OK
18.3.2002

National Qualifications 2001

Physics

Advanced Higher

Marking Instructions

Scottish Qualifications Authority

Detailed Marking Instructions – Advance Higher Physics 2001

1. General Marking Instructions

SQA published *Physics General Marking Instructions* in July 1999. Please refer to this publication when interpreting the detailed marking instructions that follow.

2. Recording of marks

The following additional advice was given to markers regarding the recording of marks on candidate scripts. This advice may be useful in helping you interpret the exemplar candidate scripts that accompany these marking instructions.

(a) The total mark awarded for each question should be recorded in the outer margin. The inner margin should be used to record the mark for each part of a question as indicated in the detailed marking instructions.

(b) The fine divisions of marks shown in the detailed marking scheme may be recorded within the body of the script beside the candidate's response. Where such marks are shown they must total to the mark in the inner margin.

(c) Numbers recorded on candidate scripts should always be the marks being awarded. Negative marks or marks to be subtracted should not be recorded on scripts.

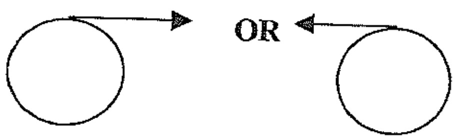
(d) The number out of which a mark is scored should **never** be recorded as a **denominator**. (½ mark will always mean one half mark and never 1 out of 2)

(e) Where square ruled paper is enclosed inside answer books it should be clearly indicated that this item has been considered by the marker. The mark awarded should be transferred to the script booklet inner margin and marked **G**.

(f) The mark awarded for each question should be transferred to the grid on the back of the script. When the marker has completed marking the candidate's response to all questions, the marks for individual questions are added to give the total script mark.

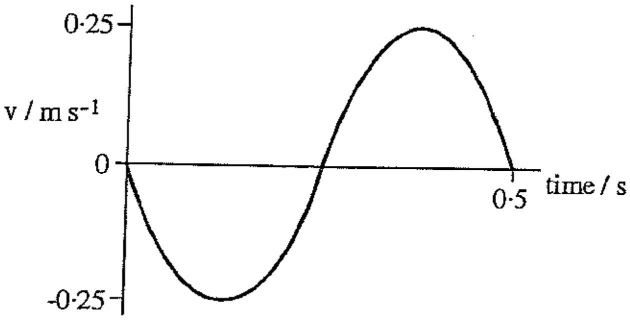
(g) The total mark awarded for an individual question may include an odd half mark - ½. If there is an odd half mark in the total script mark, this is rounded up to the next whole number when transferred to the box on the front of the script.

2001 AH Physics

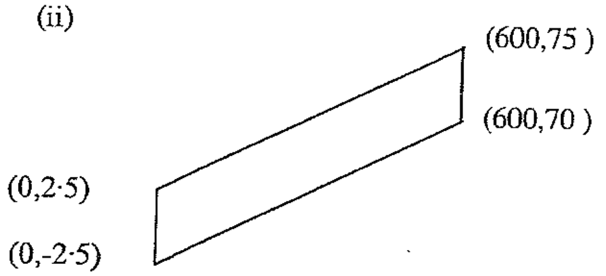
Sample answer and mark allocation	Notes	Margin	
1 a) (i) $s = ut + ½at^2$ (½) $100 = 0 + (0{\cdot}5 \, x \, a \, x \, 8{\cdot}0^2)$ (½) $a = 3{\cdot}1 \text{ m s}^{-2}$ (1)	$3{\cdot}125 \text{ m s}^{-2}$ acceptable	2	11
a) (ii) % uncertainty in $t = (\frac{0.4}{8}) \, x \, 100 = 5\%$ (½) % uncertainty in $t^2 = 2 \, x \, 5\% = 10\ \%$ (½) % uncertainty in $s = (\frac{1}{100}) \, x \, 100 = 1\%$ (½) % uncertainty in $a = 10\%$ (½)	**OR** % uncertainty in s negligible (½) if missing 1½ max **OR** $\sqrt{(1^2 + 10^2)} = 10\%$ (½)	2	
b) $a = \alpha r$ (½) $\alpha = \frac{a}{r}$ $= \frac{3.1}{0.30}$ (½) $= 10 \text{ rad s}^{-2}$ **(1)**	10·333 (-½) sig fig error accept $10{\cdot}33 \text{ rad s}^{-2}$ accept $10{\cdot}4 \text{ rad s}^{-2}$ if $3{\cdot}13 \text{ m s}^{-2}$ used	2	
c) (i) centripetal **OR** central **OR** $\frac{mv^2}{r}$ **(1)** not big enough (to maintain circular motion) **(1)** no half marks: 2, 1 or 0	force **(1)** qualitative comparison **(1)**	2	
c) (ii) $\frac{mv^2}{r} = F$ (½) $v^2 = \frac{Fr}{m}$ $= \frac{3x0.30}{4x10^{-3}}$ (½) $v = 15 \text{ m s}^{-1}$ **(1)**	m = 4·0 (g) in calculation, treat as ARITH error forget to take square root, max **(1)**	2	
c) (iii) tangential to tyre surface **(1)** **OR**  **OR**	accept horizontal **(1)**	1	

