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MARKSCHEME

November 2008

PHYSICS

Standard Level

Paper 2

11 pages

General Marking Instructions

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. 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.

9. Only consider units at the end of a calculation. Unless directed otherwise in the markscheme, unit errors should only be penalized once in the paper.

10. 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*

SECTION A

A1. (a) correct placing of both error bars; ***[1]***
Total error bar length 3 to 5 squares.
Be generous as the error bars are a bit difficult to place.

(b) (i) a straight line can be drawn;
that passes through the error bars; ***[2]***
Notice that first point may be implicit, for example, if they have drawn a straight-line of best fit.

(ii) slope $= -1.0$; *(accept answers in the range -0.95 to -1.1 and ignore any units)*
intercept $= 1.85$; *(accept answers in the range of 1.75 to 1.90)*
correct statement of equation *e.g.* $\frac{R}{R_S} = 1.85 - 1.0 \times \frac{M}{M_S}$; $\left\{ \begin{array}{l} \textit{accept e.g.} \\ R = 1.85 - 1.0 \times M \end{array} \right.$ ***[3]***

(iii) 1.85 M_S; $\left\{ \begin{array}{l} M_S \textit{ unit needed. Accept answers in the range 1.6 } M_S \textit{ to 2.0 } M_S, \\ \textit{i.e. consistent with a line of best-fit} \end{array} \right.$ ***[1]***

(c) the maximum mass corresponds to a star of zero radius/$R = 0$, so it is unphysical / radius is zero/too small; ***[1]***

(d) (i) <u>smooth</u> curve through data points; ***[1]***

(ii) 1.4 M_S / consistent with any line of best-fit even if straight; ***[1]***
Do not penalize absence of unit M_S if already penalized earlier.

(iii) answers based on an extrapolation from a curve which is imprecise; ***[1]***
The idea is to see a comment about extrapolation outside the data range so plain references to uncertainties in general should not be accepted.

A2. (a) satisfies $pV = nRT$ (at all *p*, *V* and *T*) / point molecules / no intermolecular forces; ***[1]***
Allow any other kinetic theory assumption.

(b) (i) the (total random) kinetic energy of the molecules (of the gas); ***[1]***

(ii) the (absolute kelvin) temperature is proportional to/is a measure of the average kinetic energy of the molecules of the gas;
and hence the internal energy is proportional to the temperature (and the total number of molecules in the gas) / $U \propto NT$; ***[2]***
*Do not accept T increases U increases. Award **[0]** for **any** reference to potential energy.*

(c) (i) 2.0×10^5 Pa ; ***[1]***

(ii) correct positioning of point on graph; ***[1]***

(iii) concave curve (hyperbola) joining A to B; *(judged by eye)* ***[1]***
Do not check points, general shape of curve only.

A3. (a) the rocket exerts a force on the gases and so the gases exert a force on the rocket / there is a reaction force on rocket from gases / *OWTTE*;
force on the rocket causes the rocket to accelerate; ***[2]***

(b) the net external force on the rocket and gases/system is zero / system is closed/isolated, therefore the total momentum of the system stays the same;
change in momentum of the gases = (–) change in momentum of the rocket; ***[2]***

(c) after 1.0 s momentum of gases $= 1.4 \times \left[7.2 \times 10^3 - v\right]$ N s and momentum of rocket $= (280 - 1.4) \times v$ N s;

application of momentum conservation $\left(\text{to give } v = \dfrac{1.4 \times 7.2 \times 10^3}{280}\right)$;

$36\,\mathrm{m\,s^{-1}}$; ***[3]***

SECTION B

B1. Part 1 Wave motion

(a) (i) 1.5 mm; ***[1]***

(ii) 8.0 cm; ***[1]***

(iii) distance travelled in 0.20 s is 3.2 cm;
so speed is $\left(\frac{3.2\times10^{-2}}{0.20}\right)=0.16\,\text{m s}^{-1}$; ***[2]***

(iv) $f=\frac{0.16}{8.0\times10^{-2}}=2.0\,\text{Hz}$; ***[1]***

(b) travelling waves transfer energy (standing waves do not);
travelling waves have a constant amplitude (standing waves do not);
standing waves have points that always have zero displacement (travelling waves do not);
the phase of a travelling wave constantly changes (but in standing waves points in between consecutive nodes have constant phase); ***[2 max]***

