
PHYSICS

9702/21

Paper 2 AS Level Structured Questions

October/November 2018

MARK SCHEME

Maximum Mark: 60

Published

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Question	Answer	Marks
1(a)(i)	distance in a specified direction (from a point)	B1
1(a)(ii)	change in velocity / time (taken)	B1
1(b)(i)	vertical component of velocity = $(5.5^2 - 4.6^2)^{1/2} = 3.0 \text{ (ms}^{-1}\text{)}$ or $5.5 \cos \theta = 4.6$ (so $\theta = 33.2^\circ$) and $5.5 \sin 33.2^\circ = 3.0 \text{ (ms}^{-1}\text{)}$	A1
1(b)(ii)	$s = ut + \frac{1}{2}at^2$ $0 = (3.0 \times t) - (\frac{1}{2} \times 9.81 \times t^2)$ or $v = u + at$ $-3.0 = 3.0 - 9.81t$	C1
	$t = 0.61 \text{ s}$	A1
1(b)(iii)	$d = 4.6 \times 0.61$ $= 2.8 \text{ m}$	A1
1(b)(iv)	$E = \frac{1}{2}mv^2$	C1
	ratio = $(\frac{1}{2} \times m \times 4.6^2) / (\frac{1}{2} \times m \times 5.5^2)$ or ratio = $(\frac{1}{2} \times m \times 5.5^2 - m \times 9.81 \times 0.459) / (\frac{1}{2} \times m \times 5.5^2)$	C1
	ratio = 0.70	A1
1(c)	straight line from positive value of v_y at $t = 0$ to negative value of v_y	M1
	straight line ends at $t = T$ and final magnitude of v_y greater than initial magnitude of v_y	A1

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Question	Answer	Marks
2(a)	$(p =) mv$ or 4.0×45 or 2.0×85 or $89v$	C1
	$(4.0 \times 45) - (2.0 \times 85) = 89v$	A1
	$v = 0.11 \text{ ms}^{-1}$	
2(b)(i)	1. speed of approach = 47 ms^{-1} and 2. speed of separation = 0	A1
2(b)(ii)	speed of separation less than/not equal to speed of approach and so inelastic collision	A1
2(c)	force is equal to rate of change of momentum	B1
	force on ball (by block) <u>equal and opposite</u> to force on block (by ball) so rates of change of momentum are <u>equal and opposite</u>	B1
	or	
	force on ball (by block) <u>equal and opposite</u> to force on block (by ball)	(B1)
	force is equal to rate of change of momentum so rates of change of momentum are <u>equal and opposite</u>	(B1)

Question	Answer	Marks
3(a)(i)	work (done)/time (taken)	B1
3(a)(ii)	energy of a mass due to its position in a gravitational field	B1
3(b)(i)	$P = Fv$	C1
	$= 2.0 \times 10^3 \times 45$	A1
	$= 9.0 \times 10^4 \text{ W}$	
3(b)(ii)	1. $W = (2.0 \times 10^3) \times (45 \times 3.0 \times 60)$ or $W = 9.0 \times 10^4 \times 3.0 \times 60$	C1
	$W = 1.6 \times 10^7 \text{ J}$	A1
	2. $(\Delta)E_P = mg(\Delta)h$	C1
	$= 1200 \times 9.81 \times 3.3 \times 3.0 \times 60$ $= 7.0 \times 10^6 \text{ J}$	A1
	3. $W = 1.6 \times 10^7 - 7.0 \times 10^6$ $= 9.0 \times 10^6 \text{ J}$	A1
3(b)(iii)	force $= (9.0 \times 10^6) / (45 \times 3.0 \times 60)$ $= 1.1 \times 10^3 \text{ N}$	A1
3(b)(iv)	constant velocity so no resultant force	B1
	no resultant force so in equilibrium	B1

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Question	Answer	Marks
4(a)	when (two or more) waves meet (at a point)	B1
	(resultant) displacement is the sum of the individual displacements	B1
4(b)(i)	constant phase difference (between the waves)	B1
4(b)(ii)	1. phase difference = 360° or 0	B1
	2. path difference = 1.5λ = 1.5×610 = 920 nm	A1
4(b)(iii)	$\lambda = ax/D$	C1
	$x = 22/4$ (= 5.5 mm) or $22 \times 10^{-3}/4$ (= 5.5×10^{-3} m)	C1
	$a = (610 \times 10^{-9} \times 2.7)/(5.5 \times 10^{-3})$ = 3.0×10^{-4} m	A1
4(b)(iv)	shorter wavelength and (so) separation decreases	B1
4(b)(v)	- no change to fringe separation/fringe width/number of fringes - bright fringes are brighter - dark fringes are unchanged <i>Any two of the above three points, 1 mark each.</i>	B2

