INTERNATIONAL BACCALAURÉAT BACHILLERATO
IBO
BACCALAUREATE INTERNATIONAL INTERNACIONAL

M04/431/S(2)M+

# MARKSCHEME

## May 2004

## PHYSICS

## Standard Level

## Paper 2

9 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 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. 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) reasonable scale and axes labelled;
*The graph must occupy at least half the grid.*
plots correct to within $\frac{1}{2}$ square; } *Award **[2]** if correct, **[1]** for one error and **[0]** for two or more errors* **[3]**

(b) (i) reasonable curve from 0°C to 10°C; **[1]**
*Expect smooth single line within one square of each correctly plotted point.*

(ii) 3800 ± 50 Ω;
2630 ± 20 Ω; **[2]**
*Allow ecf from candidate's graph.*

(c) correct line drawn; **[1]**

(d) (i) value correct from graph, 6.2°C; **[1]**
*Allow* $\pm\frac{1}{2}$ *square.*

(ii) error is 1.0°C;
% error = $\left(\frac{1}{5.2}\right)\times 100$;
= 19 %; **[3]**
*Allow "bald" correct answers.*
*Award **[2]** if* $\left(\frac{1}{6.2}\right)\times 100 = 16$ *% is used – or candidates figures.*

**A2.** (a) horizontal component = R sin14;
= 8500 tan14;
= 2119 N ≈ 2100 N **[2]**
*Award **[1]** for sin14 and **[0]** for cos14.*

(b) 2100 N;
horizontally / to centre of circle / correct angle clear; **[2]**

(c) use of $F = \frac{mv^2}{r}$;
$2100 = \frac{(8500v^2)}{(9.8\times 150)}$;
$v$ = 19 m s$^{-1}$; **[3]**
*Allow* $g = 10\,m\,s^{-2}$ *but award answers showing the incorrect use of g **[1 max]**.*

(d) friction must supply larger force towards centre / *OWTTE*;
car tends to slide up the ramp; **[2]**

**A3.** (a) use of $\frac{1}{2}mv^2$ and $ml$;
$\frac{1}{2}v^2 = 340 \times 10^3$;
$v = 820\,\text{m s}^{-1}$; ***[3]***
*Award **[2 max]** if $\times 10^3$ missing, answer $26\,\text{m s}^{-1}$. Award **[3]** if the candidate assumes value for m.*

(b) comment on speed *e.g.* speed is very large (> speed of sound)
*e.g.* in practice speeds are much lower than this;
hence hailstone will not melt; ***[2]***
*Allow any relevant comment and conclusion based on candidate's answer to (a).*

## SECTION B

**B1.** (a) (i) zero deflection of leaf;
negative charge on cap; *(award **[0]** if charge shown elsewhere)* ***[2]***

(ii) diagram unchanged from diagram 2; ***[1]***

(iii) leaf raised;
negative charge on leaf and cap; *(disregard number of (–) signs)* ***[2]***

(b) (i) energy per unit charge; *(ratio idea necessary)*
to move <u>positive</u> test charge between points; ***[2]***

(ii) leaf undeflected when charge on electroscope / *vice versa*;
leaf deflects when charge moved towards/away from electroscope;
<u>hence</u> gives a measure of potential; ***[3]***
*Allow any sensible relevant comments leading to a valid conclusion.*

(c) (i) use of e.m.f. = energy / charge;

$$= \frac{(8.1\times10^{3})}{(5.8\times10^{3})}$$

$$= 1.4 \text{ V};$$ ***[2]***

*Award **[0]** for formula $E = \frac{F}{Q}$ seen or implied even if answer is numerically correct.*

(ii) p.d. across internal resistance = 0.2 V; **OR** $\text{current} = \frac{1.2}{6} = 0.2\text{A};$

$\text{resistance } r = \left(\frac{0.2}{1.2}\right)\times 6.0;$ $\text{total resistance} = \frac{1.4}{0.2} = 7.0\,\Omega;$

$= 1.0\ \Omega;$ $\text{internal resistance} = 7 - 6 = 1.0\,\Omega;$ ***[3]***

*Accept any other valid route.*

(iii) idea of use of ratio of resistances;
energy transfer = $6/7\times8.1\times10^{3}$
= $6.9(4)\times10^{3}$ J; ***[2]***
*Accept any other valid route.*

(iv) charge carriers/electrons have kinetic energy / are moving;
these carriers collide with the lattice/lattice ions; *(do not allow friction)*
causing increased (amplitude of) vibrations;
this increase seen as a temperature rise;
*i.e.* a transfer to thermal energy; ***[5]***
*Allow any other relevant and correct statements*.

