Catholic High School | O-Level Physics
6091 Nov 2021
Suggested Answers

NOT IN SYLLABUS:	
P1:	-
P2:	-

Paper 1 [40 marks]

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

***Q. 1:** **C** Students who selected B or D are unable to understand the fact that R should start from the start point of vector V and end at the end point of vector W. Students who selected A failed to realise that the wind is blowing from west to east and not from east to west.

***Q. 2:** **B** Students who struggle to know how to start should think of any formula for acceleration, and then proceed to break down the terms in the formula further based on information in the question. In this case, $a = (v - u)/t$, and t = distance between posts / average speed of car between posts.

***Q. 11:** **D** Students who selected C did not understand that stability is related to the position of the centre of gravity of an object.

***Q. 12:** **B** Students who selected the wrong answers were unable to convert the incompatible units in the question to standard SI units and then to convert the answer to the non-SI metric unit of N / cm^2. Students who selected A may have forgotten to factor in gravitational field strength in their calculations.

***Q. 13:** **D** Students who selected C took the area of the piston on the right to be double that of the piston on the left.

***Q. 14:** **C** Students who selected A did not use the formula $P = P_{atm} + d\rho g$ to deduce that the y-intercept of the graph is atmospheric pressure, and that P varies linearly with d.

***Q. 21:** **B** Students who selected D took the two fixed points as the two ends of the full range of the thermometer rather than the melting point of pure ice and the boiling point of pure water.

***Q. 22:** **C** Students who selected A or B did not understand that at constant temperature, the average kinetic energy of the molecules does not change. Students who

selected D did not understand that potential energy is related to the average intermolecular distance, and that condensation reduces this.

***Q. 26: A** Students who selected B failed to understand that while the incident ray is reflected in the correct direction, it does not undergo total internal reflection, unlike A.

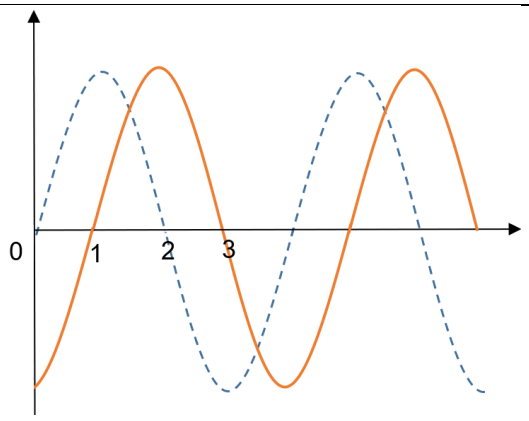
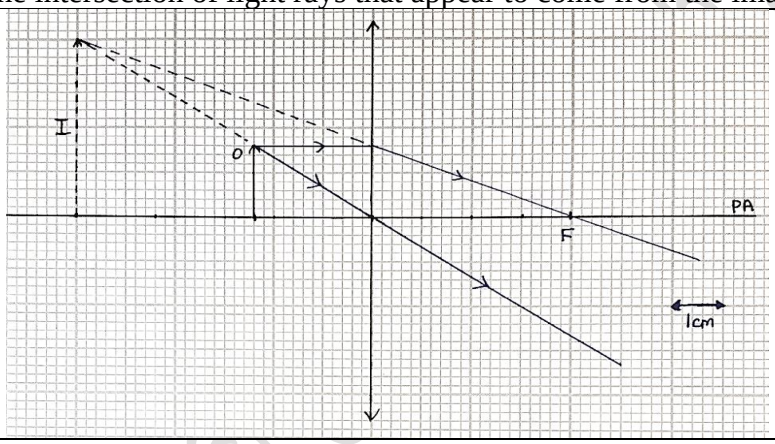
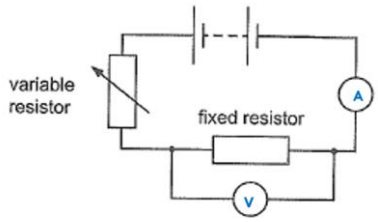
***Q. 34: C** Students need to be clear that as R = V/I, J has the highest resistance as current is 0. Students who chose B or D mistakenly thought that the gradient of the current-p.d. graph is related to the magnitude of the resistance, when in fact resistance is the ratio of p.d. to current, not the gradient (or the reciprocal of the gradient) of the current-p.d. graph.

