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MARKSCHEME

May 2008

PHYSICS

Standard Level

Paper 2

13 pages

Subject Details: Physics SL Paper 2 Markscheme

Mark Allocation

Candidates are required to answer **ALL** questions in Section A **[25 marks]** and **ONE** question in Section B **[25 marks]**. Maximum total = **[50 marks]**.

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

2. Each marking point has a separate line and the end is signified by means of a semicolon (;).

3. An alternative answer or wording is indicated in the markscheme by a slash (/) – either wording can be accepted.

4. Words in brackets ( ) in the markscheme are not necessary to gain the mark.

5. Words that are <u>underlined</u> are essential for the mark.

6. The order of marking points does not have to be as in the markscheme, unless stated otherwise.

7. If the candidate's answer has the same "meaning" or can be clearly interpreted as being of equivalent significance, detail and validity as that in the markscheme then award the mark. Where this point is considered to be particularly relevant in a question it is emphasized by writing ***OWTTE*** (or words to that effect).

8. Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.

9. Occasionally, a part of a question may require an answer that is required for subsequent marking points. If an error is made in the first marking point then it should be penalized. However, if the incorrect answer is used correctly in subsequent marking points then **follow through** marks should be awarded. Indicate this with **ECF** (error carried forward).

10. Only consider units at the end of a calculation. Unless directed otherwise in the mark scheme, unit errors should only be penalized once in the paper. Indicate this by writing **–1(U)** at the first point it occurs and **U** on the cover sheet.

11. Significant digits should only be considered in the final answer. Deduct **1 mark in the paper** for an **error of 2 or more digits** unless directed otherwise in the markscheme.

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 writing **–1(SD)** at the first point it occurs and **SD** on the cover sheet.

SECTION A

A1. (a) $\pm 0.5\,^{\circ}\mathrm{C}$; ***[1]***

Do not accept $1^{\circ}C$.

(b) (i) *at* $20^{\circ}C$: $1800\,\Omega$; ***[1]***

at $5^{\circ}C$: within range $3080\,\Omega \rightarrow 3220\,\Omega$;
within $3120\,\Omega \rightarrow 3180\,\Omega$; ***[2]***

(ii) use of tangent at correct position clear;
answer $64\,\Omega\,\mathrm{K}^{-1}$ ***or*** $64\,\Omega\,^{\circ}\mathrm{C}^{-1}$; *(allow* $\pm 2\,\Omega\,K^{-1}$ ***or*** $\pm 2\,\Omega\,^{\circ}C^{-1}$*)*
negative sign; ***[3]***

(c) gradient of graph decreases as temperature rises / increases as temperature drops; *{accept "gradient not constant".}*
so relationship cannot be linear; ***[2]***

or

straight-line joining extreme points;
does not pass through "error boxes" of all points;

(d) product *RT* calculated correctly for two points;
product calculated correctly for third point;
conclusion: not same value so suggestion not correct; ***[3]***
*Award **[2 max]** if °C used instead of K.*

A2. (a) (i) $\mathrm{kg\,m\,s^{-2}}$; ***[1]***

(ii) $\mathrm{m\,s^{-1}}$; ***[1]***

(b) $\mathrm{kg\,m^{-1}}$; ***[1]***
ECF if candidate uses Newton for (a)(i) to obtain $N\,m^{-2}\,s^{2}$.

A3. (a) (i) extension $= 4.2\,\mathrm{cm}$; *(stated or shown in the working)*
force $= (4.2 \times 2.5 =)\,10.5\,\mathrm{N}$; ***[2]***

(ii) force $= (1.8 \times 2.5 =)\,4.5\,\mathrm{N}$; ***[1]***

(b) resultant force $= 6.0\,\mathrm{N}$; *(stated or shown in the working)*
acceleration $= \left(\frac{6.0}{0.75} =\right) 8.0\,\mathrm{m\,s^{-2}}$; ***[2]***
Accept $F = (k_1 + k_2)s = (2.5 + 2.5) \times 1.2 = 6\,N$.

