MARKSCHEME

November 2006

PHYSICS

Standard Level

Paper 2

14 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.
- Words that are <u>underlined</u> are essential for 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.
- 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 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. 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**.

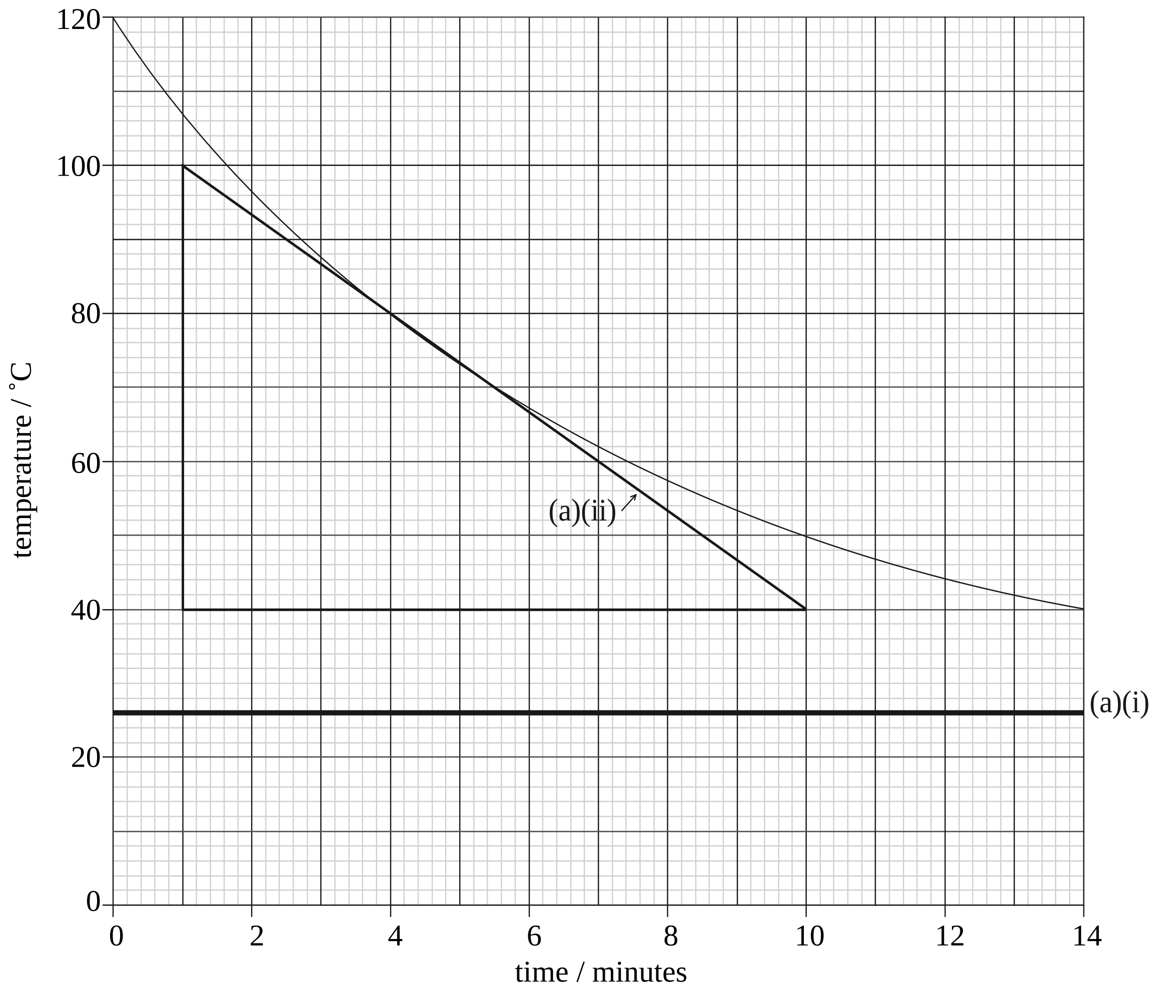
e.g. if the answer is 1.63:

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 **not** deduct again.

