1. Short Answer Questions – 2 marks each

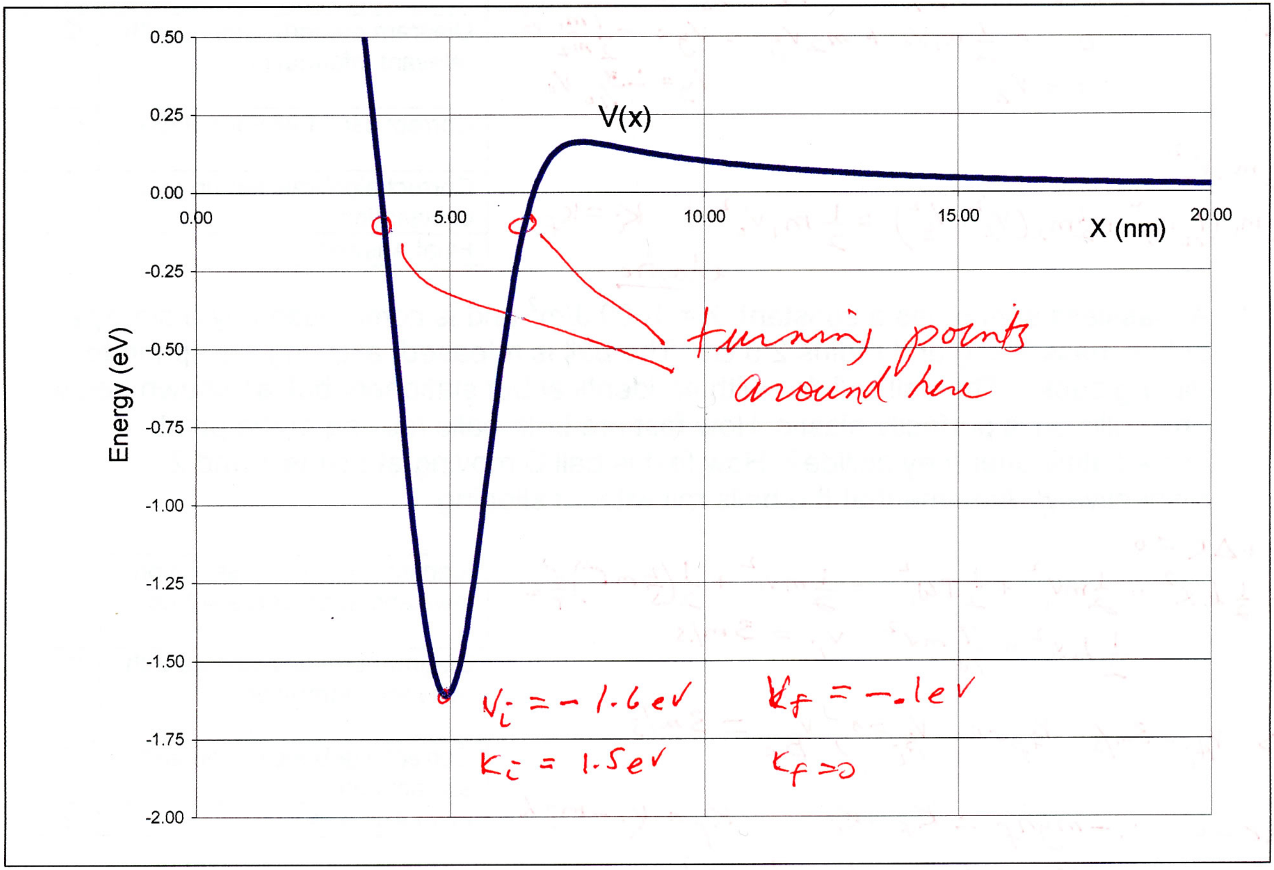
   a. Is it possible for a human being to have a weight of 150 kg? (T or F) F

   b. In any collision in which momentum is conserved, kinetic energy must also be conserved. (T or F) F

   c. What is the impulse delivered by a force of 200 N that acts for 1 minute? 12

   d. What is the rotational energy of a 5 kg sphere of radius 10 cm spinning at 20 revs/s? $\frac{1}{2}I\omega^2 = \frac{1}{2}\left(\frac{2}{5}(5)(0.1m)^2\right)(20\times 2\pi)^2 = 157.9 J$

   e. Suppose that the electron has a kinetic energy of 1.5 eV when situated at x = 5 nm. Describe the future motion of the electron and identify where the turning points of motion are located. Turning when $K = 0$ ∴



2. Imagine that in a physical chemistry experiment, carbon atoms are shot with a certain velocity v_0 at a collection of neon atoms (you may assume at rest). Note that neon atoms have very nearly 5/3 the mass of carbon atoms. Imagine that during a specific collision, the carbon atom is observed to rebound from the collision traveling at a speed of $v_1 = \frac{1}{2} v_0$ at an angle of 90° with respect to its original direction of motion. Was this carbon atom's interaction with the neon atom elastic?

