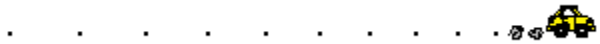
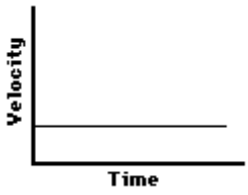
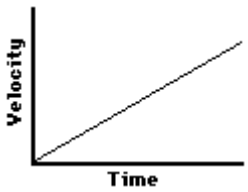
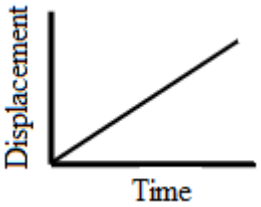
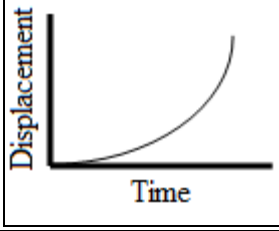
Is there a net force?

A net force (i.e., an unbalanced force) causes acceleration. In the motion unit, several means of representing accelerated motion were discussed. Combine your prior understanding of acceleration with your newly acquired knowledge that a net force causes an acceleration to determine whether a net force exists in the following situations.

Description of Motion	Net force Yes or No Explain why
	
	
	
	
	
	
	
	

QUESTIONS FOR THE INERT

1. When a car suddenly brakes to a screeching stop, you lurch forward. Why?

2. In what kind of path would the planets move if there were suddenly no gravity?

3. Must a spacecraft continually fire its rockets to maintain a constant speed in deep space once it is out there? Why or why not?

4. In terms of inertia, what is the disadvantage of a small, lightweight camera when taking a picture? Why is a massive tripod usually preferred by most professional photographers, or why do cameramen (camerawomen?) use large cameras at sporting events instead of small lightweight digital camcorders?

5. When will objects change their state of motion?

6. If the force of friction acting against a small sliding body is 10 N, how much force must be applied to keep the object moving at a constant speed? What would be the net force in this case?

7. Discuss, in terms of Newton's First Law of Linear Motion, how a quick jerk to a dusty coat or rug succeeds in removing the dust.

Free Body Diagram Practice Problems

For each scenario below, construct the free-body diagram and write the appropriate F_{net} equations used to describe the forces action on the system.

1. A rightward force is applied to a boat in order to move it through the water at constant velocity. Consider resistance forces due to the water. Neglect air resistance.

2. A skydiver is descending with a constant velocity. Consider air resistance

3. A force is applied to the right to drag a sled across loosely-packed snow (some friction) with a rightward acceleration.

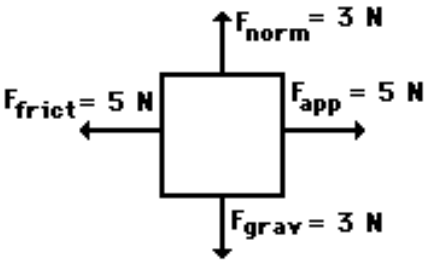
4. A football is moving upwards towards its peak after having been booted by the punter. Neglect air resistance.

5 A car is coasting to the right and slowing down.

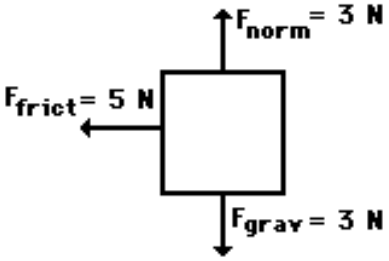
Net Force Practice Problems

1. Free-body diagrams for four situations are shown below. For each situation, write an F_{net} equation and determine the net force acting upon the object.

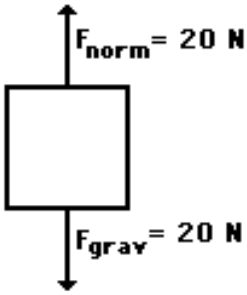
Situation A



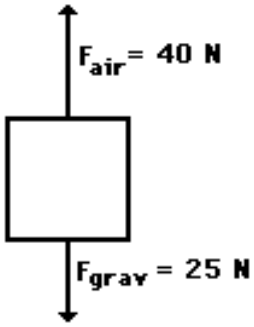
Situation B



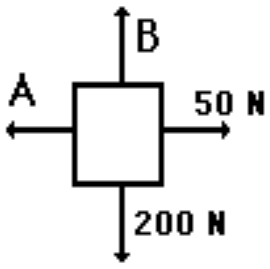
Situation C



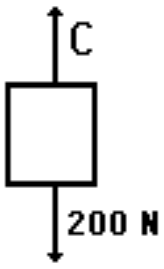
Situation D



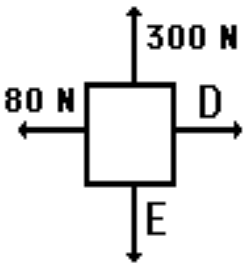
2. Free-body diagrams for four situations are shown below. In each case, the net force is known, however, the magnitudes of some of the individual forces are not known. Analyze each situation by writing a F_{net} equation to determine the magnitude of the unknown forces.



