Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

May 2015

Physics

Standard level

Paper 2

10 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.

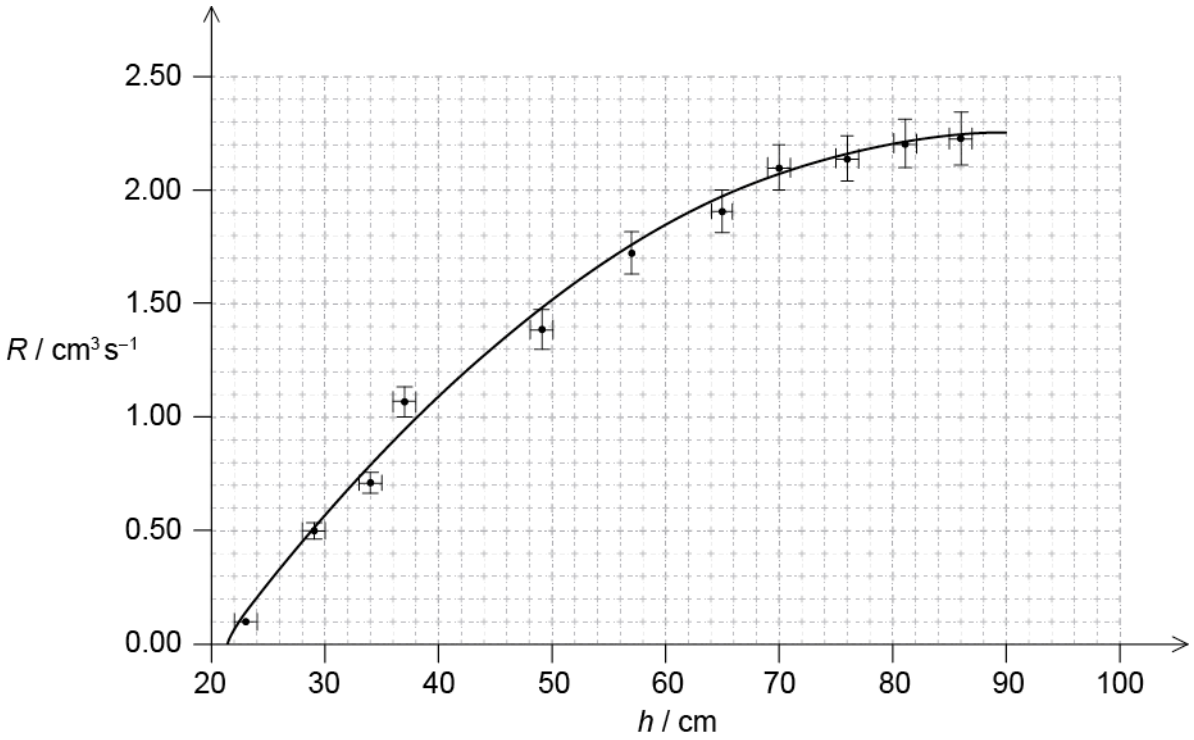
5. Words that are underlined are essential for the mark.

6. The order of marking points does not have to be as in the markscheme, unless stated otherwise.

Section A

1. (a) (i) correctly plotted ± half square; **[1]**

(ii) error bar total vertical length 1.7 (±0.4) square; **[1]**



(iii) line does not pass through all of the error bars/uncertainties; **[1]**

(iv) absolute uncertainties (in volume and time) should be constant;
constant percentage/relative/fractional uncertainty in *R* means an increase in the absolute uncertainty as *R* increases; **[2]**

(b) % uncertainty in t = 1%;
% uncertainty in V (= 5 + 1) = 6% ***or*** % uncertainty in V (= 5 − 1) = 4%;
$V\,(=2.1\times100)=210\,(\text{units})$;
absolute uncertainty (= 210 × 6%) = 12.6 / 13 / 10 (units) ***or*** absolute uncertainty (= 210 × 4%) = 8.4 / 8 (units); **[4]**

2. (a) arrow vertically downwards labelled weight/W/mg/gravitational force/F_g/$F_{gravitational}$/force of gravity; *(judge by eye)* **[1]**
Do not allow "gravity".

