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Mark Scheme (Results)

June 2010

GCE

GCE Physics (6PH05)

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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. '<u>resonance</u>'

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 mean that the final calculation mark will not be awarded.

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, for example in a spreadsheet.

2.4 The same missing or incorrect unit will not be penalised more than once within one question (one clip in epen).

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 The use of g = 10 m s^{-2} or 10 N kg^{-1} instead of 9.81 m s^{-2} or 9.81 N kg^{-1} will be penalised by one mark (but not more than once per clip). Accept 9.8 m s^{-2} or 9.8 N kg^{-1}

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] ✓
[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:

$80\ \text{cm} \times 50\ \text{cm} \times 1.8\ \text{cm} = 7200\ \text{cm}^3$

$7200\ \text{cm}^3 \times 0.70\ \text{g cm}^{-3} = 5040\ \text{g}$

$5040 \times 10^{-3}\ \text{kg} \times 9.81\ \text{N/kg}$

$= 49.4\ \text{N}$

5. Quality of Written Communication

5.1 Indicated by QoWC in mark scheme. QWC – Work must be clear and organised in a logical manner using technical wording where appropriate.

5.2 Usually it is part of a max mark, the final mark not being awarded unless the QoWC condition has been satisfied.

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.

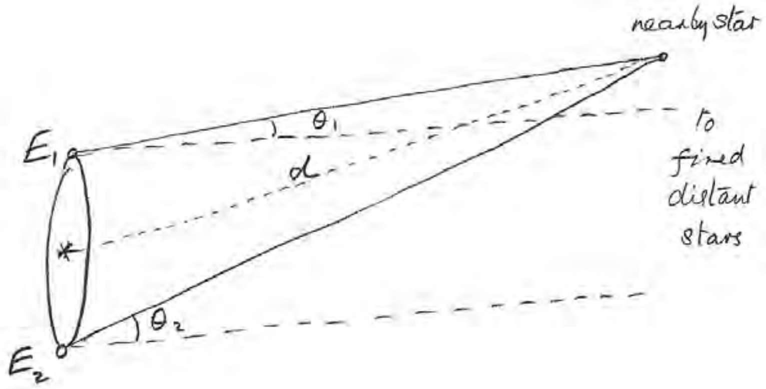
- Check the two points furthest from the best line. If both OK award mark.
- If either is 2 mm out do not award mark.
- If both are 1 mm out do not award mark.
- If either is 1 mm out then check another two and award mark if both of these OK, otherwise no mark.

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

Question Number	Answer	Mark
1	B	**(1)**
2	D	**(1)**
3	A	**(1)**
4	B	**(1)**
5	C	**(1)**
6	D	**(1)**
7	C	**(1)**
8	C	**(1)**
9	C	**(1)**
10	B	**(1)**

Question Number	Answer		Mark
11(a)	(Net force) $(\Delta)F=-k(\Delta)x$	(1)	
	Used with $F=ma$	(1)	**(2)**
11(b)	Use of $F=(-)kx$	(1)	
	Correct answer for k OR substitution of expression for k into formula below	(1)	
	Use of $\omega^2=k/m$ OR $T = 2\pi\sqrt{\frac{m}{k}}$ OR $a_{max} = -\omega^2 A$, with $a_{max}=9.81\ \text{N kg}^{-1}$	(1)	
	Use of $\omega=2\pi f$ OR $f=1/T$	(1)	
	Correct answer for f	(1)	**(5)**
	Example of calculation:		
	$k = \dfrac{0.15\,\text{kg} \times 9.81\,\text{N kg}^{-1}}{0.2\,\text{m}} = 7.4\,\text{N m}^{-1}$		
	$\omega = \sqrt{\dfrac{7.4\,\text{N m}^{-1}}{0.15\,\text{kg}}} = 7.0\left(\text{rad s}^{-1}\right)$		
	$f = \dfrac{\omega}{2\pi} = \dfrac{7\,\text{s}^{-1}}{2\pi} = 1.1\,\text{Hz}$		
	Total for question 11		**(7)**

Question Number	Answer		Mark
12(a)	β-particles can (easily) penetrate the body/skin	(1)	
	Since they are not very ionising OR reference to what will stop them	(1)	**(2)**
12(b)(i)	Use idea that number of unstable atoms halves every 8 days OR that 24 days represents 3 half-lives	(1)	**(2)**
	Correct answer	(1)	
	Example calculation: $N_0 \rightarrow \frac{N_0}{2} \rightarrow \frac{N_0}{4} \rightarrow \frac{N_0}{8}$; $t=0$, $t=t_{1/2}$, $t=2t_{1/2}$, $t=3t_{1/2}$		
	Fraction decayed = 100% - 12.5% = 87.5%		
12(b)(ii)	Use of $\lambda T_{1/2} = \ln 2$	(1)	**(3)**
	Use of an appropriate decay equation	(1)	
	Correct answer	(1)	
	Example of calculation: $\lambda = \frac{\ln 2}{T_{1/2}} = \frac{0.693}{8\,\text{day}} = 0.0866\,\text{day}^{-1}$		
	$1.50\,\text{MBq} = A_0\,e^{-0.0866\,\text{day}^{-1} \times 1\,\text{day}}$		
	$A_0 = 1.50\,\text{MBq}\,e^{0.0866} = 1.64\,\text{MBq}$		
	Total for question 12		**(7)**

