Name: ……. Index no. ……. Class…….

Bukit Batok Secondary School

GCE O LEVEL PRELIMINARY EXAMINATION 2024

SECONDARY 4 EXPRESS

PHYSICS **6091/02**

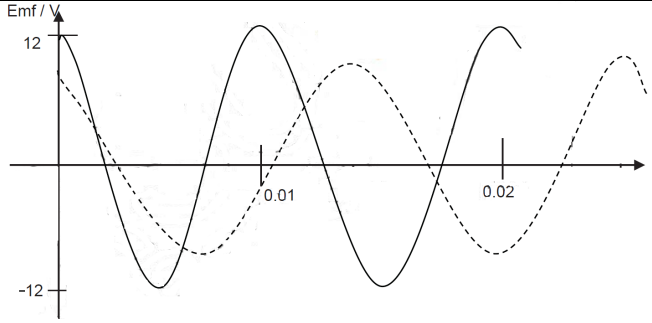
MARK SCHEME

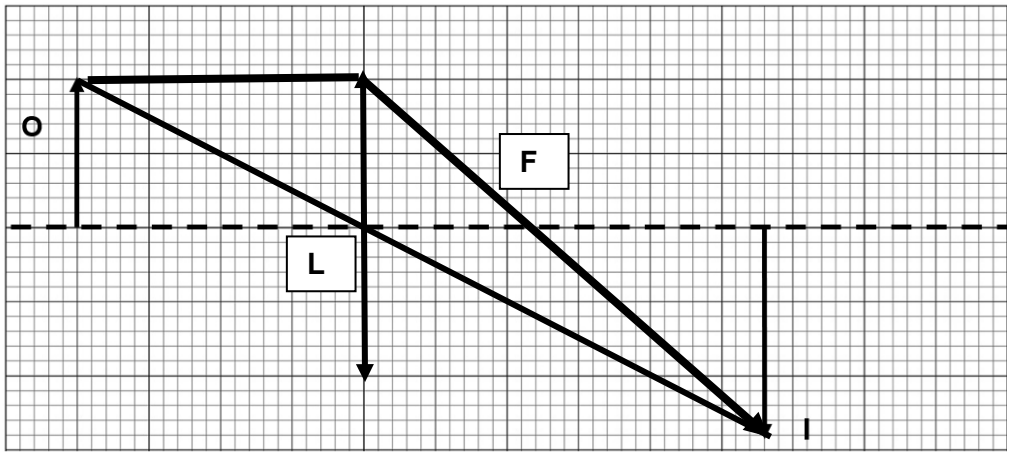
	General marking instructions: 1. If students leave their answers in 1sf, penalise one mark for the **entire** question. 2. If students leave out the units, penalise one mark for **every** question. 3. Exercise **ecf** for calculation questions which require the answer from the previous section. Students will receive full marks if the substitution and calculation is correct based on the wrong value in the previous section(s). 4. Mark Scheme Code a. B1: Independent mark b. C1: Compensation mark; given automatically if the answer is correct, i.e. the working need not be seen if the answer is correct; also given if the answer is wrong but the point is seen in the working. c. M1: Method mark: if not given subsequent A marks fall (up to next B, M or C mark). d. A1: Answer mark. e. ecf: error carried forward; it usually is applied even where not specifically indicated, i.e. subsequent working including a previous error is credited, if otherwise correct.		
	Section A		
1	**(a)**	From t= 0 s to t = 18 s, the rocket is moving upwards and accelerating upwards. [A1] From t = 18 s to t = 50 s, rocket is moving upwards and accelerating downwards. [A1] Both motion and acceleration must be mentioned to award one mark	[2]
	(b)	50 s [A1]	[1]
	(c)	Maximum is the area under the graph = ½ x 50 x 64 [M1] = 1600 m [A1] Allow ecf from **(b)**	[2]

