

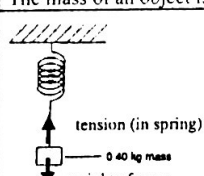
NOT IN SYLLABUS:	
P1:	Q. 35 37 – 40
P2:	Q. 8 10b

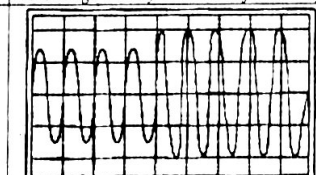
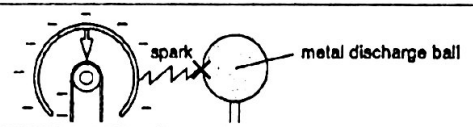
Paper 1 [40 marks]

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

- *Q. 9: (A) To calculate the moment of a force, the *perpendicular distance QC* must be used, instead of the direct distance PC.
(C is incorrect.)
- *Q. 20: (D) Visualising the wave movement seems to cause some problems.
(B is incorrect.)
- *Q. 22: (C) As the light rays are coming from a point O, the light rays entering the eye must appear to *converge at a point behind the mirror*.
(B is incorrect.)
- *Q. 27: (D) For a current to flow through the birds, there must be a *potential difference* but the birds are standing on the line which is at the same potential.
- *Q. 31: (C) For choice B, if the earth and neutral wires are swapped around, it will be a *dangerous situation but will not affect the fuse*.
(B is incorrect.)

Paper 2 [80 marks]

1	a	The mass of an object is the amount of matter in the object.	1
	bi		2
	bii	First force: Weight, $W = mg = (0.40)(10) = 4.0 \text{ N}$ (2 s.f.) Second force: Tension = Weight = 4.0 N (2 s.f.)	1 1
	c	As the mass is pulled downwards, the tension increases (which is greater than the weight of the mass). When the mass is released, the resultant force upwards (tension - weight) will accelerate the mass upwards ($F_{\text{resultant}} = ma$).	1 1
2	a	The air molecules are in constant, random motion and collide frequently with the walls of the container.	1

		There are more collisions on the larger area compared to the smaller area but the frequency of collisions per unit area is the same.	1
	bi	Work done = Fs $= 50 \times 0.015 = 0.75 \text{ J}$ (2 s.f.)	1 1
	bii	$P_1 V_1 = P_2 V_2$ $(1.0 \times 10^5)(V) = P_2(0.8V)$ $P_2 = 1.25 \times 10^5 = 1.3 \times 10^5 \text{ Pa}$ (2 s.f.)	1 1 1
3	a	For Fig 3.1: $n = \frac{\sin i}{\sin r}_{\text{air to glass}} = \frac{\sin 60^\circ}{\sin 36^\circ} = 1.47$ For Fig 3.2: $1.47 = \frac{\sin 30^\circ}{\sin r}$ $r = 19.9 = (2.0 \times 10^1)^\circ$ (2 s.f.)	1 1 1
	bi	A wavefront is an imaginary line joining points on corresponding crests / in the same phase on the wave.	1
	bii	1. decreases 2. decreases 3. remains the same	3
4	a	X-rays $\rightarrow$ ultraviolet $\rightarrow$ infra-red $\rightarrow$ microwaves	2
	b	1. To sterilize medical equipment 2. To produce artificial suntan (using sunbeds)	1 1
	c	1. They obey the laws of reflection and refraction. 2. They are transverse waves. OR: They carry energy / have the same speed of $3 \times 10^8 \text{ m/s}$ in a vacuum NOT ACCEPTED: They obey $v = f\lambda$ / They have wavelengths / They carry no charge / They are not deflected by electrical fields]	1 1
5	ai		1
	aii	The second note is louder therefore it has a higher amplitude. The second note also has a higher pitch therefore it has a higher frequency.	1 1
	bi	Electrical energy (of the mains supply) $\rightarrow$ Chemical potential energy (in battery)	1
	bii	Chemical potential energy (in battery) $\rightarrow$ Electrical energy (in phone) $\rightarrow$ Sound energy (in phone as sound is being produced)	2
6	ai	The negative charges on the metal dome repel the electrons in the metal discharge ball down the conducting rod and to earth. This is because like charges repel and the electrons will flow down the path of lowest resistance to earth.	1 1
	aii		1
	b	$I = \frac{Q}{t} = \frac{0.0016 \times 10^{-3}}{0.0012} = 0.00133 = 0.0013 \text{ A}$ (2 s.f.)	3

7	a	The two iron rods are magnetized as the current flows through the coil. The ends of the rods have same magnetic poles and repel (like poles repel).	1
	b	There will be no movement. Copper is a non-magnetic material and therefore is not magnetized.	1
8		OUT OF SYLLABUS	7
9	a	The resistance of the lamp L increases as the p.d. across it increases.	1
	bi	p.d. of supply = p.d. of supply of L + p.d. of supply of W = 1.5 + 12.0 = 13.5 V (1 d.p.)	1
	bii	$R = \frac{V}{I} = \frac{1.5}{0.8}$ = 1.875 = 1.9 Ω (2 s.f.)	1
	ci	Current $I_W = 0.8$ A	1
	cii	Current in lamp L = 2.0 A $\therefore$ Current $I = 2.0 + 0.8 = 2.8$ A (1 d.p.)	1
	ciii	$R = \frac{V}{I} = \frac{12}{0.8}$ = 15 Ω (2 s.f.)	1
	civ	$\frac{1}{R} = \frac{1}{R_L} + \frac{1}{R_W} = \frac{1}{15} + \frac{1}{6}$ $R = 4.29 = 4.3 \Omega$ (2 s.f.) OR: $R = \frac{V}{I} = \frac{12}{2.8}$	1
10	ai	(For this question ignore the presence of the 'NOT' gate and the LED.) The resistance of the LDR increases when light to the LDR is blocked by the falling card (e.g. between 0 to 0.08 s). The resistance decreases when the light strikes the LDR again (e.g. between 0.11 to 0.19 s).	1
	aii	When the resistance of the LDR decreases, the potential difference across it decreases (as p.d. is proportional to resistance in a potential divider).	1
10	b	OUT OF SYLLABUS	2
	ci	Time take for pulse 1 = 0.11 - 0.08 = 0.03 s Time take for pulse 2 = 0.205 - 0.19 = 0.015 s Distance travelled (during pulse 1), $s = vt = (1.0)(0.03) = 0.030$ m $\therefore$ Average speed during pulse 2 = $\frac{\text{Total distance}}{\text{Total time}}$ = $0.030 \div 0.015 = 2.0 \text{ m s}^{-1}$ (2 s.f.)	1
	cii	Acceleration, $a = \frac{v-u}{t}$ = $\frac{2.0-1.0}{0.103}$ = $9.71 = 9.7 \text{ m s}^{-2}$ (2 s.f.)	1
11E	a	Procedure: 1. Find mass of kettle when half filled with water, m_1 . 2. Insert a thermometer into the kettle. 3. Switch on the kettle and note the temperature of the water. 4. Start a stopwatch as water starts boiling at 100 °C (bubbles will form). 5. Switch off the kettle after time t . 6. Find the mass of the kettle with the remaining water, m_2 .	3

		Calculations: 1. Calculate mass of the water that is boiled off, $m = m_1 - m_2$. 2. Power input to kettle, $P = \frac{\Delta E}{t} = \frac{mLv}{t} = \frac{m(2.36 \times 10^6)}{6}$	2
	bi	Electrical power, in J = $Pt = 2000 \times 6 \times 60 = 720\,000 = 7.2 \times 10^5$ J (2 s.f.)	1
	bii	Electrical energy, in kWh = $2 \text{ kW} \times \frac{6}{60} \text{ h} = 0.20 \text{ kWh}$ (2 s.f.)	1
	biii	From (i) and (ii), $0.20 \text{ kWh} = 7.2 \times 10^5$ J $1.0 \text{ kWh} = 3.6 \times 10^6$ J (2 s.f.)	1
	c	During evaporation, some of the surface molecules that are more energetic (more kinetic energy) are able to escape from the surface. The average kinetic energy of the remaining molecules decreases and hence there is a loss of energy from the water.	1
11O	ai	No. of pulses = $\frac{6 \times 60}{0.00462} + 1$ = 77 923 = 7.8×10^4 (2 s.f.) [NOTE: Why add '1'? From the diagram, it can be seen that '3' intervals implies '3+1' pulses]	1
	aii	Total energy emitted = $77\,923 \times 0.00012 = 9.35 = 9.4$ J (2 s.f.)	1
	aiii	Energy absorbed by water = $mc\Delta\theta$ $9.35 = (50)(4.2)\Delta\theta$ Max. temperature rise, $\Delta\theta = 0.0445 = 0.045$ °C (2 s.f.)	1
	b	1. Some radio waves pass through water / not all the waves are absorbed. 2. The radio waves spread out / miss the beaker / not directed to water. OR: • The radio waves are absorbed / reflected by glass. • The brain does not contain of 50 g of water / the mass of brain and water are different. • The brain is not made of water / has different specific heat capacity. • The brain is cooled / has blood passing through. • The brain and water are at different distances from the phone. • The skull absorbed some of the waves / energy (not just heat is lost).	1
	ci	Power is the rate of work done.	1
	cii	Energy supplied by battery = $Pt = (0.20)(6 \times 60) = 72$ J Fraction of energy supplied by battery converted into radio wave energy = $\frac{9.25}{72} = 0.128 = 0.13$ (2 s.f.)	1

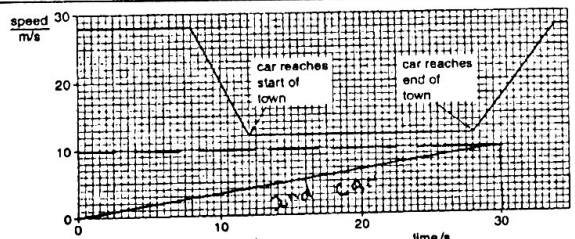
NOT IN SYLLABUS:	
P1:	Q. 36 - 40
P2:	Q. 3ai, ii 11E: c & d 11O: a, c & d

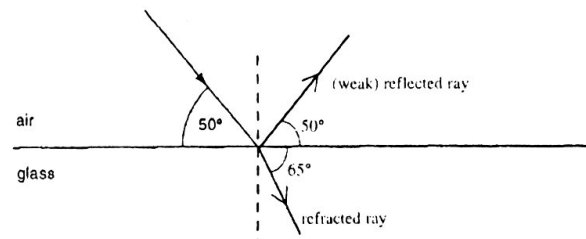
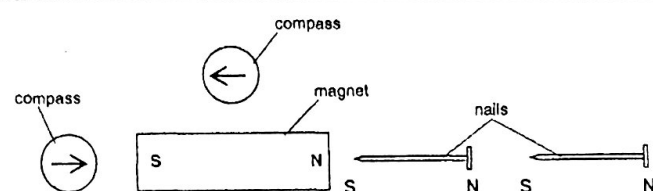
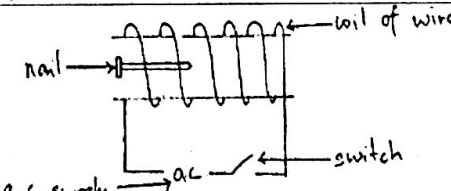
Paper 1 [40 marks]

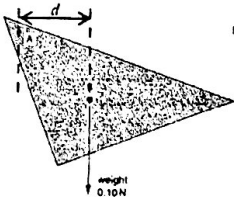
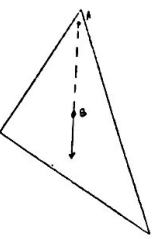
1	D	11	C	21	D	31	B
2	D	12	B	22	B	32	D
3	A	13	C	23	A	33	C
4	C	14	A	24	C	34	A
5	C	15	C	25	B	35	C
6	D	16	A	26	D	36	---
7	D	17	D	27	B	37	---
8	C	18	B	28	B	38	---
9	B	19	C	29	A	39	---
10	B	20	B	30	D	40	---

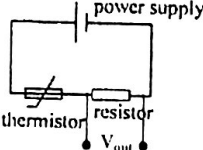
- *Q. 16: (A) The change of state takes place at constant temperature thus the average speed (and K.E.) of the water molecules *remain the same*.
(B is incorrect.)

Paper 2 [80 marks]

1	a	Distance travelled, $s = \text{Area under graph} = 12(28 - 12) = 192 = 1.9 \times 10^2 \text{ m (2 s.f.)}$	1
	b	Acceleration = Gradient of v-t graph or $\frac{v-u}{\Delta t} = \frac{28-12}{34-28} = 16 \div 6 = 2.667 = 2.7 \text{ m s}^{-2} \text{ (2 s.f.)}$	1
	c	 Distance travelled = Area under v-t graph = $\frac{1}{2}(30)(10) = 150 \text{ m} < 192 \text{ m}$ Hence, the second car <i>does not</i> reach the end of the town in 30 s.	1
2	a	Initial acceleration = $g = 10 \text{ m s}^{-2}$	1
	bi	The weight of the paper is equal to the air resistance. (Resultant force = $0 \text{ N} \Rightarrow a = 0 \Rightarrow \text{constant speed.}$)	1
	bii	The weight of the coin is much larger than the air resistance. (Resultant force $\neq 0 \text{ N} \Rightarrow a \neq 0 \Rightarrow \text{acceleration.}$)	1
	c	1. Both accelerate at the same constant acceleration of $a = g = 10 \text{ m s}^{-2}$. 2. Both fall and reach the end together. 3. Both fall faster in a vacuum / reach the base in a shorter time.	1

3	ai, ii	OUT OF SYLLABUS	2
	bi	The air is at a lower temperature (heat flows from a region of higher temperature to a region of lower temperature).	1
	bii	The black teapot will cool more quickly. Black surfaces are good emitters/radiators of <i>infrared radiation</i> .	1
4	ai		1
	aii	$n = \frac{\sin i}{\sin r} \text{ (from air to glass)}$ $= \frac{\sin 40^\circ}{\sin 25^\circ}$ $= 1.52 = 1.5 \text{ (2 s.f.)}$	1
	bi	Total internal reflection cannot occur when light passes from an optically less dense medium (air) to an optically denser medium (glass).	1
	bii	Critical angle is the angle of <i>incidence</i> in the <i>optically denser medium</i> for which the angle of refraction is 90° , when light travels from an optically denser medium to an optically less dense medium.	2
5	a b		2
	ci	Suspend one nail freely and bring <i>both ends</i> of the other nail towards the same end of the suspended nail. If both nails are still magnetized, there will be <i>repulsion</i> for one end of the other nail.	1
	cii	 Set up the circuit as shown, with an <i>a.c. supply</i>. Close the switch and pull out the nail <i>slowly</i> in an <i>east-west</i> direction, until far away from the solenoid. <u>OR:</u> Heat the nail until it is red-hot then allow it to cool in an <i>east-west</i> direction / Hammer the nail vigorously in an <i>east-west</i> direction.	1

6	a	1. Gravitational potential energy (of water) → Kinetic energy (of water) 2. Kinetic energy (of water) → Kinetic energy (of wheel)	1
	b	% of wasted energy = $\frac{\text{wasted energy}}{\text{useful energy}} \times 100\%$ = $\frac{2000-1200}{2000} \times 100\% = \frac{800}{2000} \times 100\%$ = 40% (2 s.f.)	1
	c	1. Some energy is converted to thermal energy caused by friction, as the wheel turns / due to the moving parts. 2. Some energy is converted to sound energy as the water hits the wheel. OR: K.E. of the water still remaining as the water flows out. / G.P.E. of water remaining as the water still has height.	1
7	a	Electromagnetic induction.	1
	b	Deflects to the left / opposite direction.	1
	c	The needle of the ammeter does not move. The wire is not cutting the magnetic field lines of the magnet. / The rate of change of magnetic field lines linked to the wire is zero.	1
	d	The direction is obtained using Fleming's right hand rule. The direction of the current is given by the 2 nd finger when direction of the force is given by the thumb & the direction of the magnetic field is given by the 1 st finger (all three fingers are acting at right angles to each other).	1
8	a	16 V	1
	bi	$V = IR$ $I = V \div R = 16 \div (6 + 2)$ $= 16 \div 8 = 2.0 \text{ A (2 s.f.)}$	1
	bii	$V = IR = (2)(6) = 12 \text{ V (2 s.f.)}$	1
	biii	$V = IR \Rightarrow I = V \div R = 9.0 \div 6 = 1.5 \text{ A}$ $R_{\text{new}} = V \div I = (16 - 9.0) \div 1.5 = 7 \div 1.5$ $= 4.667 = 4.7 \Omega \text{ (2 s.f.)}$	1
9	ai	The moment of a force about a point is the product of the force and the perpendicular distance from the point to the line of action of the force.	2
	aii	 Moment of weight about point A = Fd = $(0.10)(0.026)$ = 0.0026 = $2.6 \times 10^{-3} \text{ Nm (2 s.f.)}$ OR: 0.26 Ncm → for actual size diagram	1
	bi		1
	bii	In this position, the weight has no moment about point A. This is because the perpendicular distance from the line of action of the weight to point A is zero (moments balance). Moreover, the reaction force at A cancel out the weight and the resultant force is zero (forces balance).	1

	c	1. The centre of gravity is lower. 2. The base area is larger.	1
10	ai	Earth wire.	1
	aii	The table lamp cannot conduct electricity or become live. Plastic is a poor conductor of electricity.	1
	bi	It means that the lamp converts electrical energy to other forms of energy (like light and thermal energies) at a rate of 100 joules per second.	2
	bii	$P = IV \Rightarrow I = P \div V = 100 \div 230$ $\approx 0.435 = 0.43 \text{ A (2 s.f.)}$ Hence value of fuse = 1 A (fuse ratings are in whole no.)	1
	biii	$E = Pt = (100)(30 \times 60)$ $= 180\,000 = 1.8 \times 10^5 \text{ J (2 s.f.)}$	1
11E	a	Gravitational potential energy (of gas and dust) → Kinetic energy (of gas and dust) → Thermal energy (of gas and dust) [NOTE: According to question, it is similar to gravity causing the ball to fall.]	2
	b	At very high temperatures, the hydrogen atoms lose their orbital electrons and become positively-charged nuclei and will repel each other. However, at high temperatures, the high speed of the nuclei ensured that they would overcome this force of repulsion and thus come together.	1
	c,d	OUT OF SYLLABUS	3
	e	K.E. of neutron = $\frac{1}{2}mv^2 = 9.0 \times 10^{-14}$ $\frac{1}{2}(1.7 \times 10^{-27})v^2 = 9.0 \times 10^{-14}$ $v = 1.03 \times 10^7 = 1.0 \times 10^7 \text{ m s}^{-1} \text{ (2 s.f.)}$	1
11O	a	OUT OF SYLLABUS	1
	bi		2
	bii	When the sensor is hot, the resistance of the thermistor is low and potential difference across the thermistor is low. Hence the output voltage across the resistor will be high (as the resistor and the thermistor are connected in series and p.d. is proportional to resistance in a potential divider circuit).	1
	c,d	OUT OF SYLLABUS	5

