MARKSCHEME

May 2005

PHYSICS

Standard Level

Paper 2

9 pages

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 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.
- 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) 0.430; *[1]*
*Answer must have 3 significant digits to achieve **[1]**.*
Do not accept 0.429

(b) (i) correct point identified; *[1]*

(ii) plot correct to $\pm\frac{1}{2}$ square; *[1]*
Allow without label if unambiguous.

(iii) straight-line with acceptable fit; *[1]*
Line must have points on both sides and within 1 small square of both extreme/end points.

(c) (i) some indication that large triangle used;
(points separated by at least half-length of line)
correct value from candidate's graph; *[2]*
*Award **[0]** for use of data points not on candidate's line.*

(ii) intercept identified;
should be 0.32, not 0.38 so graph does not agree; *[2]*

(d) straight-line with same gradient;
having intercept of 0.32; *[2]*

A2. (a) for circular motion, force required towards centre of circle / centripetal force;
this provided as a result of extension of the spring; *[2]*
Do not give credit where candidate implies that the spring is pulled outwards by a force.

(b) force produced by spring $= 1.5 \times 18 = 27\ \text{N}$;

use of $F = \frac{mv^2}{r}$;

$27 = \frac{(0.075 \times v^2)}{0.265}$;

$v = 9.77\ \text{m s}^{-1}$; *[4]*

A3. (a) more energetic molecules leave surface;
mean kinetic energy of molecules in liquid decreases;
and mean kinetic energy depends on temperature; ***[3]***
Award ***[2]*** *if mean not mentioned.*

(b) *e.g.* larger surface area;
increased draught;
higher temperature;
lower vapour pressure; ***[2 max]***
Award ***[1]*** *if candidate merely identifies two factors.*

(c) energy to be extracted $= 0.35 \times 4200 \times 25$;
$+0.35 \times 330\,000$;
$+0.35 \times 2100 \times 5$;
$= 156\,000\,\text{J}$

time $= \dfrac{156\,000}{86} = 1800\,\text{s}$; ***[4]***
Allow ECF if one term incorrect or missing.

SECTION B

B1. (a) (i) momentum is mass × velocity;
impulse is force × time ***or*** change in momentum; ***[2]***
In each case, allow an equation, with symbols explained.

(ii) (vector) sum/total of momenta is constant;
for isolated system; ***[2]***

(iii) if force is zero, then acceleration is zero ***or*** $\frac{\Delta p}{\Delta t}$ is zero;

acceleration ***or*** $\frac{\Delta p}{\Delta t} = 0$ means that velocity/momentum must be constant; ***[2]***

(b) (i) $\rightarrow {}^{216}_{84}\mathrm{Po}$;
$+{}^{4}_{2}\mathrm{He}$; *(allow* ${}^{4}_{2}\alpha$*)* ***[2]***

(ii) energy $= 6.29\times10^{6}\times1.6\times10^{-19}$;
$= 1.01\times10^{-12}$ J; ***[2]***

(iii) $E_{\mathrm{k}} = \frac{1}{2}mv^{2}$
$1.01\times10^{-12} = \frac{1}{2}\times4\times1.66\times10^{-27}\times v^{2}$;
All terms in the equation must be seen.
$v = 1.74\times10^{7}\ \mathrm{m\,s^{-1}}$ ***[1]***

(c) (i) direction opposite to that of α-particle; ***[1]***
Ignore length.

(ii) $m_{\alpha}v_{\alpha} = m_{\mathrm{P}}v_{\mathrm{P}}$; *(In words or as an equation - some explanation essential)*

$v_{P} = \frac{4}{216}\times1.74\times10^{7}$;
$= 3.22\times10^{5}\ \mathrm{m\,s^{-1}}$; ***[3]***

(iii) α-particle and nucleus no longer in opposite directions;
any further physics *e.g.* plausible diagram “there is momentum in forward direction”;
or
if initial direction along direction of α-particle;
then no change in directions; ***[2 max]***

(d) (i) decay is a random process;
so not possible to state when nuclei will decay; ***[2]***

(ii) time for activity/mass/number of nuclei to halve;
clear indication of what halves – original isotope, (not daughters); ***[2]***

(iii) smooth curve not touching *t*-axis;
with correct activities at $nT_{\frac{1}{2}}$; ***[2]***
*Award **[1]** if one point not within* $\pm\frac{1}{2}$ *square. Award **[0]** if two points not within* $\pm\frac{1}{2}$ *square.*

(iv) activity at $t = 120\,\text{s}$;
Correct reading to within $\frac{1}{2}$ *square from candidate's graph.*
activity at $t = 330\,\text{s}$: 2^{-6} ***or*** $0.016A_0$; ***[2]***

B2. (a) (i) energy transfer;
no interruption in transfer / without mass motion of the medium; ***[2]***
Do not accept "continuous".

