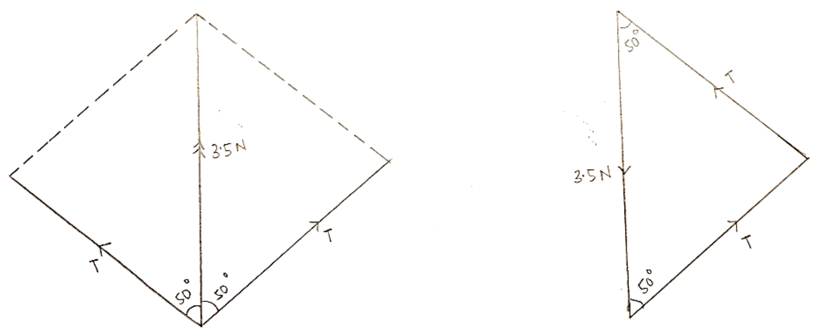
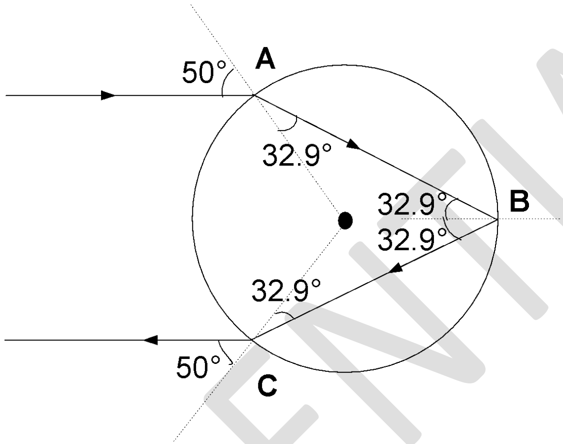
Paper 1 (40 marks) [1] × 40

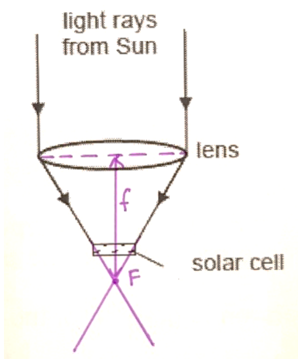
1	2	3	4	5	6	7	8	9	10
C	C	C	A	B	C	C	B	C	B
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
C	D	B	B	C	B	C	B	A	D
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
B	C	A	B	C	A	C	D	B	A
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
B	A	A	C	C	C	D	A	B	B

Paper 2

Section A (50 marks)

1	**(a)(i)**	The **weight of Y** pulling it down is **equal to the resultant force due to the tensions in the strings pulling it up**. Since resultant force on Y is zero, Y remains at rest.	B1
	(a)(ii)	 scale = 1 cm : 0.5 N resultant force of 3.5 N drawn upwards (or weight drawn downwards) with arrow and label tensions in strings drawn at correct angles with arrows and labels weight of X = 2.75 N [accept 2.65 – 2.85 N]	 M1 M1 A1
	(b)	The moment Y starts to drop, its **gravitational potential energy converts to kinetic energy as Y accelerates** downwards. Some of its kinetic energy then converts **to heat and sound energy as Y does work against air resistance**.	B1 B1
2	**(a)**	The clockwise **moment due to the force of the foot on the brake pedal** about pivot **is equal to** the clockwise **moment due to the force on the piston** about pivot. Since moment = F x d and the **perpendicular distance from force on piston to pivot is greater than the perpendicular distance from force of foot to pivot**, the **force on piston is greater** for the same moment.	B1 B1 B1

	(b)	P = F/A pressure on piston A = pressure on piston B $\frac{640}{2.0} = \frac{F}{15}$ F = 4 800 N (shown that force on piston B is greater than the force of 640 N on piston A)	M1 A1
3	(a)	n = 1 / sin c 1.4 = 1 / sin c c = 46°	A1
		 *angle 32.9° should be 33°	
	(b)(i)	n = sin i / sin r 1.4 = sin 50 / sin r r = 33° On Fig. 3.1, draw refracted ray from A to B.	B1 B1
	(b)(ii)	On Fig. 3.1, draw normal at B and reflected ray from B to C. angle of reflection = 33°	B1
	(b)(iii)	On Fig. 3.1, draw normal at C and refracted ray out at C. angle of refraction = 50°	B1
	(c)	The beads are used to reflect light falling on the road signs into motorists' eyes so that they can see the signs clearly.	B1
4	(a)	It is the distance between the optical centre of the lens and its focal point.	B1