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Question	Answer	Marks
5(a)	region (of space) where a force acts on a (stationary) charge	B1
5(b)	$E = F/Q$	B1
	$F = ma$ and (so) $a = \frac{Eq}{m}$	A1
5(c)(i)	protons = 96	A1
	neutrons = 148	A1
5(c)(ii)	mass-energy is conserved/mass change is 'seen' as energy	B1
	energy released as gamma (radiation)/KE of α /KE of Pu	B1
5(c)(iii)	ratio = $\frac{2}{4} \times \frac{240}{94}$ or ratio = $\frac{2 \times 1.60 \times 10^{-19}}{4 \times 1.66 \times 10^{-27}} \times \frac{240 \times 1.66 \times 10^{-27}}{94 \times 1.60 \times 10^{-19}}$	C1
	ratio = 1.3	A1

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Question	Answer	Marks
6(a)	<u>sum of</u> e.m.f.(s) equal to <u>sum of</u> p.d.(s)	M1
	around a loop/around a closed circuit	A1
6(b)(i)	current in variable resistor = $(6.0/2.4) + (6.0/1.2)$ (= 7.5 A)	C1
	p.d. across variable resistor = $9.0 - 6.0$ (= 3.0 V)	C1
	$R = 3.0/7.5$ $= 0.40 \Omega$	A1
	or	
	$\frac{1}{R_T} = \frac{1}{2.4} + \frac{1}{1.2}$ $R_T = 0.80 (\Omega)$	(C1)
	$\frac{3}{9} = \frac{R}{(R + 0.80)}$ or $\frac{3}{R} = \frac{6}{0.8}$	(C1)
6(b)(ii)	$P = V^2/R$ or $P = I^2R$ or $P = IV$	C1
	$P = 6.0^2/24$ or $2.5^2 \times 2.4$ or 6.0×2.5 $= 15 \text{ W}$	A1

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Question	Answer	Marks
6(b)(iii)	1. $R = \frac{\rho L}{A}$	C1
	ratio = $(2.4/1.2) \times (3/1)$ = 6.0	A1
	2. $(I = nAvq)$ $I_X/I_Y = 2.5/5.0$ or $1.2/2.4$ or 0.5	C1
	ratio = $(2.5/5.0) \times (1/3)$ or $(1.2/2.4) \times (1/3)$ = 0.17	A1

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Question	Answer	Marks
1(a)	$v_x = (6.0^2 - 4.8^2)^{1/2} = 3.6 \text{ (ms}^{-1}\text{)}$ or $6.0 \sin \theta = 4.8 \text{ (so } \theta = 53.1^\circ\text{) and } v_x = 6.0 \cos 53.1^\circ = 3.6 \text{ (ms}^{-1}\text{)}$	A1
1(b)(i)	straight line from (0, 4.8) to (0.49, 0)	M1
	straight line continues with same slope to (0.98, -4.8) (labelled Y)	A1
1(b)(ii)	a horizontal line	M1
	from (0, 3.6) to (0.98, 3.6) (labelled X)	A1
1(c)	$s = ut + \frac{1}{2}at^2$ $= (4.8 \times 0.49) + (\frac{1}{2} \times -9.81 \times 0.49^2)$ or $s = \frac{1}{2}(u + v)t$ or area under graph $= \frac{1}{2} \times (4.8 + 0) \times 0.49$ or $s = vt - \frac{1}{2}at^2$ $= \frac{1}{2} \times 9.81 \times 0.49^2$ or $v^2 = u^2 + 2as$ $s = 4.8^2 / (2 \times 9.81)$	C1
	$s = 1.2 \text{ m}$	A1

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Question	Answer	Marks
1(d)	$(\Delta)E = mg(\Delta)h$	C1
	$E = \frac{1}{2}mv^2$	C1
	ratio = $(\frac{1}{2} \times m \times 3.6^2) / (m \times 9.81 \times 1.2)$ or ratio = $[(\frac{1}{2} \times m \times 6.0^2) - (m \times 9.81 \times 1.2)] / (m \times 9.81 \times 1.2)$ or ratio = $(\frac{1}{2} \times m \times 3.6^2) / (\frac{1}{2} \times m \times 4.8^2)$	C1
	ratio = 0.56	A1
1(e)	(force due to) air resistance acts in opposite direction to the velocity or (with air resistance, average) resultant force is larger (than weight)	B1

Question	Answer	Marks
2(a)	ampere kelvin (allow mole, candela) <i>any two correct answers, 1 mark each</i>	B2
2(b)(i)	frictional (force)/friction	B1
2(b)(ii)	$W \cos 31^\circ \times 3.0$ or 90×6.0	C1
	$W \cos 31^\circ \times 3.0 = 90 \times 6.0$ $W = 210 \text{ N}$	A1
	$X = 90 \sin 31^\circ$ $= 46 \text{ N}$	A1

