

**CAMBRIDGE INTERNATIONAL EXAMINATIONS**

Cambridge International Advanced Subsidiary and Advanced Level

**MARK SCHEME for the May/June 2015 series**

**9702 PHYSICS**

**9702/41**

Paper 4 (A2 Structured Questions), maximum raw mark 100

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### Section A

- 1 (a) (gravitational) force proportional to product of masses and inversely proportional to square of separation  
reference to *either* point masses *or* particles *or* 'size' much less than separation
- M1  
A1 [2]
- (b) gravitational force provides/is the centripetal force  
 $GM_N m / r^2 = m r \omega^2$  (or  $m v^2 / r$ )  
 $2\pi / T$  (or  $v = 2\pi r / T$ ) leading to  $GM_N = 4\pi^2 r^3 / T^2$
- B1  
M1  
A1 [3]
- (c)  $M_N / M_U = (3.55 / 5.83)^3 \times (13.5 / 5.9)^2$   
 $x^3$  factor correct  
 $T^2$  factor correct  
ratio = 1.18 (allow 1.2)
- C1  
C1  
A1
- alternative method:* mass of Neptune =  $1.019 \times 10^{26}$  kg  
mass of Uranus =  $8.621 \times 10^{25}$  kg  
ratio = 1.18
- (C1)  
(C1)  
(A1) [3]
- 2 (a) (sum of) potential energy and kinetic energy of molecules/atoms/particles  
mention of random motion/distribution
- M1  
A1 [2]
- (b) (i)  $pV = nRT$   
*either* at A,  $1.2 \times 10^5 \times 4.0 \times 10^{-3} = n \times 8.31 \times 290$   
*or* at B,  $3.6 \times 10^5 \times 4.0 \times 10^{-3} = n \times 8.31 \times 870$   
 $n = 0.20$  mol
- C1  
A1 [2]
- (ii)  $1.2 \times 10^5 \times 7.75 \times 10^{-3} = 0.20 \times 8.31 \times T$  or  $T = (7.75 / 4.0) \times 290$   
 $T = 560$  K  
(Allow tolerance from graph:  $7.7-7.8 \times 10^{-3} \text{ m}^3$ )
- C1  
A1 [2]
- (c) temperature changes/decreases so internal energy changes/decreases  
volume changes (at constant pressure) so work is done
- B1  
B1 [2]
- 3 (a) (numerically equal to) quantity of (thermal) energy/heat to change state/phase of unit mass  
at constant temperature  
(allow 1/2 for definition restricted to fusion or vaporisation)
- M1  
A1 [2]
- (b) (i) at 70 W,  $\text{mass s}^{-1} = 0.26 \text{ g s}^{-1}$   
at 110 W,  $\text{mass s}^{-1} = 0.38 \text{ g s}^{-1}$
- A1  
A1 [2]



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- (b) (i) out of (plane of) paper/page (*not* “upwards”) B1 [1]
- (ii)  $B = mv/qr$  C1  
 $= (3.32 \times 10^{-26} \times 7.6 \times 10^4)/(1.6 \times 10^{-19} \times 6.1 \times 10^{-2})$  C1  
 $= 0.26 \text{ T}$  A1 [3]
- (c) sketch: semicircle with diameter < 12.2 cm B1 [1]
- 7 (a) can change (output) voltage efficiently *or* to suit different consumers/appliances by using transformers B1  
B1 [2]
- (b) for same power, current is smaller B1  
less heating in cables/wires  
*or* thinner cables possible  
*or* less voltage loss in cables B1 [2]
- 8 (a) (i)  $p = h/\lambda$   
 $= (6.63 \times 10^{-34})/(6.50 \times 10^{-12})$  C1  
 $= 1.02 \times 10^{-22} \text{ N s}$  A1 [2]
- (ii)  $E = hc/\lambda$  *or*  $E = pc$   
 $= (6.63 \times 10^{-34} \times 3.00 \times 10^8)/(6.50 \times 10^{-12})$  C1  
 $= 3.06 \times 10^{-14} \text{ J}$  A1 [2]
- (b) (i)  $0.34 \times 10^{-12} = (6.63 \times 10^{-34})/(9.11 \times 10^{-31} \times 3.0 \times 10^8) \times (1 - \cos \theta)$  C1  
 $\theta = 30.7^\circ$  A1 [2]
- (ii) deflected electron has energy M1  
this energy is derived from the incident photon A1  
deflected photon has less energy, longer wavelength (so  $\Delta\lambda$  always positive) B1 [3]
- 9 (a) nucleus/nuclei emits M1  
spontaneously/randomly A1  
 $\alpha$ -particles,  $\beta$ -particles,  $\gamma$ -ray photons A1 [3]
- (b) (i)  $N - \Delta N$  A1 [1]
- (ii)  $\Delta N/\Delta t$  A1 [1]
- (iii)  $\Delta N/N$  A1 [1]
- (iv)  $\Delta N/N\Delta t$  A1 [1]
- (c) graph: smooth curve in correct direction starting at (0,0) M1  
 $n$  at  $2t_{1/2}$  is 1.5 times that at  $t_{1/2}$  ( $\pm 2 \text{ mm}$ ) A1 [2]

