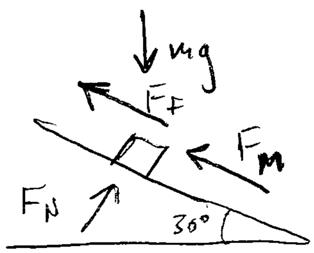
Homework solutions Physics 2414

Assignment # 6

1. a. $180\,N \cdot \boxed{5.3\,m} = 954\,J$

b. $\boxed{955\,N} \cdot \boxed{5.3\,m} = 5061.5\,J$

2. 

$F_N - mg\cos\theta = 0$

$F_M + F_f - mg\sin\theta = 0$

$F_f = \mu_K |F_N|$

a. $F_M = mg\sin\theta - \mu_K mg\cos\theta = \boxed{265\,kg}\,9.8(\sin 30 - 0.4\cos 30)$

$= 398.9\,N$

b. $398.9 \cdot \boxed{4.4\,m}\cos 180° = -1755\,J$

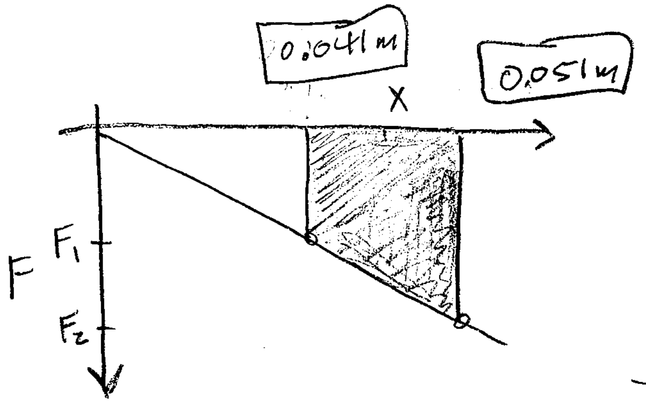
c. $\mu_K mg\cos\theta \cdot \boxed{4.4\,m}\cos 180° = -3962\,J$

d. $mg\sin\theta \cdot \boxed{4.4\,m}\cos 0 = 5719\,J$

e. $W_{net} = 5719 - 1755 - 3962 \approx 0$

$(F_{net} = 0$ so $F_{net} \cdot d = 0)$

3. Hooke's law: $F = -K\Delta x$



(not to scale)

The shaded area will be the work necessary to stretch the spring from $\boxed{4.1\,cm}$ to $\boxed{5.1\,cm}$.

The area of the quadrilateral is:

$$\frac{(|F_2| + |F_1|)}{2} \cdot (5.1 - 4.1)\,cm = \underline{0.0792\,J}$$

4. $K.E. = \frac{1}{2} m v^2$ a. If $K_1 = \frac{1}{2} m v_1^2$ and it is $\boxed{\text{quadrupled}}$ to $K_2 = 4K_1$ then $\frac{V_2^2}{V_1^2} = \frac{K_2}{K_1} = 4$

so, $V_2 = \sqrt{4 v_1^2} = \underline{2 v_1}$

b. If $K_1 = \frac{1}{2} m v_1^2$ then $K_2 = \frac{1}{2} m (\boxed{4} v_1)^2$

and $\frac{K_2}{K_1} = \frac{m 4^2 v_1^2}{m v_1^2} = \underline{16}$ $\underline{K_2 = 16 K_1}$

5.

$$W = 95N \cdot \boxed{0.81m} = 76.95J$$

Work done will equal K.E.

$$76.95 = \frac{1}{2}mv^2 \qquad v^2 = \frac{2 \cdot 76.95J}{\boxed{0.08Kg}}$$

$$v = \underline{43.86 \; m/s}$$

6. Assume car can break with Force F.

Then, to stop, $F \cdot d_1 = \frac{1}{2}mv_1^2 - 0 = \Delta K.E.$

Now, $v_2 = \boxed{1.6 v_1}$ so,

$$F \cdot d_2 = \frac{1}{2}mv_2^2 - 0 = \Delta K.E.$$

$$\frac{d_2}{d_1} = \frac{v_2^2}{v_1^2} = \frac{1.6^2 v_1^2}{v_1^2} = \underline{2.56}$$

7. $K.E._{before} = P.E_{After}$

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

$$\frac{1}{2}\boxed{1100kg}\left[\boxed{55Km/h} \cdot \frac{1000m/Km}{3600 s/h}\right]^2 = \frac{1}{2}K(\boxed{2.2m})^2$$

solving for K, $K = \underline{53047.8 \; N/m}$

8. $K.E._{Before} = P.E._{After}$

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

a. $\frac{\boxed{3.8 m/s}^2}{2} = gh \qquad h = \underline{0.736 m}$

b. Length of the vine won't affect answer. Energy is conserved.

9. $K.E._{Before} + P.E._{Before} = K.E._{After}$

a. $\frac{1}{2}mv_i^2 + mgh = \frac{1}{2}mv_f^2$

$\frac{1}{2}\boxed{75 kg}\boxed{4.5 m/s}^2 + \boxed{75 kg} \cdot 9.8 \frac{m}{s^2} \cdot 3m = \frac{1}{2}\boxed{75 kg} v_f^2$

$v_f^2 = 79.05 m^2/s^2 \qquad v_f = \underline{8.89 m/s}$

b.

$K.E._{Before} = P.E._{After}$

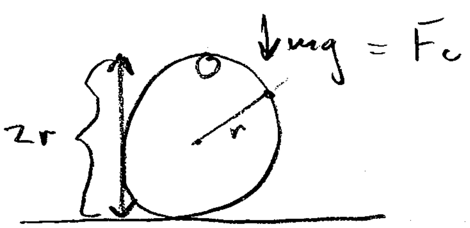
$\frac{1}{2}\boxed{75 kg} v_f^2 = \frac{1}{2}kx^2$

$75 \cdot 79.05 = 5.2 \times 10^4 x^2$

$x^2 = 0.114 m^2 \qquad x = \underline{0.3377 m}$

10. We must imagine the minimal conditions necessary for the ball to complete the loop.

At the very top of the loop, conditions will be minimal if there is no normal force and the only contribution to centripetal acceleration is mg:



Thus, at the top of the loop, $\boxed{F_c = \frac{mv^2}{r} = mg}$

Energy conservation says,

$$P.E._{\text{at } h} = P.E._{\text{at } 2r} + K.E._{\text{at } 2r}$$

So,

$$mgh = mg(2r) + \frac{1}{2}mv^2$$

Substitute:

$$mgh = 2mgr + \frac{1}{2}mgr = \frac{5}{2}mgr$$

and $$h = \frac{5}{2}r$$

h must be at least $\frac{5}{2}r$ for the ball to traverse the loop properly.