M10/4/PHYSI/SP2/ENG/TZ2/XX/M+

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MARKSCHEME

May 2010

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. Unit errors can 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

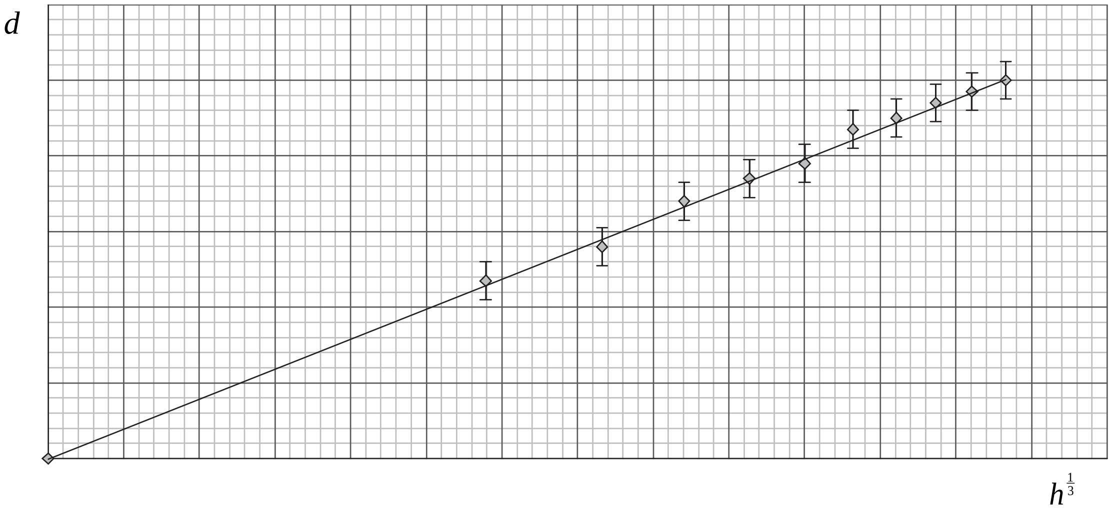
A1. (a) two error bars in the correct position;

two error bars of the correct length; *(allow a square-length each side of the data points judge by eye and allow for the thickness of the line drawn)* ***[2]***

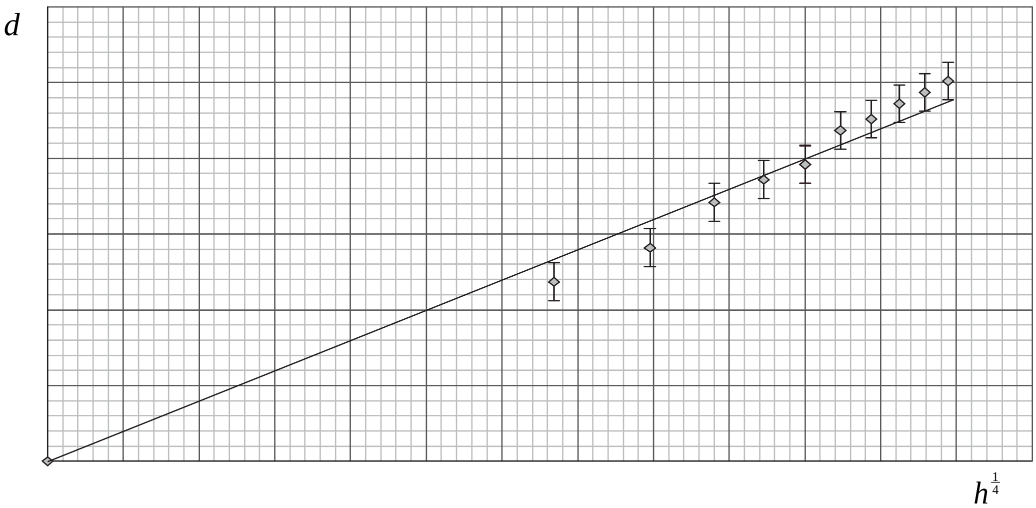
(b) suitable curve that goes through the two error bars;
and through (0,0); ***[2]***

(c) a straight line cannot be drawn through the error bars and through the origin;
so height is not directly proportional to the diameter;
(and) height is proportional to energy; ***[3]***

(d) **theory 1**



theory 2



(i) correct line of best-fit for theory 1;
correct line of best-fit for theory 2; ***[2]***
For theory 2 accept a straight line that goes through all the error bars but not through the origin.

