International Baccalaureate®
Baccalauréat International
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MARKSCHEME

May 2011

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 underlined 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.

9. Only consider units at the end of a correct calculation.

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) (i) the graph is not linear/a straight line (going through the error bars) / does not go through origin; ***[1]***

(ii) $7.7\ \text{m s}^{-1}$; ***(N.B.** line is drawn for candidate, answer must be correct)* ***[1]***

(b) (i) % uncertainty in $v = \left(\frac{0.3}{7.7} = \right) 3.9\%$;

doubles 3.9% *(allow ECF from (a)(ii))* to obtain % uncertainty in $v^2 (= 7.8\%)$;
absolute uncertainty $(= \pm[0.078 \times 59.3]) = 4.6$;
$(= \pm 5\,\text{m}^2\,\text{s}^{-2})$ ***[3]***

or

calculates overall range of possible value as $7.4 - 8.0$; *(allow ECF)*
squares values to yield range for v^2 of 54.8 to 64; *(allow ECF)*
so error range becomes 9.2 hence ± 4.6; *(must see this value to 2 sig fig or better to award this mark)*

(ii) correct error bars added to first point ($\pm\frac{1}{2}$ square) <u>and</u> last-but-one point (± 2.5 squares); *(judge by eye)* ***[1]***

(iii) a straight-line/linear graph can be drawn that goes through origin; ***[1]***

(iv) uses triangle to evaluate gradient; *(triangle need not be shown if read-offs clear, read-offs used must lie on candidate's drawn line)*
to arrive at gradient value of 1.5 ± 0.2; *(unit not required)*
recognizes that gradient of graph is a^2 <u>and</u> evaluates $a = 1.2 \pm 0.2\,(\text{m}^{\frac{1}{2}}\,\text{s}^{-1})$; ***[3]***

or

candidate line drawn through origin <u>and</u> one data point read;
correct substitution into $v^2 = a^2\lambda$; *(a^2 does not need to be evaluated for full credit)*
$a = 1.2 \pm 0.2\,(\text{m}^{\frac{1}{2}}\,\text{s}^{-1})$;
*Award **[2 max]** if line does not go through origin – allow $\frac{1}{2}$ square.*
*Award **[1 max]** if one or two data points used <u>and</u> no line drawn.*

(v) $k = 9.4\,\text{m s}^{-2}$; *(allow ECF from (b)(iv))* ***[1]***

A2. (a) $h=\dfrac{v^2}{2g}$;

$=\left(\dfrac{225}{20}=\right)11\,\text{m}$; **[2]**

*Award **[1 max]** for 91 m or 91.25 m (candidate adds cliff height incorrectly).*

(b) time to reach maximum height $=1.5\,\text{s}$;
time to fall $91\,\text{m}=4.3\,\text{s}$;
total time $=5.8\,\text{s}$; **[3]**
Answer can be alternatively expressed as 3.0 (to return to hand) + 2.8 (to fall 80 m).

or

use of $s=ut+\frac{1}{2}at^2$;
$80=-15t+5t^2$ ***or*** $-80=15t-5t^2$;
$t=5.8\,\text{s}$;

A3. (a) internal energy is the total kinetic and potential energy <u>of the molecules</u> of a body;
thermal energy is a (net) amount of energy transferred between two bodies;
at different temperatures; **[3]**

(b) the internal energy of the iron is equal to the total KE plus PE of the molecules;
the molecules of an ideal gas have only KE so internal energy is the total KE of the molecules; **[2]**

(c) (i) $60\times[\theta-45]$; **[1]**

(ii) $\left(2.0\times10^3\times29\right)=5.8\times10^4\,\text{J}$; **[1]**

(iii) $60\times[\theta-45]=5.8\times10^4$;
$\theta=1000\,^\circ\text{C}$; *(allow 1010°C to 3 sig fig)* **[2]**

SECTION B

B1. Part 1 Simple harmonic motion and a wave in a string

(a) the maximum displacement of the system from equilibrium/from centre of motion / *OWTTE*; *[1]*

(b) (i) the amplitude of the oscillations/(total) energy decreases (with time);
because a force always opposes direction of motion/there is a resistive force/ there is a friction force; *[2]*
Do not allow bald "friction".

