The following information pertains to questions 1-5:
A 10 kg block is being pulled to the right by a rope as shown. The rope has a constant tension of 50 N. A force of kinetic friction of magnitude 20 N acts on the block as slides.

1. As the block slides, how many forces act on it?
   a. 1   b. 2   c. 3   d. 4   e. 5   f. 6

2. Of the forces that act on the block, how many do work (nonzero work that is) on the block?
   a. 1   b. 2   c. 3   d. 4   e. 5   f. 6

3. If the block starts at rest and slides 2.0 m as described how much work does the rope do on the block?
   a. 40 J   b. 60 J   c. 100 J   d. 140 J   e. 160 J
   f. -40 J   g. -60 J   h. -100 J   i. -140 J   j. -160 J

\[ W = F \cdot s \cdot \cos \theta \]
\[ W = 50 \text{N} \cdot 2 \text{m} \cdot \cos 0^\circ \]
\[ W = 100 \text{J} \]

4. If the block starts at rest and slides 2.0 m as described how much work does friction do on the block?
   a. 40 J   b. 60 J   c. 100 J   d. 140 J   e. 160 J
   f. -40 J   g. -60 J   h. -100 J   i. -140 J   j. -160 J

\[ W = F \cdot s \cdot \cos \theta \]
\[ W = 20 \text{N} \cdot 2 \text{m} \cdot \cos 180^\circ \]
\[ W = -40 \text{J} \]

5. If the block starts at rest and slides 2.0 m as described, what will the final kinetic energy of the block be?
   a. 40 J   b. 60 J   c. 100 J   d. 140 J   e. 160 J
   f. -40 J   g. -60 J   h. -100 J   i. -140 J   j. -160 J

\[ W = K_f - K_0 \]
\[ W_{Ff} + W_{fk} = K_f \]
\[ 100 \text{J} - 40 \text{J} = K_f \]
\[ 60 \text{J} = K_f \]
The following information pertains to questions 6-8: A particle of mass m is moving to the right with an initial velocity of \( v_0 \) to the right as shown. The net force on the particle is zero until the particle reaches \( x=0 \) at which time, it comes under the influence of a force of \( F_x = kx^3 \hat{i} \) where \( k \) is a positive constant and the positive \( x \) direction is to the right.

6. Once the particle is past \( x=0 \), which of the following statements is true about the work being done on the particle by the given force?
   - The work is positive
   - The work is negative
   - The work is zero
   - It is impossible to tell if the work is positive or negative.

7. How much work is done on the particle by the given force during the interval in which the particle moves from \( x=0 \) to \( x=d \) (where \( d>0 \))
   a. \( \frac{+k d^2}{2} \)
   b. \( \frac{+k d^3}{3} \)
   c. \( \frac{+k d^4}{4} \)
   d. \( \frac{+k d^5}{5} \)
   e. \( \frac{+k d^6}{6} \)
   f. \( \frac{-k d^2}{2} \)
   g. \( \frac{-k d^3}{3} \)
   h. \( \frac{-k d^4}{4} \)
   i. \( \frac{-k d^5}{5} \)
   j. \( \frac{-k d^6}{6} \)

8. At which point (value of \( x \)) will the particle have a speed of \( 2v_0 \)?
   a. \( \left( \frac{9mv_0^2}{2k} \right)^\frac{1}{3} \)
   b. \( \left( \frac{6mv_0^2}{k} \right)^{\frac{1}{4}} \)
   c. \( \left( \frac{15mv_0^2}{2k} \right)^{\frac{1}{5}} \)
   d. \( \left( \frac{9mv_0^2}{k} \right)^{\frac{1}{6}} \)
   e. \( \left( \frac{3mv_0^2}{2k} \right)^{\frac{1}{3}} \)
   f. \( \left( \frac{2mv_0^2}{k} \right)^{\frac{1}{4}} \)
   g. \( \left( \frac{5mv_0^2}{2k} \right)^{\frac{1}{5}} \)
   h. \( \left( \frac{3mv_0^2}{k} \right)^{\frac{1}{6}} \)

9. Larry lifts a box of mass \( m \) to a height \( h \) in a time \( t \). Curly lifts the same box to the same height in half the time. If Larry's average power output during the lifting is 400 W, what is Curly's average power output?
   a. 400 W
   b. 800 W
   c. 200 W
   d. 100 W
   e. None of the above

\[
\rho = \frac{\text{Work}}{\text{time}}
\]

\[\text{Half the time} \rightarrow \text{twice the power} \]
An object moving in one-dimension is subject to a force whose potential energy function is shown below. Assume we are using a coordinate system where the positive x direction is to the right.

