Anderson Serangoon Junior College 2022 JC2 H2 Physics Prelim Mark Scheme

Paper 1 (30 marks)

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
B	C	A	C	D	B	B	B	A	A
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
C	B	C	B	A	D	D	B	B	A
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
B	C	D	B	B	C	B	A	C	C

1	**B** Replace J with SI base unit of energy kg m^2 s^{-2} in the original expression J kg^{-1} K^{-1} will give m^2 s^{-2} K^{-1}.
2	**C** In the calculation of fractional uncertainty of 3*X*, the coefficient 3 will cancel out, also, for calculation of uncertainty, we always add and not subtract because the uncertainty should increase with more terms involved rather than decrease, so the final answer is $x + 2y$.
3	**A** All responses show a flat constant v at the initial distance travelled. For the next part where a is constant, using $v^2 = u^2 + 2as$, we see that when we plot v vs s, we get a square root curve, so **A** is the answer. Alternatively, gradient of graph $= \frac{dv}{ds} = \frac{dv}{dt} \times \frac{dt}{ds} = a \times \frac{1}{v}$ As v approaches zero, $\frac{1}{v}$ approaches infinity, so the gradient approaches infinity.
4	**C** Since we are using the same scales, it is expected that the initial velocity is the same as the air resistance is negligible when the velocity is small.
5	**D** Consider horizontal direction, the change of momentum = $p \cos\theta - p\cos\theta = 0$ So average horizontal force = 0 Consider vertical direction, Change in momentum = $p \sin\theta - (-p\sin\theta) = 2p\sin\theta$ Average vertical force = $\frac{dp}{dt} = \frac{2p\sin\theta}{t}$
6	**B** Moment by weight about bottom left corner of book = *Wx/2* clockwise

	To avoid rotation (i.e. achieve rotational equilibrium), the resultant moment must be zero about bottom left corner of book. Hence, student must provide *Wx/2* anticlockwise
7	**B** rate of increase of kinetic energy = $F_{net} \times v = mav$ = (250000)(0.90)(5.0) = 1.1 MW Alternatively, output force of train's engine, F, can be found using N2L: $F_{net} = ma$ F – 15000 = 250000(0.90) F = 240000 N output power of the train's engine = Fv = 240000 × 5.0 = 1 200 000 W However, some of this output power is used against resistive force, while the rest accelerates the train and increases the kinetic energy. Hence, rate of increase of kinetic energy = 1 200 000 – 15000(5.0) = 1.1 MW
8	**B** T = 15.9 days = 15.9 × 24 × 3600 s r = 1.22 × 10^9 m centripetal acceleration = $r\omega^2$ $= (1.22 \times 10^9)(2\pi/(15.9 \times 24 \times 3600))^2$ $= 2.55 \times 10^{-2}$ m s^{-2}
9	**A** Since $v = r\omega$, and ω is constant and the same for every point on the record, v is then prop ortional to r.
10	**A** For the molecule to escape, total energy at Earth's surface must at least be zero (min energy at infinity). Hence, $-\frac{GMm}{r} + \frac{1}{2}mv^2 = 0 \Rightarrow v = \sqrt{\frac{2GM}{R_E}}$ Therefore, $v_{new} = \sqrt{\frac{2GM}{3R_E}} = \frac{1}{\sqrt{3}}\sqrt{\frac{2GM}{R_E}} = \frac{1}{\sqrt{3}} \times 1.1 \times 10^4$ $= 6.4 \times 10^3$ m s^{-1} Alternatively, use ratio method $v \propto \sqrt{\frac{1}{r}}$, therefore $\frac{v_{new}}{v_{original}} = \frac{r_{original}}{r_{new}}$ $\frac{v_{new}}{1.1\times10^4} = \sqrt{\frac{R_E}{3R_E}}$ $v_{new} = \sqrt{\frac{1}{3}}\ (1.1 \times 10^4)$ $= 6.4 \times 10^3$ m s^{-1}

11	**C** Option A: Geostationary satellites can only be found above the equator Option B: The linear speed of the geostationary satellite has to be greater as it is further away from Earth's centre and has the same angular speed as Earth Option D: Geostationary satellites travel in the same direction as Earth's rotation and that is from west to east.
12	**B** Container X: $p_X V_Y = n_X RT_X \rightarrow p_X = \frac{n_X RT_X}{V_X} = \frac{n_X R2T}{2V} = \frac{n_X RT}{V}$ Container Y: $p_Y V_Y = n_Y RT_Y \rightarrow p_Y = \frac{n_Y RT_Y}{V_Y} = \frac{n_Y RT}{V}$ Since $p_X = p_Y$, $n_X = n_Y$, $\frac{n_X}{n_Y} = 1$.
13	**C** Let the amount of added heat be Q. So, $Q = mc_w \Delta T_w$ ……………. (1) {heat added to water} $Q = mc_i \Delta T_i$ ……………. (2) {heat added to iron} Eqn. (1) = (2), $\frac{c_w}{c_i} = \frac{\Delta T_i}{\Delta T_w}$ Since $c_w > c_i$, $\Delta Ti > \Delta Tw$ → the final temperature of iron is going to be higher than the water's final temperature.
14	**B** Net work done by gas = enclosed area = ½ × (4 - 1) × 10^{-3} × (8 - 4) ×10^4 = 60 J Net work done on gas = - 60 J Alternatively, Net work done by gas = (1/2 × (8 + 4) × 10^4 x (4-1) × 10^{-3}) - ((4-1) × 10^{-3} x 4 ×10^4) = 180 - 120 = 60 J Net work done on gas = - 60 J
15	**A** Amplitude of oscillation decreases exponentially, causing the shape of the graph to be a curve.
16	**D** i. The speed at point P is zero, not maximum.

