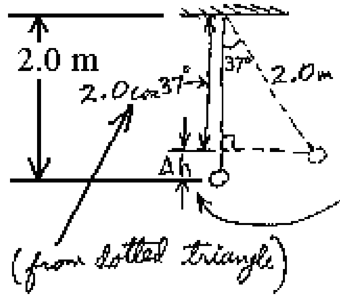
Phy 131 - Assignment 5

A.



A) Notice: $2.0_m = 2.0\cos 37° + \Delta h$

$2.0 - 2.0\cos 37° = \Delta h$

$\Delta h = .4027_m$

$\Delta U_g = mg\Delta h$

$= (5_{kg})(9.8\,{}^{m}/_{s^2})(.4027) = \boxed{19.7_J}$ ANS

B) Conservation of Energy:

$mgh_o + \frac{1}{2}mv_o^2 = mgh_f + \frac{1}{2}mv_f^2$

$-\frac{1}{2}mv_f^2 + \frac{1}{2}mv_o^2 = \underbrace{mgh_f - mgh_o}_{19.7_J}$

$-\frac{1}{2}(5_{kg})v_f^2 + \underbrace{\frac{1}{2}(5_{kg})(4\,{}^{m}/_{s})^2}_{40} = 19.7$

$\underbrace{40 - 19.7}_{20.3} = 2.5\,v_f^2 \Rightarrow v_f = \sqrt{\frac{20.3}{2.5}} = \boxed{2.85\,{}^{m}/_{s}}$ ANS

B. 1. Only the component of the force parallel to the displacement does work. Here, $\vec{F} \perp \vec{s}$ so that component is zero.

$W = (F\underbrace{\cos\theta}_{\cos 90° = 0})s$

2. i. <u>At the top</u>. $U_g = mgh$.
ii. <u>When first thrown</u>. Friction continually removes energy after that.

3. As the hint says, $v^2 = \vec{v} \cdot \vec{v} = v_x^2 + v_y^2$ Or, you can also see that $v^2 = v_x^2 + v_y^2$ by applying the Pythagorean theorem to this triangle:

A) $KE_i = \frac{1}{2} m v_0^2 = \frac{1}{2} m \left(v_x^2 + v_y^2\right)_i$

$= \frac{1}{2}(3_{kg})\underbrace{(6^2 + (-2)^2)}_{40} = \boxed{60\,J}$ ANS

B) $\Delta KE = KE_f - KE_i$

$= \frac{1}{2}(3_{kg})(8^2 + 4^2) - 60_J$

$= 120 - 60 = \boxed{60\,J}$ ANS

C. 1. The dot product of two vectors is $\vec{A} \cdot \vec{B} = |A||B| \cos\theta$. The magnitudes of all these vectors is one. (That's what "unit vector" means.) If the vector is being dotted with itself, the angle between the vector and itself is 0°, and cos 0° = 1. If the vector is being dotted with something perpendicular ($\hat{i}$, $\hat{j}$, and $\hat{k}$ are all perpendicular to each other) cos 90° = 0. So, any unit vector dotted with itself is one, any vector dotted with a perpendicular vector is zero. Answers: <u>1,0,0,1,0.</u>

2. <u>Vertically.</u> Work = $\vec{F} \cdot \vec{s} = |F||s| \cos\theta$. If he goes horizontally, the force and displacement are perpendicular. Cos 90° = 0, so no work is done. If he goes vertically, the force and displacement are in the same direction. Cos 0° = 1, so the work equals the force times the distance.

3. $E_i + W = E_f$

$KE_i \quad + \quad (-fs) \quad = \quad mgh_f$

($U_i = 0$) ($W = f \cos 180° \, s$) ($KE_f = 0$: at rest)

540,000 J – (250 N)s = (1200 kg)(9.8 m/s_2)(s sin4°)

540,000 – 250 s = 820 s

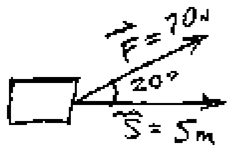
540,000 = 1070 s

s = 540,000 / 1070 = $\boxed{505 \text{ m}}$

D. 1. Work is a scalar. (So is energy.) Expressing it in terms of components would be like expressing your age (which is also a scalar) with components. How many years to the east and how many years to the north do you have?

2.

a)

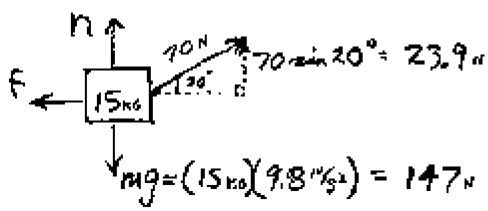


$$W = \vec{F} \cdot \vec{S} = (70_N)(\cos 20°)(5_m) = \boxed{329 \text{ JOULES}} \text{ ANS}$$

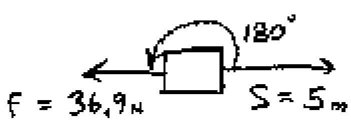
b) First, need f.

$f = \mu_k n$

need n



$$\Sigma F_y = 0$$
$$n + 23.9_N - 147_N = 0$$
$$n = 123.1_N$$
$$f = (.3)(123.1_N) = 36.9_N$$



$$W = (36.9_N)\underbrace{(\cos 180°)}_{-1}(5_m) = \boxed{-185 \text{ J}} \text{ ANS}$$

E. 1. NO - Mechanical energy is not conserved when nonconservative forces are present. (Hence the name.) They turn it into or get it from non-mechanical forms, such as heat.

2. a. Work = $\vec{F} \cdot \vec{s} = (.7\hat{\imath} + .4\hat{\jmath}) \cdot (3\hat{\imath} + 0\hat{\jmath}) = (.7)(3) + (.4)(0) = 2.1 + 0$

($\vec{s}$ is the displacement: 3 m along the x axis) <u>Work = 2.1 J (ans)</u>

b. $E_i + W = E_f$

$0 + 2.1\text{ J} = ½mv^2$ ($U_i = U_f$ because it moves horizontally. $KE_i = 0$ because it starts at rest.)

$2.1 = .5(.25\text{ kg})v^2$

$2.1 / .125 = v^2$

$v = \sqrt{16.8} = \boxed{4.10 \text{ m/s}}$

F. a. $E_A + W = E_B$

$(mgh_A + 0) + (–35 \text{ J}) = (0 + ½mv_B^2)$

$(22 \text{ kg})(9.8)(2.06 \text{ m}) – 35 = ½(22 \text{ kg})(v^2)$

$444.1 – 35 = 11 v^2$

$409.1 = 11 v^2$

$37.19 = v^2$

<u>6.10 m/s = v (ans.)</u>

b. While falling from B to C (taking down as positive):

$\Delta y = v_{yi}t + ½ a_y t^2$

$1.15 \text{ m} = 0 + ½ (9.8) t^2$ (The y component of v_B is zero because she is moving horizontally.)

$1.15 = 4.9 t^2$

$.2347 = t^2$

$.48446 = t$ That is, about <u>.484 s</u> (ans.)

c. $\Delta x = (v_{av})_x t$

$\Delta x = (6.10 \text{ m/s})(.48446 \text{ s}) =$ <u>2.96 m</u> (ans)