probs 14-15

Thursday, November 29, 2007
9:30 AM

14. Suppose a person pushes a 340-kilogram bobsled with a force of 380 Newtons for a distance of 6 meters, on the level ice just before the beginning of the downhill bobsled run.

(a) What is the kinetic energy of the bobsled at the end of the push? How fast is the bobsled moving at the end of the push?
(b) The bobsled then goes down the bobsled run, traveling a distance of 1400 meters, ending up 120 meters lower than the starting line. Assuming there's no friction, how fast would the bobsled be moving at the end of the run?
(c) In reality, of course, there is some friction, even on a bobsled track. At the finish line the bobsled's speed is measured to be 33 m/sec. What is the kinetic energy of the sled at that speed? How much (negative) work must have been done by the friction force during the run? What is the average friction force?

(a) work done by person goes into KE and PE of the sled, but the ice is level, so really just into KE

$W_{person} = 380N \cdot 6m = 2280J = K$

(b) sled starts with 2280J of KE

and $mgh = 340kg \; 9.8\frac{N}{kg} \; 120m = 399840J$ of PE

for a total of 402120 J of energy.

If there were no friction, this would all be KE at the bottom of the hill.

$K_{bottom} = \frac{1}{2}mV_{bottom}^2$

$V_{bottom} = \sqrt{\frac{2K}{m}} = 48.6 \; m/sec$

(C) In reality, at the bottom the sled only had

$\frac{1}{2} 340kg \left(33\frac{m}{sec}\right)^2 = 185130J$ of KE

So friction must have "stolen"

$402120 - 185130 = 216990J$

of energy. That is the amount of work done by friction.

$W_{fric} = F_{FR} \cdot d$

$= 216990J$

$$F_{Fk} = \frac{W_{fric}}{d} = \frac{216990\,J}{1400m} = 155\,N$$

15. At the scene of a car accident, on a level road, the skid marks of a car are measured to be 24 meters long by the accident investigator. The investigator has a reference book that lists the coefficient of kinetic friction between the car's brand of tire and the asphalt to be 0.75. The mass of the car is 1800 kg.

(a) What is the weight of the car?
(b) What was the frictional force when the car was sliding?
(c) How much (negative) work was done by friction?
(d) What was the kinetic energy of the car just before the brakes were locked and the car started skidding?
(e) How fast was the car moving when the driver started skidding?

(a) $F_g = m \cdot g = 17640\,N \overset{SF}{=} 18000\,N$

(b) The friction force was $\mu_k \cdot F_N = 13230\,N$

(c) So the work done by friction was $13230N \cdot 24m =$
$-317520\,J \overset{SF}{=} -320000\,J$

(d) Friction "stole" all the car's initial KE.
$K_i = 317520\,J \overset{SF}{=} 320000\,J$

(e) $V = \sqrt{\frac{2K}{m}} = 18.78\,\frac{m}{sec} \overset{SF}{=} 19\,m/sec$