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Mark Scheme (Results)
Summer 2008

GCE

GCE Physics (6731/01)

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Mark scheme notes

Underlying principle

The mark scheme will clearly indicate the concept that is being rewarded, backed up by examples. It is not a set of model answers.

For example:

(iii) Horizontal force of hinge on table top

66.3 (N) or 66 (N) **and** correct indication of direction [no ue] [Some examples of direction: acting from right (to left) / to the left / West / opposite direction to horizontal. May show direction by arrow. Do not accept a minus sign in front of number as direction.]	✓	**1**

This has a clear statement of the principle for awarding the mark, supported by some examples illustrating acceptable boundaries.

1. **Mark scheme format**
   - 1.1 You will not see 'wtte' (words to that effect). Alternative correct wording should be credited in every answer unless the ms has specified specific words that must be present. Such words will be indicated by underlining e.g. 'resonance'
   - 1.2 Bold lower case will be used for emphasis.
   - 1.3 Round brackets ( ) indicate words that are not essential e.g. "(hence) distance is increased".
   - 1.4 Square brackets [ ] indicate advice to examiners or examples e.g. [Do not accept gravity] [ecf].

2. **Unit error penalties**
   - 2.1 A separate mark is not usually given for a unit but a missing or incorrect unit will normally cause the final calculation mark to be lost.
   - 2.2 Incorrect use of case e.g. 'Watt' or 'w' will **not** be penalised.
   - 2.3 There will be no unit penalty applied in 'show that' questions or in any other question where the units to be used have been given.
   - 2.4 The same missing or incorrect unit will not be penalised more than once within one question but may be penalised again in another question.
   - 2.5 Occasionally, it may be decided not to penalise a missing or incorrect unit e.g. the candidate may be calculating the gradient of a graph, resulting in a unit that is not one that should be known and is complex.
   - 2.6 The mark scheme will indicate if no unit error penalty is to be applied by means of [no ue].

3. **Significant figures**
   - 3.1 Use of an inappropriate number of significant figures in the theory papers will normally only be penalised in 'show that' questions where use of too few significant figures has resulted in the candidate not demonstrating the validity of the given answer.
   - 3.2 Use of an inappropriate number of significant figures will normally be penalised in the practical examinations or coursework.
   - 3.3 Using g = 10 m s^{-2} will **not** be penalised.

4. Calculations

4.1 Bald (i.e. no working shown) correct answers score full marks unless in a 'show that' question.

4.2 If a 'show that' question is worth 2 marks then both marks will be available for a reverse working; if it is worth 3 marks then only 2 will be available.

4.3 **use** of the formula means that the candidate demonstrates substitution of physically correct values, although there may be conversion errors e.g. power of 10 error.

4.4 **recall** of the correct formula will be awarded when the formula is seen or implied by substitution.

4.5 The mark scheme will show a correctly worked answer for illustration only.

4.6 Example of mark scheme for a calculation:

'Show that' calculation of weight

Use of L × W × H	✓	
Substitution into density equation with a volume and density	✓	
Correct answer [49.4 (N)] to at least 3 sig fig. [No ue] [Allow 50.4(N) for answer if 10 N/kg used for g.] [If 5040 g rounded to 5000 g or 5 kg, do not give 3rd mark; if conversion to kg is omitted and then answer fudged, do not give 3rd mark] [Bald answer scores 0, reverse calculation 2/3]	✓	**3**

Example of answer:

80 cm × 50 cm × 1.8 cm = 7200 cm^3

7200 cm^3 × 0.70 g cm^{-3} = 5040 g

5040 × 10^{-3} kg × 9.81 N/kg

= 49.4 N

5. Quality of Written Communication

5.1 Indicated by QoWC in mark scheme, placed as first mark.

5.2 Usually it is part of a max mark.

5.3 In SHAP marks for this are allocated in coursework only but this does not negate the need for candidates to express themselves clearly, using appropriate physics terms. Likewise in the Edexcel A papers.

6. Graphs

6.1 A mark given for axes requires both axes to be labelled with quantities and units, and drawn the correct way round.

6.2 Sometimes a separate mark will be given for units or for each axis if the units are complex. This will be indicated on the mark scheme.

