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MARKSCHEME

May 2014

PHYSICS

Standard Level

Paper 2

12 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.

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 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 ***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. Do **not** penalize candidates for errors in units or significant figures, **unless** it is specifically referred to in the markscheme.

SECTION A

1. (a) smooth curve drawn through all error bars and curve extrapolated appropriately to x-axis;
their own intercept correctly read to within ± 6 minutes (1 small square) / 7:50 hour to 8:00 hour if no line drawn; ***[2]***

(b) calculates total energy used by house $= 8$ (kWh) ***or*** 28.8 (MJ);
estimate of total area $= 14 \pm 1$ (kWh) ***or*** 50.4 ± 3.6 (MJ);
6 ± 1 (kWh) ***or*** 21.6 ± 3.6 (MJ); *(allow ECF from first two marking points)* ***[3]***

or

clear attempt to estimate any area of graph;
correct calculation of area above 2 kW line on graph;
6 ± 1 (kWh) ***or*** 21.6 ± 3.6 (MJ); *(allow ECF from first two marking points)*

(c) read-off error bar at 12:00 hour as 0.4;
calculate uncertainty in $P = \left(\frac{100 \times 0.4}{6.0} = \right) 6.6\,\%$;
$\frac{\Delta V}{V} = \frac{\left[\frac{\Delta P}{P} - \frac{\Delta R}{R}\right]}{2} = 2.3\,\%$; ***[3]***

(d) intercept 8.7 ± 0.1;
gradient equals $\left(\frac{8.7}{210} = \right)(-)0.041$; *(allow ECF from first marking point)*
$P^2 = 8.7 - 0.041t$; *(negative sign essential)* *(allow ECF from first and second marking points)* ***[3]***
Do not accept "inverse" relationship or "linear".
*Award **[3]** for a bald correct answer.*
*Award **[2 max]** if gradient is left as a fraction.*

2. (a) same temperature so (average) kinetic energy (of atoms/molecules) the same;

(interatomic) potential energy of atoms is greater for liquid / energy is needed to separate the atoms; *(do not allow "forces are weaker" arguments)*

internal energy = potential energy + kinetic energy; *(allow BOD for clear algebra)*
(so internal energy is greater) ***[3]***

(b) energy lost by freezing zinc $= 1.5 \times 113000$ $(= 170000\,\text{J})$; *(watch for power of ten error)*

energy gained by iron $= 12 \times 440 \times [89 - 20] (= 364000\,\text{J})$;
energy lost by cooling solid zinc $= 195000\,(\text{J})$;

specific heat capacity of zinc $= \frac{195000}{1.5 \times [420 - 89]} = 390\,(\text{J kg}^{-1}\,\text{K}^{-1})$; ***[4]***

Award ***[3 max]*** *for an answer of 733 ($kJ\ kg^{-1}\ K^{-1}$) (1.5 × 113 was used).*

or

thermal energy lost by zinc = thermal energy gained by iron;
indication that thermal energy lost by zinc has a latent heat contribution and a specific heat contribution expressed algebraically or numerically;
substitution correct;
answer;

3. (a) difference between mass of a nucleus and the sum of mass of nucleons/ constituents/particles; ***[1]***

(b) (i) binding energy of left-hand side $= 1.11 \times 2$ <u>and</u> binding energy of right-hand side $= 3 \times 2.6$; *(both needed) (allow ECF)*

energy release $= 5.58$ (MeV); *(ignore sign)* ***[2]***

(ii) line goes through Ni point and nickel is the maximum ± 2 small squares horizontally; *(allow Fe-56 as maximum – this is just outside the range allowed)*

line starts at 0, downward trend for *A* after 62, trend after nickel less steep than before; ***[2]***

Line must go through part of the X to award first marking point.
Line must not flatten out to award second marking point.
Allow smooth curve for low A.
Allow incorrect variations at low A.

(iii) nucleus produced in the reaction is higher up the curve than the reactants / *OWTTE*; *(must see reference to graph)*

reference to binding energy/other valid reason results in energy release; ***[2]***

Award ***[0]*** *for a bald correct answer.*
Award ***[0]*** *for any discussion of fission.*

SECTION B

4. (a) only non-renewable is depleted/cannot re-generate whereas renewable can / consumption rate of non-renewables is greater than formation rate and consumption rate of renewables is less than formation rate; ***[1]***
Do not allow "cannot be used again".

