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Mark Scheme (Results)
January 2011

GCE

GCE Physics (6PH05) Paper 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] [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.
   - 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.

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.

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.

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

Section A

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

Question Number	Answer	Mark
11(a)	Use of $pV=NkT$ (1) $T =$ 870 (K) OR p = 12.4 (atmospheres) (1) If final pressure is given as 1.24×10^6 Pa, then just "use of" mark <u>Example of calculation</u>: $T = \frac{pV}{Nk} = \frac{12 \times 1.0 \times 10^5 \text{ Nm}^{-2} \times 3.00 \times 10^{-4} \text{ m}^3}{3 \times 10^{22} \times 1.38 \times 10^{-23} \text{ JK}^{-1}} = 869.6 \text{ K}$ OR $p = \frac{NkT}{V} = \frac{3 \times 10^{22} \times 1.38 \times 10^{-23} \text{ JK}^{-1} \times 900 \text{ K}}{3 \times 10^{-4} \text{ m}^3}$ $\therefore p = 1.24 \times 10^6 \text{ Pa} = \frac{1.24 \times 10^6 \text{ Pa}}{3 \times 10^{-4} \text{ Pa}} = 12.4$	2
11(b)*	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) <u>Atoms/molecules</u> would gain energy (1) <u>Atoms/molecules</u> would escape from the liquid OR liquid propellant would vaporise / turn into gas OR the amount of gas in can would increase (1) Pressure would increase due to **both** temperature/energy increase **and** increase in amount of gas OR pressure would increase more for the same temperature increase OR pressure would be greater than 12 atmospheres before 900 K (1) Can would explode before 900 K reached (1)	Max 3
	Total for question 11	5

Question Number	Answer	Mark
12(a)	Use of $L/4\pi d^2$ **or** $F \propto 1/d^2$ (1) $F_{mars} / F_{earth} = 0.43$ (1) Accept 1 : 2.35 or other ratio simplifying to 0.43 <u>Example of calculation</u> $F = \frac{L}{4\pi\pi^2}$ $\frac{F_{mars}}{F_{earth}} = \frac{d^2_{earth}}{d^2_{mars}} = \left(\frac{1.5 \times 10^{11}\,m}{2.3 \times 10^{11}\,m}\right)^2 = 0.43$	2
12(b)	Observation that (radiation) flux is about half that on the Earth OR Earth has about double the (radiation) flux of Mars (ecf answer to (a)) (1) Sensible comment that makes reference to energy/intensity/number of photons OR sensible comparison with polar or deep sea regions on the Earth OR reference to a thinner atmosphere (allowing a greater fraction of photons get through to surface) (1)	2
	Total for question 12	4

Question Number	Answer	Mark
13(a)	Object must have a standard/known luminosity OR luminous properties independent of its position (1) It can be used to calculate distances (1) Reference to any **two** of the following: ♦ Radiation/energy flux measured (1) ♦ Observed brightness compared with luminosity (1) ♦ Use of inverse square law [accept if equation quoted] (1) ♦ Object must be commonly found in the universe (1)	Max 4
13(b)	When star contracts (front of) star is moving away from observer OR explanation in terms of a rotating/binary star (1) Movement away from observer results in a decrease in the frequency of the radiation/red shift (1) Accept converse argument for an expanding star	2
	Total for question 13	6

Question Number	Answer	Mark
14(a)(i)	Use of πr^2 or $\pi d^2/4$ (1) Use of ρ=m/V (1) m = 1960 (kg) (1) Reverse argument leading to ρ = 9130 (kg m^{-3}) scores max 2 <u>Example of calculation</u> $V = \pi r^2 \ell = \pi \times (0.815 \times 10^{-3}\,m)^2 \times 105 \times 10^3\,m = 0.219\,m^3$ $m = \rho V = 8960\,kgm^{-3} \times 0.219 m^3 = 1962\,kg$	3
14(a)(ii)	Use of $\Delta E = mc\Delta T$ (1) $\Delta E = 8.0 \times 10^8$ J (1) $\Delta E = 8.2 \times 10^8$ J if show that value used <u>Example of calculation</u> $\Delta E = m c \Delta\theta = 1962\,kg \times 385\,JK^{-1}kg^{-1} \times (1085 - 25)K = 8.0 \times 10^8\,J$	2
14(b)	Idea that whilst copper is being heated to melting point, energy supplied is (mainly) transformed into K.E. of atoms/molecules (1) At melting point: no change in K.E. of atoms/molecules OR energy supplied is transformed into P.E. of atoms/molecules (1)	2
	Total for question 14	7

