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N03/430/S(2)M+

MARKSCHEME

November 2003

PHYSICS

Standard Level

Paper 2

10 pages

Subject Details: Physics SL Paper 2 Markscheme

General

A markscheme often has more specific points worthy of a mark than the total allows. This is intentional. Do not award more than the maximum marks allowed for part of a question.

When deciding upon alternative answers by candidates to those given in the markscheme, consider the following points:

- Each marking point has a separate line and the end is signified by means of a semicolon (;).
- An alternative answer or wording is indicated in the markscheme by a “/”; either wording can be accepted.
- Words in (…) in the markscheme are not necessary to gain the mark.
- The order of points does not have to be as written (unless stated otherwise).
- If the candidate’s answer has the same “meaning” or can be clearly interpreted as being the same as that in the markscheme then award the mark.
- Mark positively. Give candidates credit for what they have achieved, and for what they have got correct, rather than penalizing them for what they have not achieved or what they have got wrong.
- Occasionally, a part of a question may require a calculation whose answer is required for subsequent parts. If an error is made in the first part then it should be penalized. However, if the incorrect answer is used correctly in subsequent parts then **follow through** marks should be awarded.
- Units should always be given where appropriate. Omission of units should only be penalized once. Ignore this, if marks for units are already specified in the markscheme.
- Deduct **1 mark in the paper** for gross sig dig error *i.e.* for an **error of 2 or more digits**.

e.g. if the answer is 1.63:

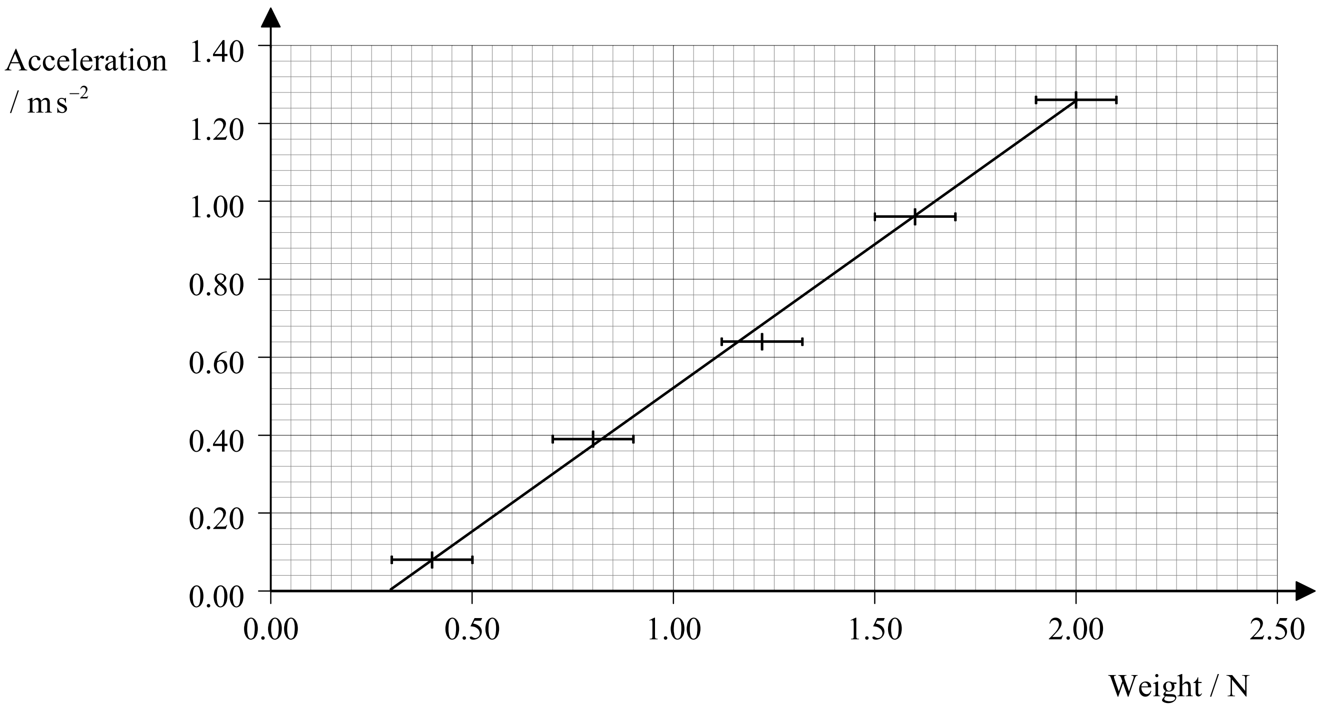
2	*reject*
1.6	accept
1.63	accept
1.631	accept
1.6314	*reject*

However, if a question specifically deals with uncertainties and significant digits, and marks for sig digs are already specified in the markscheme, then do **not** deduct again.

