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M03/430/S(2)M+

MARKSCHEME

May 2003

PHYSICS

Standard Level

Paper 2

7 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 candidate's 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 candidates credit for what they have achieved, and for what they have got correct, rather than penalising them for what they have not achieved or what they have got wrong.
- Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.
- 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 penalised. 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 penalised once. Indicate this by **"U-1"** at the first point it occurs. 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*

Indicate the mark deduction by **"SD-1"**. However if a question specifically deals with uncertainties and significant digits, and marks for sig digs are already specified in the markscheme, then do <u>not</u> deduct again.

SECTION A

A1. (a) bubbles rise at constant rate / constant temperature using a thermometer; ***[1]***

(b) can check that rate of boiling is constant;
because the two masses should be equal; ***[2]***

(c) (i) reasonable line drawn; ***[1]***

(ii) triangle for gradient with hypotenuse at least half length of line;
some working shown (*e.g.* coordinates used made clear);
answer 12 (W g^{-1}) ± 1; ***[3]***

(d) gradient = $\frac{L}{200}$;
$L = 2400$ *allow ecf from (c)(ii)*;
correct unit J g^{-1}; ***[3]***

(e) heat energy losses / systematic error;
to the atmosphere / any other detail; ***[2]***

A2. (a) (i) from satellite towards centre of Earth;
(ii) tangent to circle at satellite in correct direction;
(no labels, ***[1 max]***) ***[2]***

(b) direction of motion is changing / force acts on satellite;
and changing direction means changing velocity / any further detail; ***[2]***

(c) work done is product of force and distance moved in direction of force;
force is always normal to direction of motion;
hence no work done;
(accept argument based on changes in E_k and E_p) ***[3]***

A3. (a) gas that obeys the equation $pV = nRT$ / no forces between molecules;
at all pressures, volumes and temperatures / or any other postulate; ***[2]***

(b) (i) $pV = nRT$
$20\times10^{6}\times2\times10^{-2} = n\times8.3\times290$;
$n = 170$ (166); ***[2]***

(ii) number $= n\times N_A$;
number = $166\times6.02\times10^{23} = 1.0\times10^{26}$; ***[2]***

SECTION B

B1. (a) ray: direction in which wave (energy) is travelling;
wavefront: line joining (neighbouring) points that have the same phase / displacement /
Or suitable reference to Huygen's principle;
ray is normal to a wavefront; ***[3]***

(b) (i) wavefront parallel to D; ***[1]***

(ii) frequency is constant;
since $v = f\lambda, v \propto \lambda$;
wavelength larger in medium I, **hence** higher speed in medium I; ***[3]***
Allow solution based on angles marked on diagram or speed of wavefronts.

(iii) ratio = $\frac{v_I}{v_R} = \frac{\lambda_I}{\lambda_R}$ (or based on Snell's law);
$= \frac{3.0}{1.5} = 2.0$ *allow* ± 0.5; ***[2]***

(c) (i) velocity / displacement / direction in (+) and (–) directions;
idea of periodity; ***[2]***

(ii) period = 3.0 ms;
frequency = $\frac{1}{T}$ = 330 Hz; ***[2]***

(iii) *Accept any one of the following.*
at time t = 0, 1.5 ms, 3.0 ms, 4.5 ms, *etc.* ; ***[1]***

(iv) area of half-loop = 140 ± 10 squares / mean v = 4.0 m s^{-1} *accept* ± 0.2;
$= 140 \times 0.4 \times 0.1 \times 10^{-3}$ / $4.0 \times 1.5 \times 10^{-3}$;
$= 5.6 \times 10^{-3}$ m / 6.0×10^{-3} m;
Award ***[1]*** *for area of triangle.* ***[2]***

(v) (twice) the amplitude;
Allow distance moved in 1.5 m s. ***[1]***

(d) travelling wave transfers energy;
standing wave does not transfer energy;
amplitude same for all particles in a travelling wave;
amplitude varies from zero to a maximum in a standing wave; ***[4]***

(e) (i) distance shown as length of two loops; ***[1]***

(ii) wavelength = $\frac{2}{5} \times 120 = 48$ cm;
$v = f\lambda = 250 \times 0.48$;
$= 120\,\text{m}\,\text{s}^{-1}$; ***[3]***

B2. (a) (i) lines parallel and normal to plates; *(ignore any edge effect)*
equally spaced;
direction from (+) to (–); ***[3]***

(ii) curved path between plates and no curvature outside;
in downward direction; ***[2]***

(b) (i) change = $q\Delta V$;
$= 1.6\times10^{-19}\times750$
$= 1.2\times10^{-16}$ J; ***[2]***
Or 750 eV.