	(b)	 focal length = 1.9 cm	M1 A1
	(c)	P: Power = energy converted / time R: Since the lens is able to **converge light rays onto the solar cell**, it will **increase the amount of energy absorbed** by the cell. O: This will lead to an **increase in the amount of electrcial power generated** by the solar cell.	B1 B1
	(d)	P: The **light rays will converge at a further distance** after passing through the lens of longer focal length. R: Since **less light rays converge onto the solar cell**, the amount of electrical power generated by the solar cell will reduce. O: This makes the solar cell **less efficient**.	B1 B1
5	**(a)**	V = IR 240 = (P / V) x R 240 = (48 / 240) x R R = 1 200 Ω	 M1 A1
	(b)	P: V = IR R: At the start, the **resistance of the lamp increases** at a decreasing rate. O: Hence, **current in the lamp decreases** at a decreasing rate. R: The **resistance of the lamp then becomes constant**. O: Hence, **current in the lamp remains constant**.	 B1 B1 B1
	(c)	**1** The filament in the second lamp is longer than the first. **2** The filament in the second lamp is thinner than the first.	B1 B1
6	**(a)(i)**	V = IR 4.20 = I x 12 I = 0.35 A	 A1
	(a)(ii)	V = 6.0 – 4.20 = 1.8 V V = IR 1.8 = 0.35 x R R = 5.14 Ω	M1 A1
	(b)(i)	P: X connected in parallel with the 12 Ω resistor results in a **lower effective resistance in the parallel part** of the circuit. R: Since, V = IR, the **voltage across the 12 Ω resistor decreases**. O: Hence, the **reading on the voltmeter decreases**.	B1 B1
	(b)(ii)	P: X connected in parallel with the 12 Ω resistor results in a **lower effective resistance** of the whole circuit. R: Since, V = IR, the **overall current in the circuit increases**. O: Hence, the **reading on the ammeter increases**.	B1 B1

7	**(a)(i)**	north	B1
	(a)(ii)	upwards	B1
	(b)(i)	increase the number of turns of coil around the iron core <u>OR</u> increase the voltage of the d.c. supply to increase current through the circuit <u>OR</u> increase the number of electrons in the beam	B1
	(b)(ii)	reverse the direction of coil around the iron core <u>OR</u> reverse the polarities of the d.c. supply <u>OR</u> use a beam of protons instead	B1
8	**(a)**	$\frac{V_S}{V_P} = \frac{N_S}{N_P}$ $\frac{V_S}{V_P} = \frac{200}{400}$ $V_S = 0.5V_P$ P = VI Efficiency $= \frac{useful\ output\ power}{input\ power} \times 100$ $= \frac{3.0 \times 0.5V_P}{5.0 \times V_P} \times 100$ = 30 %	M1 (for $V_S = 0.5V_P$) M1 (for Efficiency) A1 (for = 30 %)
	(b)	● There are power losses due to the resistance of the coils. ● There is leakage of magnetic flux between the primary and secondary coils. ● There are power losses dues to eddy currents induced in the iron core. ● There is hysteresis loss caused by the flipping of magnetic dipoles in the iron core due to the a.c. supply. [any two reasonable answers for 1 mark each]	B2
	(c)(i)	As a.c. current flows through the primary coil, the **rate of change of magnetic flux induces an e.m.f.** in the coil connected to the lamp. This is given by Faraday's Law of Electromagnetic Induction. **Hence an induced current** flows in the coil connected to the lamp, causing the lamp to light up.	B1 B1
	(c)(ii)	If the distance between the two coils increase, the **rate of change of magnetic flux will decrease inducing a smaller e.m.f.**, and hence a smaller induced current, in the coil connected to the lamp. This smaller induced current causes the lamp to be dimmer.	B1

