MARKSCHEME

November 2007

PHYSICS

Standard Level

Paper 2

General Marking Instructions

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.
- 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. Where this point is considered to be particularly relevant in a question it is emphasized by writing *OWTTE* (or words to that effect).
- 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.
- 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.
- Only consider units in the final answer. Omission of units should only be penalized once in the paper.
- Significant digits should only be considered in the final answer. Deduct **1 mark in the paper** 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*

  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) equation corresponds to a straight line (and this is a curve); ***[1]***

(b) (i) unit is s/seconds; ***[1]***

(ii) 2.35; *(3 significant digit essential)* ***[1]***
Responses may be given in table. Do not penalize wrong units.

(c) (i) 31.5, 3.10; *(plotted to within $\pm 1\,\text{mm}$)*
22.5, 2.35; *(plotted to within $\pm 1\,\text{mm}$) (allow e.c.f. from (b)(ii))* ***[2]***

(ii) reasonable best-fit straight-line; ***[1]***

(d) (i) at $35\,\text{m}\,\text{s}^{-1}$, allow $\frac{D}{v}$ in range $3.30 \rightarrow 3.45\,(\text{s})$;
so D within range $116 \rightarrow 121$ m; ***[2]***
Penalize once if $\frac{D}{v}$ is not in the range $3.30 \rightarrow 3.45\,(\text{s})$ and then use ECF for the second marking point.

(ii) intercept within range $0.55 \rightarrow 0.70$ (s); ***[1]***

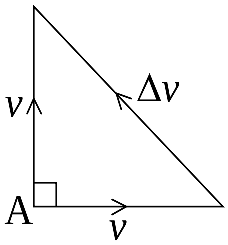
(iii) use of "triangle" with hypotenuse at least half length of graph line; $\left\{ \begin{array}{l} \textit{Only allow use of data points if} \\ \textit{the points lie on the graph line.} \end{array} \right.$
gradient in range $0.074 \rightarrow 0.084$; ***[2]***
Allow candidate's values in (d)(ii) and (d)(iii).

(e) $D = 0.62v + 0.079v^2$; ***[1]***
Accept correct equation or correct statement about the values of a and b.

(f) (i) correct substitution and calculation into formula in (e); ***[1]***

(ii) *Appropriate comment*:
e.g. close values indicate that equation is correct / two values are within possible uncertainties of measurement; ***[1]***

A2. (a)



arrow drawn (from A) of about correct length;
arrow drawn (from A) at about correct angle;
vector Δv labelled clearly and in correct direction; ***[3]***

*Award **[1 max]** if vectors are added and **[1 max]** if Δv is opposite to correct direction.*

(b) Δv is directed towards the centre of the circle;
force necessary to cause change in velocity/ Δv; ***[2]***
Response must clearly refer to diagram and be consistent with it.

A3. (a) $\dfrac{\text{p.d. across resistor}}{\text{current in resistor}}$; *(ratio must be clear)* ***[1]***

(b) (i) combined resistance $= 4.0\,\Omega$; ***[1]***

(ii) use of parallel resistors formula to give $2.4\,\Omega$;
combined resistance $= 2.4 + 6.0$;
$= 8.4\,\Omega$ ***[2]***

(iii) (vertical) resistor either side of terminals AB circled;
resistor has shorted / became zero resistance; ***[2]***

SECTION B

B1. Part 1 Linear motion

(a) (i) $E_K = \frac{1}{2} \times 72 \times 23^2$;
$= 1.9 \times 10^4$ J ; ***[2]***

(ii) uses area between the *t*-axis and the line;
correctly converts area $\rightarrow$ distance (one $1\text{cm} \times 1\text{cm}$ square $\equiv 5.0\,\text{m}$);
distance between 90 m and 105 m;
improved accuracy, distance between 95 m and 100 m; ***[4]***
Do not accept kinematic formulas. Distance can only be found from area.

(b) (i) $\Delta E_P = 72 \times 9.8 \times 41$;
$= 2.9 \times 10^4$ J ; ***[2]***
Accept 3.0×10^4 *J for responses using* $g = 10\,\text{m}\,\text{s}^{-2}$.

(ii) ratio $= \dfrac{(2.9 \times 10^4 - 1.9 \times 10^4)}{(2.9 \times 10^4)}$;
$= 0.34$; ***[2]***
Accept 0.37 for responses using $g = 10\,\text{m}\,\text{s}^{-2}$.

(iii) fraction of energy lost due to air resistance / friction between skis and slope / work to push snow away from skis; ***[1 max]***

(c) (i) $1.8 = \frac{1}{2} \times 9.8 \times t^2$;
$t = 0.61\,\text{s}$; ***[2]***

(ii) distance $= 23 \times 0.61$;
$= 14\,\text{m}$; ***[2]***

Part 2 Nuclear reactions

(a) (i) nucleus emits;
an α-particle / a β-particle / *and/or* γ-ray photon / ionizing radiations; ***[2]***

(ii) cannot tell which nucleus will decay next;
cannot state at what time a nucleus will decay; ***[2]***
*Award **[2]** for constant probability of decay per unit time.*

(b) (i) $^{17}_{8}\text{O}$;
$^{1}_{1}\text{p}$; ***[2]***

(ii) mass difference $= (-)1.29\times10^{-3}\,u$;
energy $= (1.29\times10^{-3}\times931) = 1.20\,\text{MeV}$;
indicates in some way that mass defect is on left-hand side of equation / mass defect is negative;
α-particles must <u>provide at least 1.20 MeV</u> of energy; ***[4]***

B2. Part 1 Momentum

(a) the momentum of a system (of interacting particles) is constant;
if no external force acts on system / net force on system is zero / isolated system; ***[2]***
A statement of "momentum before = momentum after" achieves first mark only.

