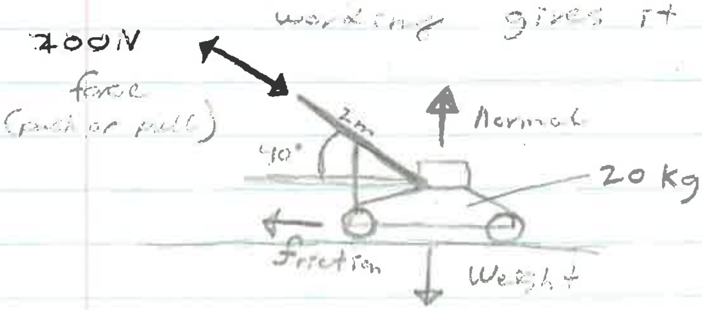
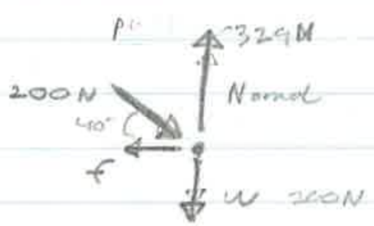
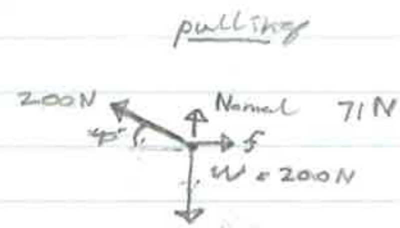
PS #4

#1. a. this is a dynamics question because the person pushing the mower exerts a force, friction exerts a force, and also there is the forces of weight and the normal force; the question's wording gives it away.



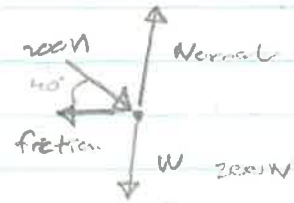
b. $\Sigma \vec{F} = m\vec{a}$ a=0 because of constant velocity





Since $F = \mu N$, the diagram with the smaller Normal force. pulling the mower reduces the normal force since some of it is taken away by the vertical component of your pull, giving a smaller frictional force. To get the same acceleration/work done, pulling the mower will minimize the force necessary.

c. pushing:



$200N + 200 \sin 40° = 329\ N$

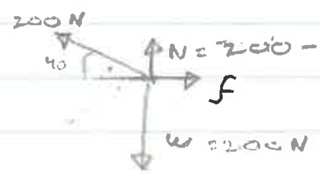
horizontal: $\sum \vec{F} = m\vec{a}$

$$200 \cos 40° - 1.2(329) = 20\,kg\ a$$

$$-12\ m/s^2 = a$$

when you hit the rough patch, the resulting acceleration is $-12\ m/s^2$

d. pulling



$N = 200 - 200 \sin 40 = 71\ N$

horizontal: $\sum \vec{F} = m\vec{a}$

$$200 \cos 40 - 1.2 \cdot 71 = 20 \cdot a$$

$$3.4\ m/s^3 = a$$

the resulting acceleration is $3.4\ m/s^2$

e. person = $200 \cos 40 \cdot 2\,m = 306.\ J$

friction $71 \cdot 1.2 \cdot 2 = 170.\ J$

$$KE + W_{human} - W_{friction} = KE$$

$$\tfrac{1}{2}\,20(3)^2 + 306 - 170 = \tfrac{1}{2}(20)\,v^2$$

$$4.8\ m/s = v$$

f. push = person: $200 \cdot \cos 40 \times 2 = 306\ J$

Friction $1.2 \cdot 329 \times 2 = 789.6\ J$

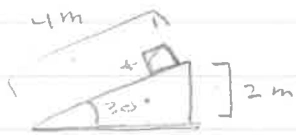
$$\tfrac{1}{2}\,20 \cdot (3)^2 + 306 - 789.6\,J = \tfrac{1}{2}(20)\,v^2$$

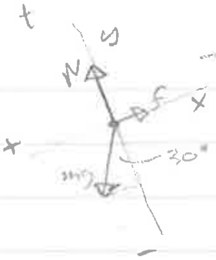
$$-39 = v^2$$

the mower will have stopped before you reach 2 m because μ is so big (1.2)

P-4

#2





$$\sum \vec{F_x} = ma$$

$$\sum F_y = 0$$

y: $N - mg\cos 30 = 0$ $N = mg\cos 30$

x: $mg\sin 30 - \mu N = ma$

$10\,m\sin 30 - .8(10\,M\cos 30) = Ma$

$10\sin 30 - 8\cos 30 = a$

$\boxed{-1.9\ m/s^2 = a}$

the acceleration is in the − direction, in the direction of friction, so the box never moves unless pushed

a.

Energy: $m\,10\cdot 2 - .8(10\,M\cos 30)\cdot 4 = \frac{1}{2}mv^2$

$20 - 8\cos 30\cdot 4 = \frac{1}{2}v^2$

$-15.4 = v^2$

$\boxed{v^2 = -15.4 \quad \text{(impossible)}}$

b. $\frac{1}{2}mv^2 + mgh - \mu mg\cos 30\cdot 4 = 0\,mgh + 0\,\frac{1}{2}mv^2$

$\frac{1}{2}v^2 + 10\cdot 2 - .8(10\cos 30)\cdot 4 = 0$

$\frac{1}{2}v^2 - 7.7 = 0$

$v = 3.9\ m/s$ **the initial required velocity is 3.9 m/s down the slope**

c. 4 m $v_f = 0$

d. $v_0 = 3.9$

$0 = (3.9)^2 + 2a(4)$

$a = -1.9\ m/s^2$

$0 = 3.9 + -1.9t$

$2 = t$

time = 2 seconds.

acceleration = −1.9 m/s²

(it slows as it goes down the slope)

e. see above

3. a. $m_w v_w = m_p v_p + 0 v_w \cdot m_w$

• water's momentum is 0 (0 velocity on the axis after colision) because it is perpendicular to its original velocity/direction.

b. Lost ~ 1 meter of water

$\pi (.025/2)^2 \times 1\,m \times \frac{1000\,Kg}{m^3} = .5\,Kg$ of water

$F = \frac{\Delta p}{\Delta t} = \frac{.5(45)}{.02\overline{2}\,s} \approx$ **1000 N**

$1\,m = 45\,m/s \cdot t$ seconds

$.0\overline{22} = t$

I think this is easily enough force to knock you over!