(d) chemical energy in battery → electrical energy / kinetic energy of electrons;
electrical energy → magnetic energy / kinetic energy of iron pieces;
→ (gravitational) potential energy of iron pieces; ***[3]***

**B2.** (a) (i) distance travelled per unit time;
by the energy of the wave / by a wavefront; ***[2]***

(ii) velocity has direction;
but light travels in all directions; ***[2]***

(b) (i) distance in a particular direction; *(accept in terms of energy transfer)*
(of a particle) from its mean position; ***[2]***

(ii) *longitudinal*: displacement along;
*transverse*: displacement normal to;
direction of transfer of wave energy / propagation, **not** motion; ***[3]***
*Award **[0]** for left/right and up/down for longitudinal/transverse.*

(c) (i) $\left(\frac{700}{75}\right) = 9.3\,\text{km}\,\text{s}^{-1};\ (\pm 0.1)$ ***[1]***

(ii) $\left(\frac{700}{120}\right) = 5.8\,\text{km}\,\text{s}^{-1};\ (\pm 0.1)$ ***[1]***
*Award **[1 max]** if the answers to (i) and (ii) are given in reversed order.*

(d) (i) P shown as the earlier (left hand) pulse; ***[1]***

(ii) laboratory $L_3$; ***[1]***

(iii) *e.g.* pulses arrive sooner;
smaller S-P interval;
larger amplitude of pulses; ***[3]***
*Allow any feasible piece of evidence, award **[1]** for each up to **[3 max]**.*

(iv) *distance from* $L_1$ = 1060 km; (± 20)
*distance from* $L_2$ = 650 km; (± 20)
*distance from* $L_3$ = 420 km; (± 20)
*Accept 3 significant digits in all three estimates.*
some explanation of working; ***[4]***

(v) position marked, consistent with answers to (iv);
to the right of line $L_2\ L_3$, closer to $L_3$; ***[1 max]***
*If the answers given in (iv) means that the point cannot be plotted, then only allow the mark if the candidate states that the position cannot be plotted/does not make sense.*

(e) (i) illustration showing node at centre, antinode at each end; ***[1]***

(ii) wavelength of standing wave $= (2 \times 280) = 560$ m / ecf ***or*** $\frac{3.4 \times 10^3}{6} = 570\,\text{m}$ ;

frequency $= \frac{(3.4 \times 10^3)}{560} \approx 6\,\text{Hz}$ ***or*** wavelength of standing wave $= (2 \times 280) = 560\,\text{m}$ ;

earthquake frequency is natural frequency of vibration of building / mention of resonance / multiple/submultiple if ecf; ***[3]***

**B3.** (a) (i) *fission*:
nucleus splits;
into two parts of similar mass;

*radioactive decay*:
nucleus emits;
a particle of small mass and/or a photon; ***[4]***

(ii) ${}^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n}$ ;
$\rightarrow {}^{90}_{38}\mathrm{Sr} + {}^{142}_{54}\mathrm{Xe} + 4{}^{1}_{0}\mathrm{n}$ ; ***[2]***
*Allow ecf for RHS if LHS is incorrect.*

(iii) mass number unchanged;
atomic number increases by +1; ***[2]***

(b) (i) use of $E_k = \dfrac{p^2}{2m}$ / equivalent;
correct conversion of MeV to joule $(1.63\times10^{-11}\,\mathrm{J})$;
correct conversion of mass to kilogram $(1.50\times10^{-25}\,\mathrm{kg})$;
momentum $= 2.2\times10^{-18}\,\mathrm{N\,s}$; ***[4]***

(ii) total momentum after fission must be zero;
must consider momentum of neutrons (and photons); ***[2]***

(iv) xenon not opposite to strontium but deviation $< 30°$);
arrow shorter / longer; ***[2]***

(c) (i) energy $= 0.25\times198\times1.6\times10^{-13}$;
$= 7.9\times10^{-12}\,\mathrm{J}$; ***[2]***

(ii) use of $\Delta Q = mc\Delta\theta$;
energy $= 0.25\times4200\times80$;
$= 8.4\times10^{4}\,\mathrm{J}$; ***[3]***

(iii) number of fissions $= \dfrac{(8.4\times10^{4})}{(7.9\times10^{-12})}$;
$= 1.1\times10^{16}$;
mass $= 1.1\times10^{16}\times3.9\times10^{-25}$;
$= 4.1\times10^{-9}\,\mathrm{kg}$; ***[4]***