(b) (i) use of volume $= \pi r^2 \times v$;
$= \pi \times (1.4 \times 10^{-3})^2 \times 18$;
$= 1.1 \times 10^{-4}\ \text{m}^3$ ***[2]***

(ii) mass ejected per second $= 1.1 \times 10^{-4} \times 1000 = 0.11\ \text{kg}$;
change in momentum per second $= 0.11 \times 18$;
by Newton's 2nd, this is <u>force on</u> (ejected) <u>water</u>;
by Newton's 3rd, equal <u>force acts upwards on rocket</u>;
so force is $2.0\ \text{N}$ ***[4]***
Do not accept references to momentum conservation.

(iii) weight of water to be ejected $= 5.0\ \text{N}$ / mass of water to be ejected $= 0.51\ \text{kg}$;
time delay $= 4.6\ \text{s}$; ***[2]***

Part 2 Temperature and thermal energy

(a) property measured at two known temperatures (and at unknown temperature);
(temperature calculated) assuming linear change of property with temperature; ***[2]***
*Award **[1]** for descriptions of constructing a thermometer.*

(b) thermometer absorbs (thermal) energy/heat from the body / has a thermal capacity;
so changes temperature of body;

or

time taken for (thermal) energy/heat to be conducted into thermometer;
so may not be able to follow changing temperature; ***[2]***

(c) (i) quantity of (thermal) energy/heat required to raise temperature of unit mass;
by one degree;

or

$c = \dfrac{\Delta Q}{m \Delta \theta}$;
with ΔQ, m and $\Delta\theta$ explained; ***[2]***

(ii) $m \times 330$;
$+ m \times 4.2 \times 8$;
$= 0.45 \times 4.2 \times 16$;
$m = 0.083\,\text{kg}$; ***[4]***
*Award **[2 max]** for an answer $m = 0.092\,\text{kg}$ – ignoring ice-water.*

(d) (i) *(both are change from liquid $\rightarrow$ vapour phase)*
evaporation:
occurs at surface of liquid;
occurs at all temperatures;

boiling:
occurs in the body of the liquid;
occurs at one temperature / boiling point; ***[2 max]***

(ii) separation of molecules increases in the change from liquid to vapour phase;
this involves an increase in potential energy;
but temperature observed to change only when kinetic energy changes; ***[3]***

B3. **Part 1** Wave properties

(a) (i) direction in which energy is travelling / locus of one point on a wavefront; ***[1]***

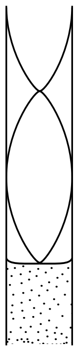
(ii) speed at which energy is propagated along the wave; ***[1]***

(b) (i) frequency $\left(=\left\{6.0\times10^{-3}\right\}^{-1}\right)=170\,\text{Hz}$; ***[1]***

(ii) at $t=1.0\,\text{ms}$, displacement $(=1.7+0.7)=2.4\,\text{mm}$;
at $t=8.0\,\text{ms}$, displacement $=1.7-0.7$;
$=1.0\,\text{mm}$; ***[3]***

(c) (i) wave (travels down tube and) is reflected at (water surface);
incident and reflected waves interfere/superpose; ***[2]***

(ii)



i.e. $\frac{3}{4}\lambda$, 2 nodes, 2 antinodes;
<u>all</u> nodes marked; ***[2]***

Accept pressure nodes if clearly identified.

(iii) substitution in $v=f\lambda$;
$\frac{1}{2}\lambda=56\,\text{cm}$;
$v=(2\times0.56\times310)=350\,\text{m s}^{-1}$; ***[3]***

Part 2 Magnetic and electric fields

(a) (i) use of $qV = \frac{1}{2}mv^2$;
$1.6\times10^{-19}\times420 = \frac{1}{2}\times1.67\times10^{-27}\times v^2$
$v = 2.8\times10^5\ \mathrm{m\,s^{-1}}$; ***[2]***

(ii) arc of circle / continuous curve within region ABCD and deflected upwards *i.e.* towards AB;
straight-line as tangent to arc beyond BC; ***[2]***

(iii) $F = 1.5\times10^{-2}\times1.6\times10^{-19}\times2.8\times10^5$;
$= 6.7\times10^{-16}\ \mathrm{N}$; *(allow 6.8×10^{-16} N)* ***[2]***

(b) (i) force per unit positive charge;
on small test charge (placed at that point); ***[2]***

(ii) $6.7\times10^{-16} = 1.6\times10^{-19}\times E$;
$E = 4.2\times10^3\ \mathrm{V\,m^{-1}}$; ***[2]***

(iii) undeviated / straight line (along original path);
reason *e.g.* forces in field always equal and opposite; ***[2]***