***Q. 35: C** Students can consider using the formula I = V/R (where V is the e.m.f. of the circuit and R is the resistance of each parallel branch) to deduce that since the e.m.f. of the circuit is the same for all 3 branches, the current through the left and centre branches (1 unit) is half that of the current through the right branch (2 units). Since the main current in the branch is the sum of the currents through all 3 branches (ie 4 units), the ratio of the currents is 4:1.

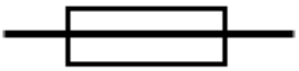
***Q. 36: D** Students need to use Potential Divider Principle for both branches to determine the potentials at P and Q respectively, and select the option where the potential at P is larger than that of Q. At first glance, options B and C can be eliminated as the ratios of resistances for both branches is the same, so the potentials at P and Q are the same.

Paper 2 [80 marks]

1	a	kelvin / ampere / mole (any one)	1
	bi	10^{-9}	1
	bii	M, k, d, c	1
	ci	Average speed = distance / time = (πr)/t = (π)(20) / 7.5 = 8.38 m/s	 1 1
	cii	Displacement = 2 x 20 = 40 m	1
	ciii	Average velocity is determined by the total displacement divided by the time taken. Since the total displacement for one complete lap is zero, (the average velocity of the athlete is zero.)	1
2	a	W = mg m = W/g = 61 / 10 = 6.1 kg	 1
	b	By Newton's 2nd Law, F_{net} = ma 95 – 61 = 6.1a a = 5.6 m/s^2 upwards (2 sf)	 1 1
	ci	1. Speed of balloon 2. Cross-sectional area of balloon (perpendicular to direction of motion)	1 1
	cii	When the upward force is equal to the sum of the weight and the air resistance, there is no resultant force acting on the balloon. By Newton's 1st (or 2nd) Law, its acceleration is zero and it rises with constant velocity.	1 1
3	a	When an object is in equilibrium, the sum of clockwise moments about a point is equal to the sum of anti-clockwise moments about the same point.	 1 1
	b	Perpendicular distance from P to the line of action of the weight.	1
	ci	Taking moments about P, Anti-clockwise moment = Sum of clockwise moments F x 1.6 [1] = 300 x 0.90 + 600 x (0.9 + 2.5) [1] F = 1 440 N	 2 1
	cii	By Newton's First Law, Upwards force = Sum of downwards forces F at P = 1 440 + 300 + 600 = 2 340 N	 1
4	a	Pressure is the force acting per unit area perpendicular to the direction of the force.	1 1
	b	Atmospheric pressure can be measured using p = hρg. The vertical height of the oil column, h in metres, can be measured using a measuring tape from the surface of the oil at the base to the top of the oil column in contact with the vacuum (as shown). The density of the oil ρ and gravitational field strength g can be expressed in kg/m^3 and N/kg respectively.	1 1 1
5	a	parallel perpendicular material / the medium / matter	 2
	bi	f = 1/T = 1 / (4 x 10^{-3}) = 250 Hz	 1 1
	bii	λ = v/f = 340 / 250	 1

		= 1.36 m	1
	biii		1
6	a	The focal length is the distance between the optical centre of the lens and the point where all light rays parallel to the principal axis converge after passing through the lens.	1 1
	bi	A virtual image is one that cannot be captured on a screen and is formed by the intersection of light rays that appear to come from the image.	1
	bii		1
	biii	4.0 cm	1
7	a		1
	bi	R = V / I = 18.0 / 1.50 = 12.0 Ω	1 1
	bii	When the variable resistor is at its maximum resistance, the p.d. across the fixed resistor is minimum. As the resistance of the fixed resistor is constant, the current of 0.40 A is minimum and cannot be smaller.	1
	biii	$R_2 / R_1 = (\rho l_2/A_2) / (\rho l_1/A_1)$ $= (l_2 / l_1) (A_1/A_2)$ $= (2)(1/2^2) = 0.5$ $\Rightarrow R_2 = 0.5\ R_1 = 6.00\ \Omega$	1 1 1
8	a	Magnetic field is stronger at P than Q. Magnetic field at P is directed out of the plane of page while that at Q is directed into the plane of page.	1 1
	bi	Into the plane of the paper.	1