(b) (i) volume released $= (22\times10^6\times6=)\,1.32\times10^8\,(\text{m}^3)$;

volume per second $=\dfrac{1.32\times10^8}{6\times3600}(=6111\,\text{m}^3)$; ***[2]***

(ii) use of average depth for calculation (3 m);
gpe lost $=6100\times1000\times9.81\times3$;
0.18 (GW); ***[3]***
Accept $g=10\,m\,s^{-2}$.
*Award **[1 max]** if 6 m is used and an "average" is used at end of solution without mention of average depth.*

(iii) converts/states output with units; *(allow values quoted from question without unit)*

converts/states input with units; *(allow values quoted from question without unit)*

calculates efficiency from $\dfrac{\text{output}}{\text{input}}$ as 0.31; ***[3]***
*Award **[3]** for bald correct answer.*

eg:
power output $=\dfrac{5.4\times10^8}{365\times24\times3600}(=17\,\text{kW h s}^{-1})$;
$=17\times3600000=6.16\times10^7$ (W);
efficiency $=\left(\dfrac{6.16\times10^7}{2.0\times10^8}=\right)31\,\%$ ***or*** 0.31;

or

0.2 GW is 1.752×10^9 (kWh year^{-1});
$\dfrac{5.4\times10^8}{1.752\times10^9}$;
efficiency $=0.31$;

(c) (i) cloud cover / weather conditions;
latitude;
time of year / season;
nature/colour of surface; ***[2 max]***

(ii) areas of ice/snow (at poles) will increase / alternative consistent mechanism;

any three from:
reduction in use of fossil fuels will reduce greenhouse gases/named greenhouse gas;
enhanced greenhouse effect reduced;
temperature reduces / surface will cool;
more sunlight/incident radiation reflected at surface; ***[4 max]***
Descriptions of (enhanced) greenhouse effect are irrelevant and neutral.

(d) (i) (total) momentum unchanged before and after collision / momentum of a system is constant; } *(allow symbols if explained)*
no external forces / isolated system / closed system; ***[2]***
Do not accept "conserved".

(ii) final momentum of neutron $= \text{neutron mass} \times 9.8\times10^6 - 1\text{u}\times12\times1.5\times10^6$; } *(allow any appropriate and consistent mass unit)*
final speed of neutron $= 8.0$ ***or*** $8.2\times10^6\ (\text{m s}^{-1})$;
$(\approx 8.0\times10^6\ (\text{m s}^{-1}))$ ***[2]***
Allow use of 1 u for both masses giving an answer of $8.2\times10^6\ (\text{m s}^{-1})$.

(iii) initial energy of neutron $= 8.04\times10^{-14}$ (J) <u>and</u> final energy of neutron $= 5.36\times10^{-14}$ (J); } *(both needed)*
fractional change in energy $= \left(\dfrac{(8.04-5.36)}{8.04} = \right)0.33$; ***[2]***

or

fractional change $= \left(\dfrac{\frac{1}{2}mv_i^2 - \frac{1}{2}mu_f^2}{\frac{1}{2}mv_i^2}\right)$; } *(allow any algebra that shows a subtraction of initial term from final term divided by initial value)*
$\left(= \dfrac{(9.8\times10^6)^2-(8.0\times10^6)^2}{(9.8\times10^6)^2}\right)$ *(allow omission of* 10^6 *)*
$= 0.33$; *(allow 0.30 if 8.2 used)*
Do not allow ECF if there is no subtraction of energies in first marking point.

(iv) $(0.33)^n = 10^{-6}$;
$n = 13$; *(allow* $n=12$ *if 0.3 is used)* ***[2]***

(v) neutrons produced in fission have large energies;
greatest probability of (further) fission/absorption (when incident neutrons have thermal energy or low energy); ***[2]***
Do not accept "reaction" for "fission reaction".

5. Part 1 Simple harmonic motion (SHM) and sound

(a) acceleration is proportional to displacement;
force/acceleration is directed towards equilibrium (point)/rest position; *(do not accept "centre" or "fixed" point)*
straight line through the origin shows the proportionality;
negative gradient shows acceleration directed towards equilibrium (point) / acceleration has opposite sign to displacement; ***[4]***

(b) (i) gradient $= (-)\omega^2$;
$\omega^2 = 1.56\times10^6\,(\text{s}^{-2})$;
$\omega = 1250\,(\text{rad s}^{-1})$;
$f = 198\,(\text{Hz})$; ***[4]***

or

$\omega^2 = (-)\frac{a}{x}$;
$\omega = \sqrt{\frac{75}{48\times10^{-6}}}$;
$f = \frac{1}{2\pi}\sqrt{\frac{75}{48\times10^{-6}}}$;
$f = 198\,(\text{Hz})$;
Allow substitution for fourth mark.

