



# **MARKSCHEME**

**May 2013**

**PHYSICS**

**Standard Level**

**Paper 2**

12 pages

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## Subject Details: Physics SL Paper 2 Markscheme

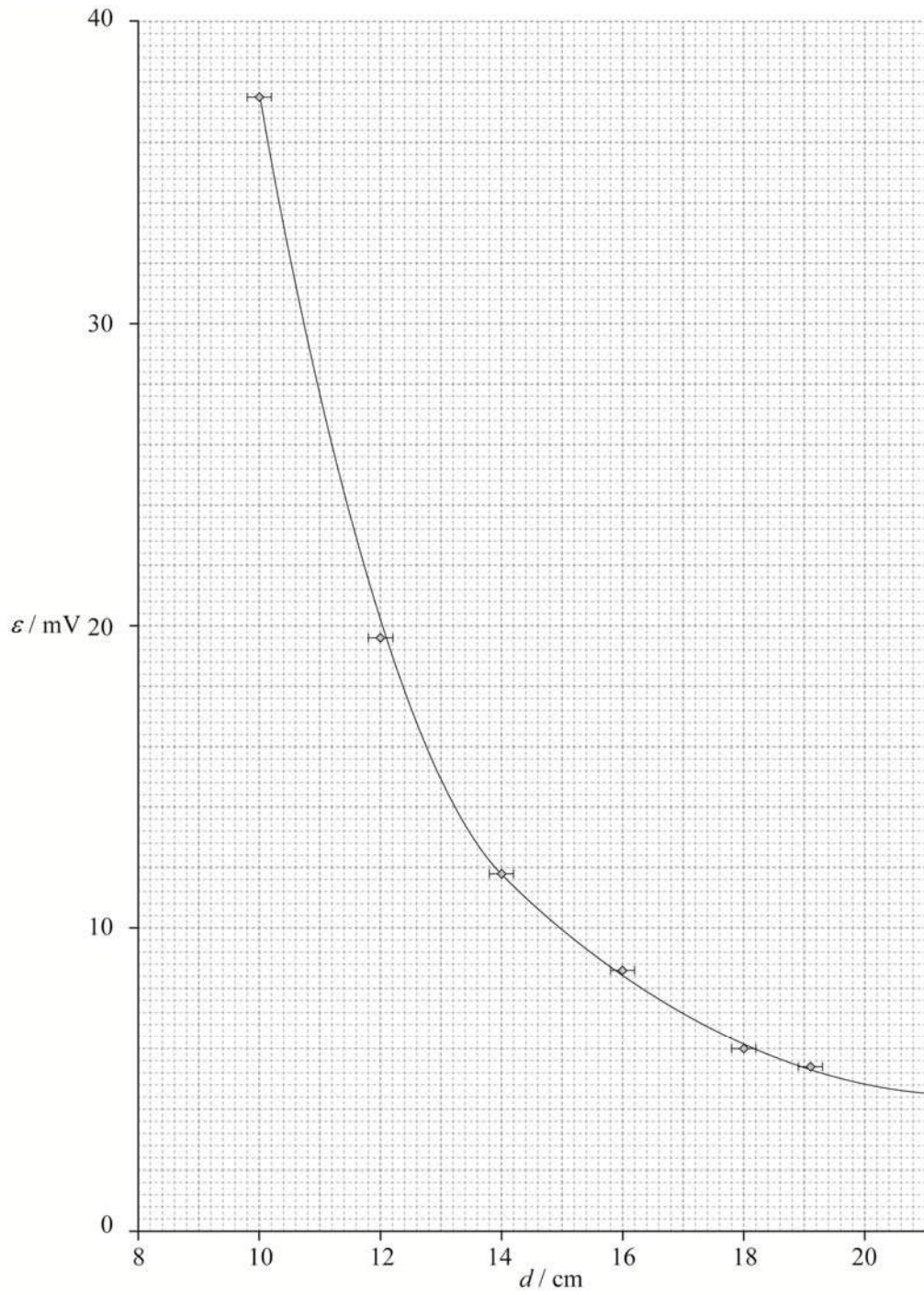
### Mark Allocation

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**

- A1.** (a) reference to meter/instrument;  
reference to constant accuracy/precision; **[2]**
- (b) (i) looking for constant value;  
clear deviation means not/unlikely to be valid;  
close to constant only means possibility of validity; **[2 max]**
- (ii) two of 105, 138, 375 correct;  
third value correct;  
products so far apart clearly not inversely proportional;
- or*
- attempts to show that  $\frac{d_1}{\varepsilon_2} \neq \frac{d_2}{\varepsilon_1}$  **or**  $\frac{d_1}{d_2} \neq \frac{\varepsilon_2}{\varepsilon_1}$  for two pairs of values;  
third pair of values used;  
ratios so far apart clearly not inversely proportional; **[3]**
- (c) (i) point plotted  $\pm \frac{1}{2}$  small square; **[1]**
- (ii) symmetrical error bar, 1 small square in each direction  $\pm \frac{1}{2}$  small square; **[1]**
- (iii) single smooth curve within each error bar; **[1]**



