2024 YIJC JC2 Preliminary Exam H2 Physics Paper 1 Solution

Question	Answer
1	A
2	C
3	B
4	C
5	B
6	A
7	D
8	B
9	A
10	A

Question	Answer
11	A
12	D
13	A
14	B
15	D
16	C
17	C
18	A
19	D
20	B

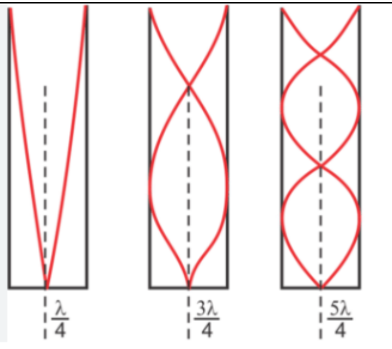
Question	Answer
21	D
22	B
23	C
24	B
25	C
26	A
27	C
28	B
29	C
30	C

MCQs Solutions

Qn	Answer	Explanation
1	A	Surface area of cylinder $A = 2\pi rL = 282.7$ cm^2 $\frac{\Delta A}{A} = \frac{\Delta r}{r} + \frac{\Delta L}{L}$ $\Delta A = \left(\frac{\Delta r}{r} + \frac{\Delta L}{L}\right)A = \left(\frac{0.1}{3.0} + \frac{0.1}{15.0}\right)282.7 = 10\ \text{cm}^2$ (to 1 s.f.) Therefore $A = (280 \pm 10)$ cm^2
2	C	During free fall, $v = u + at$ $v = 0 + (-9.81)(1.0)$ $v = -9.81 \text{m s}^{-2}$ On hitting the sand, $v^2 = u^2 + 2as$ $0 = (-9.81)^2 + 2a(8.0 \times 10^{-3})$ $a = -6.0 \times 10^3 \text{m s}^{-2}$

3	**B**	Considering car and trailer as a single system to find common acceleration $F_{net} = F_D - f_{car} - f_{trailer} = 5600 - 1200 - 400 = 4000 \text{ N}$ $a = \dfrac{4000}{1500 + 500} = 2.0 \text{ m s}^{-2}$ Considering only the trailer: $F_{net} = m_{trailer}a = 500(2.0) = 1000 \text{ N}$ $F_{net} = T - f_{trailer}$ $1000 = T - 400$ $T = 1400 \text{ N}$
4	**C**	Taking moments at P, force at Q must be upwards to balance the larger clockwise moment due to weight. Taking moments at Q, force at P must be downwards to balance the larger clockwise moment due to tension.
5	**B**	$EPE = \dfrac{1}{2}Fx = \dfrac{1}{2}(70)(0.040 - 0.020) = 0.70 \text{ J}$
6	**A**	Component of the weight parallel to the slope = W sin30^{o} = $(1.0\times10^{3})(0.50) = 0.50\times10^{3}$ N Because the barrel is moving at constant v, the applied F = W sin30^{o} WD = Fx = $(0.50\times10^{3})(5.0)$ = 2500 J
7	**D**	Useful WD in lifting the weight = (480)(3.5) = 1680 J WD by man in pulling rope = (200)(10.5) = 2100 J $\text{Efficiency} = \dfrac{1680}{2100} \times 100\% = 80\%$
8	**B**	period of sound wave, $T = \dfrac{1}{f}$ $\theta = \dfrac{2\pi}{16} = \dfrac{\pi}{8} \text{ rad}$ $\omega = \dfrac{\theta}{T} = \theta f = \left(\dfrac{\pi}{8}\right)(2200) = 864 \text{ rad s}^{-1}$
9	**A**	Using $KE = \dfrac{GMm}{2R}$ and $TE = -\dfrac{GMm}{2R}$, both satellites will have the same TE if their KE is equal. Hence **A** is false. Since KE is same, mass of satellite is proportional to *R*. So, if X has a larger mass, it will have a larger radius of orbit. Option B is valid. Kepler's 3rd law would suggest that X has a larger period. Since angular velocity is inversely proportional to period, the former is smaller.

10	**A**	Work done in moving from X to Z $W_{X\to Z} = W_{X\to Y} + W_{Y\to Z} = 100 + (-120) = -20$ J $W_{X\to\infty} = W_{X\to Z} + W_{Z\to\infty} = -20 + 2000 = 1980$ J $\phi_X = \dfrac{W_{\infty\to X}}{2.0} = \dfrac{-W_{X\to\infty}}{2.0} = -990 \text{ J kg}^{-1}$
11	**A**	Heat supplied by kettle $=$ heat absorbed by water $+$ heat loss $(1.2\times10^3)(30\times60) = (0.80)(4.2\times10^3)(100-25) + (0.80)(2300\times10^3) + \text{heat loss}$ $\text{heat loss} = 6.8\times10^4$ J $\text{power loss} = \dfrac{6.8\times10^4}{30\times60} = 38$ W
12	**D**	$U = \dfrac{3}{2}NkT = \dfrac{1}{2}Nm(c_{rms})^2$ $\dfrac{T}{(c_{rms})^2} = \text{constant}$ $\left(\dfrac{T}{(c_{rms})^2}\right)_{initial} = \left(\dfrac{T}{(c_{rms})^2}\right)_{final}$ $\dfrac{330}{(c_{rms})^2} = \dfrac{T_{final}}{(120\%\times c_{rms})^2}$ $T_{final} = 475$ K
13	**A**	With damping, the amplitude will be lower for all frequencies due to loss in energy.
14	**B**	Look for minimum cycle (pattern) that repeats. Distance between two successive tall peaks = 5 cm Period $T = (5 \text{ cm})(2.00 \text{ ms cm}^{-1}) = 10$ ms $f = \dfrac{1}{T} = \dfrac{1}{(10\times10^{-3})} = 100$ Hz
15	**D**	Each emergent light beam has the amplitude $A' = A\cos 45^o$ As there are two incident beams incident on the polarizer in phase, due to superposition the total emergent light beam has amplitude = $2A' = 2A\cos 45^o = \sqrt{2}A$ Since $I \propto A^2$ $\dfrac{I_E}{I} = \left(\dfrac{\sqrt{2}A}{A}\right)^2 = 2$ $I_E = 2I$

