edexcel
advancing learning, changing lives

Mark Scheme January 2009

GCE

GCE Physics (8540/9540)

International Supplement

If you have any subject specific questions about the content of this Mark Scheme that require the help of a subject specialist, you may find our Ask The Expert email service helpful.

Ask The Expert can be accessed online at the following link:

http://www.edexcel.com/Aboutus/contact-us/

Alternately, you can speak directly to a subject specialist at Edexcel on our dedicated Science telephone line: 0844 576 0037

(If you are calling from outside the UK please dial + 44 1204 770 696 and state that you would like to speak to the Science subject specialist.)

January 2009

Contents

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 / Wes opposite direction to horizontal. May show direction by arrow. Do not acce 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 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 k
omitted and then answer fudged, do not give 3rd mark] **3**
[Bald answer scores 0, reverse calculation 2/3]

Example of answer:

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

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

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

$= 49.4 \text{ N}$

5. Quality of Written Communication

5.1 Indicated by QoWC in mark scheme, 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.

6735 Unit Test PHY5

Question Number	Answer	Mark
1 (a)	**Either**: $F = GMm/r^2$ (or equivalent form of equation) **(1)** With all symbols (except G) defined **(1)** **Or:** Force is directly proportional to the <u>product</u> of the masses. And inversely proportional to the square of their distance apart.	**(2)**
(b) (i)	Correct attempted use of above equation with given masses and distances (ignore powers of 10) **(1)** Correct answer 0.59 (N) **(1)** Example of answer: $F = \frac{GMm}{r^2}$ $= \frac{6.67 \times 10^{-11}\ \text{N m}^2\ \text{kg}^{-2} \times 1.0 \times 10^{10}\ \text{kg} \times 2.0 \times 10^4\ \text{kg}}{(150\ \text{m})^2}$ $= 0.59(3)$ N	**(2)**
(ii)	$F = ma \rightarrow a = F/m$ [Correct <u>use</u> of equation, with 'm' being the mass of the <u>asteroid</u>, and F the force value from part (i).] **(1)** [<u>OR</u> use of 'g' = GM/r^2, *with* 'M' being the mass of the <u>tractor</u>.] Correct answer 5.9 x 10^{-11} m s^{-2} [or 6.0 x 10^{-11} m s^{-2}] **(1)** Example of answer: $a = \frac{F}{m} = \frac{0593\ \text{N}}{1.0 \times 10^{10}\ \text{kg}} = 5.9 \times 10^{-11}\ \text{m s}^{-2}$	**(2)**
	(iii) 2.0×10^4 kg / the same / unchanged. **(1)** [Allow bald statement or calculation that demonstrates this, ecf their first acceleration value.]	**(1)**
	Total	**7**

Question Number	Answer	Mark
2 (a)(i)	V m^{-1} and N C^{-1}. Substitution of J C^{-1} for V **or** Nm C^{-1} for V **or** kg m s^{-2} for N **(1)** [Answers must be in terms of unit equivalences, not quantities] Completion of valid substitution and manipulation to demonstrate equivalence. **(1)** Example of answer: V m^{-1} = J C^{-1} m^{-1} = N m C^{-1} m^{-1} = N C^{-1}	**(2)**
(ii)	Vertical line drawn mid-way between plates, <u>labelled</u> 3V **(1)** Vertical line drawn just left of three-quarter distance, <u>labelled</u> 4V **(1)** [Gauge by eye, ignore 'edge effects' at plate edges]	**(2)**
(b) (i)	E = V/d and $F = Eq$. **(1)** [Correct statement of <u>both</u> equations, or re-arrangements, or combination] E = 1.5 (V cm^{-1}) or 150 (V m^{-1}) (no u.e.) **(1)** [Correct use of first equation to get numerical field value] Correct answer 2.4×10^{-17} N **(1)** [Correct use of second equation to get force value (ecf their E)] [Correct final answer gets 3/3] Example of answer: $F = \frac{V \times q}{d} = \frac{6.0\text{ V} \times 1.6 \times 10^{-19}\text{ C}}{4.0 \times 10^{-2}\text{ m}} = 2.4 \times 10^{-17}\text{ N}$	**(3)**
(ii)	Correct answer 5.0 x 10^{10} (s^{-1}) **(1)** [Correct numerical value] Example of answer: $n = \frac{8.0 \times 10^{-9}\text{ C s}^{-1}}{1.6 \times 10^{-19}\text{ C}} = 5.0 \times 10^{10}\text{ s}^{-1}$	**(1)**
	Total	**8**