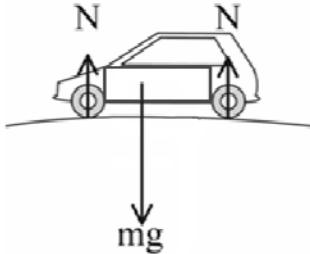
(d) % uncertainty in  $d$  value  $\left( = \frac{0.2 \text{ cm}}{18 \text{ cm}} \right) = 1/1.1\%$ ;

% uncertainty in  $d\epsilon$  product = 4/4.1%;

[2]

- A2. (a) direction changing;  
velocity changing so accelerating; [2]

(b)



weight/gravitational force/mg/w/ $F_w$ / $F_g$  and reaction/normal reaction/perpendicular contact force/N/R/ $F_N$ / $F_R$  both labelled; (*do not allow "gravity" for "weight".*) weight between wheels (in box) from centre of mass and reactions at both wheels / single reaction acting along same line of action as the weight; [2]

- (c)  $g = \frac{v^2}{r}$ ;  
 $v = \sqrt{50 \times 9.8}$ ;  
 $22 \text{ ms}^{-1}$ ; [3]  
*Allow [3] for a bald correct answer.*

- A3. (a) (when two similar waves meet) the resultant displacement is the (vector) sum of the individual displacements; [1]

- (b) (i) (constructive interference gives) amplitude  $2A$ ;  
intensity is proportional to square of total amplitude ( $= 4A^2$ ); [2]

- (ii) attempted use of Pythagoras to measure path difference;  
path difference =  $0.55 \text{ m}$ ;  
path difference =  $\frac{\lambda}{2}$  (so out of phase / destructive interference); [3]  
*Attempted use of Pythagoras may appear on diagram for (b)(i).*

**SECTION B**

**B1. Part 1** Impulse and momentum

(a) (i) (gravitational) potential energy (of club head) goes to kinetic energy (of club head);  
some kinetic energy of club head goes to internal energy of club head/kinetic energy of ball; [2]

(ii) equating  $mgh$  to  $\frac{1}{2}mv^2$ ;  
 $v = 4.1 \text{ (ms}^{-1}\text{)}$ ; [2]

(b) deformation prolongs the contact time;  
increased impulse  $\Rightarrow$  bigger change of momentum/velocity;

**or**

(club head) stores (elastic) potential energy on compression;  
this energy is passed to the ball; [2]

(c) (i) any value of  $\frac{\text{mass} \times \text{velocity}}{\text{time}}$ ;  
 $1.3 \times 10^4 \text{ N}$ ; [2]

(ii)  $-1.3 \times 10^4 \text{ N}$ ; [1]  
*Accept statement that force is in the opposite direction to (c)(i).  
Allow the negative of any value given in (c)(i).*

(iii) clear use of conservation of momentum / impulse = change of momentum;  
 $21 \text{ ms}^{-1}$  ;

**or**

$a = \left( \frac{F}{m} = \frac{-13000}{0.17} = \right) (-) 76500 \text{ ms}^{-1}$ ;  
 $v = (u + at = 38 - 76500 \times 0.00022 =) 21 \text{ ms}^{-1}$ ; [2]

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

**Part 2** Nuclear fusion

- (a) (i) difference in total mass of individual nucleons and nucleus / energy needed to divide nucleus into component nucleons / energy liberated when nucleus formed from component individual nucleons;  
nuclear binding energy is the energy equivalent of mass defect / reference to  $E = mc^2$ ; [2]
- (ii) S marked near line between 50 and 70; [1]
- (iii) binding energy per nucleon read from graph as 1.1/1.2 and 7.1/7.2 MeV;  
both values multiplied by 4;  
difference given between 23.6 and 24.4 MeV;  
 $3.8 \times 10^{-12} \text{ J}$  *or*  $3.9 \times 10^{-12} \text{ J}$ ; [4]
- (b) (i)  ${}^1_1\text{H}$  /  ${}^1_1\text{p}$ ;  
 ${}^3_2\text{He}$ ;  
 ${}^0_{-1}\text{e}$  /  ${}^0_{-1}\beta$ ;  
 ${}^0_0\bar{\nu}$ ; (*do not allow neutrino*) [4]
- (ii) recognition that fusion process is more likely (at high temperatures);  
the (electric) force between nuclei is repulsive;  
nuclei need  $\sim 10^{-15} \text{ m}$  separations for strong force to act;  
kinetic energy of nuclei increases with temperature;  
(higher temperature) increases probability of nuclear collisions;  
radioactive decay is unaffected by temperature; [3 max]