2001 AH Physics Sample answer and mark allocation	Notes	Margin	
2 (a) (i) $\theta = \omega_o t + \frac{1}{2}\alpha t^2$ (½) $16\pi = 0 + (0{\cdot}5 \times \alpha \times 6{\cdot}0^2)$ (½) $\alpha = 2{\cdot}8$ rad s^{-2} (1)	$\omega = \frac{2\pi}{T} = \frac{16\pi}{6}$ (0) then $\alpha = \frac{\omega - \omega_o}{t}$ (½) no sig fig penalty	2	12
a) (ii) $\omega_1 = \omega_o + \alpha t$ (½) $= 0 + (2{\cdot}8 \times 6{\cdot}0)$ (½) $= 17$ rad s^{-1} (1)	16·8 rad s^{-1} acceptable	2	
b) (i) Torque $= F d$ $= 3{\cdot}0 \times 0{\cdot}02$ $= 0{\cdot}06$ N m (½) unbalanced torque $= 0{\cdot}06 - 0{\cdot}01$ $= 0{\cdot}05$ N m $T = I\alpha$ (½) $I = \frac{T}{\alpha}$ $= \frac{0.05}{2.8}$ $= 0{\cdot}018$ kg m^2 (1)	use 0·01 N m alone (½ for equation) use 0·06 N m (1 max) take care carrying through incorrect values: eg use 0·06 $\Rightarrow I = 0{\cdot}021$ kg m^2 (1) max	2	
b) (ii) (A) $T = I\alpha$ (½) $\alpha = \frac{T}{I}$ $= \frac{0.01}{0.017}$ (½) $= 0{\cdot}56$ rad s^{-2} (1)	↓ $\alpha = 0{\cdot}48$ rad s^{-2} (2) **OR** $-0{\cdot}56$ rad s^{-2}	2	
b) (ii) (B) $\alpha = \frac{\omega_1 - \omega_o}{t}$ (½) $t = \frac{\omega_1 - \omega_o}{\alpha}$ $= \frac{0 - 17}{-0.56}$ (½) $= 30$ s (1)	↓ $t = 35$ s (2)	2	
c) Shorter t only (0) Shorter t + wrong physics (0) Shorter t + correct but irrelevant physics (1) Shorter t + torque greater **OR** θ less (2)		2	