Question Number	Answer	Mark
3(a) (i)	Correct answer 31 (J) (or 31.25 / 31.3 / 31.2) (J). **(1)** [Correct use of $E = ½CV^2$ equation to find E to 2s.f. or better] Example of answer: $E = \frac{CV^2}{2} = \frac{10\,\text{F} \times (2.5\,\text{V})^2}{2} = 31.3\,\text{J}$	**(1)**
(ii)	(ii) Use of volume = $\pi r^2 h$, with r = 0.5 and h = 2 **(1)** [i.e. ignore powers of 10] Correct answer 2.0 / 1.9 ×10^7 (J m^{-3}) **(1)** [31.3J → 2. 0 × 10^7 , 30J → 1.9 x 10^7] Example of answer: $\frac{E}{V} = \frac{31.3\ \text{J}}{\pi \times (0.5 \times 10^{-2}\ \text{m})^2 \times 2.0 \times 10^{-2}\ \text{m}} = 2.0 \times 10^7 (\text{J m}^{-3})$	**(2)**
(b) (i)	Use of $Q = CV$ and $Q = It$ **or** of R = V/I and t = RC Q = 25 (C) (no u.e.) **or** R = 12.5 (Ω) (no u.e.) **(1)** [Correct use of first equation to get charge or resistance value] Correct answer 125 s **(1)** [Correct use of second equation to get time value (ecf errors in their Q or R)] [Correct final answer gets both marks] Example of answer: $Q = CV = 10\ \text{F} \times 2.5\ \text{V} = 25\ \text{C}$ $t = \frac{Q}{I} = \frac{25\ \text{C}}{0.2\ \text{A}} = 125\ \text{s}$	**(2)**
	(ii) Why current not constant? The potential difference/voltage will fall. **(1)**	**(1)**
	Total	**6**

Question Number	Answer	Mark
4(a)	(i) Parallel, equally-spaced lines (minimum 3) between P and Q and perpendicular to them. **(1)** [ignore edge effects] with arrows on at least 2 of the lines to show direction towards Q. **(1)**	**(2)**
	(ii) Field <u>is</u> uniform (along the line / between the centres of the magnets) **(1)** but <u>may</u> not be nearer the edges / away from the central line. **OR** but the experiment does not give information about the field nearer the edges / away from the central line. **(1)**	**(2)**
(b) (i)	Field pattern shows following features: Vertical 'cross' shape (no field lines drawn meeting or crossing, minimum 2 lines from each magnet) **(1)** Arrows on field lines so directions are downwards on lines from P and upwards on lines from Q [ecf direction in a(i)] **(1)** 'Neutral point' clearly labelled approximately centrally between P and Q **(1)**	**(3)**
(ii)	Line (straight or curved) begins at positive value in range 2 to 4 units for distance = 0cm **and** ends at equal negative reading -2 to -4 units at distance = 3cm. **(1)** [Line is straight or shows reasonable rotational symmetry] Reading is 0 at distance = 1.5cm but not elsewhere. **(1)**	**(2)**
	Total	**9**

Question Number	Answer	Mark
5(a)	(a) <u>Fleming's Left</u> hand rule / (Fleming's / The) <u>motor</u> rule **(1)** (b) Arrow, labelled *F*, acting on wire S, to right. **(1)** **[accept on figure 1]** (c) Arrow upwards on wire R **(1)** (d) Arrow, labelled *B*, acting up the page. **(1)** Arrow length is (approximately) **<u>4 x</u>** $\lvert B_{R/S} \rvert$, (acting up the page). **(1)**	**(5)**
	Total	**5**

Question Number	Answer	Mark
6(a)	QoWC **(1)** And/or one mark each for any of: The input voltage (or current) is <u>alternating</u> / <u>a.c.</u> **(1)** → alternating/changing (magnetic) field/flux [<u>not</u> 'flux linkage' here] in primary/core. **(1)** → alternating/changing (magnetic) field/flux/flux linkage in secondary. **(1)** → <u>Induced e.m.f.</u> (in secondary) ['in secondary' stated or implicit] **or** emf (in secondary) according to Faraday's law of electromagnetic induction **(1)** $V_2 < V_1$ **because** $N_2 < N_1$; [link to turns values must be explicit]. **(1)**	**(Max 5)**
	Total	**5**
	Total for paper	**40**