(b) $(N =)\ mg\cos\theta$ / correct substitution;
$(= 73 \times 9.81 \times \cos 12^\circ =)\ 700\ \text{N}$; **[2]**

(c) tension = frictional force + component of weight parallel to slope /
tension $= 65 + mg\sin\theta$;
214 / 210 N; **[2]**

(d) (Newton's first law states that a body remains at rest or moves with) constant velocity/steady speed/uniform motion unless external/net/resultant/unbalanced force acts on it;
clear link that in this case there is constant/steady <u>velocity</u> so no resultant force; **[2]**

3. (a) energy supplied / bonds broken/heat absorbed;
increases potential energy;
no change in kinetic energy (so no change in temperature); **[3]**

(b) (i) energy required to raise temperature of object by 1 K / 1°C; **[1]**

or

mass × specific heat capacity;

(ii) J K^{-1} / $\text{J}^\circ\text{C}^{-1}$; **[1]**

(iii) use of $M \times 4.2 \times 10^3 \times \Delta\theta$;
$ml = 75 \times 10^{-3} \times 3.3 \times 10^5$ / 24750 J;
recognition that melted ice warms and water cools to common final temperature;
3.4°C; **[4]**

Section B

4. Energy sources

(a) needs to be windy/high average wind speeds;
space/land/room for wind turbines;
ability to import oil/nuclear fuel;
ability to dispose of nuclear waste;
comment relating to need for geological stability; **[3 max]**

(b) (i) $\pi 4.7^2$ ***or*** 69.4 m^2;
power = 15300 to 15400 W;
470 to 490 GJ; **[3]**

(ii) wind must retain kinetic energy to escape ***or*** not all KE of wind can be converted to KE of blades;
energy lost to thermal energy (due to friction) in generator/turbine/dynamo;
turbine will suffer downtime when no wind/too much wind; **[2 max]**
Allow any two relevant factors.

(c) (i) indication that energy supplied to islanders is output and chemical energy input / $\frac{8}{25}$ used;
32 % / 0.32; **[2]**

(ii) <u>energy/it</u> is wasted due to inefficient burning of oil / <u>thermal/heat energy</u> loss to surroundings/environment / <u>electrical energy</u> is used to run the power station's systems / <u>energy/it</u> is wasted due to frictional losses in the turbine/generator; **[1]**

(iii) heating of wires by electric current / inefficient transformers; **[1]**

(d) (i) addition of greenhouse gases/named greenhouse gas to the atmosphere;
increasing the temperature of the Earth's surface/global warming; **[2]**

(ii) radiation emitted by Earth in (long wavelength) infrared region;
frequency corresponds to resonant frequency of greenhouse gases (either vibration or difference in energy levels);
radiation absorbed by greenhouse gases is (partly) re-radiated back to Earth; **[3]**

(e) percentage of U-235 in naturally occurring ores is too low to support fission ***or*** naturally occurring U-238 does not undergo fission;
percentage of U-235 (which can usefully capture thermal neutrons) is increased; **[2]**

(f) $\left({}^{1}_{0}\text{n} + {}^{235}_{92}\text{U} \rightarrow {}^{92}_{36}\text{Kr} + {}^{141}_{56}\text{Ba} + 3\,{}^{1}_{0}\text{n}\right)$
235;
36;
3; **[3]**
The number of neutrons must be consistent with chosen isotope of uranium.

(g) control rods absorb neutrons;
moderators slow down neutrons;
both affect the rate of reaction;
both rely on the neutrons colliding with their atoms/nuclei; **[3 max]**
Must see reference to collision/interaction for fourth marking point.