2001 AH Physics Sample answer and mark allocation	Notes	Margin	
3. a) (i) $g = \frac{GM_p}{R_p^{\ 2}}$ **OR** $mg = \frac{GmM_p}{R_p^{\ 2}}$ (½) $= \frac{6.67 x 10^{-11} x 2.18 x 10^{20}}{(261 x 10^3)^2}$ (½) $= 0{\cdot}213\ N\ kg^{-1}$ **(1)**	use diameter, $g = 0{\cdot}053\ N\ kg^{-1}$ (1½) accept $m\ s^{-2}$	2	8
a) (ii) $\omega^2 = \frac{GM_p}{R^3}$ **OR** $m\omega^2 R = \frac{GmM_p}{R^2}$ (½) $= \frac{6{\cdot}67 x 10^{-11} (\text{½ data}) x\ 2{\cdot}18 x 10^{20}}{(271 x 10^3)^3 (\text{½ data})}$ $(\omega = 8{\cdot}5 x 10^{-4}\ rad\ s^{-1})$ $T = \frac{2\pi}{\omega}$ (½) $= \frac{2x3.14}{8.5x10^{-4}}$ $= 7350\ s$ **(1)**	$T = 2\pi\sqrt{\frac{R^3}{GM_p}}$ (1) wrong formula, max **(1)** for data $261 + 10 = 271$ (½) if $R = 261$, $\omega = 9{\cdot}0 x 10^{-4}$ $T = 6944\ s$ (1½) max 122 minutes	3	
b) (i) $10m_o = \frac{m_o}{\sqrt{1-\frac{v^2}{c^2}}}$ (½) $1-\frac{v^2}{c^2} = 0.1^2$ $v^2 = 0{\cdot}99\ x\ (3{\cdot}0 \times 10^8)^2$ (½ data) $v = 2{\cdot}98\ x\ 10^8\ m\ s^{-1}$ **(1)**	$c = 3 \times 10^8\ m\ s^{-1}$ **(½ data)** $2{\cdot}985 \times 10^8\ m\ s^{-1}$ acceptable	2	
b) (ii) if $v > c$ this gives $\sqrt{negative\ number}$ **(1)**	**OR** as $v \to c \Rightarrow m \to \infty$ **(1)** **OR** $v = c \Rightarrow m = \infty$ **(1)**	1	

2001 AH Physics Sample answer and mark allocation	Notes	Margin	
4 a) (i) $\omega = \frac{2\pi}{T}$ (½) $= \frac{2\pi}{0.5}$ (= 12·56) (½) $\omega^2 = (12{\cdot}56)^2$ $= 158$ (½) acceleration = $-\omega^2 y$ (½)	$T = 0{\cdot}5$ (½)	2	7
(a) (ii) $v_{max} = \omega r$ $= 12{\cdot}56 \times 0{\cdot}02$ $= 0{\cdot}25$ m s^{-1} **(1)**  axes (½) correct shape, including start from zero **(1)** period (= 0·5 s = 500 ms) (½)	0·25 m s^{-1} or 250 mm s^{-1} **(1)** inverted **(2)** max (lose **1** for shape)	3	
b) a (**OR** F) $\propto -x$ **(1)** object has constant speed **(1)**	constant speed **(1)**	2	

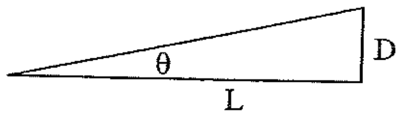
2001 AH Physics Sample answer and mark allocation	Notes	Margin	
5 a) (i) (A) at X, $E = 0$ (1)		1	10
a) (i) (B) at Y, $E = \frac{Q}{4\pi\varepsilon_o r^2} + \frac{Q}{4\pi\varepsilon_o r^2}$ (½) + (½) $= \frac{9x10^9 x3x10^{-9}}{0.10^2} + \frac{9x10^9 x3x10^{-9}}{0.30^2}$ (½) $= 3000$ N C^{-1} (1) to the right (½)	$E = E_1 + E_2$ **(½ for sum)** $E = \frac{Q}{4\pi\varepsilon_o r^2}$ **(½ for formula)** value of ε_o **(½ data)** value + unit (1) direction (½)	3	
a) (ii) (Electrostatic potential at a point is) the work done per unit charge (1) moving charge from infinity to the point	no half marks: 1 or 0 accept from point to ∞	1	
a) (iii) At X, $V_X = \frac{Q}{4\pi\varepsilon_o r} + \frac{Q}{4\pi\varepsilon_o r}$ (½) + (½) $V_X = \frac{9.0x10^9 x3x10^{-9}}{0.10} + \frac{9.0x10^9 x3x10^{-9}}{0.10}$ $= 540$ V (½) At Y, $V_Y = \frac{Q}{4\pi\varepsilon_o r} + \frac{Q}{4\pi\varepsilon_o r}$ $= \frac{9.0x10^9 x3x10^{-9}}{0.30} + \frac{9.0x10^9 x3x10^{-9}}{0.10}$ $= 360$ V (½) $V_{XY} = (540 - 360)$ $= 180$ V (1)	sum for V_X **OR** V_Y (½) $V = \frac{Q}{4\pi\varepsilon_o r}$ (½) $V_X = 540$ V (½) $V_Y = 360$ V (½) $V_{XY} = 180$ V (1)	3	
b) $-4{\cdot}5 \times 10^{-19}$ C is suspect (1) since this is equal to 2·8 electron charges (1)	**OR** not a whole number of electron charges (1)	2	

