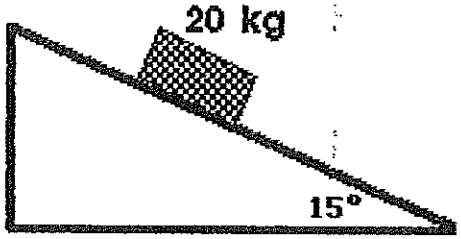
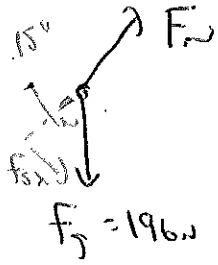
Answers F9

Force diagrams with acceleration

1. A 20 kg mass is allowed to accelerate down a *frictionless* 15° ramp.





a. Draw a force diagram for the block.

b. Determine the value of force of earth that causes the block to accelerate.

$\sin 15 = \frac{f_{gx}}{196}$ $\quad f_{gx} = 196 \sin 15° = 50.73N$

c. What is the acceleration of the block down the ramp?

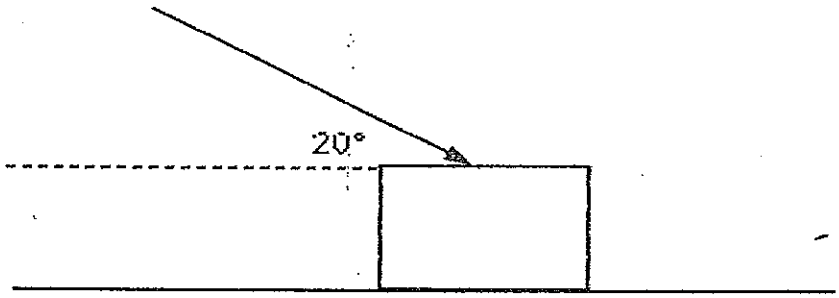
$F_{gx} = ma$

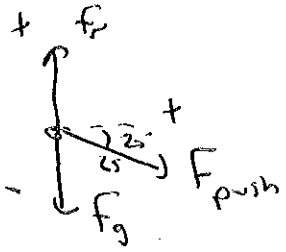
$50.73 = 20a$ $\quad a = 2.54 m/s^2$

d. Assuming the block starts from rest, how long will it take for the block to slide 30 m?

$V_0 = 0$ $\quad \Delta x = 30m$ $\quad \Delta x = \frac{1}{2}at^2 + V_0 t$ $\quad t = 4.9s$

2. An applied 25 N force pushes on a 5.0 kg block resting on a *frictionless* horizontal surface. The force is directed downwards at an angle of 20°.





a. Draw a force diagram for the block.

b. Determine horizontal component of the applied force.

$\cos 20° = \frac{f_{px}}{f_{push}}$ $\quad f_{px} = f_{push} \cos 20° = 23.5N$

c. What is the acceleration of the block?

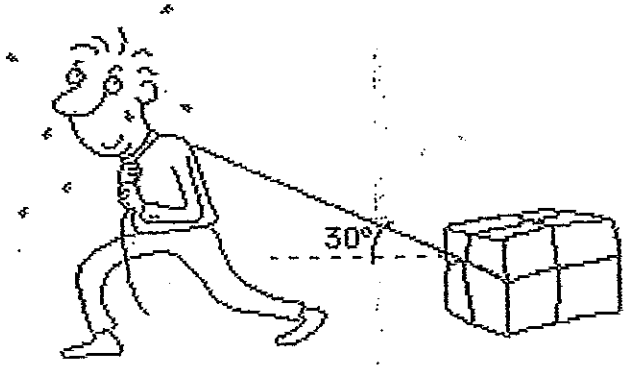
$f_{px} = ma$ $\quad 23.5 = 5a$ $\quad a = 4.7 m/s^2$

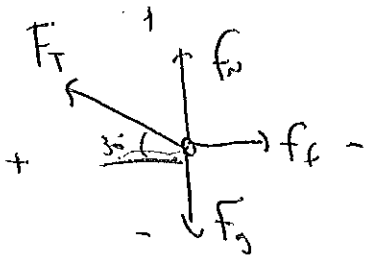
d. What is the normal force on the block?

$F_N - F_g - F_{py} = 0$ $\quad F_g = 25N$

$F_N = 57.6N$ $\quad f_{py} = f_{push} \sin 20°$

3. A 70.0 kg box is pulled by a 400 N force at an angle of 30° to the horizontal. The force of kinetic friction is 75.0 N. Draw the force diagram for the box.





