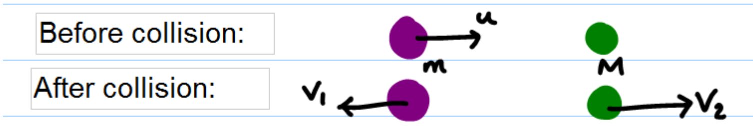
JURONG JUNIOR COLLEGE
PHYSICS DEPARMENT
JC2 Prelim Exam 2013
H2 Physics Paper 1 solutions

Qn	Ans	Suggested solution (Font Arial, 11 pt)
1	**C**	$F = BIL\sin\theta$ $[F]=[B][I][L] \Rightarrow [B]=\frac{[F]}{[I][L]}=\frac{\text{kg m s}^{-2}}{\text{A m}}=\text{kg A}^{-1}\text{ s}^{-2}$
2	**C**	The changes in horizontal and vertical components of the ball's velocity means that the force acting on the ball by the horizontal surface has components in the –x and +y directions.
3	**D**	Taking downwards and to the right as positive, u_x = 5.0 cos 30° and u_y = 5.0 sin 30° Applying $v^2 = u^2 + 2as$ to the vertical component of motion just before the ball hit the floor, $v^2 = (5.0 \sin 30°)^2 + 2(9.81)(2.5) = 55.3$ Speed just before ball hit floor = $\sqrt{(5.0\cos 30°)^2 + 55.3}$ = 8.61 m s^{-1}
4	**A**	$\Sigma F = ma \Rightarrow a = \frac{\Sigma F}{m} = \frac{75-25}{(10+15)} = 2\text{ms}^{-1}$ For the 10kg mass, Resultant force=10(2)=20 N
5	**D**	 By conservation of momentum, $p_i = p_f$ $m(u) = m(-v_1) + M(v_2)$.................(1) Relative speed of approach = Relative speed of separation $u = v_1 + v_2$.....................$(2) \Rightarrow v_2 = u - v_1$ Subst.(2) into (1) $m(u) = m(-v_1) + M(u - v_1)$. $v_1 = \frac{(M-m)}{(m+M)}u$
6	**C**	By definition.

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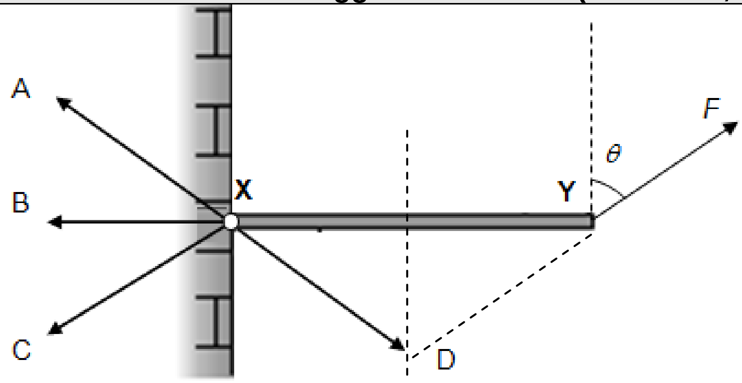
7	D	 The 3 forces acting on the rod must must all act through the same point. Since there is an upward component provided by *F*, there should be a upward component provided by the unknown force. Thus the force on the rod by the wall should be pointing in the option A direction. By Newton's 3rd Law, the force acting on the wall by the rod should be equal in magnitude and opposite in direction, therefore the ans is option D.
8	C	Since the car is moving at constant speed, forward force = frictional force WD by friction = Fd = 3800 x 300 = 1140 kJ
9	C	$KE = ½ mv^2 = ½ m(u^2 + 2as) = mas$ since $u = 0$ This means that KE is directly proportional to displacement (linearly related) Consider when $x=0$ (At ground level), *KE* will be maximum Consider when $x=H$ (At top of tower), *KE* will be zero Hence graph of *KE vs x* is best represented by C
10	D	Consider the forces acting on the body of 1 kg at top $T_{top} + mg = mv^2/r$ Consider the forces acting on the body of 1 kg at the bottom $T_{bottom} – mg = mv^2 /r$ Note: v is the same when body is at top and bottom. Hence $T_{top} + mg = T_{bottom} – mg$ Difference in tension = 2mg = 2(1)(10) = 20 N
11	B	$T \sin \theta = mv^2/r$ -----------(1) $T \cos \theta = mg$ ------------(2) (1)/(2) $\tan \theta = v^2/rg$ $(1)^2+(2)^2$ $T^2 = m^2g^2 + m^2v^4 / r^2$

