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PHYSICS

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Paper 4 Extended Theory

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MARK SCHEME

Maximum Mark: 80

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Question	Answer	Marks
1(a)(i)	(a scalar) does not have direction	B1
1(a)(ii)	energy and temperature	B1
1(b)	straight line and non-zero gradient	B1
1(c)	scale ≥ 1 cm: 1 m / s	B1
	two arrows/lines and correct resultant OR rectangle and correct diagonal (towards bottom left)	B1
	7.2 $\rightarrow$ 7.6 m/s	B1
	26.0° $\leq$ angle below E–W $\leq$ 30.5° OR 239.5° $\leq$ bearing $\leq$ 244°	B1
	Total:	7

Question	Answer	Marks
2(a)	Column 1 Box 3 mass same	B1
	Column 2 Box 4 weight 1/6	B1
	Column 3 Box 3 deceleration same	B1
2(b)	$P = F / A$ in any form or $(F =) PA$	C1
	$(F_1 = 500\,000 \times 0.00065 =) 330 \text{ (N)}$	C1
	$F_1 d_1 = F_2 d_2$ in any form or $F_1 d_1 / d_2$	C1
	$(F_2 = 325 \times 7/24 =) 95 \text{ N}$	A1
	Total:	7

Question	Answer	Marks
3(a)	'force and time'	B1
3(b)(i)	(momentum =) mv	C1
	(momentum = 2.4×3 =) 7.2 kg m/s OR Ns	A1
3(b)(i)	$(m_A + m_B)v = m_A \times 3$ OR momentum conserved	C1
	$(v = 7.2 / 3.6 =)$ 2.0 m/s	A1
3(b)(i)	(impulse / Ft =) $m(v - u)$	C1
	(impulse / $Ft = 1.2 \times (2-0)$ =) 2.4 kg m/s OR Ns	A1
3(b)(ii)	thermal/sound energy (produced at collision/lost)	B1
	Total:	8

Question	Answer	Marks
4(a)	impulse/change of momentum (of molecules) during collision	B1
	{force (to change momentum) <u>of molecules</u> OR <u>molecules</u> hitting walls} (causes pressure)	B1
4(b)	more (frequent) collisions <u>with walls</u>	B1
	greater (total) force (caused by molecules) OR reduced area OR grater (rate) change of momentum (of molecules)	B1
4(c)	$p_1V_1 = p_2V_2$ in any form OR (p_2 =) p_1V_1/V_2	C1
	($p_2 = 500 \times 1.1 \times 10^5 / 200$ =) 2.8×10^5 Pa	A1
	Total:	6

Question	Answer	Marks
5(a)(i)	$E = mc(\Delta)T$ in any form or $(E =) mc(\Delta)T$	C1
	$(E = 0.6 \times 4200 \times 80 =) 200\,000 \text{ (J)}$	C1
	$E = VIt$ in any form or $(t =)E / VI$	C1
	$(t = 201\,600 / (12 \times 240) =) 70 \text{ s}$	A1
5(a)(ii)	no (thermal) energy losses	B1
5(b)	put (hot) water in bottle AND place thermometers/measure temperatures each side of (centre of) bottle	M1
	put thermometers near bottle	A1
	good detail e.g. - thermometers equal distances from bottle - thermometer bulbs same height - record temperatures regularly	A1
	thermometer near black has higher reading/rises faster/larger temperature difference or reverse argument	A1
	Total:	9

Question	Answer	Marks
6(a)(i)	3.4 cm	B1
6(a)(ii)	30 cm	B1
6(b)	$v = f \lambda$ in any form or $(f =)v / \lambda$	C1
	$(f = 8.0/2.5 =) 3.2 \text{ Hz}$	A1
6(c)(i)	3 crests straight AND some spreading out	B1
	2 wavelengths same as original	B1
6(c)(ii)	(wavelength) increases/ longer AND (because wave) travels further in same/periodic time or because wave has higher speed /moves faster	B1
6(c)(i)	<u>More</u> diffraction/spreading/deflection out/more curved OR no/smaller straight part in centre	B1
	Total:	8

Question	Answer	Marks
7(a)(i)	(n =) speed in air / speed in liquid	C1
	$(n = 3 \times 10^8 / 2.0 \times 10^8) = 1.5$	A1
7(a)(ii)	$n = \sin i / \sin r$ in any form	C1
	$(r = \sin^{-1} (\sin 40 / 1.5) =) 25^\circ$	A1
7(b)	one ray from object either with refraction at surface OR vertical	M1
	another ray from object, must have refraction at surface away from normal	A1
	both rays extended back to meet <u>in the liquid</u> AND intersection labelled image/ I	B1
	Total:	7

Question	Answer	Marks
8(a)(i)	$P=VI$ in any form OR $(I =) P/V$	C1
	$(I = 9.0 / 6.0 =) 1.5 \text{ A}$	A1
8(a)(ii)	$V=IR$ in any form OR $(R =) V/I$ OR $P=V^2/R$ in any form OR $(R =) V^2/P$	C1
	$(R = 6.0 / 1.5 =) 4.0 \Omega$ or $(R = 36 / 9.0 =) 4.0 \Omega$	A1
8(b)(i)	resistance <u>of wire</u> is greater (than at X) OR current is less OR p.d. <u>across lamp</u> is less	B1
8(b)(ii)	(for normal brightness of lamp,) resistance <u>of circuit</u> $(= 12 / 1.5) = 8.0 \Omega$	C1
	resistance <u>of wire</u> $= (8.0 - 4.0 =) = 4.0 \Omega$	C1
	(distance $AX = 1.0 \times 4/5 =) 0.80 \text{ m}$ OR (sliding contact is) 0.80 m (from A)	A1
	OR V across $AX = 6.0 \text{ V}$	(C1)
	resistance <u>of wire</u> $= (6/\text{current from a(i)} =) 4.0 \Omega$	(C1)
	(distance $AX = 1.0 \times 4/5 =) 0.80 \text{ m}$ OR (sliding contact is) 0.80 m (from A)	(A1)
	Total:	8

Question	Answer	Marks
9(a)(i)	arrow left to right and horizontal, labelled (M)	B1
9(a)(ii)	if M L to R arrow downwards, labelled (F) if M R to L arrow upwards, labelled (F)	B1
9(b)	<u>force</u> reversed/opposite of 9(a)(i)	B1
9(c)(i)	one ring (roughly circular) centred on wire	M1
	(at least) three rings (roughly circular)	A1
	field lines clockwise (as drawn)	B1
9(c)(ii)	(magnetic field is) stronger or field lines closer together	B1
9(d)	(vertically) downwards	B1
	Total:	8

Question	Answer	Marks
10(a)	2→4 arrows outwards at any angle 	B1
10(b)	NOR	B1
10(c)(i)	logic circuit with 2 inputs & 1 output. Circuit contains at least 2 <u>acceptable</u> gates. No other gates used	M1
	logic circuit that produces correct output	A1
10(c)(ii)	work from input to output, any intermediate point labelled X following <u>acceptable</u> gate(s) only with truth table correct for circuit drawn	B1
	Total:	5

Question	Answer	Marks
11(a)	(some) β /beta/radiation would penetrate gloves/reach other body parts (so insufficient protection)	B1
	middle: any path to the left within 45° of horizontal	B1
	bottom: path to the right and deflected down ending in a straight line	B1
11(b)	radiation from background/rock/air/outer space/cosmic rays	B1
	random variation owtte.	B1
11(c)	thick gloves would stop α /alpha (so helpful)	B1
	(some) β /beta/radiation would penetrate gloves/reach other body parts (so insufficient protection)	B1
	Total:	7