Section B (30 marks)

9	**(a)(i)**	Moment = F x d = 165 x (240 / 100 ÷ 2)	M1

		= 198 Nm	A1
	(a)(ii)	Moment = F x d = F_H x 100 / 100 + F_V x 240 / 100 = (F_H + 2.4F_V) Nm	 M1 A1
	(b)(i)	As the man walks down the ramp, the **perpendicular distance between the line of action of his weight and end O decreases**. Since moment = F x d, the **clockwise moment due to his weight about end O decreases**. Hence, the total clockwise moments about end O decreases.	B1 B1
	(b)(ii)	point – O force – friction OR normal reaction force	B1 B1
	(b)(iii)	The **weight of the ramp produces an anticlockwise moment about T**. If this other force is not present to **produce a clockwise moment about T**, the ramp will not be able to **remain in equilibrium** in the position shown in Fig. 9.1. *friction cannot be explained using moments about T	B1 B1
		Total marks	10
10	**(a)**	The **relative power increases at a decreasing rate until a maximum value**. It **then decreases at** an approximately **constant rate**.	B1 B1
	(b)	Some thermal **radiation emitted by the stove have wavelengths in the red region of visible light**. However, **none of the radiation emitted by the rock have wavelengths within the visible light region**.	B1 B1
	(c)	**A large portion of the radiation emitted by the light bulb have wavelengths that fall within the infrared region.** Since the light bulb gives out more heat than visible light, it is **inefficient**.	B1 B1
	(d)(i)	Ultraviolet radiation is an **ionising radiation**. Excess amounts of it can **damage biological molecules** and lead to abnormal patterns of cell division. [harmful effects]	B1
	(d)(ii)	v = fλ 3 x 10^8 = f x 400 x 10^{-9} f = 7.5 x 10^{14} Hz [M1 for identifying longest wavelength] [M1 for stating the value of speed]	 M2 A1
		Total marks	10
11	**EITHER**		
	(a)(i)	Number of pulses = (6.0 x 60) ÷ (4.62 x 10^{-3}) = 7.79 x 10^4	M1 A1
	(a)(ii)	Total energy = 7.79 x 10^4 x 1.2 x 10^{-4} = 9.35 J	 A1
	(a)(iii)	Q = mcΔθ 9.35 = 50 x 4.2 x Δθ	 M1

		$\Delta\theta$ = 0.0445 °C	A1
	(b)	The **brain is found under layers of hair and skin**, which would have **absorbed some of the energy** from the radio waves during the phone call. Since there will be **less energy transferred to the brain** as compared to the water, the temperature rise produced in the brain will be lesser. [any other reasonable answers]	B1 B1
	(c)(i)	The phone converts 0.20 J of electrcial energy to other forms of energy in one second.	B1
	(c)(ii)	fraction of energy $= \frac{radio\ wave\ energy}{input\ energy\ of\ phone}$ $= \frac{9.35}{0.20 \times 6.0 \times 60}$ $= \frac{187}{1\ 440}$	 M1 A1
		Total marks	10
11	**OR**		
	(a)(i)	Pressures above the water levels in both arms of the manometer were equal.	B1
	(a)(ii)	When the gas tap was opened, the **number of gas molecules per unit volume** of the space between the water and the gas tap **increase**. The **frequency of collisions with the walls of the tube and the water surface increases**. The pressure of gas in that space increases. The **water levels readjust such that atmospheric pressure, together with pressure of 0.14 m of water, on the left side of the manometer is equal to the gas pressure on the right side of the manometer**.	B1 B1 B1
	(b)	$P_{gas} = P_{atm} + P_{water}$ = 100 000 + ρhg = 100 000 + 1 000 x 0.14 x 10 = 101 400 Pa (or 101 kPa in 3 sf)	 M1 A1
	(c)	It would not be suitable. A water pressure of 50 kPa will **require a much larger height of water** and hence a much taller tube. [any other reasonable answers]	B1 B1
	(d)(i)	The liquid levels remain the same in both arms.	B1
	(d)(ii)	The liquid levels remain the same in both arms.	B1
		Total marks	10