Catholic High School | O-Level Physics
5059 Nov 2013
Suggested Answers

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.)

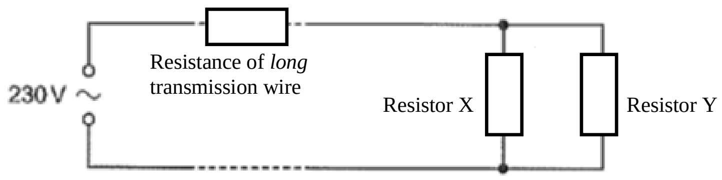
***Q. 12:** **(A)** The centre of mass of the conical flask is lower than that of the beaker.
(D is incorrect.)

***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:

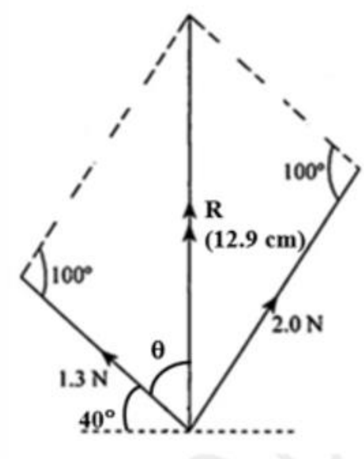
- resistance of the transmission line (‘***long** transmission line*’ → hence considerable resistance in the transmission line), and
- heaters as resistors.

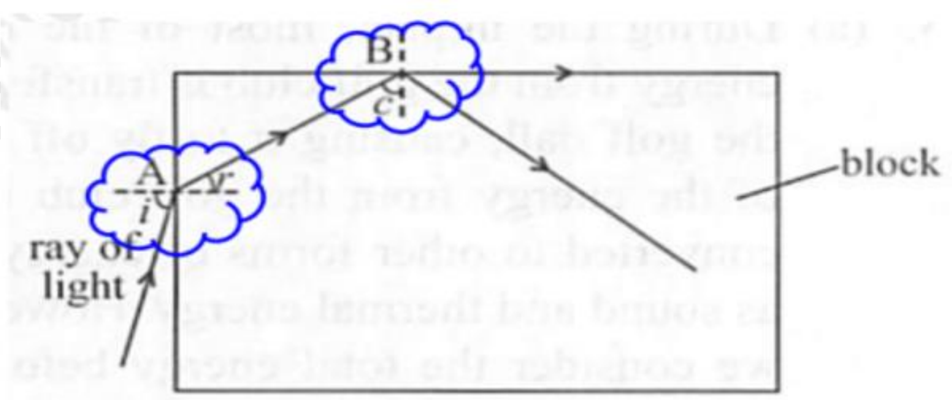


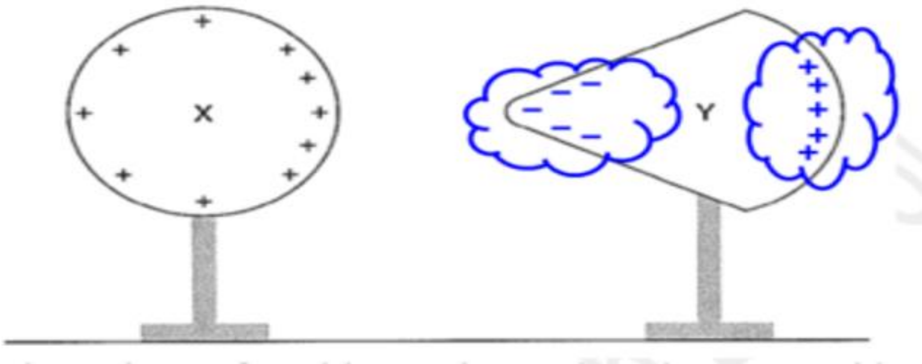
When resistor X is removed, p.d. across Y increases (potential divider circuit), as the resistance across Y alone is now larger (compared to the previous resistance of X and Y in parallel).

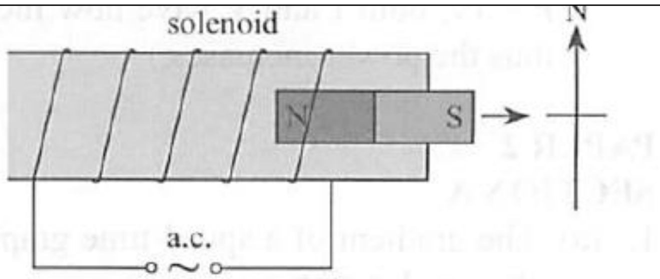
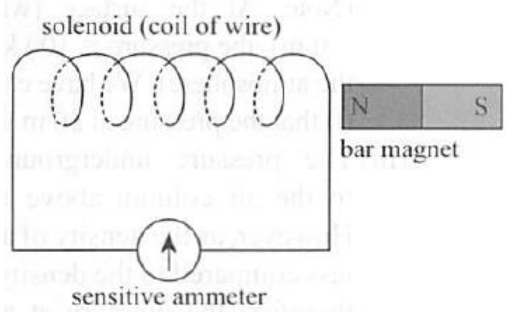
As $P = \frac{V^2}{R}$, with resistance of Y constant and V larger, P_Y increases.
(B is incorrect.)

