Name: _____

Class: _____

Due Date: _____

Physics Topic 15D - Work and Energy with Calculus

Answer the following questions. The solutions to this worksheet can be found on the YouTube channel Go Physics Go.

1. E: Determine a formula for the work done by the following forces:

   a. $F = 30x^4$

   b. $F = 36\cos(4x)$

2. E: A brick with a mass of 80 kg is pushed to the right on a smooth horizontal surface with a varying force given by the equation $F = 15x^2$ from $x_\mathrm{i} = 6$ m to $x_\mathrm{f} = 10$ m with an initial velocity of $v_\mathrm{i} = 6.78233\ \frac{\mathrm{m}}{\mathrm{s}}$.

   a. Calculate the work done by the force from (6,0) to (10,0).

   b. Calculate the change in kinetic energy of the brick.

   c. Calculate the final velocity of the brick.

3. E: A block, starting from rest, is pushed to the right on a smooth horizontal surface with a varying force given by the equation $F = 180x^2 - 12x^3$.

   a. Find the locations at which the force on the block is zero.

   b. Determine a formula for the work done.

   c. Find the points at which the block stops to turn around.

   d. Use definite integrals to find the work done between the following two points:

      i. $x_\mathrm{i} = 0$ to $x_\mathrm{f} = 12$

      ii. $x_\mathrm{i} = 0$ to $x_\mathrm{f} = 15$

iii. $x_i = 12$ to $x_f = 15$

iv. $x_i = 15$ to $x_f = 20$

e. The particle will make one round trip from the origin (0,0) out to (20,0) and back to the origin where it will stop. Find those segments during the trip where

i. dx is positive

ii. dx is negative

iii. F is positive

iv. F is negative

v. W is positive

vi. W is negative

4. The potential energy is given by the following function:

$$U = 3x^2 + 2xy + 6y^2 - 18x + 28y$$

a. Find an expression for the force associated with this potential energy.

b. Calculate the value of the potential energy at (0,0).

c. Calculate the change in the potential energy as we move from location (1,2) to (5,3).

d. Find the equilibrium points, that is, the points at which $\vec{F} = (0,0)$.

e. Is this equilibrium point stable, unstable, or a saddle point?

f. Calculate the potential energy at the equilibrium point.

5. A force is given by the following formula:

$$F = -(+12x + 6y + 18)\hat{\imath} - (+6x - 2y - 16)\hat{\jmath}$$

a. Find a formula for the potential energy associated with this force. Assume that $U = 0$ at the origin (0,0).

b. Find the equilibrium point. Is it stable, unstable, or a saddle point?