Birla Institute of Technology and Science, Pilani (RAJ)
General Physics (PHY F112) : Mid-Semester Examination (Closed Book)

Date : 12 Oct 2023   **90 Marks : 90 Mins**

1. The only two forces acting on a object have magnitudes of 20 N (along x axis) and 35 N at $\theta = 80°$ from x axis. The resulting acceleration has a magnitude of 20 m/s^2. (a) Calculate the mass of the body. (b) If initially the object is at origin (0,0) calculate the coordinate of the same after 5 seconds. (c) Calculate the net acceleration if the mass is doubled?

[7+7+4]

2. A certain spring is found not to conform to Hooke's law. The force (in newtons) it exerts when stretched a distance x (in meters) is found to have magnitude $20x + 10x^2$ in the direction opposing the stretch. (a) Compute the work required to stretch the spring from $x = 0.5$ m to $x = 1.0$ m. (b) With one end of the spring fixed, a particle of mass 2 kg is attached to the other end of the spring when it is stretched by an amount $x = 1.0$ m. If the particle is then released from rest, what is its speed at the instant the stretch in the spring is $x = 0.5$ m? (c) Is the force is conservative or non-conservative and why? (d) Obtain the expression for the potential energy of this spring.

[6+5+3+4]

3. A 1.5 kg ball is connected by the massless strings of $L = 2$ meters of rotating rod. The strings are tied to the rod with the separation $d = 2$ meter. The tension in the upper string is 40 N.
(a) Find the tension in lower string. (b) Find rotation speed of the ball. (c) If this whole assembly is now rotating in vertical plane, then when the total tension would be maximum and when the tension in the strings would be minimum.
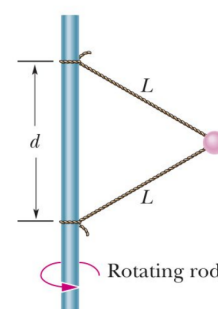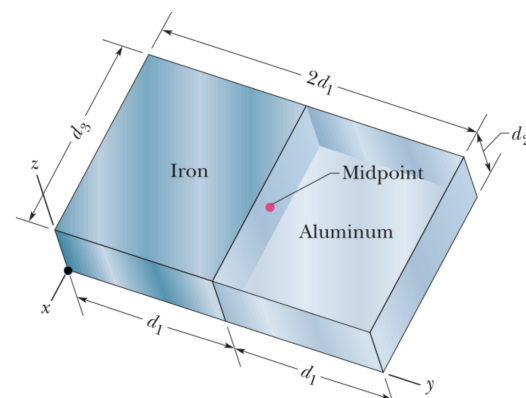

[6+7+5]

4. Two objects of mass m_1 and m_2 with initial velocities v_{1i} and v_{2i} elastically collides (in one dimension) and achieve the final velocities v_{1f} and v_{2f}. (a) Obtain the general expressions for v_{1f} and v_{2f} in terms of the m_1, m_2, v_{1i} and v_{2i}. (b) If say $v_{2i} = 0$ then find v_{1f} and v_{2f} when $m_2 = m_1$ and $m_2 = 1000m_1$.

[12+6]

5. (a) Define center-of-mass and prove that the net force exerted on the system of 3 particles would be equivalent to the sum of the forces exerting on individual particles.
(b) Figure shows a slab with dimensions $d_1 = 11$ cm, $d_2 = 2.8$ cm, and $d_3 = 13$ cm. Half the slab consists of aluminum (density = 2.7 g/cm^3) and half consists of iron (density = 7.85 g/cm^3). Calculate the coordinate of the center of mass (x,y,z) if the bottom left corner is the origin (black dot).

[6+12]