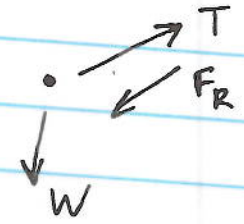
F 13 – 1



Free body diagram

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Kinetic diagram

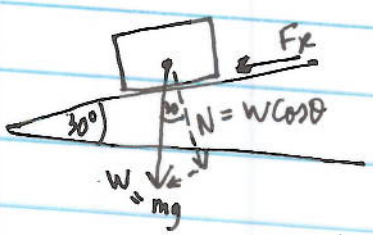
T is the tensile force in cable which we have been asked to find.

F_R is the friction force resisting the motion by definition

$$F_R = \mu_K N$$

where μ_K is the coefficient of friction for the surface/system being analyzed

N is the normal reaction to the friction surface.



$$F_R = \mu_R N = 0.3(20)(9.81)(\cos 30)$$

$$= 50.97 \text{ Newtons}$$

Now considering forces along or parallel to the plane of motion, the tension is opposed by the friction and the component of the weight on the plane of motion so,

$$\sum F = T - F_R - W_c \quad \text{(taking upwards as positive)}$$

$$= T - 50.97 - 20(9.81)(\sin 30^\circ)$$

$$= T - 149.07 \quad \text{—(1)}$$

Now we need to analyze kinetic diagram

object moves 6m in 3s starting from rest so, from 3rd Equation of motion

$$v^2 = u^2 + 2as$$

$$a = \frac{v^2 - u^2}{2s} = \frac{v^2}{2(6)} = \frac{v^2}{12} \quad \text{—(2)}$$

from 1st Equation of motion

$$v = u + at$$

$$a = \frac{v - u}{t} = \frac{v}{3} \quad \text{—(3)}$$

(2) = (3) $\Rightarrow$

$$\frac{v^2}{12} = \frac{v}{3}$$

$$3v^2 - 12v = 0$$

$$v(v - 4) = 0$$

$$v = 0, \; v = 4 \text{ m/s}$$

so from (3)

$$a = \frac{4}{3} = 1.33 \text{ m/s}^2$$

Alternately we could have determined a in one step using 2nd Equation of motion

$$s = ut + \frac{1}{2}at^2$$

$$6 = 0 + \frac{1}{2}a(3)^2$$

$$12 = 9a$$

$$a = \frac{12}{9} = 1.33 \text{ m/s}^2$$

So now apply Newton's 2nd Law to motion along the slope.

$$\Sigma F = ma$$

(from Eqn (1)

$$T - 149.07 = 20(1.33)$$

$$T = 20(1.33) + 149.07$$

$$T = 175.67 \text{ N}$$

We could worked this entire problem based on resolving all forces onto a vertical and horizontal axes, and analyzing each seperately Students conduct this excersise and confirm.

13 – 2

Along the slope (see sketch below)

$$\sum F = F - F_D - W \sin\theta$$

$$= \frac{1}{20} W - \frac{1}{500} W - 0.0995 W$$

$$= W\left(0.05 - 0.002 - 0.0995\right)$$

$$= 160{,}000 \text{ Kg } (9.81)(-0.05149)$$

$$= -80{,}824 \text{ N}$$

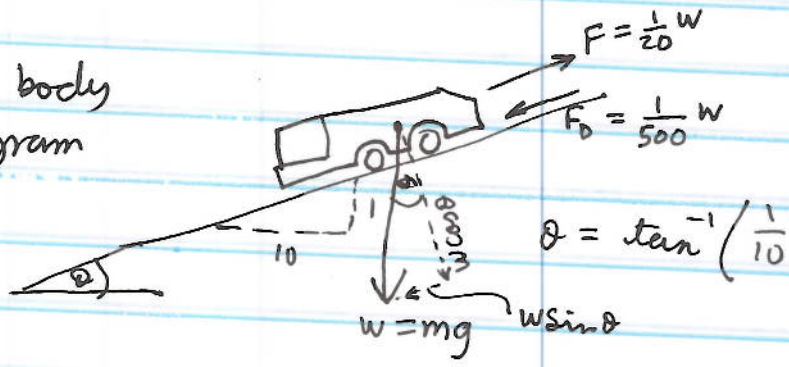
now by Newton's 2nd Law.

$$\sum F = ma$$

$$160{,}000\, a = -80{,}824$$

$$a = -0.5051 \text{ m/s}^2$$

Free body Diagram



$$\theta = \tan^{-1}\left(\frac{1}{10}\right) = 5.71°$$

[As I mentioned before, you may use vertical and horizontal axes components to do the analysis]

13-3

Refer to sketch for 13-2.

Analyzing forces along the slope.

$$\Sigma F = F - W\sin\theta$$
$$= \frac{W}{8} - W\sin 5.71$$
$$= W\left(0.125 - 0.0995\right)$$
$$= 160{,}000\,(9.81)(0.0255)$$
$$= 40{,}024 \text{ N}$$

now

$$\Sigma F = ma$$
$$160{,}000\,a = 40{,}024$$
$$a = 0.25 \text{ m/s}^2$$

so using 3rd equation of motion

$$v^2 = u^2 + 2as$$
$$= 0 + 2(0.25)(1000)$$
$$v = 22.36 \text{ m/s}$$