2022 PRELIMINARY EXAM SUGGESTED ANSWER SCHEME

PAPER 1 (40 marks)

Qn	Answer	Explanation		
1	В	Micrometer must be a choice for measuring diameter. Vernier calipers are not suitable for measuring length of wires.		
2	С	Volume of sphere = $\pi/6 (0.481 \text{ cm})^3$; Density = (0.450 / 0.058)x 1000 kgm ⁻³ = 7720 kgm ⁻³		
3	В	Returning back to the starting point will result in zero displacement. Total distance is non- zero		
4	С	A & B are not possible as the value is less than $\sqrt{4^2 + 5^2}$ kN or 6.4 kN. 8.3 kN is closer to 9.0 kN when the two forces are parallel to each other.		
5	В	velocity v v v v v v v v v v v v v		
6	D	The gradient, which is the acceleration, is greater at X than at Y. Therefore the resultant force is acting on the raindrop is greater at X.		
7	D	The graph shows increasing velocity (increasing gradient) followed by constant velocity		
8	A	There is no atmosphere to slow down the feather. It moves with constant acceleration.		
9	В	Distance travelled = ½(3.0s)(22+8)ms ⁻¹ = 45 m		
10	С	At constant speed, resultant force = 0. Total upward force = total downward force.		
11	В	$P_{atm} - P_{chamber} = P_{40 cmH20} = (0.4m)(1000 kgm^{-3})(10N kg^{-1}) = 4000 Nm^{-2}$		
12	D	P = W/A. Since all 5 blocks have the same mass, P \propto 1/A \Rightarrow an inverse function graph		
13	С	T x 5.0 cm = 40 x 35 cm \Rightarrow T = 280 N		
14	С	The CG of the block falls through a height of 0.9 m. Δ GPE = 500 N x 0.9 m = 450 J		
15	С	Shortest time to reach her classroom is by running. More power is used to gain the same amount of GPE as Power = work done / time		
16	С	Efficiency = (200 x 6000)W / (500 x 10 x 300)W x 100% = 80%		
17	A	Molecules do not expand when a solid is heated		
18	A	Evaporation resulted in the lowering of the KE of the remaining molecules in the liquid. Molecules leaving need to attain the necessary KE to overcome the bonds and escape into the atmosphere. Therefore they must possess high energy.		
19	С	In one second 6000 J = m x 4200 Jkg ^{-1o} C x 20 ^o C \Rightarrow m = 0.0714 kg		
20	С	Molecules do not expand. The KE of molecules do not increase – only PE increases during change of state		

Question	Answer	Explanation
21	D	$1.8 = \sin R/\sin 30^{\circ} \Rightarrow R = \sin^{-1} (0.9) = 64.15^{\circ}$
22	С	Total internal reflection occurs when angle of incidence in the optically denser medium is greater than critical angle and can only occur inthe optically denser medium
23	В	The dotted lines locate the image to the left and on the same side as the object. This is the image formed when image is less than the focal length of the lens.
24	В	R = V/I
25	D	All other choices have an open circuit
26	В	Variable resistor is connected in parallel to the fixed resistor. Voltmeter will register an increase when resistance is increased. (alternative explanation : Increasing the variable resistor increases the total resistance of the two parallel resistors . Using potential divider eqn before and after adjustment, V1 decreases and V2 increases)
27	A	Resistance is lowest when temperature for thermistor is high and LDR is placed in bright light.
28	D	Overheating is due to high current than allowed by the fuse
29	В	Mobile electrons are attracted to the positively-charged sphere. Electrons from earth discharges the positive charges at the bottom of the plate. Removing the earthing wire first results in metal having a net negative charge.
30	В	Bringing the positive rod near will induce electrons on top and positive charges at the bottom
31	D	Like charges repel each other
32	С	Currents flowing in difference direction create a strong field in the centre.
33	Α	Recall question
34	В	Distance = (0.04 s x 300 m/s) = 12 m
35	С	The crest/ trough moves forward, thus constituting the wave velocity.
36	Α	$\lambda/2 = L; V = f\lambda \Rightarrow f = V/\lambda = V/2L$
37	C	Use right-hand grip rule
38	С	Apply Fleming's Left-hand rule with the centre finger pointing in the direction opposite to the motion of the -ve charge
39	A	Ns/Np = Vs/Vp \Rightarrow Vs = 1/20 x 240 = 12 V. lp = 12 V/ 6.0 Ω = 2.0 A. From lpVp = lsVs \Rightarrow lp(240V) = 2.0 A (12 V) Thus lp = 0.1 A
40	D	Increasing coil speed increases the frequency as well as the amplitude

