International Baccalaureate®
Baccalauréat International
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MARKSCHEME

November 2011

PHYSICS

Standard Level

Paper 2

14 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 shown 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, numbers, or units 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 ***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 when marking. Indicate this by adding **ECF** (error carried forward) on the script.

10. Only penalize candidates for errors in units or significant figures, when a penalty is specifically referred to in the markscheme.

SECTION A

A1. (a) (i) fractional uncertainty in distance $= \dfrac{2}{150}$ and
fractional uncertainty in time $= \dfrac{0.5}{8.3}$;
(allow use of percentage uncertainty)

fractional uncertainty in speed $= \dfrac{2}{150} + \dfrac{0.5}{8.3} \left(= 0.074 \text{ } \textbf{\textit{or}} \text{ } 7.4\,\%\right)$;
absolute uncertainty $= 18 \times 0.074$;
$= 1.3\ (\text{cm s}^{-1})$ ***[3]***

or

maximum $= \dfrac{152}{7.8}$;
minimum $= \dfrac{148}{8.8}$;
shows subtraction of maximum and minimum and division by 2;

(ii) error bars drawn as ± 1.3; ***[1]***

(b) (i) smooth curve within limits of all error bars; ***[1]***

(ii) a straight line cannot be drawn;
that goes through all the error bars / that goes through the origin; ***[2]***

(c) c versus $\sqrt{d}$ / $d^{0.5}$ ***or*** c^2 versus d ***or*** lg c versus lg d ***or*** ln c versus ln d; ***[1]***
Allow as symbols or written in words.

(d) (i) error that is identical for each reading / error caused by zero error in instrument / *OWTTE*; ***[1]***

(ii) graph will not go through origin / intercept non-zero;
graph will not be straight line/linear; ***[1 max]***

A2. (a) conduction is due to movement of the free electrons (transferring charge around circuit);
tungsten is a good electrical conductor with large numbers of free electrons;
glass is a poor electrical conductor with few/no free electrons; ***[2 max]***

(b) (i) $\frac{6^2}{15}$ ***or*** $I=\frac{15}{6}$ and $R=6\times\frac{6}{15}$;
$=2.4\,\Omega$ ***[1]***

(ii) $\text{area}=\frac{5.6\times10^{-7}\times0.35}{2.4}$;
$0.082\,\text{mm}^2$ ***or*** $8.2\times10^{-8}\,\text{m}^2$; ***[2]***

(c) lamp connected so that pd can be varied;
ammeter in series with lamp and voltmeter
in parallel with lamp; *(both needed)* ***[2]***
*Award **[0]** if lamp cannot light.*

A3. (a) (i) number of fusions required per second $=\frac{2.5\times10^{8}}{2.8\times10^{-12}}(=8.93\times10^{19})$;
1 tritium nucleus has mass of $3\,\text{amu}=3.0\times1.67\times10^{-27}\,(\text{kg})(=5.0\times10^{-27})$;
total tritium mass required $=4/4.4/4.5/4.48\times10^{-7}\,(\text{kg s}^{-1})$; ***[3]***
*Award **[3]** for a bald correct answer.*

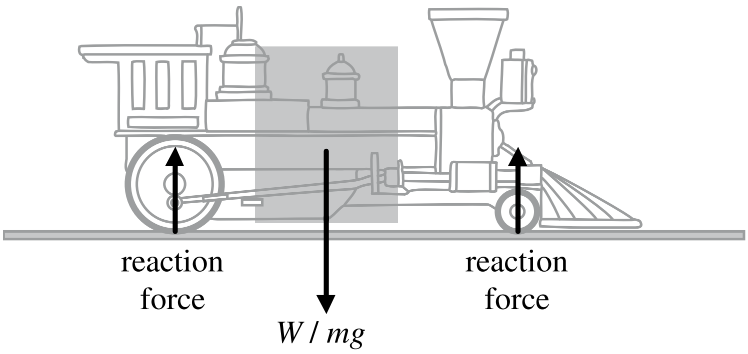
(ii) *Award any two appropriate problems e.g.*:
difficulty in maintaining high temperature for long periods;
difficulty in maintaining high density of plasma for long periods;
difficulty in enclosing plasma for long periods;
difficulty in controlled removal of heat from plasma;
difficulty in maintaining magnetic fields; ***[2 max]***

(b) one-eight remains / 87.5 decayed;
3 half lives;
13500 (days); ***[3]***

SECTION B

B1. **Part 1** Forces

(a)



The shaded box shows the acceptable range of position for W/mg.

single downward arrow labelled *W*/weight ***or*** *mg*/gravity force; *(do not allow gravity)*

two upward arrows labelled reaction/contact forces; *(do not allow for only one arrow seen)*

arrow positions as shown in diagram; ***[3]***

(b) horizontal forces have resultant of zero; *(must describe or imply horizontal force)*
valid statement linked to theory (*e.g.* Newton 1/Newton 2/conservation of momentum) explaining why zero force results in constant velocity/zero acceleration; ***[2]***

