



# **MARKSCHEME**

**May 2014**

**PHYSICS**

**Standard Level**

**Paper 2**

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## 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  $\pm 6$  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*  $50.4 \pm 3.6$  (MJ);  
 $6 \pm 1$  (kWh) *or*  $21.6 \pm 3.6$  (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;  
 $6 \pm 1$  (kWh) *or*  $21.6 \pm 3.6$  (MJ); (allow ECF from first two marking points)

- (c) read-off error bar at 12:00 hour as 0.4;  
 calculate uncertainty in  $P = \left( \frac{100 \times 0.4}{6.0} \right) 6.6\%$ ;

$$\frac{\Delta V}{V} = \frac{\left[ \frac{\Delta P}{P} - \frac{\Delta R}{R} \right]}{2} = 2.3\% ; \quad [3]$$

- (d) intercept  $8.7 \pm 0.1$ ;  
 gradient equals  $\left( \frac{8.7}{210} \right) (-)0.041$ ; (allow ECF from first marking point)

$$P^2 = 8.7 - 0.041t ; \quad \left. \begin{array}{l} \text{(negative sign essential)} \\ \text{(allow ECF from first and second marking points)} \end{array} \right\} [3]$$

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;  $\left. \begin{array}{l} \text{(do not allow "forces are} \\ \text{weaker" arguments)} \end{array} \right\}$   
 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 J);  $\left. \begin{array}{l} \text{(watch for power of} \\ \text{ten error)} \end{array} \right\}$   
 energy gained by iron =  $12 \times 440 \times [89 - 20]$  (= 364000 J);  
 energy lost by cooling solid zinc = 195000 (J);  
 specific heat capacity of zinc =  $\frac{195000}{1.5 \times [420 - 89]} = 390$  (J kg<sup>-1</sup> K<sup>-1</sup>); [4]

*Award [3 max] for an answer of 733 (kJ kg<sup>-1</sup> K<sup>-1</sup>) (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 =  $1.11 \times 2$  and binding energy of right-hand side =  $3 \times 2.6$ ; } (both needed)  
 energy release = 5.58 (MeV); (ignore sign) } (allow ECF) [2]
- (ii) line goes through Ni point and nickel is the maximum  $\pm 2$  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 =  $(22 \times 10^6 \times 6) = 1.32 \times 10^8 \text{ (m}^3\text{)}$ ;  
 volume per second =  $\frac{1.32 \times 10^8}{6 \times 3600} (= 6111 \text{m}^3)$ ; [2]

(ii) use of average depth for calculation (3 m);  
 gpe lost =  $6100 \times 1000 \times 9.81 \times 3$ ;  
 0.18 (GW); [3]

*Accept  $g = 10 \text{ m s}^{-2}$ .*

*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  $\frac{\text{output}}{\text{input}}$  as 0.31; [3]

*Award [3] for bald correct answer.*

*eg:*

$$\text{power output} = \frac{5.4 \times 10^8}{365 \times 24 \times 3600} (= 17 \text{ kW h s}^{-1});$$

$$= 17 \times 3600000 = 6.16 \times 10^7 \text{ (W)};$$

$$\text{efficiency} = \left( \frac{6.16 \times 10^7}{2.0 \times 10^8} = \right) 31 \% \text{ or } 0.31;$$

**or**

$$0.2 \text{ GW is } 1.752 \times 10^9 \text{ (kWh year}^{-1}\text{)};$$

$$\frac{5.4 \times 10^8}{1.752 \times 10^9};$$

$$\text{efficiency} = 0.31;$$

- (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 } (allow symbols if  
 / momentum of a system is constant; } explained) [2]  
 no external forces / isolated system / closed system;  
*Do not accept "conserved".*
- (ii) final momentum of neutron } (allow any appropriate and  
 = neutron mass  $\times 9.8 \times 10^6 - 1 \text{ u} \times 12 \times 1.5 \times 10^6$ ; } consistent mass unit) [2]  
 final speed of neutron =  $8.0 \text{ or } 8.2 \times 10^6 \text{ (ms}^{-1}\text{)}$ ;  
 ( $\approx 8.0 \times 10^6 \text{ (ms}^{-1}\text{)}$ )  
*Allow use of 1 u for both masses giving an answer of  $8.2 \times 10^6 \text{ (ms}^{-1}\text{)}$ .*
- (iii) initial energy of neutron =  $8.04 \times 10^{-14} \text{ (J)}$  and final energy } (both needed)  
 of neutron =  $5.36 \times 10^{-14} \text{ (J)}$ ;  
 fractional change in energy =  $\left( \frac{8.04 - 5.36}{8.04} \right) = 0.33$ ; [2]
- or*
- fractional change =  $\left( \frac{\frac{1}{2}mv_i^2 - \frac{1}{2}mu_f^2}{\frac{1}{2}mv_i^2} \right)$ ; } (allow any algebra that shows a  
 subtraction of initial term from final }  
 term divided by initial value)
- $\left( = \frac{(9.8 \times 10^6)^2 - (8.0 \times 10^6)^2}{(9.8 \times 10^6)^2} \right)$  (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 } (*do not accept "centre" or*  
 (point)/rest position; } (*"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 =  $(-)\omega^2$  ;  
 $\omega^2 = 1.56 \times 10^6 \text{ (s}^{-2}\text{)}$  ;  
 $\omega = 1250 \text{ (rad s}^{-1}\text{)}$  ;  
 $f = 198 \text{ (Hz)}$  ; [4]

*or*

$$\omega^2 = (-)\frac{a}{x}$$

$$\omega = \sqrt{\frac{75}{48 \times 10^{-6}}}$$

$$f = \frac{1}{2\pi} \sqrt{\frac{75}{48 \times 10^{-6}}}$$

$$f = 198 \text{ (Hz)}$$

*Allow substitution for fourth mark.*

- (ii) at origin; [1]
- (c) (i) ray shown at  $90^\circ$  to wavefront A, plausible reflection and } (*judge by*  
 reflected ray goes in direction of position 1; } (*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  $g = 10 \text{ m s}^{-2}$  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 s);  
 change in kinetic energy =  $\frac{1}{2} \times 1200 \times [28^2 - 12^2]$  (= 384 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 s);  
 use of a kinematic equation to determine acceleration (=  $1.28 \text{ m s}^{-2}$ );  
 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);  
 $a = \frac{1725}{1200} = 1.44 \text{ (ms}^{-2}\text{)}$  or  $a = \frac{1741}{1200} = 1.45 \text{ (ms}^{-2}\text{)}$ ; [3]  
 Award [2 max] for an answer of  $0.49 \text{ (ms}^{-2}\text{)}$  (omits 2300 N).

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

- (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]