(ii) speed /rate at which energy / wavefronts are propagated; ***[1]***

(b) (i) frequency: number of oscillations/vibrations per unit time; ***[1]***
Do not accept specific units e.g. seconds.

wavelength: distance moved by wave during one oscillation of the source; ***[1]***
Accept distance between successive crests or troughs.

(ii) distance moved during f oscillations $= f\lambda$ ***or*** $f = 1/T$;
if f is frequency, then $f\lambda$ moved in unit time **or** moves distance λ in time T
hence $v = f\lambda$;

(c) (i) wave travels down tube and is reflected;
incident and reflected waves interfere to give standing wave; ***[2]***

(ii) air (column) in tube has natural frequency of vibration;
when fork frequency equals natural frequency;
maximum amplitude of vibration / maximum loudness;
when fork frequency not equal to natural frequency, no resonance / loudness drops; ***[4]***

(iii) $\frac{1}{2}\lambda = 65\,\text{cm}$;
$\text{speed} = 0.65 \times 2 \times 256 = 330\,\text{m s}^{-1}$; ***[2]***
*Award **[1 max]** for $660\,m\,s^{-1}$.*

(d) pressure $= \dfrac{\text{force}}{\text{area}}$
$= \dfrac{(4.0 \times 10^{-5})}{(30 \times 10^{-6})}$;
$= 1.3\,\text{Pa}$;

(e) (i) idea of using area under the line / $\frac{1}{2}kx^2$;
energy $= \frac{1}{2} \times 6 \times 10^{-5} \times 1.5 \times 10^{-2} \times 10^{-3}$ ***or*** $112.5\ (\pm 2.5)$ squares;
$= 4.5 \times 10^{-10}\,\text{J}$; *(Allow $\pm 0.1 \times 10^{-10}$ if candidate counts squares.)* ***[3]***

(ii) period $= 1.0$ ms;
and energy is supplied in $\frac{1}{4}$ period ($= 0.25\,\text{ms}$);
$\text{power} = \dfrac{4.5 \times 10^{-10}}{0.25 \times 10^{-3}}$;
$= 1.8 \times 10^{-6}\,\text{W}$; ***[4]***

(iii) strain energy / energy of deformation of eardrum / kinetic energy of eardrum / vibrational energy; ***[1]***

B3. Part 1 Electrical components

(a) component X, battery, ammeter all in series and including means of varying current;
with voltmeter in parallel across component X; ***[2]***

(b) (i) 4.0 A; ***[1]***

(ii) use of $R = \frac{V}{I}$, and **not** gradient of graph;
resistance $= 1.5\,\Omega$; ***[2]***

(c) (i) straight-line through origin, quadrants 1 or 3 or both;
correct gradient, *i.e.* passes through $V = 4.0\,\text{V}$, $I = 2.0\,\text{A}$; ***[2]***

(ii) p.d.'s across X and across R will be 3.7 V ($\pm 0.1\,\text{V}$) and 6.0 V;
*Award **[0]** if only one p.d. is correct.*
total p.d. = 9.7 V; ***[2]***

(d) (i) large change in resistance with temperature change;
unique value of R at any temperature;
not dissipate thermal energy;
small physical size / small thermal capacity; ***[2 max]***

(ii) measure resistance at two "known" temperatures;
divide scale into equally sized units;
any further detail
e.g. $t/^{\circ} = \frac{(R_t - R_0)}{(R_{100} - R_0)} \times 100$ ***or*** scale is empirical (for this thermometer only) ***or***
fixed point specified; ***[3]***

Part 2 Magnetic fields

(a) concentric circles;
separation increases (at least three circles required to see this);
correct direction (anticlockwise); ***[3]***

(b) (i) current in one turn produces magnetic field in region of the other turn;
gives rise to a force on the wire;
Newton's third / idea of *vice versa* (gives rise to attraction) / idea of *vice versa* (gives rise to shortening); ***[3]***

(ii) use of $B = \frac{\mu_0 I}{2\pi r}$ (gives $B = 1.0 \times 10^{-4}\, I$);
use of $F = BIL$;
$= 1.0 \times 10^{-4} \times I^2 \times 2\pi \times 3.0 \times 10^{-2}$;
this force is equal to mg;
hence $I^2 = 52.04$, and $I = 7.2\,\text{A}$; ***[5]***