Anderson Serangoon Junior College 2023 H2 Physics Prelim P3 Mark Scheme

Paper 3 (80 marks) **E – Easy, A – Average, D – Difficult**

ECF	Error carried forward	**SF**	Significant figures error	**M0**	No A marks awarded
AE	Arithmetic error	**BOD**	Benefit of doubt	**^**	More is needed in answer
POT	Power of ten error	**CON**	Contradictory response	**XP**	Wrong physics
TE	Transcription error	**IR**	Irrelevant (part) response		

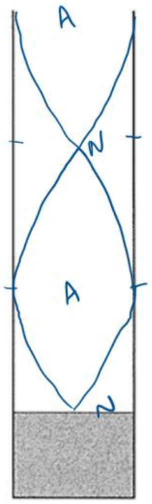
1a	<u>Gradient</u> is not constant so <u>acceleration</u> changes with speed Hence resultant force changes with speed Resultant force consist of weight and air resistance and weight is constant (hence can be deduced that air resistance varies with speed).	**A**	M1 A1 A0
1bi	Fnet = $mg - kv^2$ Using N2L, F_{net} = ma $mg - kv^2$ = ma m$(g - a) = kv^2$ $(g-a)=\dfrac{kv^2}{m}$	**A**	 B1 B1 A0
1bii	At v = 4.0 m s^{-1} Gradient=$\dfrac{6.0-2.8}{0.68-0.28}=\dfrac{3.2}{0.40}=8.0$ a = 8.0 m s^{-2} $g - a$ = 9.81 – 8.0 = 1.8 (or 1.81)	**A**	 M1 A1 A0
1biii	From **b(i),** $(g-a)=\dfrac{kv^2}{m}$, $\dfrac{(g-a)}{v^2}=\dfrac{k}{m}$ should be a constant for 4.0 m s^{-1}, $\dfrac{(g-a)}{v^2}=\dfrac{1.8}{4.0^2}=0.11$ or 8.0 m s^{-1}, $\dfrac{(g-a)}{v^2}=\dfrac{9.8}{8.0^2}=0.15$ Hence, values of $\dfrac{(g-a)}{v^2}$ are not the same, suggestion is incorrect.	**A**	M1 A1

2a	The resultant force acting on a body is the rate of change of momentum of the body and acts in the direction of the change in momentum.	**E**	A1
2b	Work W is the product of a force F and a displacement s in the direction of the force. Since Power P is the rate of doing work, Hence, P = W/t = Fs/t = Fv	**A**	 B1 B1 A0

2ci	At constant speed, no net force acting on lorry. Hence, magnitude of driving force is equal to that of resistive force on lorry. Driving force, F = P/v = 130 000/25 = 5200 N	**A**	M1 M1 A0
2cii	Friction between tyres of lorry and road exerts a backward force on the road. By Newton's third law, road surface exert a forward force of equal magnitude on tyres.	**A**	B1 B1
2d	F - mg sin θ – R = ma F = 36000(9.81 sin 1.4) + 5200 + (36000)(0.15) = 19228 N = 19000 (19200) N	**A**	 C1 A1

3a	Centripetal acceleration: Car on path X and Y has the same acceleration Both experienced the same centripetal force at maximum speed since the centripetal force is provided by the (maximum lateral) friction force. As both cars are identical and hence have the same mass, they will have the same centripetal acceleration. Maximum speed: Car on path Y will have a bigger maximum speed. $F = \frac{mv^2}{r}$ $v = \sqrt{\frac{Fr}{m}}$ Since F and m are the same for both cars, $v \propto \sqrt{r}$. Since radius of path Y is bigger than that of X, maximum speed of car on path Y is larger.	**A**	 M1 A1 M1 A1
3bi	For circular motion, centripetal force on moon of mass m is provided by the gravitational force due to Jupiter on moon, $\frac{GM_J m}{R^2} = mR\omega^2$ $G\frac{M_J m}{R^2} = mR(\frac{2\pi}{T})^2$ $\Rightarrow T = \sqrt{\frac{4\pi^2 R^3}{GM_J}}$ where ω is the angular velocity of moon.	**A**	M1 M1 A0
3bii	Since $T^2 \propto R^3$, $\left(\frac{T_{Th}}{T_{Am}}\right)^2 = \left(\frac{R_{Th}}{R_{Am}}\right)^3 \Rightarrow \left(\frac{0.676}{T_{Am}}\right)^2 = \left(\frac{3.18}{2.62}\right)^3$ T_{Am} = 0.506 Earth-days	**A**	 M1 A1