PAPER 2 SECTION A (50 marks)

Qn	Part	Answer	Mark	Remarks
1	(a)	Measuring tape		
	(b)(i)	Average density = $18000 \text{ kg} / (2.0 \times 15.0 \times 0.25) \text{ m}^3$ = 2400 kgm^{-3}		
	(ii)	Average pressure = $(18000 \times 10)N / (0.25 \times 15)m^2$ = $4.8 \times 10^6 Nm^{-2}$		
	(iii)	Doubling the length doubles the volume. Since density is constant, mass/weight is doubled. Since area is also doubled, pressure remains unchanged		
2	(a)	Speed is rate of change of distance while velocity is the rate of change of displacement. Since displacement is a vector, velocity has a direction and magnitude while speed is a scalar		
	(D)(I)	velocity change = (+25m/s)-(-22m/s) = +47 m/s		
	(ii)	Average acceleration = $(+47m/s)/0.0013 s$ = $+3.6 \times 10^4 ms^{-2}$		
	(iii)	Average force F = ma = $0.16 \text{ kg x } [+3.6 \text{ x } 10^4] \text{ ms}^{-2}$ = $+ 5.8 \text{ x } 10^3 \text{ N}$		
3	(a)	A point where the whole weight of the body appears to act regardless of the body's orientation		
	(b)(i)	Applying principle of moments, $W \ge 0.2m = 80 \ N \ge 0.5 \ m + 70 \ N \ge 1.3 \ m$ $= 40 \ Nm + 91 \ Nm$ $\Rightarrow W = 655 \ N$		
	(iii)	Either : Move the 70 N weight to the right until the CG of the weight is directly above B. Reason : the weight of the stationary student must be the maximum to produce the corresponding anticlockwise moment to keep the plank in equilibrium. OR : Move the pivot to the left . Reason: This creates a greater clockwise moment . To keep the plank in equilibrium, the weight of the student will need to increase.		
4	(a)	 Density of ice <u>decreases</u> as the temperature increases from – 5°C to 0°C At 0°C, the density <u>increases (when its volume</u> <u>decreases)</u> from 33 cm³ to 30 cm³. 		
	(b)	Density of ice at volume 33 cm ³ = $(30/33)$ gcm ⁻³ = 0.91 gcm ⁻³ Density of ice at volume 30 cm ³ = $(30/30)$ gcm ⁻³ = 1.00 gcm ⁻³ Change in density = $(1.00 - 0.91)$ gcm ⁻³ = 0.09 gcm ⁻³		