2001 AH Physics Sample answer and mark allocation	Notes	Margin	
6 a) X is positive (+) Y is negative (-) (1)	no half marks: 1 or 0	1	9
b) (i) points (0,0) and (670,81) gradient $= \frac{81-0}{670-0}$ (1) $= 0{\cdot}12$ (mg mA^{-1}) (1)	**OR** similar **OR** (½) for each point 0·125 **(0)** - selected points cannot be on line	2	
(ii)  max gradient $= \frac{75-(-2.5)}{600-0}$ (½) $= 0{\cdot}13$ (½) min gradient $= \frac{70-2.5}{600-0}$ (½) $= 0{\cdot}11$ (½) absolute uncertainty $= \frac{\max-\min}{2\sqrt{n-2}}$ (½) $= 0{\cdot}005$ (mg mA^{-1}) (½)	accept (0,3·0) (0,-3·0) or (0,2·0) (0,-2·0)	3	
c) $F = BIL$ (½) $B = \frac{F}{IL}$ $= \frac{(0.12x10^{-3})x(10^{-3})x9.8}{10^{-3}x0.06}$ (½) + (½) + (½) $= 0{\cdot}020$ T (1)	use point on line, max **(3)** use point from table max **(2)** (½) substitution (½) x 2 for unit conversions Forget 9·8 (1½) max $B = \frac{F}{IL} = \frac{12}{100x0.06} = 2$ T (1)	3	

2001 AH Physics Sample answer and mark allocation	Notes	Margin	
7 a) (perpendicularly) into page **(1)**	no half marks: 1 or 0	1	13
b) $E = \frac{V}{d}$ (½) $= \frac{2000}{4 x 10^{-2}}$ $= 5 \times 10^4$ (V m^{-1}) (½) $F_B = F_E$ $Bqv = Eq$ (½) $v = \frac{E}{B}$ (½) $(= \frac{5 x 10^4}{B})$	$v = \frac{E}{B}$ **(1)**	2	
c) (i) there is a centripetal force on the ion **(1)**	**OR** F perpendicular to velocity **(1)**	1	
c) (ii) $\frac{mv^2}{r} = Bqv$ (½) + (½) + **(1)** $(R = \frac{mv}{Bq})$	(½) + (½) for each side **(1)** for equating	2	
c) (iii) $v = \frac{5 x 10^4}{B}$ $= \frac{5 x 10^4}{0.5}$ $= 10^5$ m s^{-1} **(1)** $R = \frac{mv}{Bq}$ $= \frac{3.65 x 10^{-26} x 10^5}{0.50 x 1.6 x 10^{-19}}$ (½) $= 0{\cdot}046$ m (½) $SX = 0{\cdot}046 \times 2$ $= 0{\cdot}092$ m **(1)**		3	
d) (i) B **and** E are unchanged. **(1)** $v = \frac{E}{B}$ **(1)**	no half marks: 2, 1 or 0	2	
d) (ii) mass less only **(0)** mass less + wrong physics **(0)** mass less + correct but irrelevant physics **(1)** mass less + correct explanation **(2)**		2	

2001 AH Physics Sample answer and mark allocation	Notes	Margin	
8 a) Back e.m.f. (1) Opposition to increasing current (1) **OR** Explanation of back e.m.f. production		2	10
b) (i) $V_{(s)} = IR$ (½) $= 0{\cdot}4 \times 25$ (½) $= 10$ V (1)		2	
b) (ii) $V = (-)\ L\frac{dI}{dt}$ (½) $\frac{dI}{dt} = \frac{V}{L}$ $= \frac{10}{2}$ (½) $= 5$ A s^{-1} (1)		2	
b) (iii) $E_{max} = ½ L I^2$ (½) $= 0{\cdot}5 \times 2{\cdot}0 \times 0{\cdot}4^2$ (½) $= 0{\cdot}16$ J (1)	minus sign present treat as ARITH error (-½)	2	
c) current decreases quickly **OR** magnetic field decreases quickly **OR** $\frac{dI}{dt}$ is large (1) **large** e.m.f. generated (causing spark) (1)		2	