6735 Unit Test PHY5 - Practical Test

6735/2A

6736 Unit Test PHY6

Question number	Answer	Mark
1 (a) (i)	use of $\upsilon = s/t$ in the form $t = s/\upsilon$ **(1)**	
	⇨ $t = 1.2 \times 10^{-4}$ s / 0.12 ms **(1)**	
(ii)	fraction of rev /$\Delta\theta$ = 400 rev $s^{-1} \times 0.12 \times 10^{-3}$ s **(1)**	
	⇨ angle is 0.048 of 360^0 / 0.048 of 2π [e.c.f.] **(1)** (yielding 17^0/0.30 rad)	
(iii)	spread of atoms / dots along horizontal line **(1)**	
	fast at right <u>and</u> slow at left **(1)** [give 1 on plate for fast/slow]	**(6)**
(b) (i)	use of $\rho = p / gh$ (ignore powers of ten) **(1)**	
	⇨ ρ = 13 000 / 13 300 kg m^{-3} **(1)**	
(ii)	Pa as N m^{-2} **(1)**	
	p in kg m^{-3} <u>and</u> h in m <u>and</u> g in N kg^{-1} / m s^{-2} **(1)**	**(4)**
(c) (i)	(half way) between slits C_1 and C_2 / at peak of parabolic path **(1)**	
(ii)	removes an / loses electron / electrons (from the atom) **(1)**	**(2)**
(d) (i)	use of $s = ½gt^2$ **(1)**	
	⇨ t = 4.7(4) ms **(1)**	
(ii)	use of pico as 10^{-12} **(1)**	
	use of 1.6×10^{-19} (C per singly ionised atom) **(1)**	
	⇨ number of ions per unit time as $1.1(25) \times 10^9$ s^{-1} **(1)**	**(5)**
(e) (i)	$<c>$ as a number between 380 and 440 (no u.e.) **(1)**	
	choose $p = ⅓\rho<c^2>$ **(1)**	
	⇨ $p/\rho \approx <c>^2$ (from above) ÷ 3 [e.c.f] **(1)**	
	with unit m^2 s^{-2} **(1)**	**(4)**
(ii)	stated attempt to find area under graph **(1)**	
	method apparently successful **(1)**	
	30 000 to 36 000 **(1)**	**(3)**

(iii)	peak to right of existing peak **(1)** peak lower than existing peak **(1)** quality mark – areas ≈ equal **(1)**	
(iv)	same area means same N **(1)**	**(4)**
(f) (i)	any λ between 700 nm and 500 μm (n.b. 500 micrometre) **(1)**	
(ii)	select $\Delta\lambda/\lambda = v/c$ **(1)** correct substitution to calculate v/c (yields 2.8×10^{-6}) **(1)** ⇨ percentage shift $\Delta\lambda/\lambda = 2.8 \times 10^{-4}$ (%) **(1)**	**(4)**
	Total	**32**

Question number	Answer	Mark
2 (a) (i)	mathematical models: spring : $F = kx$ / $x = F \div k$ / x is proportional to F **(1)** capacitor : $V = Q \div C$ / $Q = CV$ / Q is proportional to V **(1)** [Neither F, x and k nor V, Q and C need be explicitly defined] [Pairings must be correct to gain the second mark] the way in which energy is stored: energy stored in spring as $\frac{1}{2}Fx$ / $\frac{1}{2}kx^2$ / $\frac{1}{2}F^2 \div k$ / as elastic potential energy / mechanical potential energy / strain energy **(1)** energy stored in capacitor as $\frac{1}{2}VQ$ / $\frac{1}{2}Q^2 \div C$ / $\frac{1}{2}CV^2$ / as electric energy / in the electric field **(1)** [Pairings must be correct to gain the second mark] [Accept shaded graph of F against x / V against Q] series and parallel arrangements: *either*: springs in parallel analogous to capacitors in series / capacitors in parallel analogous to springs in series *or*: either on a diagram **(2)** [for one or two correct formula give 1/2]	**(6)**
(ii)	capacitors have a maximum (working) voltage / leak at high voltage / have insulation that conducts at a high voltage **(1)**	**(1)**
(b) (i) **(ii)**	A: metal / conducting (dome) **(1)** B: (insulating) rubber / plastic (belt) **(1)** C: insulating support / plastic / Perspex / column **(1)** the motor / mechanism / person (driving the belt) **(1)** (not 5 kV power supply)	**(4)**
(iii)	use of $Q = It$ **(1)** use of $C = Q/V$ **(1)** ⇨ $C = 9.6 \times 10^{-12}$ F / 9.6 (pF) **(1)** assume no loss of charge **(1)**	**(4)**
	Total	**15**

