Mark Scheme (FINAL)

Summer 2008

GCE

GCE Physics (6731/01)

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

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] ✓ **1**
[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.]

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 $g = 10\ \text{m s}^{-2}$ 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:

<u>'Show that' calculation of weight</u>

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] **3**
[Bald answer scores 0, reverse calculation 2/3]

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

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>
[Accept answers where the units are not combined eg $kg\ m\ s^{-3}\ m$ for power]
[Do not accept answers written in dimension symbols eg $M\ L^2\ T^{-2}$ for gravitational potential energy]</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) [Note: 15 m s^{-2} does not require the word uniform or constant] ["constantly accelerating" give no marks] (Followed by) constant / uniform speed / velocity (of 90 m s^{-1})/ (1) [Accept words such as 'steady' which mean constant or uniform] [Accept "0 acceleration" for uniform speed]	**(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) [Only award the equations mark if the equations are applied separately to the two parts of the journey] [May need to look at the graph for evidence of this] Correct **expression** or **value** for the area under the graph between either 0 – 4 s [240 m] or 4-10 s [540 m] (1) [Expressions such as $\frac{90(\text{m s}^{-1})+30(\text{m s}^{-1})}{2}$ x 4 s or 90 m s^{-1} x 4 s would get this mark] Answer : 780 (m) [no ue] (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 = $\frac{90\text{ m s}^{-1}+30\text{ m s}^{-1}}{2}$ 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 780 m/800 m/their value and initially shows distance from finishing line decreasing with time[Allow up to 0.4 s ie 2 squares at the beginning where it might appear not to decrease] (1) **The next two marks are consequent on this first mark being awarded** **Curve with increasing negative gradient** followed by straight line[Be lenient if the line has not been drawn with a ruler] (1) [Award this mark even if at the point where the curve and line meet there is a change of gradient] Graph shows a straight line **beginning** at coordinate (4 s, 540 m [allow values in the range 520 m – 560 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>Principle of conservation of linear momentum
Provided no external [other/resultant/outside] force acts (1)
[For this mark accept ‘closed system’ or ‘closed environment’]
[Do not accept fixed for closed]

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)
[Accept a formula for this mark eg $m_av_a + m_bv_b = (m_a + m_b)V$, the symbols do not have to be defined if written in a clear form such as this]
[Ignore all references to elastic and inelastic. Do not credit simple statement that ‘total momentum is conserved’]</td><td>(2)</td></tr>
<tr><td>(b) i</td><td>Measuring velocity

<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 [They do not have to be shown connected to the light gate]</td><td>Datalogger/PC [They do not have to be shown connected to the motion sensor]</td><td>Metre rule / markings on the track</td><td>(1)</td></tr>
</table>
[The points above maybe labelled on the diagram]
[Do not give these first 2 marks for ruler and stopwatch]
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)
[Candidates who have described a ruler and stopwatch method can get this final mark]</td><td>(3)</td></tr>
<tr><td>(b) ii</td><td>Further measurements
The mass(es) of both A and B / the trolleys (1)
[Give this mark even when other unnecessary(but not conflicting) information is given]
[Accept ‘Weigh the mass of the two trolleys’ but not ‘weigh the two trolleys’ or ‘weigh the mass of the trolley’]
[Do not accept bald answers ‘mass’ or ‘masses’]</td><td>(1)</td></tr>
<tr><td>(b) iii</td><td>Explain constant velocity requirement
[In place of resultant accept unbalanced or net throughout]
Either
(For the law to be demonstrated) there must be no external [accept ‘outside’] force /resultant force / friction acting (1)
[do not accept closed system]
(If the trolley(s) are moving with constant velocity) the external[accept ‘outside’] force / resultant force / (effect of)friction (acting on the system)is zero. (1)
[Award mark for converse statement ie ‘(if the trolley(s) are changing speed) the external [accept ‘outside’] force / resultant force / (effect of)friction (acting on the system)is not zero]
[Award this second mark for candidates who state friction has been compensated for]</td><td>(2)</td></tr>
</table>

	Or There must be no external [accept ‘outside’] force / resultant force **/** friction acting [do not accept closed system] (1) if acceleration is zero (1) **Or** The velocity / speed measurements required are the velocities / speeds (at the instant) when the trolleys collide(1) [Award this mark for statements such as ‘the velocities / speeds measured would not be the speeds they have when they collide’] Measurement of these velocities is impossible / difficult (1) [Award no marks for arguments involving just energy]	
	Total for question	**(8)**

