## Catholic High School | O-Level Physics 6091 Nov 2020 Suggested Answers

NOT IN SYLLABUS:					
<u>P1:</u>	-				
<u>P2:</u>	-				

## Paper 1 [40 marks]

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

- \*Q.4: C Students have to recognise that air resistance affects the behavior of the ball. (A and B are incorrect.)
- \*Q.7: A Students have to recognise that both balls being copper indicates that they have the same density. (B is incorrect.)
- **\*Q.9: D** Question was asking for the force exerted by the shoulder on stick, not F. (C is incorrect.)
- \*Q.11: A Students have to read the question carefully to obtain the correct information for density and height of liquid column instead of following the usual symbols. (B and C are incorrect.)
- \*Q. 14: A To solve this question, we have to find the GPE gained and the distance moved by the box along the slope. The distance moved by the box along the slope has to be solved using Pythagoras' Theorem. (D is incorrect.)
- \*Q. 22: A Those who chose C did not understand that "moves backwards and forwards between two positions" means that the point is oscillating between two extreme ends whose distance apart is twice the amplitude. (C is incorrect.)
- \*Q. 24: B Students may have mistakenly thought that when the object moves towards the lens, the image will also move toward the lens. (C and D are incorrect.)
- \*Q. 28: A Students may have thought that the position of the earth connection affects the movement of electrons through the earth connection. (C is incorrect.)

- \*Q. 29: B The key difficulty for this question was to determine the rate of flow of electrons that is related to but different from the rate of flow of electric charge. Students have to use the information about current to determine the answer. (A, C and D are incorrect.)
- \*Q. 30: C To solve this question, students have to add the e.m.f. of cells in the same configuration and then subtract those with the reverse configuration. (A and B are incorrect.)
- \*Q. 34: B Students have to recall that fuses are designed to prevent excessive current from flowing through the appliance as it will melt. (D is incorrect.)

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I apei							
1	а	Vector: Displacement, acceleration, force, moment of a force (any one)					
	1.	Scalar: Distance, time, energy (any one)					
	bı	Velocity of the point will change from 0.24 m / s in one direction to					
		0.24  m / s in the opposite direction and then back to $0.24  m / s$ in the initial					
		direction.					
		There is no net change in velocity at the end of one complete rotation even					
		though its direction is constantly changing (despite magnitude remaining					
		constant).	1				
	bii	Radius = D / 2 = C / $2\pi$ = (velocity x time) / $2\pi$					
		$= (0.24 \times 30 \times 60) / 2\pi \rightarrow$ convert minutes to seconds	1				
		= 69  m (least sf)	1				
2	a	Acceleration	1				
	bi	+4 0.0 s to 0.6 s: Straight line					
		velocity +3-	1				
		m/s +2					
		At 0.6 s: Vertical straight line					
		+1 till -3 m/s	1				
		t/s 0.6 s to 0.8 s: Gradient of graph					
		same as graph from 0.0 s to					
			1				
		-3-					
		-4					
	bii	"x" at 0.2 s	1				
3	а	The sum of the weight of man and the force by jetpack on man, both acting					
		downwards on man, is balanced by force by gas from jetpack acting	1				
		upwards on man. Hence, there is no resultant force acting on him.					
	bi	Mass is a measure of the amount of substance in an object,					
		while weight is the amount of gravitational force acting on it.	1				
	bii	Total mass = $75 + W_{jetpack} / g$					
		= 75 + 160/10					
		= 91 kg					
	biii	By Newton's $2^{nd}$ Law, $F_{net} = ma$					
		$F_{jetpack} - W_{total} = m_{total} a$					
		$F_{jetpack} = 91 \times 10 + 91 \times 0.20 = 930 \text{ N} (3 \text{ sf})$					
4	a	Work done is the product of the force applied by the racket on the					
		shuttlecock and the distance moved in the direction of the force.					
	b	As the shuttlecock slowed down as it reaches Y, kinetic energy (KE)					
		decreased.					
		As the height of the shuttlecock also decreased, gravitational potential					
		energy (GPE) also decreased.					
		Some of the original KE and GPE is converted to thermal energy due to					
		work done against air resistance and sound energy of air.					
	с	$E = \frac{1}{2} mv^2$					
		$v = \sqrt{(2E/m)}$					
		$=\sqrt{2 \times 0.36} / 0.0050$					
		=12  m/s					