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Question	Answer	Marks
3(a)	<u>sum/total</u> momentum (of a system of bodies) is constant or <u>sum/total</u> momentum before = <u>sum/total</u> momentum after	M1
	for an isolated system or no (resultant) external force	A1
3(b)(i)	$m = \rho V$	C1
	$= 1.3 \times \pi \times 0.045^2 \times 1.8 \times 2.0 = 0.030 \text{ (kg)}$	A1
3(b)(ii)	1. $(\Delta)p = (\Delta)mv$	C1
	$= 0.030 \times 1.8$ $= 0.054 \text{ N s}$	A1
	2. $F = 0.054/2.0$ or $0.030 \times 1.8/2.0$ $= 0.027 \text{ N}$	A1
3(b)(iii)	force on air (by propeller) equal to force on propeller (by air)	M1
	and opposite (in direction)	A1
3(b)(iv)	resultant force = 0.20×0.075 (= 0.015 N) frictional force = $0.027 - 0.015$	C1
	$= 0.012 \text{ N}$	A1

Question	Answer	Marks
4(a)	vibration(s)/oscillation(s) (of particles) parallel to direction of propagation of energy	B1
4(b)(i)	phase difference = 180°	A1
4(b)(ii)	$v = f\lambda$	C1
	$\lambda/2 = 25 \text{ (cm) or } 0.25 \text{ (m)}$	C1
	$f = 330/0.50$ $= 660 \text{ Hz}$	A1
4(b)(iii)	(readings from graph =) 2.6 <u>and</u> 4.0	C1
	ratio = $(2.6/4.0)^{1/2}$ $= 0.81$	A1

Question	Answer	Marks
5(a)	$n\lambda = d\sin\theta$	C1
	$\lambda = 640 \times 10^{-9} \text{ (m)}$	C1
	$2 \times 640 \times 10^{-9} = 1.7 \times 10^{-6} \times \sin\theta$ so $\theta = 49^\circ$	A1
5(b)	$2 \times 640 \times 10^{-9} = 3 \times \lambda$ or $1.7 \times 10^{-6} \times \sin 49^\circ = 3 \times \lambda$	C1
	$\lambda = 4.3 \times 10^{-7} \text{ m}$	A1

Question	Answer	Marks
6(a)	joule/coulomb	B1
6(b)(i)	$7.0 = (I \times 5.2) + (I \times 6.0) + 1.4$	C1
	$I = 0.50 \text{ A}$	A1
6(b)(ii)	$R = 1.4/0.50$ $= 2.8 \Omega$	A1
6(b)(iii)	$P = EI$ or $P = VI$ or $P = I^2R$ or $P = V^2/R$	C1
	efficiency = $[(0.50^2 \times 6.0)/(7.0 \times 0.50)] (\times 100)$ or efficiency = $[(0.50 \times 3.0)/(7.0 \times 0.50)] (\times 100)$ or efficiency = $[(3.0^2/6.0)/(7.0 \times 0.50)] (\times 100)$	C1
	efficiency = 43%	A1
6(b)(iv)	$R = \rho l/A$	C1
	$\alpha = \rho/R$ $= 3.7 \times 10^{-7}/6.0$ $= 6.2 \times 10^{-8} \text{ m}$	A1

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Question	Answer	Marks
7(a)	A: (cross-sectional) area (of wire)	B1
	n : number of free electrons per unit volume or number density of free electrons	B1
7(b)	line drawn between (X, v_x) and (Y, $4v_x$)	M1
	line has increasing gradient	A1

Question	Answer	Marks
8(a)	antineutrino and positron both underlined (and no other particles)	B1
8(b)(i)	nucleon number = 27	A1
	proton number = 13	A1
8(b)(ii)	weak (nuclear force/interaction)	B1
8(b)(iii)	an (electron) antineutrino / $\bar{\nu}_{(e)}$ is produced (and this has energy)	B1
	X has kinetic energy	B1

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Question	Answer	Marks
1(a)	current temperature (allow amount of substance, luminous intensity) <i>any two correct answers, 1 mark each</i>	B2
1(b)(i)	$W = 2 \times (150 \times \sin 17^\circ)$ or $2 \times (150 \times \cos 73^\circ)$	C1
	$W = 88 \text{ N}$	A1
1(b)(ii)	1. $\sigma = F/A$	C1
	$= 150 / (7.5 \times 10^{-6})$ $= 2.0 \times 10^7 \text{ Pa}$	A1
	2. $\varepsilon = \sigma / E$	C1
	$= 2.0 \times 10^7 / (2.1 \times 10^{11})$ $= 9.5 \times 10^{-5}$	A1

