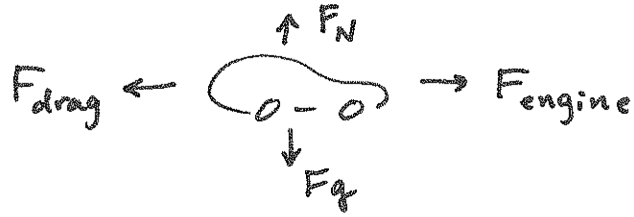
ENERGY & WORK

1.) In this situation you must realize a few things...

- The gasoline's energy is used in the car's engine.
- when the car is traveling at a constant velocity it is in equilibrium:



$$F_{drag} = F_{engine} \quad \& \quad F_N = F_g$$

$$\hookrightarrow \quad F_{engine} = 320\,N$$

The car's engine does work against friction ~~of~~ over a distance of 18 km.

$$W = F \cdot d = (320\,N)(18000\,m) = 5.76 \times 10^6\,J$$

$$V_{gas} = \frac{5.76 \times 10^6}{5.6 \times 10^6} = \boxed{1.03\,L}$$

2.) The energy of the gas is converted into Kinetic Energy which is then converted into gravitational potential energy.

$$E_{gas} = U_g \leftarrow mgh$$

$$5.6 \times 10^6 = (0.06)(9.8)h$$

$$\boxed{\begin{array}{c} h = 9.52 \times 10^6\,m \\ \text{Yes... enters L.E.O.} \end{array}}$$

3.) The spring energy = spring & potential

E_o = E_f

$$\frac{1}{2}kx^2 = \frac{1}{2}kx^2 + mgh$$

★ Final Height: ★

$1 \sin 30 = 0.5\,m$

$$\frac{1}{2}(50)(0.1)^2 = \frac{1}{2}(15)x^2 + (0.019)(9.8)(0.5)$$

$$\boxed{X = 0.145\,m}$$

4.)

E_o = E_f

Spring = kinetic + potential

★ Final Height ★

$$\frac{1}{2}kx^2 = \frac{1}{2}mv^2 + mgh$$

$0.5 \sin 30 = 0.25\,m$

$$\frac{1}{2}(50)(0.1)^2 = \frac{1}{2}(0.019)v^2 + (0.019)(9.8)(0.25)$$

$$\boxed{V = 4.63\,m/s}$$

MOMENTUM

1.) In a collision momentum is <u>always</u> conserved ...

$$p_o = p_f$$

$$(1\,kg)(2\,m/s) = (1\,kg)(-1.4\,m/s) + m\,(0.2\,kg)$$

Solving for m ...

$$\boxed{m = 17\ kg}$$

2.) $J = F \cdot t = \Delta p$

<u>First Cart</u>

I did it backwards → ~~$\Delta p = (1)(2) - (1)(-1.4)$~~

~~$= 3.4$ kg·m/s~~ or N·s

$\Delta p = (1)(-1.4) - (1)(2)$

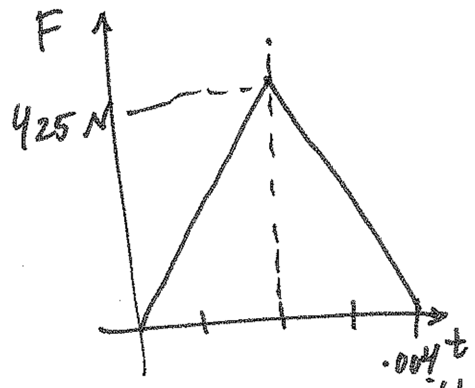
$= -3.4$ kg·m/s or N·s

<u>Second Cart</u>

$\Delta p = (17)(0.2) - 0$

$= 3.4$ kg·m/s or N·s

3.)



Draw anything with an area of 3.4

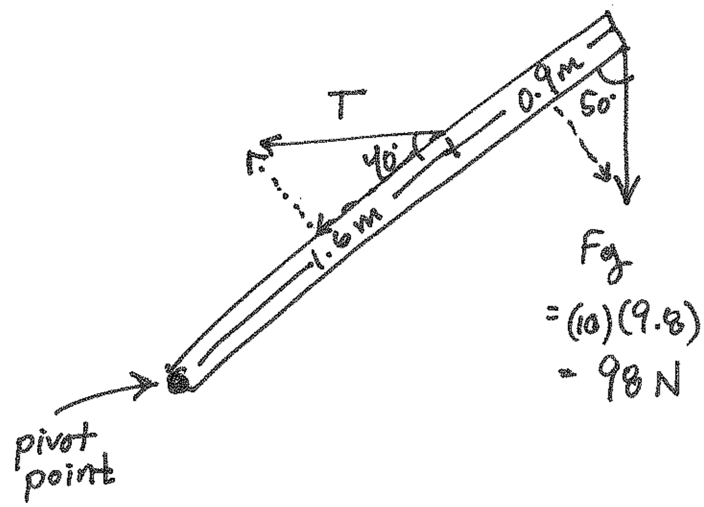
4.) $KE_o = \frac{1}{2}(1)(2)^2 = 2\ J$

$KE_f = \frac{1}{2}(1)(1.4)^2 + \frac{1}{2}(17)(0.2)^2$

$= 1.32\ J$

$$\boxed{KE_o \neq KE_f \quad \text{Not Elastic}}$$

TORQUE



☆ When the force is at an angle you can always find components so that one is parallel to lever arm and one is perpendicular.

If the sign is not moving, then the torques must be balanced. Recall that torque is $\tau = F \cdot r \cdot \sin\theta$

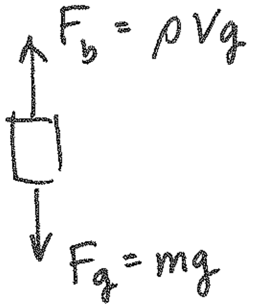
$$\tau_{up} = \tau_{down}$$

$$(1.6)\cdot(T \sin 40) = (98 \sin 50)(1.6 + 0.9)$$

$$\boxed{T = 182.5\,N}$$

BUOYANCY

1.)



when box is in equilibrium as it is here, then

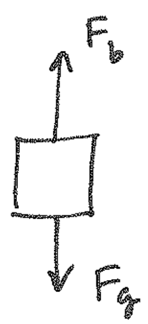
$$F_b = F_g$$

$$\rho V \cancel{g} = m \cancel{g}$$

$$\overset{\rho}{(1000)}(0.45 \times 0.45 \times 0.225) = \overset{\checkmark}{m}$$

$$\boxed{m = 45.6 \text{ kg}}$$

2.)



Box is still in equilibrium, but now sits lower in the water, displacing more fluid.

$$F_b = F_g$$

$$\rho V \cancel{g} = m \cancel{g}$$

$$\underset{\rho}{(1000)}\underbrace{(0.45)(0.45)(0.45)}_{V} = m$$

$$m = 91.125 \text{ kg}$$

$$m_{fluid} = m_{full} - m_{empty}$$

$$m_{fluid} = 91.125 - 45.6$$
$$= 45.6 \text{ kg}$$

$$\rho = m/V \rightarrow V = m/\rho = 45.6/920 = 0.0495 \text{ m}^3$$

$$V = l \times w \times h \rightarrow 0.0495 = (0.45) \times (0.45) \times h$$

$$\boxed{h = 0.245 \text{ m}}$$