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M04/432/S(2)M+

MARKSCHEME

May 2004

PHYSICS

Standard Level

Paper 2

11 pages

If you do not have a copy of the current Physics guide,
please request one from IBCA.

Subject Details: Physics SL Paper 2 Markscheme

General

A markscheme often has more specific points worthy of a mark than the total allows. This is intentional. Do not award more than the maximum marks allowed for part of a question.

When deciding upon alternative answers by candidates to those given in the markscheme, consider the following points:

- Each marking point has a separate line and the end is signified by means of a semicolon (;).
- An alternative answer or wording is indicated in the markscheme by a "/"; either wording can be accepted.
- Words in (…) in the markscheme are not necessary to gain the mark.
- The order of points does not have to be as written (unless stated otherwise).
- If the answer has the same "meaning" or can be clearly interpreted as being the same as that in the markscheme then award the mark.
- Mark positively. Give credit for what they have achieved, and for what they have got correct, rather than penalizing them for what they have not achieved or what they have got wrong.
- Occasionally, a part of a question may require a calculation whose answer is required for subsequent parts. If an error is made in the first part then it should be penalized. However, if the incorrect answer is used correctly in subsequent parts then **follow through** marks should be awarded. Indicate this with **"ECF"**, error carried forward.
- Units should always be given where appropriate. Omission of units should only be penalized once. Ignore this, if marks for units are already specified in the markscheme.
- Deduct **1 mark in the paper** for gross sig dig error *i.e.* for an **error of 2 or more digits**.

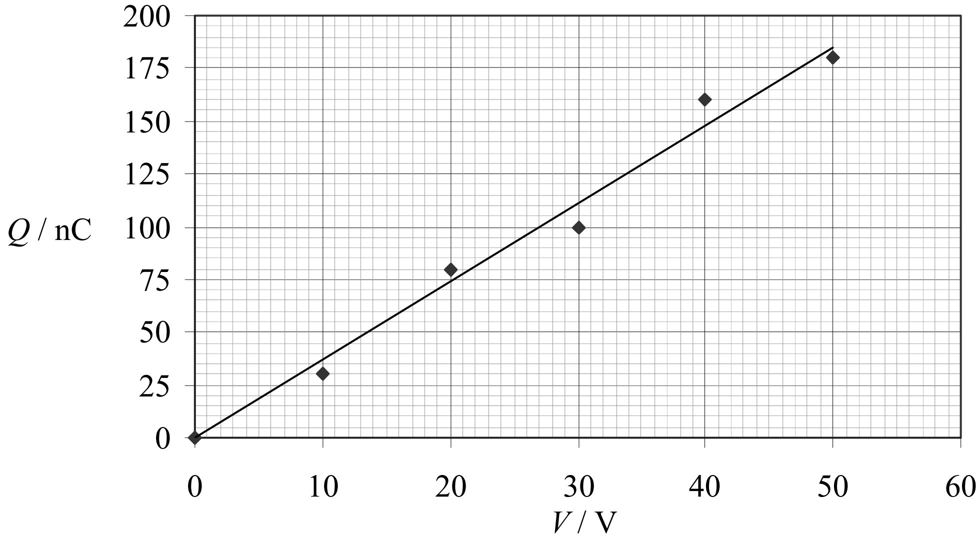
e.g. if the answer is 1.63:

2	*reject*
1.6	accept
1.63	accept
1.631	accept
1.6314	*reject*

However, if a question specifically deals with uncertainties and significant digits, and marks for sig digs are already specified in the markscheme, then do **not** deduct again.

SECTION A

A1. (a)



half area of graph paper at least to be used;
axes labels including units;
scale;
data points; *((0, 0) need not be included)* ***[4]***

(b) best fit line need not go through origin; ***[1]***

(c) use of at least half the line / algebraic indication;
value $= 3.6$ ***or*** 3.6×10^{-9}; ***[2]***

(d) $\mathrm{C\,V^{-1}}$; ***[1]***

(e) recognize that the gradient $m = \frac{\varepsilon_0 A}{d}$;

therefore $\varepsilon_0 = \frac{dm}{A}$;

substitute to get $\varepsilon_0 = 9.0\times10^{-12}\ \mathrm{C\,V^{-1}\,m^{-1}}$ ($\mathrm{C^2\,N^{-1}\,m^{-2}}$ – data book unit or $\mathrm{F\,m^{-1}}$); ***[3]***