SECTION A

A1. (a) a straight line;
through the origin; ***[2 max]***

(b) any straight line;
that fits within ALL the error bars; ***[2 max]***



(c) (i) a *systematic* error is when every data point deviates from the "correct" value;
by the same fixed amount as seen by intercept on graph / *OWTTE*; ***[2 max]***
Accept answers that explain by giving an example of a possible systematic error e.g. friction.

(ii) 0.3 N; ***[1]***
Accept 0.25 N → 0.35 N. ***N.B.*** *Watch for use of wrong axis!*

(iii) realization that mass = (gradient)$^{-1}$;
Award this mark for full Newton II equation (with friction)
to give mass = 1.4 kg *(Accept 1.2 kg → 1.6 kg.)*; ***[2 max]***
Use of F = ma for 1 data point receives ***[0]*** *(unless candidate's line is through origin).*
Watch for ecf from candidate's own line.

A2. (a) *[1] for any valid and relevant point e.g.*
Geiger-Marsden experiment involved bombardment of gold foil by alpha particles;
most passed straight through / were deviated through small angles but, some deflected through large angles;
these alpha particles were heading towards central nucleus; ***[3 max]***

(b) *[1] for any valid and relevant point e.g.*
protons in nucleus repel each other (seen or implied);
but are held together by the strong nuclear force / or neutrons are involved keeping it bound together / *OWTTE*; ***[2 max]***

(c) (i) attempted use of $F = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2}$;
with $q_1 = q_2 = 10^{29}\, e = 1.6\times10^{-10}\ \text{C}$;
and r = 100 m;
to get $F = 2.3\times10^{26}\ \text{N} \approx 10^{26}\ \text{N}$; ***[4 max]***

(ii) people are overall electrically neutral;
equal numbers of positive charges mean that overall the electrical force is zero / *OWTTE*; ***[2 max]***

N.B. *This question is different from Higher Level, and so is markscheme. If marking both Higher and Standard Level, you need to take care!*

A3. (a) longitudinal; ***[1]***

(b) (i) wavelength = 0.5 m; ***[1]***

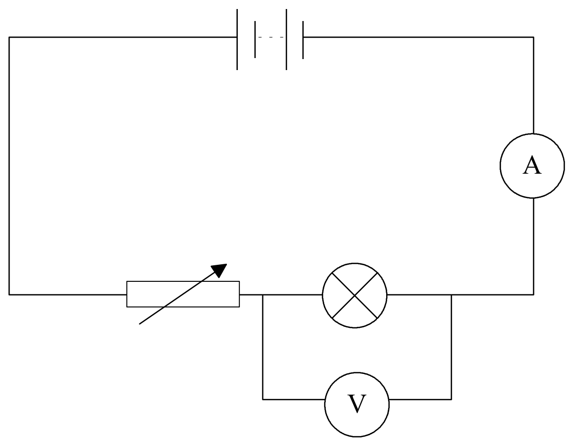
(ii) amplitude = 0.5 mm; ***[1]***

(iii) correct substitution into speed = frequency × wavelength;
to give $v = 660 \times 0.5 = 330\ \text{m s}^{-1}$; ***[2 max]***

B1. (a) (i) correct substitution into power = p.d. × current
to give power $= 12 \times 0.5 = 6$ W; ***[1 max]***

(ii) correct substitution into $V = \mathrm{I} \times \mathrm{R}$
to give $R = \dfrac{12}{0.5} = 24\,\Omega$; ***[1 max]***

(b) correct positioning of ammeter;
correct positioning of voltmeter;
e.g.

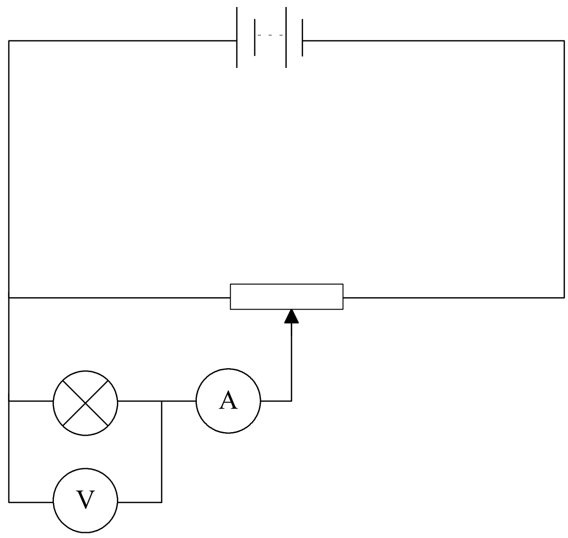


[2 max]

(c) (i) the battery (**or** the ammeter **or** the wires) must have some resistance;
some p.d. is "used up" so less "available" / *OWTTE*; ***[2 max]***