5. Part 1 Thermistor circuit

(a) (i) the work done per unit charge in moving a quantity of charge completely around a circuit / the power delivered per unit current / work done per unit charge made available by a source; **[1]**

(ii) place voltmeter across battery; **[1]**

(b) (i) $V_X = 7.5$ V;
$I\left(=\frac{4.5}{100\times10^{3}}\right) = 4.5\times10^{-5}\,\text{A}$ ***or*** $\frac{V_X}{V_R} = \frac{R_X}{R_R}$;
$R_x\left(=\frac{7.5}{4.5\times10^{-5}}\right) = 1.67\times10^{5}\,\Omega$ ***or*** $R_x\left(=\frac{7.5}{4.5}\times100\times10^{3}\right) = 1.67\times10^{5}\,\Omega$;
$T = -37$ ***or*** -38 °C; **[4]**

(ii) −50 to (up to) −30 °C / at low temperatures; **[1]**

(iii) as the temperature decreases R_x increases;
same <u>current</u> through R and X so the ratio increases ***or*** V_X increases <u>and</u> V_R decreases so the ratio increases; [**2**]

Part 2 Vibrations and waves

(c) (periodic) motion in which acceleration/restoring force is proportional to the displacement from a fixed point;
directed towards the fixed point / in the opposite direction to the displacement; **[2]**

(d) (i) $\omega = (2\pi f = 2\pi \times 1250) 7854 \text{ rad s}^{-1}$;
$a_0 = (-\omega^2 x_0 = -7854^2 \times 0.85 \times 10^{-3} =) \ (-)5.2 \times 10^4 \text{ m s}^{-2}$; **[2]**

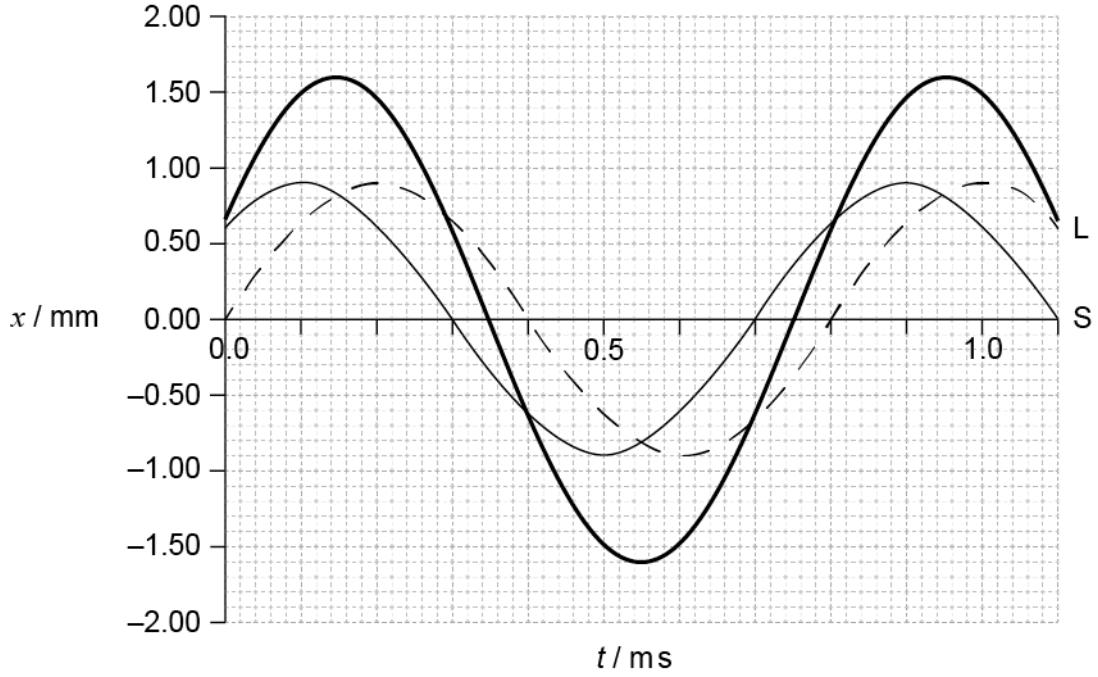
(ii) correct substitution into $E_T = \frac{1}{2} m\omega^2 {x_0}^2$ irrespective of powers of 10;
0.14 to 0.15 J; **[2]**

(e) (i) 0.264 m; **[1]**

(ii) longitudinal;
progressive / propagate (through the air) / travels with constant speed (through the air);
series of compressions and rarefactions / high and low (air) pressure; **[3]**

(f) (i) S leads L / idea that the phase of L is the phase of S minus an angle;
$\frac{1}{8}$ period / 1×10^{-4} s / 0.1 ms;
$\frac{\pi}{4}$ / 0.79 rad / 45 degrees; **[3]**

