Catholic High School | O-Level Physics
6091 Nov 2022
Suggested Answers

NOT IN SYLLABUS:	
P1:	-
P2:	-

Paper 1 [40 marks]

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

***Q. 2:** **D** Students who selected C related an acceleration to a change in speed rather than to a change in velocity.

***Q. 9:** **B** Students who selected A were able to understand that Y is larger than X and Z due to Newton's First Law. However, they erroneously thought that the magnitudes of the two forces X and Z are directly proportional to their distances from the centre of gravity. This could be due to them trying to answer using proportions rather than considering the Principle of Moments equation.

***Q. 14:** **D** Students who selected A did not consider that the temperature of the vapour and the liquid water are equal, and the effect of temperature on the molecular kinetic energies.

***Q. 17:** **D** This question is challenging, with most students selecting C which suggested that the athlete would cool down more quickly rather than more slowly. They may have learnt that shiny surfaces are poor emitters and poor absorbers of infra-red radiation but could not automatically relate this to the reflection properties. Students who selected A or B did not consider it plausible that a shiny surface could result in less radiation being reflected.

***Q. 19:** **C** Students commonly selected A. It is important to read the question carefully to distinguish between total internal energy and average internal energy.

***Q. 21:** **B** Students who selected D are unable to see the inverse relation between period and frequency based on the formula. They may also not have considered the fact that the straight line shown could have been extrapolated to negative periods or frequencies which, in the context of wave motion, are meaningless concepts.

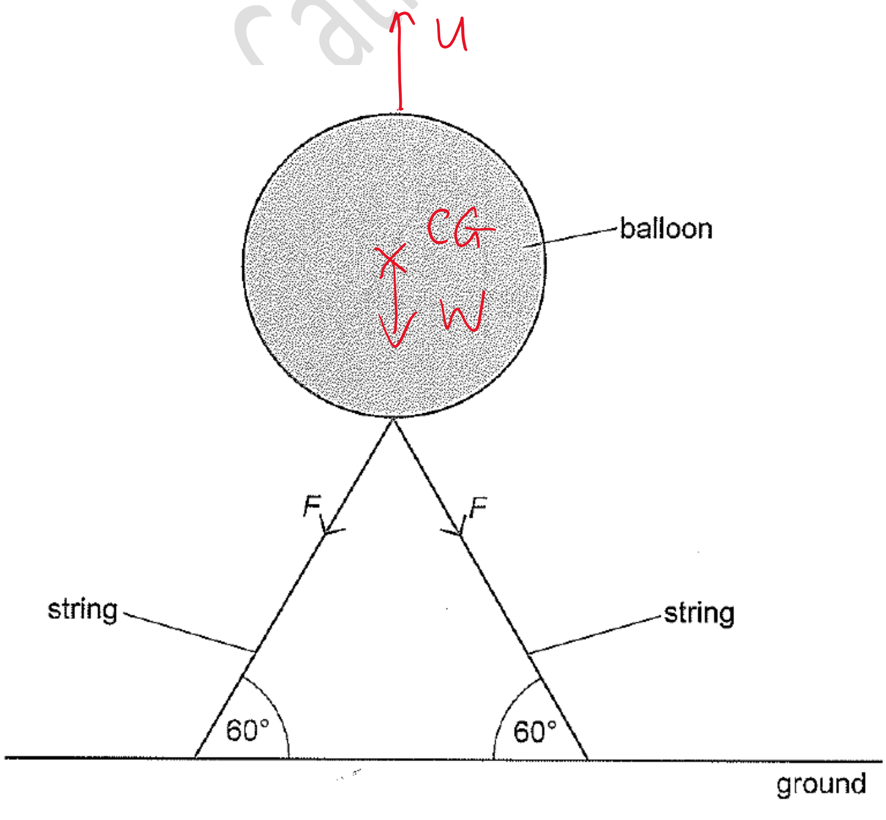
***Q. 30:** **B** Students who selected C suggested that the filament lamp has a constant resistance, which is incorrect as the lamp is an ohmic conductor with a resistance that increase with voltage/current.

