An object of mass $m = 20$ kg is pulled up with a force of $F = 150$ N on an inclined plane for a distance of $s = 3.0$ m. The plane makes an angle of $\theta = 30°$ with the horizontal and the coefficient of kinetic friction between the object and the plane is $\mu = 0.3$. Draw the free body diagram and calculate the work done by each force.

Solution:

The free body diagram is as follows
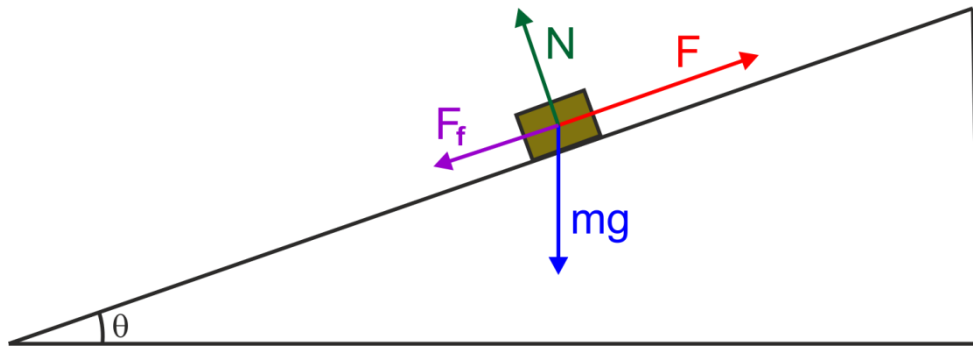
The work done by definition

$$W = Fs \cos \alpha$$

We get

$$W_F = Fs \cos 0° = Fs = 150 \times 3.0 = 450 \text{ J}$$

$$W_{mg} = mgs \cos(90° + \theta) = -mgs \sin \theta = -20 \times 9.8 \times 3.0 \times \frac{1}{2} = -294 \text{ J}$$

$$W_N = Ns \cos 90° = 0 \text{ J}$$

$$W_{F_f} = F_f s \cos 180° = -\mu mgs \cos \theta = -0.3 \times 20 \times 9.8 \times 3.0 \times \frac{\sqrt{3}}{2} = -153 \text{ J}$$

Answers:

$W_F = 150$ J,

$W_{mg} = -294$ J,

$W_N = 0$,

$W_{F_f} = -153$ J