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Principles of Physics (10th edition)
(Discussion)
Chapter 5: Force and motion I
Problems: 1, 10, 15, 35, 45, 51, 59

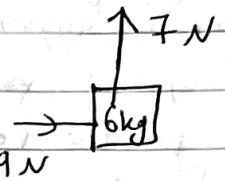
Problem 1: When two perpendicular forces 9 N (toward positive x) and 7 N (toward positive y) acts on a body of mass 6 kg. What are (a) magnitude and (b) direction of the acceleration of the body?

Sol: a) $F_{net} = \sqrt{F_x^2 + F_y^2}$

$= \sqrt{9^2 + 7^2}$

$= \sqrt{130}$

$= 11.4\ N$



according to Newton 2nd law $\vec{F} = m\vec{a}$

$a = \frac{\vec{F}}{m} = \frac{11.4}{6} = 1.9\ m/s^2$

b) $\theta = \tan^{-1}\left(\frac{F_y}{F_x}\right) = \tan^{-1}\left(\frac{7}{9}\right) = 37.8° \simeq 38°$

the direction of $\vec{a}$ is the direction of $\vec{F}$

Problem 10: A 0.150 kg particle moves along an x axis according to $x(t) = -13 + 2t + 4t^2 - 3t^3$ with x in meters and t in seconds. In unit-vector notation, what is the net force acting on the particle at $t = 2.6$ s

Sol:

$x(t) = -13 + 2t + 4t^2 - 3t^3$

$v(t) = x'(t) = 2 + 8t - 9t^2$

$a(t) = x''(t) = 8 - 18t$

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

$\vec{F} = 0.15\ (8 - 18t)\ \hat{i}$

$\vec{F} = (1.2 - 2.7t)\ \hat{i}\ N$

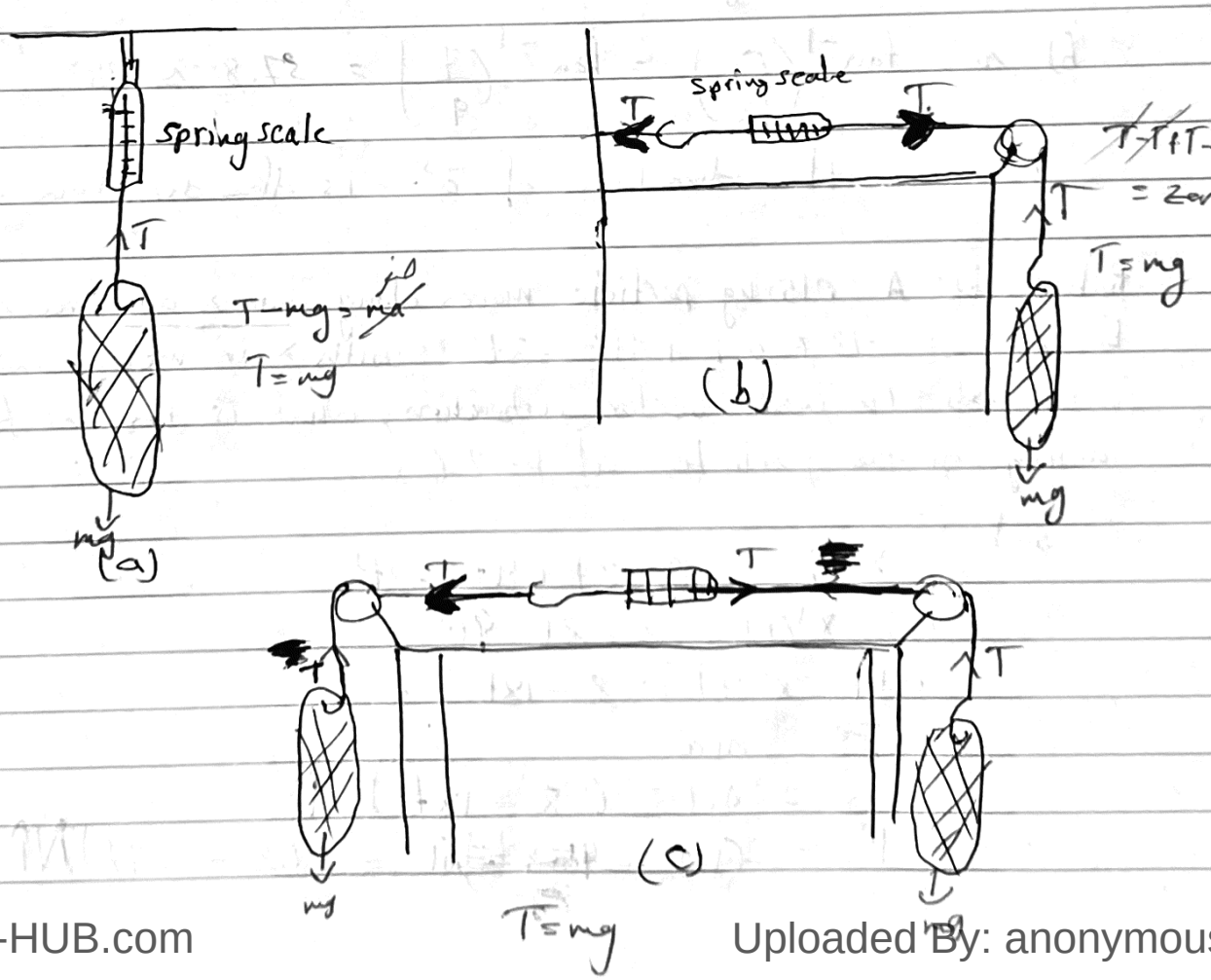
$F(t=2.6) = (1.2 - 2.7 \times 2.6)\uparrow$