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<table>
<tr><th>Qn</th><th>Ans</th><th>Suggested solution (Font Arial, 11 pt)</th></tr>
<tr><td>12</td><td>C</td><td>A is wrong as the geostationary satellite must be at a fixed distance above the Earth equator.

B is wrong as linear speed is proportional to the distance away from the centre of the earth ($v=r\omega$) hence the speed of the satellite can never be the same as the speed on the equator.

D is wrong as the earth is rotating from west to east hence the satellite must follow the same direction.</td></tr>
<tr><td>13</td><td>C</td><td>Gravitational potential at X = -8 kJ kg^{-1}.
Hence gravitational potential at Y is -4 kJ kg^{-1} as gravitational potential is inversely proportional to r.

Hence change in GPE = m x change in gravitational potential
= (2)(final gravitational potential – initial gravitational potential)
= (2)(-4 – (-8)) = + 8kJ</td></tr>
<tr><td>14</td><td>B</td><td>Across the broken filament, the p.d is equal to the voltage source at the mains so filament 5 is broken. Since no current flows through the circuit, there is no p.d across the lamps in which the filaments are not broken.</td></tr>
<tr><td>15</td><td>B</td><td>Current in 3.0 Ω resistor: $\left[P = I^2R\right] 12 = I^2(3) \rightarrow I^2 = 4 \rightarrow I = 2\text{ A}$
Voltage across 3.0 Ω resistor: $\left[V = IR\right] V = (2)(3) = 6\text{ V}$
Voltage across internal resistance r = 10 – 6 = 4 V
Current through internal resistance r = 4 A
$\left[V = IR\right] 4 = (4)(r) \rightarrow r = 1.0\,\Omega$</td></tr>
<tr><td>16</td><td>B</td><td>Does not obey Ohm's law as it is not a straight line passing through origin.
When V > 1.8 V, its resistance is not constant.</td></tr>
<tr><td>17</td><td>D</td><td>When resistance of LDR is 200 Ω, p.d across LDR $= \frac{750}{200+750}(40) = 32\text{ V}$

When resistance of LDR is 2000 Ω, p.d across LDR $= \frac{750}{2000+750}(40) = 11\text{V}$</td></tr>
<tr><td>18</td><td>B</td><td><table>
<tr><th>Solid</th><th>Melting point/ °C</th><th>Specific heat capacity/ J kg^{-1} K^{-1}</th><th>ΔT from 20 °C to melting pt</th><th>Energy required for ΔT/ kJ</th></tr>
<tr><td>A</td><td>80</td><td>1200</td><td>60</td><td>72m</td></tr>
<tr><td>B</td><td>100</td><td>800</td><td>80</td><td>64m</td></tr>
<tr><td>C</td><td>150</td><td>600</td><td>130</td><td>78m</td></tr>
<tr><td>D</td><td>300</td><td>250</td><td>280</td><td>70m</td></tr>
</table>
Hence solid B will melt first.</td></tr>
</table>

