

MARK SCHEME for the May/June 2012 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) (i) V units: m^3 (allow metres cubed or cubic metres) A1 [1]
- (ii) Pressure units: $\text{kg ms}^{-2} / \text{m}^2$ (allow use of $P = \rho gh$) M1
Units: $\text{kg m}^{-1} \text{s}^{-2}$ A0 [1]
- (b) V / t units: $\text{m}^3 \text{s}^{-1}$ B1
Clear substitution of units for P , r^4 and l M1
- $$C = \frac{\pi P r^4}{8 V t^{-1} l} = \frac{\text{kg m}^{-1} \text{s}^{-2} \text{m}^4}{\text{m}^3 \text{s}^{-1} \text{m}}$$
- Units: $\text{kg m}^{-1} \text{s}^{-1}$ A1 [3]
(8 or π in final answer –1. Use of dimensions max 2/3)
- 2 (a) (i) $v = u + at$ C1
 $= 4.23 + 9.81 \times 1.51$ M1
 $= 19.0(4) \text{ ms}^{-1}$ (Allow 2 s.f.) A0 [2]
(Use of $-g$ max 1/2. Use of $g = 10$ max 1/2. Allow use of 9.8. Allow 19 m s^{-1})
- (ii) either $s = ut + \frac{1}{2} at^2$ (or $v^2 = u^2 + 2as$ etc.) C1
 $= 4.23 \times 1.51 + 0.5 \times 9.81 \times (1.51)^2$ A1 [2]
 $= 17.6 \text{ m}$ (or 17.5 m)
(Use of $-g$ here wrong physics (0/2))
- (b) (i) $F = \Delta P / \Delta t$ need idea of change in momentum C1
 $= [0.0465 \times (18.6 + 19)] / 12.5 \times 10^{-3}$ C1
 $= 140 \text{ N}$ A1
(Use of $-$ sign max 2/4. Ignore $-ve$ sign in answer)
Direction: upwards B1 [4]
- (ii) $h = \frac{1}{2} \times (18.6)^2 / 9.81$ C1
 $= 17.6 \text{ m}$ (2 s.f. –1) A1 [2]
(Use of 19 m s^{-1} , 0/2 wrong physics)
- (c) either kinetic energy of the ball is not conserved on impact
or speed before impact is not equal to speed after hence inelastic B1 [1]
- 3 (a) Resultant force (and resultant torque) is zero B1
Weight (down) = force from/due to spring (up) B1 [2]
- (b) (i) 0.2, 0.6, 1.0 s (one of these) A1 [1]
- (ii) 0, 0.8 s (one of these) A1 [1]
- (iii) 0.2, 0.6, 1.0 s (one of these) A1 [1]

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(c)	(i) Hooke's law: extension is proportional to the force (<i>not mass</i>) Linear/straight line graph hence obeys Hooke's law	B1 B1	[2]
	(ii) Use of the gradient (<i>not just</i> $F = kx$) $K = (0.4 \times 9.8) / 15 \times 10^{-2}$ $= 26(.1) \text{ N m}^{-1}$	C1 M1 A0	[2]
	(iii) <i>either</i> energy = area to left of line <i>or</i> energy = $\frac{1}{2} ke^2$ $= \frac{1}{2} \times [(0.4 \times 9.8) / 15 \times 10^{-2}] \times (15 \times 10^{-2})^2$ $= 0.294 \text{ J}$ (<i>allow 2 s.f.</i>)	C1 C1 A1	[3]
4	(a) (i) $R = V^2 / P$ <i>or</i> $P = IV$ and $V = IR$ $= (220)^2 / 2500$ $= 19.4 \Omega$ (<i>allow 2 s.f.</i>)	C1 A1	[2]
	(ii) $R = \rho l / A$ $l = [19.4 \times 2.0 \times 10^{-7}] / 1.1 \times 10^{-6}$ $= 3.53 \text{ m}$ (<i>allow 2 s.f.</i>)	C1 C1 A1	[3]
	(b) (i) $P = 625, 620$ or 630 W	A1	[1]
	(ii) R needs to be reduced <i>Either</i> length $\frac{1}{4}$ of original length <i>or</i> area $4\times$ greater <i>or</i> diameter $2\times$ greater	C1 A1	[2]
5	(a) (i) sum of e.m.f.'s = sum of p.d.'s around a loop/circuit	B1	[1]
	(ii) energy	B1	[1]
	(b) (i) $2.0 = I \times (4.0 + 2.5 + 0.5)$ $I = 0.286 \text{ A}$ (<i>allow 2 s.f.</i>) (<i>If total resistance is not 7Ω, 0/2 marks</i>)	C1 A1	[2]
	(ii) $R = [0.90 / 1.0] \times 4 (= 3.6)$ $V = IR = 0.286 \times 3.6 = 1.03 \text{ V}$ (<i>If factor of 0.9 not used, then 0/2 marks</i>)	C1 A1	[2]
	(iii) $E = 1.03 \text{ V}$	A1	[1]
	(iv) <i>either</i> no current through cell B <i>or</i> p.d. across r is zero	B1	[1]
6	(a) (i) coherence: constant phase difference between (two) waves	M1 A1	[2]
	(ii) path difference is <i>either</i> λ <i>or</i> $n\lambda$ <i>or</i> phase difference is 360° <i>or</i> $n \times 360^\circ$ <i>or</i> $n2\pi$ rad	B1	[1]