(ii) $\frac{1}{2}mv^2 = 1.2\times10^{-16}$;
$\frac{1}{2}\times9.1\times10^{-31}\times v^2 = 1.2\times10^{-16}$ / $v^2 = 2.64\times10^{14}$ to give $v = 1.67\times10^{7}\ \text{m s}^{-1}$; ***[2]***

(c) (i) inside solenoid, lines parallel to axis;
line spacing about double at ends / lines equally spaced in solenoid;
reasonable shape (symmetry and curving);
correct direction (to left); ***[4]***

(ii) path with no deviation along axis; ***[1]***

(d) (i) velocity component normal to field $= 1.6\times10^{7}\times\sin 35$;
$= 9.2\times10^{6}\ \text{m s}^{-1}$; ***[2]***

(ii) circular motion;
in plane normal to paper;
$\frac{mv^2}{r} = Bqv$ / $r = \frac{(9.1\times10^{-31}\times9.2\times10^{6})}{(4.0\times10^{-3}\times1.6\times10^{-19})}$;
radius of circle $= 1.3\times10^{-2}$ m; ***[4]***

(iii) velocity component along field $= 1.6\times10^{7}\times\cos 35$
$= 1.3\times10^{7}\ \text{m s}^{-1}$; ***[1]***

(iv) force is zero;
because $F = Bqv\sin\theta$ and $\theta = 0$ *or in "words"*; ***[2]***

(e) helical shape *(allow spiral shape)*;
any further detail *e.g.* constant pitch *etc.*;
*Award **[2]** for a good diagram.* ***[2]***

B3. (a) *Deduct **[1]** for each error or omission, stop at zero*

Property	***Effect on rate of decay***		
	increase	*decrease*	*stays the same*
temperature of sample			✓
pressure on sample			✓
amount of sample	✓		

[2 max]

(b) (i) ${}^{4}_{2}\text{He}$ / ${}^{4}_{2}\alpha$;
${}^{222}_{86}\text{Rn}$; ***[2]***

(ii) mass defect = $5.2\times10^{-3}\,u$;
energy $= mc^2$
$= 5.2\times10^{-3}\times1.661\times10^{-27}\times9.00\times10^{16}$ / 1 u = 930 MeV;
$= 7.77\times10^{-13}$ J / 4.86 MeV; ***[3 max]***

(c) (i) (linear) momentum must be conserved;
momentum before reaction is zero;
so equal and opposite after (to maintain zero total); ***[3]***

(ii) $0 = m_\alpha v_\alpha + m_{\text{Rn}} v_{\text{Rn}}$;
$\frac{v_\alpha}{v_{\text{Rn}}} = -\left(\frac{m_{\text{Rn}}}{m_\alpha}\right)$;
$= -\frac{222}{4} = -55.5$;
Ignore absence of minus sign. ***[3]***

(iii) kinetic energy of α-particle $= \frac{1}{2} m_\alpha v_\alpha^{2}$;
kinetic energy of radon nucleus $= \frac{1}{2}\left(\frac{222}{4}\right)\text{m}_\alpha\left(\frac{V_\alpha}{55.5}\right)^2$;
this is 1 / 55.5 of kinetic energy of the α-particle ; ***[3 max]***
*Accept alternative approaches up to **[3 max]**.*

(d) *e.g.* (γ-ray) photon energy or radiation; ***[1]***

(e) (i) two (light) nuclei;
combine to form a more massive nucleus;
with the release of energy / with greater total binding energy; ***[3]***

(ii) high temperature means high kinetic energy for nuclei;
so can overcome (electrostatic) repulsion (between nuclei);
to come close together / collide;
high pressure so that there are many nuclei (per unit volume);
so that chance of two nuclei coming close together is greater; ***[5]***