16	**C**	 $\frac{5}{4}\lambda = 60 \text{ cm} \Rightarrow \lambda = 48 \text{ cm} = 0.48 \text{ m}$ $v = f\lambda$ $330 = f(0.48)$ $f = 688 \text{ Hz}$
17	**C**	$d\sin\theta = n\lambda$ $d\sin\theta_5 = 5\lambda_1$ $d\sin\theta_4 = 4\lambda_2$ $5\lambda_1 = 4\lambda_2$ $\lambda_2 = \frac{5(480)}{4} = 600 \text{ nm}$
18	**A**	For the net force to be acting to the left, the charge Q needs to exert a force on X to counter the downward force on X by Y. Thus Q is negative. The vertical component of force on X by Q = force on X by Y $k\frac{Qq}{(\sqrt{2}r)^2}\cos(45^o) = k\frac{qq}{r^2}$ $Q = 2.8q$ Thus $Q = -2.8q$
19	**D**	Work done on the charge by external agent $=$ change in potential energy $=$ final EPE $-$ initial EPE $= -qV_2 - (-qV_1)$ $= q(V_1 - V_2)$
20	**B**	Wire P: $R = \frac{\rho L}{A} = \frac{\rho l}{\pi(d/2)^2} = \frac{4\rho l}{\pi d^2}$ $d^2 = \frac{4\rho l}{\pi R}$ Wire Q: $\frac{1}{4}R = \frac{(\frac{1}{3}\rho)(2l)}{\pi(d_Q/2)^2} = \frac{2}{3}\frac{4\rho l}{\pi d_Q^2}$ $d_Q^2 = \frac{8}{3}\frac{4\rho l}{\pi R} = \frac{8}{3}d^2$ $d_Q = 1.6d$
21	**D**	$E = 3r + 3(1)$ $E = 2r + 2(2)$ solving, $E = 6.0$ V

22	**B**	Since the galvanometer reads zero when PS = 40.0 cm p.d. across the wire PS = 5.00 mV. A length of 40.0 cm of wire PS has a resistance of $\frac{40.0}{100.0}(5.00)$ = 2.00 Ω. Using potential divider rule, $\frac{2.0}{5.0+R}(2.000) = 5.00\times10^{-3}$ $R = 795\ \Omega$
23	**C**	$B_S = \mu_0 nI = 4\pi\times10^{-7}\times15\times0.20$ $B_C = \frac{\mu_0 NI}{2r} = \frac{4\pi\times10^{-7}\times0.90}{2\times1.6}$ $B_{resultant} = B_S - B_C = 3.4\ \times10^{-6}$
24	**B**	For parallel wires with current flowing in the opposite directions, the wires will repel each other. If the currents are flowing in the same direction, the wires will attract each other. Since side PS is nearer than side QR, force of repulsion is greater than attraction and thus the loop will move to the right.
25	**C**	Using Fleming's Left Hand Rule, electrons in the conductor are moving to the right and will experience a force **upwards** in a magnetic field pointing out of the plane of the page. Hence, S will be at a higher potential as electrons will gather at R. $\varepsilon = Blv$ $= \left(2.8\times10^{-3}\right)\left(15\times10^{-2}\times\sin60^\circ\right)(10)$ $= 3.6\times10^{-3}\ \text{V}$ $= 3.6\ \text{mV}$ (Each quantity in the equation should be components that are perpendicular to each other.)
26	**A**	$I_{\max} = \frac{V_{\max}}{R} = \frac{150}{20} = 7.5\ \text{A}$ $\text{I}_{rms} = \frac{I_{\max}}{\sqrt{2}} = \frac{7.5}{\sqrt{2}} = 5.3\ \text{A}$ average Power $= \frac{1}{2}I_{\max}V_{\max} = \frac{1}{2}(7.5)(150)$ $= 560\ \text{W}\ (2\text{sf})$
27	**C**	Option A: electrons are ejected only if the wavelength is smaller than some maximum value. Option B: de Broglie wavelength of the ejected electrons is not the same as the wavelength of the incident light. Option D: The maximum energy depends on the type of metal.

28	**B**	Option A is wrong. Most of the energy of the electrons goes towards heating the metal target Option C is wrong. "$\frac{hc}{eV}$" is the minimum wavelength Option D is wrong. The intensity of the X-ray spectrum increases. Option B is correct. The wavelengths of the characteristic X-ray spectral lines depend on the material used to make the target (and not the potential difference applied to the electrons).
29	**C**	As the nucleus is very small compared to the atom, there are a lot of space, hence the alpha particles can pass through. When the α-particles come very close to the gold nucleus, the experience a large repulsive force and hence can deviate at large angle
30	**C**	A beta decay will result in no change of nucleon number and +1 in proton number. A alpha decay will result in −4 in nucleon number and +2 in proton number. Hence the new particle will have nucleon number of 234 and proton number of 91. Hence its neutron number will be 143.