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	(iii) path difference is <i>either</i> $\lambda/2$ or $(n + \frac{1}{2}) \lambda$ or phase difference is odd multiple of <i>either</i> 180° or π rad	B1	[1]
	(iv) $w = \lambda D / a$ $= [630 \times 10^{-9} \times 1.5] / 0.45 \times 10^{-3}$ $= 2.1 \times 10^{-3} \text{ m}$	C1 C1 A1	[3]
	(b) no change to <u>dark</u> fringes no change to separation/fringe width <u>bright</u> fringes are brighter/lighter/more intense	B1 B1 B1	[3]
7	(a) (i) 2 protons and 2 neutrons	B1	[1]
	(ii) e.g. positively charged $2e$ mass $4u$ constant energy absorbed by thin paper or few cm of air ($3 \text{ cm} \rightarrow 8 \text{ cm}$) (<i>not low penetration</i>) <u>highly</u> ionizing deflected in electric/magnetic fields (<i>One mark for each property, max 2</i>)	B2	[2]
	(b) <u>mass-energy</u> is conserved difference in mass 'changed' into a form of energy energy in the form of kinetic energy of the products / γ -radiation photons / e.m. radiation	B1 B1 B1	[3]

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- 1 (a) $\frac{V}{t} = \frac{\pi P r^4}{8 C l}$
 $C = [\pi \times 2.5 \times 10^3 \times (0.75 \times 10^{-3})^4] / (8 \times 1.2 \times 10^{-6} \times 0.25)$
 $= 1.04 \times 10^{-3} \text{ N s m}^{-2}$ C1
A1 [2]
- (b) $4 \times \%r$ C1
 $\%C = \%P + 4 \times \%r + \%V/t + \%l$
 $= 2\% + 5.3\% + 0.83\% + 0.4\% (= 8.6\%)$ A1
 $\Delta C = \pm 0.089 \times 10^{-3} \text{ N s m}^{-2}$ A1 [3]
- (c) $C = (1.04 \pm 0.09) \times 10^{-3} \text{ N s m}^{-2}$ A1 [1]
- 2 (a) (i) $v^2 = u^2 + 2as$
 $= (8.4)^2 + 2 \times 9.81 \times 5$ C1
 $= 12.99 \text{ m s}^{-1}$ (allow 13 to 2 s.f. but not 12.9) A1 [2]
- (ii) $t = (v - u) / a$ or $s = ut + \frac{1}{2}at^2$
 $= (12.99 - 8.4) / 9.81$ or $5 = 8.4t + \frac{1}{2} \times 9.81t^2$ M1
 $t = 0.468 \text{ s}$ A0 [1]
- (b) reasonable shape M1
suitable scale A1
correctly plotted 1st and last points at (0,8.4) and (0.88 – 0.96,0)
with non-vertical line at 0.47 s A1 [3]
- (c) (i) 1. kinetic energy at end is zero so $\Delta KE = \frac{1}{2}mv^2$ or $\Delta KE = \frac{1}{2}mu^2 - \frac{1}{2}mv^2$ C1
 $= \frac{1}{2} \times 0.05 \times (8.4)^2$
 $= (-) 1.8 \text{ J}$ A1 [2]
2. final maximum height $= (4.2)^2 / (2 \times 9.8) = (0.9 \text{ (m)})$
change in PE $= mgh_2 - mgh_1$ C1
 $= 0.05 \times 9.8 \times (0.9 - 5)$ C1
 $= (-) 2.0 \text{ J}$ A1 [3]
- (ii) change is – 3.8 (J) B1
energy lost to ground (on impact) / energy of deformation of the ball /
thermal energy in ball B1 [2]
- 3 (a) A body continues at rest or constant velocity unless acted on by a resultant (external) force B1 [1]
- (b) (i) constant velocity/zero acceleration and therefore no resultant force M1
no resultant force (and no resultant torque) hence in equilibrium A1 [2]
- (ii) component of weight $= 450 \times 9.81 \times \sin 12^\circ (= 917.8)$ C1
tension $= 650 + 450 g \sin 12^\circ = (650 + 917.8)$ C1
 $= 1600 \text{ (1570) N}$ A1 [3]