3biii	Since the <u>orbital period</u> of Thebe is not the same as the <u>rotation period</u> of Jupiter, So not in stationary orbit. Or orbital period of Thebe = 0.676 Earth-days, not the same as a <u>Jupiter-day which is approximately 0.417 Earth-days</u>, so not (possible to be) in stationary orbit.	**D**	M1 A1 (M1) (A1)

4a	Change in depth of water.	**E**	B1
4b	$L = \lambda/4$ $v = f\lambda$ So, $v = f\,(4L)$ $= 480 \times 4 \times 0.18$ $= 345.6$ m s^{-1} $= 346$ (350) m s^{-1}	**A**	 C1 A1
4ci	 A node at the water surface and an antinode at the open end of the air column Length of air column equals ¾ of wavelength of the stationary wave, with total of 2 nodes and 2 antinodes labelled correctly Correct sinusoidal shape (only award when both M marks are scored)	**A**	M1 M1 A1
4cii	Vibrate along axis of the tube, Vibrate with maximum amplitude.	**A**	B1 B1
4ciii	$L = ¾\,\lambda$ so $\lambda = 4/3\,L = \lambda'/3$ where λ' is the wavelength in part **(b)** Since $v = f\lambda$, $f = 3\,f'$ where f' is the frequency in part **(b)** $f = 3 \times 480 = 1440$ Hz	**D**	 C1 A1

5a	As <u>temperature (of the filament) increases</u> with *V* the <u>resistance of the lamp increases</u> hence V/I ratio increases.	**A**	M1 A1
bi	From *I*-*V* graph, find the common current when the individual p.d. of each lamp sum up to 12 V. $I = 0.40$ A (± 0.01 A)	**A**	B1 B1

bii	Current is the same, but p.d. across lamp B is higher than that of lamp A OR resistance of lamp B is higher than resistance of lamp A Using $P = IV$, lamp B will have greater power dissipation.	**A**	M1 A1
c	From bi, $V_A = 4.0$ V , $V_B = 8.0$ V For zero current in the galvanometer G, k(XJ) = 4V where k = 12/0.80 XJ = (4/ 12) x 0.80 = 0.27 (0.267) m OR For zero current in the galvanometer G XJ = [4/(4+8)] x 0.80 = 0.27(0.267) m	**A**	 C1 A1 (C1) (A1)

6a	Each coil acts as a current-carrying conductor in the magnetic field of the neighbouring turn Magnetic field (due to current) in one loop cuts / is normal to the current in second loop. By Fleming's left-hand rule, there will be a (magnetic) force on the second loop towards the first loop. (By Newton's third law, this gives rise to mutual attraction between the loops.) Hence, separation decreases.	**A**	 M1 M1 A0
6bi	Mass exert a downward force on the frame. / mass exert a (clockwise) moment on the frame For frame to have no net moment about pivot (or for the frame to be in rotational equilibrium**)**, magnetic force must act downwards on near side of frame.	**A**	B1 A1
6bii	$F = BIL$ $24 \times 10^{-3} = B \times 4.5 \times 4.6 \times 10^{-2}$ $B = 0.116$ T = 0.12 T	**A**	 C1 A1

7a	When the rate of decay of Xe-143 is faster than that of Cs-143, the number of Cs-143 increases. When the rate of decay of Xe-143 decreases, as number of Xe-143 decreases, till it is below the rate of decay of Cs-143, the number of Cs-143 decreases. Or When the rate of decay of Cs increases, as number of Cs increases, till it is above the rate of decay of Xe, the number of Cs-143 decreases	**A**	B1 A1 (A1)
7b	Due to the **spontaneous** nature of radioactivity decay, the rate of decay is unaffected by external environment such as surrounding temperature.	**A**	A1
7c	The number of radiations does not just come from Xenon, but also from Caesium. The count rate may include background radiation.	**A**	B1 B1
7d	β-particles have high speeds/energy	**D**	B1

	when charged particle is accelerated/slowed down electromagnetic radiation is produced β-particles stopped in the lead produce X-ray radiation which escapes.		M1 A1 B1