Question Number	Answer	Mark
13(a)	Idea that the Earth is orbiting the Sun (1) Reference to (trigonometric) parallax (1) Idea that more distant stars have "fixed" positions (1)	**(3)**
13(b)	Diagram to show how to measure angular displacement of star over a 6 month period e.g.  (1) [Diagram should indicate the Earth in two positions at opposite ends of a diameter, with lines drawn heading towards a point with a relevant angle marked; accept the symmetrical diagram seen in many textbooks.] Use trigonometry to calculate the distance to the star (1) [May be indicated by an appropriate trigonometric formula. Do not accept use of Pythagoras] Need to know the diameter/radius of the Earth's orbit about the Sun (1) [This may be marked on the diagram or seen in a trigonometric formula]	**(3)**
13(c)	Standard candle/Cepheid variable/supernovae (1)	**(1)**
	Total for question 13	**(7)**

Question Number	Answer		Mark
14(a)	Alpha-radiation only has a range of a few cm in air / cannot penetrate walls of container / skin	(1)	**(1)**
14(b)(i)	Top line: ^{241}Am ^{237}Np $^{4}\alpha$ Bottom line: $_{95}Am$ $_{93}Np$ $_{2}\alpha$	(1) (1)	**(2)**
14(b)(ii)	Attempt at calculation of mass defect Use of $(\Delta)E=c^2(\Delta)m$ OR use of 1 u = 931.5 MeV Correct answer [5.65 MeV; accept 5.6 – 5.7 MeV] Example of calculation: $\Delta m = 241.056822\,u - 237.048166\,u - 4.002603\,u = 0.006053\,u$ $\Delta m = 0.006053\,u \times 1.66 \times 10^{-27}\ kg\,u^{-1} = 1.005 \times 10^{-29}\ kg$ $E = 1.005 \times 10^{-29}\ kg \times \left(3 \times 10^{8}\ ms^{-1}\right)^2 = 9.04 \times 10^{-13}\ J$ $E = \dfrac{9.04 \times 10^{-13}\ J}{1.6 \times 10^{-13}\ MeV\,J^{-1}} = 5.65\,MeV$	(1) (1) (1)	**(3)**
14(c)	Reference to half-life and typical lifespan	(1)	**(1)**
	Total for question 14		**(7)**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>15(a)(i)</td><td>Use of $\lambda_{max}T=2.898 \times 10^{-3}$ (1)

Correct answer (1)

Example of calculation:
$T = \dfrac{2.898 \times 10^{-3}\ \text{mK}}{5.2 \times 10^{-7}\ \text{m}} = 5570\ \text{K}$</td><td>(2)</td></tr>
<tr><td>15(a)(ii)</td><td>Use of $F=L/4\pi d^2$ (1)

Correct answer (1)

Example of calculation:
$L = 1370\ \text{Wm}^{=2} \times 4\pi \times \left(1.49 \times 10^{11}\ \text{m}\right)^2 = 3.8 \times 10^{26}\ \text{W}$</td><td>(2)</td></tr>
<tr><td>15(a)(iii)</td><td>Use of $L=4\pi r^2\sigma T^4$ (1)

Correct answer (7.46×10^8 m) (1)

Example of calculation:
$r^2 = \dfrac{3.82 \times 10^{26}\ \text{W}}{4\pi \times 5.67 \times 10^{-8}\ \text{Wm}^{-2}\text{K}^{-4} \times \left(5570\ \text{K}\right)^4} = 5.57 \times 10^{17}\ \text{m}^2$
$r = \sqrt{5.57 \times 10^{17}\ \text{m}^2} = 7.46 \times 10^8\ \text{m}$

<table><tr><th></th><th>3.8×10^{-26} W</th><th>4×10^{26} W</th></tr><tr><td>5570 K</td><td>7.46</td><td>7.6</td></tr><tr><td>6000 K</td><td>6.4</td><td>6.6</td></tr></table></td><td>(2)</td></tr>
<tr><td>15(b)

QWC</td><td>The answer must be clear, use an appropriate style and be organised in a logical sequence

High temperature AND high density/pressure (1)

Any two reasons from:
Overcome coulomb/electrostatic repulsion (1)
<u>Nuclei</u> come close enough to fuse/for strong (nuclear) force to act (1)
High collision rate/collision rate is sufficient (1)</td><td>(max 3)</td></tr>
<tr><td></td><td>Total for question 15</td><td>(9)</td></tr>
</table>