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Question	Answer	Marks
2(a)	energy (of a mass/body/object) due to motion/speed/velocity	B1
2(b)(i)	$E = \frac{1}{2}mv^2$	C1
	$480 = \frac{1}{2} \times m \times 80^2$ so $m = 0.15 \text{ kg}$	A1
2(b)(ii)	1. $E = mgh$ or $\Delta E = mg\Delta h$	C1
	$= 0.15 \times 9.81 \times 210$ $= 310 \text{ J}$	A1
	2. work done = $480 - 310$ $= 170 \text{ J}$	A1
2(b)(iii)	work done = Fs	C1
	force = $170/210$ $= 0.81 \text{ N}$	A1
2(b)(iv)	curved line from positive value on v -axis to $(T, 0)$	M1
	magnitude of gradient decreases	A1
2(b)(v)	as shell rises force decreases and as shell falls force increases	B1
	as shell rises force is downward and as shell falls force is upward	B1
	or	
	as shell rises the force decreases and is downward	(B1)
	as shell falls the force increases and is upward	(B1)

Question	Answer	Marks
3(a)	(resultant) force proportional/equal to rate of change of momentum	B1
3(b)(i)	$\rho = m/V$	C1
	$V = \pi \times (7.5 \times 10^{-3})^2 \times 13 \times 0.2 (= 4.59 \times 10^{-4} \text{ m}^3)$	A1
	$m = \pi \times (7.5 \times 10^{-3})^2 \times 13 \times 0.2 \times 1000 = 0.46 \text{ kg}$	
3(b)(ii)	1. $(\Delta)p = (\Delta m)v$	C1
	$(\Delta)p = 0.46 \times 13$ $= 6.0 \text{ N s}$	A1
	2. $F = 6.0/0.20$ $= 30 \text{ N}$	A1
3(b)(iii)	force on water (by rocket/nozzle) equal to force on rocket/nozzle (by water)	M1
	in the opposite direction	A1
3(b)(iv)	1. mass = $0.40 + 0.70 - 0.46 = 0.64 \text{ kg}$	A1
	2. acceleration = $[30 - (0.64 \times 9.81)]/0.64$ or $30/0.64 - 9.81$	C1
	$= 37 \text{ m s}^{-2}$	A1

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Question	Answer	Marks
4(a)	graph with x-axis labelled 'distance' and wavelength/ λ correctly shown	B1
	graph with x-axis labelled 'time' and period/ T correctly shown	B1
	graph with y-axis labelled 'displacement' and amplitude/ A correctly shown	B1
4(b)(i)	wave (moves along string and) reflects at fixed point/Y/X/end/wall/boundary	B1
	the incident and reflected waves interfere/superpose	B1
4(b)(ii)	100/40 or 2.5 (cycles/periods/ T)	C1
	1. displacement = 0	B1
	2. distance = 130 mm	A1
4(b)(iii)	1. $f = 1/40 \times 10^{-3}$ = 25 Hz	A1
	2. $v = f\lambda$ or $\lambda = vT$	C1
	$\lambda = 30/25$ or $30 \times 40 \times 10^{-3}$ (= 1.2 m)	C1
	distance = 1.2×1.5 = 1.8 m	A1

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Question	Answer	Marks
5(a)	$E = F/Q$	M1
	$F = ma$ and (so) $q/m = a/E$	A1
5(b)	$m = (4 \times 1.60 \times 10^{-19} \times 3.5 \times 10^4) / 1.5 \times 10^{12} (= 1.49 \times 10^{-26} \text{ kg})$	B1
	$= 1.49 \times 10^{-26} / 1.66 \times 10^{-27} = 9.0 \text{ (u)}$	A1
5(c)	protons: 4 and neutrons: 5	A1
5(d)(i)	nuclei have the same charge and so same (magnitudes of) force	B1
5(d)(ii)	nuclei have different masses and same force and so different (magnitudes of) acceleration	B1

Question	Answer	Marks
6(a)	(coulomb is an) ampere second	B1
6(b)	$8.0 \times 10^{-19} \text{ C}$ and $1.6 \times 10^{-19} \text{ C}$ both underlined (and no others underlined)	B1
6(c)	line drawn between (S, $1.00v_s$) and (T, $0.25v_s$)	M1
	line with decreasing magnitude of gradient	A1

Question	Answer	Marks
7(a)	<u>sum of</u> current(s) in(to) junction = <u>sum of</u> current(s) out of junction or (algebraic) sum of current(s) at a junction is zero	B1
7(b)(i)	1. potential difference = 0	A1
	2. potential difference = 9.6 V	A1
7(b)(ii)	for resistance in parallel: $(1/R_T) = (1/400) + (1/400)$ $R_T = 200 (\Omega)$	C1
	$V/9.6 = 200/600$	C1
	$V = 3.2 \text{ V}$	A1