A4. (a) gold leaf fallen;
negative charge on cap and no charge on gold leaf; ***[2]***

(b) gold leaf raised;
negative charge over gold leaf and cap; ***[2]***

(c) it would (give a measure of the charge) in diagram 4 but not in diagram 3; ***[1]***
Answer to be consistent with the candidate's diagrams 3 and 4.

SECTION B

B1. Part 1 Momentum

(a) (i) momentum is mass × <u>velocity</u>; ***[1]***

(ii) impulse is force × time / change in momentum; ***[1]***
In each case allow an equation, with symbols explained.

(b) (i) $\Delta p = 450\ (18-13)$;
$= 2250\,\text{kg m s}^{-1}$ ***[1]***

(ii) idea of equating Δp to change in momentum of water;
$m = \frac{2250}{19} = 118\,\text{kg}\ (\approx 120\,\text{kg})$; ***[2]***

(iii) time of trolley in tank $= \frac{9.3}{15.5} = 0.60\,\text{s}$;

$a = \frac{(18-13)}{0.60}$ ***or*** $force = \frac{2250}{0.60}\ (= 3750\,\text{N})$;

$a = 8.3\,\text{m s}^{-2}$ $a = \frac{3750}{450} = 8.3\,\text{m s}^{-2}$; ***[3]***

or

$v^2 = u^2 + 2as$;

$a = \frac{13^2 - 18^2}{2 \times 9.3}$;

$a = 8.3\,\text{m s}^{-2}$;

(c) (i) $E_\text{K} = \frac{1}{2}mv^2$;
$= \frac{1}{2} \times 450 \times (18^2 - 13^2)$;
$= 35\,000\,\text{J}$; ***[3]***

(ii) $E_K = \frac{1}{2} \times 118 \times 19^2$
$= 21000\,\text{J}$; *(allow 22 000 J for use of m = 120 kg)* ***[1]***

(d) some water will be thrown "sideways";
this will account for the difference in the kinetic energies;
this will not have any momentum in the forward direction / equal masses of water to left and right; ***[3]***

B1. Part 2 Force fields

(a) (i) *at A*: constant;
at B: decreasing; ***[2]***

(ii) field line gives the direction of the force (on mass or charge);
if lines touched (or crossed), particle would move in two directions at the same time and this is impossible; ***[2]***

(b) (i) must be a force normal to direction of motion / some reference to circular motion;
so field is magnetic; { *Do not award if there is no reasoning or reasoning is fallacious or misleading.* ***[2]***

(ii) particles are oppositely charged; ***[1]***

(iii) $r = \frac{mv}{Bq}$;
speed is decreasing / particle losing energy;
hence radius is decreasing; { *Do not award if there is no reasoning or reasoning is fallacious or misleading.* ***[3]***

B2. Part 1 Latent heat and specific heat

(a) (i) quantity of thermal energy/heat required to convert unit mass / mass of 1 kg of liquid to vapour/gas;
with no change of temperature / at its boiling point; ***[2]***

(ii) on vaporizing, potential energy of molecules/atoms increases;
on vaporizing, kinetic energy of molecules/atoms does not change;
only change in kinetic energy seen as change in temperature; ***[3]***
The term "vaporizing" or "phase change" should be present at least once to award full marks.

(b) (i) heater, variable resistor and power supply in series;
ammeter in series with heater, voltmeter in parallel with heater; ***[2]***

(ii) $P = VI$ used – not merely quoted;
$I = \frac{80}{9} = 8.9\,\text{A}$; ***[2]***

(iii) idea of $power \times time = mass \times latent\ heat$;
allowance made in equation for heat loss to atmosphere;
$(80 - 35) \times 60 = (1.89 - 0.70) \times L$;
$L = 2300\,\text{J g}^{-1}$; ***[4]***
*Award **[3 max]** for use of two powers and a reference to heat loss to atmosphere/environment to explain the difference in numerical values of L.*
*Award **[2 max]** for use of two powers and taking an average.*
*Award **[1 max]** for use of one power only.*

(c) (i) $\text{mass} = (650 - 350) \times 6 \times 1 = 1800\,\text{g}$; ***[1]***

(ii) $\text{energy} = 1.8 \times 4.2 \times 10^3 \times (100 - 18)$;
$= 6.2 \times 10^5\,\text{J}$ ***[1]***
Award mark for the substitution, not the final answer.