(c) (i) it is the speed of energy transfer/rate/speed at which wavefronts move forward; ***[1]***

(ii) a standing wave is formed from the superposition of two travelling waves;
wave speed refers to the speed of the travelling waves; ***[2]***

(d) (i) the oscillating string collides with the air molecules surrounding it;
creating a pressure/longitudinal wave; ***[2]***

(ii) wavelength of wave on string is $2\times0.80=1.6\,\text{m}$;
frequency is then $\left(\frac{240}{1.6}\right)=150\,\text{Hz}$;
sound has the same frequency and so wavelength is $\left(\frac{340}{150}\right)=2.3\,\text{m}$; ***[3]***

*Award **[1 max]** for those using a wavelength of 0.80 m obtaining a wavelength of 1.1 m in air. Accept alternative derivations that use a ratio and do not calculate the frequency explicitly.*

Part 2 Mechanics

(a) the rate at which work is being performed / work (done) divided by time (taken); ***[1]***

(b) $W = F\Delta s$

$P = \dfrac{W}{\Delta t}$;

$= F\dfrac{\Delta s}{\Delta t}$;

$= Fv$ ***[2]***

Accept word equation answer.

(c) (i) (energy supplied in $5.0\,\mathrm{s} =$) $54\times10^3 \times 5 \left(= 2.7\times10^5\ \mathrm{J}\right) = \frac{1}{2}\times1200\times v^2$;

giving $v = 21\,\mathrm{m\,s^{-1}}$; ***[2]***

(ii) $54\times10^3 = F\times21$;

$54\times10^3 = 1200\times a\times21$;

giving $a = 2.1\,\mathrm{m\,s^{-2}}$; ***[3]***

(d) <u>straight line</u>;

through origin; ***[2]***

B2. **Part 1** Mechanics

(a) (i) $\dfrac{350}{9.8} = 36\,\text{kg}$; *(accept 35 kg)* ***[1]***

(ii) girl took 0.5 s to fall;
so $v = gt = (9.8 \times 0.5) = 4.9\,\text{m s}^{-1}$; *(accept 5.0 m s^{-1})* ***[2]***

(iii) $h = \frac{1}{2} g t^2$
$= \frac{1}{2}(9.8 \times 0.50^2)$;
$= 1.2\,\text{m}$; *(accept 1.3 m)* ***[2]***

or

use of conservation of energy to get
$\frac{1}{2} m v^2 = mgh \Rightarrow h = \dfrac{v^2}{2g}$;
$h = \dfrac{4.9^2}{2 \times 9.8} = 1.2\,\text{m}$; *(accept 1.3 m)*

(iv) maximum force on girl $= 1400\,\text{N}$;
so maximum acceleration $= \dfrac{1400}{36} = 39\,\text{m s}^{-2}$; *(accept 40 m s^{-2})* ***[2]***

(b) (i) the net force is still in the downward direction / the trampoline force is less than the weight / the trampoline has not yet deflected enough to give rise to a force larger than the weight;
and so the girl keeps accelerating downwards; ***[2]***

(ii) the change in momentum $=$ area under graph from point C to point D;
$= \frac{1}{2} \times 350 \times (0.53 - 0.50)$;
$\approx 5\,\text{N s}$ ***[2]***

(iii) $36 \times (v_{\text{max}} - 4.9) = 5\,\text{N s}$;
so $v_{\text{max}} = 5\,\text{m s}^{-1}$; ***[2]***

Part 2 Radioactivity

(a) (i) nuclei with the same atomic number but different mass number; ***[1]***

(ii) identification of a proton/${}^{1}_{1}\text{H}$/p;
correct equation *i.e.* ${}^{1}_{0}\text{n} + {}^{14}_{7}\text{N} \rightarrow {}^{1}_{1}\text{p} + {}^{14}_{6}\text{C}$; ***[2]***

(b) ${}^{14}_{6}\text{C}$ is unstable while ${}^{12}_{6}\text{C}$ is stable;
neither ${}^{14}_{6}\text{C}$ nor ${}^{12}_{6}\text{C}$ may be replenished (through food/breathing as in an animal that is alive) after bone is dead;
${}^{14}_{6}\text{C}$ decays, decreasing its concentration in the bone; ***[2 max]***

