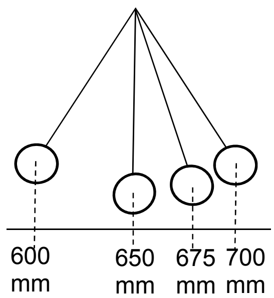
2017 AJC JC2 H2 Physics Prelim Solutions
Paper 1 (30 marks)

Answer

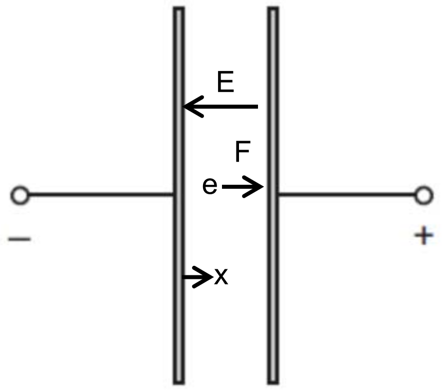
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
D	A	B	B	C	D	B	D	C	D
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
A	C	B	D	A	C	C	C	A	C
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
A	D	A	C	A	D	B	B	B	A

No	Answer & Solution
1	**Ans: D** 2000 pV = 2000 x 10^{-12} V = 2 x 10^{-9} V = 2 x 10^{-15} x 10^{6} V = 2 x 10^{-15} x M V p.d. = work done per unit charge, hence V is equivalent to J C^{-1}
2	**Ans : A** For the projectile motion, horizontal speed is constant, *v*. Vertical speed is zero initially and acceleration is *g*, downwards. Let the height of the table be *h*. Using $s = ut + ½ at^2$ $h = 0 + ½ gT^2$ $T = \sqrt{\frac{2h}{g}}$ *T* is independent of mass. Range, *D* = *vT*. Since both *v and T* are independent of mass, *D* will remain the same.
3	**Ans : B** The scale reads the contact force between the sack and scale. Since the scale reading is larger than the mass, the upward contact force must be larger than the downward weight. The sack experiences a net force and acceleration upwards. (12 – 10) x 9.81 = 10 x acceleration acceleration = 1.962 ≈ 2.0 m s^{-2}.
4	**Ans : B** For elastic collision, total KE is conserved OR relative speed of approach equals to relative speed of separation. Total KE before impact = ½ mv^2 + ½ mv^2 = mv^2 Thus, total KE after impact = mv^2. Answer C is wrong because during collision, KE is not conserved. It is converted to elastic PE then back to KE. Answer D is wrong because total momentum before impact = mv + m(-v) = 0

	Answer A is wrong because when the spheres stick together, it is already a perfectly inelastic collision. Also note that relative speed of approach = $u_1 - u_2 = v - (-v) = 2v$ (non-zero). If the spheres stick together, they will share the same speed and relative speed of separation will be zero.
5	**Ans : C** Work done is minimum if the force applied is just enough to overcome the barrel's weight on its way up the plank, with no change in speed. The barrel gains GPE without any gain in KE. Minimum work = Gain in GPE = mgh = 50 x 9.81 x 1.6 = 784.8 J ≈ 780 J Alternative method : Work done = Force x distance = mg sin θ x d = 50 x 9.81 x (1.6/3.4) x 3.4 = 784. 8 J
6	**Ans: D** Upthrust = weight of air displaced (smallest force as density of air is very small). Viscous drag is proportional to speed which increases as ball falls. At terminal speed, downward weight of ball is a constant which is balanced by upward drag and upthrust. Hence, weight > viscous drag > upthrust.
7	**Ans: B** For equilibrium, all three forces must meet at a common point, which is a point below trapdoor along the line of action of *W*. Hence option C and D are wrong as direction of *H* is wrong. Tension must act away from the door, hence direction of *T* is wrong. So option A is also wrong.
8	**Ans: D** The vertical component of the acceleration is the centripetal acceleration which is present since the particle is performing circular motion. The horizontal component of the acceleration causes the speed of the object to increase.
9	**Ans: C** $a = v^2/r$, So $v = \sqrt{ar} = \sqrt{120 \times 0.030} = 1.897$ Since ω is constant and ω = v/r Hence $\omega = \frac{v_1}{r_1} = \frac{v_2}{r_2}$ $v_2 = \frac{v_1}{r_1} \times r_2 = \frac{1.897}{0.030} \times 0.050 = 3.16 \text{ m s}^{-1}$ OR $a = \omega^2 r$ $\omega = \sqrt{(120/0.030)}$ $= 63.25 \text{ rads}^{-1}$ $v = r\,\omega$ $= 0.050\ (63.25)$ $= 3.16 \text{ ms}^{-1}$