(ii) agreement at all zero displacements;
maxima and minimum at correct times;
constant amplitude of 1.60 mm; **[3]**



6. Part 1 Kinematics and gravitation

(a) upwards (or away from the Moon) is taken as positive / downwards (or towards the Moon) is taken as negative / towards the Earth is positive; **[1]**

(b) (i) tangent drawn to curve at 0.80 s;
correct calculation of gradient of tangent drawn;
-1.3 ± 0.1 m s^{-1} ***or*** 1.3 ± 0.1 m s^{-1} downwards; **[3]**

or

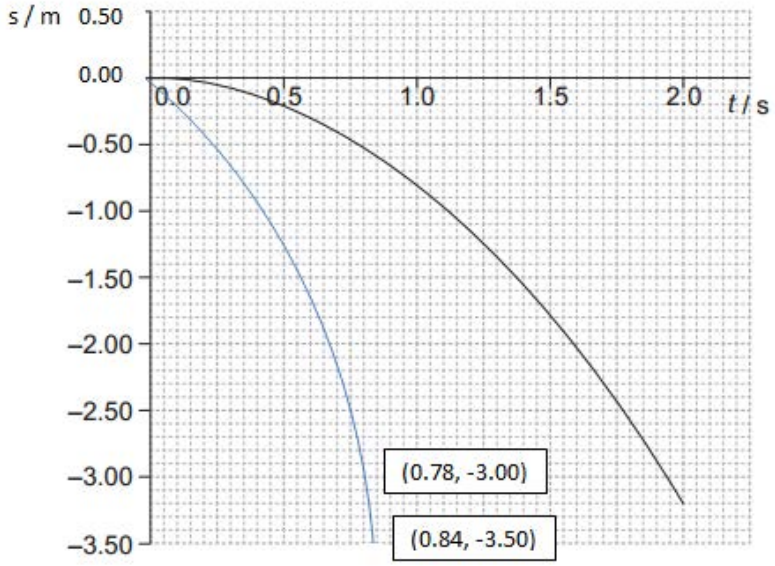
correct coordinates used from the graph;
substitution into a correct equation;
-1.3 ± 0.1 m s^{-1} ***or*** 1.3 ± 0.1 m s^{-1} downwards;

(ii) any correct method used;
correct reading from graph;
1.6 to 1.7 m s^{-2}; **[3]**

(c) values for masses, distance and correct G substituted into Newton's law;
see subtraction (*ie r* value $= 3.84 \times 10^8 - 1.74 \times 10^6 = 3.82 \times 10^8$ m);
$F = 5.4$ to 5.5×10^{-4} N / $a = 2.7 \times 10^{-3}$ m s^{-2};
comment that it's insignificant compared with ($0.2 \times 1.63 =$) 0.32 to 0.33 N / 1.63 m s^{-2}; **[4]**

(d) 7.7 m s^{-1}; **[1]**

(e) curve permanently below Moon curve;
smooth parabola; *(judge by eye)*
line passing through s = –3.00 m, t = 0.78 s ***or*** s = –3.50 m, t = 0.84 s (±1 mm); **[3]**



Part 2 Radioactivity

(f) Ca-40 has 20 protons and 20 neutrons, Ca-47 has 20 protons and 27 neutrons / Ca-47 has 7 additional neutrons;
mention of strong/nuclear **and** coulomb/electrostatic/electromagnetic forces;
excess neutrons/too high a neutron-to-proton ration leads to the coulomb/electrostatic' electromagnetic force being greater than the strong/nuclear force (so the nucleus is unstable); **[3]**
*Award **[1 max]** for an answer stating that Ca-47 has more neutrons so is bigger and less stable.*

(g) six half-lives occurred;
$\left(\left(\frac{1}{2}\right)^6 =\right)$ 1.6 % remaining;
98.4 / 98 % decayed; **[3]**

(h) (i) (electron) anti-neutrino / $\overline{\nu}$; **[1]**

(ii) 46.95455 u − (46.95241 u + 0.00055 u) = 0.00159 u;
1.48 MeV; **[2]**

(iii) does not account for energy of (anti) neutrino/gamma ray photons; **[1]**