]***

(ii) mass of $LHS = 235.0439 + 1.0087 = 236.0526u$;
mass of $RHS = 95.9342 + 137.9112 + 2 \times 1.0087 = 235.8628u$;
$LHS - RHS = 0.1898u$;
$= 0.1898 \times 932 = 176.9\,\text{MeV}$; ***[4]***

(d) they can initiate a chain reaction;
the two neutrons can react with two other nuclei to produce four neutrons *etc.*; ***[2]***
*Award **[1]** for mention of chain reaction and **[1]** for explanation of chain reaction.*

(e) kinetic energy (of the Rb and Cs nuclei);
gamma radiation; ***[2]***

(f) if the net external force acting on a system is zero / for an isolated system of interacting particles;
the momentum of the system is constant; ***[2]***
*Award **[1]** for momentum before collision equals momentum after collision.*

(g) $2.00\,\text{MeV} = 3.20 \times 10^{-13}\,\text{J}$;
$v = \sqrt{\frac{2E}{m}} = \sqrt{\frac{6.40 \times 10^{13}}{1.68 \times 10^{-27}}}$;
$= 1.95 \times 10^{7}\,\text{m s}^{-1}$ ***[2]***

(h) (i) momentum of neutron before $= 1.95 \times 10^{7} m$;
momentum of neutron after $= -1.65 \times 10^{7} m$;
therefore, $1.95 \times 10^{7} m = -1.65 \times 10^{7}\,\text{m} + 12mv$;
to give $v = 0.30 \times 10^{7}\,\text{m s}^{-1}$ ***[3]***
If the candidates go straight to the third marking point do not penalize them.

(ii) $KE_{\text{before}} = \frac{1}{2}(1.95)^2 m = 1.90m$ ***or*** $3.19 \times 10^{-13}\,\text{J}$;
$KE_{\text{after}} = \frac{1}{2}(1.65)^2 m + 6(0.3)^2 m = 1.90m$ ***or*** $3.19 \times 10^{-13}\,\text{J}$;
collision is elastic since $KE_{\text{before}} = KE_{\text{after}}$; ***[3]***
Accept argument based on approach velocity = separation velocity.

(iii) loss in $KE = 6(0.3)^2 m = 0.54m$ ***or*** $9.07 \times 10^{-14}\,\text{J}$;
fractional loss $= \frac{0.54}{1.90}$ ***or*** $\frac{0.91 \times 10^{-13}}{3.19 \times 10^{-13}} = 0.285 \approx 0.3\,(30\%)$; ***[2]***

(iv) $0.21 / 0.20 / \frac{2}{9}$; ***[1]***

B3. Part 1 Ideal gas behaviour

(a) when the gas is heated the average KE of the molecules increases;
therefore, their average speed increases;
therefore, they strike the container walls with greater frequency / with greater speed / rate of momentum change on collision with container walls is greater / *OWTTE*; ***[3]***
*Award **[2 max]** if no mention of "average".*

(b) (i) $P \propto \frac{1}{V}$ ***or*** $V \propto \frac{1}{P}$ ***or*** $pV = \text{constant}$ ***or*** pressure inversely proportional to volume *etc*.; ***[1]***

(ii) $V \propto T$ *etc*.; ***[1]***

(c) (i) $\frac{P_1}{T_1} = \frac{P_2}{T'}$ ***or*** $P_1T' = P_2T_1$; ***[1]***

(ii) $\frac{V_1}{T'} = \frac{V_2}{T_2}$ ***or*** $V_1T_2 = V_2T'$; ***[1]***

(d) from (i) $T' = \frac{P_2T_1}{P_1}$;
from (ii) $T' = \frac{V_1T_2}{V_2}$;
equate to get $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$;
so that $\frac{PV}{T} = \text{constant}$ ***or*** $PV = KT$; ***[4]***

(e) $\frac{PV}{T} = K$;
substitute $\frac{2.00 \times 10^5 \times 2.49 \times 10^{-2}}{300} = 16.6$;
recognize that $K = nR$ so $n = 2$;
therefore, $\text{mass} = 2 \times 40 = 80\,\text{g}$; ***[4]***

Part 2 Electrical circuits

(a) (i) correct labelling of A and V; ***[1]***

(ii) P on resistor at “bottom”; ***[1]***

(b) (i) $I = 0.40\,\text{A}$;

$R = \frac{V}{I} = \frac{10}{0.40} = 25\,\Omega$; ***[2]***

(ii) the rate of increase of *I* decreases with increasing *V* / *OWTTE*;
because: the conductor is (probably) heating up as the current increases / *OWTTE*;
and resistance (of a conductor) increases with increasing temperature; ***[3]***

(c) (i) resistance of Y at $0.20\,\text{A} = 12.5\,\Omega$; ***[1]***

(ii) total series resistance $= 12.5 + 25 = 37.5\,\Omega$;
total pd across resistance $= 0.2 \times 37.5 = 7.5\,\text{V} = \text{e.m.f.}$; ***[2]***