(c) (i) 1.3×10^{-12}; ***[1]***

(ii) evidence of locating the point in the graph with *F* value half of the initial;
to get half-life 5700 (±100) years; ***[2]***

(d) evidence of locating the point in the graph with *F* value 0.6×10^{-12};
to get age = 6400 (±100) years; ***[2]***

(e) the dinosaur bone has been dead for millions of years;
the *F* value is negligibly small/too small to be measured with any accuracy / *F* value in atmosphere might have varied; ***[2]***

B3. Part 1 Calorimetry

(a) energy required to increase the temperature by 1 degree; ***[1]***

(b) (i) change in temperature of calorimeter is $6.0\,^{\circ}\mathrm{C}$;
and so $Q = (950 \times 6) = 5.7 \times 10^{3}\,\mathrm{J}$; ***[2]***

(ii) change in temperature of copper block is $72\,^{\circ}\mathrm{C}$;
and so $C = \left(\dfrac{5.7 \times 10^{3}}{72}\right) = 79\,\mathrm{J\,K^{-1}}$; ***[2]***

(c) the mass of the block; ***[1]***

(d) *Any two suitable suggestions*.
the temperature of the block may not be $100\,^{\circ}\mathrm{C}$;
some boiling water may be transferred to the calorimeter;
the calorimeter is not perfectly insulated; ***[2 max]***

Part 2 Electricity and magnetism

(a) work done per unit charge in moving charge completely around the circuit / power supplied per unit current; ***[1]***

(b) (i) two sets of series resistors at $90\,\Omega$ each;
and these are in parallel for a total of $45\,\Omega$;
plus the internal resistance in series for a grand total of $50\,\Omega$; ***[3]***

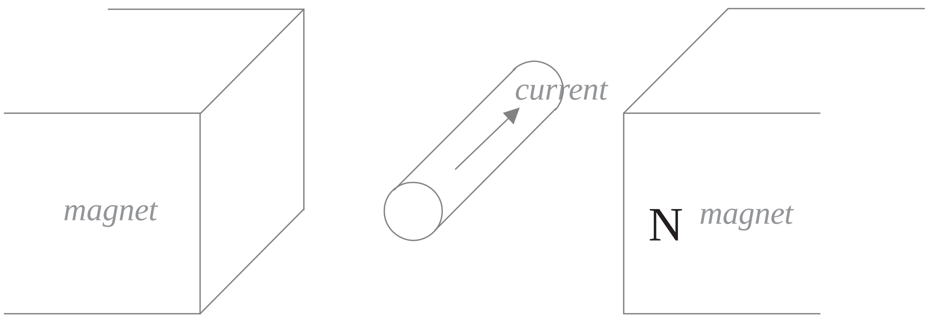
(ii) total current is $I = \left(\frac{12}{50}\right) = 0.24\,\text{A}$; ***[1]***
Watch for ECF if answer for resistance is wrong.

(iii) $P_{\text{total}} = EI$;
$= (12 \times 0.24) = 2.9\,\text{W}$; ***[2]***
Watch for ECF if answer for current is wrong.

(iv) across $30\,\Omega$ voltage drops by $3.60\,\text{V}$ (so potential at X is $3.60\,\text{V}$);
across $60\,\Omega$ voltage drops by $7.20\,\text{V}$ (so potential at Y is $7.20\,\text{V}$);
so potential difference between X and Y is (negative) $3.6\,\text{V}$; ***[3]***

(c) in the original circuit there is no current between X and Y / the resistance between X and Y is infinite;
introducing a real voltmeter changes the total resistance of the circuit / allows current between X and Y / the resistance between X and Y is no longer infinite; ***[2]***

(d) (i)



because the magnetic force on the rod must be vertically upward and the law for the magnetic force requires field directed to the left, hence right pole is N; ***[1]***

(ii) $0.20 \times I \times 0.80 = 4.0$;
and so $I = 25\,\text{A}$; ***[2]***

(iii) at Y;
the magnetic fields of the wire and of the magnet add; ***[2]***
*Award **[0]** for a correct answer with no explanation or with an incorrect explanation.*
Watch for ECF in case they got the polarity of the magnets wrong earlier in which case the answer is X.