EXAM PAPERS PRACTICE

Boost your performance and confidence with these topic-based exam questions

Practice questions created by actual examiners and assessment experts

Detailed mark scheme

Suitable for all boards

Designed to test your ability and thoroughly prepare you

2002

XVIII

1583

Time allowed
**60 Minutes**

**Score**
/50

**Percentage**
%

# Physics

**Mark Scheme**

**AQA**
**AS & A LEVEL**

## 3.7 Fields and their consequences (A-level only)

1 (a) (i) $h$ (= $ct$) (= $3.0 \times 10^{8} \times 68 \times 10^{-3}$) = $2.0(4) \times 10^{7}$ m **(1)**

(ii) $g = (-)\frac{GM}{r^2}$ **(1)**

$r$ (= $6.4 \times 10^{6} + 2.04 \times 10^{7}$) = $2.68 \times 10^{7}$ (m) **(1)**

(allow C.E. for value of $h$ from (i) for first two marks, but not 3rd)

$$g = \frac{6.67 \times 10^{-11} \times 6.0 \times 10^{24}}{(2.68 \times 10^{7})^2}$$ **(1)** (= 0.56 N kg$^{-1}$)

**4**

(b) (i) $g = \frac{v^2}{r}$ **(1)**

$v = [0.56 \times (2.68 \times 10^7)]^{½}$ **(1)**

$= 3.9 \times 10^3$m s$^{-1}$ **(1)** ($3.87 \times 10^3$ m s$^{-1}$)

(allow C.E. for value of *r* from a**(**ii**)**

[or $v^2 = \frac{GM}{r} =$ **(1)**

$v = \left(\frac{6.67 \times 10^{-11} \times 6 \times 10^{24}}{2.68 \times 10^7}\right)^{1/2}$ **(1)**

$= 3.9 \times 10^3$ m s$^{-1}$ **(1)**]

(ii) $T\left(= \frac{2\pi r}{v}\right) = \frac{2\pi \times 2.68 \times 10^7}{3.87 \times 10^3}$ **(1)**

$= 4.3(5) \times 10^4$s **(1)** (12.**(1)** hours)

(use of $v = 3.9 \times 10^3$ gives $T = 4.3$**(1)** $\times 10^4$ s = 12.0 hours)

(allow C.E. for value of *v* from (I)

[alternative for (b):

(i) $v\left(\frac{2\pi r}{T}\right) = \frac{2\pi \times 2.68 \times 10^7}{4.36 \times 10^4}$ **(1)**

$= 3.8(6) \times 10^3$ m s$^{-1}$ **(1)**]

(allow C.E. for value of *r* from (a)(ii) and value of *T*)

(ii) $T^2 = \left(\frac{4\pi^2}{GM}\right)r^3$ **(1)**

$\left(= \frac{4\pi^2}{6.67 \times 10^{-11} \times 6.0 \times 10^{24}} \times (2.68 \times 10^7)^3\right) = (1.90 \times 10^9$ **(**s$^2$**) (1)**

$T = 4.3(6) \times 10^4$ s **(1)**

5

**[9]**

2 (a) orbits (westwards) over Equator **(1)**

maintains a fixed position relative to surface of Earth **(1)**

period is 24 hrs (1 day) or same as for Earth's rotation **(1)**

offers uninterrupted communication between transmitter and receiver **(1)**

steerable dish not necessary **(1)**

**Max 3**

(b) (i) $G\frac{Mm}{(R+h)^2} = mw^2(R+h)$ **(1)**

use of $w = \frac{2\pi}{T}$ **(1)**

(ii) gives $\frac{GM}{(R+h)^3} = \frac{4\pi^2}{T^2}$, hence result **(1)**

(iii) limiting case is orbit at zero height i.e. $h = 0$ **(1)**

$$T^2 = \left(\frac{4\pi^2 R^3}{GM}\right) = \frac{4\pi^2 \times (6.4 \times 10^6)^3}{6.67 \times 10^{-11} \times 6.0 \times 10^{24}}$$ **(1)**

$T = 5090$ s **(1)** (= 85 min)

**6**

(c) speed increases **(1)**

loses potential energy but gains kinetic energy **(1)**

[or because $v^2 \propto \frac{1}{r}$ from $\frac{GMm}{r^2} = \frac{mv^2}{r}$]

[or because satellite must travel faster to stop it falling inwards when gravitational force increases]