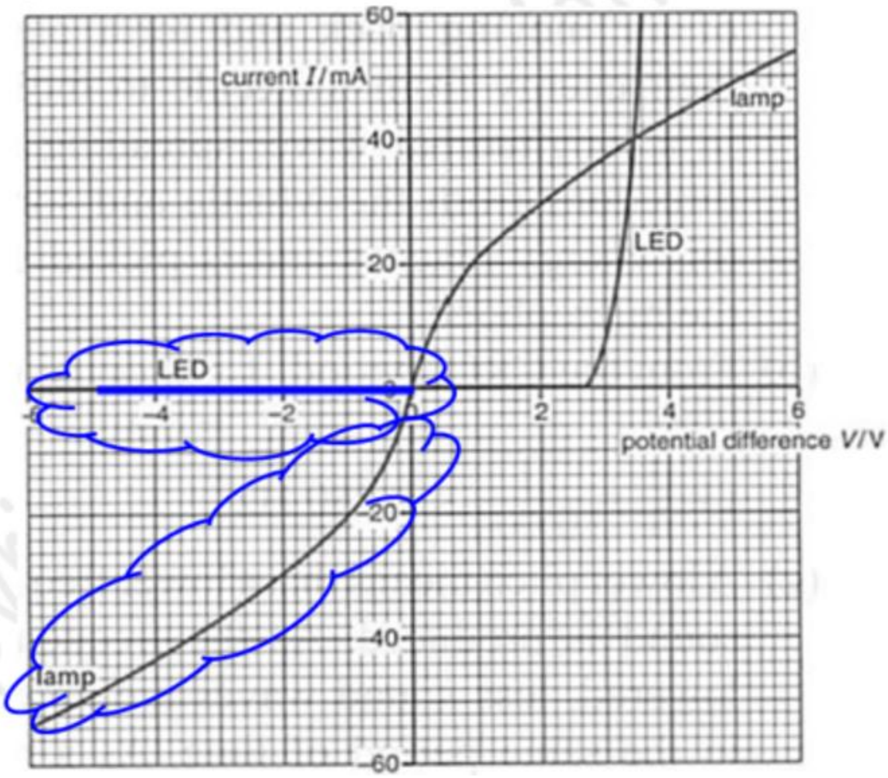
Paper 2 [80 marks]

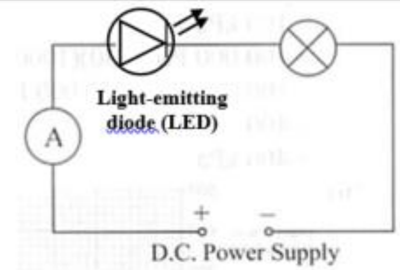
1	a	By finding the gradient of a speed-time graph.	1
	b	From A to C, the stone undergoes decreasing acceleration. From C to D, the stone undergoes a uniform and large deceleration.	1 1 1
	c	As the stone falls, the air resistance acting on it increases with increasing speed. As the weight of the stone is constant, the resultant force acting downwards on the stone is decreasing. By Newton's Second Law of Motion ($F_{resultant}$ = 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. [<u>Note</u>: 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 × 0.2 = <u>2.58 N</u> [Actual: 2.57 N] θ = 50° [Actual: 50°; accept ± 1°] Direction (between resultant force and horizontal: as given in question) = <u>90° to horizontal/ vertically upwards</u> [<u>Note</u>: Compass directions should not be used in this question, e.g. 'due north', as compass directions are not mentioned in the question.]	1 dia-gram 1 1
	b	2.58 N [<u>Note</u>: The weight of the stone will balance the resultant of the two tensions, as the stone is in equilibirum.]	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 of the surrounding air (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 of the surrounding air. [<u>Note</u>: Initial K.E. of golf club = Final K.E. of golf club + K.E. of golf ball + Thermal and sound energies of surrounding air.]	1 1 1
	bi	Increase in GPE of ball between A and B = mgh = (0.045)(10)(16) = <u>7.20 J</u> (3 s.f.)	1 1
	bii	By Conservation of Energy, Total energy at A = Total energy at B K.E. at A = G.P.E. at B + K.E. at B = 7.20 + 2.5 = <u>9.70 J</u>	1

