edexcel

GCE

Edexcel GCE

Physics (6733/01)

Summer 2005

advancing learning, changing lives

Mark Scheme (Results)

Edexcel GCE
Physics (6733/01)

Contents

Notes on the Mark Schemes

1. *Alternative responses:* There was often more than one correct response to a particular question and these published mark schemes do not give *all* possible alternatives. They generally show only the schemes for the most common responses given by candidates. They are **not** model answers but indicate what the Examiners accepted in this examination.

2. *Error carried forward:* In general, an error made in an early part of a question is penalised there but not subsequently, i.e. candidates are penalised once only, and can gain credit in later parts of a question by correct reasoning from an earlier incorrect answer.

3. *Quantity algebra:* The working for calculations is presented using quantity algebra in the mark schemes for Units PHY1, PHY2, PHY3 (Topics), PHY4, PHY5/01, and PHY6 but candidates are not required to do this in their answers.

4. *Significant figures:* Use of an inappropriate number of significant figures in the theory papers will normally be penalised only in "show that" questions where too few significant figures has resulted in the candidate not demonstrating the validity of the given answer. Use of an inappropriate number of significant figures will normally be penalised in the practical tests. In general candidates should nevertheless be guided by the numbers of significant figures in the data provided in the question.

5. *Unit penalties:* A wrong or missing unit in the answer to a calculation will generally lose one mark unless otherwise indicated.

6. *Quality of written communication:* Each theory paper will usually have 1 or 2 marks for the quality of written communication. The mark will sometimes be a separate mark and sometimes be an option in a list of marking points.

Within the schemes:

- / indicates alternative marking point
  ( ) brackets indicate words not essential to the answer
  [ ] brackets indicate additional guidance for markers

- The following standard abbreviations are used:

a.e.	arithmetic error (–1 mark)
e.c.f.	error carried forward (allow mark(s))
s.f.	significant figures (–1 mark only where specified)
no u.e.	no unit error

6733/01 Unit Test PHY3 (Topics)

Topic A - Astrophysics

(a) Base units of intensity

(i) W = J s^{-1} / N m s^{-1} or $P = E / t$ or $P = F v$ ✓

J = kg m^2 s^{-2} or kg m s^{-2} m ✓

Algebra to kg s^{-3} shown (e.g. kg m^2 s^{-2} s^{-1} m^{-2}) ✓ **3**

Luminosity calculation

(ii) Correct substitution ✓

3.82 or 3.8 [ignore 10^n] ✓

hence 3.8(2) × 10^{26} W [ue] [allow 3.9 or 4] ✓ **3**

(b) CCD advantages

(i) Any three from:

- Higher (quantum) efficiency / more sensitive
- Detect fainter or more distant stars
- More linear response
- Digital / link to computer / remote imaging
- No processing time / use repeatedly / real-time imaging
- Quicker image collection (i.e. quicker & reason)
- Greater range of wavelengths

✓✓✓

(ii) CCD disadvantage ✓

Resolution / pixel size larger **Max 4**

(c) Satellite advantages

Quality of written communication ✓

No atmosphere (for radiation to pass through / above atmosphere) ✓

Idea of no absorption (of i.r.) ✓ **3**

(d) Forces within star

(i) 1. Fusion forces [allow 'pressure from nuclear reactions' or 'hydrogen burning'] or radiation / photon pressure ✓

2. Gravitational / Weight (not just gravity) ✓

(ii) Equal ✓ **3**

(iii) White dwarf & red giant differences

Any three from:

- Temperature: T_{wd} (6000K – 30000K) > T_{rg} (2000K – 5000K)
- Volume: $V_{rg} > V_{wd}$ - allow A / d / r / bigger
- Mass: e.g. $M_{wd} < 1.4\ M_{\odot}$ AND ($0.4M_{\odot}$ <) $M_{rg} < 8m_{\odot}$
- Fusion (of He / heavier elements) in rg / no fusion in wd
- Luminosity: L_{rg} [$10^2 – 10^6$] > L_{wd} [10^{-2} - 10^{-4}] in terms of $L_{\odot}$
- Wd is (core) remnant of rg / rg before wd stage
- Density: $\rho_{wd} > \rho_{rg}$

✓✓✓ **Max 3**

[no numerical values for any property - max 2/3)

