Name: KEY

Dynamics Problem Set

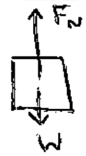
1) A rocket blasts off vertically from rest and attains a speed of 45 m/s in 15.0 s. An astronaut on board has a mass of 57 kg.
(a) What is the net force acting on the astronaut?

$V_0 = \emptyset$
$V = +45\ m/s$
$t = 15s$
$a = ?$

$V = V_0 + at$
$+3\ m/s^2 = a$

$\Sigma \vec{F} = m\vec{a}$
$= +171N$ (171 N UP)

(b) What is the astronaut's apparent weight (i.e. normal force acting on him)?



$W = 559N$

F_N IS WINNING BY 171 N

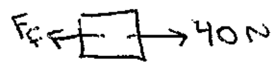
$F_N = 730.N$

2) A horizontal force of 40.0 N accelerates a 5.0-kg block resting on the floor.
(a) If the floor is frictionless, what is the acceleration of the block?

$a = \frac{\Sigma F}{m} = 8\ m/s^2$

(b) The actual acceleration of the block is measured to be 6.0 m/s^2. What is the magnitude of the frictional force?

$\Sigma F = ma = 30N$



"40N" IS WINNING BY 30N

$F_f = 10N$

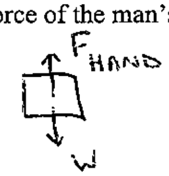
(c) What is the coefficient of kinetic friction between the block and the floor?

$F_N = W = 49N$

$F_f = \mu_k F_N \rightarrow \mu_k = \frac{F_f}{F_N} = \frac{10N}{49N} = 0.204$

3) A man lifts a 2.0-kg stone vertically with his hand at a constant upward velocity of 1.5 m/s. What is the magnitude of the force of the man's hand on the stone?

$\Sigma F = \emptyset$

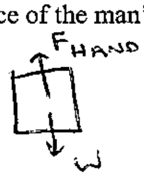


$W = 19.6N$

$F_{HAND} = 19.6N$

4) A man lifts a 2.0-kg stone vertically with his hand at a constant upward acceleration of 1.5 m/s^2. What is the magnitude of the force of the man's hand on the stone?

$\Sigma \vec{F} = m\vec{a} = 3N$ UP



$F_{HAND} = 22.6N$

5) A 10-N box rests on a surface. The coefficients of static and kinetic friction are 0.8 and 0.5, respectively.
(a) How much force is required to start moving the box?

$F_f \le \mu_s F_N$
$F_f \le (0.8)(10N)$
$F_f \le 8N$

MUST PUSH WITH AT LEAST 8N TO OVERCOME STATIC FRICTION

(b) Once the box is in motion, how much force is required to move the box at a constant rate?

$F_f = \mu_k F_N$
$= (0.5)(10N)$
$= 5N$

ONCE IN MOTION, A 5-N FORCE WILL BALANCE WITH KINETIC FRICTION AND PUT BOX IN EQUILIBRIUM

(c) If you pushed the box with a force twice as strong as what you found in Part (b), what is the acceleration of the box?

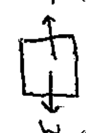
$\Sigma F = 5N$

$W = mg \rightarrow m = \frac{W}{g} = \frac{10N}{9.8\ N/kg} = 1.02\ kg$

$a = \frac{\Sigma F}{m} = \frac{5N}{1.02\ kg} = 4.9\ m/s^2$

6) A 6.00-kg box is sliding across the horizontal floor of an elevator. The coefficient of kinetic friction between the box and the floor is 0.360. Determine the kinetic frictional force that acts on the box when the elevator is:

(a) stationary. $W = F_N = 58.8\,N$



$F_f = \mu_k F_N = (0.360)(58.8\,N) = \boxed{21.2\,N}$

(b) accelerating upward at 1.20 m/s^2.

$\Sigma F = ma = 7.2\,N$ UP

$F_N = W + 7.2\,N = 66.0\,N$

$F_f = \mu_k F_N = (0.360)(66.0\,N) = \boxed{23.8\,N}$

(c) accelerating downward at 1.20 m/s^2.

$\Sigma F = ma = 7.2\,N$ DOWN

$F_N = W - 7.2\,N = 51.6\,N$

$F_f = \mu_k F_N = (0.360)(51.6\,N) = \boxed{18.6\,N}$

7) A 15-kg wooden box, initially moving at +8 m/s, is sliding across a wooden surface ($\mu_k = 0.30$).

(a) What is the net force acting on the box (assumed to be solely due to friction)?

$W = F_N = 147\,N$

$\Sigma F = F_f = \mu_k F_N = 44.1\,N$

DIRECTION IS NEGATIVE (OPPOSES MOTION)

(b) What is the acceleration of the box?

$a = \frac{\Sigma F}{m} = \frac{-44.1\,N}{15\,kg} = \boxed{-2.94\,m/s^2}$

(c) How much time does it take the box to come to rest?

$v_0 = +8\,m/s$

$v = 0$

$a = -2.94\,m/s^2$

$v = v_0 + at$

$\boxed{2.72\,s = t}$

(d) How far did the box slide before coming to rest?

$v^2 = v_0^2 + 2ax$

$\boxed{+10.9\,m = x}$

8) A dockworker loading crates on a ship finds that a 20-kg crate, initially at rest, requires a 75-N horizontal force to set it into motion. However, after it is in motion, a horizontal force of only 60 N is required to keep the crate moving with a constant speed. Find the coefficients of static and kinetic friction between the crate and the floor.

$F_N = W = 196\,N$

STATIC $F_{f_{max}} = 75\,N$

$\mu_s = \frac{F_{f_{max}}}{F_N} = \boxed{0.383}$

KINETIC: $F_f = 60\,N$

$\mu_k = \frac{F_f}{F_N} = \boxed{0.306}$

9) A 10-kg box of books rests on a horizontal surface.