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### Section B

- 10 (a) (i)** (potential =)  $1.2 / (1.2 + 4.2) \times 4.5 = +1.0\text{V}$  A1 [1]
- (ii)** (for  $V_{\text{IN}} > 1.0\text{V}$ )  $V^+ > V^-$  B1  
output (of op-amp) is +5V or positive M1  
diode conducts giving +5V across R or  $V_{\text{out}}$  is +5V A1
- (for  $V_{\text{IN}} < 1.0\text{V}$ ) output of op-amp  $-5\text{V}$ /negative so diode does not conduct,  
giving  $V_{\text{out}} = 0$  or  $0\text{V}$  across R A1 [4]
- (b) (i)** square wave with maximum value +5 V and minimum value 0 M1  
vertical sides in correct positions and correct phase A1 [2]
- (ii)** re-shaping (digital) signals/regenerator (amplifier) B1 [1]
- 11 (a)** change/increase/decrease anode/tube voltage B1  
electrons striking anode have changed (kinetic) energy/speed B1  
X-ray/photons/beam have different wavelength/frequency B1 [3]
- (b) (i)**  $I = I_0 e^{-\mu x}$  B1 [1]
- (ii)** contrast is difference in degree of blackening (of regions of the image) B1  
 $\mu$  (very) similar so similar absorption of radiation (for same thickness) so little contrast A1 [2]
- 12 (a) (i)** loudspeaker/doorbell/telephone etc. B1 [1]
- (ii)** television set/audio amplifier etc. B1 [1]
- (iii)** satellite/satellite dish/mobile phone etc. B1 [1]
- (b)** e.g. lower attenuation/fewer repeaters  
more secure  
less prone to noise/interference  
physically smaller/less weight  
lower cost  
greater bandwidth  
*(any two sensible suggestions, 1 each)* B2 [2]
- (c) (i)** ratio =  $25 + (62 \times 0.21)$  C1  
= 38 dB A1 [2]
- (ii)** ratio/dB =  $10 \lg(P_2/P_1)$  C1  
 $38 = 10 \lg(P/\{9.2 \times 10^{-6}\})$
- $P = 58 \text{ mW}$  or  $5.8 \times 10^{-2} \text{ W}$  A1 [2]  
*(allow 1/2 for missing 10 in equation)*

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- 13 (a) (i) to align nuclei/protons  
to cause Larmor/precessional frequency to be in r.f. region
- B1  
B1 [2]
- (ii) Larmor/precessional frequency depends on (applied magnetic) field strength  
knowing field strength enables (region of precessing) nuclei to be located  
by knowing the frequency
- B1  
M1  
A1 [3]
- (b)  $E = 2.82 \times 10^{-26} \times B$   
 $6.63 \times 10^{-34} \times 42 \times 10^6 = 2.82 \times 10^{-26} \times B$
- C1
- $B = 0.99 \text{ T}$
- A1 [2]