(ii) $\omega = \sqrt{\frac{2g}{l}}$;

$T = 2\pi\sqrt{\frac{0.32}{2 \times 9.81}}$;

$= 0.80\,\text{s}$; *[3]*

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

(ii) $y_0 = 0.050\,(\text{m})$ and $y = 0.030\,(\text{m})$;

$\omega = \left(\frac{2\pi}{0.80} =\right) 7.85\left(\text{rad s}^{-1}\right)$;

$v = 7.85\sqrt{[0.05]^2 - [0.03]^2}$;

$= 0.31\,\text{m s}^{-1}$; *(allow working in cm to give* $31\,cm\,s^{-1}$*)* *[4]*

(iii) $\lambda = 4.0\,\text{m}$;

recognition that $f = \frac{1}{0.80} (= 1.25)$;

$(f\lambda =)\, v = 1.25 \times 4.0$;

$(= 5.0\,\text{m s}^{-1})$ *[3]*

(iv) $y = -3.0\,\text{cm}$, $d = 0.6\,\text{m}$; *[1]*

Part 2 Unified atomic mass unit and a nuclear reaction

(a) $\frac{1}{12}$th mass of an <u>atom</u> of carbon-12/^{12}C; *[1]*

(b) $(254.1001\times 931.5=)\,236.7\left(\text{GeV c}^{-2}\right)$; (*only accept answer in GeV* c^{-2}) *[1]*

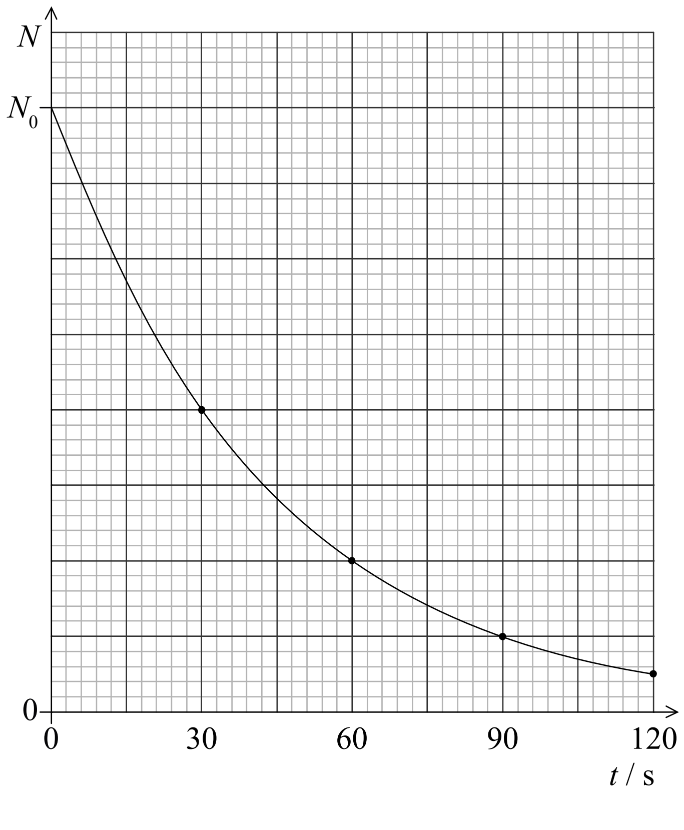
(c) (i) proton / hydrogen nucleus / H^+ / ^1_1H / ^1_1p; *[1]*

(ii) $\Delta m = \left(16.8383-[3.7428+13.0942]=\right)0.0013\left(\text{GeV c}^{-2}\right)$;
energy required for reaction $=1.3$ (MeV);
KE of $^{17}_{8}O+\mathbf{X}=(7.68-1.3=)\,6.4\,(6.38)\,\text{MeV}$; *(allow correct answer in any valid energy unit)* *[3]*

(d) (i) (nuclei of same element with) same proton number, different number of neutrons / *OWTTE*; *[1]*

(ii) the time for the activity of a sample to reduce by half / time for the number of the radioactive nuclei to halve from original value; *[1]*