(ii) at origin; ***[1]***

(c) (i) ray shown at 90° to wavefront A, plausible reflection and reflected ray goes in direction of position 1; *(judge by eye)* ***[1]***

(ii) 1.65 (m); *(allow ECF from (b))* *(accept rounding to 1.6 or 1.7)* ***[1]***

(iii) mention of diffraction;
diffraction means that sound spreads beyond the limit of geometrical shadow/can go around a corner / *OWTTE*; ***[2]***
Accept marking points in the form of a clearly drawn correctly labelled diagram.

(d) interference/superposition mentioned;
when sounds arrive out of phase / path difference half integer number of wavelengths / *OWTTE*;
cancellation occurs / destructive (interference);
some (back) reflection from walls so cancellation may not be complete (hence "faint" not "zero"); ***[3 max]***

Part 2 Electric and magnetic fields

(e) conductor has free electrons/charges that are free to move within/through it / insulator does not have free electrons/charges that are free to move within/ through it;
electrons act as charge carriers;
when a pd acts across a conductor a current exists when charge (carriers) move; ***[2 max]***
Do not allow "good/bad conductor/resistor" or reference to conductivity/resistivity.

(f) anti-clockwise arrows;
at least three circles centred on wire;
increasing in separation from centre; ***[3]***

(g) (i) arrow to the right; ***[1]***

(ii) $\frac{F}{l} = BI$;

$I = \left(\frac{mg}{lB} = \right)\frac{1.41 \times 10^{-4} \times 9.8}{40 \times 10^{-6}}$;

35 (A); ***[3]***

*Award **[3]** for a bald correct answer.*

Allow use of $g = 10\,m\,s^{-2}$ which also gives an answer of 35 (A).

6. Part 1 Motion of a car

(a) use of a kinematic equation to determine motion time $(=12.5\,\text{s})$;
change in kinetic energy $=\frac{1}{2}\times 1200\times\left[28^2-12^2\right]\ (=384\,\text{kJ})$;
rate of change in kinetic energy $=\frac{384000}{12.5}$; *(allow ECF of 16^2 from $(28-12)^2$ for this mark)*
31 (kW); ***[4]***

or

use of a kinematic equation to determine motion time $(=12.5\,\text{s})$;
use of a kinematic equation to determine acceleration $(=1.28\,\text{m}\,\text{s}^{-2})$;
work done $=\frac{F\times s}{\text{time}}=\frac{1536\times 250}{12.5}$;
31 (kW);

(b) (i) force $=\frac{\text{power}}{\text{speed}}$;
2300 ***or*** 2.3k (N); ***[2]***
*Award **[2]** for a bald correct answer.*

(ii) resistive force $=\frac{2300}{4}$ ***or*** $\frac{2321}{4}\ (=575)$; *(allow ECF)*
so accelerating force = (2300 – 580 =) 1725 (N) ***or*** 1741 (N);
$a=\frac{1725}{1200}=1.44\,(\text{m}\,\text{s}^{-2})$ ***or*** $a=\frac{1741}{1200}=1.45\,(\text{m}\,\text{s}^{-2})$; ***[3]***
*Award **[2 max]** for an answer of 0.49 $(\text{m}\,\text{s}^{-2})$ (omits 2300 N).*

(c) (i) centripetal force must be <6000 (N); *(allow force = 6000 N)*
$v^2=F\times\frac{r}{m}$;
31.6 $(\text{m}\,\text{s}^{-1})$; ***[3]***
*Allow **[3]** for a bald correct answer.*
*Allow **[2 max]** if 4× is omitted, giving 15.8 $(\text{m}\,\text{s}^{-1})$.*

(ii) statement of Newton's first law;
(hence) without car wall/restraint/friction at seat, the people in the car would move in a straight line/at a tangent to circle;
(hence) seat/seat belt/door exerts centripetal force;
(in frame of reference of the people) straight ahead movement is interpreted as "outwards"; ***[3 max]***

Part 2 Electricity

(d) (i) voltmeter in parallel with cell; *(allow ammeter within voltmeter leads)*
ammeter in series with variable resistor; } *(must draw as variable arrangement or as potential divider)* ***[2]***
Allow cell symbol for lemon/cell/box labelled "lemon cell".
*Award **[1 max]** if additional cell appears in the circuit.*

(ii) $E = I(R + r)$ and $V = IR$ used; *(must state both explicitly)*
re-arrangement correct *ie* $E = V + Ir$; } *(accept any other correct re-arrangement eg. involving energy conversion)* ***[2]***

(iii) line correctly extrapolated to *y*-axis; *(judge by eye)*
1.6 ***or*** 1.60 (V); *(allow ECF from incorrect extrapolation)* ***[2]***

(iv) correct read-offs from large triangle greater than half line length;
gradient determined;
290 to 310 (Ω); ***[3]***
*Award **[2 max]** for the use of one point on line and equation.*

(v) 0.35 (C); ***[1]***