SECTION A

A1.



(a) (i) line in correct position from $t = 0$ to $t = 14\,\text{min}$; ***[1]***

Allow $\pm\frac{1}{2}$ square.

(ii) reasonable tangent drawn at correct position *i.e.* at 76°C but allow $70^{\circ}\text{C} \rightarrow 85^{\circ}\text{C}$;

*If tangent position is not acceptable, award **[1 max]** in this section for length of tangent.*

line length used for tangent at least 8 cm;

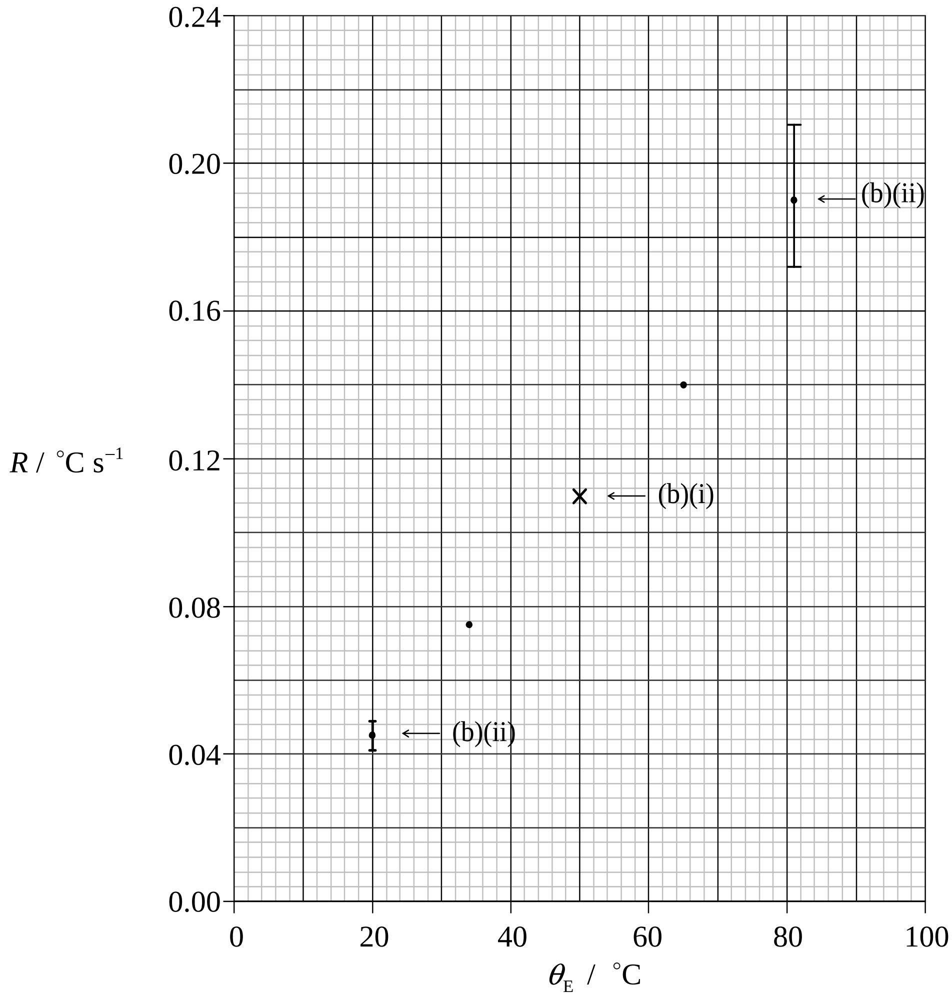
value $0.09 \rightarrow 0.13$;

accuracy – value within $0.10 \rightarrow 0.12$; ***[4]***

*Award **[1]** for value between $\pm 10\%$ and $\pm 20\%$ of 0.11 and **[2]** for value $0.11 \pm 10\%$.*

Unit of answer is not required. If the candidate fails to convert to s^{-1}, then award one of the last two marks for answer in range $6.0 \rightarrow 7.2^{\circ}\text{C}\,\text{min}^{-1}$.

