

**MARK SCHEME for the October/November 2010 question paper
for the guidance of teachers**

9702 PHYSICS

9702/21

Paper 2 (AS Structured Questions), maximum raw mark 60

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- 1 (a) length, current, temperature, amount of substance, (luminous intensity)
any three, 1 each B3 [3]
- (b) (i) F : kg m s^{-2} B1
 ρ : kg m^{-3} B1
 v : m s^{-1} B1 [3]
- (ii) some working e.g. $\text{kg m s}^{-2} = \text{m}^2 \text{kg m}^{-3} (\text{m s}^{-1})^k$ M1
hence $k = 2$ A1 [2]
- 2 (a) (i) horizontal speed constant at 8.2 m s^{-1} C1
vertical component of speed = $8.2 \tan 60^\circ$ M1
= 14.2 m s^{-1} A0 [2]
- (ii) $14.2^2 = 2 \times 9.8 \times h$ (using $g = 10$ then -1) C1
vertical distance = 10.3 m A1 [2]
- (iii) time of descent = $14.2 / 9.8 = 1.45 \text{ s}$ C1
 $x = 1.45 \times 8.2$
= 11.9 m A1 [2]
- (b) (i) smooth path curved and above given path M1
hits ground at more acute angle A1 [2]
- (ii) smooth path curved and below given path M1
hits ground at steeper angle A1 [2]
- 3 (a) force = rate of change of momentum (allow symbols if defined) B1 [1]
- (b) (i) $\Delta p = 140 \times 10^{-3} \times (5.5 + 4.0)$ C1
= 1.33 kg m s^{-1} A1 [2]
- (ii) force = $1.33 / 0.04$ M1
= 33.3 N A0 [1]
- (c) (i) taking moments about B C1
 $(33 \times 75) + (0.45 \times g \times 25) = F_A \times 20$ C1
 $F_A = 129 \text{ N}$ A1 [3]
- (ii) $F_B = 33 + 129 + 0.45g$ C1
= 166 N A1 [2]

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- 4 (a) (i) F/A B1 [1]
- (ii) $\Delta L/L$ B1 [1]
- (iii) allow $FL/A\Delta L$ B1 [1]
- (iv) allow $\rho L/A$ or $\rho(L + \Delta L)/A$ B1 [1]
- (b) (i) $\Delta L = FL/EA$
 $= (30 \times 2.6) / (7.0 \times 10^{10} \times 3.8 \times 10^{-7})$
 $= 2.93 \times 10^{-3} \text{ m} = 2.93 \text{ mm}$ M1
A0 [1]
- (ii) $\Delta R = \rho \Delta L / A$ C1
 $= (2.6 \times 10^{-8} \times 2.93 \times 10^{-3}) / (3.8 \times 10^{-7})$
 $= 2.0 \times 10^{-4} \Omega$ A1 [2]
- (c) change in resistance is (very) small
so method is not appropriate M1
A1 [2]
- 5 (a) when a wave passes through a slit / by an edge
the wave spreads out / changes direction M1
A1 [2]
- (b) diagram: wavelength unchanged M1
wavefront flat at centre, curving into geometrical shadow A1 [2]
- (c) $d \sin \theta = n\lambda$ C1
for $\theta = 90^\circ$
 $1 / (650 \times 10^3) = n \times 590 \times 10^{-9}$ M1
 $n = 2.6$
number of orders is 2 A1 [3]
- (d) intensity / brightness decreases (as order increases) B1 [1]
- 6 (a) (i) either $P = V^2/R$ or $P = VI$ and $V = IR$ C1
 $R = 4.0 \Omega$ A1 [2]
- (ii) sketch vertical axis labelled appropriately B1
(straight) line from origin then curved in correct direction B1
line passes through 12 V, 3.0 A B1 [3]
- (b) (i) 2.0 kW A1 [1]
- (ii) 0.5 kW A1 [1]
- (iii) total resistance = $3R/2$ C1
power = 0.67 kW A1 [2]

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- 7 (a) *either* different forms of same element
or nuclei have same number of protons
different numbers of neutrons (in the nucleus) M1
A1 [2]
- (b) (i) proton number conserved B1
nucleon number conserved B1
mass-energy conserved B1 [3]
- (ii) 1. $Z = 36$ A1 [1]
2. $x = 3$ A1 [1]