(ii) low voltage requires low current and thus large resistance;
max resistance of variable resistor not infinite / *OWTTE*; ***[2 max]***

(d) (i) any circuit involving potentiometer or equivalent;
that correctly controls the p.d. across the bulb;
with meters still correctly connected;



[3 max]

(ii) ***[1]*** *for each relevant point e.g.*
the 12 V is "shared" by the two halves of the resistor;
if the LH half is zero resistance, the p.d. will be zero / *OWTTE*; ***[2 max]***

(e) (i) appropriate statement of Ohm's law;
e.g. p.d. proportional to current of constant temperature.
temperature is not constant as current varies / *OWTTE*; ***[2 max]***

(ii) lamp B must have greater power dissipation;
since it has a greater current for the same p.d. / *OWTTE*;
so power dissipation (= $V \times$ I) is greater; ***[3 max]***

(f) (i) current lamp A <u>equals</u> the current in lamp B / *OWTTE*; ***[1 max]***

(ii) any answer that is less than 0.5 A but above 0.3 A;
realization (seen or implied) that each lamp does not have the same p.d.;
explanation (or evidence from the graph) of trying to find the current when the individual p.d.s sum to 12 V;
to give 0.4 A (± 0.1); ***[4 max]***

(iii) lamp A will have greater power dissipation;
since current the same, but it takes greater share of p.d.; ***[2 max]***

B2. (a) statement that gravitational mass and inertial mass have the same numerical value;
understanding of what gravitational mass means;
e.g. "a quantity that determines the gravitational force on the object"
understanding of what inertial mass means;
e.g. "a quantity that determines the acceleration of the object" ***[3 max]***

(b) (i) the acceleration = gradient of first section of graph;
acceleration = 0.80 / 0.50 = 1.6 m s^{-2}; ***[2 max]***
Accept bald correct answer for full marks.

(ii) the total distance travelled by the lift = area under graph;
distance = $(11 \times 0.80) + (0.50 \times 0.80) = 8.8 + 0.4 = 9.2$ m; ***[2 max]***
Accept bald correct answer for full marks.

(iii) the work done = P.E. gained (= force × distance);
work done = $2500 \times 9.2 = 23000$ J = 23 kJ; ***[2 max]***
Accept bald correct answer for full marks.

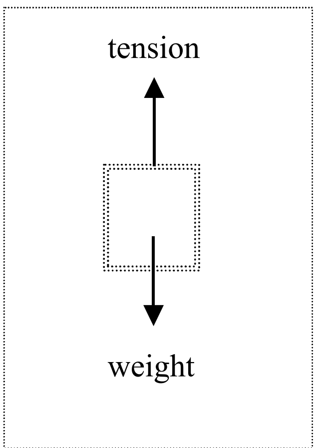
(iv) correct substitution into power = work done / time taken
= 23000 / 12;
= 1916 W
= 1.9 kW; ***[2 max]***

(v) correct substitution into efficiency = power out / power in
= 1.9 / 5.0;
= 0.38 = 38 %; ***[2 max]***

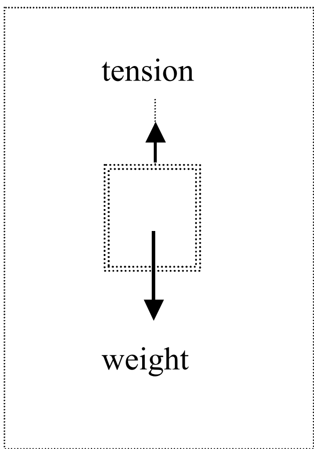
(c) graphs should show curving or "shoulders" at the changes;
since acceleration must be finite / speed cannot change instantaneously / *OWTTE*; ***[2 max]***

(d) *Mark part (i) and (ii) together.*
weight arrow the same in both diagrams;
magnitude of tension (size of arrow) **equal to** weight in (i);
magnitude of tension (size of arrow) **less than** weight in (ii);

