Edexcel GCE

Physics

Unit no. 6733/01

June 2006

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Mark Scheme (Results)

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Physics

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Mark scheme notes June 2006

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. '<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 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:

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

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

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

$= 49.4 \text{ N}$

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.

6733 Unit Test PHY3 (Topics)

Topic A - Astrophysics

(a)	<u>H-R Diagram</u>		
(i)	L and T	✓	
	$L_{\odot}$ and K	✓	**2**
	[or L and $L_{\odot}$ ✓**,** T and K ✓, not W]		
(ii)	Any 2 correct [of 10^2, 1 or 10^0, 10^{-2}]	✓	
	All 3 correct	✓	**2**
(iii)	20 000 and 5 000	✓	**1**
	<u>Identify stars</u>		
(iv)	Red giant = (B and) C	✓	
	Low mass ms star = E [ignore X]	✓	**2**
	<u>Zeta Tauri Luminosity</u>		
(v)	Use of $L = 4\,\pi\,D^2\,I$	✓	
	Correct substitution	✓	
	$3.8(2) \times 10^{30}$ (W)	✓	**3**
	<u>Zeta Tauri identification</u> (ecf)		
(vi)	$3.8(2) \times 10^{30}$ W ÷ 3.9×10^{26} W [or 4×10^{30} W used]	✓	
	Correct ratio [e.g. 9700, 9800, 10300 or 10^4, etc.]	✓	
	Hence A [from answer in range 9700 to 10300]	✓	**3**

(b)	Fusion calculations		
(i)	Mass difference substitution [(2 × 5.0055) – (6.6447 + 2 × 1.6726)]	✓	
	2.11×10^{-29} kg [or 0.0211×10^{-27} kg]	✓	**2**
(ii)	$E = mc^2$ seen	✓	
	1.9×10^{-12} J [ecf]	✓	**2**
(c)	Pulsars		
(i)	Neutron star	✓	
	Core remnant	✓	
	Supernova	✓	
	1.4 [accept 0.4 and 1.4]	✓	**4**
	Binary pulsar system		
(ii)	Quality of written communication	✓	
	(Varying) radio signals	✓	
	(Regular) pulses **detected** [like lighthouse]	✓	
	Idea of two overlapping pulses (from same location)	✓	**4**
(iii)	Black hole	✓	**1**
(d)	White dwarf density		
(i)	$M \div \frac{4}{3} \pi r^3$ [allow M, m, R, r]	✓	**1**
(ii)	Any pair of values correctly read [may be implied, ignore 10^6]	✓	
	Any correct substitution [with 2.0×10^{30} and 10^6, ecf on (i)]	✓	
	Two correct answers [in kg m^{-3}, no statement required]	✓	**3**
	White dwarf future		
(iii)	Cools / temperature decreases	✓	
	Becomes dimmer / changes colour [not brown dwarf]	✓	**2**
		TOTAL	**32**

Topic B - Solid Materials

(a)	<u>Stress – strain graph</u>		
(i)	Stress	✓	
	Pa / MPa / GPa / N m^{-2}	✓	**2**
(ii)	Use of $E = \sigma \div \varepsilon$ / E = gradient	✓	
	Any correct substitution [for linear region]	✓	
	Suitable scale: 1, 2, 3, 4, 5 and x 10^9 / G	✓	**3**
	<u>UTS and yield stress</u>		
(iii)	5 GPa [ecf]	✓	**1**
(iv)	The stress at which plastic deformation begins / beyond elastic region [not just 'beyond Hooke's law']	✓	**1**
(v)	Y at or just beyond end of straight line on graph [$0.03 < \varepsilon < 0.04$]	✓	**1**
	<u>Second material</u>		
(vi)	Lower gradient initially	✓	
	Straight line to right-hand edge of graph	✓	**2**
	<u>Energy density and Work done</u>		
(vii)	Any reference to area [may be implied]	✓	
	Correct technique: rectangle (and triangle) or counting squares	✓	
	$7.5 – 8.5 \times 10^8$ J m^{-3} [no ecf]	✓	**3**
(viii)	8×10^8 J m^{-3} $\times 3.8 \times 10^{-7}$ m^3 [ecf on energy density from (vii)]	✓	
	Correct answer [300 J, ecf]	✓	**2**
(b)	<u>Crystal lattice dislocations</u>		
(i)	XY = Slip plane	✓	**1**
(ii)	Quality of written communication	✓	
	Layers / planes (of atoms) slip over each other / move	✓	
	Bonds break one at a time (along XY / slip plane)	✓	
	Less force (or stress) required (to do this)	✓	**4**