**B2. Part 1** Simple harmonic motion and forced oscillations

(a) (i) 32 mm; [1]

(ii) period = 160 ms;  
frequency = 6.2/6.3 Hz; [2]  
*Allow ECF for incorrect period.*

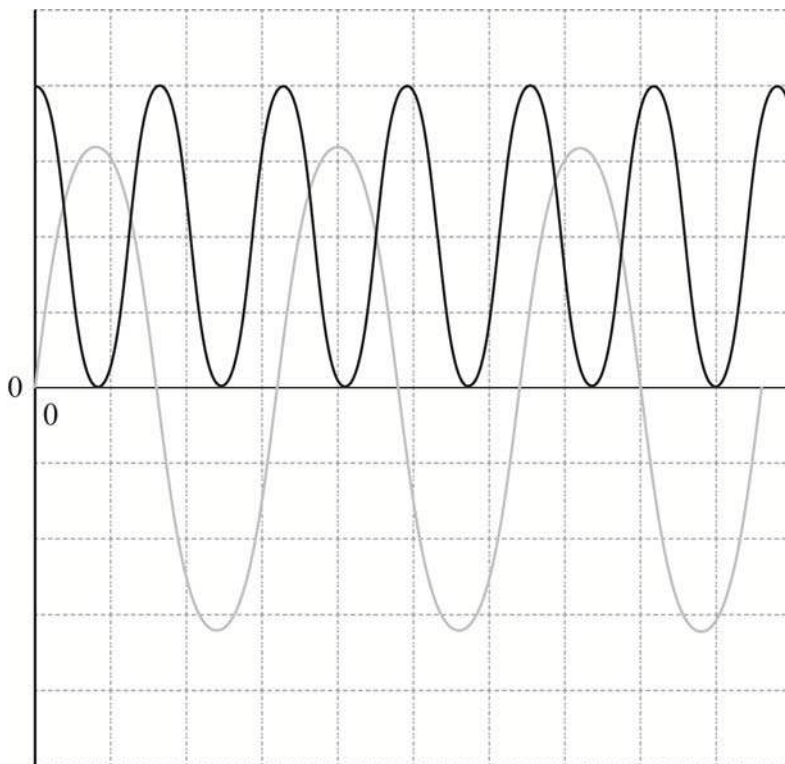
(b) (i)  $\omega = 2\pi \times 6.25$ ;  
 $v (= 39.3 \times 32 \times 10^{-3}) = 1.3 \text{ (ms}^{-1}\text{)}$ ; (*allow ECF from (a)*)

**or**

tangent drawn to graph at a point of zero displacement;  
gradient calculated between 1.2 and 1.4; [2]

(ii) displacement = 23 – 26 (mm) ;  
 $35 - 40 \text{ (ms}^{-2}\text{)}$ ; [2]

(c)



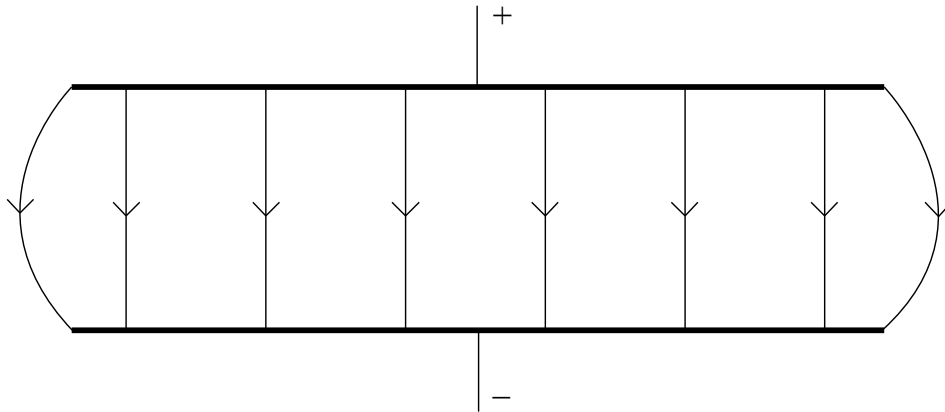
double frequency;  
always positive and constant amplitude;  
correct phase *ie* cosine squared; [3]  
*A minimum of one complete, original oscillation needed to award [3].*

