Antonine Education

A2 Physics

Test on Fields

Examination Time – 70 minutes

Name	*Mark Scheme*

Put your name on the paper. No name, no mark

Answer all the questions on the paper.

You should show all your working.

You will have a data sheet with all the constants and formulae you need.

You are expected to use a calculator where appropriate

You are reminded of the need for good English and clear presentation.

In questions requiring description and explanation you will be assessed on your ability to use an appropriate form and style of writing, to organise relevant information clearly and coherently, and to use specialist vocabulary where appropriate. The degree of legibility of your handwriting and the level of accuracy of your spelling, punctuation and grammar will also be taken into account.

Section A

1. Jun 2009 PA04A Q10

   C

2. Jan 2009 PA04A Q8

A

3. Jan 2009 PA04A Q9

   C

4. Jan 2009 PA04A Q10

   C

5. Jan 2009 PA04A Q11

   A

6. Jan 2009 PA04A Q12

   C

7. Jun 2005 PA04A Q10

   C

8. Jun 2005 PA04A q11

   A

9. Jun 2005 PA04AQ12

   B

10. Jun 2005 PA05A Q7

    C

Total for Section A = 10 marks

Section B

1. Jun 2009 PA04B Q3

Question 3			
(a)	(i)	gradient $\left(=\frac{5.9\times10^8}{6000}\right)$ = 9.83 × 10^4 (m $s^{-2/3}$) ✓ (for 9.83 allow 9.7 to 10.0)	6
	(ii)	cube root of equation is $R=\left(\frac{GM}{4\pi^2}\right)^{1/3}T^{2/3}$ (or equation predicts $R \propto T^{2/3}$) ✓ $R \propto T^{2/3}$ confirmed by graph as a straight line through (0, 0) (or a line of constant gradient through (0, 0)) ✓	
	(iii)	use of gradient of graph as $\left(\frac{GM}{4\pi^2}\right)^{1/3}$ or $\left(\frac{R}{T^{2/3}}\right)$ ✓ $\left(\frac{GM}{4\pi^2}\right)^{1/3}$ = 9.83 × 10^4 gives $\left(\frac{GM}{4\pi^2}\right)$ = 9.50 × 10^{14} ($m^3 s^{-2}$) ✓ mass of Saturn $M = \frac{9.50\times10^{14}\times4\pi^2}{6.67\times10^{-11}}$ = 5.62 × 10^{26} kg ✓	

(b)	similarity: graph would also be a straight line (through (0, 0) because $R \propto T^{2/3}$ (or $R^3 \propto T^2$) always applies to any satellite ✓ difference: gradient would be *larger* because mass of Sun > mass of Saturn ✓	2
	Total	**8**

8 marks

Turn over

2. Jun 2009 PA04B Q4

Question 4			
(a)	(i)	radial straight lines ✓ symmetrical in all directions ✓ directed inwards towards charge ✓ (marks could be taken from diagram)	4
	(ii)	line, labelled **L**, which is a circular arc (or a complete circle) centred on charge ✓	
(b)	(i)	$E\left(=\frac{Q}{4\pi\varepsilon_0 r^2}\right)=\frac{0.80\times10^{-9}}{4\pi\times8.85\times10^{-12}\times(40\times10^{-3})^2}$ ✓ = 4.50 × 10^3 (V m^{-1}) ✓	5
	(ii)	point marked at (40, 4.5) ✓ curve of decreasing gradient ✓ correct $E \propto (1/r^2)$ relationship shown by line drawn ✓	
		Total	**9**

9 marks

3. (**Jan 2005 PA04 Q3**)

Question 3

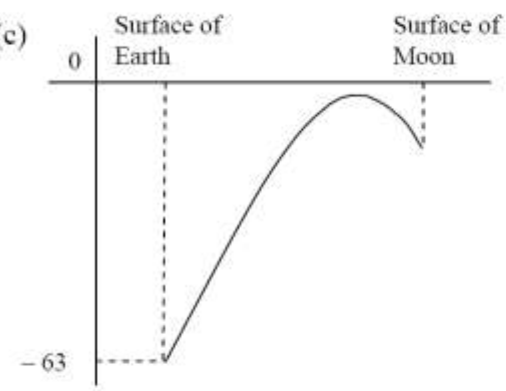
(a) work done/energy change (against the field) per unit mass ✓
when moved from infinity to the point ✓ *(2)*

(b) $V_E = -\frac{GM_E}{R_E}$ and $V_M = -\frac{GM_M}{R_M}$ ✓

$V_M = -\ G\times\frac{M_E}{81}\times\frac{3.7}{R_E} = \frac{3.7}{81}V_E$ ✓

$= 4.57\times10^{-2}\times(-63) = -2.9\ \text{MJ kg}^{-1}$ ✓ $(2.88\ \text{MJ kg}^{-1})$ *(3)*

(c)



limiting values ($-63, -V_M$) on correctly curving line ✓
rises to value close to but below zero ✓
falls to Moon ✓
from point much closer to M than E ✓

max*(3)*
(8)

8 marks

4. (**Jan 2005 PA10) Q4**

(a)(i) $\lambda = \dfrac{3.0\times10^8}{1200\times10^6}$ ✓ = (0.25 (m))

angular width $\left(=\dfrac{\lambda}{d}\right) = \dfrac{0.25}{1.8} = 0.14$ (rad) ✓

$= 8.0°$ ✓

(ii) beam width at 15 000 km = 0.14 × 15 000 (km) ✓ (= 2100 km) *(4*

(b)(i) gravitational force on satellite of mass $m = \dfrac{GMm}{(R+h)^2}$ ✓

centripetal acceleration = $\dfrac{v^2}{(R+h)}$ ✓

for a circular orbit, $\dfrac{GMm}{(R+h)^2} = \dfrac{mv^2}{(R+h)}$ ✓ (hence $v = \left(\dfrac{GM}{(R+h)}\right)^{1/2}$)

(ii) $v = \left(\dfrac{6.67\times10^{-11}\times6.0\times10^{24}}{(6.4\times10^6+15\times10^6)}\right)^{1/2}$ ✓

$= 4.3(2)\times10^3\ \text{m s}^{-1}$ ✓

time period $\left(=\dfrac{2\pi r}{v}\right) = \dfrac{2\pi\times21.4\times10^6}{4.3\times10^3}$ ✓

$= 3.1(3)\ \text{s}\times10^4$ ✓

(allow C.E. for values of v)

(iii) beam speed across surface $\left(=\dfrac{\text{Earth's circumference}}{\text{time period}}\right)$

$= \dfrac{2\pi\times6.4\times10^6}{3.1\times10^4}$ ✓ (= $1.3\times10^3\ \text{m s}^{-1}$)

contact time $\left(=\dfrac{\text{beam width}}{\text{speed}}\right) = \dfrac{2.1\times10^6}{1.3\times10^3}$ ✓ (= 1615 s = 27 min) *(9)*

(13)

5. (**Jan 2011 PHYA4 Q4**) **8 marks**

Total for Section B = 45 marks

Total = 55 marks