(e) scale drawn on *t* axis; *(allow 10 grid squares ≡ 30 s or 40 s)*
smooth curve passes through $\frac{N_0}{2}$ at 30 s, $\frac{N_0}{4}$ at 60 s, $\frac{N_0}{8}$ at 90 s, $\frac{N_0}{16}$ at 120 s (to within 1 square); *(points not necessary)* *[2]*



B2. Part 1 Power production and global warming

(a) energy transferred to surroundings/from system; *(do not allow bald "energy lost")*
energy no longer available for use/cannot be used again; ***[2]***

(b) (i) U-235 fissions / neutrons are produced;
nuclei/neutrons have high energy/are fast moving;
nuclei transfer (kinetic) energy to (reactor) core / neutrons transfer (kinetic) energy to moderator;
names energy of moving nuclei/neutrons as kinetic;
core/moderator energy transferred to coolant/named coolant/surroundings; ***[4 max]***

(ii) heat exchanger allows transfer of (thermal) energy between reactor and coolant;
coolant transfers (thermal) energy to steam/other named fluid;
steam/fluid allows turbine to drive generator/dynamo; ***[3]***

(c) *Allow any* ***one*** *of the following.*
heating the working fluid in the exchanger;
the working fluid passing through the turbine;
cooling the working fluid having passed through the turbine;
named dissipative/friction process in power station machinery; *(do not allow "air resistance/friction" unless seat of loss is clear)* ***[1 max]***

(d) energy output of Drax $= \left(4.0\times10^{9}\times3.2\times10^{7} =\right) 1.28\times10^{5}$ TJ ;

mass of U-235 needed $= \left(\dfrac{1.28\times10^{5}}{82} =\right) 1.6\times10^{3}$ kg ; ***[2]***

(e) frequency of vibration is close to that of the frequency of infrared radiation;
(atmospheric) carbon dioxide absorbs the infrared radiated by the surface of Earth;
the part of the radiation that is re-radiated back to Earth will cause the temperature of the surface to rise / re-radiated at a different frequency / *OWTTE*; ***[3]***

(f) $\Delta T = \dfrac{\Delta V}{\gamma V}$; *(award mark if correct substitution seen)*

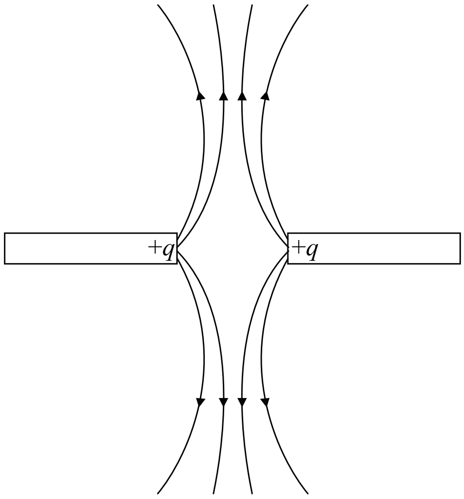
$\dfrac{\Delta V}{V} = \dfrac{6.4\times10^{-2}\times\text{area}}{4.0\times10^{2}\times\text{area}} = 1.6\times10^{-4}$;

$\Delta T = \left(\dfrac{1.6\times10^{-4}}{5.1\times10^{-5}} =\right) 3.1\text{K}$; ***[3]***

Part 2 Electric charge

(a) in the plastic there are no free electrons;
(but) electrons can be transferred to/from the cloth (by friction) leaving an imbalance of charge on the rod / *OWTTE*;
electrons can move freely in copper;
electrons transferred from/to the cloth from/to the rod;
because the body is a conductor;
will flow to/from Earth leaving the rod neutral; ***[5 max]***

