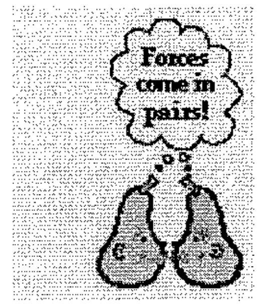
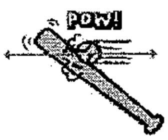
Name:________________________

Forces in Equations

A force is a push or pull resulting from an interaction between two objects. Whenever there is a force, there are two objects involved - with both objects pushing (or pulling) on each other in opposite directions. While the direction of the pushes (or pulls) are opposite, the strength or magnitudes are equal. This is sometimes stated as Newton's Third Law of motion: *for every action, there is an equal and opposite reaction.* A force is a push or a pull and it always results from an interaction between two objects. These forces always come in pairs.

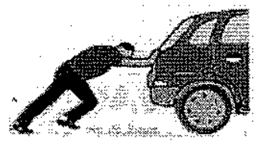


A For each stated *action force*, identify the *reaction force.*



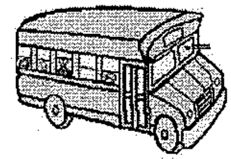
Bat hits ball.

Ball hits Bat



Man pushes car.

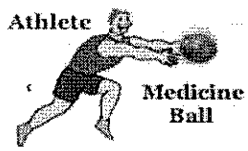
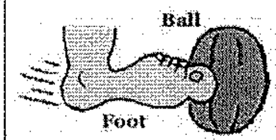
Car Pushes Man

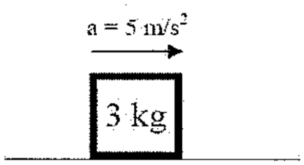


Bus hits bug.

Bug hits Bus

Identify by words the action-reaction force pairs in each of the following diagrams.

		
athlete pushes medicine ball, Medicin ball pushes man	Floor pushes foot, foot pushes floor	Foot pushes ball, ball pushes foot



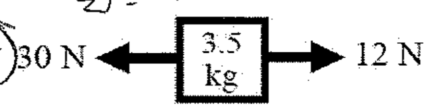
1. A 3 kg object is accelerating 5 m/s² to the right. Calculate the net force acting on the object.

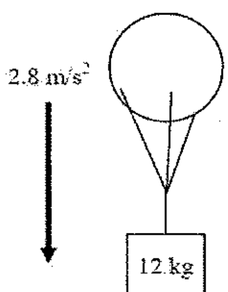
$\Sigma F = m \cdot a \quad = 3\,kg \cdot 5\,m/s^2 = 15\,N$

2. Calculate the acceleration of the object at the right.

$\Sigma F = -30\,N + 12\,N = -18\,N$

$a = \frac{\Sigma F}{m} = \frac{-18\,N}{3.5\,kg} = 5.14\,m/s^2$





$F_w = 12\,kg \cdot 10\,m/s^2$
$-120\,N$

3. A. Draw a force diagram for the object at the left next to the object.

B. Is the acceleration positive or negative? negative

C. Calculate the tension in the rope.

$T + F_w = m \cdot a$

$T + (-120\,N) = 12\,kg \cdot -2.8\,m/s^2$

$T - 120\,N = -33.6$

$T = 86.4\,N$

4. A. Draw the force diagram for the lady in the elevator.

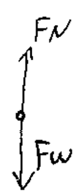
B. Is the acceleration positive or negative? neg

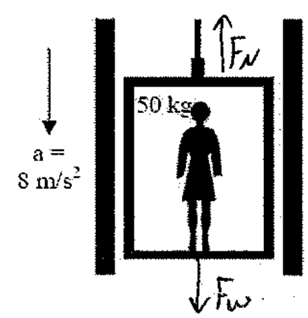
C. Figure out the normal force acting on the lady.

