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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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This document consists of **12** printed pages.



Question	Answer	Marks
1(a)	change of velocity per unit time OR $\frac{v-u}{t}$	B1
1(b)	line starts at origin and is asymptotic to x-axis	B1
	increasing gradient initially and no decrease	B1
	constant and clearly positive gradient finally	B1
1(c)(i)	no external forces OR isolated system	B1
	sum of momenta / (total) momentum remains constant	B1
	rocket <u>gains</u> (upward) momentum	B1
1(c)(ii)	(ejected) gas <u>gains</u> equal (quantity of) momentum in opposite direction OR momentum of gas <u>decreases</u> by equal amount	B1

Question	Answer	Marks
2(a)	$(W =) mg$ OR $3.4 \times 10^3 \times 10$	C1
	$3.4 \times 10^4 \text{ N}$	
2(b)(i)	moment = Fx in any form OR (moment) = Fx OR 0.50 (seen)	C1
	$3.4 \times 10^4 \times (1.8 - 1.3)$ OR $3.4 \times 10^4 \times 0.50$	C1
	$1.7 \times 10^4 \text{ N m}$	A1
2(b)(ii)	1. (the point) where (all) the mass can be considered to be concentrated	B1
	2. $1.7 \times 10^4 / (1.3 + 0.70)$ OR $1.7 \times 10^4 / (2.0)$	C1
	$8.5 \times 10^3 \text{ N}$	A1
2(c)	(moment / it) increases	B1
	perpendicular distance (between P and line of action of) W increases	B1

Question	Answer	Marks
3(a)	(air) molecules / they move / collide	B1
	(air) molecules / they collide with cube / (upper) surface (of cube) / wall	
	impulse exerted (on surface) OR momentum change (of molecules)	
3(b)(i)	$p = h\rho g$ in any form OR ($p =$) $h\rho g$ OR $0.028 \times 1500 \times 10$	C1
	420 Pa	A1
3(b)(ii)	$F = pA$ in any form words, symbols or numbers OR ($F =$) pA OR 420×4.0^2 OR 420×0.040^2 OR 420×16 OR $420 \times 1.6 \times 10^{-3}$	C1
	0.67 N	A1
3(c)(i)	$W = Fd$ in any form words, symbols or numbers OR ($W =$) Fd OR 0.67×0.034	C1
	0.023	A1
	lifting liquid as well OR friction between liquid and container / pipe	B1

Question	Answer	Marks
4(a)(i)	$E = mc(\Delta)T$ in any form words, symbols or numbers OR $(E =) mc(\Delta)T$ OR $0.23 \times 0.72 \times 550$	C1
	91 J	A1
4(a)(ii)	1. $t = E / P$ in any form words, symbols or numbers OR $(t =) E / P$ or 91 / 2.4	C1
	38 s	A1
	2. (thermal) energy is used to increase the temperature of / lost to cylinder / piston / heater / surroundings	B1
4(b)(i)	it / piston moves to the <u>right</u> / <u>away from</u> <u>heater</u> OR <u>accelerates</u> (to right)	M1
	pressure (of gas) greater / pressure greater (on left) / <u>resultant</u> force to right	A1
4(b)(ii)	$V_2 = p_1 V_1 / p_2$ in any form OR $(V_2 =) p_1 V_1 / p_2$ OR $2.9 \times 10^5 \times 1.9 \times 10^{-4} / 1.0 \times 10^5$	C1
	$5.5 \times 10^{-4} \text{ m}^3$	A1

Question	Answer	Marks
5(a)(i)	any two from: occurs throughout the liquid OR bubbles formed occurs at one temperature / boiling point does not produce cooling OR unaffected by draught / surface area / humidity	B2
5(a)(ii)	(more) energetic molecules escape (from the liquid) OR molecules gain energy and escape OR molecules overcome intermolecular forces / break bonds	B1
	average speed decreases OR molecules with less (kinetic) energy left behind	B1
	temperature of liquid decreases	B1
5(b)	(thermal) energy conducted / gained from skin / body OR (thermal) energy lost by skin / body	B1
	molecules touching OR no space between molecules	B1
	large (repulsive / intermolecular) forces (when moved closer)	B1