Question Number	Answer	Mark
4_(a) i	<u>Give expression</u> *W* = *R* + *F*	**(1)**
(a) ii	<u>Complete statements</u> ……. surface / ground (1) ……. Earth ('s mass) [Only accept this answer] (1) ……. gardener('s hands) / hand(s) (1) [When 2 different answers are given award no marks]	**(3)**
(b) i	<u>Add to diagram</u> Line inclined to the vertical pointing to the left and upwards [Award this mark; if the arrow is not drawn from the bottom of the existing arrow; the arrow does not touch the handle; the arrow appears to come from X; the arrow is not labelled P] **If the letter X is 'out of clip', but the arrow looks right give the mark.**	**(1)**
(b) ii	<u>Explain change in direction and magnitude</u> 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) [Award this mark if candidates refer to friction having to be overcome to move the wheelbarrow]	**(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) [Allow one wrong distance. Ecf candidate's value of normal reaction, they will not get the second mark] Calculation showing moments equal (1) [Candidates who show, using the principle of moments, that the force at B is 11 N should be awarded both marks] 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) [Only give this mark if the moment of the ornament is added to the moment of the length of wood, even if the distance is wrong] [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 QWOC (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] [If candidates describe the unbalanced state as being due to forces being unbalanced do not give this mark] [Do not accept "fall" or "falls over"] Calculation or description to explain why the limiting position is less than 20 cm from B or 17.5 cm seen (1) **QWOC + 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 (Do not penalise spelling of newton also accept newton beginning with upper case ie Newton)	**(1)**
	Total for question	**(10)**

Question Number	Answer	Mark
6_(a)	Show speed is about 2 m s^{-1} **Either** Substitution into force x distance (1) Equates work done and kinetic energy (1) **Or** Substitution into equation for force (1) [Give this mark even if the negative value for force (or acceleration) is omitted] Correct use of $v^2 = u^2 + 2as$ or two appropriate equations (1) [Do not give this mark for use of +1.53 m s^{-2} and/or u = 0] Answer [(1.94 – 1.97) (m s^{-1})] [At least 3 sig fig. No unit error] (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** $a = \frac{F}{m} = \frac{-2.75\,\mathrm{N}}{1.80\,\mathrm{kg}} = -1.53\ \mathrm{m\ s^{-2}}$ $v^2 = u^2 + 2as$ $0 = u^2 + 2 \times -1.53\ \mathrm{m\ s^{-2}} \times 1.25\ \mathrm{m}$ u = 1.95 (m s^{-1})	**(3)**
(b)	Momentum 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)	Momentary force Selects $F = \frac{\Delta p}{t}$ or v = u + at and F = ma [May just write $F = \frac{m(v-u)}{t}$] (1) [If the formulae are not seen, but are clearly used give this mark] Average value of unbalanced force [(5.0 – 5.2) (N)] (1) Average value of momentary force [(7.7 - 7.9) N](1) [Ecf candidate's value of momentum from b] Eg $F = \frac{\Delta p}{t}$ **Or** v = u + at ; 2 ms^{-1} = (0 +) a x 0.7 s $= \frac{3.51\ \mathrm{kg\ m\ s^{-1}}}{0.7\ \mathrm{s}}$ F = ma; $F = 1.8\ \mathrm{kg} \times \frac{2\ \mathrm{m\ s^{-1}}}{0.7\ \mathrm{s}}$ = 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. At least 2 sig fig. No unit error] (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 = $\frac{55\ \text{W}}{7.65\times10^{-13}\ \text{J}}$ = 7.19 x 10^{13} (Bq)	**(2)**
(b)	Show that decay constant is about 1.4 x 10^{-11} s^{-1} Use of λ = $\frac{0.69}{T_{1/2}}$ (1) [Give this mark if the half life is not converted into seconds and even if conversion factor is used without the half life value.] Answer [(1.35 – 1.36) x 10^{-11} (s^{-1}). 3 sig fig required. No ue.] (1) Eg λ = $\frac{0.69}{1620\ \text{years}\times3.15\times10^{7}\ s}$ = 1.35 x 10^{-11} (s^{-1})	**(2)**
(c)	The number of radium 226 nuclei Use of A = λN (1) [Ecf their value of A.] 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 [Ecf answer from part c] Divides number of radium 226 nuclei by 6.02 x 10^{23} and multiplies by 226 (1) Answer [1870 g. – 2040 g] (1) Eg Mass of radium = 226 g x $\frac{5.33\times10^{24}}{6\times10^{23}}$ = 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) [Accept atom(s)] recoil releasing (thermal) energy[accept heat] 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) [The paths should both emerge from the dotted circle to the right of the nucleus - there should be no sharp changes of direction - Path B should be drawn as a curve and, if not drawn as a straight line, so should A – the curve should be upwards and begin to the left of the nucleus] 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) [Do not credit suggestions such as; 'to prevent alpha escaping to the surroundings' ; 'to protect the experimenters from exposure']	**(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 [accept 'it' for ke] does not have an effect (on the observation / deflection /results / contact time) [Also converse statement 'otherwise there will be an effect (on the observation / deflection /results/ contact time) due to the speed / velocity / (kinetic) energy] [Do not accept to simply 'make it a fair test'] [Do not accept in place of 'deflected' reflect or refract or diffract. Accept words like deviated]	**(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)**