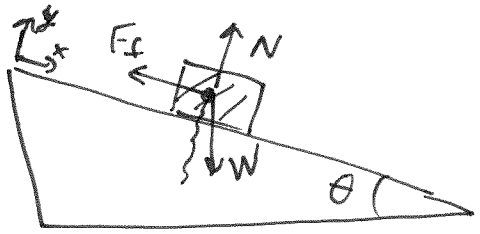
Chapter 6 Problem 64

$\theta = 30.0°$

$m = 20.0\ kg$

$\mu = 0.0300$



a) Find the acceleration of the box.

$$\Sigma \vec{F} = m\vec{a}$$

$$\vec{F}_f + \vec{N} + \vec{W} = m\vec{a}$$

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

x-dir: $-F_f + mg\sin\theta = ma$ (#1)

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

$F_f = \mu N$ (#3)

Sub (#3) into (#1) & then ~~into #~~ (#2) into the result.

$$-\mu N + mg\sin\theta = ma$$

$$-\mu mg\cos\theta + mg\sin\theta = ma$$

$$mg[-\mu\cos\theta + \sin\theta] = ma$$

$$a = g[\sin\theta - \mu\cos\theta] = (9.80\ m/s^2)[\sin(30°) - (0.030)\cos(30°)]$$

$$= \boxed{4.65\ m/s^2}$$

b) Find the velocity of the box at the end of the plane.

$\Delta x = 2.00\ m$

$v_0 = 0\ m/s$

Using the 4th kinematic equation

$$v^2 - v_0^2 = 2a\Delta x$$

$$v = \sqrt{v_0^2 + 2a\Delta x}$$

$$= \sqrt{(0)^2 + 2(4.65\ m/s^2)(2.00\ m)}$$

$$\boxed{v = 4.31\ m/s}$$