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	(iii) work done against frictional force or friction between log and slope output power greater than the gain in PE / s	M1 A1	[2]
4	(a) total resistance = 20 (k Ω) current = 12 / 20 (mA) or potential divider formula p.d. = [12 / 20] $\times$ 12 = 7.2 V	C1 C1 A1	[3]
	(b) parallel resistance = 3 (k Ω) total resistance 8 + 3 = 11 (k Ω) current = 12 / 11 $\times$ 10 ³ = 1.09 $\times$ 10 ⁻³ or 1.1 $\times$ 10 ⁻³ A	C1 C1 A1	[3]
	(c) (i) LDR resistance decreases total resistance (of circuit) is less hence current increases	M1 A1	[2]
	(ii) resistance across XY is less less proportion of 12 V across XY hence p.d. is less	M1 A1	[2]
5	(a) $E = \text{stress} / \text{strain}$	B1	[1]
	(b) (i) 1. diameter / cross sectional area / radius 2. original length	B1	[1]
	(ii) measure original length with a <u>metre</u> ruler / tape measure the <u>diameter</u> with micrometer (screw gauge) <i>allow digital vernier calipers</i>	B1 B1	[2]
	(iii) energy = $\frac{1}{2} Fe$ or area under graph or $\frac{1}{2} kx^2$ $= \frac{1}{2} \times 0.25 \times 10^{-3} \times 3 = 3.8 \times 10^{-4} \text{ J}$	C1 A1	[2]
	(c) straight line through origin below original line line through (0.25, 1.5)	M1 A1	[2]
6	(a) two waves travelling (along the same line) in opposite directions overlap/meet same frequency / wavelength resultant displacement is the sum of displacements of each wave / produces nodes and antinodes	M1 A1 B1	[3]
	(b) apparatus: source of sound + detector + reflection system adjustment to apparatus to set up standing waves – how recognised measurements made to obtain wavelength	B1 B1 B1	[3]
	(c) (i) at least two nodes and two antinodes	A1	[1]
	(ii) node to node = $\lambda / 2 = 34 \text{ cm}$ (allow 33 to 35 cm) $c = f\lambda$ $f = 340 / 0.68 = 500$ (490 to 520) Hz	C1 C1 A1	[3]

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- 7 (a) $W = 1$ and $X = 0$ A1 [1]
 $Y = 2$ A1 [1]
 $Z = 55$ A1 [1]
- (b) explanation in terms of mass – energy conservation B1
energy released as gamma or photons or kinetic energy of products or
em radiation B1 [2]