Catholic High School | O-Level Physics
5059 Nov 2007
Suggested Answers

NOT IN SYLLABUS:	
P1:	Q. 39 – 40
P2:	Q. 4a 110

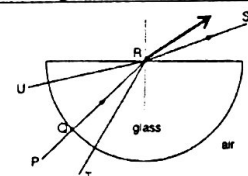
Paper 1 [40 marks]

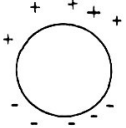
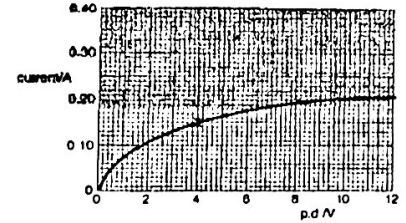
1	C	11	C	21	C	31	B
2	B	12	C	22	A	32	A
3	B	13	A	23	C	33	D
4	C	14	A	24	D	34	D
5	D	15	D	25	B	35	C
6	C	16	A	26	D	36	C
7	A	17	B	27	B	37	C
8	D	18	A	28	B	38	B
9	B	19	D	29	C	39	---
10	B	20	D	30	C	40	---

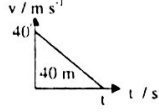
- *Q. 9: (B) The reservoir is 10 m *below* the tank, thus the pump needs to supply additional energy equivalent to this difference of 10 m of G.P.E. (D is incorrect.)
- *Q. 20: (D) Images in the mirror are always *behind* the mirror and *not on it* (thus cannot be choice C), unless the object is touching the mirror. (C is incorrect.)
- *Q. 28: (B) The I-V graph for a filament lamp is a *curve*, not a straight line. Thus the set of values of I and V must be non-linear. (C is incorrect.)

Paper 2 [80 marks]

1	ai	0 – 2 s and 16 – 24 s	1
	aii	From t = 0 – 2 s, the car is at rest. From t = 16 – 24 s, the car is travelling at a constant speed.	1
	bi	At t = 2 s, total driving force = 2500 N $F = ma \Rightarrow a = F \div m = 2500 \div 850 = 2.9 \text{ m s}^{-2}$ (2 s.f.) OR: At t = 2 s, total driving force = 0 N $F = ma \Rightarrow a = F \div m = 0 \text{ m s}^{-2}$	1
	bii	When $a = 2.0 \text{ m s}^{-2}$, $F = ma = (850)(2.0) = 1700 \text{ N}$ Total resistive force = 2500 – 1700 = 800 N From graph, when total resistive force = 800 N, $t = 6.4 \text{ s}$ (1 d.p.)	1
2	a	1. X rays are able to penetrate the body. 2. X rays can be absorbed by the bone. 3. X rays cause little harm or ionisation in the body. 4. X-rays are able to affect a photographic film / can cause fluorescence.	2
	b	1. Gamma rays are used for the treatment of cancer, as they can penetrate through the body to the cancer cells / cause high ionization in killing the cancer cells / are high-frequency, highly-energetic waves. 2. Gamma rays are used in the sterilization of medical equipment, as they can travel deep into the materials being sterilized / cause high ionization in killing the bacteria / are high-frequency, highly-energetic waves.	1

3	a	Vernier calipers	1
	bi	$W = mg \Rightarrow g = W \div m = 1.80 \div 176.8 = 0.0102 \text{ N/g}$ (3 s.f.) or 10.2 N/kg	1
	bii	$\rho = \frac{m}{V} = \frac{4.01 \times 2.04 \times 1.12}{176.8} = 19.3 \text{ g cm}^{-3}$ (3 s.f.)	2
	biii	Yes. The calculated density and the given density are the same when given to 3 significant figures. OR: No. The calculated density of the bar was higher than that of the given density.	1
4	a	OUT OF SYLLABUS	3
	b	As more air molecules are pumped into the inner tube, the number of molecules per unit volume increases. Frequency of collisions of the air molecules with the walls of the inner tube will increase, thus the force per unit area (which is the pressure) increases.	1
5	ai	The specific latent heat of vaporization is the amount of <i>thermal</i> energy required to change 1 kg of the substance from liquid to gas or vice versa, <i>without a change in temperature</i> .	1
	aii	Amount of water vaporized = 500 – 100 = 400 g $Q = ml_v$ and $P = \frac{\Delta E}{t} = \frac{Q}{t} \Rightarrow Pt = ml_v$ $(1.2 \times 10^3)(t) = (400)(2250)$ $t = 750 = 7.5 \times 10^2 \text{ s}$ (2 s.f.)	1
	b	The jet of steam produces more (internal) energy This is because the steam will condense to liquid water and liberate latent heat OR the increase energy was caused by the breaking of inter-molecular bonds as the water boiled.	1
6	ai	The ray is not refracted as it enters the glass block because the angle of incidence is 0° / the ray enters along the normal.	1
	aii	$n = \frac{c}{v} \Rightarrow v = c \div n = (3.0 \times 10^8) \div 1.5$ $= 2.0 \times 10^8 \text{ m s}^{-1}$ (2 s.f.)	1
	aiii	speed: increases wavelength: increases	2
	b		1
	c	The ray of light is totally internally reflected at R [$\leftarrow$ better answer] OR: Refracted towards the normal OR: Refracted along the surface (assuming critical angle)	1
7	ai	$P = IV$	1
	aii	Total power required = 1800 + 200 = 2000 W I required = $P \div V = 2300 \div 230 = 8.7 \text{ A}$ (2 s.f.) Suggested I rating = <u>9 A</u> (fuse ratings are in whole no.) OR: I through air con = $P \div V = 1800 \div 230 = 7.82 = 7.9 \text{ A}$ I through fridge = $P \div V = 200 \div 230 = 0.870 = 0.87 \text{ A}$ Total I = $7.82 + 0.870 = 8.69 = 8.7 \text{ A}$ (1 d.p.)	1

	aiii	No of kWh = $(200 \div 1000) \text{ kWh} \times (15 \div 60) \text{ hr}$ = 0.050 kWh (2 s.f.)	1
	b	(i) Melts (ii) Unaffected (iii) Switch off / Do not work (iv) Switch off / Do not work NOT ACCEPTED: Nothing happens / Do not work properly (both appliances are initially switched on and working properly)	1 1 1 1
8	a	The <u>surface</u> electrons from the plate are transferred to the cloth, leaving the plate positively charged.	1
	bi	Light neutralizes the positive charges on the charged plate. [OR: The charged plate becomes an electrical conductor in the presence of light.]	1
	bii		1
	biii	The negative charges on the bottom of the power particle are attracted to the positively charged plate (as unlike charges attract). The force of repulsion between the positive charges on the plate and the particle is weaker than the force of attraction OR it is not possible for the negative charges on the power particle to flow onto the plate as the plate is an insulator.	1 1
9	a	Voltmeter 1: The reading on voltmeter 1 is at 12 V when C is at X. As C moves towards Y, the reading on voltmeter 1 will decrease from 12 V. Voltmeter 2: The reading on voltmeter 2 is at 0 V when C is at X. As C moves towards Y, the reading on voltmeter 2 will increase from 0 V. Ammeter: As C moves towards X, the ammeter reading will decrease (as overall resistance in the circuit increases).	3 1 for values
	b	i 	1
	ii	For a lamp, the resistance increases with current. Hence, the gradient of the I-V graph of a lamp will decrease with the potential difference, p.d. across it (reciprocal of the gradient of I-V graph is the resistance / the current increases at a decreasing rate with p.d.).	1
	iii	From the graph, when the potential difference is 4.0V, the current is 0.15 A. $Q = It = (0.15)(5 \times 60) = 45 \text{ C}$ (2 s.f.)	1 2
10	a	K.E. = $\frac{1}{2}mv^2 = (0.5)(700)(40^2)$ = 560 000 = 560 kJ (shown)	1 1

	b	The kinetic energy of the car is being converted to gravitational potential energy as the car moves uphill. Some of the kinetic energy was lost as heat when being used to do work against friction.	1 1
	ci	Change in G.P.E. = $mgh = (700)(10)(3)$ = 21 000 J = $2.1 \times 10^4 \text{ J}$ (2 s.f.)	1 1
	cii	K.E. left in car = $560\,000 - 21\,000 = 539\,000 \text{ J}$ = Work against friction $W = Fs \Rightarrow$ Average frictional force = $W \div s = 539\,000 \div 40$ = 13 475 = $1.3 \times 10^4 \text{ N}$ (2 s.f.) OR: Distance travelled along slope = Area under v-t graph $40 = \frac{1}{2}(40)(t) \Rightarrow t = 2.0 \text{ s}$  $a = \frac{v-u}{t} = \frac{0-40}{2} = -20 \text{ m s}^{-2}$ Resultant $F = ma = (700)(-20) = -14\,000 \text{ N}$ Hence, average frictional force = $1.4 \times 10^4 \text{ N}$ (2 s.f.) [NOTE: The frictional force calculated using $F = ma$ is larger as the effect of gravity in slowing down the car is not taken into account, i.e. $a = -20 \text{ m s}^{-2}$ includes the component of gravitational acceleration along the slope.]	1 1 1 1 1 1
	d	- Roughness/ type of surface or tyre - Mass/ weight of car - Size/ evenness/ distribution of stones - Wind speed/ direction NOT ACCEPTED: Air resistance, as this would depend on the car's speed.	1
11E	OUT OF SYLLABUS		10
11O	ai	The X-shift and Y-shift controls were adjusted to shift the trace towards the right and downwards respectively. The Y-gain was adjusted to produce a larger trace vertically. The time base was adjusted to give a larger distance between the pulses on the screen.	1 1 1
	aii	Time between the two pulses = $7 \times 0.1 = 0.7 \text{ s}$ (1 d.p.) Amplitude = $3.5 \times 5 = 17.5 \text{ mV}$ (1 d.p.)	1 1
	bi	When the magnet falls through the coil, there is a constant change in the magnetic flux linkages within the coil / the magnetic field within the coil is constantly changing / the magnetic field lines are constantly cutting the coil at a different rate. According to Faraday's Law of Electromagnetic Induction, an e.m.f. is generated within the coil. As the circuit is closed, an induced current will be produced, giving rise to the first pulse.	1 1 1
	bii	Using the right hand grip rule, a north pole will be produced at the top of the solenoid, as Lenz's Law predicts that the current will flow to oppose the magnetic effect causing it. Since like poles repel, the magnet will be repelled.	1 1

NOT IN SYLLABUS:

P1:

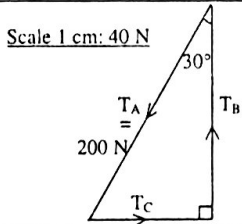
P2: Q. 3

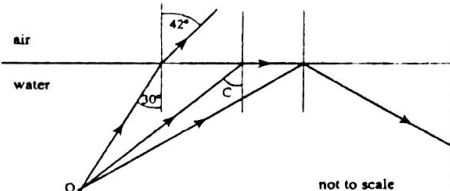
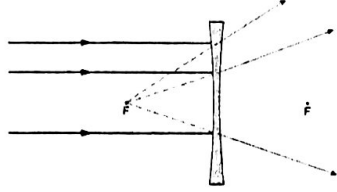
Paper 1 [40 marks]

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

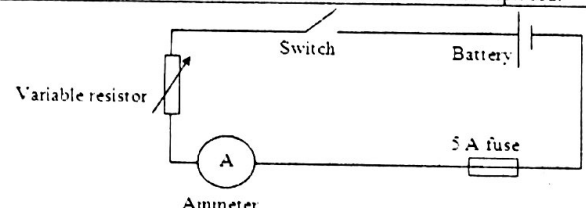
- *Q. 15: (B) If the speed of the molecules increases but the pressure remains constant, then the molecules must collide less frequently with the piston.
 - If the rate of collision stayed the same, the pressure would increase. (C is incorrect.)
 - If the rate of collision increased, the pressure would increase even more. (A is incorrect.)

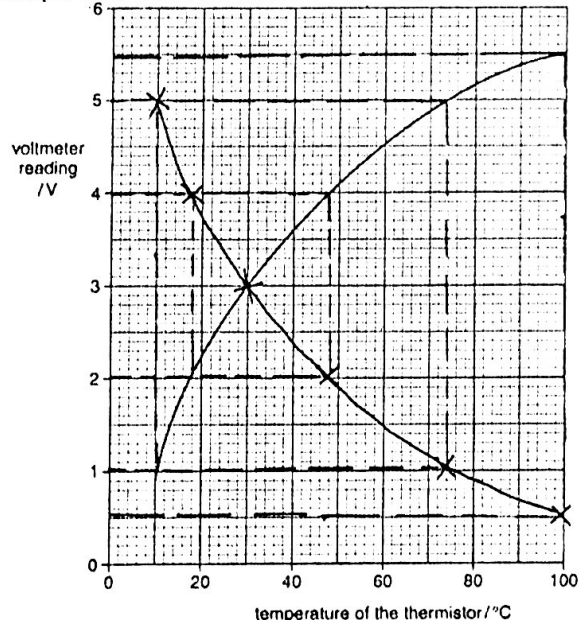
Paper 2 [80 marks]

1	a	A vector quantity is a physical quantity that has both magnitude and direction. A scalar quantity is a physical quantity that has magnitude only.	1
	b	Acceleration / Displacement / Velocity etc.	1
	c	Tension in string B is $= 4.3 \times 40 \text{ N}$ $= 172 \text{ N}$ $= 1.7 \times 10^2 \text{ N}$ (2 s.f.), at 90° to string C Tension in string C is $= 2.4 \times 40 \text{ N}$ $= 100 \text{ N}$ $= 1.0 \times 10^2 \text{ N}$ (2 s.f.), at 90° to string B [Actual answers: 173.2 N & 100 N] 	3
2	a	As the man fell further beyond A, both his gravitational potential energy (G.P.E.) and kinetic energy (K.E.) decreased (as his speed decreases due to the pull of the elastic rope). Hence the elastic potential energy and thermal energy (in the form of heat generated) in the rope increases as the rope is stretched. When the man reaches the lowest point at B, his K.E. is zero and the elastic potential energy in the rope is maximum.	1 1 1
	b	Change in G.P.E. = $mg\Delta h = (80)(10)(56) = 44\,800 = 4.5 \times 10^4 \text{ J}$ (2 s.f.)	1 1
	c	Maximum K.E. = 23 000 J $\Rightarrow \frac{1}{2}mv^2 = \frac{1}{2} \times 80 \times v^2 = 23\,000$ Maximum speed, $v = 23.979 = 24 \text{ m s}^{-1}$ (2 s.f.)	1 1