6.3 A mark given for choosing a scale requires that the chosen scale allows all points to be plotted, spreads plotted points over more than half of each axis and is not an awkward scale e.g. multiples of 3, 7 etc.

6.4 Points should be plotted to within 1 mm.

- Check the two points furthest from the best line. If both OK award mark.
- If either is 2 mm out do not award mark.
- If both are 1 mm out do not award mark.
- If either is 1 mm out then check another two and award mark if both of these OK, otherwise no mark.

6.5 For a line mark there must be a thin continuous line which is the best-fit line for the candidate's results.

<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>1 (a)</td><td><u>Add missing information</u>

For four correct responses in the ‘vector or scalar’ column (1)
For the ‘base unit’ column :-
4 correct responses (3)
3 correct responses (2)
2 correct responses (1)

<table>
<tr><th>Quantity</th><th>Base unit</th><th>Vector or scalar</th></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td>m</td><td>vector</td></tr>
<tr><td></td><td>kg m^2 s^{-2}</td><td>scalar</td></tr>
<tr><td></td><td>kg m^2 s^{-3}</td><td>scalar</td></tr>
<tr><td></td><td>kg m s^{-1}</td><td>vector</td></tr>
</table>
</td><td>(4)</td></tr>
<tr><td></td><td>Total for question</td><td>(4)</td></tr>
</table>

Question Number	Answer	Mark
2(a)(i)	Describe motion Constant / uniform acceleration or (acceleration of) 15 m s^{-2} (1) (Followed by) constant / uniform speed / velocity (of 90 m s^{-1}) (1)	**(2)**
(a)(ii)	Show that distance is approximately 800 m Any attempt to measure area under graph or select appropriate equations of motion required to determine **total** distance (1) Correct **expression** or **value** for the area under the graph between either 0 – 4 s [240 m] or 4-10 s [540 m] (1) Answer : 780 (m) (1) Eg distance = 60 m s^{-1} x 4 s + 90 m s^{-1} x 6 s = 240 m + 540 m = 780 (m) Eg distance in first 4 s $s = \frac{v+u}{2} t = \frac{90\ m\ s^{-1} + 30\ m\ s^{-1}}{2}$ 4 s = 240 m Distance in final 6 s s = ut = 90 m s^{-1} x 6 s = 540 m Total distance = 240 m + 540 m = 780 (m)	**(3)**
(b)	Sketch graph Graph starts at 760 m - 800 m/their value and initially shows distance from finishing line decreasing with time (1) **The next two marks are consequent on this first mark being awarded** **Curve with increasing negative gradient** followed by straight line (1) Graph shows a straight line **beginning** at coordinate (4 s, 540 m) **and** finishes at coordinate (10 s, 0 m) (1)	**(3)**
	Total for question	**(8)**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>3(a)</td><td><u>Principle of conservation of linear momentum</u>
Provided no external [other/resultant/outside] force acts (1)

The total momentum (of a system) does not change[is constant] / total momentum before (collision) = total momentum after (collision)
['Total' or 'sum' should be seen at least once, do not accept 'all']
(1)</td><td>(2)</td></tr>
<tr><td>(b)(i)</td><td><u>Measuring velocity</u>

<table><tr><td>Tickertape</td><td>Light gate(s)/sensor</td><td>Motion sensor</td><td>Video</td><td>(1)</td></tr><tr><td>Tickertimer</td><td>Datalogger/PC/timer</td><td>Datalogger/PC</td><td>Metre rule / markings on the track</td><td>(1)</td></tr></table>[The points above maybe labelled on the diagram]

Description of distance measured and corresponding time or
$v = \frac{d}{t}$ or any mention of a distance against time graph[mention of gradient not required for this mark] (1)</td><td>(3)</td></tr>
<tr><td>(b)(ii)</td><td><u>Further measurements</u>
The mass(es) of both A and B / the trolleys (1)</td><td>(1)</td></tr>
<tr><td>(b)(iii)</td><td><u>Explain constant velocity requirement</u>
Either
(For the law to be demonstrated) there must be no <u>external</u> [accept 'outside'] force /<u>resultant</u> force / friction acting (1)
[do not accept closed system]