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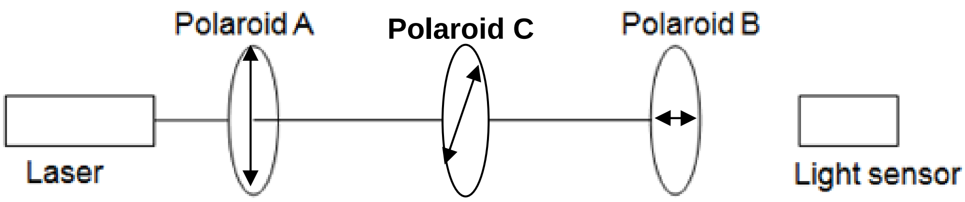
19	**D**	A: Density decreases because the same mass of gas occupies a larger volume. B: Larger volume implies smaller frequency of collision of gas molecules with walls of syringe. C: Apply first law of Thermodynamics. *Q* is assumed zero because piston is drawn outwards quickly. *W* is negative as work is done by gas. Hence ΔU is negative, implying a decrease in the temperature of gas and root-mean-square speed of the atoms.
20	**C**	Car suspension system is an example of critical damping.
21	**B**	The P.E against displacement graph will follow U shape graph as P.E=$\frac{1}{2}m\omega^2x^2$
22	**C**	Only transverse waves can be polarized, but not longitudinal waves. (Some sunglasses have polarized lens, i.e. the lens are actually a form of polarizing filters and block out certain orientations of light.) Option A: Reason for this is due to the diffraction of sound waves but not light as the waves encounter the obstacle (the corner). Option B: Reason being light travels faster than sound. Option D: Reason being light may be considered as consisting of photons each with energy hf.
23	**B**	Based on the waveforms at time zero and using the Principle of Superposition, the resulting stationary wave pattern will start off at position Y. The resultant of the the subsequent paths of P and Q will give you wave X. So the order will be Y X Y Z. Note: In every cycle, the stationary wave pattern will become perfectly flat (position Y) twice.
24	**B**	For zero intensity to occur at the light sensor, the polaroids' axes must be perpendicular to each other (for eg. with Polaroid A's polarizing axis perfectly vertical and Polaroid B's polarizing axis perfectly horizontal, as shown in diagram below). By placing a third polaroid C with its polarizing axis at an angle, in between Polaroids A and B, a small amount of light that has passed through Polaroid A will also be able to pass through Polaroid C. Likewise, a small component of the light that is able to pass through Polaroid C will also be able to pass through Polaroid B. 

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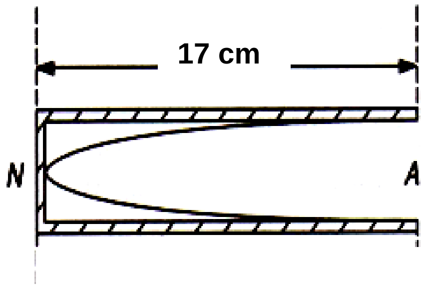
25	**D**	An antinode would be formed at the open end of the tube while a node would be formed at the closed end of the tube.  Hence, 17 cm = distance between node and adjacent antinode = $\lambda/4$ ⇨ λ = 68 cm
26	**D**	Electric field strength, $E \propto \frac{1}{x^2}$, Electric potential, $V \propto \frac{1}{x}$
27	**A**	Electric field lines are represented as directed lines from high to low potentials. The negative charge on the top plate will induce positive charge on the surface of the bottom plate by repelling electrons to the earth.
28	**A**	(A) is right as $Bqv = mv\omega \Rightarrow Bqv = mv(\frac{2\pi}{T}) \Rightarrow T = \frac{2\pi m}{Bq}$ (B) is wrong as the speed of the electron remains constant once it is inside the magnetic field. (C) is wrong as $r = mv/Bq$ (D) is wrong as $F = BqV$
29	**C**	$torque=(NBIL)x=40\times0.010\times0.0050\times0.0080\times0.0160 \approx 2.6\times10^{-7}\,Nm$
30	**C**	Recall that magnetic flux density, $B = \Phi/A$ Hence, the smallest cross-sectional area will give the largest variation in magnetic flux density for the same amount of magnetic flux (magnetic flux in concentrated within the soft-iron ring). **Points to note:** At any time the magnetic flux is the same for all the coils. The flux density is largest where the area is smallest, so the largest variation of flux density is for coil C.
31	**A**	By Fleming's LHR, induced current flow from Y to X in the rod, hence X is of higher potential. Induced current will cause an opposing effect to the change and thus the magnetic force will be directed to the left.

