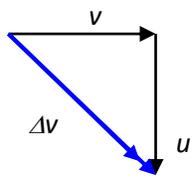
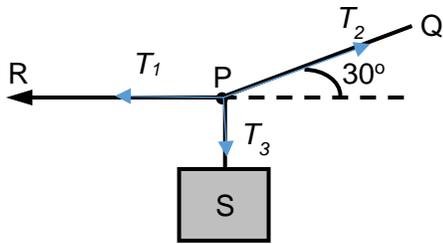
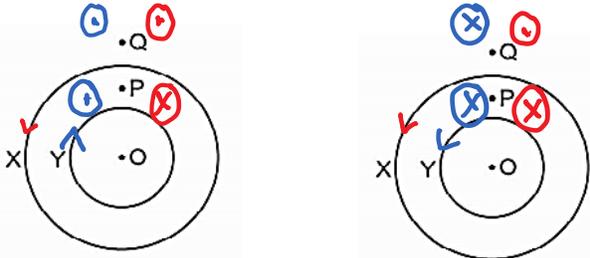


HCI 2016 H1 Physics Prelim Paper 1 Solutions and Explanations:

QN	Ans	Explanation
1	D	Energy = power/time, or Energy = work done = force x displacement Units of energy = W s = N m = kW h
2	A	$\Delta v = v - u$ 
3	C	$\rho = \frac{m}{V} = \frac{m}{\pi r^2 l} = \frac{4m}{\pi d^2 l}$ $\frac{\Delta \rho}{\rho} = \frac{\Delta m}{m} + \frac{2\Delta d}{d} + \frac{\Delta l}{l} = \frac{1}{20} + \frac{2(0.1)}{2.5} + \frac{0.1}{5} = 0.15$ $\Delta \rho = 0.15\rho = 122 = 100 \text{ (uncertainty must be rounded to 1 s.f.)}$ <p>Hence density = $(800 \pm 100) \text{ kg m}^{-3}$</p>
4	C	$s = ut + \frac{1}{2}at^2 = \frac{1}{2}at^2 \text{ (since balls are dropped from rest)}$ <p>Based on s-t graph, at equal intervals of s, time intervals becomes smaller.</p>
5	C	$s = ut + \frac{1}{2}at^2$ $-2.5 = 30 \sin 5^\circ t + 2(-9.81)t^2$ $t = 1.0 \text{ s}$
6	C	There is a constant force, hence a constant deceleration. The momentum will decrease at a constant rate. However, the displacement will increase at a decreasing rate. OR Since $p = mv$, the graph of p against s is the same trend as the graph of v against s . Given constant deceleration, $v = \sqrt{u^2 - 2as}$
7	C	Applying conservation of linear momentum, we find that the speed after the collision is 2.0 m s^{-1} . Hence, the total kinetic energy after the collision is $\frac{1}{2} m_{\text{tot}} v^2 = 0.5 \times 15 \times 2.0^2 = 30 \text{ J}$. Furthermore, the force on either trolley is $\Delta p / \Delta t = 20 / 0.20 = 100 \text{ N}$.
8	C	Relative speed of approach = relative speed of separation $v_1 - v_2 = u_2 - u_1$ $v_\alpha - v_\beta = u_\beta - u_\alpha$ $-v - 4v = u_\beta - u_\alpha$ $-5v = u_\beta - u_\alpha \text{ --- (1)}$ <p>By the principle of conservation of linear momentum,</p> $m u_\beta + 4m u_\alpha = 0$ $u_\beta = -4u_\alpha \text{ --- (2)}$ <p>Combining (1) and (2),</p> $-5v = -4u_\alpha - u_\alpha$ $v = u_\alpha$ $u_\beta = -4u_\alpha = -4v$