(iv) Neutron star

Core remnants' mass ✓

Must be > 1.4 $M_{\odot}$ or < 2.5 $M_{\odot}$ ✓ **2**

(e) When Sun was formed

(i) Attempted use of $L_{\odot} = 1.4\ L$ ✓

2.8×10^{26} W ✓

(ii) 1.06^2 used ✓

5.5×10^{18} m^2 / 5.5×10^{12} km^2 ✓ **4**

Show temperature change

(iii) $L = \sigma T^4 A$ (or implied) ✓

Correct substitution [ecf] ✓

Hence 5500 (K) [no ecf] ✓

Hence 5800 – 5500 [or 330, 308, 310] ✓ **4**

Wien's law

(iv) Use of $\lambda_{(max)} T = 2.90 \times 10^{-3}$ m K ✓

530 nm or 500 nm [no ue] ✓

$\Delta\lambda$ = 30 nm (when rounded to 1 s.f.) ✓ **3**

TOTAL **32**

Topic B - Solid Materials

(a)	Base units of energy density		
(i)	J m^{-3} or N m^{-2}	✓	
	J = kg m^2 s^{-2} or N = kg m s^{-2}	✓	
	Algebra to kg m^{-1} s^{-2} shown (i.e. kg m^2 s^{-2} m^{-3} or kg m s^{-2} m^{-2})	✓	**3**
(ii)	Energy density calculation		
	200×10^6 used	✓	
	Energy density = ½ σ ε (or implied)	✓	
	Correct substitution to 95 000 [no ue]	✓	**3**
(b)	Rubber band graph		
(i)	Clear labels (or arrows up & down)	✓	**1**
(ii)	Hysteresis	✓	**1**
	Maximum stress		
(iii)	Use of F/A with 12 (N)	✓	
	2×10^6 Pa / N m^{-2} [ue, no ecf]	✓	**2**
(iv)	Internal energy gain		
	Any attempt at area / 0.5 F x	✓	
	Correct values approximated [ignore 10^n] [allow counting squares] [ecf]	✓	
	(½ ×) 12 N × 500 × 10^{-3} or counted squares conversion to energy (1cm^2 : 0.2 J)	✓	
	3 J [when rounded to 1sf, ue, no ecf]	✓	**4**
(v)	Hence show loop area		
	Attempt at loop area / attempt at area under unloading line	✓	
	Hence working to show 1 J	✓	**2**
	Mechanism		
(vi)	Creep	✓	**1**

Hooke's law

(vii) (Loading) force is proportional to extension

[OR may be $F = k\Delta x$ with symbols defined] ✓ **1**

Force-extension apparatus

(viii) Valid diagram ✓

Clamp and rubber band, both labelled ✓

Ruler and masses/weights, both labelled ✓

Accuracy technique (eye-level, clamp ruler, use set-square) ✓ **4**

(c)(i) Glass properties

Brittle ✓

Stiff ✓ **2**

[-1 per error if more than two properties circled]

(ii) Extension calculation

Any three from:

- S.I. conversion of d and l
- $\sigma = F / A$ and $\varepsilon = \Delta l / l$ [or $E = F\,l / A\,\Delta l$ (may be implied)]
- Any use of $E = \sigma / \varepsilon$ [or use of $E = F\,l / A\,\Delta l$, allow incorrect A]
- Correct use of πr^2 / $\frac{1}{4}\pi d^2$ (no 10^n penalty)

✓✓✓

3.0×10^{-4} m ✓ **4**

(d) Cross-linked polymers

Quality of written communication ✓

Diagram showing cross-links ✓

Polythene / Polymer chains / long molecules [may be as a label in diagram] ✓

Describe bonds between chains ✓ **4**

TOTAL **32**

Topic C - Nuclear and Particle Physics

(a) Base units of eV

(i) Reference to joule ✓

Useful energy equation / units shown [e.g. $\frac{1}{2}mv^2$, mgh, mc^2, Fd, *not* QV *or* Pt] ✓

Algebra to J = kg m^2 s^{-2} shown (e.g. kg $(m\ s^{-1})^2$ or kg m s^{-2} m) ✓ **3**