3	OUT OF SYLLABUS	6
4	ai* 1.0×10^{-15} to $1.0 \times 10^{-2} \text{ m}$ (Actual: 1.0×10^{-10} to $1.0 \times 10^{-7} \text{ m}$)	1
	aii Speed of X-rays is $3.0 \times 10^8 \text{ m s}^{-1}$	1
	$v = f\lambda \Rightarrow f = \frac{v}{\lambda} = \frac{3.0 \times 10^8}{1.0 \times 10^{-10}} = 3.0 \times 10^{18} \text{ Hz}$ (2 s.f.)	1 1
	b Ionisation is the process of ion formation through the addition or removal of charged particles (electrons or other ions) from atoms or molecules.	1
	ci X-rays causes mutation or destruction of living cells and tissues.	1
	cii There is a rise in temperature of living cells and tissues.	1
5	a	1
		
	b Refractive index, $n = \left(\frac{\sin i}{\sin r} \right)_{\text{air to water}} = \left(\frac{\sin r}{\sin i} \right)_{\text{water to air}} = \frac{\sin 42^\circ}{\sin 30^\circ} = 1.338$ $n = \frac{1}{\sin c} \Rightarrow c = \sin^{-1} \frac{1}{1.338} = 48.4 = 48^\circ$ (2 s.f.)	1 1 1
	ci 	1
	cii Light undergoes total internal reflection as it strikes the optical fibre at an incidence angle greater than the critical angle of the optical fibre.	1
6	ai	2
		
	aii When light rays enter the lens, there is an increase in the optical density as light enters an optically denser medium. This causes the speed of light to decrease, resulting in light rays bending towards the normal (as the light rays travel a shorter distance due to the decrease in speed).	1 1
	b The object is placed at a distance less than the focal length of the converging lens ($u < f$).	1
7	ai When V is negative, $I = 0 \text{ A}$.	1
	aii When V is positive, $I = 0 \text{ A}$ from $V = 0 \text{ V}$ to about $V = 0.6 \text{ V}$. When $V > 0.6 \text{ V}$, I will increase at an increasing rate.	1 1

	b	From graph, $I = 6 \text{ mA}$ (0 d.p.) $\rightarrow 1.5$ small squares, not 2 small squares (8 mA) $R = \frac{0.80}{6 \times 10^{-3}} = 133 = 1.3 \times 10^2 \Omega$ (2 s.f.)	1 1 1
	c	No. Using $R = \frac{V}{I}$ when current $I = 0 \text{ A}$, resistance R is infinite.	1
8	a	The alternating current in the primary coil will produce a constantly changing magnetic field in the primary coil. This constantly changing magnetic field in the primary coil is linked to the secondary coil through the soft iron core. By Faraday's Law of Electromagnetic Induction, there is a constant change in the magnetic field lines linked to the secondary coil (OR: constant change in magnetic flux linkages with the secondary coil), thus inducing an e.m.f. in the secondary coil. (Optional: As the number of turns of coil in the secondary coil is larger than that in the primary coil, the rate of change of magnetic field lines linked to the secondary coil is larger and thus the voltage is stepped up.)	1 1 1
	b	$\frac{N_p}{N_s} = \frac{V_p}{V_s} = \frac{25\,000}{400\,000} = \frac{1}{16} = 1:16$ or 0.63 (2 s.f.) [NOTE: Turns ratio = $\frac{N_s}{N_p}$]	1
	c	$\frac{N_p}{N_s} = \frac{I_s}{I_p} \Rightarrow \frac{1}{16} = \frac{I_s}{12\,000}$ $I_s = 750 = 7.5 \times 10^2 \text{ A}$ (2 s.f.)	1 1
	d	The current used in transmission will be low and there will be less power lost ($P_{\text{loss}} = I^2 R$) in the cables as in the form of heat. (NOT: R is reduced as $V = IR$.)	1
9	ai	Mass of car (without any load) is 900 kg. When load in car is doubled from 80 kg to 160 kg, the total mass of the car (including the load) is not doubled. From Newton's 2 nd Law of Motion ($F = ma$), since the increase in mass is small, the acceleration will only decrease slightly.	1 1
	aii	As the car increased its speed, the sum of resistive forces (air resistance and friction) acting on the car increase. When the car has a maximum speed, the forward thrust produced by the car engine is equal to the sum of resistive forces and thus the resultant force is zero and the acceleration is zero.	1 1
	bi	$\text{Time} = \frac{\text{total distance}}{\text{average speed}} = \frac{49 \times 1000}{10.9} = 4\,495 = 4.5 \times 10^3 \text{ s}$ (2 s.f.)	1
	bii	$P = \frac{\Delta E}{t} \Rightarrow \text{Energy provided by battery} = Pt = (4.24 \times 1\,000) \times 4\,495$ $= 19\,058\,800 = 1.91 \times 10^7 \text{ J}$ (3 s.f.) (NOTE: Use $P = 4.24 \text{ W}$, not $P = IV = 95 \times 48$)	1
	biii	$P = IV = (95)(48) = 4\,560 \text{ W}$ $P = \frac{\Delta E}{t} \Rightarrow t = \frac{\Delta E}{P} = \frac{19\,058\,800}{4\,560} = 4\,179.6 \text{ s} = 4.2 \times 10^3 \text{ s}$ (2 s.f.)	1 1
	biv	There is no heat loss to the surroundings. (OR: The charging current remains at a maximum of 95 A.)	1
	c	There is a reduction in urban pollution.	1
10	ai	Polystyrene is a poor conductor of heat. Conduction of heat from outside to the inside of the refrigerator is reduced.	1 1

	aii	Air near the cooling unit is cooled and contracts, becoming denser (since density is mass per unit volume) and thus sinks to cool the contents of the refrigerator at the bottom. Warmer air will rise towards cooling unit to replace the colder air and is cooled. The cycle repeats itself and convection currents are set up.	1 1
	aiii	Light-coloured surfaces are poor EMITTORS of infrared radiation. Thus the inside white wall will emit little infrared radiation to heat up the contents.	1
	bi	Energy lost by water = $mc\Delta\theta = (100)(4.2)(50 - 46)$ $= 1\,680 = 1.7 \times 10^3 \text{ J}$ (2 s.f.)	1 1
	bii	Thermal energy needed by ice = $mc\Delta\theta$ $= (3)(4.2)(46 - 0) = 579.6 = 5.8 \times 10^2 \text{ J}$ (2 s.f.)	1
	biii	By Conservation of Energy, Heat gained by ice = Heat lost by water $579.6 + \text{Latent heat required to melt ice cube} = 1\,680$ Latent heat required to melt ice cube $= 1\,680 - 579.6 = 1\,100.4 = 1\,100$ (whole no.) $= 1.10 \times 10^3 \text{ J}$ (3 s.f.)	1
	biv	Latent heat required to melt ice cube = ml_f $1\,100.4 = (3.0)(l_f) \Rightarrow l_f = 366.8 = 3.7 \times 10^2 \text{ J g}^{-1}$ (2 s.f.)	1
11E	ai	'Live' refers to the wire of the mains supply that is at maximum potential (it allows the current to flow from the mains supply to the appliance).	1
	aii	'Neutral' refers to the wire of the mains supply that is at zero potential (it allows the current to flow from the appliance to the mains supply).	1
	bi	The 5 A fuse will prevent any current higher than 5 A from flowing through. If the fuse is replaced by a 30 A one, current would still be allowed to flow to the appliance even if the maximum safe current is exceeded. This is dangerous as overheating of the appliance or wires could occur.	1 1
	bii	When earth wire is not connected to metal case, metal case could become 'live' if the wires are damaged and are in contact with the metal case. Anyone touching the metal case could become electrocuted as the current cannot flow through the earth wire to the earth.	1 1
	c	It is easy to reset the circuit breaker, while the fuse must be replaced.	1
	d	 Procedure: - Set up the circuit as shown. - Set the variable resistor at maximum resistance. The initial ammeter reading, I must be less than 5 A. - Slowly decrease the resistance of the variable resistor, until I approaches 5 A. - When $I = 5 \text{ A}$, the fuse should blow and the ammeter reading should drop to 0 A. - This shows that the fuse blows at 5 A.	1 2

110	a	As the temperature increases, the resistance of the thermistor decreases. Hence the p.d. across the resistor (voltmeter reading) increases as the p.d. across the thermistor decreases. In a potential divider circuit, the potential difference (p.d.) is proportional to the resistance.	1 1
	b	From the graph, at 40 °C, V = 3.6 V Hence, p.d. across thermistor = 6.0 - 3.6 = 2.4 V By proportion, resistance of thermistor = $\frac{2.4}{3.6} \times 1.6 = 1.07 = 1.1 \text{ k}\Omega$ (2 s.f.)	1 1 1
	c	(Total p.d. across resistor and thermistor = 6.0 V at all temperatures.) 	2
	d*	<u>Additional Apparatus:</u> • Heater • Thermometer clamped to a retort stand (OR: Temperature probe, connected to a data logger) <u>Procedure:</u> 1. Place the heater near the thermistor. 2. Place the bulb of thermometer (clamped to a retort stand) on thermistor. (OR: Attach the temperature probe to the thermistor.) 3. Adjust the power of the heater until the temperature on the data logger reads 10 °C. 4. Record the voltmeter reading, V. 5. Adjust the power of the heater for further temperatures until 100 °C, at intervals of 10 °C (for at least 7 sets of readings). 6. Record the corresponding voltmeter readings, V. 7. Repeat the experiment again to obtain the average readings of V.	1 2

Catholic High School | O-Level Physics
5059 Nov 2009
Suggested Answers

NOT IN SYLLABUS:

P1:

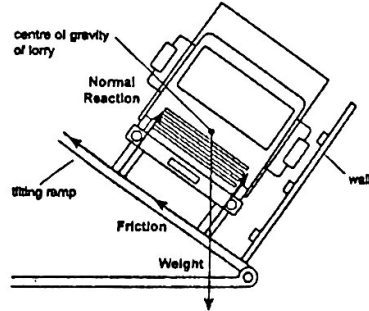
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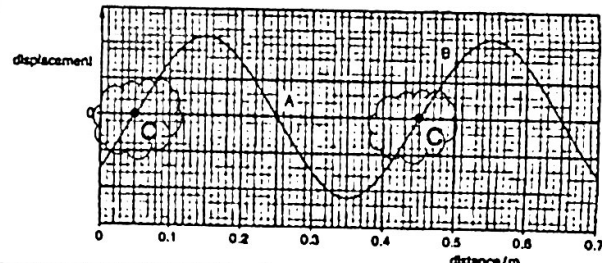
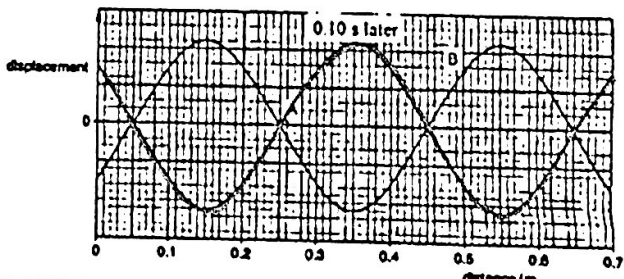
Paper 1 [40 marks]

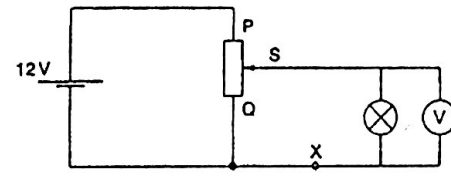
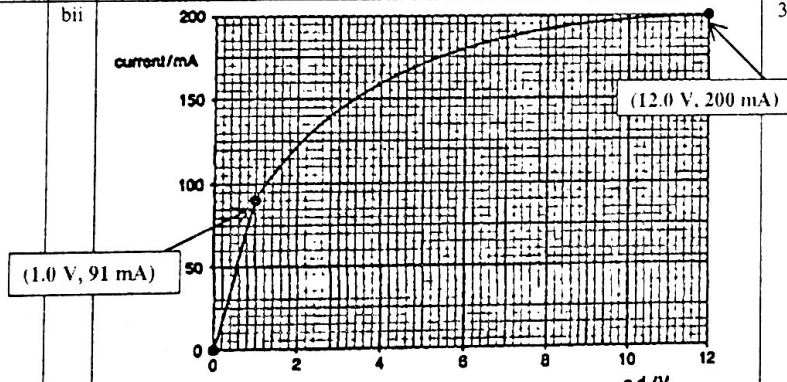
1	C	11	B	21	D	31	C
2	D	12	C	22	D	32	D
3	D	13	A	23	C	33	C
4	C	14	A	24	C	34	D
5	B	15	B	25	B	35	A
6	C	16	B	26	C	36	C
7	A	17	B	27	D	37	B
8	A	18	D	28	A	38	D
9	B	19	D	29	D	39	D
10	C	20	B	30	C	40	D

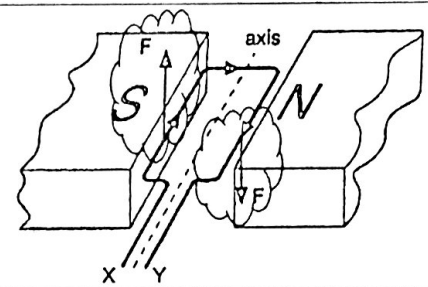
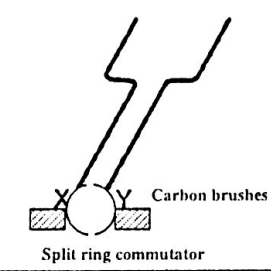
- *Q. 19: (D) Refractive index of a medium is defined as $n = \frac{c}{v}$, where c : speed of light in vacuum (not air) to the speed of light in the medium.
(A is incorrect.)

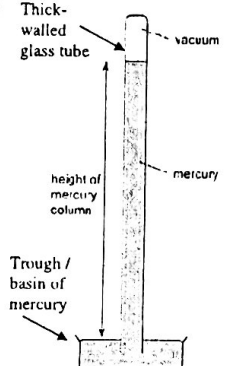
Paper 2 [80 marks]

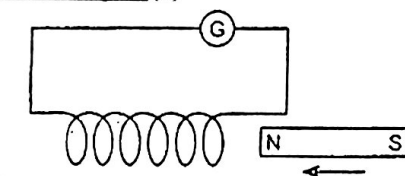
1	ai	Uniform speed is the constant rate of change of distance.	1
	aii	Uniform acceleration is the constant rate of change of velocity.	1
	b	Distance travelled by A = Area under speed-time graph $= 20 \times 14 = 280 = 2.8 \times 10^2 \text{ m (2 s.f.)}$ Distance travelled by B = $\frac{1}{2}(10)(20) = 100 = 1.0 \times 10^2 \text{ m (2 s.f.)}$ Distance between the two cars = $280 - 100 = 180 = 1.8 \times 10^2 \text{ m (2 s.f.)}$	1 1 1
	c	From $t = 0$ to 4 s: distance between the two cars increases at a constant rate. From $t = 4$ to 14 s: distance increases at a decreasing rate.	1
2	a		3
	b	When it is tilted any further, the line of action of the weight of the lorry will fall outside the base area. There will be a clockwise moment of its weight about the bottom right wheel and cause the lorry to topple. [Note: Lorry is currently in unstable equilibrium!]	1 1

	c	The lower the position of the centre of gravity, the more stable the lorry is.	1
3	ai	Mass is the amount of matter present in a body and is a scalar quantity. Weight is the amount of gravitational force acting on a body and is a vector quantity.	1 1
	aii	Increase in G.P.E. = $mg\Delta h = (20)(10)(4.0) = 800 = 8.0 \times 10^2 \text{ J (2 s.f.)}$	1 1
	b	Power = Total work done on 5 suitcases $\div$ time taken $= (5 \times 800) \div 60 = 66.7 = 6.7 \times 10^1 \text{ W (2 s.f.)}$	1 1
4	a	0.40 m (2 d.p.)	1
	b	As the wave is moving to the right, the initial direction of particle B is downwards and it moves downwards till it reaches a maximum negative displacement. It then moves upwards to a maximum possible displacement before moving downwards to its original position to complete one complete cycle.	1 1
	c		1 Any one
	di	Constant speed, $v = \frac{\text{Total distance, } s}{\text{Total time, } t}$ Total distance, $s = vt = 2.0 \times 0.10 = 0.20 \text{ m (2 s.f.)}$	1
	dii		1
5	a	The negatively charged rod is brought near the uncharged metal sphere (but not touching it). The earth connection is connected to the metal sphere. With the charged rod is still held in position, the earth connection is removed and the charged rod removed lastly.	1 1 1

	b	The negatively charged free electrons on the sphere are repelled by the charged rod (to the side furthest from the rod) when the rod is brought near the metal sphere (as like charges repel). When the earth connection is connected to the metal sphere, the free electrons flow from the metal sphere to the earth through the connection (as the earth is at a higher potential).	1 1
	c	$I = Q/t = (2.4 \times 10^{-9}) \div 5.0 \rightarrow (\text{nano, n: } 10^{-9})$ $= 4.8 \times 10^{-10} \text{ A (2 s.f.)}$ (OR: 0.48 nA)	1 1
6	a	1. The live wire was not inserted fully into the live terminal. 2. The cable grip was incorrectly connected over the inner wires instead of over the outer insulation. NOT ACCEPTED: The live wire was not connected to the fuse.	1 1
	b	Earth wire.	1
	c	Wet hands reduce the resistance of the skin and when resistance of the human body is low, very large current can flow from the socket to the body. This can cause an electric shock to the user / electrocute the user.	1
7	ai		2
	aii	The brightness of the lamp decreases. [NOTE: As $R_{SQ} \downarrow$, $V_{SQ} \downarrow$ and p.d. across lamp $\downarrow$]	1
	bi	$I = V/R = 1.0 \div 11 = 0.091 = 9.1 \times 10^{-2} \text{ A (2 s.f.)}$ NOTE: 0.09 V (1 s.f.) will be marked wrong!	1
	bii		3