$= (1.2 - 7.02)\uparrow$

$F(t=2.6) = -5.82$ ~~3.118~~ $N\uparrow$

$\simeq -6\,N$

Problem 15: (a) An 11 kg salami is supported by a cord that runs to a spring scale, which is supported by a cord hung from the ceiling (Fig 5-24a). What is the reading on the scale which is marked in SI weight units? (This is way to measure weight by deli owner) (b) In Fig. 5.24b the salami is supported by a cord that runs around a pulley and to a scale. The opposite end of the scale is attached by a cord to a wall. What is the reading on the scale? (This is the way by a physics major) (c) In Fig 5-24c the wall has been replaced with a second 11 kg salami, and the assembly is stationary. What is the reading on the scale? (This is the way by a deli owner who was once a physics major).



Sol:- (a) (c) In all three cases the scale is not accelerating which means that the two cords (أحبال) exerts forces of equal magnitude on it.

The scale reads the magnitude of either of these forces.

In each case the tension force of the cord attached to the salami (سلامي) must be the same in magnitude as the weight of the salami because the salami is not accelerating.

Thus the scale reading is mg, where m is the mass of the salami. Its value is $(11)\times(9.8) = 107.8 \simeq 108\,N$

Problem 35: An object weighs 2.5 kg. In time t, measured in seconds, the velocity of the object is given by $\vec{v} = (7t\hat{i} + 2t^2\hat{j})$ m/s. At the instant the net force on the object has a magnitude of 35 N, what are (a) the direction of the net force (b) the object's direction of travel

Sol $\quad F = m\vec{a}$, $\quad \vec{v} = (7t\hat{i} + 2t^2\hat{j})$ m/s

$\vec{a} = \dot{\vec{v}} = (7\hat{i} + 4t\hat{j})\ m/s^2$

$F = 2.5(7\hat{i} + 4t\hat{j})$

$\Rightarrow \boxed{F = 17.5\hat{i} + 10t\hat{j}}\ N \quad (1)$

$F = 35$ (معطى في السؤال)

$F = \sqrt{F_x^2 + F_y^2}$

$35 = \sqrt{(17.5)^2 + (10t)^2}$

$35 = \sqrt{306.25 + 100t^2}$

$1225 = 306.25 + 100t^2$

$918.75 = 100t^2 \Rightarrow 9.1875 = t^2 \Rightarrow \boxed{t = 3.03}$

$$F = 17.5\hat{i} + 10t\hat{j}$$

$$F(t=3.0s) = 17.5\hat{i} + 10 \times 3.03\hat{j}$$

$$35 = 17.5\hat{i} + 30.3\hat{j}$$

$$\Rightarrow \theta = \tan^{-1}\frac{F_y}{F_x} = \tan^{-1}\left(\frac{30.3}{17.5}\right)$$

$$\Rightarrow \theta = 60^\circ \quad \text{The direction of net force}$$

b) the direction of travel $\Rightarrow$ (the direction of v)