(c)	<u>Pole vault energy</u>		
(i)	AB: chemical to…	✓	
	BC: kinetic to elastic / strain / g.p.e.	✓	
	CD: …to <u>gravitational</u> potential / g.p.e.	✓	**3**
(ii)	8.0 m s^{-1}	✓	**1**
(iii)	*m g h* = 2100 (J) [or 3.3 seen]	✓	
	(3.3 + 0.9 + 1.2 =) 5.4 (m)	✓	**2**
(d)	<u>Pole material</u>		
(i)	Made of more than one material [ignore benefits here]	✓	**1**
(ii)	to gain (beneficial) properties of each material [not just 'stronger']	✓	**1**
(iii)	<u>Pole properties</u>		
	Elastic	✓	
	Flexible	✓	
	Strong	✓	**3**
	[−1 penalty per error if > 3 circled]		
(iv)	No plastic deformation (or almost none) / only deforms elastically [not just 'breaks easily']	✓	**1**
		TOTAL	**32**

Topic C - Nuclear and Particle Physics

(a)	<u>Energy spectrum graph</u>		
(i)	Number of β^- / particles	✓	
	<u>Kinetic</u> energy [accept k.e.]	✓	
	MeV	✓	**3**
	<u>Antineutrino evidence</u>		
(ii)	Quality of written communication	✓	
	0.78 = maximum energy / ΔE of reaction	✓	
	Expect single energy for β^- / energy conservation	✓	
	(Anti)neutrino / other particle takes away missing energy	✓	**4**
(b)	<u>β – decay equations</u>		
(i)	n = udd and p = uud	✓	
	β^- and $\bar{\nu}$ have no quarks / are leptons / are fundamental	✓	**2**
(ii)	p → n	✓	
	β^+ and ν [on RHS, allow e^+]	✓	**2**
	<u>Weak interaction</u>		
(iii)	Change of quark flavour / type	✓	
	d → u (in β^-) AND u → d (in β^+) [accept "vice versa"]	✓	
	(anti) neutrino only affected by weak interaction	✓	**3**
(iv)	$\beta^- = W^-$	✓	
	$\beta^+ = W^+$	✓	**2**
	[just W's, or W^- W^+ swapped gets ✓✗]		

(c)	Nuclear density		
(i)	use of $\rho = m \div V$	✓	
	$\frac{4}{3}\pi\,(5.34 \times 10^{-15}\text{ m})^3$ / $6.38 \times 10^{-43}(\text{m}^3)$	✓	
	1.46×10^{-25} kg	✓	**3**
	Nucleon number and radius		
(ii)	1.46×10^{-25} kg ÷ 1.66×10^{-27} kg [ecf] [or $88 \times 1.66 \times 10^{-27}$ kg]	✓	
	hence 87.99 / 88 [accept integer 88] [or hence 1.46×10^{-25} kg]	✓	**2**
(iii)	$r = r_0 A^{1/3}$ [seen or implied by substitution, or $\frac{4}{3}\pi r^3$ route]	✓	
	5.34×10^{-15} m ÷ $88^{1/3}$ [must be shown]	✓	
	1.2×10^{-15} m	✓	**3**
(d)	Hydrogen		
	baryon and hadron	✓	
	lepton	✓	**2**
(e)	Antihydrogen		
(i)	Antiproton [or anti-up quark, anti-down quark] and positron	✓	**1**
(ii)	$\overline{p} = -1$ and $e^+ = +1$ [accept correct $\overline{u}$, $\overline{d}$ charges for $\overline{p}$]	✓	
	$\overline{u}\,\overline{u}\,\overline{d}$ (e^+ fundamental / no quarks) [ecf from (b), credit if in (i)]	✓	**2**
(iii)	zero / neutral	✓	**1**
	Antimatter storage		
(iv)	Annihilates	✓	
	(On contact) with matter / container / protons / H OR Not charged: not affected by magnetic fields	✓	**2**
		TOTAL	**32**