8	a		1
	b	The coil starts to rotate in a clockwise direction. It will then vibrate at the vertical position, which is a quarter turn (90° clockwise) from its original position, before coming to a rest.	1
	ci	 Split ring commutator	2
	cii	When the split ring commutator is used, the direction of the flow of current in the coil is reversed each time the coil passes the vertical position. This ensures that the force on the left side of the coil (the side nearer the S-pole) is always upwards and the force on the right side of the coil (near the N-pole) is always downwards, in order for the coil to rotate continuously in one direction.	1 1
9	ai	Volume of copper cable = Length $\times$ Cross sectional area $= 5000 \times (3.0 \times 10^{-4}) = 1.5 \text{ m}^3$ Mass = Density $\times$ Volume $= 8900 \times 1.5 = 13\,350 \text{ kg} = 1.3 \times 10^4 \text{ kg (2 s.f.)}$	1 1
	aii	$W = mg = 13350 \times 10 = 133\,500 \text{ N}$ Min. no. of towers = $(133\,500 \div 9000) + 1 \rightarrow 2$ towers for 1 cable $= 14.8 + 1 = 15.8 = 16$ (0 d.p. / 2 s.f.) [Accept: 15]	1 1
	bi	Total R of 5 km of aluminium cable = $5 \text{ km} \times 0.075 \Omega/\text{km} = 0.375 \Omega$ P.d. between grid and factory, V = $IR = (500)(0.375) = 187.5$ $= 1.9 \times 10^2 \text{ V (2 s.f.)}$	1
	bii	$P_{\text{loss}} = I^2 R = (500)^2 (0.375)$ $= 93\,750 \text{ W} = 9.4 \times 10^4 \text{ W (2 s.f.)}$	1 1
	bihi	Cost of power loss per day = $93.75 \text{ kW} \times 24 \text{ h} \times 22 \text{ cents/kWh}$ $= 49500 \text{ cents} = \495	1 1
	ci	Aluminium is less dense ($2\,700 \text{ kg/m}^3$) than copper ($8\,900 \text{ kg/m}^3$) and thus the weight of the aluminium cable will be less than the copper cable. This will reduce the number of towers needed to support the cable.	1

	cii	The resistance per unit length of steel is very high ($210 \Omega/\text{km}$) compared to that of copper ($0.050 \Omega/\text{km}$). This will cause large power lost in a steel cable in the form of heat which overheat the cable.	1
10	ai	1. Optical fibres are lighter and thinner, and being made of glass, are cheaper. 2. Optical fibres can carry a larger volume of information. 3. Optical fibres allow higher quality of information transmission over very long distances, with negligible signal loss. (NOTE: 'Information transmission is faster in optical fibres' is not accepted.)	2 Any two
	aii	In microwave ovens for cooking of food.	1
	bi	Excessive UVA radiation can lead to sunburn and skin damage/cancer.	1
	bii	The longest wavelength will result in the lowest frequency, which is $400 \text{ nm} = 400 \times 10^{-9} = 4.0 \times 10^{-7} \text{ m}$. Lowest frequency for UVA and UVB $= v \div \lambda = (3.0 \times 10^8) \div (400 \times 10^{-9}) = 7.5 \times 10^{14} \text{ Hz}$ (2 s.f.)	1 1
	biii	X rays / Gamma rays	1
11E	a	<u>Labelled diagram:</u> [1]  <u>Readings to be taken:</u> [1] Measure the mercury height from the surface of the liquid in the container to the surface of the liquid in the tube, h in metres. <u>Calculations:</u> [2] Atmospheric pressure, P_{atm} (in Pascals) $= h\rho g$, where h : height of mercury column, in m ρ : density of mercury, in kg/m^3 g : gravitational field strength, 10 N/kg	4
	bi	The internal energy of the air molecules refers to the total energy of the molecules and consists of the kinetic energy and potential energy of the molecules.	1
	bii	$Q = mc\Delta\theta = (0.025)(0.70)(70 - 20) = 0.875 \text{ J} = 0.88 \text{ J}$ (2 s.f.)	1 1
	biii	After t_2 , the temperature of the air starts to drop (as the temperature of the air in the cylinder after t_2 is higher than the surrounding temperature). The air molecules move slower and possess less kinetic energy. There will be less frequent (and less violent) collisions of the air molecules with the walls of the cylinder, resulting in a decreased force per unit area (and hence reduced pressure).	1 1 1

11O	a	When the tuning fork vibrates, a sound wave is produced and regions of compressions and rarefactions are generated, causing layers of air molecules to vibrate left and right. The disc (and thus the magnet) will eventually vibrate too as the energy from the adjacent vibrating air layers is transferred to the disc. As the magnet vibrates, the magnetic field lines of the magnet will cut the coil and cause a <u>constant</u> change in magnetic flux linkages with the coil. By Faraday's Law of Electromagnetic Induction, there will be an induced e.m.f. in the coil.	1 1 1 1
	b	The amplitude of the induced e.m.f. is larger. A louder sound will result in greater amplitude of oscillation of the air molecules and the disc (and magnet) thus moves faster, causing a greater change in magnetic flux linkages with the coil.	1 1
	c	<u>Labelled diagram:</u> [1]  <u>Procedure:</u> [2] 1. Set up a solenoid using a coil of wire and connect both ends of the solenoid to a galvanometer. 2. Insert the north pole of a bar magnet into the solenoid and observe the deflection on the galvanometer. 3. By using the right hand grip rule, the current should be flowing in such a direction that a like pole (north pole) was produced on the end of the solenoid nearest the approaching magnet to oppose its motion. <u>Explanation:</u> [1] Using Lenz's Law, the current will flow in the circuit such that it will oppose the magnetic effect causing it. In this case, a north pole is produced on the end of the solenoid nearest the approaching magnet to oppose its motion and like poles repel each other.	4

Catholic High School | O-Level Physics
5059 Nov 2010
Suggested Answers

NOT IN SYLLABUS:	
P1:	
P2:	

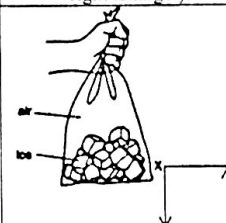
Paper 1 [40 marks]

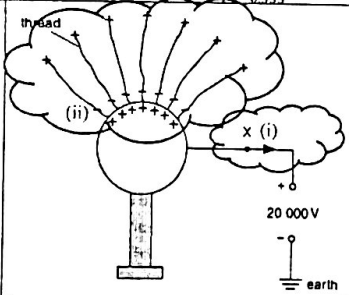
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2	D	12	B	22	C	32	D
3	B	13	D	23	A	33	B
4	C	14	B	24	D	34	A
5	A	15	D	25	B	35	C
6	A	16	C	26	C	36	D
7	B	17	B	27	A	37	A
8	D	18	C	28	B	38	C
9	B	19	C	29	A	39	A
10	B	20	A	30	D	40	C

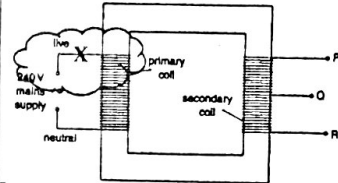
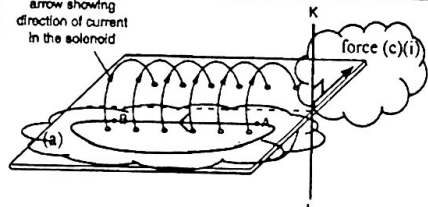
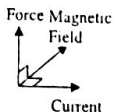
- *Q. 16: (C) Atmospheric pressure pushes equally in all directions, not pushing less upwards than downwards.
(B is incorrect.)
- *Q. 23: (A) Though the rays were still diverging after passing through the lens, it does not mean that the lens is diverging.
(C and D are incorrect.)
- *Q. 29: (A) 0.6 V is needed to make the diode start conducting.
(C is incorrect.)

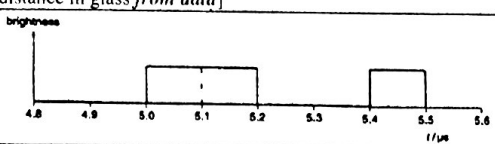
Paper 2 [80 marks]

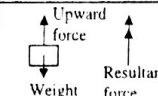
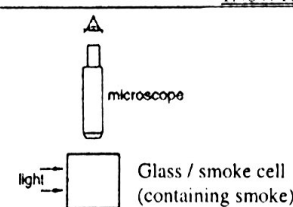
1	a	The stone falls with constant acceleration of $g = 10 \text{ m s}^{-2}$. OR: The stone's speed is increasing at a uniform rate, at $g = 10 \text{ m s}^{-2}$.	1
	b	Area under speed-time graph (= distance travelled) between A & B larger. OR: By calculations, Area between A & B = Distance travelled = $\frac{1}{2}(1.05)(10.0) = 5.25 \text{ m}$ (3 s.f.) Area between C & D = $\frac{1}{2}(1.90 - 1.05)(8.0) = \frac{1}{2}(0.85)(8.0) = 3.4 \text{ m}$ (2 s.f.) < 5.25 m Hence, distance covered between A and B is larger.	1
	ci	Speed is the rate of change of distance / change of distance per unit time while velocity is the rate of change of displacement / change of displacement per unit time. Speed is a scalar quantity and has only magnitude. Velocity is a vector quantity and has both magnitude and direction. [Note: Not 'rate of change of distance per unit time'!]	1
	cii	1) Change in speed = $8.0 - 10.0 = -2.0 \text{ m s}^{-1}$ (1 d.p. / 2 s.f.) Accept: 2.0 m s^{-1} 2) Change in velocity = $(-8.0) - 10.0 = -18.0 \text{ m s}^{-1}$ (1 d.p. / 3 s.f.) Accept: 18.0 m s^{-1}	1
2	a	The Principle of Moments states that <i>when a body is in equilibrium</i> , the sum of clockwise moments about a point equals to the sum of anti-clockwise moments about the same point.	1

	bi	Taking moments about the thread on rod 1: Clockwise moments = Anti-clockwise moments $0.16 \times 4.0 = 0.60 \times d$ $d = 1.07 = 1.1 \text{ cm}$ (2 s.f.)	1
	bii	Weight of R = $\frac{1}{2}(0.60 + 0.16) = \frac{1}{2}(0.76) = 0.38 \text{ N}$ (2 s.f.) Weight of S = Weight of R = 0.38 N (2 s.f.) OR: Taking moments about the thread on rod 2: Clockwise moments = Anti-clockwise moments (Weight of R + Weight of S)(10 cm) = (Weight of P + Weight of Q)(10 cm) Weight of R + Weight of S = $0.60 + 0.16 = 0.76$ Since R and S are same distance away from the thread on rod 3, Weight of R = Weight of S = $0.76 \div 2 = 0.38 \text{ N}$ (2 s.f.)	1
	bihi	Rod 1: It rotates anti-clockwise about the string on it (pivot), and also rises (as rod 2 rotates clockwise) As only P is left on rod 1, there is an anti-clockwise moment about the pivot. Rod 2: It rotates clockwise about the string on it (pivot). The clockwise moment of the total forces on the right about the pivot is larger than the anti-clockwise moment (total forces on the right is larger).	1
3	ai		1
	aii	The air near X is cooled by the ice and <i>contracts</i> , becomes denser and sinks. The surrounding warmer air is less dense and will rise to replace the sinking cool air, thus forming the convection current. (NOTE: The <i>warm air does not expand</i> in this case. It is the cool air which contracts, causing a difference in densities.)	1
	b	Air is a poor conductor / good insulator of heat. Conduction is reduced. The air between the bags is also trapped, thus reducing the possibility of air flow in convection.	1
	c	Assuming no heat loss to the surroundings, Heat gain by ice = Heat loss by surroundings $m_i c_i \Delta T_i = P t$ $(100 \div 1000)(336\ 000) = 24(t)$ $t = 1400 = 1.4 \times 10^3 \text{ s}$ (2 s.f.)	1
4	a	1. Both the emitted pulse and the reflected pulse at the sea bed will travel in all directions. 2. Energy of the pulse is also lost when absorbed by water or by seabed.	1
	bi	$t = (12 \times 50 \text{ ms}) \div 2 = 600 \div 2 = 300 = 3.0 \times 10^{-2} \text{ ms}$ (2 s.f.)	1

	bii	Constant speed, $v = \frac{\text{Total distance, s}}{\text{Total time, t}}$ $300 \text{ ms} = 300 \times 10^{-3} \text{ s}$ Distance, $s = vt = 1500 \times (300 \times 10^{-3})$ $= 450 = 4.5 \times 10^2 \text{ m (2 s.f.)}$	1 1
5	a	A wavefront is an imaginary line joining points with the same phase (or joining points on the corresponding crests of waves).	1
	b	Wave motion is a periodic motion that transfers energy without the transfer of matter. The water particles oscillate/vibrate perpendicular to the direction of motion of the water wave.	2 1
	ci	Scale of diagram is 2.0 cm : 4.0 cm (diagram : actual) i.e. 1.0 cm : 2.0 cm Wavelength, $\lambda = 2.0 \text{ cm}$ (1 d.p./2 s.f.) $\rightarrow$ measured distance is 1.0 cm OR: Actual distance between A and B = $6.0 \times 2 = 12.0 \text{ cm}$ No. of wavelengths between A and B = 6 Wavelength, $\lambda = 12.0 \div 6 = 2.0 \text{ cm}$ (1 d.p./2 s.f.)	1
	cii	Actual distance between A and B = $6 \times 2.0 = 12.0 \text{ cm}$ (Constant) speed of wave, $v = \frac{\text{Total distance, s}}{\text{Total time, t}}$ $= 12 \div 2.0 = 6.0 \text{ cm s}^{-1}$ (2 s.f.) OR: Period of wave, $T = 2.0 \text{ s} \div 6 \text{ wavelengths} = 0.333 = 0.33 \text{ s}$ (2 s.f.) Speed of wave, $v = f\lambda = \left(\frac{1}{0.333}\right)(2.0 \text{ cm}) = 6.0 \text{ cm s}^{-1}$ (2 s.f.)	1
	ciiii	Frequency of wave, $f = v \div \lambda = 6.0 \div 2.0 = 3.0 \text{ Hz}$ (2 s.f.) OR: Period of wave, $T = 2.0 \text{ s} \div 6 \text{ wavelengths} = 0.333 = 0.33 \text{ s}$ (2 s.f.) Frequency of wave, $f = \frac{1}{T} = \frac{1}{0.333} = 3.0 \text{ Hz}$ (2 s.f.)	1
6	a		1 1
	b	There are forces acting on the charged threads and the threads show the direction of the electric field by pointing in the direction of the field.	1
	c	Aircraft refuelling / petrol tankers / lightning. • For aircraft refuelling / petrol tankers, the danger is reduced by earthing, by connecting the aircraft / petrol tankers to the ground by means of a metal chain. • For lightning, a lightning conductor is connected to earth.	1 1
7	ai	6000 turns (output and input voltages are the same)	1

	aii	$\frac{N_{PQ}}{N_{primary}} = \frac{V_{PQ}}{V_{primary}}$ $\frac{N_{PQ}}{6000} = \frac{110}{240}$ $N_{PQ} = 2750 = 2.8 \times 10^3 \text{ turns (2 s.f.)}$	1 1
	bi		1
	bii	When placed in the live wire, the fuse can melt and switch off a high voltage / high current. This will prevent the large current from damaging the transformer or stop the possibility of electrocution. (NOTE: A fuse placed in the neutral wire will melt just as readily as a fuse in the live wire if there is just a large current in the live and neutral wires.)	1 1
	c	An earth wire is not required if the casing of the electrical device is an insulator. Some electrical devices do not use high voltages.	1
8	a		2 1
	ci	[NOTE: The magnetic field line MUST pass through A and B, as stated in the question.]	
	bi	Strength: Remains the same. Direction: Reversed (direction is now from B to A).	1
	bii	The magnetic field lines are closer together.	1
	cii	Fleming's left hand rule states that when the direction of the magnetic field (represented by the index/first finger) is perpendicular to the direction of conventional current flow (represented by the middle/second finger) in the wire KL, the direction of the force acting on the wire is represented by the thumb, and all three fingers are perpendicular to each other. 	2
9	a	Speed of light in glass for ray 1, $v = \frac{\text{Total distance, s}}{\text{Total time, t}} = 1000 \text{ m} \div (5.0 \times 10^{-6}) \text{ s} = 2.0 \times 10^8 \text{ m s}^{-1}$ Refractive index, $n = \frac{c}{v} = \frac{3.0 \times 10^8}{2.0 \times 10^8} = 1.5$ (2 s.f.)	1 1
	b	$n = \frac{\sin i}{\sin r} \Rightarrow 1.5 = \frac{\sin 35^\circ}{\sin r}$ $r = 22.48 = 22^\circ$ (2 s.f.)	1 1

ci *	Ray 2 travels 54 m further than ray 1, and hence spends a longer time of 0.3 μ s in the fibre. Ray 3 travels 164 m further than ray 1, and hence spends a longer time of 0.8 μ s in the fibre. [Note: At least 2 rays related to time of travel in glass or distance in glass <i>from data</i>]	1
cii		2
ciii	Time allowed between pulses = 0.9 μ s No of pulses for light that leave the 2 km fibre in 1 s = $1 \text{ s} \div (0.9 \times 10^{-6}) \text{ s}$ = 1.1×10^6 (2 s.f.)	1 1
civ *	At long distances, the difference in time between a ray and another ray emerging becomes larger. [OR: The width/ length of one pulse increases.] [OR: The pulses become more spread out in time / distance.]	1
10 ai	(Since the lamps are connected in series and has normal brightness, the p.d. across each lamp is 12 V.) No. of lamps = $240 \text{ V} \div 12 \text{ V} = 20$ lamps	1
aii	$I = P \div V = 2 \div 12$ = 0.167 = 0.17 A (2 s.f.)	1 1
aiii	$R = V \div I$ = $240 \div 0.167$ = $1440 = 1.4 \times 10^3 \Omega$ (2 s.f.)	1 1 1
bi	$P = \frac{V^2}{R} \Rightarrow R = \frac{V^2}{P}$ R of replacement lamp at normal brightness = $\frac{V^2}{P} = \frac{6.0^2}{2.0} = 18 \Omega$ R of original lamp at normal brightness = $\frac{V^2}{P} = \frac{12^2}{2.0} = 72 \Omega$ The resistance of the replacement lamp is smaller than that of the original.	1 1
bii	The remaining 12 V lamps will be brighter. When the replacement lamp is used, the overall resistance of the series circuit decreases and the current in the circuit increases. Also the p.d. across each 12 V lamp in series is higher. Hence the lamps are brighter as brightness depends on $P = IV$.	1 1
11 E ai	Energy cannot be created nor destroyed. It can only be converted from one form to another or transferred from one body to another but the total amount remains constant.	1 1
aii	By the Principle of Conservation of Energy: G.P.E. of object at the top = K.E. of object at the bottom = constant. $\Rightarrow mgh = \frac{1}{2}mv^2 \Rightarrow v = \sqrt{2gh}$. The value obtained is only approximate as the calculations do not take into account the work done against air resistance as some of the energy of the object becomes the thermal energy (heat) or kinetic energy of the air.	1 1
bi	$a = \frac{v-u}{t} \Rightarrow 0.40 = \frac{v-0}{\frac{20}{20}}$ $v = 8.0 \text{ m s}^{-1}$ (2 s.f.)	1 1

