**Exam 4 - Review Problems**

Name: _____

1. In winter why does the temperature not rise more than a few degrees above freezing as long as there is snow cover?

2. Joe (70kg) rides his 5.0 kg sled 30.0 meters down a slight incline covered in snow. If he changes his elevation by 10.0 meters during this ride, determine his final speed if we ignore friction on the slope.

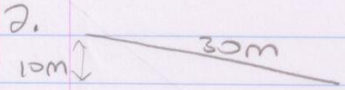
3. If we include friction and it turns out that Joe travels at a constant speed down this slope, find the average force of friction acting on the sled.

4. Disappointed with the slow ride, Joe waxes his sled and rides 30.0 meters down a steeper snowy mountain that makes an angle of $25^{o}$ with the horizontal. If the coefficient of friction between the sled and the incline is 0.15,
    a. use the concepts of work and energy to solve for the final speed of the sled.
    b. How much snow is melted by the sled (when friction is included) if the snow is at $0^{o}C$?

5. A 5.0 kg block of ice is initially at -65 $^{o}C$ and then combined with 1.0 kg of steam at $110^{o}C$. What is the final temperature of the system, what is the final mass of ice, water and steam?

1. Energy from the sun or a warm airmass that moves in has to melt the snow before it can begin warming things. The snow is at 0°C when it is melting or 32°F keeping things cool until it has all melted.

2.

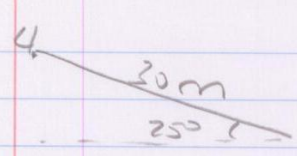



Joe + sled = 75 kg

$$U_{gi} + K_i = U_{gf} + K_f$$
$$mgh_i + 0 = 0 + \tfrac{1}{2}mv_f^2$$
$$2gh_i = v_f^2$$
$$2\ 9.8\ m/s^2\ 10m = v_f^2$$
$$\sqrt{19.6\ m^2/s^2} = \sqrt{v_f^2}$$
$$14\ m/s = v_f$$

3. $U_{gi} + K_i = U_{gf} + K_f + W_f$
$mgh_i + 0 = 0 + 0 + W_f$
$75kg\ 9.8\ m/s^2\ 10m = W_f$
$7350J = W_f$

$W_f = f \cdot d$
$W_f/d = f$
$7350J/30m = f$
$245N = f$



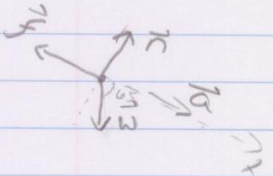

new height $\sin 25° = h/30m$

$12.67m = h$

$\mu = 0.15$

a. $U_{g_i} + K_i = U_{g_f} + K_f + W_f$

$mgh_i + 0 = 0 + \frac{1}{2}mv_f^2 + f \cdot d$




$f = \mu n$ so need normal

$\Sigma F_y = n - W\cos 25° = 0$

$n = mg\cos 25°$

Back to energy:

$mgh_i = \frac{1}{2}mv_f^2 + \mu(mg\cos 25°)d$

$gh - \mu g\cos 25° d = \frac{1}{2}v_f^2$

$9.8 m/s^2\ 12.67m - 0.15(9.8 m/s^2 \cos 25°)30m = \frac{1}{2}v_f^2$

$124.17 m^2/s^2 - 39.97 m^2/s^2 = \frac{1}{2}v_f^2$

$2(84.2 m^2/s^2) = v_f^2$

$13 m/s = v_f$

5. $m_{ice}$ 5kg @ -65°C  $m_{steam}$ 1kg @ 110°C

ice to 0°C = $5\,kg \cdot 2090\ J/kg\,K \cdot (0°C - (-65°C)) = 679,250\ J$

melt ice = $5\,kg \cdot 3.33 \times 10^5\ J/kg = 1,665,000\ J$

steam to 100°C = $1\,kg \cdot 2010\ J/kg\,K \cdot (100°C - 110°C) = -20,100\ J$

steam to liquid = $1\,kg \cdot 2.26 \times 10^6\ J/kg = -2,260,000\ J$

to make ice liquid: $679,250\ J + 1,665,000\ J = 2,344,250\ J$

TO make steam liquid: $-20,100\ J + -2,260,000\ J = -2,280,100\ J$

This tells us that the energy in the steam is enough to melt all the ice. We end up with water at some $T_F$

$$\underbrace{Q_{ice}}_{-65\to 0} + Q_{ice\,melt} + \underbrace{Q_{ice}}_{\text{now liquid},\ 0\to T_F} + \underbrace{Q_{steam} + Q_{steam\,condense}}_{110\to 100} + \underbrace{Q_{steam}}_{\text{now liquid},\ 100\to T_F} = 0$$

$$2,344,250\ J + 5\,kg \cdot 4180\ J/kg\,K \cdot (T_F - 0) + -2,280,100\ J + 1\,kg \cdot 4186\ J/kg\,K \cdot (T_F - 100) = 0$$

$$64,150\ J + 20,930\ J/K\ T_F + 4186\ J/K\ T_F - 418,600\ J = 0$$

$$-354,450\ J + 25,116\ J/K\ T_F = 0$$

$$25,116\ J/K\ T_F = 354,450\ J$$

$$\boxed{T_F = 14.1°C}$$