1. A ring of mass M hangs from a thread, and two beads of mass m slide on it without friction. The beads are released simultaneously from the top of the ring and slide down opposite sides. Show that the ring will start to rise if $m > 3M/2$, and find the angle at which this occurs.

2. A block shown in the drawing is acted on by a spring with spring constant k, and a weak friction force of constant magnitude f. The block is pulled distance x_0 from the equilibrium and released. It oscillates many times before coming to a halt.

   (a) Show that the amplitude decreases by same amount in each cycle of oscillation.

   (b) Find the number of cycles n, the mass oscillates before coming to rest.

3. Find the forces for the following potential energies.

   (a) $U = Ax^2 + By^2 + Cz^2$

   (b) $U = A \ln\left(x^2 + y^2 + z^2\right)$

   (c) $U = A\cos\theta/r^2$ (Plane Polar Coordinates)

4. A particle of mass m moves in a horizontal plane along the parabola $y = x^2$. At $t = 0$ it is at point $(1, 1)$ moving in the direction shown with speed v_0. Apart from the force of constraint holding it to the path, it is acted on by the following external forces

$$\begin{aligned} \mathbf{F}_a &= -Ar^3\hat{\mathbf{r}} \\ \mathbf{F}_b &= B\left(y^2\mathbf{i} - x^2\mathbf{j}\right) \end{aligned}$$

   (a) Are the forces conservative?

   (b) What is the speed v_f of the particle when it arrives at the origin?

5. The potential energy function for a particular two dimensional force field is given by $U = Cxe^{-y}$, where C is a constant.

   (a) Sketch constant energy lines.

   (b) Show that along the constant energy lines $d\mathbf{r} = dx(\mathbf{i} + \mathbf{j}/x)$.

   (c) Using b, show explicitly that ∇U is perpendicular to the constant energy line.

6. How much work is done around the path that is shown by the force $\mathbf{F}_b = A\left(y^2\mathbf{i} + 2x^2\mathbf{j}\right)$, where A is a constant and x and y are in meters? Find the answer by evaluating the line integral as well as by the surface integral (Stokes' Theorem)

7. If a force field is given by $\mathbf{F} = 3x^2y\mathbf{i} + (x^3 + 3y^2)\mathbf{j}$, find the potential energy.