bii	Resultant force, $F = ma = 14\,000 \times 0.40$ = $5600 = 5.6 \times 10^3 \text{ N}$ (2 s.f.)	1 1
biii	 Resultant force, $F = \text{Upward force} - \text{Weight}$ 5 600 = Upward force - 140 000 Upward force = 145 600 (whole no.) = $1.46 \times 10^5 \text{ N}$ (3 s.f.)	1 1 1
11 O ai	 microscope light Glass / smoke cell (containing smoke)	2
aii	Bright specks of lights (which are the smoke particles) are seen to move with constant, random motion. (NOTE: Not 'at high speeds', which is for air particles) The air particles collide <u>unevenly</u> with the smoke particles from all directions. Thus the smoke particles move in the direction of the resultant force.	1 1 1
bi	Atmospheric pressure + Pressure due to weight of piston = Pressure of gas $P = \frac{F}{A}$ $1.0 \times 10^5 + \frac{\text{Weight of piston, } W}{4.0 \times 10^{-4}} = 1.5 \times 10^5$ $\frac{W}{4.0 \times 10^{-4}} = 0.5 \times 10^5$ $W = 20 = 2.0 \times 10^1 \text{ N}$ (2 s.f.) Mass of piston, $m = W \div g = 20 \div 10 = 2.0 \text{ kg}$ (2 s.f.)	1 1 1 1
bii	Many air molecules are frequently hitting the walls of the pistons at high speeds and rebound. These air molecules exert an upward force (per unit area) on the walls to support the weight of the piston.	1 1

Catholic High School / O-Level Physics
5059 Nov 2011
Suggested Answers

NOT IN SYLLABUS:	
P1:	
P2:	

Paper 1 [40 marks]

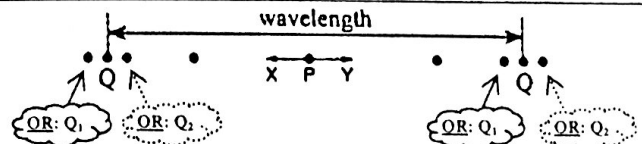
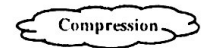
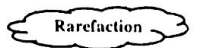
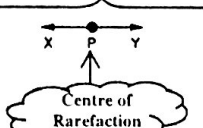
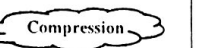
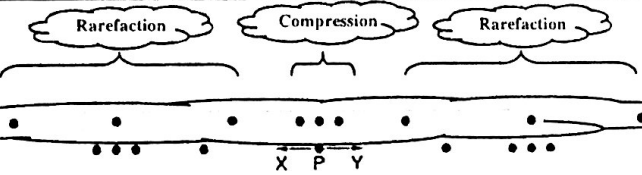
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2	C	12	C	22	C	32	C
3	B	13	B	23	A	33	B
4	C	14	D	24	B	34	D
5	B	15	B	25	C	35	A
6	A	16	C	26	B	36	B
7	A	17	B	27	C	37	D
8	C	18	A	28	B	38	D
9	C	19	D	29	A	39	A
10	B	20	A	30	B	40	D

- *Q. 11: (D) The mass is momentarily stationary at both extremes of the vibration, so at points P and Q there is no kinetic energy.
(C is incorrect.)
- *Q. 23: (A) The diverging rays entering lens A diverge more slowly after the lens, so it is the converging lens.
OR: The light rays entering lens A are bending 'inwards' from their original direction of travel.
(C is incorrect. The rays converge more slowly (with distance) after the lens, so it must be a diverging lens.)
- *Q. 33: (B) Only 2 events will cause the fuse to blow:
* A person touches the earth wire. → nothing will happen
* A person touches the neutral wire. → current passes through appliance then through the person, electrocuting him
* A person touches the live wire. → current passes through the person (whose body still has resistance)
✓ The live wire touches the neutral wire. → current short-circuits and skips the appliance
✓ The live wire touches the earth wire. → current short-circuits and skips the appliance
(C is incorrect.)
- *Q. 36: (B) Zero induced e.m.f. must mean that the magnet is stationary, i.e. at the highest and lowest points.
(A and C are incorrect.)

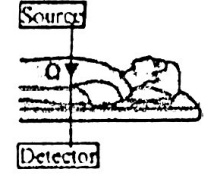
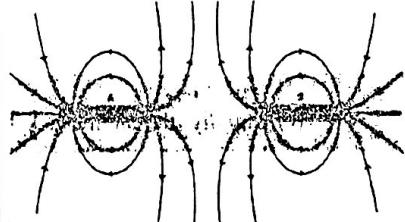
Paper 2 [80 marks]

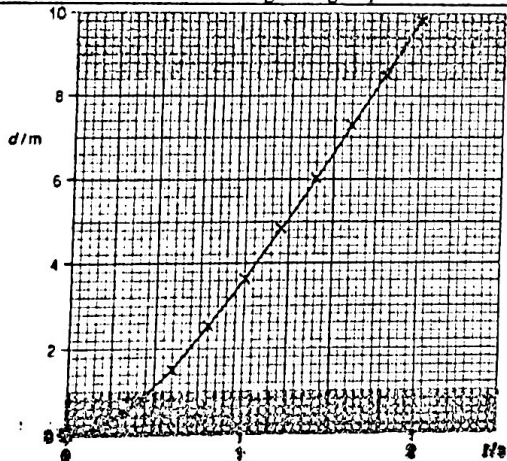
1	a	Pressure is the force acting (normally) per unit area. [Note: NOT 'force on an area' or just simply writing the formula ' $P = \frac{F}{A}$ '.]	1
	b	Pressure of gas = Pressure of water + Atmospheric pressure = $h\rho g + (1.0 \times 10^5)$ = $(0.8 \text{ m} - 0.2 \text{ m})(1000)(10) + (1.0 \times 10^5)$ = $106\,000$ (0 d.p.) = $1.06 \times 10^5 \text{ Pa}$ (3 s.f.)	1

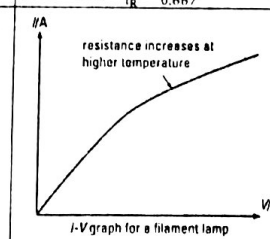
	c	When the temperature of the gas increases, the thermal energy supplied is converted to the kinetic energy of the molecules, and they move faster. [Note: Not 'vibrate faster'.] The molecules collide with the walls of the container more frequently and with a greater force. The sum of the forces per unit area increases and the pressure increases.	1
2	a	The Law of Conservation of Energy states that • Energy can neither be created nor destroyed in any process. • It can be converted from one form to another, or • It can be transferred from one body to another, but • The total amount remains constant	2
	bi	Loss in GPE = $mgh = (90)(10)(60) = 54\,000 = 5.4 \times 10^4 \text{ J}$ (2 s.f.) [Note: Loss in GPE $\neq$ GPE - KE]	2
	bii	Increase in KE = $\frac{1}{2}mv^2 = \frac{1}{2}(90)(12)^2 = 6\,480 = 6.5 \times 10^3 \text{ J}$ (2 s.f.) [Note: Increase in KE $\neq$ Loss in GPE. 'Increase in KE = Loss in GPE' does not apply all the time! E.g. only for an object falling from rest.]	1
	c	The loss in GPE and the increase in KE is not the same because of the production of thermal energy due to friction on the road and air resistance. The Law of Conservation of Energy applies to this situation as the loss in GPE is equal to the sum of the increase in KE and other forms of energy such as thermal energy.	1
3	ai	Thermocouple.	1
	aii	The thermocouple junction is small and the metallic junctions also have low specific heat capacity (OR: metallic junctions are good thermal conductors). Thus a thermocouple responds quickly to any change in temperature / a thermocouple is responsive . [Note: This question is talking about responsiveness, not sensitivity.]	1
	bi	In 1 s, 2500 J of thermal energy is supplied to 75 g of cold air. $Q = mc\Delta\theta$ Change in temperature, $\Delta\theta = \frac{Q}{mc} = \frac{2500}{(75)(1.1)} = 30.3 = 30^\circ\text{C}$ (2 s.f.) Temperature of hot air that emerges = $20 + 30.3 = 50.3 = 50$ (0 d.p.) = $5.0 \times 10^1^\circ\text{C}$ (2 s.f.)	1
	bii	Water boils only at 100°C . However, it can evaporate at any temperature. [Note: Not vague answers like 'there is not enough energy to boil'.]	1
4	a	The distance between adjacent particles increases to a maximum, or decreases to a minimum. [Note: Not 'The distance does not change'.]	1

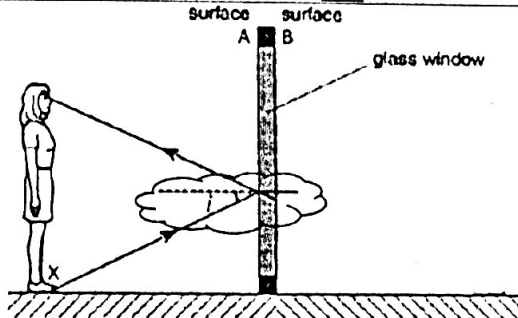
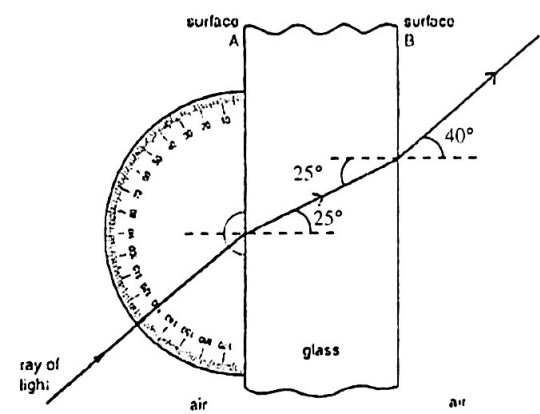
b	*	 [NOTE: There are 3 possible sets of particles that are 1 wavelength apart.] For info below: Note the centres of compression and of rarefaction  Compression  Centre of Compression  Rarefaction  Centre of Rarefaction  Compression  Centre of Compression	1
		ci Amplitude = $6.0 \div 2 = 3.0 \text{ mm}$	1
		cii Period of wave, $T = 2.0 \text{ s}$ $f = \frac{1}{T} = \frac{1}{2.0} = 0.50 \text{ Hz}$ (2 s.f.)	1
		ciii $v = f\lambda = (0.5)(0.40 \text{ m})$ $= 0.20 \text{ m s}^{-1}$ (2 s.f.)	1
		civ  [NOTE: At $t = 0.3 \text{ s}$, the waves have moved 1.5 wavelengths from its original position. This means that where there was a region of compression, it would now be a region of rarefaction and vice versa.]	1

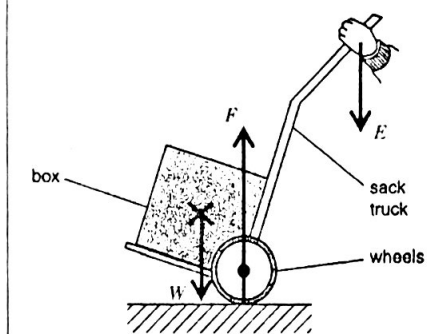
5	a	Microwaves	1
	bi	Radio waves	1
	bii	Infra-red	1
	biii	Microwaves	1
	c	Ultrasound is high-frequency sound wave and is a longitudinal wave (not a transverse wave). [NOTE: Not just vague answers like 'Ultrasound is high-frequency sound wave' or 'Ultrasound cannot be heard'.]	1

d	ultrasound  X-ray  [NOTE: The method of imaging differs in ultrasound and X-rays. Ultrasound is reflected and X-rays are transmitted through the body.]		2
	6	a (Surface) electrons are transferred from the cloth to the plastic. The plastic has excess electrons and becomes negatively charged, while the cloth has excess positive charges and becomes positively charged. [NOTE: Transfer of 'electrons', not just transfer of 'negative charges'. And not transfer of 'positive charges'.] b The piece of metal is an electrical conductor, so any excess charges on the metal will be earthed (through the hand). ci Energy in an average lightning strike = Pt $= (100)(5.0 \times 10^6) = 5.0 \times 10^8 \text{ J}$ (2 s.f.) cii Average power released by all the lightning strikes in the world = $\frac{\Delta E}{t}$ $= \frac{\text{Total energy released by the 90 lightning strikes around the world in 1 s}}{1 \text{ s}}$ $= \frac{90(5.0 \times 10^8)}{1} = 4.5 \times 10^{10} \text{ W}$ (2 s.f.) [NOTE: Average power $\neq 90 \times 100 \text{ W}$.] 1 ciii Average e.m.f. of a lightning strike = $\frac{W}{Q}$ $= \frac{5.0 \times 10^8}{4.0} = 1.25 \times 10^8 = 1.3 \times 10^8 \text{ V}$ (2 s.f.)	1
	d	Laser printer / Photocopier OR: Electrostatic precipitator / Spray painting / Crop sprayers [NOTE: Not 'generator'.]	1
	7	a The force of repulsion is larger than the force of attraction (as the N-poles are closer together). [NOTE: Not • 'the N-poles repel each other', or • 'like poles repel' - it is already mentioned in the question that 'the N-pole of magnet A repels the N-pole of magnet B...']	1
	b	 Symmetrical [1] Field lines not crossing [1] Correct direction [1] [NOTE: • Field lines cannot cross each other (especially near poles), • Field lines cannot pass through neutral point.]	3

		<i>To improve the answer:</i> 1. Do not draw too many lines at each pole. 2. Draw fewer lines (symmetrically), each starting from a separate point on the surface of the magnet near the poles.	
8	a	As the coil is rotated and cuts the magnetic field, there is a change in the magnetic flux linkage with the coil. By Faraday's Law of Electromagnetic Induction, an e.m.f. is induced in coil. [NOTE: Not just 'the magnetic field changes'.]	1
	b	The slip rings provide electrical contact between the coil and the external circuit, and thus ensure that the output voltage (and current) is alternating. It also prevents the coil from entangling as the coil rotates.	1
	c	Using Fleming's Left-Hand Rule, the direction of force acting at X is downwards, due to the direction of the current. This will create an anti-clockwise moment to oppose the rotation of the coil. [NOTE: Not just by quoting Lenz's Law, without explaining how the coil's motion is affected; or wrongly stating 'a new current would flow in the opposite direction to X, thereby opposing the current at X'.]	2
9	a	The distance fallen from 0.20 s to 0.40 s is $0.74 - 0.19 = 0.55$ m. The distance fallen from 0.40 s to 0.60 s is $1.56 - 0.74 = 0.82$ m. Since the distance fallen increases for the same period of time, the speed of the light shuttlecock is increasing at $t = 0.40$ s. OR: Average speed at 0.20 s = $\frac{\Delta s}{\Delta t} = \frac{0.19}{0.20} = 0.95 \text{ m s}^{-1}$ Average speed at 0.40 s = $\frac{\Delta s}{\Delta t} = \frac{0.74}{0.20} = 3.7 \text{ m s}^{-1}$ Average speed at 0.60 s = $\frac{\Delta s}{\Delta t} = \frac{1.56}{0.20} = 7.8 \text{ m s}^{-1}$ Since average speed is increasing from $t = 0.20$ to 0.60 s, the speed of the light shuttlecock is increasing at $t = 0.40$ s. [NOTE: Need to use data in the table and not just merely giving general statements such as 'the distance gets larger'.]	1
	b		2
	bii	The gradient of the graph becomes constant after around 0.8 s. OR: The line becomes a straight line after around 0.8 s.	1