	(c)	 Water molecules/particles <u>at the surface of the ice</u> 	
		obtain sufficient (vibrational) kinetic energy to	
		overcome the forces of attraction between each	
		other and exist as free molecules.	
		 These water molecules must also have sufficient 	
		(translational) kinetic energy to escape into the	
		space above the ice and exists as free molecules.	
5	(a)(i)	Number of pulses = (6 x 60 s) / 0.00462 s ⁻¹	
		= 77921	
		= 78000	
	(ii)	Total energy = 77921 x 0.00012 J	
		= 9.35 J	
	(iii)	From Q = mc $\Delta \theta$	
		9.35 J = 50 g x 4.2 Jg ⁻¹ °C ⁻¹ x Δθ	
		$\Rightarrow \Delta \theta = 0.045 ^{\circ}\text{C}$	
	(b)	 Energy absorbed by the skull resulted in less energy 	
		transmitted to the brain	
		 Nature of the fluid in the brain is different from 	
		water. Thus the specific heat capacity differs.	
	(c)	Input energy = 0.20 W x (60 x 6)s	
		= 72 J	
		Fraction of energy converted into radio waves	
		= 9.35 J/72 J	
		= 0.13	
6	(a)	P _{atm} = 0.76 m x 13.6 x 10 ⁻³ kgm ⁻³ x 10 Nkg ⁻¹	
		= 103360 Nm ⁻²	
		= 100000 or 10 ⁵ Nm ⁻²	
	(b)	 Since vertical height below mercury meniscus in 	
		tube is less than 760mm, higher atmospheric	
		pressure forces air through the hole and bubbles	
		through the mercury upwards.	
		 Air pressure in the space above meniscus increases 	
		and pushes the mercury meniscus down slowly.	
		 When the meniscus move past the hole, the 	
		meniscus will go down quickly since the pressure	
		inside the tube is the same as P _{atm} .	
7	(a)	P & Q ; Q & R ; P and R	
	(b)	Given that $\frac{l_P}{l_P} = \frac{3}{4}$ and $\frac{A_P}{A_P} = \frac{2}{1}$	
		$\xrightarrow{R_P} \stackrel{l_P}{\longrightarrow} \stackrel{R_R}{\longrightarrow} \stackrel{l_R}{\longrightarrow} \stackrel{R_R}{\longrightarrow} \stackrel{I}{\longrightarrow} \stackrel{I}{\longrightarrow} \stackrel{R_R}{\longrightarrow} \stackrel{I}{\longrightarrow} \stackrel{I}{\longrightarrow} \stackrel{I}{\longrightarrow} \stackrel{R_R}{\longrightarrow} \stackrel{I}{\longrightarrow} \stackrel{I}{$	
		\rightarrow $\frac{1}{R_R} - \frac{1}{l_R} \wedge \frac{1}{A_P}$	
		$=\frac{3}{4}\times\frac{1}{2}=\frac{3}{8}$	
	(c)(i)	A ₁ . The current in A ₁ is the sum of the currents in A ₂ , A ₃	
		and A ₄ .	
	(ii)	A ₁ /A ₃ . Current bypasses P, Q and R as the resistance of	
		switch is very low.	
	(d)	A_3 and A_1 will be ruined.	
	()	The closing of the switch and the absence of resistor S	
		results in the bulk of the current passing through only	
		ammeter A_3 and A_1 and bypassing P and R.	
8	(a)(i)	Sinusoidal graph with no change in period but higher	
_	,	amplitude.	
	(ii)	Crests/troughs will be closer to each other.	

(b)	The (sinusoidal) electrical signal/current from the	
	amplifier produces a changing magnetic field and in the	
	This changing magnetic field interacts with the radial	
	magnetic field of the permanent magnet producing a	
	varying force of different magnitudes per cycle of the	
	signal and in different directions.	
	Since the coll is attached to the paper cone, the	
	changing force (both in magnitude and direction) will oscillate the cone back and forth thereby setting the	
	volume of air into oscillation	
	(This oscillation of the air layers is the sound which was	
	played on the trumpet.)	
(d)(i)	Method 1	
	$f_{\text{base}} = 1/(8 \times 200 \times 10^{-3} \text{ s})$	
	From $\frac{f_{note}}{f_{base}} = 2$ $T_{note} = 4 \times 200 \text{ ms}$	
	$f_{\text{note}} = 1/4 \times 200 \times 10^{-3} \text{ s}$	
	$f_{note} = 2 \times f_{base} = 1.25 \text{ Hz}$	
(= 1.25 Hz	
(ii)	Halt-cycle drawn across 8 divisions of the same peak.	

