Your solutions should be neat, correct and complete. Same instructions as Mission 1 apply here.

Recommended Homework from Textbook (Serway):
Chapter 7 $\#'s$ 9, 11, 19, 23, 33, 38
Recommended Homework from Recommended Textbook (Young & Freedman, 9th ed):
Chapter 6 (work and kinetic energy) $\#'s$ 1, 5, 7, 9, 11, 13, 17, 21, 23, 27, 29, 33, 35, 37, 39, 47, 52, 55, 57, 59, 63, 65, 67, 71

Suggested Reading the following resources may be helpful:

- **(a.)** Lectures 15, 16, 17 and 18 as posted on the course website,
- **(b.)** Chapter 7 of the required text.

Problem 37: (2pts) Suppose steady wind blows 20^o north of east such that it places a force of $100\,N$ on an eagle flying south. What is the work done on the eagle as it flies one mile south ?

Problem 38: (2pts) Suppose $F(x) = a - kx$ where a, k are constants. Find the potential energy function U for which $U(0) = 0$. Also, find the work done by F as a particle moves from x_1 to x_2.

Problem 39: (3pts) Let $\vec{F} = \langle 2x, 2y - x \rangle$. Calculate the work $W = \int_C \vec{F} \bullet d\vec{r}$ done by this force field on a particle which moves along the following paths:

(a.) C is the straight line from $(1, 0)$ to $(0, 1)$ given by $x = 1 - t, y = t$ for $0 \leq t \leq 1$

(b.) C is the quarter-circle given by $x = \cos t, y = \sin t$ for $0 \leq t \leq \pi/2$

(c.) Is $\vec{F}$ a conservative vector field on $\mathbb{R}^2$? (explain)

Problem 40: (1pts) For each force given below, find a potential energy function U for which $\vec{F} = -\nabla U$.

(a.) $\vec{F} = (x^2 + 1)\hat{\mathbf{x}} + \hat{\mathbf{y}} + ze^{-z^2}\hat{\mathbf{z}}$

(b.) $\vec{F} = \vec{F}_o$ where $\vec{F}_o = \langle a, b, c \rangle$ and a, b, c are constants.

Problem 41: (3pts) Consider a mass $M = 20\,kg$ which moves from $(1.00\,m, -2.00\,m)$ in a straight line from to the final position $(4.00\,m, 3.00\,m)$. Find

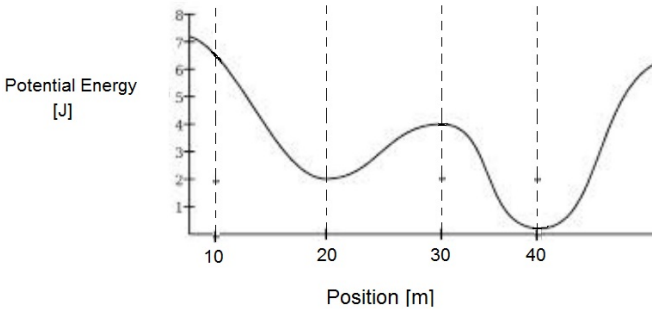
(a.) the work done by $\vec{F}_1 = \langle 10N, 0\rangle$,

(b.) the work done by $\vec{F}_2 = \langle 10N, 3N\rangle$,

(c.) work done by the variable force $\vec{F}_3 = (10N/m)\langle x, y\rangle$

(d.) would the answers be different if the motion was not along a straight line ?

Problem 42: (1pts) You are given the graph of potential energy for a particle under the influence of a particular conservative force.



(a.) If the total energy of the particle of $1.0\,J$ and your initial position is $x = 40\,m$ then what is the possible range of motion (answer is approximate)

(b.) If the total energy of the particle is $5.0\,J$ and your initial position is $x = 20\,m$ then what is the possible range of motion (answer is approximate)

Problem 43: (2pts) Suppose $U(x) = x^2 - x^4$ is the potential energy function. Plot the energy diagram and comment on the stability of any critical points. If F is the force described by this potential energy function then explain where the force is directed right/left. Please give your answer in terms of interval notation. (for example if $2 \leq x \leq 3$ was where F points right then you would say "the force is directed to the right on $[2, 3]$)

Problem 44: (2pts) Suppose $\vec{F} = (3.2\,N)\hat{\mathbf{x}} - (6.1\,N)\hat{\mathbf{y}} + (13.1\,N)\hat{\mathbf{z}}$ acts on a mass $M = 20\,kg$ as the mass moves with constant velocity $\vec{v}(t) = \left(1.0\frac{m}{s}\right)\hat{\mathbf{x}} + \left(3.0\frac{m}{s}\right)\hat{\mathbf{y}} - \left(2.0\frac{m}{s}\right)\hat{\mathbf{z}}$. What is the power developed by the given force ? If the force is applied for the time interval $0 \leq t \leq 2.00\,s$ then what is the work done by the force on M ? What is the work done by the net-force on M ?

Problem 45: (2pts) We omit units here, my apologies. Consider $\vec{F}(x, y, z) = \langle 3x^2, 3y^3, -6z \rangle$.

(a.) Find the potential energy function for $\vec{F}$

(b.) Calculate the work done by $\vec{F}$ along a line-segment from $(1, 2, 3)$ to $(-2, 0, 4)$,

(c.) Calculate the work done by $\vec{F}$ along a curve which begins where it ends.

Problem 46: (2pts) A $30\,kg$ crate is lifted by a constant force at a constant velocity from the ground to a shelf $1.2\,m$ above the ground.

(a.) What is the work fone on the crate by the lifting force

(b.) What is the work done on the crate by the gravitational force

(c.) What is the work done on the crate by the net-force

(d.) What is the net change in KE for the crate.

Problem 47: (2pts) Two tugboats pull a disabled supertanker. Each tug exerts a constant force of $1.50 \times 10^6\, N$, one 16^o north of west and the other 16^o south of west, as the pull the tanker $0.65\, km$ toward the west. What is the total work they do on the supertanker ?

Problem 48: (2pts) You are asked to design spring bumpers for the walls of a parking garage. A freely rolling 1200 kg car moving at 0.59 m/s is to compress the spring no more than 0.070 m before stopping. What should be the force constant of the spring ? Assume the spring has negligible mass.