		[NOTE: Not just 'It reaches constant speed'. 'Explain how the graph shows ...' means that the answer must be linked to the graph.]	
	biii	Terminal velocity, $v = \text{Gradient from } 1.80 \text{ to } 2.00 \text{ s}$ $= \frac{\Delta s}{\Delta t} = \frac{9.81 - 8.56}{2.00 - 1.80} = \frac{1.25}{0.20} = 6.25 = 6.3 \text{ m s}^{-1} \text{ (2 s.f.)}$ [NOTE: Not ' $v = \frac{s}{t} = \frac{9.81}{2.00}$ ', which is the average speed!]	1
	biv	As it falls, the velocity and the air resistance on it increase. When air resistance is equal to its own weight, the forces are balanced and there's no resultant force and acceleration, and it reaches terminal velocity.	1
	ci	1. During the first 0.40 s, both shuttlecocks travelled the same distance / with the same speed. 2. After $t = 0.40$ s, the heavier shuttlecock travelled a larger distance / has a larger speed or larger acceleration. 3. The heavier shuttlecock took a longer time (around $t = 1.80$ s) to reach terminal velocity. 4. The heavier shuttlecock had a larger terminal velocity (of $v = \frac{11.07 - 9.59}{2.00 - 1.80} = \frac{1.48}{0.20} = 7.4 \text{ m s}^{-1}$).	2 Any two
	cii	1. The heavier shuttlecock has a larger resultant force at any given speed, hence it has a larger acceleration. 2. The heavier shuttlecock requires a higher air resistance and thus higher terminal velocity to balance the larger weight.	1
10	a	$I_P = \frac{P}{V} = \frac{100}{240} = 0.417 = 0.42 \text{ A (2 s.f.)}$ $I_Q = \frac{P}{V} = \frac{60}{240} = 0.25 \text{ A (2 s.f.)}$ $I_R = 0.417 + 0.25 = 0.667 = 0.67 \text{ A (2 d.p. / 2 s.f.)}$	1
	bi	$P = \frac{V^2}{R} \Rightarrow R = \frac{V^2}{P} = \frac{240^2}{60} = 960 = 9.6 \times 10^2 \Omega \text{ (2 s.f.)}$ OR: $R = \frac{V}{I} = \frac{240}{0.25} = 9.6 \times 10^2 \Omega$	1
	bii	$R_{\text{total}} = \left(\frac{1}{R_A} + \frac{1}{R_B}\right)^{-1} = \left(\frac{1}{580} + \frac{1}{960}\right)^{-1}$ $= 362 = 3.6 \times 10^2 \Omega \text{ (2 s.f.)}$ [NOTE: State the formula for resistors in parallel!] OR: $R_{\text{total}} = \frac{V}{I_R} = \frac{240}{0.667} = 360 = 3.6 \times 10^2 \Omega$	1
	ci	 The voltage across each lamp was lower when connected in series (the e.m.f. is shared by both lamps in ratio to the resistance, in a series circuit which acts as a potential divider). With reference to the I-V graph of a filament lamp drawn, filament lamps are non-ohmic conductors which operate at a lower temperature with a lower voltage, and thus have a lower resistance. [NOTE: Not 'In a series circuit, the voltage is reduced and the current is increased as $R \uparrow \left(\frac{V}{I}\right)$.']	1
	cii	$V_A = \left(\frac{R_A}{R_A + R_B}\right) \times 240 = \left(\frac{95}{95 + 830}\right) \times 240 = \frac{95}{925} \times 240$ $= 24.6 = 25 \text{ V (2 s.f.)}$	1

		OR: $I = \frac{V}{R_{\text{total}}} = \frac{240}{95 + 830} = 0.259 \text{ A}$ $V_A = IR_A = (0.259)(95) = 24.6 = 25 \text{ V}$	
11	ai	 [NOTE: Not a light ray from eye to foot!]	1 1
	aii	The angle of incidence is the angle between the incident ray and the normal to the surface at the point of incidence.	1
	bi	Angle of incidence, $i = 40^\circ$ $n = \frac{\sin i}{\sin r} \Rightarrow \sin r = \frac{\sin i}{n}$ $r = \sin^{-1} \left(\frac{\sin i}{n} \right) = \sin^{-1} \left(\frac{\sin 40^\circ}{1.5} \right)$ $= 25.4 = 25^\circ \text{ (2 s.f.)}$	1 1 1
	bii		1
	ci	Total reflection of light totally within the optical denser medium, when it strikes the boundary between two media at an incidence angle greater than the critical angle of the optically denser medium.	1
	cii	The light is travelling from an optically less dense medium to an optically denser medium. Total internal reflection can only happen when the ray of light is in the optically denser medium.	1
	ciii	The angle of incidence at surface B is always less than the critical angle of	1

	*	glass, thus total internal reflection cannot occur at surface B. [Note: The angle of incidence at surface A is always less than 90° , hence the angle of incidence at surface B is always less than critical angle.]	
11	ai	 [Note: The force F between the ground and the wheels is the reaction force from the ground. It is not a frictional force as the truck is not moving.]	3
	aii	When an object is in equilibrium, the sum of clockwise moments about any point is equal to sum of anti-clockwise moments about the same point.	1
	aiii	The perpendicular distance between the line of action of the effort and the pivot (at the wheel) is larger. Thus for the same moment required to lift the load, the effort required is less. [Or: For the same effort applied, the moment of the effort about the pivot is larger.]	1 1
	b	Taking moments about the pivot: Total moment = $Fd = 2 \times (140 \times 0.8) = 224 = 2.2 \times 10^2 \text{ Nm}$ (anti-clockwise)	1
	c	Take moments about S: Clockwise moments = Anti-clockwise moments $T_R \times (1.6 - 0.40) = 180 \times (1.6 \div 2)$ $(1.2)T_R = 144$ $T_R = 120 = 1.2 \times 10^2 \text{ N}$ (2 s.f.)	1 1 1

Catholic High School | O-Level Physics
5059 Nov 2012
Suggested Answers

NOT IN SYLLABUS:	
P1:	
P2:	

Paper 1 [40 marks]

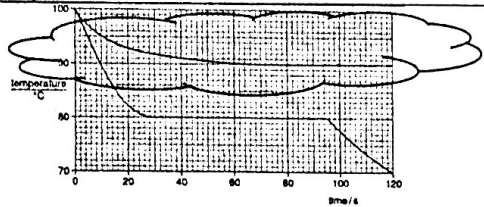
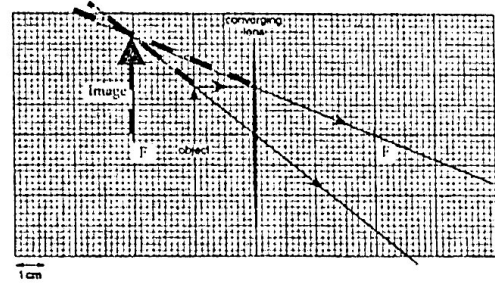
1	A	11	A	21	A	31	A
2	A	12	D	22	D	32	D
3	A	13	D	23	B	33	B
4	B	14	B	24	C	34	A
5	C	15	B	25	B	35	C
6	B	16	B	26	C	36	D
7	B	17	D	27	B	37	B
8	A	18	B	28	D	38	C
9	B	19	C	29	D	39	D
10	C	20	A	30	A	40	A

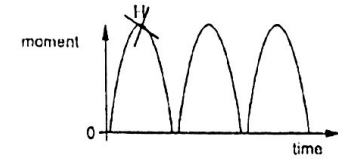
- *Q. 6: (B) The weight of the rocket must not be neglected. In $F = ma$, F is the resultant force. Thus F is not the thrust alone but $F = \text{thrust} - \text{weight}$.
(D is incorrect.)
- *Q. 13: (D) There is kinetic energy at the top of the hill.
(A is incorrect.)
- *Q. 22: (D) The image cannot be formed at the mirror surface unless the object is at the mirror surface.
(B is incorrect.)
- *Q. 23: (B) There is partial reflection at the boundary.
(A and D are incorrect.)
- *Q. 24: (C) The ray from O enters the lens normal to the surface PQ because O is the centre of the circle. Bending of the ray cannot occur at surface PQ, so D cannot be correct.
(D is incorrect.)
- *Q. 34: (A) The flat part of the curve in B suggests that the resistance has become constant, which is inconsistent with as it is stated that 'the resistance of the thermistor decreases as its temperature increases' in the question.
(B is incorrect.)
- *Q. 40: (A) The question asked for the current in the primary coil.
(C is incorrect.)

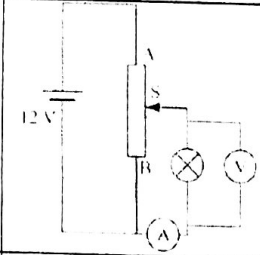
Paper 2 [80 marks]

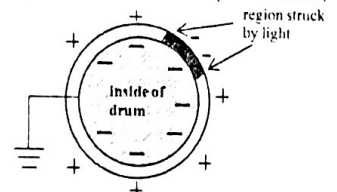
1	a	$a = \frac{v-u}{t} = \frac{25-20}{10-6}$ $= \frac{5}{4} = 1.25 = 1.3 \text{ m s}^{-2} \text{ (2 s.f.)}$	2
	b	The shaded area under the speed-time graph represents the distance travelled by the car, when it decelerated with constant deceleration between 10 – 16 s.	1
	ci	The average speed of the car is the total distance travelled divided by the total time taken. [Note: Not 'total distance per unit time.'!]	1

*	ci	The speed of the car between 6 – 16 s is always higher than 20 m s^{-1} . Between 0 – 20 s, the speed of the car is 20 m s^{-1} for half the journey. [Or: The time between 6 – 16 s is half the time taken during the journey. However the distance travelled is more than half.] [Or (longer method): Average speed between 6 – 16 s $= \frac{\text{Total distance}}{\text{Total time}} = \frac{\frac{1}{2}(4)(20+25) + \frac{1}{2}(6)(25+20)}{10}$ $= \frac{225}{10} = 22.5 = 23 \text{ m s}^{-1} \text{ (2 s.f.)}$ Average speed between 0 – 20 s $= \frac{\text{Total distance}}{\text{Total time}} = \frac{225 + (10)(20)}{20} = \frac{425}{20}$ $= 21.25 = 21 \text{ m s}^{-1} \text{ (2 s.f.)} < 23 \text{ m s}^{-1}$] [Note: Need to show comparison between 6 – 16 s and 0 – 20 s.]	1
2	a	Chemical potential energy (of swimmer) $\rightarrow$ Kinetic energy (of swimmer).	1
	b	K.E. $= \frac{1}{2}mv^2 = \frac{1}{2}(60)(0.80)^2$ $= 19.2 = 19 \text{ J (2 s.f.)}$	1
*	ci	The swimmer does work on the water by exerting a force backwards on the water, and pushes the water backwards. [Note: Need to demonstrate 'work done', by showing the idea of 'a force applied' and 'a distance moved' $\rightarrow$ work done by swimmer or on the water]	1
	ci	The work done by the swimmer on the water eventually becomes the thermal energy of the water. [Note: Not 'kinetic energy of water'.]	1
3	a	EM waves are able to travel through a vacuum. [OR: EM waves travel at the speed of $3 \times 10^8 \text{ m s}^{-1}$ in a vacuum.]	1
	bi	Visible light and infra-red radiation.	1
	bi	1. Less current $\rightarrow$ There is less infra-red radiation emitted (filament is less hot). 2. Colour of filament from white to red $\rightarrow$ The radiation emitted has lower frequency/ higher wavelengths. [Or: Only the visible red part of the EM spectrum is emitted.]	1
	ci	Metal is a good conductor of heat and hence heat is conducted from the metal filament to the metal support.	1
	ci	When the nitrogen gas is heated by the metal filament, it expands and becomes less dense and rises. The cooler, less dense nitrogen gas sinks to form convection current (to be heated by the metal filament).	1
4	a	$\rho = \frac{m}{V}$ Mass of (cold or hot) air $= \rho V = (0.0012)(30) = 0.036 \text{ g}$ Density of cold air $= \frac{m}{V} = \frac{0.036}{20} = 0.0018 \text{ g cm}^{-3} \text{ (2 s.f.)}$	1
	bi	The molecules in the cylinder are in constant, random motion and collide with the walls of the cylinder, thus exerting a force per unit area.	1
	bi	In Fig. 4.2, the molecules of the cold air are moving slower at a lower temperature and collide less frequently and less hard on the walls of the cylinder.	1

		The molecules exert a smaller force but also on a smaller area (as the total volume has decreased), to create the same pressure in Fig. 4.2.	1
	c	As the cylinder is cooled and the pressure of the air inside decreases, the larger atmospheric pressure outside pushes the piston to move inwards.	1
5	a	95 s	1
*	b	The liquid is at a higher temperature (70 to 100 °C) compared to the surroundings (20 °C) throughout the experiment.	1
	c	1. Thermal energy is lost to the laboratory as latent heat of fusion. 2. Intermolecular bonds are being formed. 3. There is a change in state from liquid to solid/ the kinetic energy of the particles remains constant.	2 Ans 2
	d	 [Note: Beaker of water is kept at temperature of 90°C.]	1
6	a	 [NOTE: 1. Image to be formed at 4.0 cm, ± 1 small square. 2. Dotted lines for virtual image.]	3
	b	The image is formed by dotted lines, which are not light rays but which appear to come from the object.	1
	c	1. The image becomes less enlarged. 2. The image moves closer to the lens.	2
7	a	Total resistance = $(\frac{1}{R_1} + \frac{1}{R_2})^{-1} = (\frac{1}{30+30} + \frac{1}{10+30})^{-1} = (\frac{1}{60} + \frac{1}{40})^{-1}$ $= 24 \Omega$ (2 s.f.)	1 1
	b	$V = IR \Rightarrow I = \frac{V}{R} = \frac{6}{24} = 0.25 \text{ A}$ (2 s.f.)	1 1
	ci	The potential difference is shared equally between the two resistors in series, which both have the same resistance.	1
	cii	Potential difference between C and D = $\frac{R_1}{R_1 + R_2} \times 6.0 = \frac{30}{30 + 10} \times 6.0 = 4.5 \text{ V}$ (2 s.f.)	1

*	ciii	Potential difference between A & C = Potential at C - Potential at A $= 4.5 - 3.0 = 1.5 \text{ V}$ (2 s.f.) [NOTE: p.d. = higher potential - lower potential]	1
8	ai	When the switch is closed, the current in the coil generates a magnetic field which interacts with the magnetic field of the magnet to produce an unbalanced resultant magnetic field. This causes an upward force to be produced on the side of the coil near the North pole, and a downwards force on the side of the coil near the South pole (using Fleming's Left Hand Rule).	1 1
	aii	When the coil passes the vertical position, the direction of the current in the coil reverses (due to the split ring commutator). This causes the force on the side of the coil near the North pole to be in the same upwards direction (and the force on the side of the coil near the South pole to be in the same downwards direction), and coil rotates clockwise.	1 1
	bi		1
	bii	1. The amplitude (maximum moment) on Fig. 8.2 increases. 2. The period on Fig. 8.2 decreases. [OR: The frequency on Fig. 8.2 increases.]	1 1
9	ai	Similarity: The speeds of water waves in both deep and shallow water increase with wavelengths (up to wavelengths of 400 m). [OR: The speeds of water waves in both deep and shallow water are similar (up to wavelengths of 40 m).]	1
	aii	Difference: The speed of water waves increases constantly with wavelength in deep water, but the speed of water waves stop increasing and become constant from wavelength of 400 m onwards.	1
	bi	The first wave to reach the ship is the wave with the fastest speed, i.e. 30.6 m s ⁻¹ . Constant speed, $v = \frac{s}{t}$ Time taken, $t = \frac{s}{v} = \frac{2000000}{30.6} = 65400 = 6.54 \times 10^4 \text{ s}$ (2 or 3 s.f.)	1 1
	bii	$V = f\lambda \Rightarrow f = \frac{v}{\lambda} = \frac{30.6}{600} = 0.051 \text{ Hz}$ (2 s.f.)	1 1
*	bihi	Time taken for wave to arrive (4 hrs after first wave) $= (6.54 \times 10^4) + (4)(60)(60) = 79800 \text{ s}$ Speed of wave, $v = \frac{s}{t} = \frac{2000000}{79800} = 25.1 \text{ m s}^{-1}$ (2 or 3 s.f.) From Fig 9.1, wavelength of wave is approximately 400 m (nearest 100 m), with a speed of 25.0 m s ⁻¹ .	1 1
	biv	1. The ship will oscillate up and down. 2. The ship will oscillate up and down, at a higher frequency/ with a lower period.	1 1