(iii) $\text{cost} = \frac{6.2 \times 10^5 \times 365 \times 3.5}{1.0 \times 10^6}$;
$= 790$ cents; ***[2]***

B2. Part 2 Linear and circular motion

(a) (i) spacing of the dots is increasing / *OWTTE*; ***[1]***

(ii) three further dots;
spacing increases by two squares between any two dots; ***[2]***

(iii) $\text{distance} = 37.6\,\text{m}$; ***[1]***

(b) (i) travels $(2.2 \times 4 =)\, 8.8\,\text{m}$ between drops;
$\text{speed} = \left(\frac{8.8}{0.80} = \right) 11\,\text{m}\,\text{s}^{-1}$; ***[2]***

(ii) in each $0.80\,\text{s}$, speed increases by $\frac{(0.4 \times 4)}{0.80} = 2.0\,\text{m}\,\text{s}^{-1}$;
$\text{acceleration} = \left(\frac{2.0}{0.80} = \right) 2.5\,\text{m}\,\text{s}^{-2}$; ***[2]***

or

in (2×0.80) seconds, distance traveled is $3.2\,\text{m}$;
$a = \frac{2(\Delta s)}{t^2} = \frac{2 \times 3.2}{(1.6)^2} = 2.5\,\text{m}\,\text{s}^{-2}$;
Allow a different choice of appropriate time interval to give correct answer.

B3. Part 1 Waves

(a) (i) C shown where graph line cuts *x*-axis; ***[1]***

(ii) amplitude $=0.20\,\text{mm}$; ***[1]***

(iii) time period $=0.30\,\text{ms}$;
use of $v = f\lambda$ <u>and</u> $f = \frac{1}{T}$ ***or*** $v = \frac{\lambda}{T}$;
$\lambda = 380\times 0.30\times 10^{-3} = 0.11\,\text{m}$; ***[3]***
ECF if time period misread.

(b) (i) superposition of two waves / *OWTTE*;
of same frequency and amplitude travelling in opposite directions; ***[2]***

(ii) stationary/standing wave is set up in the tube;
heaps form at the (displacement) nodes / powder pushed away from antinodes; ***[2]***

(iii) wavelength $= (2\times 9.3 =)\,18.6\,\text{cm}$;
speed $= (1800\times 0.186 =)\ 330\,\text{m}\,\text{s}^{-1}$; ***[2]***
ECF if value of wavelength wrong.

(c) heaps further apart means longer wavelength;
hence speed increases (as temperature rises); { *Do not award if there is no reasoning or reasoning is fallacious or misleading.* } ***[2]***

B3. Part 2 Nuclear decay

(a) (i) emission of particles and/or e.m. radiation from unstable nucleus;
not affected by temperature/environment / is spontaneous process;
constant probability of decay (per unit time) / is random process;
activity/number of unstable nuclei in sample reduces exponentially;
daughter nucleus is (energetically) more stable; ***[3 max]***

(ii) electron(s) ejected from (neutral) atoms;
to form positively and negatively charged particles; *(do not allow "ions")* ***[2]***

(b) (i) fission; ***[1]***

(ii) **N.B.** *positions may be marked on line or on x-axis.*
U shown near right-hand end of line;
Sr and Xe shown between U and the peak with Sr to the left of Xe; ***[2]***

(iii) total binding energy of uranium $= 1189 + 784.8 - 187.9$;
$= 1785.9\,\text{MeV}$;
binding energy per nucleon $= \left(\frac{1785.9}{235} =\right) 7.60\,\text{MeV}$; ***[3]***
Allow unit as MeV or MeV per nucleon.
Accept answer in Joules e.g. $1.22 \times 10^{-12}\,J$.

(iv) binding energy is zero because neutrons are separate particles; ***[1]***