## Paper 2 [80 marks]

5	а	Thicker connecting wires have a larger cross-sectional area and hence					
		a smaller resistance than the filament wire.					
		As the same current passes through both types of wires, the heating effect					
		(given by $P=I^2 R$ ) is smaller for connecting wires, so less electrical energy					
		is converted to thermal energy and they do not glow.					
	b	Thermal energy from the filament is transferred to the gas near it. The gas					
		is heated, expands, becomes less dense and rises, transferring thermal					
		energy away from the filament to the top.	1				
		The cooler, denser gas near the top sinks to replace the warm gas and in					
		turn gets heated up by the filament.	1				
		The process repeats, setting up convection currents in the lamp.	1				
	с	Glass molecules are close to each other and vibrating constantly about their					
		fixed positions due to strong inter-molecular forces. The heated gas					
		molecules collide with the glass molecules at the inner surface of the lamp,					
		causing them to vibrate more vigorously, transferring thermal energy to the					
		air outside the lamp through collisions between glass molecules.	1				
6	ai	name of component wavelength / m					
		Ultraviolet radiation 1 x 10 <sup>-7</sup>	1				
		Infra-red radiation 1 x 10 <sup>-5</sup>	1				
	aii	X-rays / gamma rays	1				
	aiii	X/Gamma rays are high energy rays that are focused on brain tumours to					
		kill cancerous cells in radiation therapy. OR					
		Different frequency range of X-rays are used to produce images of different					
		shades of contents in a luggage, so as to search for illegal items in airports.	1				
	bi	They are transverse waves. OR They are able to undergo reflection and					
		refraction.	1				
	bii	$f = v / \lambda$					
		$= 3.0 \times 10^8 / 2.0 \times 10^{-2}$					
		$= 1.50 \times 10^{10} \text{Hz}$					
7	ai	Electrons are transferred from the screen to the cloth, so there is a net excess					
		of positive charges on the screen.					
	aii	When the dust particles are near the screen, electrons in the dust particles					
		are attracted to the side closer to the screen, as unlike charges attract.					
		This leaves the side of the dust particles further from the screen to be					
		positively charged.					
		As the negatively charged region in the dust particles are nearer to the					
		screen, the force of attraction is larger than the force of repulsion with the					
		positively charged region in the dust, resulting in a net attractive force					
		between the dust particles and the screen.					
	bi	As both rods are positively charged, the glass rod experiences a force of					
		repulsion downwards, increasing the balance reading.					
	bii	The charge on the plastic rod is able to exert a force on another charged					
		object (ie. the glass rod) without any contact.					
8	а	Correct direction	1				
		Near circular loops around wire					
		Peanut shape field further out					
		from wire					