2	**(a)**	gravitational field strength, g, is the gravitational force per unit mass placed at that point. [B1]	[1]
	(b)	m = W/g or 700 / 10 [C1] = 70 kg [A1]	[1]
	(c)	F_{net} = ma or 700 – 20 = (70)(a) [C1] a = 9.71 m/s^2 accept 2sf [A1] Allow for ecf from **(b)**	[2]
	(d)	There is an initial acceleration because the **weight of the skydiver is greater than the air resistance which causes a decreasing acceleration in the same direction as the resultant force** according to N2L. [B1] When the **weight of the skydiver and air resistance is equal in magnitude and opposite in direction, there is no resultant force acting on the skydiver which resulted in no acceleration**. He continues to fall at constant velocity. [B1]	[2]
	(e)	Force on Earth by the skydiver [A1] The force is equal in magnitude (700N) but mutually opposite in direction (towards the skydiver) [A1]	[2]
3	**(a)**	$P_{cushion} = P_{column} + P_{atm}$ or 24 cmHg + 76 cmHg [C1] = 100 cmHg [A1]	[2]
	(b)	Pressure due to 50 kg mass is due to the pressure difference in liquid column = P_{column} Hence, pressure due to 50kg mass = P_{column} = 24cmHg or 0.24 [M1] x13 600x10 = 32640Pa [M1] F/A = 32640 A = 500 / 32640 = 0.0153m^2 [A1] Allow for ecf from **(previous working)**	[3]
4	**(a)**	At point A, the ball possessed energy in the gravitational potential store and kinetic store since the initial speed is not zero. [B1] **Conditional accept the term gravitational potential energy and kinetic energy. Students need to explain the presence of both energy stores in order to be awarded one mark. Important note to remind students to use the term stores in their answers.** When the ball slides down from A, energy in the gravitational potential store is converted to the kinetic store. [B1] Energy from the kinetic store is lost to the surroundings due to work done against friction which causes the speed of the ball to decrease. [B1] **No marks given if students mentioned loss to surrounding as thermal energy without mentioning how does the lost in energy comes about.** At the same time, the friction along the inclined plane caused the energy in the gravitational and kinetics stores to be converted to the internal store of the ball. This caused the ball to heat up as it rolled down the plane. [B1]	[4]
	(b)	**(i)** GPS = mgh = 0.50 x 10 x 13 = 65 J [C1]	[1]
		(ii) Assume no energy is loss and total energy is conserved, $GPE_C + W_{friction}$ = total energy at A or 65 + 10.7 = ½ (0.50) (v_0^2) +(0.50 x 10 x 7.5) [C1] v_0 = 12.4 m/s [A1] Allow for ecf from **(i)**	[2]

	(c)	There is no work done against air resistance as the ball moves up to position C. or No sound energy is transferred out of the system.		[1]
5	**(a)**	For an object in equilibrium [B1], the sum of clockwise moments about a pivot is equal to the sum of anti-clockwise moments about the same pivot [B1].		[2]
	(b)	Applying principle of moments, 0.45 x W + 19 x 1.3 +1.85 x W = 2.6 x 22 [M1] W = 14.1 = 14 N (2sf) [A1]		[2]
	(c)	Determine the magnitude and the direction of the force acting on the rod at end A. F + 22 = 19 +28 F = 25 N upwards [C1] Allow for ecf from **(ii)** even if students can't prove its 14 N		[1]
6	**(a)**	Heater Y is more efficient as thermal energy loss to the surroundings is reduced. The plastic casing reduces thermal energy lost by conduction since plastic is a poor conductor of thermal energy. [B1] OR The air trapped between the plastic casing and the water tank reduces thermal energy loss by conduction better than X since air is a poor conductor of heat. [B1] OR The white casing reduces thermal energy loss by radiation since white is a poor emitter of radiant heat. [B1] Any 2 of the following points. No mark given to just stating Heater Y without explanation.		[2]
	(b)	**(i)**	The change of its internal energy/store per unit mass for each unit change in its temperature. [accept internal energy since definition in textbook indicated as internal energy]	[1]
		(ii)	Loss of thermal energy of tea = mcΔT or = 0.25 x 4200 x (50.0- 5.0) [**ΔT = 45, obtain from the graph**] [C1] = 47250 J = 47300 (3sf) or 47000 J (2sf) [A1] do not penalise for sf, **except a reasonable range of answers from 46200 (ΔT = 44) to 48300 (ΔT = 46)**	[2]
		(iii)	Energy lost by hot water = Total energy gained by ice cubes to melt and increase temperature from 0 ºC to 5 ºC 47250 = m (336000) [C1] + m (4200) (5) [C1] m = 47250 / 357000 = 0.132 kg [A1] accept a range based on **(bii)** Allow ecf from **b(ii)**	[3]
7	**(a)**	**Electrons is transferred to the glue** from the nozzle and becomes charged via friction/contact. [B1]		[1]
	(b)	**Like charges repel** and hence the **negatively charged glue droplets moved away** from each other. [B1]		[1]
	(c)	Since **unlike charges attract,** the section of paper with the negatively charged glue attract the **sand particles that are positvely charged and neutral** . [B1]		