	bii	Using Fleming's Left Hand Rule, the index number representing the magnetic field points vertically downwards, and the middle finger points rightward as indicated by the arrow. Hence, as the fingers are mutually perpendicular, the thumb representing the force points into the plane of the paper.	1 1
9	a	KE = ½ mv^2 = ½ (1400)(90 x 1000 / 3600)^2 = 438 kJ (3 sf)	 1 1
	bi	Average energy = 50% x 160 + 50% x 140 = 150 W h	1
	bii	Maximum distance = Electrical energy of battery / Average energy used per hour for urban driving = 30 000 / 160 = 188 km (3 sf)	 1 1
	biii	Mass of car battery = Electrical energy of battery / Energy stored in 1 kg of battery = 30 000 / 130 = 231 kg (3 sf)	 1 1
	biv	Even though the energy per kg of petrol is 100 times that of the battery, the efficiency of conversion of output energy from the battery is ¼ that of the petrol. Hence, for the same output energy required, the mass of the battery in the electric car is 25 times that of the mass of petrol needed for the petrol car.	1 1
	bv	Time taken = Electrical energy of battery / Rate of transfer of electrical energy at L2 charging point = 30 000 / 7 400 = 4.05 h (3 sf)	 1 1
	bvi	For a super-charging point to be powered at 50 kW, the current required from a 230 V electrical supply would be 218 A (by P = IV) which is too large to flow through the connection wires in an ordinary home without damaging them.	1
10	ai	It is the amount of the thermal energy required to change the state of a unit mass of a substance, without a change in temperature.	1 1
	aii	The latent heat of vaporisation is the thermal energy involved when changing an object's state between liquid and gas (boiling/condensation), while the latent heat of fusion is the thermal energy involved when changing an object's state between solid and liquid (melting/freezing).	1
	bi	B, D	1
	bii	1. increases, stays constant 2. stays constant, increases	1 1
	biii	Since (thermal energy is gained by the substance at a constant rate and) the time taken for it to melt is less than the time taken for it to boil, less energy is needed to melt the substance than to boil it. Thus, its specific latent heat of fusion is smaller than that of vaporisation.	1 1
11 E	a	It is the work done by a source in driving unit charge around a complete circuit.	1 1
	bi	$1/R_{eff}$ = 1/60 + 1/60 + 1/30 R_{eff} = 15 Ω	1 1
	bii	potential difference	1

	ci	stays constant, increases	1
	cii 1.	E.m.f. = $V_R + V_L$ = 6.0 + 6.0 = 12 V	 1 1
	cii 2.	As R and L are connected in parallel, the p.d. across them must be the same. From the graph, the only value of p.d. where the sum of the currents flowing through the resistor and filament lamp is 2.0 V, where the currents are 0.2 A and 0.4 A respectively.	1 1
11 O	a	It allows the magnetic field produced by the current in the primary coil to be concentrated within it. It maximises the magnetic flux linking the secondary coil, and hence the induced e.m.f. and current in the secondary coil.	1 1
	b	Ns/Np = Vs/Vp Ns/920 = 12/230 Ns = 48	 1 1
	ci		11
	cii	This is to ensure that the current through the fuse is the same as that through the primary coil. Hence, when the fuse melts due to an excessively high current through the primary coil, it will create an open circuit in the primary coil, and subsequently prevent an induced current from flowing in the secondary coil.	1 1
	ciii	Maximum power in primary coil = IV = (0.200)(230) = 46 W Available power in secondary coil = 90% x 46 = 41.4 W Maximum number of lamps = 41.4 / 8 = 5 (round down to nearest integer)	 1 1 1

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