10	ai		3
	aii	1. The student gradually increases the current from zero by increasing the potential difference across the lamp (by moving the contact S from point B to A in the previous diagram). 2. As the current in the lamp increases, the temperature of the lamp increases. Thus the resistance of the lamp increases. [Note: 'The lamp is non-ohmic' is insufficient and does not gain any mark.]	1 1 1
	bi	$I = \frac{Q}{t} \Rightarrow Q = It = (0.20)(4.0 \times 60)$ $= 48 \text{ C (2 s.f.)}$	1 1
	bii	$V = \frac{W}{Q} = \frac{390}{48}$ $= 8.125 = 8.1 \text{ V (2 s.f.)}$	1 1
11	a	Wire A is connected to the switch and is the live wire. When the lamp is switched off, the lamp is not 'live' and it is safe to touch/safe to change the bulb. [Or: The lamp is not at high potential.]	1 1
	bi	The fuse will melt and break the circuit when the current is too high for the lamp to operate safely. This will prevent the overheating of the lamp/ wires.	2 1
	bii	When wire A touches the metal case, the current will flow to earth and melt the fuse (creating an open circuit).	1
	ci	$P = \frac{V^2}{R} \Rightarrow R = \frac{V^2}{P} = \frac{230^2}{100}$ $= 529 \Omega \text{ (2 or 3 s.f.)}$	1 1
	cii	$R = \frac{V^2}{P} = \frac{230^2}{60} = 882 \Omega \text{ (2 or 3 s.f.)}$ Ratio of resistance of first lamp to second lamp $= \frac{230^2}{100} : \frac{230^2}{60} = \frac{1}{100} : \frac{1}{60} = 60 : 100 = 3 : 5 \text{ or } 0.60 \text{ (2 s.f.)}$	1
	d	1. The lamp has a case which is made of plastic (non-metal). 2. No current can flow in the plastic case. 3. The plastic case cannot be live.	1 Any
11	ai	1. The positively charged rod is brought near the metal plate. 2. The lead connected to earth is brought into contact with the metal plate. 3. The lead connected to earth is then disconnected from the metal plate. 4. The positively charged rod is then removed.	1 1 1 1

	aii	When the positively charged rod is brought near the metal plate, the negative charges on the metal plate are attracted to the side near the rod, leaving positive charges on the other side of the metal plate. When the lead connection connected to earth is brought into contact with the metal plate, electrons from the earth flow up to neutralize the positive charges on the other side of the metal plate. When the lead connected to earth is then disconnected from the metal plate, the excess negative charges are redistributed throughout the metal plate.	1 1 1
	bi	When light strikes the regions on the drum, the positive charges in these regions are neutralised. [Or: The charges in these regions become negative by induction (due to the nearby positive charges), as electrons flow up from earth.] $\rightarrow$ 	1
	bii	1. The positively charged toner particles are repelled by the positively charged regions of the drum.	1
	bii	2. • If conducting region is neutral from (bi) $\rightarrow$ The positively charged toner particles induces a separation of charges on the conducting regions, and are then attracted to the negatively charged side of the conducting region. Or: • If conducting region is negative, from (bi) $\rightarrow$ The conducting regions are negatively charged by induction and thus attract the positively charged toner particles.	1

NOT IN SYLLABUS:

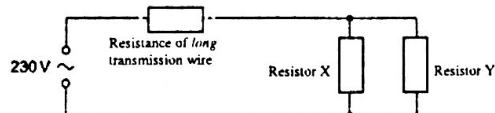
P1:

P2:

Paper 1 [40 marks]

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

- *Q. 2: (D) The word *directly* is important here. Although the calipers would give a more precise answer, they would not do so directly. In Physics, the most accurate determination of a property is not always what is needed and convenience and speed can be of equal significance in some circumstances. (A is incorrect.)
- *Q. 8: (D) Need to consider the effects of the gravitational field strength, air resistance and the mass of the ball being accelerated. (A is incorrect.)
- *Q. 12: (A) The centre of mass of the conical flask is lower than that of the beaker. (D is incorrect.)
- *Q. 30: (A) The force that acts on a positive charge is in the direction of the field, and the force on a negative charge is opposite in direction. (B is incorrect.)
- *Q. 38: (C) There is attraction between two wires carrying current in the same direction; not repulsion. Do not mix this up with the rule 'like charges repel'. (B is incorrect.)
- *Q. 40: (C) This question deals with resistors in series and parallel in the context of a domestic power supply, as the question refers indirectly to the:
- resistance of the transmission line ('long transmission line' → hence considerable resistance in the transmission line), and
 - heaters as resistors.

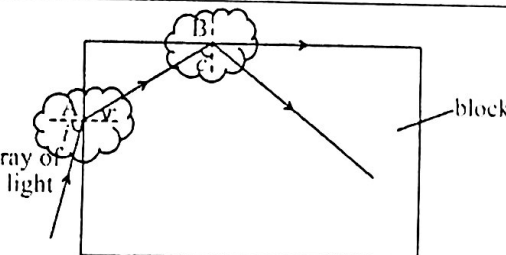


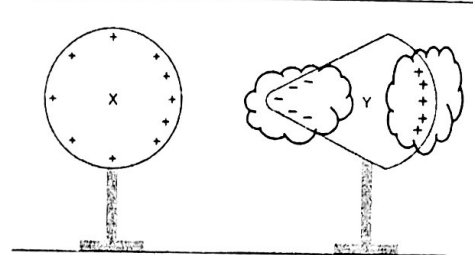
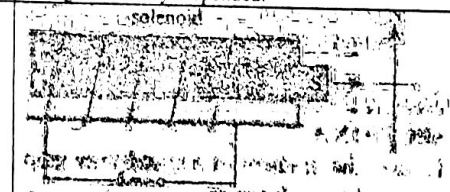
When resistor X is removed, p.d. across Y increases (potential divider circuit), as the resistance across Y alone is now larger (compared to the previous resistance of X and Y in parallel).

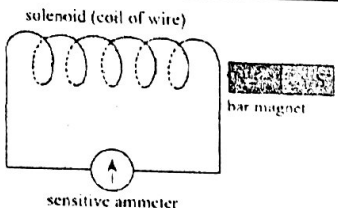
As $P = \frac{V^2}{R}$, with resistance of Y constant and V later, P_Y increases. (B is incorrect.)

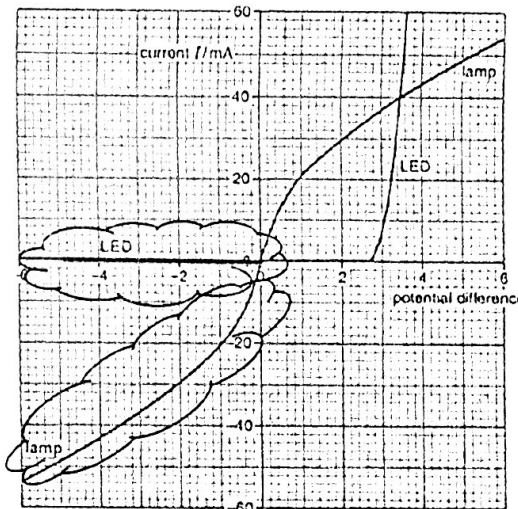
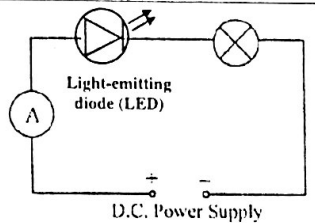
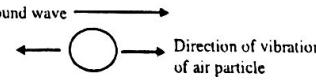
Paper 2 [80 marks]

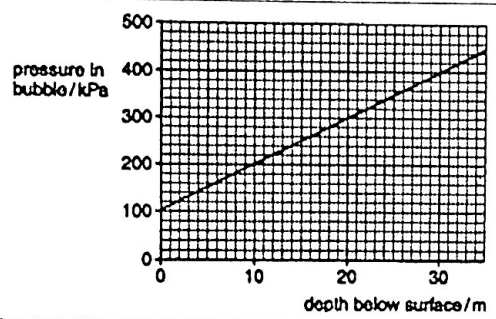
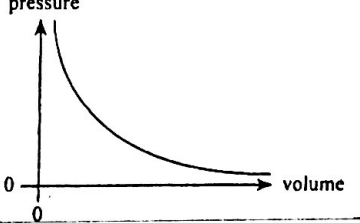
1	a	The gradient of a speed-time graph is the acceleration.	1
	b	From A to C, the stone undergoes decreasing acceleration. From C to D, the stone undergoes a uniform and large deceleration.	1 2
	c	As the stone falls, the air resistance acting on it is increasing as its speed increases. As the weight of the stone is constant, the resultant force acting downwards on the stone is decreasing. By Newton's Second Law of Motion ($F_{\text{resultant}} = ma$), the decreasing resultant force will result in a decreasing acceleration.	1 1 1
	d	The stone hits the water at point C before the speed can be constant at terminal velocity. [Note: Simply writing 'the graph had not become a straight line' is insufficient.]	1
2	a	[Parallelogram method] Scale: 1 cm to 0.2 N Resultant force, R $= 12.9 \times 0.2 = 2.58 \text{ N}$ [Actual: 2.57 N] $\theta = 50^\circ$ [Actual: 50°] Direction (between resultant force and horizontal: as given in question) $= 90^\circ$ to horizontal/ vertically upwards [Note: Compass directions should not be used in this question, e.g. 'due north', as compass directions are not mentioned in the question.]	1 1 1
	b	2.58 N [Note: The weight of the stone will balance the resultant of the two tensions, as the stone is in equilibrium.]	1
3	a	During the impact, some of the kinetic energy (K.E.) of the golf club is transferred to the golf ball. Some of the K.E. of the golf club is also converted to sound and thermal energies (energy losses). The Principle of Conservation of Energy applies during the impact, as the initial K.E. of the golf club is equal to the sum of the final K.E. of the golf club, the K.E. of the golf ball, and sound and thermal energies. [Note: Initial K.E. of golf club = Final K.E. of golf club + K.E. of golf ball + Thermal and sound energies.]	1 1 1
	bi	Increase in GPE of ball between A and B $= mgh = (0.045)(10)(16) = 7.2 \text{ J}$ (2 s.f.)	1 1
	bii	Total energy at A = Total energy at B K.E. at A = G.P.E. at B + K.E. at B $= 7.2 + 2.5 = 9.7 \text{ J}$ (2 s.f.)	1
4	a	Conduction is the transfer of thermal energy, due to the vibration of particles and the movement of free electrons. Convection is the transfer of thermal energy, due to the movement of fluid (liquid or gas) caused by density differences. [Note: Describe each process separately.]	1 1

	b	1. <u>Colour</u>: The heat sink is black in colour and black surfaces are good emitters of infra-red radiation. 2. <u>Material used</u>: The heat sink is also made of metal and metals are good conductors of thermal energy. 3. <u>Shape/ surface area</u>: The heat sink consists of fins pointing upwards, which increases the surface area of the heat sink in contact with the surrounding air (a larger surface area increases the rate of thermal energy transfer).	1
5	a	Heat capacity is the amount of thermal energy required to raise the temperature of a body by 1°C (or 1 K). Specific heat capacity is the amount of thermal energy required to raise the temperature of a <i>unit mass</i> (or 1 kg) of a body by 1°C (or 1 K). [Note: Give the definitions separately to explain the difference. Merely stating that 'heat capacity involves mass but specific heat capacity does not' is insufficient.] [Note: • Heat capacity, C: J/ °C • Specific heat capacity, c: J/ (kg °C) • $c = \frac{C}{m}$, or C = cm]	1
	b	$\Delta\theta = 90 - 20 = 70^\circ\text{C}$ Total thermal energy required to raise temperature of water and cup, Q = Q of water + Q of cup = $mc\Delta\theta + C\Delta\theta$ = $(0.20)(4200)(70) + (80)(70)$ = $58\,800 + 5\,600 = 64\,400 = 6.4 \times 10^4 \text{ J (2 s.f.)}$	1
	c	Thermal energy was required for the molecules to break free from the bonds between the molecules of water.	1
6	ai aii		1
	b	$n = \frac{1}{\sin c} \Rightarrow 1.3 = \frac{1}{\sin c}$ $c = 50.3^\circ = 50^\circ \text{ (2 s.f.)}$	1
	c	1. The higher refractive index will cause the angle of refraction at A to be smaller (the light ray is refracted more towards the normal). This will cause the angle of incidence at B to be larger. 2. The higher refractive index will also cause the critical angle, c to be smaller. [Note: The larger angle of incidence at B is now greater than the smaller critical angle.]	1

7	a	 [Note: Equal numbers of positive and negative charges at either end of conductor Y.]	2
	b	When X is brought close to Y, the electrons in Y are attracted by X as unlike charges attract. These electrons move to the left of Y and thus there are more positive charges on the right of Y.	1
	c	The excess electrons on the left of Y repel the electrons in X to the left of X, leaving excess positive charges on the right side of X.	1
	d	Y becomes negatively charged as electrons will flow from earth to neutralise the positive charges on the right of Y. [Note: The final charge on Y does not depend on whether the right or left side of Y was connected to earth. The electrons on the left of the Y are attracted to X, hence leaving the positive charges on the right of Y 'free'.]	1
	e	An electric field is a region where an <i>electric charge</i> experiences an electrical force. [Note: • Gravitational field: A region in which a <i>mass</i> experiences a gravitational force. • Magnetic field: A region where a <i>magnetic object</i> experiences a magnetic force.]	1
8	ai	The magnetic field at X is uniform.	1
	aii	The magnetic field at Y is weaker (than at X).	1
	b	The N-pole is the pole that points towards the geographic north pole when a magnet is freely suspended.	1
	c	 1) Place the bar magnet inside a solenoid connected to an alternating current (a.c. supply). 2) Withdraw the magnet slowly in a East-West direction, until it is far away from the solenoid. [Or: Reduce the magnitude of the alternating current slowly, with the magnet in a East-West direction.]	1

9	ai		1
	aii	Push the bar magnet towards the coil to produce an induced current in the coil. [Or: Push the coil towards the magnet.]	1
	b	As the magnet is moved towards the solenoid, there is a change in magnetic flux linkages <i>experienced by the solenoid</i> . [Or: The magnetic field is being cut by the solenoid.] By Faraday's Law of Electromagnetic Induction, there will be an induced e.m.f., and since it is a closed circuit, there will be an induced current.	1
10	a	$450 \text{ mA} = 450 \times 10^{-3} \text{ A} = 0.450 \text{ A}$ $34 \text{ mA} = 34 \times 10^{-3} \text{ A} = 0.034 \text{ A}$ $P_{\text{full use}} = IV = (0.450)(230) + (0.034)(230)$ $= 111.32 = 110 \text{ W (2 s.f.)}$	2
	bi	$P_{\text{standby}} = IV = (0.034)(230) = 7.82 \text{ W}$ In one week, the television is in stand-by mode for 138 h. Energy supplied in one week, E $= Pt = (7.82 \text{ W})(138 \text{ h} \times 60 \text{ min} \times 60 \text{ s})$ $= 3\,884\,976 = 3.9 \times 10^6 \text{ J (2 s.f.)}$	1
	bii	$\text{No. of kWh used} = (\text{No. of kW})(\text{No. of h}) = (0.00782 \text{ kW})(138 \text{ h})$ $= 1.07916 = 1.08 \text{ kWh}$ $\text{Cost} = (\text{No. of kWh})(\text{Cost per kWh})$ $= 1.08 \times 25 \text{ cents} = 26.979 \text{ cents} = 27 \text{ cents (2 s.f.)}$ [Or: $1 \text{ kWh} = (1 \text{ kW})(1 \text{ h}) = (1000 \text{ W})(60 \text{ h} \times 60 \text{ s}) = 3.6 \times 10^6 \text{ J}$ Hence, no. of kWh used: $= 3\,884\,976 \div 3.6 \times 10^6 = 1.08 \text{ kWh}$]	1
	ci	The television is on standby mode for more hours than the computer (138 h for the television, compared to 118 h for the computer).	1
	cii	The computer is used for more hours per week (50 h for the computer, compared to 30 h for the television), and hence it is inconvenient to keep plugging and unplugging the computer. [Note: It is wrong to suggest the computer takes more energy to restart, than is saved by turning it off, for however long it is turned off.]	1
11	ai	As the p.d. increases from zero, the resistance of the LED is very high initially (as $R = \frac{V}{I}$). As the p.d. reaches 2.7 V, the resistance of the LED starts decreasing.	1

	aii		1
	bi	 Note:  light dependent resistor	2
	bii	From the graph, at 40 mA, p.d. of the lamp and LED are both 3.5 V each (1) Output voltage of power supply = $3.5 \times 2 = 7.0 \text{ V (2 s.f.)}$	1
	bii	$40 \text{ mA} = 40 \times 10^{-3} \text{ A} = 0.040 \text{ A}$ (2) $R = V \div I = 7.0 \div 0.040$ $= 175 = 180 \Omega (2 \text{ s.f.})$	1
	c	An LED has lower resistance than a filament lamp, and thus the LED will be brighter.	1
12	a	 The sound produced from the whistle vibrates the air particles around it, producing a sound wave. The air particles thus vibrate parallel to the direction of the wave until the sound reaches the microphone (in a series of compressions and rarefactions), as sound is a longitudinal wave.	1

	b	$T = 2 \text{ divisions} \times 2 \text{ ms} = 4.0 \text{ ms} = 4.0 \times 10^{-3} \text{ s} = 0.0040 \text{ s}$ $f = 1 \div T = 1 \div 0.0040 = 250 \text{ Hz (2 s.f.)}$	1
	c	The number of waves/ cycles visible on the c.r.o. screen will be less. This is because a lower pitch sound will have a lower frequency (longer period). [Note: Need to describe 'what happens to the trace on the c.r.o. screen'.]	1
	d	The Y-gain has to be adjusted to <i>stretch/expand</i> the trace <i>vertically</i> . The time base has to be adjusted to <i>stretch/expand</i> the trace <i>horizontally</i> . The Y-shift has to be adjusted to shift the trace <i>upwards</i> to the middle of the screen.	1
12	ai	Pressure at depth of 30 m = $P_{\text{atm}} + h\rho g$ $= 100\,000 + (30)(1000)(10)$ $= 400\,000 = 4.0 \times 10^5 \text{ Pa (2 s.f.)}$	2
	aii		1
	aiii	The density of air is much less than that of water, hence the atmospheric pressure at a depth of 30 m is much less than that of water at the same depth.	1
	bi	The pressure of a gas is inversely proportional to its volume.	1
	bii		1
	biii (1)	The gas molecules are in constant, random motion and collide with the walls of the bubble. The molecules then exert a force per unit area on the walls, creating a pressure.	1
	biii (2)	As the volume of the bubble increases, the number of gas molecules per unit volume will decrease. Hence the frequency of collisions on the walls of the bubble will decrease and force per unit area will decrease.	1

NOT IN SYLLABUS:

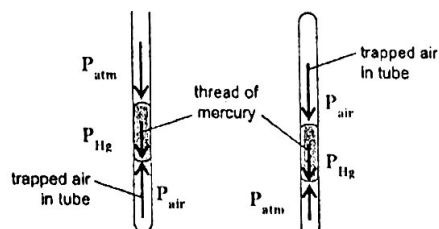
P1:

P2:

Paper 1 [40 marks]

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

*Q. 14: (C)



This question required the application of a standard fact to an unfamiliar situation. Some found this difficult.