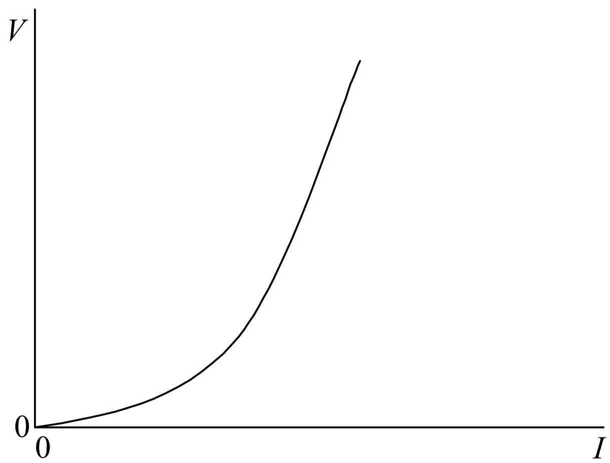
A2. (a) mass × velocity; ***[1]***

(b) (i) momentum before = 800 × 5 = 4 000 N s;
momentum after = 2 000v;
conservation of momentum gives $v = 2.0 \text{ m s}^{-1}$; ***[3]***

(ii) KE before = 400 × 25 = 10 000 J   KE after = 1 000 × 4 = 4 000 J;
loss in KE = 6 000 J; ***[2]***

(c) transformed/changed into;
heat (internal energy) (and sound); ***[2]***
Do not accept "deformation of trucks".

A3. (a)



Any reasonable curve in the right direction. ***[1]***

(b) (i) from the value of *V/I* at any point on the curve; ***[1]***
Do not accept just "from V/I".

(ii) non-ohmic because the resistance (*V/I* at each point) is not constant / *OWTTE*; ***[1]***

(c) (i) 50 Ω; ***[1]***

(ii) recognize that the voltage must divide in the ratio 3 : 1;
to give R = 150 Ω; ***[2]***
Or answer could be solved via the current.

SECTION B

B1. Part 1 Circular motion

(a) *Look for an answer on the following lines.*
the direction of the car is changing;
hence the velocity of the car is changing;
or
since the direction of the car is changing;
a force must be acting on it, hence it is accelerating; ***[2 max]***

(b) (i) arrow pointing vertically downwards; ***[1]***

(ii) weight;
Do not penalize the candidate if they state "gravity".
normal reaction;
Do not penalize the candidate if they state "push of the track on the marble". ***[2]***

(iii) loss in PE $= 0.05 \times 10 \times (0.8 - 0.35)$;
$=$ gain in KE $= \frac{1}{2}mv^2$;
to give $v = 3.0\ \text{m s}^{-1}$;
or
use of $v = \sqrt{2gh}$ to give $v = 4.0\ \text{m s}^{-1}$ at point B;
and then use of $v^2 - u^2 = 2gh$ with $v = 4.0\ \text{m s}^{-1}$ and $h = 0.35\ \text{m}$;
to get $u = 3.0\ \text{m s}^{-1}$; ***[3 max]***
Do not penalize the candidate if $g = 9.8\ \text{m s}^{-2}$ is used.

(iv) recognize that resultant force $= \dfrac{mv^2}{r}$;

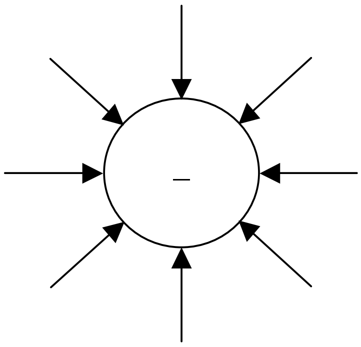
$= \dfrac{(0.05 \times 9.0)}{0.175} = 2.6\ \text{N}$;

$\text{N} = \dfrac{mv^2}{r} - mg$;

$= 2.6 - 0.5 = 2.1\ \text{N}$; ***[4]***

B1. Part 2 The charged sphere

(a)



sufficient arrows to show decreasing radial field;
direction;
no field in the centre; ***[3]***

(b) (i) use $E = k\dfrac{q}{r^2}$ to show $E = 4.0 \times 10^4\ \mathrm{V\,m^{-1}}$; ***[1]***