Question Number	Answer		Mark
16(a)	Any two from: Air behaves as an ideal gas Temperature (in the lungs) stays constant Implication of no change in mass of gas	 (1) (1) (1)	**(max 2)**
16(b)(i)	Use of ρ=m/V Correct answer (1.3×10^{-4} kg s^{-1}) Example of calculation: $m = V.\rho = 2.5 \times 10^{-4}\ m^3 \times 1.2\,kg\,m^{-3} = 3 \times 10^{-4}\ kg$ $\frac{\Delta m}{\Delta t} = 3 \times 10^{-4}\ kg \times \frac{25}{60\,s} = 1.25 \times 10^{-4}\ kg\,s^{-1}$	(1) (1)	**(2)**
16(b)(ii)	Use of $\Delta E = mc\Delta\theta$ Correct answer (2.2 W) ecf Example of calculation: $P = 1.25 \times 10^{-4}\ kg\,s^{-1} \times 1000\,J\,kg^{-1}\,K^{-1} \times (37.6 - 20.0)K = 2.2\,W$	(1) (1)	**(2)**
	Total for question 16		**(6)**

Question Number	Answer	Mark
17(a)(i)	Calculation of time period (1) Use of $v = \frac{\Delta s}{\Delta t}$ *or* $\omega = \frac{2\pi}{T}$ (1) Use of $a = \frac{v^2}{r}$ *or* $a = r\omega^2$ (1) Correct answer (1) Example of calculation: $T = \frac{24\times60\times60\,s}{15} = 5760\,s$ $v = \frac{2\pi r}{T} = \frac{2\pi\times6.94\times10^6\,m}{5760\,s} = 7.57\times10^3\,ms^{-1}$ $a = \frac{v^2}{r} = \frac{(7.6\times10^3\,ms^{-1})^2}{6.94\times10^6\,m} = 8.26\,ms^{-2}$ OR $\omega = \frac{2\pi}{T} = \frac{2\pi}{5760\,s} = 1.09\times10^{-3}\,ms^{-1}$ $a = r\omega^2 = 6.94\times10^6\times(1.09\times10^{-3})^2 = 8.26\,ms^{-2}$	**(4)**
17(a)(ii)	mg equated to gravitational force expression (1) g (= a) = 8.3 ms^{-2} substituted (1) Correct answer (1) Example of calculation: $mg = \frac{GMm}{r^2}$ $\therefore 8.3\,ms^{-2} = \frac{6.67\times10^{-11}\,N\,m^2\,kg^{-2}M}{(6.94\times10^6\,m)^2}$ $\therefore M = \frac{8.3\,ms^{-1}\times(6.94\times10^6\,m)^2}{6.67\times10^{-11}\,Nm^2kg^{-2}} = 6.0\times10^{24}\,kg$	**(3)**
17(b)	The observed wavelength is longer than the actual wavelength / the wavelength is stretched out (1) One from: The universe is expanding (1) (All distant) <u>galaxies</u> are moving apart (1) The (recessional) velocity of <u>galaxies</u> is proportional to distance (1) The furthest out <u>galaxies</u> move fastest (1)	**(max 2)**

17(c)(i)	A light year is the distance travelled (in a vacuum) in 1 year by light / em-radiation (1) The idea that light has only been able to travel to us for a time equal to the age of the universe. (1)	**(2)**
17(c)(ii)	(Use of v = H_o d to show) $H_o = \frac{1}{t}$ (1) Correct answer (1) Example of calculation: $H_o = \frac{1}{t} = \frac{1}{12 \times 3.15 \times 10^{16}\ s} = 2.65 \times 10^{-18}\ s^{-1}$	**(2)**
17(c)(iii) **QWC**	The answer must be clear and be organised in a logical sequence There is considerable uncertainty in the value of the Hubble constant (1) Any sensible reason for uncertainty (1) Idea that a guess implies a value obtained with little supporting evidence OR the errors are so large that our value is little better than a guess (1)	**(3)**
	Total for question 17	**(16)**

Question Number	Answer		Mark
18(a)	Resonance System driven at / near its <u>natural</u> frequency	(1) (1)	**(2)**
18(b)(i)	Any zero velocity point	(1)	**(1)**
18(b)(ii)	Any maximum/minimum velocity point	(1)	**(1)**
18(c)	Select 70 mm distance from passage/see 35 mm Use of a = $-\omega^2 x$ Use of v = ωA Correct answer Example of calculation: $\omega = \sqrt{\frac{0.89\,\mathrm{m s^{-1}}}{3.5\times10^{-2}\,\mathrm{m}}} = 5.04\,\mathrm{rad\,s^{-1}}$ $v = \omega A = 5.04\,\mathrm{s^{-1}} \times 3.5\times10^{-2}\,\mathrm{m} = 0.18\,\mathrm{m\,s^{-1}}$	(1) (1) (1) (1)	**(4)**
18(d) **QWC**	The answer must be clear and be organised in a logical sequence The springs/dampers absorb energy (from the bridge) (Because) the <u>springs</u> deform/oscillate with natural frequency of the bridge Hence there is an efficient/maximum transfer of energy Springs/dampers must not return energy to bridge / must dissipate the energy	 (1) (1) (1) (1)	**(max 3)**
	Total for question 18		**(11)**

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