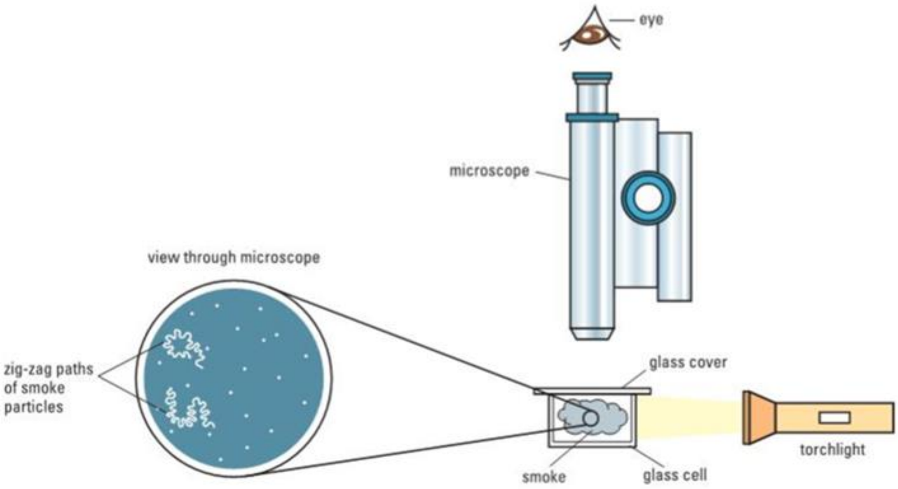
***Q. 34:** **A** Students who selected the wrong options may have failed to realise that resistance of (and hence p.d. across) the thermistor (or LDR) decreases when temperature (or light intensity) increases.

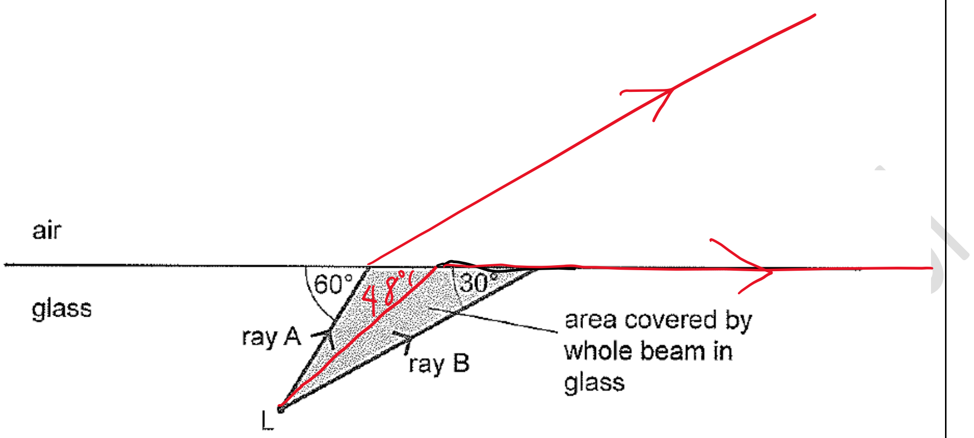
***Q. 36:** **B** Students who selected A or D ay have confused the magnetic field with an electric field. Students who selected C may not have understood correctly that the direction of (conventional) current used in Fleming's Left Hand Rule is the same as the direction of movement of positive charges and opposite to the direction of movement of negative charges.

***Q. 40:** **A** Students who selected B or D ignored the reduction in current due to losses in the transformer. Students need to appreciate that for a non-ideal transformer, the output power in the secondary coil is smaller than the input power in the primary coil, and the current in the secondary coil is smaller than what it would have been for an ideal transformer. The p,d, across the secondary coil remains the same as for an ideal transformer as it is dependent only on the turns ratio of the transformer.