1. At which of the following points will the object feel a force to the left? (More than 1 choice may apply)
   a. $x = 20 \text{ cm}$
   b. $x = 40 \text{ cm}$
   c. $x = 60 \text{ cm}$
   d. $x = 80 \text{ cm}$

2. How much work (by an external force) would be required to move the object at a constant speed from $x = 0 \text{ cm}$ to $x = 30 \text{ cm}$?
   \[ W = \frac{K_f - K_0 + U_f - U_0}{x = 30 \text{ cm}} \]
   \[ W = 8J - 4J = 4J \]
   Answer $4J$

3. If the object is initially at $x = 0 \text{ cm}$ moving to the right with an initial kinetic energy of 6 J. What is the greatest amount of kinetic energy the object has between $x = 10 \text{ cm}$ and $x = 90 \text{ cm}$ and approximately where does this occur at?
   \[ W = K_f - K_0 + U_f - U_0 \]
   \[ K_f + U_0 = K_f + U_f \]
   \[ K_f - K_0 + U_0 - U_f \]
   \[ 6J + 4J - 4J \]
   \[ x = 50 \text{ cm} \text{ when } U = 4J \]
   Answer $6J$

4. If the object is initially at $x = 50 \text{ cm}$ moving to the right with 6 J of kinetic energy, at which point does it have a kinetic energy of (approximately) 8 J?
   \[ W = K_f - K_0 + U_f - U_0 \]
   \[ U_f = K_0 + U_0 - K_f \]
   \[ 6J + 4J - 8J \]
   \[ x = 110 \text{ cm} \]
   Answer $110 \text{ cm}$

5. If the object is initially at $x = 50 \text{ cm}$, what (approximately) is the maximum value of initial kinetic energy that it can have such that its motion is bounded?
   \[ \text{bounded if } K + U \leq 8J \]
   \[ \text{(humps on either side)} \]
   \[ 4J \]
   Answer $4J$
A skier of mass 70.0 kg starts from rest at the top of a ski slope of height 80.0 m.

a. If frictional forces do $-2.00 \times 10^4$ J of work on her as she descends, how fast is she going at the bottom of the slope? [10 points]

$$W = K_f - K_0 + U_f - U_0, \quad y = 80 \text{ m}$$

$$K_f = U_0 + W$$

$$K_f = 70 \text{ kg} \cdot 10 \frac{m}{s^2} \cdot 80 \text{ m} - 2 \times 10^4 \text{ J}$$

$$= 3.6 \times 10^4 \text{ J}$$

$$K = \frac{1}{2} m v^2, \quad v = \sqrt{\frac{2K}{m}} = \sqrt{\frac{2 \cdot 3.6 \times 10^4 \text{ J}}{70 \text{ kg}}} = 32.1 \frac{m}{s}$$

Now moving horizontally, the skier crosses a patch of soft snow, where the coefficient of friction $\mu_k = 0.300$. If the patch is of width 40.0 m and the average force of air resistance on the skier is 170 N, how fast is she going after crossing the patch? [10 points]

$$W = K_f - K_0 + U_f - U_0$$

$$K_f = W + K_0$$

$$K_f = W_{fr} + W_{air} + K_0$$

$$\downarrow$$

$$F_{fr} \cdot s \cos \theta$$

$$M_k \cdot m g \cdot \cos 180^\circ + F_{air} \cdot s \cos 180^\circ + 3.6 \times 10^4 \text{ J}$$

$$= 3 \cdot 70 \text{ kg} \cdot 10 \frac{m}{s^2} \cdot 40 \text{ m} \cdot (-1) + 170 \text{ N} \cdot 40 \text{ m} \cdot (-1) + 3.6 \times 10^4 \text{ J}$$

$$K_f = 2.08 \times 10^4 \text{ J}$$

$$v = \sqrt{\frac{2K}{m}} = 24.4 \frac{m}{s}$$