(ii) Energy released

146 shown or used ✓

Δm calculation [1.9415, ecf] ✓

Multiply by 930 [allow $E = mc^2$ with mass in kg] ✓

1800 MeV [no ue] ✓ **4**

(b) Nuclear forces

Strong (nuclear) ✓

Electromagnetic (not electrostatic) ✓

Nucleons or neutrons and protons for strong AND protons for elcetromagnetic ✓

Within nucleus, infinite/beyond nucleus [allow inverse square law] ✓ **4**

(c)(i) N-Z plot

α - top right [above and to right of N=100 intersect with plot] ✓

β^- - above plots AND β^+ - below plots ✓

Both β regions near [< 5 mm] stability line [ecf if β swapped] ✓ **3**

(ii) Central region

Quality of written communication ✓

Region of stability / nuclei do not decay in stable region ✓

Nuclei decay to / move to this region ✓ **3**

(d)(i)	Decay numbers		
	${}^{1}_{1}$ p and ${}^{1}_{0}$n	✓	
	${}^{0}_{1}\beta^{+}$ and ${}^{0}_{0}\nu$	✓	**2**
(ii)	Tick the boxes		
	Proton: baryon and hadron only	✓	
	neutron: baryon and hadron only	✓	
	β^{+}: lepton and antimatter only	✓	
	ν: lepton only	✓	
	[only penalise once for including meson] [if both baryon correct but no hadrons 1 mark out of 2 and vice versa]		**4**
(e)(i)	Conservation laws		
	B: 1 = 1 + 0	✓	
	Q: 1 = 1 + 0	✓	**2**
	Diagram		
(ii)	First u and W^{-}	✓	
	d and $\bar{u}$	✓	**2**
(iii)	proton / H^{+} / hydrogen nucleus / Δ^{+} [mark is dependent on seeing uud on X in diagram]	✓	**1**
	W^{-} particle		
(iv)	Exchange particle	✓	**1**
(v)	Change in quark flavour / strangeness not conserved	✓	
	Charge conservation requires negative particle	✓	**2**
(vi)	Σ^{+} decay		
	3. due to charge conservation	✓	**1**
		TOTAL	**32**

Topic D - Medical Physics

(a) Base units of intensity

(i) $W = J\ s^{-1}$ / $N\ m\ s^{-1}$ or $P = E / t$ or $P = F v$ ✓

$J = kg\ m^2\ s^{-2}$ or $kg\ m\ s^{-2}\ m$ ✓

Algebra to $kg\ s^{-3}$ shown (e.g. $kg\ m^2\ s^{-2}\ s^{-1}\ m^{-2}$) ✓ **3**

Inverse square law

(ii) (Use of) Id^2 = constant ✓

Substitution correct ✓

1.1 m (1.07 m) ✓ **3**

OR

calculate P [11.5] ✓

2nd substitution correct ✓

1.1 m (1.07 m) ✓

(b) Electron energy and speed

(i) Use of $W = QV$ and 1.60×10^{-19} C ✓

1.04×10^{-14} [no ue] ✓ **2**

(ii) Use of $\frac{1}{2}mv^2$ ✓

Correct substitution with 9.11×10^{-31} kg ✓

$1.51 \times 10^8\ m\ s^{-1}$ [or 1.48 or 1.5] ✓ **3**

(iii) Electron energy

Heat / Internal energy ✓

X-rays ✓ **2**

(iv) Target features

Rotates / Made of tungsten /
Copper heat sink / oil-cooled ✓✓ **2**

(c) Ultrasound image

(i)	B-scan	✓	**1**
(ii)	Quality of written communication	✓	
	Any four from: • (B =) brightness • Transducer and gel/oil/coupling medium • Pulse goes in and comes out • (Transducer) rocked / array • Image: brighter areas (white areas) = (more) reflections	✓✓✓✓	**5**
(d)(i)	Radioactive tracer terms		
	(Average) time for activity to half / half the radioactive atoms to disintegrate/decay	✓	
	Time for biological processes / excretion to remove half of the tracer from body [*not* organ]	✓	
	Time for activity to half due to (combination of) other two half lives / within patient [organ acceptable] OR equation and definition in words	✓	**3**
(ii)	Biological half life calculation		
	$1/t_e = 1/t_r + 1/t_b$ [seen or implied]	✓	
	Correct substitution	✓	
	22 (21.8) days (2×10^6 s)	✓	**3**
(iii)	Decay curves		
	Two curves - start together on *y*-axis, do not cut *x*-axis [≥ 50 days needed]	✓	
	Decay curve P below decay curve L	✓	
	Half-lives of ~ 16 and 60 days attempted (not 22 days)	✓	**3**
(iv)	Radiation type for tracer		
	(γ) to penetrate skin / be detected outside body / by gamma camera	✓	
	to minimise dose / damage / least ionisation to patient / cells / tissue	✓	**2**
		TOTAL	**32**