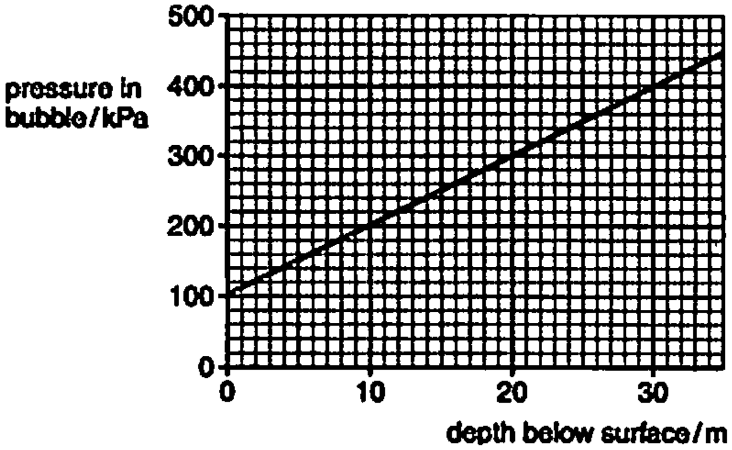
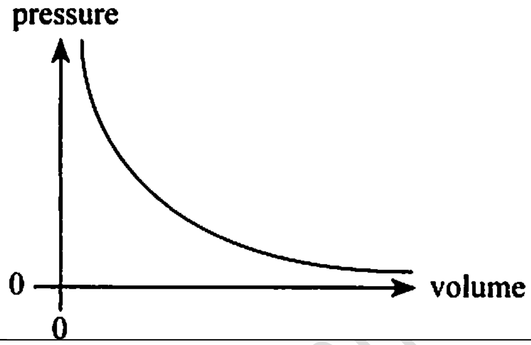
4	a	Conduction is the transfer of thermal energy, due to the vibration of particles and the movement of free electrons. Convection is the transfer of thermal energy, due to the movement of fluid (liquid or gas) caused by density differences. [Note: Describe each process separately.]	1 1
	b	1. Colour: The heat sink is black in colour and black surfaces are good emitters of infra-red radiation. 2. Material used: The heat sink is also made of metals which are good conductors of thermal energy. 3. Shape/ surface area: The heat sink consists of fins pointing upwards, which increases the surface area of the heat sink in contact with the surrounding air, which in turn increases the rate of thermal energy transfer.	1 1 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 *unit mass (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 • Specfic heat capacity, c: J/ (kg °C) • $c = \frac{C}{m}$, or C = mc]	1
	b	$\Delta\theta = 90 - 20 = 70°C$ 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 = 64.4 kJ (3 s.f.)	1 1 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 1
	b	$n = \frac{1}{\sin c} \Rightarrow 1.3 = \frac{1}{\sin c}$ c = 50.3° (3 s.f.)	1 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 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 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 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 ***electric charge*** experiences an electric force. [Note: • Gravitational field: A region in which a ***mass*** experiences a gravitational force. • Magnetic field: A region where a ***magnetic object*** 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 dia-gram 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 linkage ***experienced by the solenoid***. [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 an induced current.	1 1
10	a	450 mA $= 450 \times 10^{-3}$ A $= 0.450$ A 34 mA $= 34 \times 10^{-3}$ A $= 0.034$ A $P_{full\ use} = IV = (0.450)(230) + (0.034)(230)$ $= 111.32 =$ <u>111 W</u> (3 s.f)	 2 1
	bi	$P_{standby} = IV = (0.034)(230) = 7.82$ W In one week, the television is in stand-by mode for 138 h. [Note: Not throughout the 7 days!] Energy supplied in one week, E $= Pt = (7.82\text{ W})(138\text{ h} \times 60\text{ min} \times 60\text{ s})$ $= 3\ 884\ 976 =$ <u>3.88×10^6 J</u> (3 s.f.)	1 1 1

	bii	No. of kWh used = (No. of kW)(No. of h)= (0.00782 kW)(138 h) = 1.07916 = 1.08 kWh Cost = (No. of kWh)(cost per kWh) = 1.07916 × 25 cents = 26.979 cents = <u>27 cents</u> (whole number) [<u>Or</u>: 1 kWh = (1 kW)(1 h) = (1000 W)(60 h × 60 s) = 3.60×10^6 J Hence, no. of kWh used: = 3 884 976 ÷ 3.60×10^6 = 1.08 kWh]	1 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), hence it is inconvienient to keep plugging and unplugging the computer. [<u>Note</u>: 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 1
	aii		1 1

	bi	 Note: 	2
	bii 1	From the graph, at 40 mA, p.d. of the lamp and LED are both 3.5 V each. Output voltage of power supply = 3.5 × 2 = <u>7.0 V</u>	1
	bii 2	40 mA = 40×10^{-3} A = 0.040 A R = V ÷ I = 7.0 ÷ 0.040 = <u>175 Ω</u> (3 s.f.)	 1 1
	c	An LED has lower resistance than a filament lamp, and thus the LED will be brighter.	1
12 E	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 dia-graz 1 1
	b	T = 2 divisions × 2 ms = 4.0 ms = 4.0×10^{-3} s = 0.0040 s f = 1 ÷ T = 1 ÷ 0.0040 = <u>250 Hz</u>	1 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). [<u>Note</u>: Need to describe 'what happens to the trace on the c.r.o. screen'.]	1 1
	d	The Y-gain has to be adjusted to *stretch/expand* the trace *vertically*. The time base has to be adjusted to *stretch/expand* the trace *horizontally*. The Y-shift has to be adjusted to shift the trace *upwards* to the middle of the screen.	1 1 1
12 O	ai	Pressure at depth of 30 m = P_{atm} + hρg = 100 000 + (30)(1000)(10) = 400 000 = <u>400 kPa</u>	 2 1

	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 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