Paper 2 [80 marks]

1	a	Rate of change of displacement.	1
	b	acceleration, displacement, weight	1
	ci	AB: moving upwards and accelerating upwards BC: moving upwards and accelerating downwards CD: moving downwards and accelerating downwards	2
	cii	10.0 s (1 dp based on precision to half a smallest square)	1
	ciii	Maximum height = Area under graph from t = 0.0 s to 10.0 s = ½ (10.0)(60) = 300 m	 1 1
2	a	Weight = Density x Volume x Gravitational Field Strength = (900) $(0.20)^3$ (10) = 72 N	1 1 1
	bi	Pressure is the force acting per unit area.	1
	bii	p = F / A = W / (l x l) = 72 / (0.20 x 0.20) = 1800 N/m^2	 1 1
	biii	p = hρg ρ = p/hg = 1800 / (0.12)(10) = 1500 kg/m^3	 1 1
3	a	- W must start from CG and be vertically downwards. - U should be longer in length than W as its magnitude is the sum of the magnitudes of W and the vertical components of the two F forces. 	1 1

	b	Using a ruler, length of the 0.40 N vector is 10 cm. Hence, scale of Fig. 3.2 is 1 cm : 0.04 N *F* = 5.8 x 0.04 = 0.23 N	1 1
	ci	Work done = U x d = 0.60 x 20 = 12 J	 1 1
	cii	By Conservation of Energy, Work done by U = Gain in GPE + Gain in KE + Work done against air resistance Gain in KE is maximum if Work done against air resistance = 0 Hence, Maximum KE = Work done by U – Gain in GPE = 12 – 4.0 = 8.0 J	 1
	ciii	[Until 2023] The balloon loses energy due to work done against air resistance. [2024 onwards] As the balloon does work by moving a distance past surrounding air molecules, some of its kinetic energy is transferred mechanically to the surrounding air to increase energy in its internal store.	1
4	a	 Seal a glass cell illuminated by a torchlight containing a little smoke and place it under the microscope. Bright specks of light are observed to be moving about in a constant random motion. This is because the smoke particles are randomly bombarded by air molecules which are moving at random (ie. Brownian motion).	1 1
	b	1. They move constantly. 2. They move randomly in all directions.	1 1
	c	Very large particles generally have more mass compared to air molecules. Hence, when air molecules collide with them, they require a larger force to change their direction of motion.	1 1
5	ai	Ray A emerges into the air. This is because the angle of incidence of ray A is smaller than the critical angle for light travelling from glass into air, so total internal reflection does not occur.	1 1

<table>
<tr><td></td><td>aii</td><td>- Line from L must hit air-glass interface at an angle of 48° between the line and the interface.
- Rays emerging into air must bend away from the normal and diverge from one another.

</td><td>1

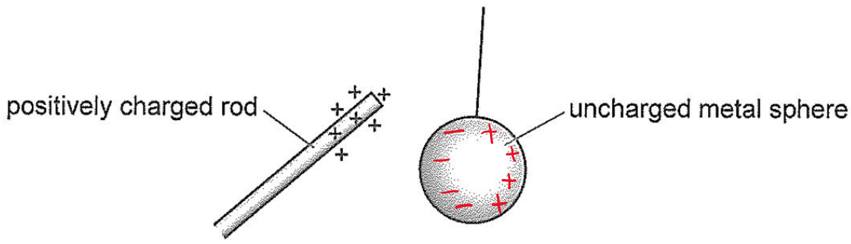
1</td></tr>
<tr><td></td><td>bi</td><td>The speed of light in the cladding is larger than that in the glass fibre, because the refractive index of the cladding is less than that of glass.</td><td>1</td></tr>
<tr><td></td><td>bii</td><td>As the refractive index of glass is more than that of the cladding which is in turn more than that of air, the speed of light in glass is less than that in the cladding which is in turn less than that of air. Hence, the ratio of the speed of light in air to glass (or refractive index of glass with respect to air) is larger than the ratio of the speed of light in cladding to glass (or refractive index of glass with respect to cladding).