9	B	 <p>Consider joint P:</p> $\sum F_x = 0 \Rightarrow T_1 = T_2 \cos 30^\circ$ $\sum F_y = 0 \Rightarrow T_2 \sin 30^\circ = T_3 = W$ $\Rightarrow T_1 = \frac{W}{\sin 30^\circ} \cos 30^\circ = W \tan 60^\circ$
10	C	Torque of couple = $F \times$ perpendicular distance between the 2 forces = $1.5 \times (0.5 \sin 50^\circ) = 0.57 \text{ N}$
11	A	<ul style="list-style-type: none"> In the first 5 seconds, the height increases at a constant speed. This means that GPE increases at a constant rate and KE did not increase. So power is constant. In the next 4 seconds, the height is constant, so this means there is no change in GPE and KE too. So power supplied is zero.
12	B	<ul style="list-style-type: none"> Work done by weight must be positive as there is always a downward component of displacement along any part of the motion Work done by normal contact force is zero as N is always perpendicular to the displacement along any tiny segment of the slope.
13	D	$P = Fv = (kv^2)v = kv^3$ $\frac{P_2}{P} = \left(\frac{v_2}{v}\right)^3 \Rightarrow P_2 = \left(\frac{25}{20}\right)^3 \times 4800 = 9375 \text{ W}$
14	C	Given the same period, doubling the time-base will require half the amount of divisions for one cycle.
15	B	From the graph, wave I has a shorter period hence larger frequency. From $v = f\lambda$, wave I has a shorter wavelength (since both waves travel at the speed of light).
16	B	At compression region of a wave traveling towards the right, the adjacent molecule on its left must have positive displacement.
17	C	This is because energy carried by the ripple is spread along the circumference of the ripple hence intensity reduces radius increases
18	A	Intensity is proportional to amplitude squared. $\frac{I_P}{I_Q} = \frac{(2A - A)^2}{(2A + A)^2} = \frac{1}{9}$
19	B	Node-to-node distance is half the wavelength of the incident wave. The side of the water tank is a node.
20	C	Double the frequency implies halved the wavelength. Originally, it was one wavelength of wave for the length of tube. Halved the wavelength would imply 2 wavelengths for the wave in the same length of tube. Drawing 2 wavelengths in the length of tube will give 5 antinodes.
21	C	Increase in potential difference leads to increase in electric field hence acceleration. Current increases when charge carriers move faster through the resistor.

22	C	fraction of power = $\frac{I^2 R}{I^2 (R+r)} = \frac{R}{R+r}$
23	A	<p>Circuit (i) $P = I^2 R = \left(\frac{4.5}{R+3r}\right)^2 R$</p> <p>Circuit (ii) $P = I^2 R = \left(\frac{1.5}{R+3r}\right)^2 R$</p> <p>Therefore $\frac{\text{power in R in circuit (i)}}{\text{power in R in circuit (ii)}} = \left(\frac{4.5}{R+3r}\right)^2 R \div \left(\frac{1.5}{R+3r}\right)^2 R = \left(\frac{4.5}{1.5}\right)^2 = 9$</p>
24	B	<p>By potential divider, for voltmeter with resistance r, $pd = \frac{r}{r+r} V = \frac{1}{2} V$</p> <p>Voltmeter with resistance $10r$, $pd = \frac{10r}{10r+r} V = \frac{10}{11} V$ (nearly V)</p>
25	A	<p>Since the B field at O is zero, the current in X and Y were initially in opposite direction. Let's assume the directions of X and Y to be as shown and hence the B field at P and Q due to X and Y will be as indicated in the diagram on the left.</p>  <p>Now let's reverse the direction of Y. The new direction of B due to Y is now given in the diagram on the right. Hence the resultant at Q increases while at P decreases.</p>
26	C	<p>Magnetic force = $BIL = 45 \times 10^{-3} \left(\frac{3.0}{6.0}\right) (0.050) = 1.125 \times 10^{-3} \text{ N}$ upwards.</p> <p>Reading increases by $\frac{1.125 \times 10^{-3}}{9.81} = 1.14679 \times 10^{-4} \text{ kg} = 0.115 \text{ g}$ when the force is removed.</p> <p>Final reading = $153.860 + 0.115 = 153.975 \text{ g}$</p>
27	C	Reverse the direction of electrons and current direction is to left. Apply FLHR.
28	C	<p>Option A : Incorrect. If the frequency of light is sufficiently high, even at extremely low intensities there will be emission of photoelectrons.</p> <p>Option B : Incorrect. From Einstein's photoelectric effect equation, there is not direct relationship between frequency and stopping potential. Increasing frequency will increase stopping potential but the relationship is not linear.</p> <p>Option D: Increasing the intensity of the incident photons will not change the energy of each photon, it just increases the no. of photons per unit time incident on the metal. Hence, the energy of the photoelectrons emitted will not change as the interaction between each photon and electron remains the same.</p>
29	D	$p = mv = \frac{h}{\lambda} \Rightarrow v = \frac{h}{mv}$

		Hence, the particle that is the most massive will have the smallest velocity.
30	A	<p>Since the gas is cold, all the atoms are at ground state.</p> <p>Consider the energy levels :</p> <p>-13.6 eV and -0.850 eV, $\Delta E = 13.6 - 0.850 = 12.75$ eV</p> <p>-13.6 eV and -0.544 eV, $\Delta E = 13.6 - 0.544 = 13.056$ eV</p> <p>Hence, we see that no excited state that has an energy exactly 13.00 eV above the ground state.</p> <p>The photons will not be absorbed by the hydrogen gas and hence there will not be any emission spectrum or spectral lines.</p>