M10/4/PHYSI/SP2/ENG/TZ1/XX/M+

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MARKSCHEME

May 2010

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 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. 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. Indicate this with **ECF (**error carried forward).

10. Only consider units at the end of a calculation. Unit errors can only be penalized once in the paper. Place ticks for all correct marking points and use the 'U' stamp from the annotations at the appropriate place. The unit error (-1) mark then shows in the 'whole paper' section of the right hand box and the mark is automatically deducted from the whole paper.

11. 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*

Place ticks for all correct marking points and use the 'SD' stamp at the appropriate place. The significant digit (-1) mark then shows in the 'whole paper' section of the right hand box and the mark is automatically deducted from the whole paper.

SECTION A

A1.

(a) reads off R and T values correctly for at least two different coordinates on line;
shows RT not constant / other sensible test *e.g.* R halves, T does not double;
hence hypothesis not supported; ***[3]***
Award ***[0]*** *for bald unsupported conclusion.*

(b) (i) $\lg R = a + \frac{b}{T}$ is in the form of an equation of a straight line;
the points can be joined by a straight line / graph is a straight line; ***[2]***

(ii) draws straight line through all error bars (judge by eye);
evidence of use of line to determine gradient;
b: gradient in range 1500 to 1700;
a: intercept in range -1.7 to -2.3; ***[4]***

Award ***[2 max]*** *for solutions where a and b are found using data points (i.e. no line used)*

(iii) correctly substitutes derived values into equation, e.g. $-2.0 + \frac{1570}{260}$;
correct calculation from equation, e.g. $R = 11000\ \Omega$; ***[2]***

or

$\frac{1}{T} = \frac{1}{260}$ (= 0.00385) **and** uses straight line to give correct value for lg R;
R= 11000 (± 2000) Ω;

A2. (a) $F\cos 25 = 470$;
520 N; ***[2]***

(b) (i) work done $= 470 \times 2500$;
1.2 MJ; ***[2]***
*Award **[1 max]** for power of 10 error.*

(ii) $\frac{1.2 \times 10^6}{1.2 \times 60 \times 60}$;
270 W; ***[2]***
Allow correct solution from power = F×v.

(c) work still done against friction ;
work done raising load vertically / increase in gravitational potential energy; ***[2]***

A3. (a) solar energy to <u>thermal/internal energy</u> ; ***[1]***
Do not accept light/heat.

(b) total power required $= (120 \times 3000 =) 360\,\text{kW}$;
input power $= \left(\frac{360 \times 100}{18} = \right) 2000\,\text{kW}$;
area $= \left(\frac{2000 \times 1000}{650} = \right) 3.1 \times 10^3\,\text{m}^2$; ***[3]***
*Award **[2 max]** if calculation is for one house only (25.8 m^2).*

(c) no/little power at night;
power fluctuates according to weather conditions/cloud;
seasonal changes;
very large surface area required; ***[2 max]***

Any other sensible physical reason.
Do not allow "low efficiency" unless compared to other devices.
Do not allow "cost" or "expense".

SECTION B

B1. Part 1 Solar radiation

(a) energy emitted per unit time / power per unit area;
proportional to [absolute temperature/temperature in K]^4; ***[2]***
Must define symbols if used.

(b) (i) power $= 5.67 \times 10^{-8} \times 4\pi \times \left[7.0 \times 10^{8}\right]^2 \times 5800^4$; ***[1]***
$= 4.0 \times 10^{26}\,\text{W}$

(ii) $\dfrac{\text{incident energy}}{\text{area}} = \dfrac{3.97 \times 10^{26}}{4\pi\left[1.5 \times 10^{11}\right]^2}$;
$= 1400\,\text{W m}^{-2}$; ***[2]***

(iii) (albedo of Earth means) some radiation is reflected;
Earth's surface is not always normal to incident radiation;
some energy lost as radiation travels to Earth; ***[2 max]***

(iv) power absorbed $=$ power radiated;
uses $5.67 \times 10^{-8} \times 255^4 =$ to yield answer close to 240 / evaluates $\sqrt[4]{\dfrac{240}{\sigma}}$; ***[2]***

(c) radiation from the Sun is re-emitted at longer wavelengths;
(longer radiation) wavelengths are absorbed by greenhouse gases;
some radiation re-emitted back to Earth; ***[3]***

(d) more CO_2/named greenhouse gas released into atmosphere;
<u>enhanced</u> greenhouse effect;
because more re-radiation of energy towards surface; ***[3]***

B1. Part 2 Kicking a football

(a) attempt to equate gpe and ke;
$v = \sqrt{9.8 \times 6.0 \times 2}$; ***[2]***
$11\,\text{m s}^{-1}$
Award ***[0]*** *for use of* $v^2 = 2as$. *Allow use of g = 10 N kg*$^{-1}$

(b) $F = \dfrac{m\Delta v}{\Delta t}$;
$40\,\text{N}$; ***[2]***

(c) (i) ball accelerates towards centre of circular path / *OWTTE*;
therefore force towards centre / upwards;
that adds to tension; ***[3]***

(ii) $F = \left(\dfrac{mv^2}{r} = \dfrac{0.55 \times 11^2}{7.5} = \right) 8.9\,\text{N}$;
$\text{weight} = (mg = 0.55 \times 0.98) = 5.4\,\text{N}$;
$\text{total} = 14\,\text{N}$; ***[3]***
Allow use of g= 10 N kg^{-1}.