(ii) theory 1
either d against $h^{\frac{1}{3}}$ / d against $h^{\frac{1}{4}}$ should produce a straight line;
theory 1 graph has a straight line that goes through the origin and all the error bars; ***[2]***

A2. (a) (i) the velocity direction is changing/the friction force between tyres and road produces a centripetal force on the car; ***[1]***

(ii) recognize to use $F = \frac{mv^2}{r}$;

$= \left(\frac{1.5 \times 10^3 \times 18^2}{2.0 \times 10^3} = \right) 240\,\text{N}$; ***[2]***

(b) (i) releases extra carbon dioxide/greenhouse gases into the atmosphere; ***[1]***

(ii) reduces the ice/snow cover;
this decreases the albedo;
leading to an increase in rate of thermal energy absorption by the atmosphere; ***[3]***

or

increases temperature of the sea;
reduces the solubility of carbon dioxide in the sea;
so increases amount of carbon dioxide in the atmosphere;

*To award **[3]** a description of a mechanism must be present. Award **[2 max]** for a description of the enhanced greenhouse effect.*

A3. (a) (i) evaporation takes place at any temperature/involves a reduction in temperature and boiling takes place at constant temperature; ***[1]***

(ii) evaporation takes place at the surface of the liquid/depends on surface area of the liquid and boiling takes place throughout the liquid/is independent of surface area; ***[1]***

(b) energy supplied $= 15 \times 4.5 \times 10^2 = 6.8 \times 10^3\,(\text{J})$;

$lhv = \frac{6.8 \times 10^3}{1.8 \times 10^{-2}}$;

$= 3.8 \times 10^5\,\text{J kg}^{-1}$; ***[3]***

(c) (thermal) energy/heat is lost to the surroundings / (thermal) energy is used to heat the calorimeter / some heat is given to the calorimeter;
and so less (thermal) energy/heat is available to boil the liquid / less mass boils away / *OWTTE*; ***[2]***

SECTION B

B1. Part 1 Fossil fuels and the greenhouse effect

(a) wide availability / a great deal available;
ease of transportation;
power stations can be built close to the source;
high energy density; ***[2 max]***

(b) (i) the energy that can be liberated per kg/stored per kg; ***[1]***

(ii) $Eff = \frac{500}{P_{\text{in}}}$;

$P_{\text{in}} = \left[\frac{500}{0.27}\right] = 1900\,(\text{MW})$;

$\text{rate} = \left[\frac{1900}{56}\right] = 33\,\text{kg}\,\text{s}^{-1}$ ***or*** $34\,\text{kg}\,\text{s}^{-1}$; ***[3]***

*Award **[3]** for correct answer if the first marking point is omitted.*

(c) (because of increased greenhouse gases) atmosphere absorbs more (IR) energy and heats up;
atmosphere radiates in all directions;
Earth's surface absorbs some of this extra (IR) radiation hence temperature increases; ***[3]***
*Award **[2 max]** if no indication made to re-radiation in all directions either by "all directions" in second marking point or by "some" in third marking point.*

(d) (i) different surfaces absorb/reflect different intensities; ***[1]***

(ii) radiation intercepted by cross section of Earth $\pi r^2 \times 1380$;
this is distributed over surface of Earth $4\pi r^2$;
therefore, radiation incident $= \frac{\pi r^2}{4\pi r^2}1380 = 345\ \text{W}\,\text{m}^{-2}$;
intensity of reflected radiation $= 0.300 \times 345$;
$= 104\ (100)\ \text{W}\,\text{m}^{-2}$ ***[4]***
*Award **[1]** for the use of 0.300×1380.*

(e) $\Delta V = \gamma V \Delta T = 8.8\times10^{-5} \times 3.6\times10^{14} \times 3.0\times10^{3} \times 2.0$;

$h = \frac{1.9\times10^{14}}{3.6\times10^{14}}$;

$= 0.53\,(0.5)\,\text{m}$ ***[2]***

Part 2 Radioactive decay and binding energy

(a) unstable nuclei/nuclides change spontaneously/randomly/emit energy;
by the emission of <u>alpha particles</u> and/or <u>electrons</u> and/or <u>gamma rays</u>; *(accept α, β and γ particles/radiation)* ***[2]***
*To award **[2 max]** reference must be made to nuclei/nuclides and to spontaneously/ randomly.*

(b) *Z:* 18 ***or*** 20;
x: neutrino/ ν / ${}^{0}_{0}\nu$ /antineutrino/ $\bar{\nu}$ / ${}^{0}_{0}\bar{\nu}$; ***[2]***
***Please note**: that β^{+} decay is not in the SL core, only β^{-} so accept answers in terms of β^{-} decay and mark any combination correct.*

(c) mass of 81 protons $= (81 \times 938 =) 75978\ \text{MeV c}^{-2}$;
mass of 125 neutrons $= (125 \times 940 =) 117500\ \text{MeV c}^{-2}$;
mass difference $= 75978 + 117500 - 191870 = 1608\ \text{MeV c}^{-2}$;
binding energy per nucleon $= 7.81\text{MeV}$; ***[4]***

(d) energy is released in the decay of Tl-206 / energy released is the difference in binding energies / decay is spontaneous / Pb-206 is more stable than Tl-206; ***[1]***

B2. Part 1 Oscillations and waves

(a) (i) upwards; ***[1]***

(ii) the acceleration is proportional to the displacement from equilibrium;
and is directed towards equilibrium / opposite to displacement; ***[2]***

(iii) $\omega^2 = \frac{14}{l}$;

$\omega^2 = \frac{4\pi^2}{T^2}$;