(b)



(i) point plotted correctly; *(allow ECF from (b))* ***[1]***

(ii) error bar at $\theta_E = 20^\circ C : 4(\pm 2)\,mm$ long;
error bar at $\theta_E = 81^\circ C : 20(\pm 4)\,mm$ long; ***[2]***
Ignore any horizontal error bars.

(c) allowing for uncertainties in readings;
points lie on straight-line;
and line passes through origin; ***[3]***
Award ***[1]*** *for "last point off line, so not obeyed".*

A2. (a) suitable choice of scale *e.g.* 4 cm represents 10 N ; *(scale must not be awkward or give rise to short vectors)*

correct construction of triangle/parallelogram;
reading on spring balance A: 16.0 (±0.5) N ;
reading on spring balance B: 12.5 (±0.5) N ; ***[4]***

(b) for equilibrium there must be an upward force and horizontal strings provide no upward force; ***[1]***

A3. changes in internal energy depend on mass, specific heat capacity and temperature rise;
specific heat capacity and temperature rise are unchanged;
mass changes so statement incorrect; ***[3]***

A4. (a) difference in mass between mass of nucleus;
and mass of (totally) separate nucleons; ***[2]***

(b) mass of helium-4 $= 4 \times 0.00760 = 0.0304u$
and mass of two deuteriums $= 4 \times 0.00120 = 0.0048u$;
mass defect $= 0.0256u$;
energy $= 0.0256 \times 1.66 \times 10^{-27} \times (3 \times 10^{8})^{2}$;
$= 3.8 \times 10^{-12}$ J ; ***[4]***

If a candidate has given an incorrect mass defect, award the last two marking points as ECF.

SECTION B

B1. Part 1 Linear motion

(a) change in velocity / rate of change of velocity;
per unit time / with time; *(ratio idea essential to award this mark)* ***[2]***

(b) (i) acceleration is constant/uniform; ***[1]***

(ii) $t = \frac{2s}{(u+v)}$ and $t = \frac{(v-u)}{a}$;
clear working to obtain $v^2 = u^2 + 2as$; ***[2]***

(c) (i) $1.96 = \frac{1}{2} \times 9.81 \times t^2$;
$t = 0.632\,\text{s}$; ***[2]***

(ii) time to fall $(1.96 + 0.12)\,\text{m}$ is $0.651\,\text{s}$;
shutter open for $0.019\,\text{s}$; ***[2]***
If the candidate gives a one significant digit answer treat it as an SD-1.
Award ***[0]*** *if the candidate uses $s = \frac{1}{2}at^2$ and $s = 12\,cm$.*

Part 2 Collisions

(a) (i) centripetal force is provided by the cable / the ball is moving along the arc of a circle; ***[1]***

(ii) centripetal force $= \dfrac{(350 \times 2.6^2)}{5.8}$;

$= 410\,\text{N}$;

tension $= 410 + (350 \times 9.8) = 3800\,\text{N}$; ***[3]***

*Award **[0]** if $\dfrac{v^2}{r}$ is not used.*

(b) idea of use of area under graph / appropriate equation;

distance $= \frac{1}{2} \times 0.15 \times 2.6$ *(allow 0.14 → 0.15 s for the time)*

$= 0.195\,\text{m}$; *(allow 0.20 m, not 0.2 m)* ***[2]***

(c) idea of momentum as *mv*;

total change $(= 2.6 \times 350) = 910\,\text{Ns}$; ***[2]***

(d) (i) for isolated/closed system;

total momentum remains constant; ***[2]***

(ii) external force acts on ball;

so law does not apply to the ball;

or

system is ball + wall/Earth;

momentum loss of ball = momentum gain of wall/Earth; ***[2]***

(e) $E_K = \frac{1}{2} \times 350 \times 2.6^2$;

thermal energy $= 350 \times 450 \times \Delta\theta$;

idea of $0.12 \times E_K = mc\Delta\theta$;