Question number	Answer	Mark
3 (a) (i)	measure l from centre of bob **(1)** to where cord is clearly / rigidly gripped [e.g. by bits of wood] **(1)** use small amplitude / angle *or* distance **(1)** with a fiducial mark / view swings as cord passes centre **(1)** measure t for 10 or more oscillations **(1)** repeat and average (calculate T, no mark) **(1)** vary l and find new T **(1)** plot l against T^2 / calculate $g = 4\pi^2 l/T^2$ **(1)** find gradient / average g for more than 2 calculated values of l **(1)**	**max (7)**
(ii)	the Earth is spinning / mention of v^2/r centripetal acceleration **(1)** speed varies with latitude / a requires F **(1)**	**(2)**
(b)	awareness of $g = Gm/r^2$ **(1)** correct substitution in $2Gm_E h/r_E^3$ (yielding $2gh/r_E$) **(1)** ⇨ $\Delta g = 8.0 / 7.97 \times 10^{-4}$ m s^{-2} / N kg^{-1} (u.e.) **(1)**	**(3)**
(c)(i)	$\Delta l/l = (18 \times 10^{-6}$ K^{-1} / 1.8×10^{-5} K^{-1})(temperature rise) **(1)** ⇨ $\Delta l = 0.43$ mm **(1)** (no × l gives 0.36 mm e.o.p.)	**(2)**
(ii)	*either*: $\Delta l \div l = 0.43 \times 10^{-3}$ m ÷ 1.2 m [e.c.f.] **(1)** yielding 3.6×10^{-4} / 3.6×10^{-2} % / 0.036 % **(1)** *or*: $T = 2\pi\sqrt{(l/g)}$ with $l = 1.200$ / 1.2 m <u>and</u> $l = 1.200\ 43$ m (e.c.f.) **(1)** yielding two values for T [2.1975 s and 2.1979 s] **(1)** *both*: comment effect not noticeable (no mark)	**(2)**
	Total	**16**

Question number	Answer	Mark
4(a)	an e.m.f. / p.d. / voltage is produced / induced (at T_1 and T_2) **(1)** mention of (magnetic) flux / Φ **(1)** through / in / linking / coil changes *or* field (lines) cut **(1)**	**(3)**
(b) (i)	qowc **(1)** step-up (transformer) means voltage / p.d. / e.m.f. out / in secondary is greater than voltage / p.d. / e.m.f. in / in primary **(1)** high-ratio refers to the turns ratio N_{out} / N_S being greater than N_{in} / N_P **(1)** with numbers in the ratio V_S/V_P *or* $N_S/N_P \geq 100$ as an example **(1)**	**(4)**
(ii)	(any peak-to-peak in cm) times (50 mV cm^{-1}/ 0.05 V cm^{-1}) **(1)** ⇨ amplitude = 50 / 55 mV **(1)** use of > one cycle to determine time period **(1)** (any time period in cm) times (2.0 ms cm^{-1} / 0.002 s cm^{-1}) **(1)** use of frequency = 1/time period **(1)** ⇨ frequency = 300 / 320 Hz (no mark)	**(5)**
(iii)	(superposition means) adding the (vector) displacements **(1)** at a point **(1)** [do not credit simple sketches of pulses adding] demonstration: using spring / ripple tank / speakers / microwaves / light **(1)** description: of what is done (may be a labelled diagram) **(1)** statement: of what is observed (e.g. maxima & minima) **(1)**	**(5)**
	Total	**17**

Further copies of this publication are available from
Edexcel UK Regional Offices at www.edexcel.org.uk/sfc/feschools/regional/
or International Regional Offices at www.edexcel-international.org/sfc/academic/regional/

For more information on Edexcel qualifications, please visit www.edexcel-international.org/quals
Alternatively, you can contact Customer Services at www.edexcel.org.uk/ask or on + 44 1204 770 696

Edexcel Limited. Registered in England and Wales no.4496750
Registered Office: One90 High Holborn, London, WC1V 7BH