CoM

$P_i = m_1 \begin{bmatrix} v_0 \\ 0 \\ 0 \end{bmatrix}$ $P_f = m_1 \begin{bmatrix} 0 \\ \frac{1}{2}v_0 \\ 0 \end{bmatrix} + m_2 \begin{bmatrix} V_x \\ V_y \\ V_z \end{bmatrix}$

$\therefore m_1 v_0 = m_2 V_x$ $\therefore V_x = \frac{3}{5} v_0$

$0 = \frac{1}{2} m_1 v_0 + m_2 V_y$ $\therefore V_y = -\frac{1}{2}\frac{m_1}{m_2} v_0$

$0 = V_z$ $V_y = -\frac{3}{10} v_0$

$\frac{5}{3} m_1$

E:

$K_i = \frac{1}{2} m_1 v_0^2$

$K_f = \frac{1}{2} m_1 (\frac{1}{2} v_0)^2 + \frac{1}{2} m_2 (V_x^2 + V_y^2) = \frac{1}{2} m_1 v_0^2$! $K_i = K_f$

elastic

Identification of Conservation laws and appropriate set-up	/3
Diagram properly labeled with relevant information	/2
Correct use of vector notation	/2
Correct algebraic set-up and explanation	/2
Final Answer	/1

3. A massless spring has a constant k = 1000 J/m^2 and is compressed by 5 cm by a ball of mass 200 g and radius 2.5 cm. The ball is released, allowing the spring to "spring back". The ball collides with an identical but stationary ball as shown below. The collision is perfectly elastic. How fast are both balls moving at the point immediately after they collide? How fast is ball B moving at points 1 and 2 respectively? Assume that the balls roll without slipping.

E $\Delta V_s + \Delta K = 0$

$\therefore V_{s_0} = \frac{1}{2} k x^2 = \frac{1}{2} m v_1^2 + \frac{1}{2} I \omega_1^2 = \frac{1}{2} m v_1^2 + \frac{1}{2}(\frac{2}{5} m r^2)\frac{v_1^2}{r^2}$

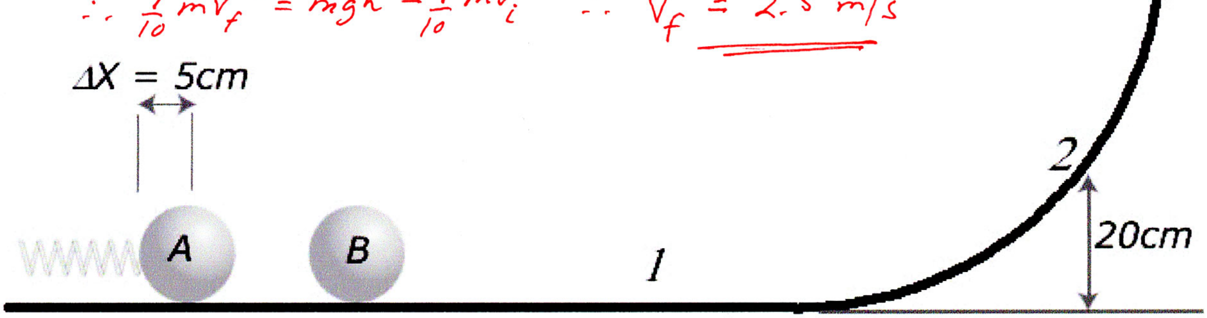
$\therefore \frac{1}{2} k x^2 = \frac{7}{10} m v^2$ $v_i = 3$ m/s

e = 1 ⇒ $V_{A_i} = 3$ m/s $V_{A_f} = 0$, $V_{B_i} = 0$, $V_{B_f} = 3$ m/s

$\Delta V_g + \Delta K = 0$ $\therefore -mgh_f = K_f - K_i$ $\therefore K_f = K_i - mgh$

$\therefore \frac{7}{10} m v_f^2 = mgh - \frac{7}{10} m v_i^2$ $\therefore V_f = 2.5$ m/s

Identification of Conservation laws and appropriate set-up	/4
Diagram properly labeled with relevant information	/1
Correct algebraic set-up and explanation	/3
Final Answers	/2



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