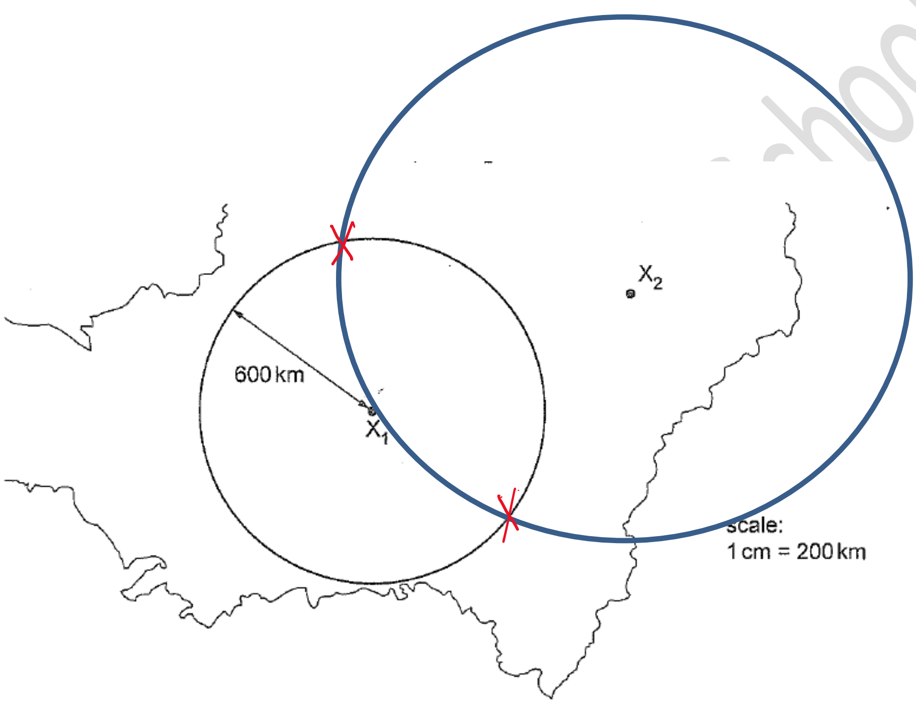
This means that the sine of the critical angle (and hence the critical angle) for light travelling from glass into the cladding is larger than that from glass into air (ie 42°).</td><td>1

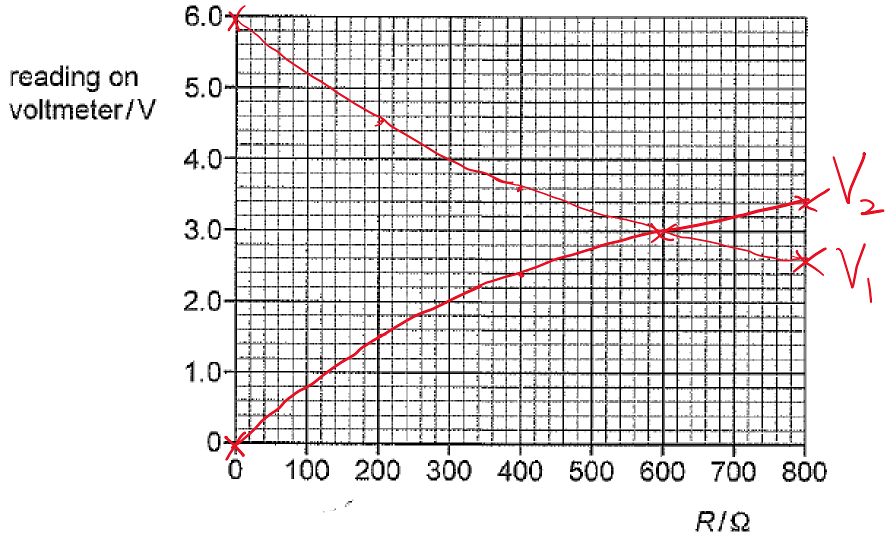
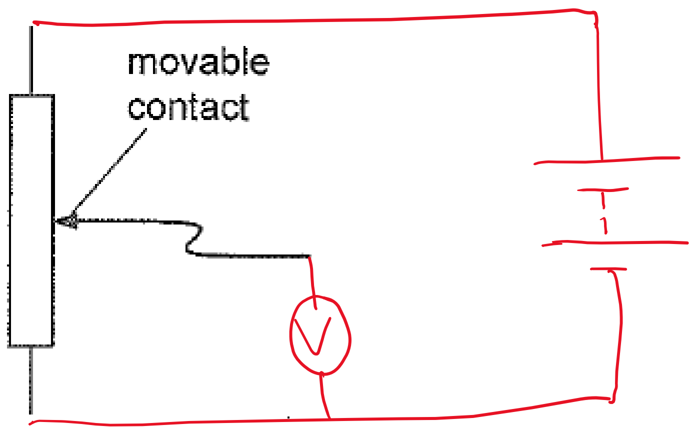
1</td></tr>
<tr><td>6</td><td>a</td><td>Its frequency is above the upper hearing limit of the human range of audibility.</td><td>1</td></tr>
<tr><td></td><td>b</td><td>The transmitter emits pulses of ultrasound into the mother’s body which are then reflected back from the layers of tissue in the mother’s body to a detector.
By measuring the time interval between the sending and receiving of the pulses, the image processor determines the distance of specific layers of tissue from the surface of the mother’s body and translates this information into an image.</td><td>1