(c) (i) along a field line; ***[1]***

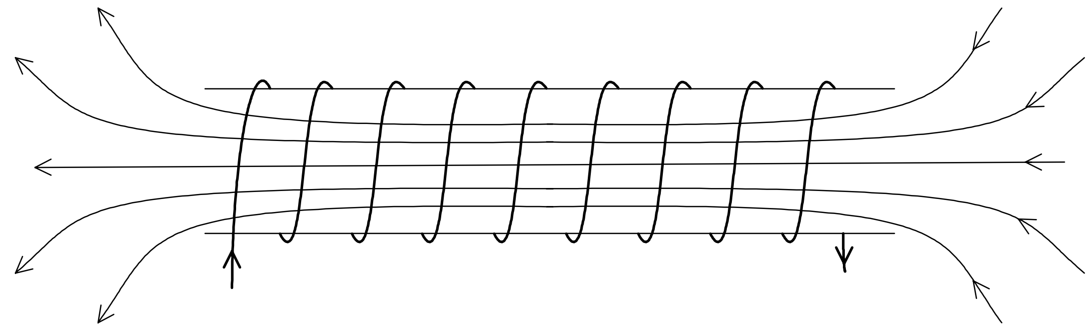
(ii) $F = ma = qE$;
$a = \dfrac{q}{m}E$;
$= 1.8 \times 10^{11} \times 4.0 \times 10^4 = 7.2 \times 10^{15}\ \mathrm{m\,s^{-2}}$; ***[3]***

(iii) decreasing;
electric field strength is decreasing so force on electron is decreasing; ***[2]***
Do not penalize the candidate if they state "field is decreasing".
Award the right answer, with the wrong reason ***[0]***.

(iv) increase in KE $= \frac{1}{2}mv^2 = 4.5 \times 10^{-31} \times 36 \times 10^{12} = 1.6 \times 10^{-17}$ J;
$= qV$;
to give $V = 100$ V; ***[3]***

B2. Part 1 The solenoid

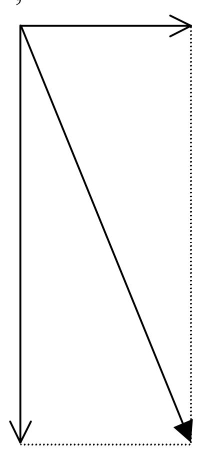
(a)



field inside;
field at ends;
field outside *(continuous loops not required)*;
direction; ***[4]***
There should be at least three lines showing symmetry.

(b) bar magnet; ***[1]***
Do not accept just "magnet".

(c) suitable scale *e.g.* $1\text{ cm} = 3\times10^{-5}\text{ T}$;



correct construction;
magnitude $= 16\ (\pm2)\times10^{-5}\text{ T}$;
direction $= 68^\circ\ (\pm3)$ to the horizontal;

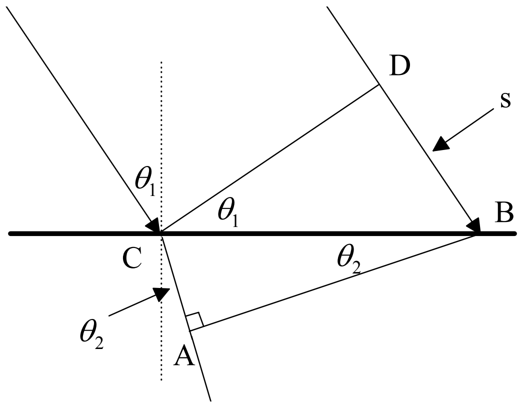
by calculation:
resultant $= [(150)^2 + (60)^2]^{\frac{1}{2}}$;
$= 16\times10^{-5}\text{ T}$;
angle to horizontal $= \tan^{-1}\left(\frac{150}{60}\right)$;
$= 68^\circ$; ***[4 max]***

(d) $I = \frac{BL}{\mu_0 N}$;
$= \frac{(16\times10^{-5}\times0.75)}{(4\pi\times10^{-7}\times500)} = 0.20\text{ A}$; ***[2]***

B2. Part 2 Refraction

(a) each point on a wavefront acts as a source of a secondary wave / *OWTTE*; ***[1]***

(b)



(i) position of AB; ***[1]***

(ii) line AC; ***[1]***
$\angle$ *CAB should look to be* 90°.

(iii) line BD = s; ***[1]***

(c) *Look for these points*:
$\angle$ DCB = θ_1;
$\angle$ CBA = θ_2;
time taken to travel CA and DB is the same;
CA $= v_2\Delta t$ and DB $= v_1\Delta t$
$\sin\theta_1 = \dfrac{\text{DB}}{\text{BC}}$;
$\sin\theta_2 = \dfrac{\text{AC}}{\text{BC}}$;
therefore $\dfrac{\sin\theta_1}{\sin\theta_2} = \dfrac{\text{DB}}{\text{AC}} = \dfrac{v_1\Delta t}{v_2\Delta t} = \dfrac{v_1}{v_2}$; ***[6]***

(d) $f = \dfrac{c}{\lambda}$;

frequency in medium 1 = frequency in medium 2 $= \dfrac{8.0}{4.0} = 2.0$ Hz; ***[2]***

(e) $\dfrac{\sin 60}{\sin 35} = \dfrac{v_1}{v_2} = 1.5$;

