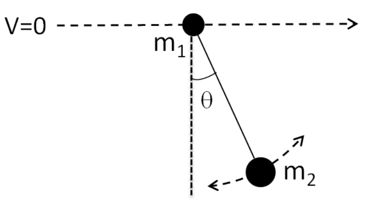
DEPARTMENT OF PHYSICS
Indian Institute of Technology Kharagpur
Classical Mechanics-I
Course: PH20007
Assignment-10: Assignment-10 (Lagrangian-2)

1. A particle is falling under the influence of gravity when frictional forces obtainable from a dissipative function $\frac{1}{2}kv^2$ are present. The maximum possible velocity for fall from rest is
(a) $\frac{mg}{2k}$
(b) $\frac{mg}{5k}$
(c) $\frac{mg}{k}$
(d) $\frac{2mg}{k}$

2. For Lagrangian (L) of any system, which of the following is true
(a) $L = L(p_k, \dot{q_k}, t)$
(b) $L = L(q_k, \dot{q_k}, t)$
(c) $L = L(p_k, \dot{p_k}, t)$
(d) $L = L(q_k, \dot{p_k}, t)$

3. A particle of mass$m$ moves in a plane in the field of force given by $\vec{F} = -kr\ cos\phi\ \hat{r}$ where k is a constant and $\hat{r}$ is the radial unit vector. which of the following is true Lagrange's equation(s)
(a) $m\ddot{r} - mr\dot{\phi}^2 + kr\ cos\phi = 0$ and $mr^2\dot{\phi} = 0$
(b) $m\ddot{r} - mr\dot{\phi}^2 + kr\ cos\phi = 0$ and $mr^2\dot{\phi} = constant$
(c) $m\ddot{r} - mr\dot{\phi}^2 + kr\ cos\phi = constant$ and $mr^2\dot{\phi} = 0$
(d) $m\ddot{r} - mr\dot{\phi}^2 + kr\ cos\phi = constant$ and $mr^2\dot{\phi} = constant$

4. Point of suspension of a simple pendulum of mass m_2 is attached to a mass m_1 that is moving along x- axis with uniform velocity v_0.
The Lagrangian of the system is given by



(a) $L = \frac{1}{2}m_1{v_0}^2 + \frac{1}{2}m_2(v_0 + lcos\theta\dot{\theta})^2 + mglcos\theta$
(b) $L = \frac{1}{2}m_2{v_0}^2 + \frac{1}{2}m_1(v_0 + lcos\theta\dot{\theta})^2 + mglcos\theta$
(c) $L = \frac{1}{2}m_1{v_0}^2 + \frac{1}{2}m_2(v_0 + lcos\theta\dot{\theta})^2 - mglsin\theta$
(a) $L = \frac{1}{2}m_1{v_0}^2 + \frac{1}{2}m_2(v_0 + lsin\theta\dot{\theta})^2 + mglcos\theta$

5. An electric dipole with opposite charges of masses m$_1$ and m$_2$ separated by a distance l is placed in an external electric field. θ is the instantaneous orientation of the dipole w.r.t. $\vec{E}$.

The lagrangian of the dipole is (p is the magnitude of dipole moment)
(i) $L = \frac{l^2}{2}(m_1 + m_2)\dot{\theta}^2 + pEcos\ \theta$
(ii) $L = \frac{l^2}{4}(m_1 + m_2)\dot{\theta}^2 + pEcos\ \theta$
(iii) $L = \frac{l^2}{6}(m_1 + m_2)\dot{\theta}^2 + pEcos\ \theta$
(iv) $L = \frac{l^2}{8}(m_1 + m_2)\dot{\theta}^2 + pEcos\ \theta$

6. Lagrange's equation of motion of an electrical circuit comprising an inductance L and capacitance C (the condenser is charged to q coulombs and the current flowing in the circuit is i amperes) is
(i) $\ddot{q} + \frac{q}{LC} = 0$
(ii) $\ddot{q} + \frac{Lq}{C} = 0$
(iii) $\ddot{q} + \frac{Cq}{L} = 0$
(iv) $\ddot{q} + \frac{q^2}{LC} = 0$

7. For a compound pendulum Lagrangian can be written as (θ is the instantaneous angle w.r.t. vertical axis and I_0 is the M.I. about the axis of rotation)
(a) $L = \frac{1}{2}I_0^2\dot{\theta}^2 - mgh\ cos\ \theta$
(b) $L = \frac{1}{2}I_0\dot{\theta}^2 - mgh\ cos\ \theta$
(c) $L = \frac{1}{2}I_0\dot{\theta}^2 - mgh\ (1 + cos\ \theta)$
(d) $L = \frac{1}{2}I_0\dot{\theta}^2 - mgh\ sin\ \theta$

8. A bead slides without friction on a wire which is rotating with angular velocity ω in the force free space. The radial velocity is
(a) $\sqrt{\omega^2 r}$
(b) $\sqrt{\omega^2 r + +constant}$
(c) $\sqrt{\omega^2 r^2}$
(d) $\sqrt{constant - \omega^2 r^2}$

9. A spring of mass M and spring constant k, is hung vertically (along y-axis). Another mass, m, is suspended from it. The K.E. of the system
(a) $\frac{1}{2}M\dot{y}^2$
(b) $\frac{1}{2}m\dot{y}^2$
(c) $\frac{1}{6}M\dot{y}^2$
(d) $\frac{1}{6}M\dot{y}^2 + \frac{1}{2}m\dot{y}^2$

10. A spring of mass M and spring constant k, is hung vertically. Another mass, m, is suspended from it. The system will execute simple harmonic motion with a period of
(a) $2\pi\sqrt{\frac{M+m}{k}}$
(b) $2\pi\sqrt{\frac{M+\frac{m}{3}}{k}}$
(c) $2\pi\sqrt{\frac{\frac{M}{3}+m}{k}}$

(d) $2\pi\sqrt{\frac{M-m}{k}}$

End