(If the trolley(s) are moving with constant velocity) the <u>external</u>[accept 'outside'] force / <u>resultant</u> force / (effect of)friction (acting on the system)is zero. (1)

Or
There must be no <u>external</u> [accept 'outside'] force / <u>resultant</u> force / friction acting [do not accept closed system] (1)

if <u>acceleration</u> is zero (1)

Or
The velocity / speed measurements required are the velocities / speeds (at the instant) when the trolleys collide (1)

Measurement of these velocities is impossible / difficult (1)</td><td>(2)</td></tr>
<tr><td></td><td>Total for question</td><td>(8)</td></tr>
</table>

Question Number	Answer	Mark
4(a)(i)	Give expression $W = R + F$ (1)	**(1)**
(a)(ii)	Complete statements ……. surface / ground (1) ……. Earth ('s mass) [Only accept this answer] (1) ……. gardener('s hands) / hand(s) (1)	**(3)**
(b)(i)	Add to diagram Line inclined to the vertical pointing to the left and upwards (1)	**(1)**
(b)(ii)	Explain change in direction and magnitude The force (at X) will have a magnitude greater than F or the force (at X) must increase. (1) This is because the wheelbarrow / it has to be lifted / tilted/ supported/ held up (by the vertical component) (1) And also because the wheelbarrow / it has to be moved (forward by the horizontal component) (1)	**(3)**
	Total for question	**(8)**

Question Number	Answer	Mark
5(a)(i)	Magnitude of normal contact force 11 N	**(1)**
(a)(ii)	Show that this is consistent with the principle of moments Use of the principle of moments (because shelf is balanced) (1) Calculation showing moments equal (1) eg 22 N x 35 (x 10^{-2}) m = 11 N x 70 (x 10^{-2}) m 7.7 (N m) = 7.7 (N m) [accept 770 (N cm) = 770 (N cm)]	**(2)**
(b)(i)	Normal contact force at B Use of the principle of moments (1) [Ecf their moment expression for the shelf from aii] Answer [48.5 N - 49.0 N] (1) eg 22 N x 35 (x 10^{-2}) m + 44 N x 60 (x10^{-2}) m = F x 70 (x 10^{-2}) m F = 48.71 N	**(2)**
(b)(ii)	Why a limit to the distance from B QOWC (1) **States** point about which moments are to be considered eg about B (1) Equates the moments for the limiting position for the point considered eg for the point B the (clockwise) moment of the ornament = the (anticlockwise) moment (of the weight) of the shelf (1) States that for any further increase in distance (eg from B) of the ornament the moments will no longer be equal or the shelf will be unbalanced (1) [accept descriptions that mean or describe unbalanced eg the shelf will tip] Calculation or description to explain why the limiting position is less than 20 cm from B or 17.5 cm seen (1) **QOWC + Max 3** Eg 22 N x 35 cm = 44 N x d *d* = 17.5 cm	**(4)**
(b)(iii)	Normal contact force at A for limiting position Zero / 0 / 0 N / 0 n / Zero N / Zero n / Zero newtons / 0 newtons	**(1)**
	Total for question	**(10)**