$F_w = 50\,kg \cdot 10\,m/s^2 = 500\,N$

$F_N + (F_w) = m \cdot a \qquad F_N - 500\,N = 50\,kg \cdot 8\,m/s^2$

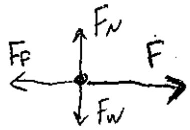
$F_N = 100$



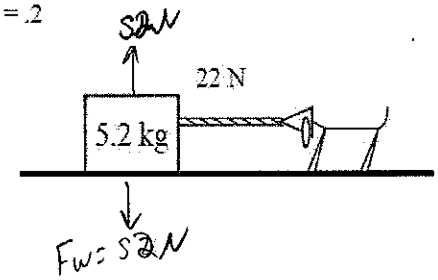


D. Does she feel lighter or heavier than normal?

much lighter 8m/s2 is very fast!



$\mu_s = .35$
$\mu_k = .2$

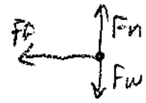


5. Bim is pulling a 5.2 kg object with 22 N. The floor has friction.
   A. Which way does friction act? Left
   B. Draw a force diagram for the object.
   C. Write the equation for friction:
      $F_k = \mu_k F_N$ or $F_s = \mu_s F_N$
   D. Calculate both types of friction acting on the object.
      $F_k = .2 \cdot 52N = 10.4N$
      $F_s = .35 \cdot 52N = 18.2N$
   E. If the object started at rest, does it start to slide? Yes
   F. Why? $F > F_s$
   G. If the object is already moving, calculate its acceleration.
      $a = \frac{\Sigma F}{m} = \frac{22N - 10.4N}{5.2kg} = 2.23 m/s^2$

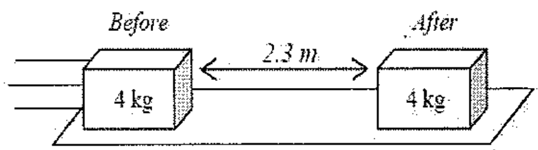
6. What is the Newton's Third Law force pair for each of the following forces found in the diagram above.
   A. The force of gravity pulling down on Bim. Bim pulling up on Earth
   B. The force of tension pulling on the mass. Mass pulling on rope
   C. The normal force of the floor on Bim's feet. Bim pushing on floor
   D. The force of friction of the floor on a block. Block's friction on floor

7. The normal force acting on the object above is equal to the force of the its weight. Why is this not a Third Law Action-Reaction pair? Action-Reaction force pairs have to be same kind: contact or field forces
   weight is a field force & the normal is a contact force

8. A 4 kg object slides to a stop due to friction in 4.8 seconds.
   A. Draw a force diagram of the object while it is moving.



   B. Use a kinematic equation to find the acceleration of the object.



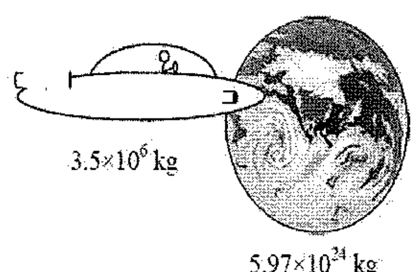
$t: 4.8s$
$\Delta x: 2.3m$
$V_f: 0m/s$
$a = ?$

$\Delta x = V_f t - \frac{1}{2}at^2$
$2.3m = 0 - \frac{1}{2}a(4.8s)^2$
$a = -0.2 m/s^2$

   C. Find the force that slowed down the object.
      $\Sigma F = ma$
      $= 4g \cdot -0.2 m/s^2 = -.8N$

   D. Use the friction equation to find the coefficient of friction (μ) of the surface.
      $F_f = \mu \cdot F_N$
      $-.8N = \mu \cdot 40N$
      $\mu = .02$
      $F_n = F_w$
      $= 4kg \cdot 10m/s^2$
      $F_n = 40N$

9. Slim Jim's spaceship the "Galactic Cruiser" is 1.8×10^8 m from the center of the earth. Calculate the force of gravity on the ship.



$F_g = G\frac{m_1 m_2}{r^2}$

$F_g = 6.673\times10^{-11} \cdot \frac{3.5\times10^6 kg \cdot 5.97\times10^{24} kg}{(1.8\times10^8 m)^2} = 4.3\times10^4 N$