B2. Part 1 Water waves

(a) (i) 1.0 mm; *[1]*

(ii) 6.0 mm; *[1]*

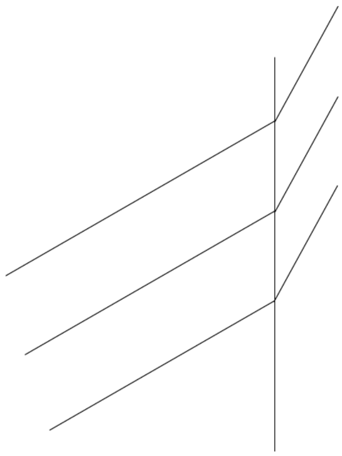
(iii) 37 Hz; *[1]*

(iv) $0.22\,\text{m s}^{-1}$; *[1]*

(b) (i) ray: direction in which energy travels;
wavefront: line connecting points with same phase/displacement; *[2]*

(ii) $\sin r = \frac{\sin 60}{1.4}$;
$r = 38^\circ$; *[2]*

(iii) wavefronts continuous at boundary and parallel;
wavefronts closer together and equally spaced by eye and in the correct direction; *[2]*



(c) (i) reference to superposition/interference;
waves (almost) cancel to give zero/small displacement;
where waves arrive out of phase/180° out/π out; *[3]*

(ii) position of any one minimum closer to centre / minima closer together;
frequency increased so wavelength decreased / correct explanation in terms of double-slit equation; *[2]*

Part 2 Nuclear processes

(a) (i) p*roton number:* 89;
nucleon number: 222; ***[2]***

(ii) 12.5% remains;
3 half lives = 4800 years; ***[2]***

(b) momentum conserved;
so different speeds as different masses;
opposite directions because momentum zero initially; ***[3]***

(c) beta have smaller mass / smaller / have greater speed than alpha;
beta have smaller charge than alpha;
therefore less likely to interact with air molecules; ***[3]***

B3. **Part 1** Electrical heater

(a) (i) use of $R\left(=\frac{pl}{A}=\right)\frac{1.1\times10^{-6}\times4.5}{6.8\times10^{-8}}$; ***[1]***

72.8Ω (73Ω)

(ii) $\frac{240^{2}}{72.8}$ / shows appropriate alternative equation;

$790\,\text{W}$; ***[2]***

(iii) one-third length so E_2 has one-third resistance of E_1 / evaluates *R* (24Ω);

(same V so) $3\times$ power of E_1;

so total power $=4\times E_1=3.2\,\text{kW}$; ***[3]***

***or** numerical method*

current in $R_1=\frac{728}{240}=3\,\text{A}$;

current in $R_2=9\,\text{A}$;

total current $=12\,\text{A}$ and total power $=3.2\,\text{kW}$;

*Award **[3]** for correct alternative working.*

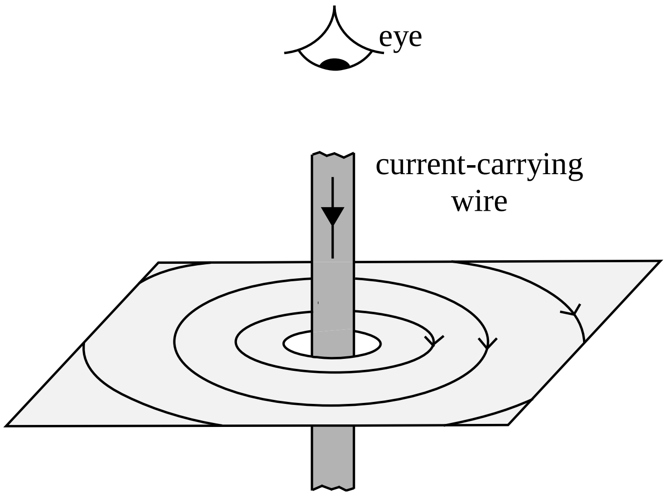
(iv) the power output will be less;

because the total resistance is greater in the series case;

hence the current is less and power depends on I^2;

$P=\frac{V^2}{R}$; ***[3 max]***

(b) (i) concentric circles (by eye);
a minimum of three circles required;
correct direction; ***[3]***



(ii) current in one turn produces magnetic field in region of adjacent turn;
this gives rise to force in adjacent turn which also has electric current;
they attract; ***[3]***

Part 2 Heating a liquid

(a) in boiling, energy is required to break bonds (in vaporization) **and** to separate molecules;
in melting, (more) energy available to overcome bond energies of molecules without large separation; ***[2]***

(b) (i) evaporation at surface of liquid, boiling occurs throughout liquid;
evaporation occurs at all temperatures, boiling at boiling pt only;
boiling: vapour pressure = atmospheric;
evaporation: vapour pressure < atmospheric; ***[2 max]***

(ii) attempt to equate energy gained by milk to energy lost by steam;
minimum $\text{energy required} = 0.30 \times 3800 \times 62 = (70\,680\,\text{J})$;
energy supplied $= [\text{steam mass}] \times [2.3 \times 10^6 + 4200 \times 20]$;
minimum $\text{steam mass} = 0.030\,\text{kg}$; ***[4]***

(iii) energy required to heat cup;
energy lost to surroundings / steam escapes from system; ***[2]***