$\Delta\theta = 9.0 \times 10^{-4}\,\text{K}$; ***[4]***

B2. Part 1 Wave phenomena

(a) (i) wave that transfers energy; ***[1]***

(ii) amplitude $= 4.0\,\text{mm}$; ***[1]***

wavelength $= 2.4\,\text{cm}$; ***[1]***

frequency $= \dfrac{1}{0.3}$;
$= 3.3\,\text{Hz}$; ***[1 max]***

speed $= 3.3 \times 2.4$;
$= 8.0\,\text{cm}\,\text{s}^{-1}$; ***[1 max]***

(b) (i) angle of incidence $= 40^{\circ}$;
$\sin\ r = \dfrac{\sin 40}{1.4}$
$r = 27^{\circ}$;
angle $= 63^{\circ}$; ***[3]***
*Award **[1 max]** for angle of incidence $= 50^{\circ}$, $r = 33^{\circ}$.*

(ii) construction: wavefronts equally spaced;
separation less in medium B;
angle in medium B correct – by eye; ***[3]***

B2. Part 2 Gases

(a) temperature of air is $290\,\text{K}$;

$$\text{amount} = \frac{(2.7\times10^{5}\times1.17\times10^{4}\times1.0\times10^{-6})}{(8.31\times290)};$$

$$= 1.31\,\text{mol};$$ ***[3]***

(b) new amount $= 1.31\times\left(\frac{3.10}{2.70}\right)$; *(or full substitution)*

$$= 1.51\,\text{mol};$$

$$\text{number of strokes} = \frac{(1.51-1.31)}{0.008};$$

$$= 25;$$ ***[4]***

(c) (i) work done $= 280\times9.0\times10^{-2}\times25$;

$$= 630\,\text{J};$$ ***[2]***

(ii) $$\text{efficiency} = \frac{(225\times100)}{630};$$

$$= 36\,\%;$$ ***[2]***

(d) *V* is volume in which the gas molecules can move;
molecules cannot move "inside" each other;
so reduce *V*; *(do not award this mark if <u>both</u> the answers above are incorrect)* ***[3]***

B3. Part 1 Electricity

(a) metal conductor: positive charges fixed;
mobile electrons;
plastic insulator: (positive charges and) electrons fixed; ***[3]***

(b) (i) electric field causes movement of electrons (in metal);
and charges are not moving; ***[2]***

(ii) electrons move;
from Earth to the electroscope; ***[2]***

(c) (i) e.m.f. is the p.d. across cell when current is zero;
find intercept on *V*-axis; ***[2]***

(ii) r is $(-)$ gradient of graph ***or*** $r =$e.m.f./current when $V = 0$ ***or*** value of R quoted at a given voltage;
relevant working shown on graph ***or*** use $E = Ir + IR$; ***[2]***

(d) diagram showing resistor in series with device;
from graph, at 1.5 A, p.d. is 2.7 V ***or*** use of $E = I(R + r)$
to give total external resistance as $1.8\,\Omega$;
p.d. across $R = 2.7 - 0.8 = 1.9\,\text{V}$ resistance of device $= \frac{0.8}{1.5} = 0.53\,\Omega$;
resistance $= \frac{1.9}{1.5} = 1.27\,\Omega$ resistance $= 1.8 - 0.53 = 1.27\,\Omega$; ***[4]***

(e) $2P$;
P;
$\frac{1}{2}P$; ***[3]***

Part 2 Radioactivity

(a) different forms of same element / nuclei having same proton number;
with different nucleon / mass numbers; ***[2]***

(b) ${}^{42}_{20}\text{Ca}$;
${}^{0}_{-1}\text{e}$ ***or*** ${}^{0}_{-1}\beta$; (*do not accept* e^{-}). ***[2]***
Award ***[1 max]*** *if any extra particle e.g. neutron is included in equation.* ***[2]***

(c) line as "inverse" of given line, *i.e.* starts at zero, curves correct direction and flattens out reasonably; ***[1]***

(d) ratio of 7.0 means $\frac{1}{8}$ of nuclei are potassium-42;
time is $(3\times 12.5 =)\,37.5$ hours; } *award this mark for reading from graph based on fraction* $\frac{1}{7}$. ***[2]***