Question Number	Answer	Mark
15(a)(i)	Use of $\omega = 2\pi/T$ (1) $\omega = 2.66 \times 10^{-6}$ (rad s^{-1}) (1) <u>Example of calculation</u> $\omega = \frac{2\pi}{T} = \frac{2\pi}{27.3 \times 24 \times 3600\text{s}} = 2.66 \times 10^{-6}(\text{rad})\text{s}^{-1}$	2
15(a)(ii)	See $(F =)\frac{Gm_1m_2}{r^2}$ (1) Evidence that gravitational force equated to centripetal force (1) Correct substitution [e.c.f.] (1) $r = 3.92 \times 10^8$ m (1) If show that value is used, $r = 3.62 \times 10^8$ m <u>Example of calculation</u> $\frac{GMm}{r^2} = m\omega^2 r$ $r^3 = \frac{GM}{\omega^2}$ $\therefore r = \sqrt[3]{\frac{6.67\times10^{-11}\text{Nm}^2\text{kg}^{-2}\times6.4\times10^{24}\text{kg}}{(2.66\times10^{-6}\text{s}^{-1})^2}} = 3.92\times10^8$ m	4
15(b)(i)	Max **two** from: ♦ Gravitational force on moon is reduced (1) ♦ (Therefore) ω or v is decreased (1) ♦ (Hence) the orbital time increases (1) ♦ Valid reference to Kepler's law: $T^2 \alpha r^3$ (1)	Max 2
15(b)(ii)	Rate of increase = 4 (cm per year) (1) <u>Example of calculation</u> Rate of increase = 800 cm / 200 yr = 4 cm yr^{-1}	1
15(b)(iii)*	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Answers based on expanding universe/galaxies/stars do not gain credit Idea that in the past the moon was closer OR the gravitational pull would have been larger (1) In the past the tidal effects would have been greater/stronger (1) The rate of change of orbital radius would have been greater (1)	3
	Total for question 15	12

Question Number	Answer	Mark
16(a)(i)	Use of $f=1/T$ (1) f = 8 Hz (1) <u>Example of calculation</u> $f = \frac{1}{T} = \frac{1}{2 \times 0.0625\,\text{s}} = 8\ \text{Hz}$	2
16(a)(ii)	At the equilibrium (position) / centre of the oscillation / mid-point (1)	1
16(a)(iii)	Use of $v_{max}=2\pi fA$ OR $v_{max}=\omega A$ (1) v_{max} = 2.5 ms^{-1} [ecf for (a)(i), see table below] (1) <u>Example of calculation</u> $v = 2\pi f A = 2\pi \times 8\,\text{s}^{-1} \times 5 \times 10^{-2}\,\text{m} = 2.5\ \text{m s}^{-1}$	2
16(b)(i)	Idea that the system is forced / driven into oscillation at / near its <u>natural</u> frequency OR driver / forcing frequency is equal / near to <u>natural</u> frequency (1) Leads to large/max energy transfer OR large/max/increasing amplitude (1)	2
16(b)(ii)	**Max 2** ♦ Rubber feet (deform and) absorb (vibration) energy (1) ♦ Reference to damping (1) ♦ Idea that energy is removed from system (1) ♦ **Hence** amplitude does not build up (1)	max 2
	Total for question 16	9

When marking 16(a)(iii) the table below may be helpful:

f/Hz	A/cm	v/ms^{-1}	Marks
8	5	2.5	2
16	5	5	2
8	10	5	1
16	10	10	1

Question Number	Answer	Mark
17(a)*	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Appropriate reference to the following: ▪ The penetrating power of beta radiation ▪ The ionising effects of the beta radiation ▪ The shielding effect that the cylinder might have had ▪ The constant activity over the 5 day period Examples of responses: Beta radiation is (moderately) ionising Beta radiation is able to penetrate the body Once inside the body beta radiation may damage / kill / mutate / alter DNA of cells Beta radiation is absorbed by a few mm of aluminium Cylinder may have reduced the radiation to safe levels / absorbed the beta radiation Greater risk of exposure if cylinder damaged or cracked Long half life means that: source stays active for a long time/activity unlikely to lower over 5 days	max 3
17(b)	Top line: $^{137}\text{Ba}\ \ ^{0}\beta^{-}$ (1) Bottom line: $_{56}\text{Ba}\ \ _{-1}\beta^{-}$ (1)	2
17(c)(i)	Cannot identify which atom/nucleus/particle will be the next to decay OR cannot say when a given atom/nucleus/particle will decay OR cannot state exactly how many atoms/nuclei/particles will decay in a set time OR can only estimate the fraction of the total number that will decay in the next time interval (1)	1

17(c)(ii)	Use of $\lambda T_{1/2} = \ln 2$ (1) Decay constant, $\lambda = 7.3 \times 10^{-10}$ (s^{-1}) (1) <u>Example of calculation</u> $\lambda = \frac{\log_e 2}{T_{1/2}} = \frac{0.693}{30 \times 365 \times 24 \times 3600\,s} = 7.32 \times 10^{-10}\,s^{-1}$	2
17(d)	Use of $\frac{dN}{dt} = \left(\frac{dN}{dt}\right)_0 e^{-\lambda t}$ (1) activity = 3.3×10^{13} Bq [3.3×10^{13} Bq if show that value used] (1) Use of $dN/dt = \lambda N$ (1) $N = 4.5 \times 10^{22}$ [4.8×10^{22} if show that value used] (1) OR Use of $dN/dt = \lambda N_o$ (1) $N_o = 7.1 \times 10^{22}$ [$N_o = 7.4 \times 10^{22}$ if show that value used] (1) Use of $N = N_0 e^{-\lambda t}$ (1) $N = 4.5 \times 10^{22}$ [4.8×10^{22} if show that value used] (1) <u>Example of calculation</u> $\frac{dN}{dt} = \left(\frac{dN}{dt}\right)_0 e^{-\lambda t} = 5.2 \times 10^{13}\,Bq \times e^{-7.32 \times 10^{-10}\,s^{-1} \times 20 \times 365 \times 24 \times 3600\,s}$ $= 3.28 \times 10^{13}\,Bq$ $N = \frac{dN/dt}{\lambda} = \frac{3.28 \times 10^{13}\,s^{-1}}{7.32 \times 10^{-10}\,s^{-1}} = 4.48 \times 10^{22}$	4
17(e)(i)	${}^{95}_{37}Rb \quad + \quad 4 \times {}^{1}_{0}n$ (1)	1
17(e)(ii)	Idea that at least one neutron needs to be available to be absorbed for a chain reaction to be sustained (1) Appreciation of the need to control/limit/restrict the number of neutrons (which can go on to produce another fission) (1)	2
	Total for question 17	12

Question Number	Answer	Mark
18(a)	**Max 4** Assumption: that no energy is transferred to the surroundings OR all energy transferred from washers to water OR energy required to raise temperature of container is negligible OR no water evaporates (1) Measure the mass of the washers and water (using a balance) (1) (Use a thermometer to) measure the temperature of the water before and after the washers are plunged into the water (1) Equate thermal energy lost by steel to the energy gained by water (1) Use a (standard) value for the specific heat capacity of the water OR specific heat capacity of water is known (1)	Max 4
18(b)(i)	Infra-red (1)	1
18(b)(ii)	Use of $\lambda_{max}T=2.898 \times 10^{-3}$ (1) T = 1450 (K) OR $\lambda_{max} = 1.93 \times 10^{-6}$ (m) (1) Example of calculation $T = \frac{2.898\times10^{-3}\text{ mK}}{2\times10^{-6}\text{ m}} = 1450\text{ K}$	2
18(b)(iii)	Use of $L = 4\pi r^2\sigma T^4$ (1) Correct substitution of radius (1) L = 1970 W [2250W if show that value used] (1) Example of calculation $L = 4\pi\times(2.5\times10^{-2}\text{ m})^2\times5.67\times10^{-8}\text{ Wm}^{-2}\text{K}^{-4}(1450\text{K})^4 = 1970\text{ W}$	3
18(b)(iv)	Curve with higher peak (1) Shifted over to left (1)	2
	Total for question 18	12

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