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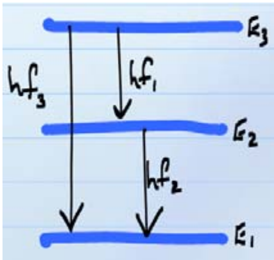
32	A	Fig 32.1, Mean Power, W = $\frac{V_{rms}^{2}}{R} = \frac{\left(\frac{V_0}{\sqrt{2}}\right)^2}{R} = \frac{V_0^{2}}{2R}$ Mean power for Figure 32.2, P_B = $\frac{V_{rms}^{2}}{R} = \frac{\left(\frac{V_0}{\sqrt{2}}\right)^2}{R} = \frac{V_0^{2}}{2R} = W$
33	B	I_{rms} = P/V = 8.333 A to 9.09 A Corresponding I_0= 11.8 A to 12.9 A Expression for $I = I_0 \sin\omega t$ $\omega = 2\pi(50) = 314$ rad s^{-1}
34	C	$hf_3 = hf_1 + hf_2 \Rightarrow f_3 = f_1 + f_2 \Rightarrow f_1 = f_3 - f_2$ 
35	A	Wavelength corresponding to the spikes depends on the target atoms. Hence no change in the wavelength. Since the overall energy of electrons increases, the total number and energy of photons released will increase. Intensity increases.
36	C	$p = mv$ = (9.11 x 10^{-31})(3.0 x 10^{6}) = 2.7 x 10^{-24} kg m s^{-1} $\Delta p = \left(\frac{0.30}{100}\right)(2.7x10^{-24})$=8.2 x 10^{-27} kg m s^{-1} Using $\Delta x.\Delta p \geq \frac{h}{4\pi}$ → Minimum $\Delta x = \frac{h/4\pi}{\Delta p} = \frac{6.63x10^{-34}}{4\pi(8.2x10^{-27})}$ = **6.4 x 10^{-9} m**
37	D	The frequency of infra-red is less than that of red light hence the energy difference for spontaneous emission will be less than that of stimulated emission. Options A and C are inaccurate as the excitation arrow should be to the highest level.
38	D	The diagrams on the left and right column show forward bias and revers bias respectively. There will be immobile negative ions at the p and immobile positive ions at the n junction. Having the higher potential (+) connected to p and lower potential (-) connected to n will help to overcome the junction barrier resulting in forward bias (Option A and D). Conventional current flows from higher potential to lower potential (Option D).

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39	**B**	Isotopes are atoms of the same element whose nuclei have the same number of protons (but different number of neutrons). Only option B allows for the atomic numbers of the original nucleus and the isotope to be equal. (See sample below) $parent^{200}_{150} \rightarrow daughter^{196}_{150} + \alpha^{4}_{2} + 2\beta^{0}_{-1}$
40	**C**	Excluding the background count-rate of 16 min^{-1}, the initial total count-rate of the α-particles and β-particles is 336 min^{-1} (= 352 – 16). The sheet of paper prevents the α-particles from reaching the detector. Hence the initial count rate due to the α-particles is 96 min^{-1} (= 352 – 256). The initial count rate due to the β-particles is 240 min^{-1} (= 336 – 96). At *t* = 12 days, count-rate of α-particles = $\left(\frac{1}{2}\right)^{\frac{12}{4}}(96)$ count-rate of β-particles = $\left(\frac{1}{2}\right)^{\frac{12}{3}}(240)$ total count-rate (including background) = $\left(\frac{1}{2}\right)^{\frac{12}{4}}(96) + \left(\frac{1}{2}\right)^{\frac{12}{3}}(240) + 16 = 43\ min^{-1}$