8ai	Heat lost by water = heat gained by mercury $m_{water}c_{water}\Delta T_{water} = m_{mercury}c_{mercury}\Delta T_{mercury}$ (18.7) (4.18) (37.4 – T) = (6.94) (0.140) (T – 23.0) T = 37.2 °C	**A**	C1 C1 A1
8aii	The glass of the thermometer OR the beaker containing the water have negligible heat capacity or gained negligble heat.	**A**	B1
8aiii	Use a liquid with a lower (specific) heat capacity (than mercury), or Use a smaller mass of mercury.	**A**	B1
8aiv	It depends on properties of a real substance, and 0 °C is not absolute zero	**D**	B1 B1
8av	Ideal gas	**E**	B1
8bi	Internal energy is the sum of the kinetic energy due to the random motion of the molecules and the potential energy Ep due to intermolecular forces between them. For ideal gas, no forces between molecules, so the potential energy of molecules is zero. Hence internal energy of the gas is equal to the total kinetic energy of the molecules	**A**	B1 B1 A0
8bii	Increase in internal energy = Q + work done, Constant volume so no work is done.	**A**	B1 B1
8biii	$Q = Nmc\Delta T$ $U = (3/2)\ NkT$, so $\Delta U = (3/2)\ Nk\Delta T$ $Q = \Delta U$, so $Nmc\Delta T = (3/2)\ Nk\Delta T$ Hence, $c = \frac{3k}{2m}$	**D**	M1 M1 A1 A0
8biv	Gas expands and does work (against the atmosphere pressure) (For the same temperature rise), more (thermal) energy is needed, so larger specific heat capacity.	**A**	M1 A1
8bv	Speed of air molecules decreases on impact with moving piston. Since the kinetic energy (of molecules) is proportional to (thermodynamic) temperature, Kinetic energy (of molecules) decreases, so temperature decreases.	**D**	B1 B1 B1

9a	The Magnetic Flux Linkage in a coil is the product of the area of the coil and the number of turns in the coil and the component of the magnetic flux density perpendicular to that area.	**E**	M1 A1
9b	t = 1.2 s e.m.f = $\dfrac{\Delta NBA}{t} = \dfrac{540\times0.250\times\pi\times0.030^2}{1.2}$ = 0.32 V	**A**	B1 C1 A1
9ci	light damping	**E**	A1
9cii	sheet cuts (magnetic) flux and causes induced emf (induced) emf causes (eddy) currents (in sheet) either currents (in sheet) cause resistive force or currents (in sheet) dissipate energy <u>smaller currents</u> in Y or <u>larger</u> currents in X, so dashed line is X	**D**	B1 B1 B1 B1
9di1	sinusoidal waves with amplitude 320 V and two time periods shown, each of 0.020 s $\omega = \dfrac{2\pi}{T}$ T = $\dfrac{2\pi}{100\pi}$ $= 0.020\text{ s}$	**A**	B1 B1
9di2	If 9di1 is positive sine function shown, sinusoidal half waves in positive V only for the first half of cycle and (peak at 320 V, line at zero for second half of cycle (two time periods shown, each of 0.020 s) If 9di1 is negative sine function shown, then vice versa – line at zero for first half cycle, then sinusoidal half waves in negative V only for second half cycle.	**D**	 B1 B1
9di3	If 9di1 is positive sine function shown, line at <u>zero for first half</u> of cycle and <u>sinusoidal half waves in negative V only for the second half</u> of cycle. (peak at 320 V two time periods shown, each of 0.020 s) If 9di1 is negative sine function shown, then vice versa –sinusoidal half waves in negative V only for first half cycle, then line at zero for second half cycle.	**D**	 B1
9dii	Average power P = ½ (V_{rms}^2/R) Or ½(P_o/2) = [½ ($\dfrac{320}{\sqrt{2}}$)^2]/120	**A**	C1

	= 210 (213) W Or Average power P = ½(P_o/2)		A1
9diii	The root-mean-square p.d is defined as <u>the steady direct current</u> which produces <u>heat at the same rate</u> as the alternating current across a given resistor.	**E**	B1
9div	Average power = $I_{rms}^2 R$ $I_{rms} = \sqrt{\frac{213}{120}}$ = 1.33 A Accept ecf Or $I_{rms} = \frac{V_{rms}}{R} = \frac{V_o}{2R}$	**A**	 C1 A1