Question	Answer	Marks
6(a)	idea of one side of wavefront enters / hits solid first OR wavefront does not all hit the solid all at once;	B1
	idea of this side slowed down first OR this side delayed relative to other side	B1
	angle of wave(front) changes OR different parts of wavefront delayed by different amounts	B1
6(b)(i)	$n = \frac{\sin i}{\sin r}$ in any form OR $n_1 \sin \theta_1 = n_2 \sin \theta_2$ OR $1.3 = \frac{\sin 67^\circ}{\sin r}$	C1
	OR ($r =$) $\sin^{-1}(\sin 67^\circ / 1.3)$ OR $\sin^{-1}(0.71)$	
6(b)(ii)	45°	A1
	$v_{ts} = c / n$ in any form OR ($v_{ts} =$) c / n OR $3.0 \times 10^8 / 1.3$	C1
	2.3×10^8 OR $3.0 \times 10^8 / 1.3$	C1
	$\lambda = v / f$ in any form OR ($\lambda =$) v / f OR $2.3 \times 10^8 / 5.7 \times 10^{14}$	C1
	OR $3.0 \times 10^8 / (1.3 \times 5.7 \times 10^{14})$	
	4.0×10^{-7} m	A1
	OR (alternative approach)	
	$\lambda = v / f$ in any form OR ($\lambda =$) v / f OR $3.0 \times 10^8 / 5.7 \times 10^{14}$	C1
	5.3×10^{-7} OR $3.0 \times 10^8 / 5.7 \times 10^{14}$	C1
	$\lambda_g = \lambda_a / n$ in any form OR ($\lambda_g =$) λ_a / n OR $5.3 \times 10^{-7} / 1.3$	C1
	OR $3.0 \times 10^8 / (1.3 \times 5.7 \times 10^{14})$	
	4.0×10^{-7} m	A1

Question	Answer	Marks
7(a)	thermistor c.a.o.	B1
7(b)(i)	$V_X = V_{30}$	B1
7(b)(ii)	$V_X = E - V_{20}$ in any form	B1
7(c)(i)	$1/R_1 + 1/R_2 = 1/R_{\text{tot}}$ OR $(R_{\text{tot}} =) R_1 R_2 / (R_1 + R_2)$ OR $1/15 + 1/30 = 1/R_{\text{tot}}$ OR $(15 \times 30) / (15 + 30)$	C1
	10 (Ω) OR 10 + 20	C1
	30 Ω	A1
7(c)(ii)	$I = V / R$ in any form OR $(I =) V / R$ OR 6.0 / 30	C1
	0.20 A	A1
7(d)	resistance of <u>X</u> decreases	B1
	ammeter reading / it increases and (total) resistance (of circuit) decreases / more voltage across 20 Ω resistor	B1

Question	Answer	Marks
8(a)(i)	<u>magnetic</u> field mentioned	B1
	coil / wire cuts (magnetic) field OR changing (magnetic) field (through coil)	
	e.m.f. / voltage <u>induced</u> OR produced by electromagnetic <u>induction</u>	
8(a)(ii)	(plane of coil) horizontal OR in position shown in diagram coil cutting magnetic field the fastest	B1 B1
8(b)	current in coil	B1
	current in (magnetic) field experiences a force	
	opposes the change causing it	B1
	OR	
	energy supplied to / lost from lamp	B1
	student must do more work / supply more energy / more energy needed	B1
	greater force to do more work	B1

Question	Answer	Marks
9(a)(i)	mark both explanation and deduction together	
	nucleus is very small	B1
	very few α -particles hit or pass near to a nucleus	B1
9(a)(ii)	mark both explanation and deduction together	
	<u>nucleus</u> is charged	B1
	(charged) α -particles experience a force	B1
9(a)(iii)	mark both explanation and deduction together	
	centre / (small) part of atom OR nucleus includes most of the mass of the atom / is (very) dense	B1
	(α -particles move and) nucleus stays still	B1
9(b)	any two from: opposite direction (much) smaller deflection undergo deflections of similar magnitude	B2