1</td></tr>
<tr><td></td><td>ci</td><td>$v = f\lambda$
$\lambda = v/f$
$= 1500 / (5.0 \times 10^{6})$
$= 3 \times 10^{-4}$ m</td><td>

1
1</td></tr>
<tr><td></td><td>cii</td><td>As infra-red radiation has a speed of 3.0×10^{8} m/s which is much larger than the speed of sound in the human body, for the same wavelength, the frequency of infra-red radiation is much larger than that of ultrasound (by $f = v/\lambda$).</td><td>1</td></tr>
<tr><td></td><td>d</td><td>X-rays are ionising and can change or destroy living cells in the unborn baby.</td><td>1</td></tr>
</table>

7	a	The positively charged rod induces a negative charge on the left side of the metal sphere as electrons move to the left side of the sphere (as unlike charges attract), leaving behind positive charges on the right side of the sphere. As the force of attraction between the positively charged rod and the negatively charged left side of the sphere is larger than the force of repulsion between the positively charged rod and the positively charged right side of the sphere, there is a net force of attraction between the sphere and the rod.  	1 1
	bi	Move the positively charged rod closer to the left side of the sphere. With the positively charged rod in place, touch the right side of the sphere with a hand. After some time, remove the hand and then the rod.	1 1
	bii	Electrons move towards the rod and remain on the left side of the sphere. When the right side of the sphere is touched with a hand, electrons from Earth move through the hand to neutralise the positive charge on the right side of the sphere. The electrons will then repel each other as like charges repel.	1 1
	biii	The sphere is now negatively charged rather than neutral, so the force of attraction is larger than in (a) as there is no longer a force of repulsion between the positively charged rod and the positive charges on the right side of the sphere.	1
8	ai	P-wave: The building moves vertically up and down, parallel to the direction of propagation of the wave. S-wave: The building moves horizontally left and right, perpendicular to the direction of propagation of the wave.	1 1
	aii	longitudinal wave: sound wave transverse wave: electromagnetic wave	
	bi	When the distance travelled by the P-wave increases from 200 km by a factor of 2, 3, 4, 5, 6, 7 and 8 times respectively, the time taken by the P-wave increases by a factor of 2, 2.9, 3.8, 4.7, 5.5, 6.3 and 7.1 times respectively. Since the respective factors are not the same, the distance travelled by the P-wave is not proportional to the time taken.	1
	bii	Speed of P-wave = distance / time = 200 000 / 29 = 6 900 m/s (to 2 sf)	 1 1
	biii	T = 156 – 85 = 71 s	1