Question Number	Answer	Mark
6(a)	<u>Show speed is about 2 m s^{-1}</u> **Either** Substitution into force x distance (1) Equates work done and kinetic energy (1) **Or** Substitution into equation for force (1) Correct use of $v^2 = u^2 + 2as$ or two appropriate equations (1) Answer [(1.94 – 1.97) (m s^{-1})] (1) Eg Work done = 2.75 N x 1.25 m $\frac{1}{2}$ 1.80kg x v^2 = 2.75 N x 1.25 m v = 1.95 (m s^{-1}) **Or** a = $\frac{F}{m} = \frac{-2.75\,N}{1.80\,kg}$ = - 1.53 m s^{-2} $v^2 = u^2 + 2as$ 0 = u^2 + 2 x - 1.53 m s^{-2} x 1.25 m u = 1.95 (m s^{-1})	**(3)**
(b)	<u>Momentum</u> Momentum equation [In symbols or numbers] (1) Answer [(3.5 - 3.6) kg m s^{-1} or N s. Ecf candidates value for speed] (1) Eg 1.8 kg x 1.95 m s^{-1} = 3.51 kg m s^{-1}	**(2)**
(c)	<u>Momentary force</u> Selects F = $\frac{\Delta p}{t}$ or v = u + at and F = ma (1) Average value of unbalanced force (1) Average value of momentary force (1) Eg F = $\frac{\Delta p}{t}$ **Or** v = u + at ; 2 ms^{-1} = (0 +) a x 0.7 s = $\frac{3.51\,kg\,m\,s^{-1}}{0.7\,s}$ F = ma; F = 1.8 kg x $\frac{2\,m\,s^{-1}}{0.7\,s}$ = 5.0 (N) = 5.0 (N) Average value of force applied = 5.0 N + 2.75 N = 7.75 N	**(3)**
	Total for question	**(8)**

Question Number	Answer	Mark
7(a)	Show that rate of decay of radium is about 7 x 10^{13}Bq Power divided by alpha particle energy (1) Answer [(7.1 – 7.2) x 10^{13} (Bq)] (1) [Give 2 marks for reverse argument ie 7 x 10^{13} Bq x 7.65 x 10^{13} J (1) (53.5 – 53.6) (W) (1)] Eg Rate of decay = $\frac{55\ \text{W}}{7.65 \times 10^{-13}\ \text{J}}$ = 7.19 x 10^{13} (Bq)	**(2)**
(b)	Show that decay constant is about 1.4 x 10^{-11} s^{-1} Use of $\lambda = \frac{0.69}{T_{1/2}}$ (1) Answer [(1.35 – 1.36) x 10^{-11} (s^{-1})] (1) Eg $\lambda = \frac{0.69}{1620\ \text{years} \times 3.15 \times 10^{7}\ s}$ = 1.35 x 10^{-11} (s^{-1})	**(2)**
(c)	The number of radium 226 nuclei Use of A = λN (1) Answer [(5.0 -5.4) x 10^{24}] (1) Eg 7.19 x 10^{13} Bq = 1.35 x 10^{-11} s^{-1} x N N = 5.33 x 10^{24}	**(2)**
(d)	The mass of radium Divides number of radium 226 nuclei by 6.02 x 10^{23} and multiplies by 226 (1) Answer [1870 – 2040 g] Eg Mass of radium = 226 g x $\frac{5.33 \times 10^{24}}{6 \times 10^{23}}$ = 2008 g	**(2)**
(e)	Why mass would produce more than 50 W The (daughter) nuclei (radon) formed as a result of the decay of radium are themselves a source of (alpha) radiation / energy (1) Also accept (having emitted alpha) the nucleus[allow sample/radium/atom] (maybe left excited and therefore also) emits gamma Also accept (daughter) nucle(us)(i) recoil releasing (thermal) energy Do not accept Nucleus may emit more than one alpha particle Nucleus may also emit beta particle	**(1)**
	Total for question	**(9)**

Question Number	Answer	Mark
8(a)	Paths of alpha particles Path A drawn less deflected than B (1) Path A drawn as a straight line (1)	**(2)**
(b)(i)	Why alpha source inside container Alpha would be absorbed by [accept would not get through] container (material) (1)	**(1)**
(b)(ii)	Why the same kinetic energy? **Either** To restrict observation to two variables / closeness of approach and deflection **or** so that speed / velocity / (kinetic) energy does not have an effect (on the observation / deflection /results / contact time)	**(1)**
(b)(iii)	Why an evacuated container? **Either** so that alphas do not get absorbed by / collide with / get deflected by / stopped by / scattered by / get in the way of / ionise / lose energy to atoms / molecules (of air) [Do not accept 'particles' of the air] **or** so that all alphas reach the foil with the same (kinetic) energy	**(1)**
	Total for question	**(5)**
	Total marks for paper	**(60)**