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- 1 (a) (i) scalar quantity has magnitude (allow size) B1
vector quantity has magnitude and direction B1 [2]
- (ii) 1. temperature: scalar B1 [1]
2. acceleration: vector B1 [1]
3. resistance: scalar B1 [1]
- (b) *either* triangle / parallelogram with correct shape C1
tension = 14.3 N (allow ± 0.5 N) A2 [3]
- (if $> \pm 0.5$ N but $\leq \pm 1$ N, allow 1 mark)
- or $R = 25 \cos 35^\circ$ (C1)
 $T = R \tan 35^\circ$ (C1)
 $T = 14.3$ N (A1)
- or $T = 25 \sin 35^\circ$ (C2)
 $T = 14.3$ N (A1)
- or R and T resolved vertically and horizontally (C2)
leading to $T = 14.3$ N (A1)
- 2 (a) (i) $V_H = 12.4 \cos 36^\circ (= 10.0 \text{ m s}^{-1})$ C1
distance = 10.0×0.17
 $= 1.7$ m A1 [2]
- (ii) $V_V = 12.4 \sin 36^\circ (= 7.29 \text{ m s}^{-1})$ C1
 $h = 7.29 \times 0.17 - \frac{1}{2} \times 9.81 \times 0.17^2$ C1
 $= 1.1$ m A1 [3]
- (b) smooth curve with ball hitting wall below original B1
smooth curve showing rebound to ground with correct reflection at wall B1 [2]
- 3 (a) point at which (whole) weight (of body) (allow mass for weight) M1
appears / seems to act ... (for mass need 'appears to be concentrated') A1 [2]
- (b) (i) point C shown at centre of rectangle ± 5 mm B1 [1]
- (ii) arrow vertically downwards, from C with arrow starting from the same margin of error as in (b)(i) B1 [1]
- (c) (i) reaction / upwards / supporting / normal reaction force M1
friction M1
force(s) at the rod A1 [3]
- (ii) comes to rest with (line of action of) weight acting through rod B1
allow C vertically below the rod B1
so that weight does not have a moment about the pivot / rod [2]

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- 4 (a) energy = average force $\times$ extension
 $= \frac{1}{2} \times F \times x$
(Hooke's law) extension proportional to (applied) force
hence $F = kx$
so $E = \frac{1}{2}kx^2$ B1
B1
B1
B1
A0 [4]
- (b) (i) correct area shaded B1 [1]
- (ii) 1.0 cm² represents 1.0 mJ or correct units used in calculation C1
 $E_s = 6.4 \pm 0.2 \text{ mJ}$ A2 [3]
(for answer $> \pm 0.2 \text{ mJ}$ but $\leq \pm 0.4 \text{ mJ}$, then allow 2/3 marks)
- (iii) arrangement of atoms / molecules is changed B1 [1]
- 5 (a) (i) distance (of point on wave) from rest / equilibrium position B1 [1]
- (ii) distance moved by wave energy / wavefront during one cycle of the source
or minimum distance between two points with the same phase or between adjacent crests or troughs B1 [1]
- (b) (i) $T = 0.60 \text{ s}$ B1 [1]
- (ii) $\lambda = 4.0 \text{ cm}$ B1 [1]
- (iii) either $v = \lambda/T$ or $v = f\lambda$ and $f = 1/T$ C1
 $v = 6.7 \text{ cm s}^{-1}$ A1 [2]
- (c) (i) amplitude is decreasing
so, it is losing power M1
A1 [2]
- (ii) intensity $\sim (\text{amplitude})^2$ C1
ratio = $2.0^2 / 1.1^2$ C1
= 3.3 A1 [3]
- 6 (a) (i) at 22.5 °C, $R_T = 1600 \Omega$ or 1.6 k Ω C1
total resistance = 800 Ω A1 [2]
- (ii) either use of potential divider formula or current = 9 / 2000 (4.5 mA) C1
 $V = (0.8/2.0) \times 9$ $V = (9/2000) \times 800$
= 3.6 V = 3.6 V A1 [2]
- (b) (i) total resistance = $4/5 \times 1200$ C1
= 960 Ω A1 [2]
- (ii) for parallel combination, $1/960 = 1/1600 + 1/R_T$ C1
 $R_T = 2400 \Omega$ / 2.4 k Ω A1 [2]
temperature = 11 °C

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- (c) e.g. only small part of scale used / small sensitivity
non-linear
(any two sensible suggestions, 1 each, max 2)
- B1
B1 [2]

- 7 (a) (i) most α -particles were deviated through small angles
(allow 1 mark for 'straight through' / undeviated)
- B2 [2]

- (ii) small fraction of α -particles deviated through large angles
greater than 90° (allow rebound back)
- M1
A1 [2]

- (b) e.g. β -particles have a range of energies
 β -particles deviated by (orbital) electrons
 β -particle has (very) small mass
(any two sensible suggestions, 1 each, max 2)
- B2 [2]