[Note: The pressure of a gas is inversely proportional to its volume.

When the tube is held upright: $P_{\text{air}} = P_{\text{atm}} + P_{\text{Hg}}$.

When the tube is held upside down: $P_{\text{air}} + P_{\text{Hg}} = P_{\text{atm}} \Rightarrow P_{\text{air}} = P_{\text{atm}} - P_{\text{Hg}}$.

The reduction in pressure causes the volume of the air to increase, assuming temperature is constant.

(B is incorrect: Atmospheric pressure acts equally in all directions.)

(D is incorrect: Pressure is exerted equally in all directions.)

*Q.15: (B) This question tested factual knowledge. A significant minority opted for A which incorrectly suggests that a gas has a fixed volume.

(A is incorrect.)

*Q. 16: (B) [Note: The better insulating materials take a longer time to heat up.] (D is incorrect.)

*Q. 20: (A) This question required the application of a standard fact to an unfamiliar situation. Some found this difficult.

[Note: Evaporation causes cooling. There is no rise in temperature.]

(D is incorrect.)

*Q. 22: (C) Some found this question challenging.

[Note: Determine the angle between the original incident ray and the reflected ray.]

(A is incorrect.)

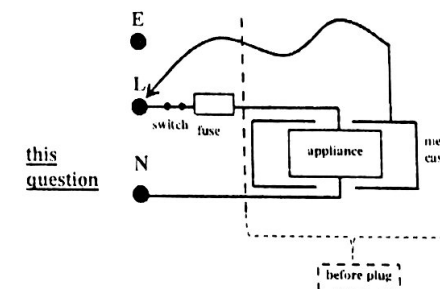
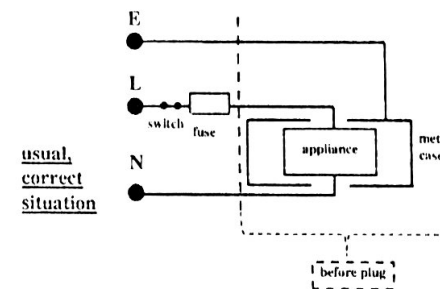
*Q. 27: (A) [Note: The current flowing through a solenoid produces a magnetic field, and not an electric field.]

(A is incorrect.)

*Q. 28 (D) [Note: The two materials must be made of insulators and not conductors, so that they will not lose their excess charges when earthed.]

(A is incorrect.)

*Q. 32 (B)



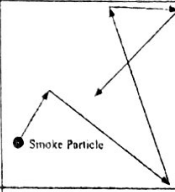
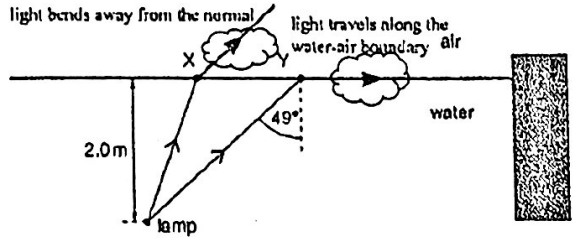
This question asked about a poorly wired mains plug and the consequence of an error shown in the diagram. Many found this a challenging question.

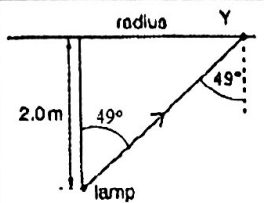
[Note: The live and the neutral wires are both correctly plugged into the mains. The metal case is wrongly connected to the mains, through the live terminal.]

(A and D are incorrect.)

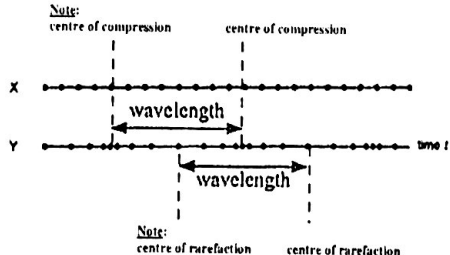
Paper 2 [80 marks]

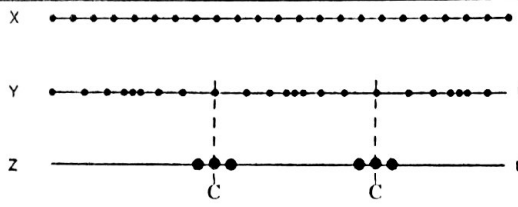
1	ai	Elastic potential energy	1
	aii	Gravitational potential energy	1
	bi	K.E. = $\frac{1}{2}mv^2$ $1900 = \frac{1}{2}(45)(v^2)$ $v = 9.19 = 9.2 \text{ m s}^{-1}$ (2 s.f.)	1 1
	bii	Not all the elastic potential energy in the spring is transferred to the gymnast as K.E. Some of it is lost as thermal or sound energy in the stretched spring. [Note: Some of it is also transferred to her as G.P.E., as B is higher than A].	1
2	ai	The precision of a ruler is 0.1 cm. It is thus not possible to accurately measure the internal diameter of the washer, 0.80 cm. with the correct precision. [Or: It is difficult to place the ruler accurately across the diameter of the washer.]	1
	aii	Vernier calipers.	1
	bi	Volume = $\pi r^2 h$ = External volume - Internal volume = $\pi[(\frac{2.5}{2})^2 - (\frac{0.80}{2})^2](0.15)$ = $0.661 = 0.66 \text{ cm}^3$ (2 s.f.) [Note: There is no need to convert the answer to m^3 .]	1 1
	bii	Density = $\frac{\text{mass}}{\text{volume}}$ = $5.2 \div 0.661$ = $7.87 = 7.9 \text{ g cm}^{-3}$ (2 s.f.) [Note: There is no need to convert the answer to kg m^{-3} .]	1 1
3	ai	Mass is the amount of substance in an object. Weight is the amount of gravitational force acting on an object.	1
	aii	$W = mg$ [Note: g = gravitational field strength, N / kg] $m = \frac{W}{g} = 150\,000 \div 10 = 15\,000 \text{ kg}$ (2 s.f.)	1
	bi	Taking moments about point X: Sum of clockwise moments = sum of anti-clockwise moments (Lift _{front})(7.0 + 5.0) = (150 000)(5.0) Lift _{front} = $\frac{(150\,000)(5.0)}{12.0}$ = $62\,500 = 63\,000 \text{ N}$ (2 s.f.)	1 1
	bii	Sum of upward forces = sum of downward forces Lift _{front} + Lift _{back} = 150 000 Lift _{back} = $150\,000 - 62\,500$ = $87\,500 = 88\,000 \text{ N}$ (2 s.f.) [Or: Take moments about C.G. or at lift _{front} .]	1 1
	c *	Reduce lift force at front rotor <u>and</u> increase lift force at back rotor. [Note: It is insufficient to just decrease the lift force at front rotor; or just increase the lift force at back rotor. This is because the question has stated that the C.G. of the helicopter stays at the same height.]	1

4	a		1
	b	1. The air molecules are in constant, random motion. 2. The air molecules collide <i>unevenly</i> with the smoke particles.	1 1
	c	When the air molecules move faster, the frequency and <i>force</i> of collisions with the walls of the glass box increases. Thus the force acting per unit area increases, and results in an increase in pressure of the air.	1 1
5	a	As a liquid solidifies, the molecules have lower potential energy as intermolecular forces of attraction between the molecules increase. The particles lose the ability to move freely and now vibrate about their fixed positions.	1
	b	Total energy removed = $mc\Delta\theta + ml_f$ = $(400)(4.2)(20 - 0) + (400)(330)$ = $165\,600 = 170\,000 \text{ J}$ (2 s.f.)	1 1 1
	c	The air around the freezing compartment <i>contracts</i> as it cools, becomes denser and sinks. Warmer, less dense air at the bottom will rise to the top, and be cooled by the freezing compartment. This forms convection currents. [Note: It is wrong to state that 'the cooler, denser air is warmed at the bottom and expands'.]	1 1 1
6	a	Critical angle is the angle of incidence in the <i>optically denser medium</i> , for which the angle of refraction in the optically less dense medium is 90° .	1
	b		2
	ci	Within the circular area, the angle of incidence is less than the critical angle and light rays will be refracted into the air. Outside the circular area, the angle of incidence is greater than the critical angle and light rays will undergo total internal reflection, reflecting totally back into the pool. As light travels in all directions, the refracted light rays will thus appear to form a circular area.	1 1

	cii	 $\tan 49^\circ = \frac{r}{2}$ $r = 2 \times \tan 49^\circ = 2.3 \text{ m (2 s.f.)}$	1 1
7	a	Light dependant resistor (LDR)	1
	b	$R_{\text{total}} = \left(\frac{1}{R_1} + \frac{1}{R_2} \right)^{-1}$ $= \left(\frac{1}{60} + \frac{1}{30} \right)^{-1} + \left(\frac{1}{80} + \frac{1}{80} \right)^{-1}$ $= 20 + 40 = 60 \Omega \text{ (2 s.f.)}$	2 1
	ci	Current is the rate of flow of electric charges.	1
	cii	The current in the battery increases. When the light intensity increases, the resistance of the LDR decreases. This reduces the overall resistance of the circuit ($I = \frac{V}{R}$).	1
8	ai	Efficiency is the ratio of useful <i>power</i> output to total <i>power</i> input. [Or: - Ratio of useful <i>energy</i> output to total <i>energy</i> input. - Ratio of useful <i>work done</i> to total <i>work done</i> .]	1
	aii	Filament lamp: Output power = $\frac{9}{100} \times 40 = 3.6 \text{ W}$ Fluorescent lamp: Output power = $\frac{40}{100} \times 10 = 4.0 \text{ W}$ Fluorescent lamp produces greater useful output power.	1
	aiii	Energy savings = (No. of kW)(No. of h) $= \left(\frac{40}{1000} \right)(600) - \left(\frac{10}{1000} \right)(600)$ $= 18 \text{ kWh}$ Cost savings = $18 \times \$0.25 = \4.50	1 1 1
	bi	Infra-red radiation	1
	bii	According to Fig. 8.2, at point P where most energy is emitted, it is in the infra-red region and is radiated as thermal energy.	1
	biii	Using Fig. 8.1: * With 96% of the radiation transmitted, the efficiency of the filament lamp is only 9%. Even if 100% of the radiation is transmitted, the efficiency of the filament lamp is not likely to increase much and is still much lower than the 40% efficiency of the fluorescent lamp. [Note: 96% of radiation transmitted $\rightarrow$ 9% efficiency 100% of radiation transmitted $\rightarrow$ $9\% \times \frac{100}{96} \approx 9.4\% \text{ efficiency} < 40\%$]	1
9	a	- The wind may be blocked by high-rise buildings. - There is not enough land in Singapore for the wind turbines. - The wind strength may not be consistent.	1 Any one
	bi	0 - 5 m s ⁻¹ : No power output. 5 - 15 m s ⁻¹ : Power output increases uniformly from 0 - 0.6 MW. Above 15 m s ⁻¹ : Power output is constant at 0.6 MW.	1 1 1

	bii	There is only power output for wind speeds $\geq 5 \text{ m s}^{-1}$.	3																																
		<table border="1"> <thead> <tr> <th>time/ min</th><th>wind speed/ m s⁻¹</th><th>power output/ MW</th><th>energy generated (in 1 min) /J</th></tr> </thead> <tbody> <tr> <td>2</td><td>16</td><td>0.6</td><td>$E = Pt = (0.6 \times 10^6)(60) = 3.6 \times 10^7 \text{ J}$</td></tr> <tr> <td>3</td><td>16</td><td>0.6</td><td>$3.6 \times 10^7 \text{ J}$</td></tr> <tr> <td>6</td><td>20</td><td>0.6</td><td>$3.6 \times 10^7 \text{ J}$</td></tr> <tr> <td>7</td><td>22</td><td>0.6</td><td>$3.6 \times 10^7 \text{ J}$</td></tr> <tr> <td>8</td><td>10</td><td>0.3</td><td>$1.8 \times 10^7 \text{ J}$</td></tr> <tr> <td>9</td><td>10</td><td>0.3</td><td>$1.8 \times 10^7 \text{ J}$</td></tr> <tr> <td colspan="3">Total</td><td>$1.8 \times 10^8 \text{ J (2 s.f.)}$</td></tr> </tbody> </table>	time/ min	wind speed/ m s ⁻¹	power output/ MW	energy generated (in 1 min) /J	2	16	0.6	$E = Pt = (0.6 \times 10^6)(60) = 3.6 \times 10^7 \text{ J}$	3	16	0.6	$3.6 \times 10^7 \text{ J}$	6	20	0.6	$3.6 \times 10^7 \text{ J}$	7	22	0.6	$3.6 \times 10^7 \text{ J}$	8	10	0.3	$1.8 \times 10^7 \text{ J}$	9	10	0.3	$1.8 \times 10^7 \text{ J}$	Total			$1.8 \times 10^8 \text{ J (2 s.f.)}$	
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	biii	The wind speed may not be constant for each 1 minute interval. [Note: The power <i>output</i> values given in the question already account for inefficiency of the turbine. Answers which merely described how the turbine wastes energy are not accepted.]	1																																
	c	Use step-up transformers to increase the voltage (at the wind turbines). This reduces the current ($P = IV$) and thus reduces power losses in the cable ($P_{\text{loss}} = I^2 R$).	1 1																																
10	a	P must be greater than 0.5 N for a resultant force to accelerate the bag from rest.	1																																
	bi	$F_{\text{resultant}} = ma$	1																																
	bii	When $P = 3.0 \text{ N}$, $a = 1.25 \text{ m s}^{-2}$ $F_{\text{resultant}} = ma$ $3.0 - 0.5 = m(1.25)$ $2.5 = m(1.25)$ $m = 2.0 \text{ kg (2 s.f.)}$	1 1																																
	ci	When $P = 2.0 \text{ N}$, $a = 0.75 \text{ m s}^{-2}$. $v = u + at = 0 + (0.75)(3.0) = 2.25 \text{ m s}^{-1} \text{ (2 s.f.)}$	1 1																																
	cii	When P is reduced to 0.5 N, the forces are balanced, there is no resultant force acting on the object. Using Newton's First Law of Motion, the bag will travel at a constant velocity (of 2.25 m s ⁻¹).	1 1																																
	d	The action-reaction pair is the pulling force acting on the student by the school bag. It acts to the left and is equal to the magnitude of P. [Note: The air resistance, weight or normal contact force are not the other part of the action-reaction pair.]	1 1																																
11	ai	E.m.f is the work done by a power source to drive a <i>unit charge around a complete circuit</i> .	1																																
	aii	P.d. is the work done to drive a <i>unit charge between two points/ across a component in a circuit</i> . [Or: P.d. is the amount of energy converted from electrical to other forms when a <i>unit charge</i> passes between two points/ across a component in a	1																																

		circuit.]	
	bi	P.d. across $R_1 = 9.0 - 2.6 \text{ V} = 6.4 \text{ V}$ (2 s.f.)	1
	bii 1	Current in $R_1 = \frac{V}{I}$ $= 6.4 \div 500$ $= 0.0128 = 12.8 \text{ mA}$ $= 0.013 \text{ A}$ (2 s.f.)	1 1
	bii 2	Current in $R_2 = 12.8 - 1.0 = 11.8 \text{ mA}$ [Or: 12 mA (2 s.f.)]	1
	bii 3	$R_2 = \frac{V}{I} = 2.6 \div 0.0118 = 220 \Omega$ (2 s.f.)	1
	ci	With a higher resistance, the current is lower.	1
	cii	Increase resistance of R_2 (potential divider).	1
	ciii *	When R_1 has a resistance of 6000Ω , the current through it is $\frac{V}{R} = \frac{6000}{6.4} = 1.07 \text{ mA}$. It is then likely that the current passing through the electronic device would be less than the 1.0 mA needed (for it to function). [Note: - A common mistake was to suggest that a high resistance would cause fire or overheating, despite having calculated a very low value of 13 mA for the current. - It is also wrong to state that there is no current or voltage if the resistance exceeds 6000Ω .]	1
11 O	ai	$v = f\lambda$ $\lambda = \frac{v}{f} = 330 \div 220$ $= 1.5 \text{ m}$ Number of vibrations $= 21 \div 1.5 = 14$ (2 s.f.)	1 1 1
	aii 1	(Question states '... using ideas about the vibrations of molecules in the air...') A frequency of 220 Hz means that the <i>air molecules</i> complete 220 oscillations/ vibrations per second.	1
	aii 2	A lower amplitude means that the <i>maximum displacement</i> of the air molecules from the undisturbed position is reduced.	1
	bi	 Note: centre of compression centre of rarefaction	
	bii	Sound energy is transferred from molecule to molecule, as the disturbed molecules vibrate more about their fixed positions and collide with neighbouring molecules. However, matter is not transferred as the molecules only vibrate about their fixed positions but do not move with the wave.	1 1

	biii	The direction of the vibration of the particles is parallel to the direction of the movement of the wave.	1
	biv	 time t time $t + T/2$	1