		The **attractive force is greater than the weight of the sand** and the sand move upwards. [B1]		[2]
8	**(a)**	From graph, Current = 1.4 + 0.35 = 1.75 A / 1.8 A [A1] (2 sf) do not penalise for sf		[1]
	(b)	R = V/I = 4/1.75 or 1.8 = 2.29 Ω/ 2.3 Ω (2 sf) or 2.22 Ω/ 2.2 Ω [C1]		[1]
	(c)	They could have different cross-sectional areas. Except other reasonable answers.		[1]
	(d)	Q = I x t = 1.75 or 1.8 x 60 = 105 C or 108 C [C1]		[1]
	(e)	W = V x Q = 4.0 x 105 or 108 = 420 J or 432 J [C1]		[1]
9	**(a)**	As the light intensity increases, the resistance of the LDR decreases [B1]. Using the potential divider formula, the voltage across the fixed resistor will increase as follows V = (6000/6000+ $R_{LDR\ decreases}$) [B1]		[2]
	(b)	Total resistance of buzzer and resistor 1/R = 1/1440 + 1/6000 R = 1160 [M1] 4.5 = 12 (1160/1160+R) 5220 + 4.5 R = 13920 R = 1930 Ω [A1] (accept 1900 2sf)		[2]
10	**(a)**	**(i)**	AB downwards, CD upwards [B1]	[1]
		(ii)	Using Fleming's Left-Hand Rule, the index finger which represent the direction of the magnetic field points to the right (from N to S) [1], the middle finger which represent the direction of the current points from A to B into the paper [1], and the thumb which represent the induced force points down. All three fingers are perpendicular to each other. [1] (All 3 points, 2 marks, 1 to 2 points, 1 mark)	[2]
		(iii)	The split ring commutator **reverses the direction of the current** in side AB of the coil **after every half a rotation**, when the coil passes the vertical plane. [1] Hence, the **direction of the force** acting on side AB of the coil also **reverses** after **every half a rotation.** [1] This ensures that the coil has a continuous anticlockwise moment about the axle. [1] (All 3 points, 2 marks, 1 to 2 points, 1 mark)	[2]
	(b)	**(i)**	Comparing the voltages of primary coil to secondary coil: Step down ratio = 3 300 : 220 = 15 : 1 [B1] Hence the coils must be step down to the same ratio of 15 : 1 Comparing the turn ratio i.e Coil M : Coil K [**wrong sequence no mark]** = 1 500 : 100 = 15 : 1 [B1]	[2]

		(ii)	In a non-ideal transformer, eddy currents are produced and the energy is transferred to the internal store of the soft iron core [B1]. Lesser induced current produced at the output resulted in lower efficiency.	[1]
	(c)	To reduce the effect of joule heating on the transmission cables, the current transmitted must be lowered [B1]. To minimise the power loss due to the reduction in the current, the voltage needs to be increased substantially [B1].		[2]
11	**(a)**	$^{226}_{88}Ra \rightarrow {}^{222}_{86}Rn + {}^{4}_{2}He$ [B1] **accept all textbook representations**		[1]
	(b)	**(i)**	12 counts/min [B1]	[1]
		(ii)	Radiation from rocks, ground, building materials, radon gas, radiation from space, the sun's cosmic rays or nuclear waste (Accept any logical answer)	[1]
		(iii)	count rate = 84 – 12 = 72 cpm	
			count rate = 21 – 12 = 9 cpm [both count rate correct: 1 mark]	[1]
		(iv)	Time interval for 3 half-lives = 19 – 10 = 9.0 minutes [C1] Half-life = 9.0/3 = 3.0 minutes [A1] **If obtain directly from the graph, award full marks.**	[2]
	(c)	One use: Beta particles can be used to measure thickness of materials in industries **except lead**. [B1] (accept any logical answer)		[1]
		One hazard: Beta particles can kill cells, cause mutations and cancer [B1] (accept any logical answer).		[1]
		Section B		
12	**(a)**	When the switch is on, the <u>iron core is magnetised</u> [B1]. The permanent magnet is <u>moved left and right at a frequency of the alternating voltage due to alternate attraction and repulsion</u> between poles. [B1] This causes the <u>cone to vibrate</u> resulting in the air molecules around it to <u>vibrate parallel to the direction of sound wave travel</u>. [B1] **If student just mentioned longitudinal without explaining no mark awarded.**		[3]
	(b)	**(i)**	frequency = 1/T = 1/ (4 x 10 x 10^{-3}) = 25 Hz,	[1]
		(ii)	distance = s x t = 330 x 2 x 10 x 10^{-3} = 6.6 m	[1]
		(iii)	At B, the sound is <u>softer</u> but <u>same pitch</u> as A or At A, the sound is <u>louder</u> but <u>same pitch</u> as B	[1]
	(c)	**(i)**	 Solid line: max emf 12 V, min emf 12 V. [B1] period = 0.010 s [B1]	[2]

		(ii)	Dotted line in diagram above Smaller peaks, longer period **(both correct one mark)**	[1]
		(iii)	A lower speed of rotation results in smaller peak voltage produced as the rate of change of magnetic flux is reduced.	[1]
13	**(a)**	 **Fig. 13.1**		
		(i)	Refer above [B1]	[1]
		(ii)	Refer above [B1]	[1]
		(iii)	Real, inverted and magnified	[1]
		(iv)	The focal length will become shorter [B1]	[1]
		(v)	Used in optical fibres during surgeries [B1] (Accept logical answers)	
	(b)	**(i)**	Using Faraday's law, as the coil rotates, it cuts the magnetic field lines between the magnets, an emf is induced in the coil. [B1] At every 180° turn, the induced emf in the coil reverses direction as the coil moves in the opposite direction. Hence an alternating current is produced. [B1] Using Lenz's law, the direction of the induced alternating current produced is such that its magnetic effect opposes the motion or change producing it. [B1]	[3]
		(ii)	A higher speed of rotation results in larger voltage produced as the rate of change of magnetic flux is increased [B1]. The frequency of the voltage output will double as well [B1].	[2]
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