(a) If the coefficient of static friction between the box and the floor is 0.4, how much force is required to move the box?

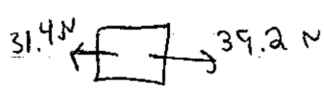
$F_N = W = 98\,N$

$F_{f_{max}} = \mu_s F_N = 39.2\,N$

NEED TO PUSH WITH 39.2 N TO OVERCOME STATIC FRICTION

(b) The coefficient of kinetic friction is 0.32. If the same force found in part (a) is applied to the box once it is in motion, find the acceleration of the box.

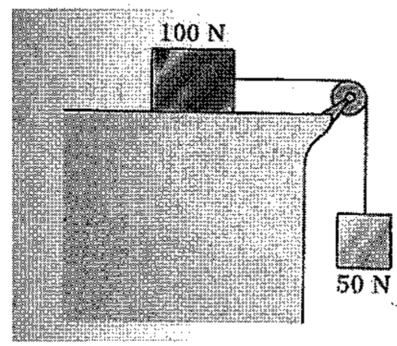
$F_f = \mu_k F_N = 31.4\,N$



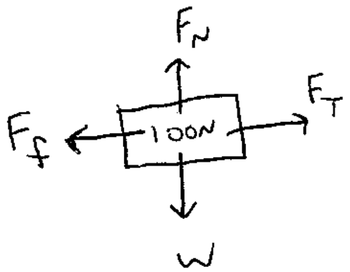
$\Sigma F = 7.8\,N$

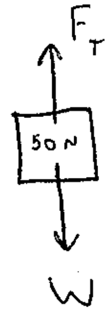
$a = \frac{\Sigma F}{m} = \boxed{0.78\,m/s^2}$

12) Refer to the diagram to the right to answer the following questions.



(a) Draw an FBFD for each of the blocks in the diagram below. (There is friction between the 100-N block and the surface.)





(b) If the blocks are at rest (EQUILIBRIUM), what is the tension in the string?

TENSION MUST BE 50 N FOR SUSPENDED BLOCK TO BE IN EQUILIBRIUM.

(c) If the blocks are at rest, what is the force of friction between the 100-N block and the surface?

F_f MUST BE 50 N FOR 100-N BLOCK TO BE IN EQUILIBRIUM

(d) What is the minimum coefficient of static friction between the 100-N block and the table to keep the blocks at rest?

$F_N = W = 100 N$

$F_f \leq \mu_s F_N$

$0.5 \leq \mu_s$

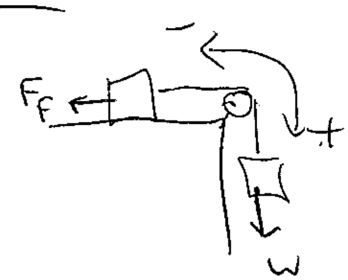
μ_s MUST BE AT LEAST 0.5

(e) If the coefficient of kinetic friction between the 100-N block and the table is 0.25, what is the acceleration of the system when in motion?

$F_f = \mu_k F_N$

$= 25 N$

EXTERNAL FORCES IN DIRECTION OF MOTION ARE FRICTION AND WEIGHT OF 50-N BLOCK.

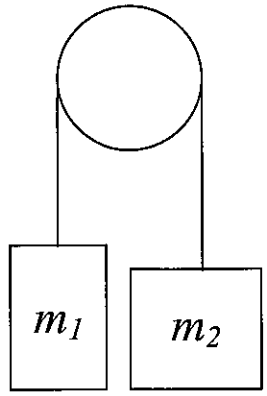


$\Sigma F = +25 N$

m = TOTAL MASS BEING ACCELERATED = 15.3 kg

$a = \frac{\Sigma F}{m} = +1.63 m/s^2$

13) The Atwood Machine consists of two masses suspended by a light string passing over a low-friction pulley. If the masses are equal, the machine will be in equilibrium and either remain at rest or move with constant velocity. If the masses are unequal, the machine will accelerate according to Newton's 2nd Law of Motion. The larger mass is called the "descending mass", and the smaller mass is called the "ascending mass".



The net force acting on the system of m_1 and m_2 is due to the **difference in their weights** (*W*). Let's assume that m_1 has a mass of 5 kg and m_2 has a mass of 8 kg.

(a) Determine the weight of mass m_1 (in Newtons).

$W = mg = \boxed{49\text{ N}}$

(b) Determine the weight of mass m_2 (in Newtons).

$W = mg = \boxed{78.4\text{ N}}$

(c) What is the net force acting on the system (i.e. what is the difference in their weights)?

$\boxed{\Sigma F = 29.4\text{ N}}$

(d) The net force you calculated above is acting on the system of both masses. The acceleration, therefore, depends upon the net force and the total mass of both m_1 and m_2. Use Newton's 2nd Law to determine the acceleration of the masses.

$a = \frac{\Sigma F}{m} = \boxed{2.26\text{ m/s}^2}$

14) An Atwood Machine is set up consisting of a 10-kg mass and a 15-kg mass.

(a) Determine the net force acting on the system of masses..

$\Sigma F = W_1 - W_2 = \boxed{49\text{ N}}$

(b) Determine the acceleration of the masses.

$a = \frac{\Sigma F}{m} = \boxed{1.96\text{ m/s}^2}$

(c) Assuming the system starts from rest, how much time does it take for the larger mass to descend 0.50 m? (*Kinematics*)

$a = 1.96\text{ m/s}^2$

$V_0 = \emptyset$

$x = 0.50\text{ m}$

$t = ?$

$x = v_0 t + \frac{1}{2}at^2$

$\boxed{0.714\text{ s} = t}$