(c) power $= 16 \times 76000$;
1.2 MW; ***[2]***

(d) acceleration $= \dfrac{16^2}{2 \times 1100} (= 0.116)$;

$m = \left(\dfrac{7.6 \times 10^4}{0.116} =\right) 6.5 \times 10^5 \text{ kg}$; ***[2]***

*Award **[2]** for a bald correct answer.*

or

use of $Fs = \dfrac{1}{2}mv^2$;

$m = \left(\dfrac{2 \times 7.6 \times 10^4 \times 1100}{16^2} =\right) 6.5 \times 10^5 \text{ kg}$;

*Award **[2]** for a bald correct answer.*

(e) (i) 57 kN; ***[1]***

(ii) $F_8 = \frac{F_{16}}{2^3}$;

$F_8 = 7.1\,(\text{kN})$;

total force $= 19 + 7.1\,(\text{kN})$;

$= 26\,\text{kN}$; ***[4]***

*Award **[4]** for a bald correct answer.*

or

$k = \left(\frac{57 \times 10^3}{16^3}\right) = 13.91$;

$F_8 = (13.91 \times 8^3) = 7.1\,(\text{kN})$;

total force $= 19 + 7.1\,(\text{kN})$;

$= 26\,\text{kN}$;

*Award **[4]** for a bald correct answer.*

(f) direction of engine is constantly changing;
velocity is speed + direction / velocity is a vector;
engine is accelerating as velocity is changing; ***[3]***
*Award **[0]** for a bald correct answer.*

or

centripetal force required to maintain circular motion;
quotes Newton 1/Newton 2;
so engine is accelerating as a force acts;
*Award **[0]** for a bald correct answer.*

Part 2 Internal energy

(a) *internal energy*:
total energy of component particles (in the human);
comprises potential energy + (random) kinetic energy;

temperature: ***[2 max]***
measure of average kinetic energy of particles;
indicates direction of (natural) flow of thermal energy;
internal energy measured in J and temperature measured in K/°C ; *(both needed)* *(accept alternative suitable units)* ***[3 max]***

(b) vaporization requires energy/latent heat supply to (sweat) molecules;
this energy is supplied by the skin/body;
allowing body to lose energy; ***[3]***

or

faster/more energetic molecules escape during evaporation;
slower/less energetic/lower temperature molecules remain;
so internal energy removed from skin; ***[3]***

(c) total energy lost $= 2.3\times10^{6}\times1.8\,(=4.14\times10^{6}\text{ J})$;
$1.2\,\text{kW}$; ***[2]***

B2. Part 1 Wave motion

(a) (i) downward arrow at P; ***[1]***

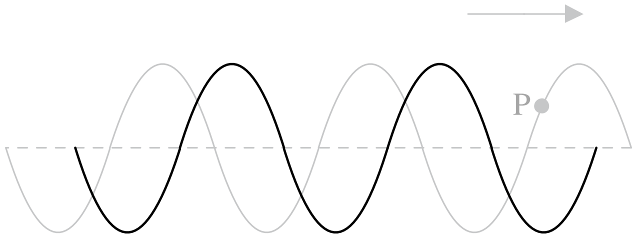
(ii) clear single wavelength marked; ***[1]***

(b) (i) $\text{frequency} = \frac{18}{25}\ (\text{Hz}) = 0.72\ (\text{Hz})$;

$\text{period} = \left(\frac{1}{0.72} =\right) 1.4\ \text{s}$; ***[2]***

*Award **[2]** for a bald correct answer.*

(ii) wave moved to right by one-third of a cycle by eye; ***[1]***

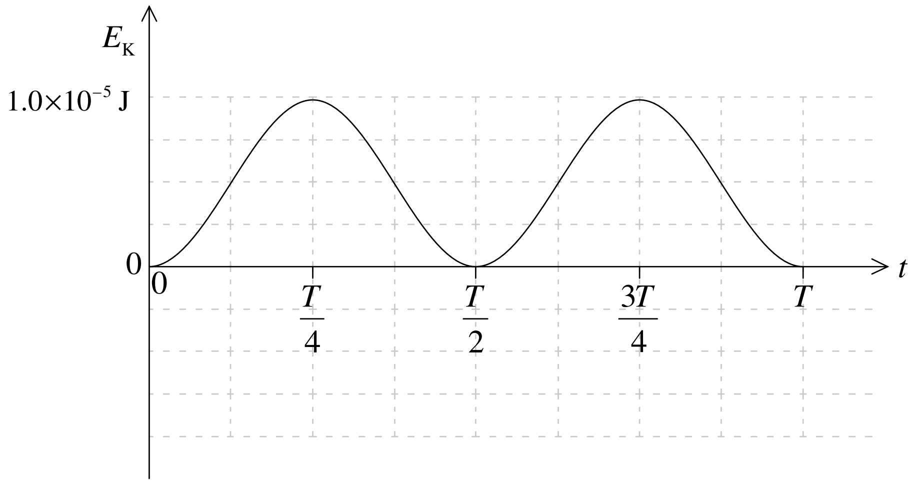


(c) (i) $\omega = \frac{2\pi}{1.4}$;