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- 1 (a) displacement is a vector, distance is a scalar B1
displacement is straight line between two points / distance is sum of lengths moved / example showing difference B1 [2]
(either one of the definitions for the second mark)
- (b) a body continues at rest or at constant velocity unless acted on by a resultant (external) force B1 [1]
- (c) (i) sum of T_1 and T_2 equals frictional force B1
these two forces are in opposite directions B1 [2]
(allow for 1/2 for travelling in straight line hence no rotation / no resultant torque)
- (ii) 1. scale vector triangle with correct orientation / vector triangle with correct orientation both with arrows B1
scale given or mathematical analysis for tensions B1 [2]
2. $T_1 = 10.1 \times 10^3 (\pm 0.5 \times 10^3) \text{ N}$ A1
 $T_2 = 16.4 \times 10^3 (\pm 0.5 \times 10^3) \text{ N}$ A1 [2]
- 2 (a) weight = 452×9.81
component down the slope = $452 \times 9.81 \times \sin 14^\circ$ M1
= 1072.7 = 1070 N A0 [1]
- (b) (i) $F = ma$ C1
 $T - (1070 + 525) = 452 \times 0.13$ C1
 $T = 1650$ (1653.76) N any forces missing 1/3 A1 [3]
- (ii) 1. $s = ut + \frac{1}{2}at^2$ hence $10 = 0 + \frac{1}{2} \times 0.13t^2$ C1
 $t = [(2 \times 10) / 0.13]^{1/2} = 12.4$ or 12 s A1 [2]
2. $v = (0 + 2 \times 0.13 \times 10)^{1/2} = 1.61$ or 1.6 ms^{-1} A1 [1]
- (c) straight line from the origin B1
line down to zero velocity in short time compared to stage 1 B1
line less steep negative gradient B1
final velocity larger than final velocity in the first part – at least 2× B1 [4]
- 3 (a) $V = h \times A$ B1
 $m = V \times \rho$ B1
 $W = h \times A \times \rho \times g$ B1
 $P = F / A$ B1
 $P = h\rho g$ B1
 P is proportional to h if ρ is constant (and g) B1 [4]
- (b) density changes with height B1
hence density is not constant with link to formula B1 [2]

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- 4 (a) electric field strength is the force per unit positive charge (acting on a stationary charge) B1 [1]
- (b) (i) $E = V / d$ C1
 $= 1200 / 14 \times 10^{-3}$
 $= 8.57 \times 10^4 \text{ V m}^{-1}$ A1 [2]
- (ii) $W = QV$ or $W = F \times d$ and therefore $W = E \times Q \times d$ C1
 $= 3.2 \times 10^{-19} \times 1200$
 $= 3.84 \times 10^{-16} \text{ J}$ A1 [2]
- (iii) $\Delta U = mgh$ C1
 $= 6.6 \times 10^{-27} \times 9.8 \times 14 \times 10^{-3}$
 $= 9.06 \times 10^{-28} \text{ J}$ A1 [2]
- (iv) $\Delta K = 3.84 \times 10^{-16} - \Delta U$
 $= 3.84 \times 10^{-16} \text{ J}$ A1 [1]
- (v) $K = \frac{1}{2}mv^2$ C1
 $v = [(2 \times 3.8 \times 10^{-16}) / 6.6 \times 10^{-27}]^{1/2}$
 $= 3.4 \times 10^5 \text{ m s}^{-1}$ A1 [2]
- 5 (a) (i) sum of currents into a junction = sum of currents out of junction B1 [1]
- (ii) charge B1 [1]
- (b) (i) $\Sigma E = \Sigma IR$
 $20 - 12 = 2.0(0.6 + R)$ (not used 3 resistors 0/2) C1
 $R = 3.4 \Omega$ A1 [2]
- (ii) $P = EI$ C1
 $= 20 \times 2$
 $= 40 \text{ W}$ A1 [2]
- (iii) $P = I^2 R$ C1
 $P = (2)^2 \times (0.1 + 0.5 + 3.4)$
 $= 16 \text{ W}$ A1 [2]
- (iv) efficiency = useful power / output power C1
 $24 / 40 = 0.6$ or $12 \times 2 / 20 \times 2$ or 60% A1 [2]

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- 6 (a) (i) diffraction bending/spreading of light at edge/slit
this occurs at each slit B1 [2]
B1
- (ii) constant phase difference between each of the waves B1 [1]
- (iii) (when the waves meet) the resultant displacement is the sum of the
displacements of each wave B1 [1]
- (b) $d \sin \theta = n \lambda$
 $n = d / \lambda = 1 / 450 \times 10^3 \times 630 \times 10^{-9}$ C1
 $n = 3.52$ M1
hence number of orders = 3 A1 [3]
- (c) λ blue is less than λ red M1
more orders seen A1
each order is at a smaller angle than for the equivalent red A1 [3]
- 7 (a) thin paper reduces count rate hence α B1
addition of 1 cm of aluminium causes little more count rate reduction hence only
other radiation is γ B1 [2]
- (b) magnetic field perpendicular to direction of radiation B1
look for a count rate in expected direction / area if there were negatively
charged radiation present. If no count rate recorded then β not present. B1 [2]