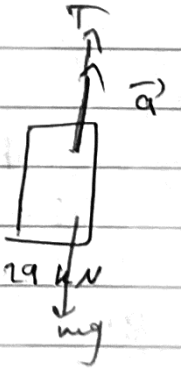
$$v = 7t\hat{i} + 2t^2\hat{j}$$

$$v(t=3.03) = 7 \times 3.03\hat{i} + 2 \times (3.03)^2\hat{j}$$

$$v(t=3.03) = 21.21\hat{i} + 18.3618\hat{j}$$

$$\theta = \tan^{-1}\left(\frac{v_y}{v_x}\right) = \tan^{-1}(.866) = 40.9^\circ$$

Problem 45: An elevator cab that weighs 29kN moves upward. What is the tension in the cable if the cab's speed is (a) increasing at a rate of 1.5 m/s² and (b) decreasing at rate of 1.5 m/s²?



sol:

$$m = \frac{w}{g} = \frac{29 \times 10^3}{9.8} = 2959.2\ kg$$

$$T - mg = ma_y$$

$$T - mg - ma_y = 0$$

$$T - m(g + a_y) = 0$$

(5)

a) $T = m(g+a_y) = 2959.2(9.8+1.5) = 33438.7\ N$
$= 33.4\ kN$

b) $T = m(g+a_y) = 2959.2(9.8-1.5)$
$= 24561.36\ N$
$= 2.45\ kN$

Problem 51 : Figure 6-37 shows two blocks connected by a cord (of negligible mass) that passes over a frictionless pulley (also negligible mass). The arrangement is known as Atwood's machine. One block has mass $m_1 = 1.3\ kg$ the other has mass $m_2 = 2.8\ kg$. What are (a) the magnitude of block's acceleration and (b) the tension in the cord?

$\Sigma F = m_1 a$

$$T - m_1 g = m_1 a \quad (1)$$

$\Sigma F = m_2 a$

$$m_2 g - T = m_2 a$$

$$T - m_2 g = -m_2 a$$

$$m_2 g - T = m_2 a \quad (2)$$

(2) + (1):

$$T - m_1 g + m_2 g - T = m_1 a + m_2 a$$

$$g(m_2 - m_1) = a(m_1 + m_2) \Rightarrow \boxed{a = g\frac{(m_2 - m_1)}{m_1 + m_2}}$$

a) عوض قيم m_1 ، m_2 لإيجاد a

$$a = \left(\frac{m_2 - m_1}{m_2 + m_1}\right) g$$

$$= \left(\frac{2.8 - 1.3}{2.8 + 1.3}\right) 9.8$$

$$= 3.58$$

$$\boxed{a \simeq 3.6 \ m/s^2}$$

b) عوض قيمة a في أحد المعادلتين لتكن ①

$$T - m_1 g = m_1 a$$

$$T = m_1 g + m_1 a$$

$$= m_1 (g + a)$$

$$= 1.3 (9.8 + 3.6)$$

$$\boxed{T = 17.42 \ N}$$

أو عوض $a = \left(\frac{m_2 - m_1}{m_2 + m_1}\right) g$ في أحد المعادلتين لتكن ①

$$T - m_1 g = m_1 a \Rightarrow T = m_1 (g + a)$$

$$T = m_1 \left(g + \left(\frac{m_2 - m_1}{m_2 + m_1}\right) g\right)$$

$$T = m_1 g \left(1 + \frac{m_2 - m_1}{m_2 + m_1}\right)$$

$$T = g \left(m_1 + \frac{(m_2 - m_1) m_1}{m_2 + m_1}\right)$$

$$T = g \left(\frac{m_1 (m_2 + m_1)}{(m_2 + m_1)} + \frac{m_2 m_1 - m_1^2}{m_2 + m_1}\right)$$