$F_{Tx} = F_T \cos 30 = 400 \cos 30 = 346.4$

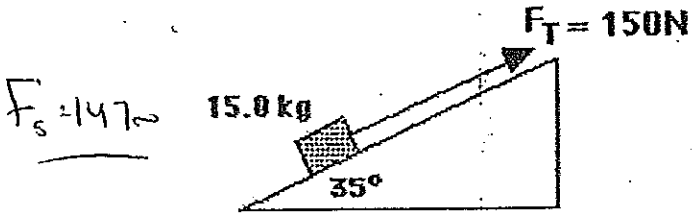
What is the acceleration of the box?

$F_{Tx} - f_f = ma$

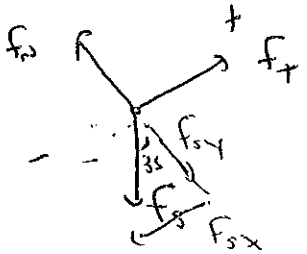
$346.4 - 75 = 70a$

$a = 3.9 \text{ m/s}^2$

4. A block is pulled up a ramp as shown in the diagram below. Assume that the ramp is *frictionless*. Draw the force diagram for the block on the ramp.



$F_g = 147 \text{ N}$



What is the component of the force of earth acting against the tension force?

$F_{gx} = F_g \sin 35 = 84.3 \text{ N}$

What is the acceleration of the block?

$F_T - F_{gx} = ma$

$150 - 84.3 = 15a$

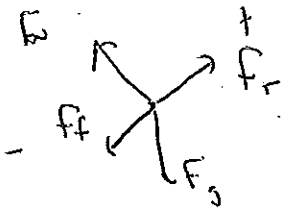
$a = 4.38 \text{ m/s}^2$

5. Repeat problem 4, except now, assume there is a frictional force acting on the block on the block which is 25.0 N.

$F_T - F_{gx} - f_f = ma$

$150 - 84.3 - 25 = 15a$

$2.71 \text{ m/s}^2 = a$



Basic Forces

Answers

F14

1. Using his hockey stick, a hockey player exerted a force of 80 N on a puck of mass 0.5 kg.
   a. What will the acceleration of the puck be while the hockey stick is in contact with it?

$F = ma$

$80 = .5a$

$a = 160 m/s^2$

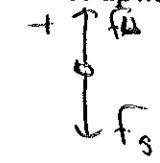
   b. If the stick applies that force for approximately seven tenths of a second, what will the speed of the puck be as it loses contact with the hockey stick?

$V_0 = 0$ $\quad a = 160 m/s^2$ $\quad V_f = at + V_0$

$V_f = ?$ $\quad t = 0.7s$

$V_f = 112 m/s$

2. A lady applies a 100 N force to lift a grocery bag weighing 75 N. What is the acceleration of that grocery back as it is moves upward?



$F_L - f_g = ma$

$100 - 75 = 7.65a$

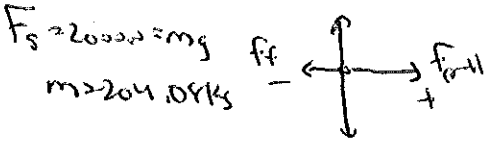
$3.27 m/s^2 = a$

$f_g = mg$

$75 = mg$

$7.65 kg = m$

3. A block that weighs 2000N is accelerated uniformly on a horizontal surface at 8 m/s^2. The force of friction between the block and the surface is 27.4 N.
   a. How much force is being exerted horizontally on the block?

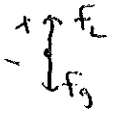


$F_{pull} - f_f = ma$

$f_{pull} - 27.4 = (204.08)(8)$

$f_{pull} = 1660 N$

   b. How much force would be required to lift the block upward with an acceleration of 8 m/s^2?

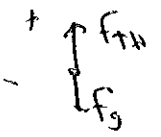


$F_L - f_g = ma$

$F_L - 2000 = (204.08)(8)$

$f_L = 3632.64 N$

4. A rocket is powered upward by an engine thrusting force of 12,000N. If the resulting upward acceleration is 6.4 m/s^2, what is the rocket's mass?



$F_{Thrust} - f_g = ma$

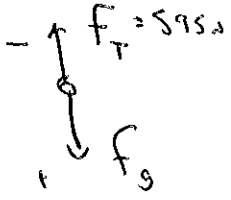
$12{,}000 - f_g = m(6.4)$

$12000 - m(9.8) = m(6.4)$

$12000 = m(16.2)$

$740.74 kg = m$

5. A person who has a mass of 75 kg is lowered with a rope down a well. The rope being used can support a maximum of 595 N. What is the minimum rate the person must accelerate downward so the rope does not break?



$F_g - f_T = ma$

$735 - 595 = 75a$

$1.87 m/s^2 = a$ (downward)