	biv	At d = 1000 km, T = 246 – 136 = 110 s	1
	bv	Draw a circle with centre X_2 and a radius of (1000 / 200 = 5 cm). The two points of intersection of the drawn circle and the existing circle in Fig. 8.3 are the two possible positions for the hypocentre.  Fig. 8.3	1
	bvi	The amplitudes of the waves that arrive at X_2 are smaller than that which arrive at X_1. This is because X_2 is further from the hypocentre than X_1, so the waves travel a longer distance, and more of the energy of the waves are lost to kinetic energy of objects on the Earth's surface such as buildings.	1
9	a	voltmeter 1: increases voltmeter 2: decreases ammeter: increases	2
	bi	6.0 V, 0.0 V	1
	bii	By Potential Divider Principle, $V_1 = R_{600} / (R_{600} + R_v) \times V_E$ $= 600 / (600 + 800) \times 6.0$ $= 2.6$ V $V_2 = V_E - V_1$ $= 6.0 - 2.6 = 3.4$ V	 1 1 1

	biii	6.0 5.0 4.0 3.0 2.0 1.0 0 reading on voltmeter / V 0 100 200 300 400 500 600 700 800 R / Ω V2 V1	
	c	movable contact V	2

10 E	ai	When a current flows through the fixed upper arm, iron arm and the coil around the iron core through the pivot, the iron core becomes magnetised. When the current is large than 30 A, the iron core's magnetic field is strong enough to attract the iron arm. The iron arm rotates anti-clockwise about the pivot, causing the lower contact to lose contact with the upper contact, creating an open circuit.	1 1 1
	aii	The springy metal holds the iron arm in the horizontal position so that the upper contact is touching the lower contact when the circuit breaker is reset.	1
	aiii	The current needed to break the circuit is smaller, because for a certain current, the coil with more turns of wire has a larger magnetic field strength than that with less turns of wire. Hence a smaller current is needed for the coil with more turns of wire to attract the iron arm and break the circuit.	1
	bi	P = IV I = P / V = 9 000 / 230 = 39.1 A Hence a suitable current rating for the circuit breaker is 45 A. [Note: It is advised not to put 40 A for the current rating as it may be too close to the typical current of 39.1 A.]	1 1
	bii	Electrical Energy = Thermal Energy $P \times t = mc\Delta\theta$ $(9\,000)(60) = (8.3)(4\,200)\,\Delta\theta$ $\Delta\theta = 15°C$ (2 sf)	1 1 1
10 O	ai	When current flows into the plane of the page through the side of the coil closest to the S pole, and out of the plane of the page through the side of the coil closes to the N pole, the magnetic field of the permanent magnet interacts with the magnetic field caused by the current to generate a force on the sides of the coil. The direction of the force is downwards on the side of the coil closest to the S pole, and upwards on the side of the coil closes to the N pole by Fleming's Left Hand Rule. These two forces produce a net clockwise moment of the coil about its pivoting axis.	1 1 1
	aii	As the coil becomes more vertical, the perpendicular distances of the line of action of both forces from the pivoting axis become smaller, causing a smaller turning effect.	1
	bi	The coil experiences a change in magnetic flux linkage as it rotates within the magnetic field of the magnet. By Faraday's Law, there is an induced e.m.f. in the coil.	1
	bii	By Lenz' Law, the induced current flows in a direction so that its magnetic effect opposes the motion causing the induced e.m.f. Hence, the induced e.m.f. is in a direction that reduces the current in the coil.	1
	ci	$P = V^2 / R$ $= (6.0)^2 / 100$ $= 0.36$ W	1 1
	cii	$1/R_{eff} = 1/R_M + 1/R_L + 1/R_L$ $= 1/100 + 1/70 + 1/70$ $R_{eff} = 26\ \Omega$ (2 sf)	1 1