	bi	$R_{eff} = V / I = 12 / 6.0 = 2.0 \ \Omega$	1		$R_X / / R_Y =$	$(1 / 1 + 1 / 1)^{-1} = 0.5 \Omega$	1
		$R + (R_X // R_Y) = R_{eff} = 2.0$			$V_{XY} = R_{XY}$	$I = 0.5 \times 6.0 = 3.0 V$	
		$R + (1 / 1 + 1 / 1)^{-1} = 2.0$	1		$V_{R} = 12 - 3$	3.0 = 9  V	1
		$R = 1.5 \Omega$	1		$R = V_R / I =$	$= 9 / 6 = 1.5 \Omega$	1
	bii	A circuit breaker can be reset quickly by flipping the switch, unlike a fuse			the switch, unlike a fuse		
		which has to be replaced when melted (which takes a longer time).			es a longer time).	I	
9	а		SW	itc	$h S_1$	switch S <sub>2</sub>	1
		point P	c	los	sed	closed	l
		point R	(	op	en	open / closed	I
	bi	At 1000 W / $m^2$ , max voltage	= 0.59	91	V		
		Max output voltage = $4 \times 0.59$	9 = 2.3	36	V		1
	bii	Max I = V / R = $2.36 / 2 = 1.1$	8 A				1
	ci	The percentage of the total	input	(1	ight) energy	/power supplied that is	
		converted to useful output (el	ectrica	ıl)	energy/pow	er.	1
	cii	The power output is given by	$\mathbf{P} = \mathbf{I}$	V.	. At points F	and R, V and I are zero	
		respectively, resulting in zero	powe	r	output.		1
		As efficiency is the ratio of	usefu	ıl D	power outp	ut to total power input,	4
		efficiency of the solar cell at	and	K	1s zero.		1
	C111	Max power output = $2.0 \text{ W}$ (corresponding to 18% of total input power)					1
	1	Energy per second = $100/18 \times 2.0$					1
		= 11.1  J/S	Duri aht				1
		Surface area = Input Power / Brightness = 11 1 W / (1000 W/m <sup>2</sup> ) = 0.0111 m <sup>2</sup>				1	
		$= 11.1 \text{ W} / (1000 \text{ W/m}^2) = 0.0111 \text{ m}^2$ The maximum power output is directly proportional to the brightness of the				1	
	CIV	I he maximum power output is directly proportional to the brightness of the light					
		light.					
		and the power output doubles meaning that the efficiency of the cell					
		remains the same					1
10	ai	An electric current that periodically reverses its direction of flow.				1	
10	aii	Alternating current in the primary coil produces a changing magnetic field					-
		around it.				1	
		The secondary coil thus experiences a change in magnetic flux linkage.				1	
		By Faraday's Law, an e.m.f. is induced in the secondary coil.				1	
	bi	$f = 1 / T = 1 / (4 \times 10^{-3})$				1	
		= 25.0  Hz					1
	bii	Vs / Vp = Ns / Np					1
	biii	$V_s / V_p = N_s / N_p$					
		10 / Vp = 1 / 4				1	
		Vp = 40 V			1		
11	a	Ratio of the speed of light in vacuum to the speed of light in the medium.				2	
Е					-	-	

	bi		Normal and angle of incidence	1
		30°	Direction of refracted ray	1
		30°L-		
		2.0. / 7		
		600		
	bii	$n = \sin i / \sin r$		
		$1.5 = \sin i / \sin 30^{\circ}$ (Principle of Reve i = 48.6°	rsibility of Light)	1 1
		Hence, angle of deviation from origin	al direction = $48.6^{\circ} - 30^{\circ} = 18.6^{\circ}$	1
	C1	45	prism	
			Light is deviated by an angle of 90°	
			after totally internally reflecting off the diagonal side of prism	1
		45		-
	cii	Light is travelling from an opticall	y denser to an optically less dense	1
		medium. The angle of incidence of the light of	$545^{\circ}$ is greater than the critical angle	1
		of the glass, which is 41.8° internally reflected.	Hence, the light is totally	1
11 Or	а	The Celsius scale is defined by two f	ixed points, the ice point at 0°C and	1
01		For ice point, place the thermomet	er in pure melting ice. Allow the	1
		thermometer to reach thermal equilibr	ium with the ice before taking note of	
		the value of the physical quantity measured. Let this value be $x_0$ . For steam point, place the thermometer above pure boiling water. Allow the		
		thermometer to reach thermal equilibrium with the steam before taking note		
		of the value of the physical quantity measured. Let this value be $x_{100}$ .		
		The range of the physical quantity from $x_0$ to $x_{100}$ is then divided into 100 equal intervals such that each interval corresponds to 1°C.		
	bi	J/°C		1
C	bii	$Q = mc\Delta T$		1
	5	= (1.2) (4200) (90 – 20) = 353 kJ		1 1
	bii	Energy wasted in one year		
	2	$ = (352\ 800\ x\ 365) $ = (352\ 800\ x\ 365) / (1000\ x\ 3600) kW	Zh	1
		$ = (352 800 \times 305)^{7} (1000 \times 3000) \text{ KW}$  = 35.8  kWh	11	1 1
	biii	1. Some energy is used to heat up	the kettle itself, so the specific heat	1
		2. Some energy is lost to the sur	rounding air which is at a lower	I
		temperature than the kettle.		1