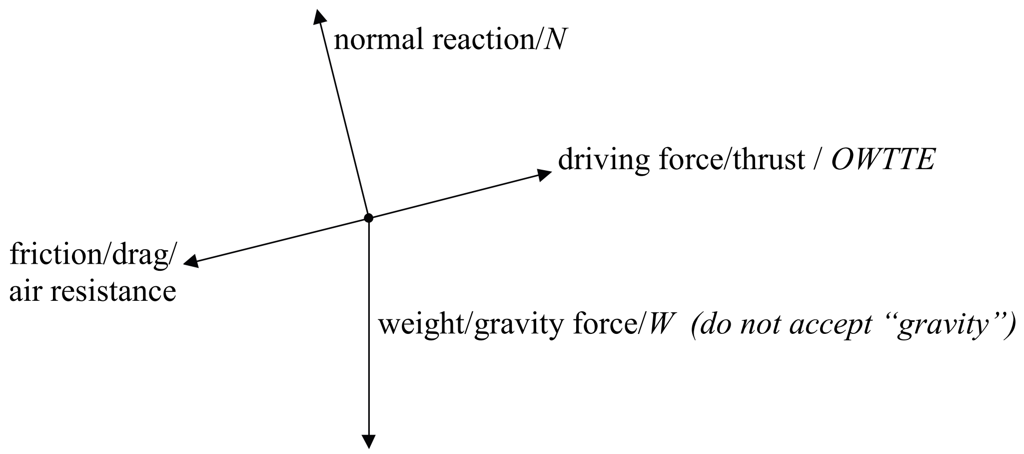
(b)



at least four field lines (minimum two per rod) to show overall shape of pattern;
direction of lines all away from poles; ***[2]***
Ignore all working outside region.
Any field lines crossing loses first mark even if accidental.

B3. Part 1 Power and efficiency

(a) (i)



identification of normal reaction/*N* and weight/*W*;
identification of friction and driving force;
correct directions of all four forces;
correct relative lengths; *(friction ≅ driving force and N ≅ W but N must not be longer than W) (judge by eye)* ***[4]***

(ii) zero; ***[1]***

(b) input power $= \frac{\text{output power}}{\text{efficiency}} = \frac{70}{0.35}$;
$= 200\,\text{kW}$; ***[2]***
*Award **[2]** for a bald correct answer.*

(c) height gained in $1\,\text{s} = (6.2\sin 6 =)\ 0.648\,(\text{m})$;
rate of change of PE $= 8.5\times10^3 \times 9.81\times 0.648$;
$= 5.4\times10^4\ \text{W}$; ***[3]***

(d) power used to overcome friction $= (7\times10^4 - 5.4\times10^4 =)\ 1.6\times10^4\ (\text{W})$; *(allow ECF from (c))* ***[4]***
$F = \left(\frac{p}{v} =\right) \frac{1.6\times10^4}{6.2}$;
$= 2.6\,\text{kN}$; ***[3]***

(e) (i) component of weight down slope $= 8.5\times10^3 \times 9.81\sin 6$;
net force $= 2.6\times10^3 + 8.5\times10^3 \times 9.81\sin 6$
$= 11\,\text{kN}$; ***[2]***
Watch for ECF from (d).

(ii) air resistance decreases as speed drops;
so net force decreases; ***[2]***

Part 2 Electrical resistance

(a) use of $l = \frac{RA}{\rho}$; *(allow if correct substitution seen – watch for use of circumference in place of area)*

$= \left(\frac{1.5 \times \pi \times [1.8]^2 \times 10^{-8}}{1.7 \times 10^{-8}} = \right) 9.0\,\text{m}$; ***[2]***

(b) (i) the resistance of a conductor/copper/metal increases with increasing temperature; increased power (dissipation) leads to higher temperature in the resistor/resistor heating up; ***[2]***

(ii) $I = \left(\sqrt{\frac{P}{R}} = \right) \sqrt{\frac{1.0}{1.5}}$;

$(= 0.82\,\text{A})$ ***[1]***

Allow working using 0.82 A to show that power is 1.0086 W, in this case final answer must be to 2 sig fig or better.

(iii) total resistance $= [R + 3.3]$;

$6.0 = 0.82[R + 3.3]$;

to give $R = 4.0\,\Omega$; *(allow use of 1.65 Ω leading to 3.9 Ω)* ***[3]***

or

total resistance in circuit $= \frac{6.0}{0.82} = (7.3\,\Omega)$;

internal resistance + fixed resistance $= 3.3\,\Omega$;

to give $R = 4.0\,\Omega$;