**Part 2** Electric and magnetic force fields

(a) force per unit charge;  
on a positive test charge / on a positive small charge; [2]

(b) (i) top plate positive and bottom negative (or +/- and ground); [1]

(ii)



uniform (by eye) line spacing and edge effect, field lines touching both plates;  
downward arrows (minimum of one and none upward); [2]

(iii)  $F = 2.5 \times 10^3 \times 1.6 \times 10^{-19}$  ;  
 $4.0 \times 10^{-16}$  N; [2]  
*Award [2] for a bald correct answer.*

(c) (i) use of  $F = \frac{(1.60 \times 10^{-19})^2}{4\pi\epsilon_0 (5.0 \times 10^{-3})^2}$  *or*  $F = \frac{(1.60 \times 10^{-19})^2}{(5.0 \times 10^{-3})^2} \times 8.99 \times 10^9$  ;  
 $9.2 \times 10^{-24}$  N; [2]

(ii)  $1.0 \times 10^7 \text{ ms}^{-2}$  ( $9.9 \times 10^6 \text{ ms}^{-2}$  if  $9 \times 10^{-24}$  N used); [1]

(iii) electron will continue to accelerate;  
speed increases with acceleration;  
acceleration reduces with separation;  
when outside the field no further acceleration/constant speed;  
any reference to accelerated charge radiating and losing (kinetic) energy; [3 max]

(iv) minimum of two concentric circles centred on Y;  
anti-clockwise; [2]

**B3. Alternative energy supplies**

- (a) (i) mention of blades/propeller and turbine/generator/dynamo;  
 kinetic energy of wind → kinetic energy of turbine;  
 (rotational) kinetic energy → electricity/electrical energy; [3]  
*Award [1 max] for statement of (unqualified) kinetic energy to electrical energy.*
- (ii)  $A (= \pi r^2) = 6.4 \times 10^3 \text{ m}^2$ ;  
 ( $P =$ ) 1.95 MW; [2]
- (iii)  $0.24 \times 1.95 \text{ MW} (= 0.47 \text{ MW}/0.48 \text{ MW})$ ;  
 ( $0.47 \text{ MW} = 470 \text{ kW}$  thus) two generators would meet the maximum demand; [2]
- (b) (i) sea is smoother (does not interrupt wind flow) / no obstacles on sea /  
 less friction / less turbulence (vice versa for land) / *OWTTE*; [1]  
*Allow named obstacles, eg trees/buildings/hills, etc.*
- (ii)  $\frac{v_{land}}{v_{sea}} = \frac{10}{12.4}$ ;  
 $\frac{P_{land}}{P_{sea}} = \left[ \frac{10}{12.4} \right]^3 = 0.52$ ; [2]  
*Award [1 max] for 1.9 due to inverted ratio.*
- (c) photovoltaic cells generate emf/electricity;  
 solar panels generate thermal energy/heat / *OWTTE*; [2]
- (d) (i) emf = 3.0 V; [1]
- (ii) series combination of resistance = 7.2 Ω;  
 use of parallel resistance formula;  
 2.4 Ω; [3]  
*Award [3] for a bald correct answer.*
- (iii) attempted use of  $IV$ ,  $I^2R$  or  $\frac{V^2}{R}$ ;  
 0.94W; [2]  
*Allow ECF from (d)(i) and (d)(ii).*
- (iv) (series) increases the total emf/voltage;  
 (parallel) increases the current/decreases internal resistance/ensures some  
 power if single cell fails / *OWTTE*; [2]

- (e) (i) the solar radiation is captured by a disc of area  $\pi R^2$  where  $R$  is the radius of the Earth;  
but is distributed (when averaged) over the entire Earth's surface which has an area four times as large;

*or*

rays make an angle  $\theta$  with area of Earth's half-sphere and so average intensity is proportional to average of  $\cos^2 \theta$  i.e.  $\frac{1}{2}$ ;

there is an additional factor of  $\frac{1}{2}$  due to the other half of the sphere; [2]

- (ii) variation of solar emission / Earth's orbit is elliptical/not quite circular; [1]

- (iii) input power needed =  $(5 \times 850 \text{ kW}) = 4.25 \times 10^6 \text{ W}$  ;

$$\frac{4.25 \times 10^6 \text{ W}}{3.5 \times 10^2 \text{ W m}^{-2}} = 1.2 \times 10^4 \text{ m}^2 ; \quad [2]$$

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