SECTION B (30 m)

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Qn	Part	Answer		
9	(a)	Gravitational PE = 80 kg x 10 Nkg ⁻¹ x 85 m = 68000 J or 68 kJ		
	(b)	The sum of the kinetic, gravitational and elastic potential energy is always constant during the jump and is equal to 68kJ.		
	(c)	Kinetic v / ms ⁻¹ Energy/kJ 29.3		
	(d)	 The bungee jump experiences decreasing acceleration from h = 60 m to h = 40 m Between 40 m to 20 m, he is experiencing increasing deceleration. 		
	(e)	 Resultant force (W – T) between h = 60 m and h = 40 m, is <u>decreasing downwards</u> as the tension is increasing Resultant force between from h = 40 m to h = 20 m is increasing upwards as (T - W) is increasing since the tension in the rope is increasing 		
	(f)	In Fig. 9.3 a, the forces are all acting on the student and a thus free-body diagram forces. In Fig. 9.3 b, the two forces are action-reaction pair forces as they are acting on separate bodies.		
10	(a)	Magnetic induction is the temporary transformation of a magnetic material into a magnet when it is placed in a magnetic field while electromagnetic induction is the production of an induced electromotive force (e.m.f.) by a changing magnetic flux linkage.		
	(b)(i)	 There is a rate of change of magnetic flux linkage with the solenoid as the N-pole of the magnet approaches the coil. As it is a closed circuit, an induced current thus flows such as to produce a N-pole at the coil facing the approaching N-pole. As the magnet is accelerating under gravity, the rate of change of magnetic flux is increasing non-uniformly, thereby producing a non-uniform increase in the induced e.m.f. 		
	(ii)	 As the magnet enters the magnet, the induced emf and hence the direction of the induced current in the coil differs in direction and magnitude. The induced current in the coils at the bottom coils flows in such a direction as to produce a N-pole at the bottom coils and decreasing in magnitude. As the S-pole recedes from the coils at the top, the induced e.m.f. and hence the induced current flows in the opposite direction to that at the bottom and induces a N-pole at the top coils but increasing in magnitude. The two opposing currents cancel out when the magnet reached the middle of the coil as the e.m.f. 		

		induced by both poles are the same in magnitude	
	(c)	 A large current flowing will produce a stronger magnetic field already existing in the solenoid. This stronger magnetic field is further concentrated by the iron core in the solenoid besides already inducing it to become a temporary magnet. The resulting stronger magnetic field, already attracting the iron armature due to the opposite polarity , attracts it with a larger attractive force. The iron armature rotates clockwise about the pivot and breaks contact with the springy metal which is connected to terminal 1. An open circuit results and current ceases to flow when the springy metal touches the reset button. 	
11	FITHER		
	(a)		
	(b)	Laterally Inverted; vertically inverted; real	
	(c)(i)	It the distance between the optical centre of the lens	
	(ii)	0.35 cm / 3.5 mm	
	(iii)	 The light ray bend towards the normal It then converges to a point and does not emerge out of the plastic disc. 	
	(iv)1	lens	
	(iv)2	0.1 cm /1 mm	
	(v)	Raised the lens <u>by the same amount</u> that the disc is raised.	

11	OR		
	(a)(i)	From P = VI	
		I = 2500 W/240 V	
		= 10.4 A	
	(ii)	1.25 mm. Thinner wire will result in a fire as the	
		resistance is very high.	
	(iii)	Constant bending of the wire will result in the wires	
		breaking the insulation. The live wire may touch the	
		neutral wire /earth wire which will result in a large	
		current bypassing the heating element and flows	
		through the fuse , thereby melting it.	
	(iv)	When the power is switched off, the appliance is still	
		live as the live wire is still connected to the appliance	
		and is at a high potential.	
	(b)(i)	 The electrical cables are insulated from the internal 	
		components .	
		 The internal components are insulated from the 	
		external casing.	
	(ii)	Total power consumed in two weeks by hairdryer	
		= 1.25 kW x 2 x 0.75 h	
		= 1.875 kWh	
		Total power consumed by kettle in one week	
		= 2.5 kW x 14 x 0.25 h	
		= 8.75 kWh	
		lotal cost = (1.875 + 8.75)kWh x \$0.40	
		= \$4.25	