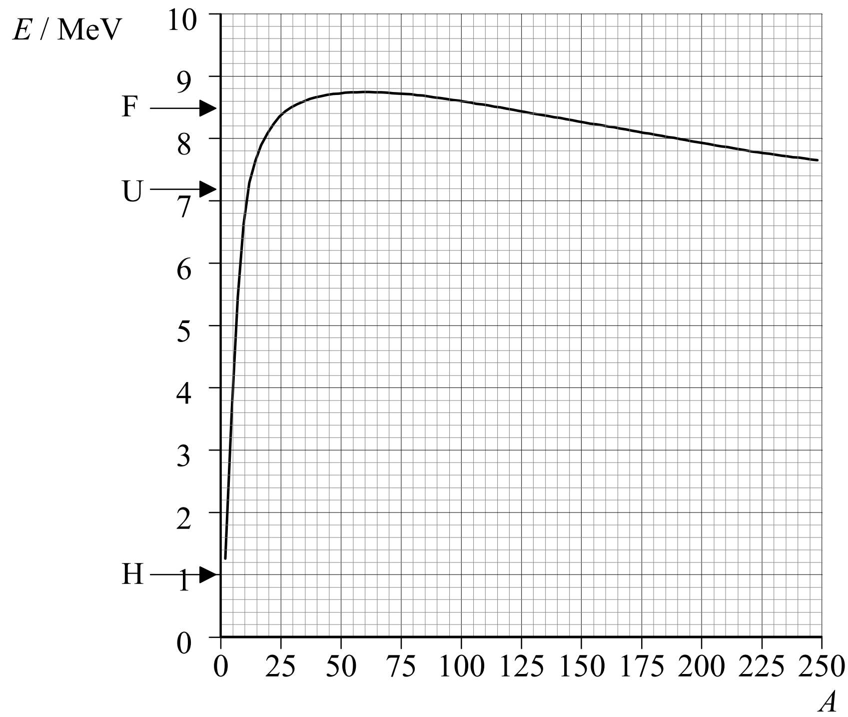
therefore $v_2 = \dfrac{8.0}{1.5} = 5.3\ \text{cm s}^{-1}$; ***[2]***

B3. Part 1 Nuclear binding energy

(a) (i) a proton or a neutron; ***[1]***
*Both needed to receive **[1]**.*

(ii) the difference between the mass of the nucleus and the sum of the masses of its individual nucleons / the energy required to separate a nucleus into its component nucleons / *OWTTE*; ***[1]***

(b)



Don't expect precision for any of these.

(i) F: between 8 and 9; ***[1]***

(ii) H: between 1 and 2; ***[1]***

(iii) U: between 7 and 8; ***[1]***

(c) general overall shape;
max at F = 56, end point U; ***[2]***

(d) mass of nucleons $= (2 \times 1.00728) + 1.00867 = 3.02323$ u;
mass difference $= 0.0072$ u $= 6.7$ MeV;
binding energy per nucleon $= 6.7/3 = 2.2$ MeV; ***[3]***

(e) (i) fusion; ***[1]***

(ii) from the position on the graph, the energy required to assemble two nuclei of ${}^{2}_{1}H$ is greater than that to assemble one nucleus of ${}^{3}_{2}He$;
hence if two nuclei of ${}^{2}_{1}H$ combine to form one nucleus of ${}^{3}_{2}He$ energy must be released / *OWTTE*; ***[2]***

B3. Part 2 Melting ice

(a) (165, 0); *[1]*

(b) *Look for these points*:
to change phase, the separation of the molecules must increase;
Some recognition that the ice is changing phase is needed.
so all the energy input goes to increasing the PE of the molecules;
Accept something like "breaking the molecular bonds".
KE of the molecules remains constant, hence temperature remains constant; *[3]*
If KE mentioned but not temperature then assume they know that temperature is a measure of KE.

(c) (i) time for water to go from 0 to $15\,^{\circ}\mathrm{C} = 30$ s;
energy required $= ms\Delta\theta = 0.25 \times 15 \times 4\,200 = 15\,750$ J;
power $= \dfrac{\text{energy}}{\text{time}} = 525\ \mathrm{W} \approx 530\ \mathrm{W}$; *[3]*

(ii) ice takes 15 s to go from $-15\,^{\circ}\mathrm{C}$ to 0;
energy supplied $= 15 \times 530$ J;
sp ht $= \dfrac{(530 \times 15)}{(15 \times 0.25)} = 2100\ \mathrm{J\,kg^{-1}\,K^{-1}}$; *[3]*

(iii) time to melt ice = 150 s;
$L = \dfrac{(150 \times 530)}{0.25} = 320\ \mathrm{kJ\,kg^{-1}}$; *[2]*