	ii. The displacement at any point, including point Q, varies sinusoidally with time, thus it is not always zero. iii. The energy at point R is entirely potential, not kinetic. iv. The acceleration at point S is a maximum since displacement is maximum. $a = -\omega^2 x$
17	**D** $I \propto A^2$ For maximum intensity, $I_o \propto (2A + A)^2$ For minimum intensity, $I \propto (2A - A)^2$ $\frac{I}{I_o} = \left(\frac{A}{3A}\right)^2$ $I = \frac{I_o}{9}$
18	**B** $s = r\,\theta$ $\theta = \frac{s}{r} = \frac{25}{335 \times 10^3} = 7.46 \times 10^{-5} = 7.5 \times 10^{-5}$ rad Minimum angle of resolution $\theta_m = \frac{\lambda}{b} = \frac{500 \times 10^{-9}}{200 \times 10^{-3}} = 2.5 \times 10^{-6}$ rad Images seen are resolved since angular separation between two sources is larger than the minimum angle of resolution.
19	**B** In order to hold the positively-charged particle P halfway between the two plates, the upper plate must be at a lower potential with respect to the lower plate (so that electric force acts upwards which is balanced by the gravitational force acting downwards). By decreasing *V* and causing the positively-charged particle P to move towards the lower plate (which is at a higher potential), the EPE of the particle increases (since a positive charge's EPE increases with electric potential). However, as the particle has fallen to a lower position, its GPE decreases.
20	**A** Electric field strength is given by the negative potential gradient. Consider the line joining PQ, from P till the 0 V equipotential line, for every decrease in potential of 100 V, the distance between the equipotential line gets larger and larger, hence the magnitude of the electric field strength decreases. Similarly from the centre of PQ where the 0 V equipotential line towards Q, for every decrease in potential of 100 V, the distance between the equipotential line gets smaller and smaller, hence the magnitude of the electric field strenght increases.
21	**B** For metal wire at constant temperature, the value of resistance should be constant. For filament lamp, the resistance increases with potential difference.

	For diode, it requires a p.d. of around 0.3 – 0.7 V to conduct. After that, when it is forward bias, the resistance is very low as seen by the near vertical line of the graph.
22	**C** No current flows through voltmeter. Hence $I_1 = I_2$. Current through ammeter = $I_1 = I_2$ Voltmeter reading = $R_1 I_2$ = $R_2 I_3$ = E - $I_4 R_3$
23	**D** Using LHR, for the magnetic force on the wire to be downwards, the magnetic field must be towards the right.
24	**B** $E = Blv$, where v is the horizontal component of the rod's velocity. From P to Q, the rod is moving parallel to the B-field and hence E is zero. From Q to R, as the rod rolls down the slope, the component of its weight parallel to the slope causes the velocity to increase at a constant rate, and hence the horizontal component of the velocity increases at a constant rate. Hence E increases at a constant rate. From R onwards, the rod is moving in a projectile motion under free fall and its horizontal velocity is constant and hence, E remains constant.
25	**B** $V_{\text{rms}} = \frac{150}{\sqrt{2}}$ $P = \frac{V_{\text{rms}}^2}{R}$ $13 = \frac{150^2}{2R}$ R = 865 Ω, hence $R_{\text{total}} = 2 \times 865$ $P = \frac{240^2}{2 \times 865} = 33$ W
26	**C** $\frac{V_S}{V_P} = \frac{5}{1} \Rightarrow V_S = 5 \times 240 = 1200\,V$ Current in the secondary circuit = 1200/1000 = 1.2 A $\frac{I_P}{I_S} = \frac{5}{1}$ $I_P = 5 \times 1.2 = 6.0\ A$

27	**B** Electrons emitted per unit time: $dN_e / dt = I / e = 2.0 \times 10^{-6} / (1.6 \times 10^{-19})$ $= 1.25 \times 10^{13}$ Photons emitted per unit time: $dN_p / dt = P / E = 3.1 \times 10^{-3} / (3.11 \times 1.6 \times 10^{-19})$ $= 6.23 \times 10^{15}$ $\frac{\text{electrons emitted per unit time}}{\text{photons incident per unit time}} = \frac{1.25 \times 10^{13}}{6.23 \times 10^{15}} = 2.0 \times 10^{-3}$
28	**A** $\Delta p_x \, \Delta x \geq h$ $(5.30 \times 10^{-26} \times \Delta v)(0.25 \times 10^{-3}) \geq 6.63 \times 10^{-34}$ $\Delta v \geq 10^{-5}$ m s^{-1}
29	**C** Most particles will pass through undeflected thus having a high *n* value at 0°, with very few deflected at larger angles.
30	**C** As the half-life is 33 years, there will be minimal change in the activity of the sample in 2 days, thus activity can be taken as constant for 2 days. As activity is the number of decay per unit time, The number of decays in 2 days = activity x time $= 4.0 \times 10^5 \times 2 \times 24 \times 3600$ $= 6.912 \times 10^{10}$ particles