2001 AH Physics Sample answer and mark allocation		Notes	Margin	
9 a) (i) (A) $2\pi f = 62{\cdot}8$ $f = \frac{62.8}{2x3.14}$ $= 10$ Hz	(½) (½) (1)	$\omega = 62{\cdot}8$ (½)	2	9
a) (i) (B) $\frac{2\pi}{\lambda} = 1{\cdot}25$ $\lambda = \frac{2x3.14}{1.25}$ $= 5{\cdot}02$ m	(½) (½) (1)	accept 5 m, 5·0 m	2	
a) (ii) (A) the amplitude	(1)	accept 3·5	1	
a) (ii) (B) *intensity* $\propto$ (*amplitude*)^2 new amplitude = $\sqrt{2}\,x$ previous amplitude $= \sqrt{2}\,x\,3{\cdot}5$ $= 4{\cdot}95$ m new equation: $y = 4{\cdot}95 \sin(62{\cdot}8t - 1{\cdot}25x)$	(½) (½) (1)	use $3{\cdot}5^2 = 12{\cdot}25$ max **(1)** accept 5 for 4·95	2	
b) $f = f_s \frac{v}{v - v_s}$ $= 1020x\frac{340}{(340-22)}$ $= 1100$ Hz	(½) (½) (1)	accept 1091 Hz **OR** 1090 Hz 1090·6 Hz (-½) sig fig	2	

2001 AH Physics Sample answer and mark allocation	Notes	Margin	
10 a) division of amplitude **(1)**		1	6
b)  $\left(\Delta x = \frac{\lambda}{2\tan\theta}\right)$ $\tan\theta = \frac{D}{L}$ (½) $D = \frac{\lambda L}{2\Delta x}$ (½) $= \frac{589 x 10^{-9} x 75.0 x 10^{-3}}{2 x 0.08 x 10^{-3}}$ (½) $= 2{\cdot}80 \, x \, 10^{-4}$ m (½)	**OR** $\tan\theta = \frac{\lambda}{2\Delta x}$ (½) $= 3{\cdot}68 \, x \, 10^{-3}$ (½) $D = L\tan\theta$ (½) $= 2{\cdot}80 \, x \, 10^{-4}$ m (½)	2	
c) (i) fringes become closer together **(1)**		1	
c) (ii) fringe separation $\Delta x \propto \lambda$ **(1)** $\lambda_{water} < \lambda_{air}$ **(1)** **OR** optical path difference increases (by a factor of n) **OR** (consecutive) maxima and minima happen sooner	can use $\Delta x = \frac{\lambda L}{2nD}$ in explanation	2	

2001 AH Physics Sample answer and mark allocation	Notes	Margin	
11 a) electric field (½) vibrates in all directions in unpolarised light vibrates in one direction only in polarised light } (½)	 unpolarised (½)  polarised must mention electric field to attain **(1)**	1	5
b) $n = \dfrac{\sin i_p}{\sin r}$ (½) $i_p + r = 90°$ (½) $\Rightarrow \quad n = \dfrac{\sin i_p}{\sin(90 - i_p)}$ (½) $= \dfrac{\sin i_p}{\cos i_p}$ (½) $= \tan i_p$ QED	logical steps must be shown $n = \dfrac{\sin i_p}{\cos i_p}$ alone **(0)**	2	
c) $n = \tan i_p$ (½) $\tan i_p = 1{\cdot}33$ $i_p = 53°$ (½) $\theta = 90 - 53$ $= 37°$ (1)	$i_p = 0{\cdot}926° \Rightarrow$ calculator in radian mode, max **(1½)** missing degree (°) unit (-½)	2	

[END OF MARKING INSTRUCTIONS]