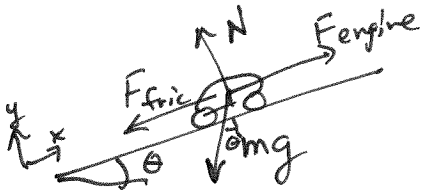
Chapter 7 Problem 76

what is the power output for the car to climb the slope at constant speed?

$\theta = 2.00°$
$m = 950 kg$
$v = 30.0 m/s$
$F_{fric} = 600N$



From Newtons second law

$$\sum \vec{F} = m\vec{a}$$
$$\vec{F}_f + \vec{N} + \vec{F}_e + \vec{w} = m\vec{a} = 0 \quad \text{(constant speed so, no acceleration)}$$

Place x-axis along the slope

$$-F_f \hat{i} + N\hat{j} + F_e \hat{i} - mg\sin\theta \hat{i} - mg\cos\theta \hat{j} = 0$$

x-dir) $-F_f + F_e - mg\sin\theta = 0 \rightarrow F_e = F_f + mg\sin\theta$ (#1)

y-dir) $N - mg\cos\theta = 0 \rightarrow N = mg\cos\theta$ (#2)

The force of the engine is

$$F_e = 600N + (950kg)(9.8 m/s^2)\sin(2.00°)$$
$$= 600N + 325N$$
$$\boxed{F_e = 925N}$$

Now power is

$$P = \frac{W}{t} = \frac{F_e \cdot \Delta x}{\Delta t} = F_e \frac{\Delta x}{\Delta t} = F_e \cdot v$$

The power of the engine is then

$$P = (925N)(30.0 m/s) = \boxed{27,750 W}$$

convert to horse power

$$P = 27,750W\left(\frac{1 hp}{746 W}\right) = \underline{37.2 hp}$$