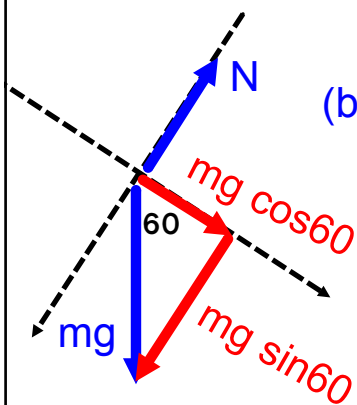


1 pt for Normal force pointing in the correct direction & correctly labeled

1 pt for Weight or Gravity pointing in the correct direction & correctly labeled. mg is allowable.



1 pt for some statement of Newton's 2nd Law, or equivalent relation

1 pt for correct component

1 pt for correct acceleration with units

Now, use the acceleration to find the roof edge velocity

$$v^2 = v_0^2 + 2a(X - X_0)$$

$$v^2 = (0)^2 + 2(5)(4)$$

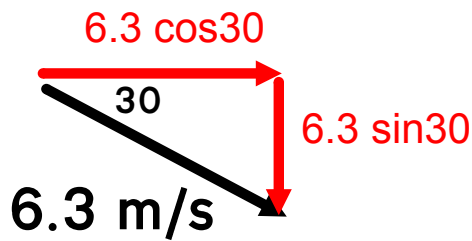
$$v^2 = 40$$

$$v = 6.3 \text{ m/s}$$

1 pt for correct substitution of v_0 , a and $(X - X_0)$ into correct equation of kinematics (alternate two-step solutions are allowable)

1 pt for correct answer and units

(c) Break the velocity up into components



1 pt for correct identification of velocity components

First, find the time it takes to get to ground:

$$Y = Y_0 + V_{y0}t + 0.5at^2$$

$$0 = 3 - 6.3 \sin 30t + (0.5)(-10)t^2$$

$$0 = 3 - 3.16t - 5t^2$$

1 pt for correct substitution of Y, Y₀, V_{y0} and a into the correct equation of kinematics

applying the quadratic formula

$$t = -1.15 \text{ s or } 0.52 \text{ s}$$

choose the positive answer, and proceed to x direction:

1 pt for correct time

$$X = X_0 + V_{x0}t$$

1 pt for correct substitution of X, X₀, V_{x0} into the correct equation of kinematics

$$X = 0 + (6.3 \cos 30)(0.52)$$

$$X = 2.8 \text{ m}$$

1 pt for correct answer and units

(d) This requires conservation of momentum, which we have not done yet

$$P_i = P_f$$

1 pt for statement of conservation of momentum or equivalent relation

$$MV_i = MV_f$$

1 pt for correct substitution of masses and velocity

$$(6)(6.3 \cos 30) = (12)V_f$$

$$2.7 \text{ m/s} = V_f$$

1 pt for correct answer and units

(a) Take the antiderivative to get velocity function

$$a = 3t$$

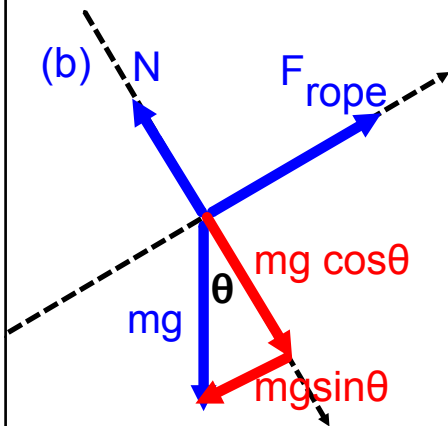
$$V = \text{antideriv}(3t)$$

$$V = (3/2)t^2 + V_0$$

since $V_0 = 0$: $V = 1.5t^2$

1 pt for recognition of the fact that antiderivative of acceleration is velocity

1 pt for correctly taking the antiderivative



$$\Sigma F_x = ma$$

$$F_{\text{rope}} - mg \sin \theta = ma$$

$$F_{\text{rope}} - mg \sin \theta = m(3t)$$

$$F_{\text{rope}} = 3mt + mg \sin \theta$$

1 pt for statement of Newton's 2nd Law or equivalent relation

1 pt for correct x-component

1 pt for correct substitution of acceleration function

1 pt for correct answer

(c) Finding total impulse is something we have not done, yet.

$$\text{impulse} = \int F dt$$

$$\text{total impulse} = \int F_{\text{net}} dt$$

$$= \int ma dt$$

$$= \int m(3t) dt$$

$$= (3/2)mt^2 = 1.5mt^2$$

1 pt for recognition of the fact that total impulse is the integral of the net force with respect to time

1 pt for correct substitution of acceleration function

1 pt for correctly taking integral

(d) Take the antiderivative again to get the position function

$$v = 1.5t^2$$

1 pt for recognition of the fact that antiderivative of acceleration is velocity

$$X = \text{antideriv}(1.5t^2)$$

$$X = (1.5/3)t^3 + X_0$$

1 pt for correctly taking the antiderivative

$$(X - X_0) = 0.5t^3$$

$$\text{displacement} = 0.5t^3$$

1 pt for correct displacement equation

(e) The magnitude of the kinetic friction force is equal to μN

$$\Sigma F_y = 0$$

1 pt for correct recognition that the kinetic friction applies

$$N - mg \cos\theta = 0$$

1 pt for correct application of Newton's 2nd Law

$$N = mg \cos\theta$$

$$f = \mu N = \mu mg \cos\theta$$

1 pt for correct answer