$\left(\frac{1}{2}\times 3.5\times10^{-3}\times\left[\frac{4\pi^2}{1.4^2}\right]\times\left[1.7\times10^{-2}\right]^2\right) = 1.0\times10^{-5}\ \text{J}$; ***[2]***

*Award **[2]** for a bald correct answer.*

(ii)



correct shape $(\sin^2)$; *(allow any phase for this graph)*

varying between 0 and 1.0×10^{-5} J; *(allow ECF from (c)(i) but do not allow E to be negative)*

one period takes $\frac{T}{2}$; ***[3]***

(d) (i) reduced wavelength;
reduced amplitude; ***[2]***

(ii) speed reduced and frequency constant;
therefore wavelength reduced;
some energy reflected at boundary / second string is denser/greater mass per unit length;
therefore amplitude reduced; ***[3 max]***

Part 2 Renewable energy sources

(a) (i) water storage in lakes / pumped storage / utilization of existing river; ***[1]***

(ii) relies on water collection from natural sources / electrical pumping to higher storage with controlled release when required / river channelled through turbine system / *OWTTE*;
conversion of gpe/ke to electrical form (via generator); ***[2]***

(b) (i) $2\times1.2\times10^5\times2.6\times1100$;
$=6.86\times10^8$ (kg);
($\approx 6.9\times10^8$ kg) ***[2]***
Check working and look for 3 + sf.

(ii) centre of mass of water changes by $\frac{2.6}{2}$;
change in gpe $=6.9\times10^8\times9.8\times\frac{2.6}{2}\left(=8.8\times10^9\text{ J}\right)$;
available electrical energy $=(8.8\times10^9\times0.23)=2.0\,\text{GJ}$; ***[3]***
*Award **[2 max]** if the candidate omits factor of 2 in the first marking point.*
Allow $g=10\text{ N kg}^{-1}$ giving 2.1 GJ.

(c) wind may not always blow;
requires large area of land;
noisy;
destroys bird life;
visual pollution; ***[2 max]***

B3. Part 1 Greenhouse effect

(a) effect caused by gas such as $H_2O/NH_3/CH_4/CO_2$ /greenhouse gas in the atmosphere;
gas absorbs outgoing (long wave) radiation from Earth;
gas re-radiates some of the energy back to Earth; ***[3]***

(b) (i) $\frac{3.0\times10^{8}}{6.5\times10^{13}} = 4.6\,(\mu\text{m})$;
$\approx 5\,(\mu\text{m})$ ***[1]***

(ii) water vapour molecules have a natural frequency of oscillation;
if this frequency of oscillation is 6.5×10^{13} / reference to frequency at X;
due to resonance this radiation is readily absorbed by the molecules / the radiation matches the natural frequency of oscillation; ***[3]***

or

X is a natural frequency (of oscillation) of water molecule;
so resonance effects mean that molecules are excited at this frequency;
and energy is removed/less energy transmitted from electromagnetic waves at this (particular) frequency;

(iii) energy gained by absorption needs to be re-emitted (as molecules de-excite);
in other directions / some returns to Earth; ***[2]***

(iv) more greenhouse gases means that there is more absorption of outgoing radiation;
therefore more energy returns to Earth;
leading to a further/greater increase in the temperature of the surface (of Earth); ***[3]***

(c) change in volume $= 2.3\times10^{3}\times10^{9}\times0.5\times2.1\times10^{-4}\,(=2.4\times10^{8})$;
change in water level $= \frac{2.3\times10^{3}\times10^{9}\times0.5\times2.1\times10^{-4}}{2.4\times10^{5}\times10^{6}}\,(=1\times10^{-3}\text{ m})$;
clear statement that this value is similar to fall due to evaporation; ***[3]***

Part 2 Electric motor

(a) (i) upward arrow labelled *T*/tension/force in cable and downward arrow labelled *W*/*mg*/weight/gravity force; *(both needed)*

tension arrow length > weight length; ***[2]***

(ii) $a = \frac{2s}{t^2}$;

$a = \left(\frac{2 \times 8.0}{6.5^2} = \right) 0.38 \left(\mathrm{m\,s^{-2}}\right)$;

$T = ma + mg$ ***or*** $T = 350\,(0.38 + 9.8)$;

3.6 kN; ***[4]***

Allow $g = 10\ \mathrm{N\,kg^{-1}}$ *(same answer to 2 sf).*

(b) (i) change in gpe $= 350 \times 9.81 \times 7.0\,(= 24\,\mathrm{kJ})$;

power $\left(= \frac{24 \times 10^3}{15}\right) = 1.6\,\mathrm{kW}$; ***[2]***

Allow $g = 10\ \mathrm{N\,kg^{-1}}$.

(ii) power input to motor $= 13.5$ (kW);

efficiency $= \left(\frac{1.6}{13.5} = \right) 0.12$ ***or*** 12%; ***[2]***