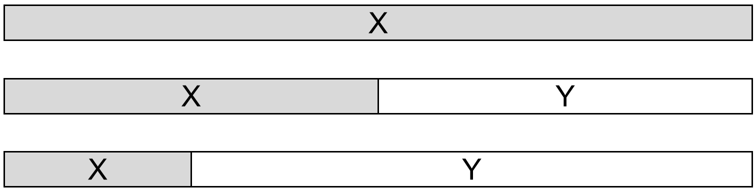
10	Ans: D The antenna will have the same speed as the space-craft and is still bound in orbit. There is still gravitational force acting on it which causes it to move in circular motion.
11	Ans: A Let the amount of added heat be Q. So, $Q = mc_w \Delta T_w$ ……………. (1) {heat added to water} $Q = mc_i \Delta T_i$ ……………. (2) {heat added to iron} Eqn. (1) = (2), $\frac{c_w}{c_i} = \frac{\Delta T_i}{\Delta T_w}$ Since cw > ci, ΔTi > ΔTw → the final temperature of iron is going to be higher than the water's final temperature.
12	**Ans: C** The total volume of the cylinder is not changed. Neither is the total number of molecules. Hence, the average space given to each molecule remains constant. This implies that the average distance between molecules is unchanged.
13	**Ans: B** $\Delta U = Q + W$ in case (i), W –ve, ΔU +ve (PV ↑ ⇒ T↑), ∴Q +ve in case (ii), ΔU = 0 since T is constant. W is -ve, thus Q is positive and heat is gained.
14	**Ans : D** Taking the initial position at 650 mm mark, $x = x_0 \sin \omega t = x_0 \sin\left[\left(\frac{2\pi}{T}\right)t\right]$ $25 = 50 \sin\left[\left(\frac{2\pi}{2}\right)t\right]$ $t = 0.167$ s 
15	**Ans : A** At x = 0.2 m, $a = -\omega^2 x$ $20 = -\omega^2(-0.2)$ $\omega = 10$ rad s^{-1} $v_{max} = \omega x_o = 10 \times 0.2 = 2.0$ m s^{-1}

16	**Ans: C** 3 x (Period of S) = 30. Hence Period of S= 10 ms At t = $\frac{1}{4}$ x period of S = 2.5 ms, amplitude of S = displacement of R. $y = y_o \sin \omega t = y_o \sin [(2\pi/T)t]$ $= 8 \sin [(2\pi/30) \times 2.5] = 4$ cm
17	**Ans: C** Since particles A and B are at two sides of a node of a stationary wave, they are anti-phase. Hence phase difference is 180° Maximum KE is proportional to amplitude. Since amplitude of A < amplitude of B, $K_A < K_B$
18	**Ans: C** For diffraction grating: $n \lambda = d \sin\theta$ or $\sin\theta = n \lambda / d$ for n=1, $\sin (15.4) = \lambda / d$ ……….(1) for n=2, $\sin \theta_2 = 2\lambda / d$ …………..(2) (2)/(1): $\sin \theta_2 = 2 \sin (15.4)$ $\theta_2 = 32.8°$ Angle between first and second maxima = 32.8 – 15.4 = 16.7°
19	**Ans : A** Terminal p.d. = 1.2 x 80 = 96 V ---(1) Terminal p.d. = 120 – (1.2+0.40) r ---(2) Equating (1) and (2), r = 15 Ω <u>Alternative method:</u> Let r be the internal resistance of supply and X the resistance of the lower resistor. p.d. across 80 Ω resistor = p.d. across the lower resistor, $X = \frac{1.2 \times 80}{0.40} = 240\ \Omega$ total current = 1.2 + 0.40 = 1.6 A = supply voltage/total resistance $1.6 = \frac{120}{r + \left(\frac{80 \times 240}{80 + 240}\right)}$ $r = 15\ \Omega$
20	**Ans : C** Energy = QV
21	**Ans : A** Let $V_R = 0$ V. $V_Q = 6$ V $V_P - V_Q = 3 \text{ V} \Rightarrow V_P = 9$ V $V_P - V_S = 5 \text{ V} \Rightarrow V_S = 4$ V Hence, $V_{QS} = 6 - 4 = 2$ V and $V_{SR} = 4 - 0 = 4$ V

22	**Ans: D**  2 parallel plates, so E is constant → F is constant and in the same direction as x, as shown in the diagram. Potential V increases linearly with x. Since electron is negatively charged, from U = qV, U of electron decreases linearly with x.
23	**Ans: A** Efield lines radiates out of positive charges and enters the negative charge. Efield lines of like charges should repel each other.
24	**Ans: C** As the number of coils is halved, solenoid length is also halved, hence *n* does not change. As $I = V/R$ where $R = \rho L/A$, since *L* is halved, *R* will be halved and I will be twice as before. Hence *T* will be twice.
25	**Ans : A** The peak value of the induced e.m.f. , $E_0 = (2\pi f)BAN$ and T=1/f When f is halved, E_0 will halve but T will double.
26	**Ans : D** Power dissipated across a resistor, $P = V_{rms}^2/R$ When V_{rms} is doubled with R unchanged, P will increase 4 times
27	**Ans : B** The number of photoelectrons emitted per second ($\frac{N}{t}$) is directly proportional to the intensity of incident radiation. Since the intensity of radiation is constant, the number of photoelectrons varies proportional with time.
28	**Ans : B** $eV = hc/\lambda_{min}$ higher V means smaller λ_{min} so Q has the higher voltage applied same characteristic X-ray indicates same target material
29	**Ans : B** Based on COE and COM, the kinetic energy of the daughter nuclei is negligible hence the total energy released is shared between β particle and neutrino. Since the highest possible KE of β particle is 13.4 MeV, i.e. when neutrino has zero KE, hence the total energy released by the reaction is also 13.4 MeV, and this value is fixed for this particular reaction. Thus, when an emitted β particle has KE of 6.0 MeV, the associated neutrino must have 13.4 – 6.0 = 7.4 MeV of energy.

30	**Ans : A**

	X : Y
Initial	1 : 0
After 1 $t_{1/2}$	1 : 1
After 2 $t_{1/2}$	1 : 3



1 half-life after time t, the number of nuclides of X will reduced by ½ and the number of nuclides of Y will increase by ½. The ratio will then become 1:3.