(i) 0.50 to 11.50 s

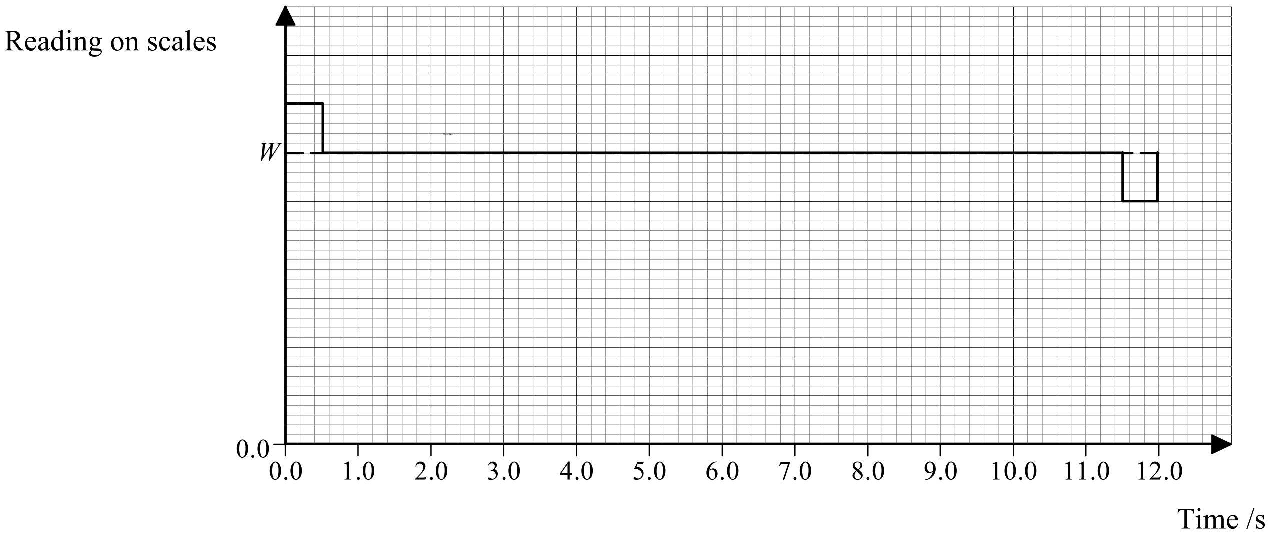


(ii) 11.50 to 12.00 s



[3 max]

(e) a constant value **greater** than W from 0.00 to 0.50 s;
a constant value **equal** to W from 0.50 to 11.50 s;
a constant value **less** than W from 11.50 to 12.00 s;



[3 max]

(f) ***[1]*** *for each appropriate and valid point. Essentially* ***[2]*** *for journey up and* ***[2]*** *for journey down. Some explanation or justification is required for full marks e.g.*
the law of conservation of energy does apply to round trip;
energy is all dissipated into heat and sound;
on the way up, most electrical energy converted into g.P.E., initially some electrical energy is converted into K.E;
on the way down electrical energy does work "breaking" lift some (not all) g.P.E. is converted into K.E.; ***[4 max]***
Reject answers that imply that P.E. converts into K.E. as lift falls.

B3. (a) *[1] for each appropriate and valid point e.g.*
thermal energy is the K.E. of the component particles of an object;
thus measured in joules;
the temperature of an object is a measure how hot something is (it can be used to work out the direction of the natural flow of thermal energy between two objects in thermal contact) / measure of the average K.E. of molecules;
it is measured on a defined scale (Celsius, Kelvin *etc*.); ***[4 max]***

(b) (i) correct substitution: energy $= \text{power} \times \text{time}$;
$= 1200\ \text{W} \times (30 \times 60)\ \text{s}$;
$= 2.2 \times 10^6\ \text{J}$ ***[2 max]***

(ii) use of $E = m\,c\,\Delta\theta$;
to get $\Delta\theta = 2.2 \times 10^6 / (4200 \times 70)\ \text{K}$;
$= 7.5\ \text{K}$; ***[3 max]***

(c) ***[1]*** *naming each process up to* ***[3 max]****.*
convection;
conduction;
radiation;

[1] *for an* <u>*appropriate*</u> *(matching) piece of information / outline for each process up to* ***[3 max]****.*
e.g. convection is the transfer of thermal energy via bulk movement of a gas due to a change of density;
conduction is transfer of thermal energy via intermolecular collisions;
radiation is the transfer of thermal energy via electromagnetic waves (IR part of the electromagnetic spectrum in this situation) / *OWTTE*; ***[6 max]***

(d) (i) *[1] for each valid and relevant point e.g.*
in evaporation the faster moving molecules escape;
this means the average K.E. of the sample left has fallen;
a fall in average K.E. is the same as a fall in temperature; ***[3 max]***

(ii) energy lost by evaporation $= 50\,\% \times 2.2 \times 10^6\ \text{J}$;
$= 1.1 \times 10^6\ \text{J}$;
correct substitution into $E = m\,l$
to give mass lost $= 1.1 \times 10^6\ \text{J} / 2.26 \times 10^6\ \text{J kg}^{-1}$
$= 0.487\ \text{kg}$
$= 487\ \text{g}$; ***[3 max]***

(iii) *[1] for any valid and relevant factors* ***[2 max]*** *e.g.*
area of skin exposed;
presence or absence of wind;
temperature of air;
humidity of air *etc*.;

[1] for appropriate and matching explanations ***[2 max]*** *e.g.*
increased area means greater total evaporation rate;
presence of wind means greater total evaporation rate;
evaporation rate depends on temperature difference;
increased humidity decreases total evaporation rate *etc*.; ***[4 max]***