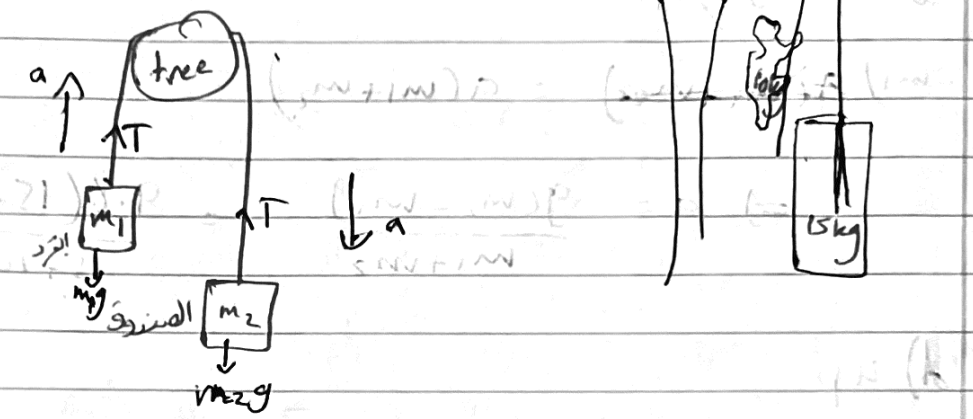
$$T = g \left(\frac{m_1 m_2 + m_1^2 + m_2 m_1 - m_1^2}{m_2 + m_1}\right)$$

$$\boxed{T = \left(\frac{2 m_2 m_1}{m_2 + m_1}\right) g}$$

#7

Problem 59 : A 10 kg monkey climbs up a massless rope that runs over a frictionless tree limb and back down to a 15 kg package on the ground (Fig 5-44) a) what is the magnitude of the least acceleration the monkey must have if it is to lift the package off the ground ? if after the package has been lifted the monkey stops it climbs and holds on to the rope, what are the (b) magnitude and (c) direction of the monkey's acceleration and (d) the tension in the rope?

sol



a) 

القرد

$$T - m_1g = m_1a \rightarrow (1)$$

لان يريد اقل تسارع يتاجه القرد حتى يحرر m_1 فإن الصندوق يكون ساكنا

الصندوق

$$\vec{T} - m_2\vec{g} = 0$$

$$T = m_2g \rightarrow (2)$$

(1) في (2) عوض

$$T - m_1g = m_1a$$

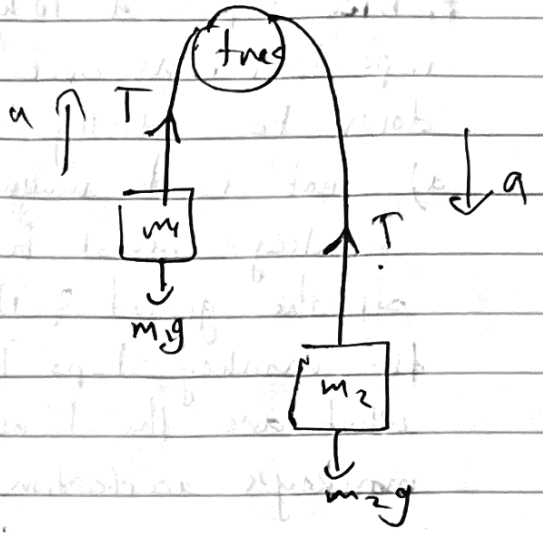
$$m_2g - m_1g = m_1a \rightarrow g(m_2 - m_1) = m_1a$$

$$\Rightarrow a = \left(\frac{m_2 - m_1}{m_1}\right) g = \left(\frac{15-10}{10}\right) \times 9.8 = 4.9 \text{ m/s}^2$$

(8)

b) ارضًا

نعتبر اتجاه a هو الموجب



$T - m_1 g = m_1 a$ ——— (1)

$m_2 g - T = m_2 a$ ——— (2)

- اجمع المعادلتين

$m_1 g + m_2 g - T = m_1 a + m_2 a$

$g(m_2 - m_1) = a(m_1 + m_2)$

$\Rightarrow a = \frac{g(m_2 - m_1)}{m_1 + m_2} = \frac{9.8(15-10)}{15+10} = 1.96 \, m/s^2$

d) up

- c) نعوض في a في احدى المعادلتين لتكن (1)

$T - m_1 g = m_1 a$

$T = m_1 g + m_1 a$

$= m_1 (g + a)$

$= 10 (9.8 + 1.96)$

$\boxed{T = 117.6 \, N}$