Topic D - Medical Physics

(a)	<u>Decay graph</u>		
(i)	Time / t	✓	**1**
(ii)	Use of t_r line shown on graph	✓	
	5, 10, 15, 20 at marks / 6, 12, 18 clearly marked AND hours / h [at least 2 added values required from one set shown here]	✓	**2**
	<u>Biological half-life</u>		
(iii)	Correct reading of t_e = 4 hours [ecf]	✓	
	Use of $1/t_e = 1/t_r + 1/t_b$ [only this, i.e. not $\lambda t_{½} = 0.69$]	✓	
	12 hours [no ecf, accept 720 min or 43200 s]	✓	**3**
(b)	<u>Molybdenum</u>		
(i)	${}^{99}_{42}\text{Mo} \rightarrow {}^{99m}_{43}\text{Tc} + {}^{0}_{-1}\beta$ [accept ${}^{0}_{-1}$e, ignore $\bar{\upsilon}$, γ or Q]	✓	**1**
(ii)	(nuclear) reactor	✓	**1**
	<u>Elution method</u>		
(iii)	Quality of written communication	✓	
	(saline) solution washed / flushed / pushed **through** (elution cell)	✓	
	Tc dissolves / is removed (from cell)	✓	
	<u>Mo</u> insoluble	✓	**4**
	<u>Technetium daughter</u>		
(iv)	${}^{99m}_{43}\text{Tc} \rightarrow {}^{99}_{43}\text{Tc} + \gamma$ [ecf on proton number]	✓	**1**
(v)	Minimise dose / damage / radiation to patient / cells	✓	
	(Very) low activity / relatively stable / excreted before it can cause damage	✓	**2**

(c)	<u>Proton number *Z*</u>		
(i)	*Z* = proton number (or atomic number)	✓	**1**
(ii)	$Z_{bones} > Z_{tissue / air}$ [comparison required, may be non-specific]	✓	
	Bones absorb more X-rays due to high(er) *Z*	✓	**2**
	<u>X-ray tube</u>		
(iii)	1 = Vacuum	✓	
	Allows <u>electrons</u> to pass through tube	✓	
	2 = High voltage (supply)	✓	
	To **accelerate** electrons (from cathode to anode) [not attracts]	✓	
	3 = (Rotating tungsten) <u>anode</u> [accept positive electrode]	✓	
	Emits X-rays (when struck by electrons)	✓	**6**
(d)	<u>Ultrasound *Z*'s</u>		
(i)	(specific) acoustic impedance	✓	
	of two materials / media [conditional on SAI]	✓	**2**
(ii)	$[\rho] = kg\ m^{-3}$ **or** $[c] = m\ s^{-1}$	✓	
	$kg\ m^{-3} \times m\ s^{-1}$	✓	**2**
	<u>Reflection coefficient calculation</u>		
(iii)	Correct substitution	✓	
	1.1×10^{-3} / 0.0011 / 0.11% AND no unit	✓	**2**
	<u>Transmitted percentage</u>		
(iv)	$1 - \alpha$ / 100% - 0.11% [ecf]	✓	
	99.9% [ecf]	✓	**2**
		TOTAL	**32**