Do not allow β -particles have negative charge or β -particles have high speed

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- 1 (a) allow 0.05 mm $\rightarrow$ 0.15 mm B1 [1]
- (b) allow 0.25 s $\rightarrow$ 0.5 s B1 [1]
- (c) allow 8 N $\rightarrow$ 12 N B1 [1]
- ignore number of significant figures
- 2 crystalline: atoms / ions / particles in a regular arrangement / lattice long range order / orderly pattern B1
(lattice) repeats itself (1)
- polymer: long chain molecules / chains of monomers B1
some cross-linking between chains / tangled chains (1)
- amorphous: disordered arrangement of molecules / atoms / particles B1
any ordering is short-range (1)
- (three 'B' marks plus any other 2 marks) B2 [5]
- 3 connect microphone / (terminals of) loudspeaker to Y-plates of c.r.o. B1
adjust c.r.o. to produce steady wave of 1 (or 2) cycles / wavelengths on screen B1
measure length of cycle / wavelength λ and note time-base b M1
frequency = $1 / \lambda b$ A1 [4]
(assume b is measured as $s\ cm^{-1}$, unless otherwise stated)
- (if statement is 'measure T , $f = 1/T$ ' then last two marks are lost)
- 4 (a) acceptable straight line drawn (touching every point) B1 [1]
- (b) the distance fallen is not d C1
 d is the distance fallen plus the diameter of the ball A1 [2]
- ('d is not measured to the bottom of the ball' scores 2/2)
- (c) (i) diameter: allow $1.5 \pm 0.5\ cm$ (accept one SF) A1 [1]
no ecf from (a)
- (ii) gradient = $4.76, \pm 0.1$ with evidence that origin has not been used C1
gradient = $g / 2$ C1
 $g = 9.5\ m\ s^{-2}$ A1 [3]

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- 5 (a) (i) Fig. 5.2 B1 [1]
- (ii) Fig. 5.3 B1 [1]
- (b) kinetic energy increases from zero then decreases to zero B1 [1]
- (c) (i) $\Delta E_p = mg\Delta h / mgh$
 $= 94 \times 10^{-3} \times 9.8 \times 2.6 \times 10^{-2}$ using $g = 10$ then -1
 $= 0.024 \text{ J}$ C1
A1 [2]
- (ii) either $0.024 = \frac{1}{2} k \times (2.6 \times 10^{-2})^2$ or $\frac{1}{2} kd^2 = \frac{1}{2} k \times (2.6 \times 10^{-2})^2 - \frac{1}{2} kd^2$ C1
 $0.012 = \frac{1}{2} k \times d^2$ $kd^2 = \frac{1}{2} k \times (2.6 \times 10^{-2})^2$ C1
 $d = 0.018 \text{ m}$ $d = 0.018 \text{ m}$
 $= 1.8 \text{ cm}$ $= 1.8 \text{ cm}$ A1 [3]
- 6 (a) when two (or more) waves meet (at a point) B1
(resultant) displacement is (vector) sum of individual displacements B1 [2]
- (b) (i) $\lambda = ax / D$ (if no formula given and substitution is incorrect then 0/3) C1
 $590 \times 10^{-9} = (1.4 \times 10^{-3} \times x) / 2.6$ C1
 $x = 1.1 \text{ mm}$ A1 [3]
- (ii) 1. 180° (allow π if rad stated) A1 [1]
2. at maximum, amplitude is 3.4 units and at minimum, 0.6 units C1
intensity $\sim$ amplitude² allow $I \sim a^2$ C1
ratio $= 3.4^2 / 0.6^2$
 $= 32$ A1 [3]
- 7 (a) (i) path: reasonable curve upwards between plates B1
straight and at a tangent to the curve beyond the plates B1 [2]
- (ii) 1. $(F =) E.g$ B1 [1]
2. $(t =) L / v$ B1 [1]
- (b) (i) total momentum of a system remains constant **or** total momentum of a system before a collision equals total momentum after collision M1
provided no external force acts on the system A1 [2]
(do not accept 'conserved' but otherwise correct statement gets 1/2)
- (ii) $(\Delta p =) EqL / v$ allow ecf from (a)(ii) B1 [1]
- (iii) either charged particle is not an isolated system M1
so law does not apply A1 [2]
or system is particle and 'plates' (M1)
equal and opposite Δp on plates / so law applies (A1)

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- 8 (a) (i) either $P = V^2 / R$ or $I = 1200 / 230$ or 5.22
 $R = (230 \times 230) / 1200$ or $R = 230 / 5.22$
 $= 44.1 \Omega$ $= 44.1 \Omega$ C1
M1
A0 [2]
- (ii) $R = \rho L / A$ C1
 $= (1.7 \times 10^{-8} \times 9.2 \times 2) / (\pi \times \{0.45 \times 10^{-3}\}^2)$ M1
 $= 0.492 \Omega$ A0 [2]
- (b) current = 230 / 44.6 C1
power = $(230 / 44.6)^2 \times 44.1$ C1
= 1170 W A1 [3]
(allow full credit for solution based on potential divider)
- (c) e.g. less power dissipated in the heater / smaller p.d. across heater /
more power loss in cable / current lower B1
cable becomes heated / melts B1 [2]
(any two sensible suggestions, 1 each, max 2)
- 9 (a) nucleus emits α -particles or β -particles and/or γ -radiation B1
to form a different / more stable nucleus B1 [2]
- (b) (i) fluctuations in count rate (not 'count rate is not constant') B1 [1]
- (ii) no effect B1 [1]
- (iii) if the source is an α -emitter B1
either α -particles stopped within source (and gain electrons)
or α -particles are helium nuclei B1 [2]
- allow 1/2 for 'parent nucleus gives off radiation to form daughter nucleus'