**2**

**[11]**

3 (a) period is 24 hours (or equal to period of Earth's rotation) **(1)**

remains in fixed position relative to surface of Earth **(1)**

equatorial orbit **(1)**

same *angular* speed as Earth (or equatorial surface) **(1)**

**max 2**

(b) (i) $\frac{GMm}{r^2} = m\omega^2 r$ **(1)**

$T = \frac{2\pi}{\omega}$ **(1)**

$r\left(=\frac{GMT^2}{4\pi^2}\right) = \left(\frac{6.7\times10^{-11}\times6.0\times10^{24}\times(24\times3600)^2}{4\pi^2}\right)^{1/3}$ **(1)**

(gives $r = 42.3 \times 10^3$ km)

(ii) $\Delta V = GM\left(\frac{1}{R}-\frac{1}{r}\right)$ **(1)**

$= 6.67 \times 10^{-11} \times 6 \times 10^{24} \times \left(\frac{1}{6.4\times10^6}-\frac{1}{4.23\times10^7}\right)$

$= 5.31 \times 10^7$ (J kg$^{-1}$) **(1)**

$\Delta E_P = m\Delta V$ (= 750 × 5.31 × $10^7$) = 3.98 ×$10^{10}$ J **(1)**

(allow ecf for value of $\Delta V$)

**6**

(c) (i) signal would be too weak at large distance **(1)**

(or large aerial needed to detect/transmit signal, or any other acceptable reason)

the signal spreads out more the further it travels **(1)**

(ii) **for** road pricing would reduce congestion

stolen vehicles can be tracked and recovered

uninsured/unlicensed vehicles can be apprehended

**against** road pricing would increase cost of motoring

possibility of state surveillance/invasion of privacy

**(1)(1)** any 2 valid points (must be for both for **or** against)

**4**

**[12]**

4

(a) force of attraction between two point masses (or particles) **(1)**

proportional to product of masses **(1)**

inversely proportional to square of distance between them **(1)**

[**alternatively**

quoting an equation, $F = \frac{GM_1M_2}{r^2}$ with all terms defined **(1)**

reference to point masses (or particles) **or** $r$ is distance between centres **(1)**

$F$ identified as an attractive force **(1)**]

**max 2**

(b) (i) mass of larger sphere $M_L$ $\left(= \frac{4}{3}\pi r^3 \rho\right) = \frac{4}{3}\pi \times (0.100)^3 \times 11.3 \times 10^3$ **(1)**
$= 47(.3)$ (kg) **(1)**

[**alternatively**

use of $M \propto r^3$ gives $\frac{M_L}{0.74} = \left(\frac{100}{25}\right)^3$ **(1)** (= 64)

and $M_L = 64 \times 0.74 = 47(.4)$ (kg) **(1)**]

**2**

(ii) gravitational force F $\left(= \frac{GM_L M_S}{x^2}\right) = \frac{6.67 \times 10^{-11} \times 47.3 \times 0.74}{0.125^2}$ **(1)**

$= 1.5 \times 10^{-7}$ (N) **(1)**

**2**

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(c) for the spheres, mass $\propto$ volume (or $\propto r^3$, or $M = \frac{4}{3}\pi r^3\rho$) **(1)**

mass of either sphere would be 8 × greater (378 kg, 5.91 kg) **(1)**

this would make the force 64 × greater **(1)**

but separation would be doubled causing force to be 4 × smaller **(1)**

net effect would be to make the force (64/4) = 16 × greater **(1)**
(ie $2.38 \times 10^{-6}$ N)

**max 4**

**[10]**

5 (a) work done/energy change (against the field) per unit mass **(1)**
when moved from infinity to the point **(1)**

**2**

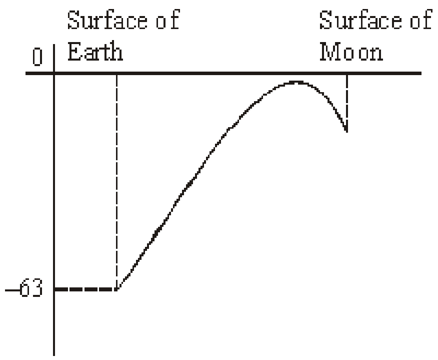
(b) $V_E = -\frac{GM_E}{R_E}$ and $V_M = -\frac{GM_M}{R_M}$ **(1)**

$V_M = -G \times \frac{M_E}{81} \times \frac{3.7}{R_E} = \frac{3.7}{81} V_E$ **(1)**

$= 4.57 \times 10^{-2} \times (-63) = -2.9$ MJ kg$^{-1}$ **(1)** (2.88 MJ kg$^{-1}$)

**3**

(c)




limiting values ($-63, -V_M$) on correctly curving line **(1)**
rises to value close to but below zero **(1)**
falls to Moon **(1)**
from point much closer to M than E **(1)**

**max 3**

**[8]**