$l = \frac{14\times\ 1.4^{\ 2}}{40}$;

$= 0.70\,\text{m}$ ***[3]***

(b) sine curve / negative sine curve; ***[1]***

(c) (i) $\omega^2 = \frac{14}{0.70} = 20\ \ \text{rad}^{-1}$;
max acceleration $= (20 \times 0.12 =)\ 2.4\,\text{m}\,\text{s}^{-2}$; ***[2]***

(ii) any point where $v = 0$; ***[1]***

(d) (i) period $= 1.4\,\text{s}$;
$c = \frac{\lambda}{T} = \frac{0.45}{1.4} = 0.32\,\text{m}\,\text{s}^{-1}$; ***[2]***

(ii) $\frac{2.8}{3.7}$;
0.76; ***[2]***

(iii) 0.57 ***or*** 0.58; ***[1]***

Part 2 Electrical resistance and electric circuits

(a) *resistance*: the ratio of potential difference across a device/load/resistor to current in the device/load/resistor;

Ohm's law: the resistance of a conductor is constant provided its temperature is constant / the current is proportional to the voltage across; ***[2]***

(b) $\rho = \frac{RA}{l}$;

$= \left(\frac{1.5 \times \pi \times 1.2^2 \times 10^{-6}}{2.2 \times 10^{-2}} = \right) 3.1 \times 10^{-4}\,\Omega\,\text{m}$; ***[2]***

(c) $I = \left(\sqrt{\frac{P}{R}} = \right) \sqrt{\frac{1}{1.35}}$;

$= 0.86\,\text{A}$; ***[2]***

(d) (i) the power supplied per unit current / work done per unit charge in moving charge completely round the circuit / energy per unit charge made available by the source; ***[1]***

(ii) minimum resistance is $2.0\,\Omega$, maximum resistance is $2.5\,\Omega$;

so maximum power is $\left(\frac{2.0^2}{2.0} \right) = 2.0\,\text{W}$;

and minimum power is $\left(\frac{2.0^2}{2.5} \right) = 1.6\,\text{W}$; ***[3]***

B3. Part 1 Momentum, energy and power

(a) when a force acts on a body an equal and opposite force acts on another body / in the interaction between two bodies A and B, the force that A exerts on B is equal and opposite to the force that B exerts on A; ***[1]***

(b) forces on Earth and book are equal and opposite / no external force acts on the system;
changes in momentum of Earth and book are equal and opposite / net force on Earth-book system is zero;
hence momentum of Earth-book system stays the same/is always zero and so is conserved; ***[3]***

(c) (i) $v = \sqrt{2\times 9.8\times 1.6}$;
$= 5.6\,\mathrm{m\,s^{-1}}$ ***[1]***

(ii) calculation of speed of ball and spike $3.5\times 5.6 = 4.3\,\mathrm{V}$;
$V = \left(\dfrac{3.5\times 5.6}{4.3} =\right) 4.6\,\mathrm{m\,s^{-1}}$;

KE before $= \tfrac{1}{2}\left[3.5\times 5.6^2\right]$ KE after $= \tfrac{1}{2}\left[4.3\times 4.56^2\right]$;
energy dissipated $= 54.88 - 44.70$;
$= 10\,\mathrm{J}$ ***[4]***
Accept 9.4 J if 4.6 used for V.

(d) $F = \dfrac{\Delta KE}{s}$;
$\Delta KE = 0.50\times 4.3\times 4.6^2 = 45\,(\mathrm{J})$;
$F = \left(\dfrac{45}{7.3\times 10^{-2}} =\right) 6.2\times 10^2\,\mathrm{N}$; ***[3]***

or

$a = \dfrac{v^2}{2s}$;
$a = 1.45\times 10^2\ \mathrm{m\,s^{-2}}$;
$F = ma = 4.3\times 1.45\times 10^2 = 6.2\times 10^2\,\mathrm{N}$;

(e) $\text{time} = \dfrac{\text{work}}{\text{power}}$;
$\text{work} = (3.5\times 1.6\times 9.8 =)\ 55\,(\mathrm{J})$;
$\text{time} = \left(\dfrac{55}{18} =\right) 3.1\,\mathrm{s}$; ***[3]***

Part 2 Electric and gravitational fields

(a) a conductor contains “free” electrons and insulators do not / *OWTTE*; ***[1]***

(b) to have a current electrons must be accelerated/move along the wire;
and so a (electric) force must act on them;
this is provided by the electric field; ***[3]***

(c) $8.8\times10^{-18}\text{ N}$; ***[1]***

(d) *similarity*:
both follow an inverse square law;

difference:
gravitational force is always attractive/is much weaker than electric force / electric force can be repulsion/is much stronger than gravitational force; ***[2]***

(e) (i) 25 N kg^{-1}; ***[1]***

(ii) $M=\dfrac{25R^2}{G}$;

$=\dfrac{25\times7.0^2\times10^{14}}{6.7\times10^{-11}}$;

$=1.8\times10^{27}\text{ kg}$ ***[2]***