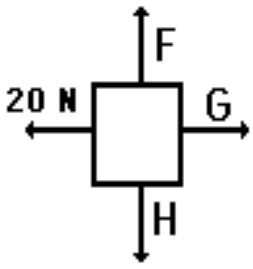
F_{net} = 0 N



F_{net} = 900 N, up



F_{net} = 60 N, left



F_{net} = 30 N, right

F=ma Worksheet

Show all work!!! FBD, Drawings, F_{net} equations, givens, motion equations, substitutions and answers.

1. A 95 kg person falls at terminal (constant) velocity through the air while skydiving. What is the net force acting on the person?

2. A 25 kg box is pulled by a net force of 150 N. What would its acceleration be?

3. If a child on a bike produces a net force of 180 N and is observed to accelerate at a rate of 3.0 m/s^2. What is the total mass of the child and his bike?

4. A 1.800 Kg cart starts from rest and accelerates through a distance of 1.2 m in 2.1 s. What is the net force acting on the cart?

$V_i =$

$V_f =$

$d =$

$a =$

$t =$

5. A 2.3 kg cart is moving at 2.1 m/s when a net force of 3.5 N acts in the direction of movement. How fast will the cart be traveling after 5.0 s?

$V_i =$

$V_f =$

$d =$

$a =$

$t =$

6. A 1500 kg car drifts along a level road and slows down from +35 m/s to +25 m/s in 30 seconds. What is the net force acting on the car?

$V_i =$

$V_f =$

$d =$

$a =$

$t =$

7. On Mars, you observe a freely falling object drop 1.83 m in one second (remember in free fall we start from rest). What will the 61 kg girl weigh on Mars?

$V_i =$

$V_f =$

$d =$

$a =$

$t =$

8. The g on Jupiter (cloud tops) is estimated at 26 m/s^2. How much would a 2.1 Kg camera weigh there?

(2) 6.0 m/s^2 (3) 60 kg (4) 1.0 N (5) 9.7 m/s (6) -500 N (7) 223 N (8) 54.6 N

Drag Force Practice Problems

1. A jet plane accelerates horizontally with the thrust of the engines increasing to 50,000 N eastward at a time when air resistance (drag) acting on the 4000 kg plane amounts to 30,000 N westward, what will be the plane's acceleration?

2. A car is being pushed forward by three ingenious physics students. They know the force of friction of the car is approximately 320 N. If the car's sticker says it has a mass of 1040 kg, and it is accelerating forward at a rate of 1.2 m/s^2, what force are each applying if they are applying equal forces?

3. A 1200 kg car is traveling with a constant speed of 25 m/s. What is the net force acting on it?

4. My car accelerates from 0 to 18 m/s in 3.2 seconds. If the mass of my car is 2450 kg and the force of friction is 3,900 N, what is the force produced by my car's engine?

1) 5.0 m/s^2 (2) 523 N (3) too easy (4) 17,700 N

Friction Problems: $F_f = \mu \cdot F_N$

1. A 75 kg baseball player is sliding into home plate. The coefficient of friction between the player and the ground is 0.55, what is the force of friction on the player?

2. What force is required to keep a 25 kg box moving across the floor at constant velocity when the coefficient of friction between the box and the floor is 0.45?

3. A boy pulls his little sister on a sled across loosely packed snow where the coefficient of friction between the snow and the sled is 0.15. The little sister and the sled have a mass of 30 kg and the boy pulls with a force of 80 N; what is the acceleration of the sled?

4. A 900 kg car traveling 27 m/s skids to a stop over a distance of 44 meters; what is the coefficient of friction between the tires and the road?

1) 400 N (2) 110 N (3) 1.2 m/s^2 (4) 0.85

Falling and Air Resistance – Terminal Velocity

Bronco skydives and parachutes from a stationary helicopter. Various stages of fall are shown in positions **a** through **f**. Using Newton's 2nd law,

$$F_{net} = F_{air} - F_g = ma$$

$$a = \frac{F_{air} - F_g}{m}$$

Find Bronco's acceleration at each position (answer in the blanks to the right). You need to know that Bronco's mass ***m* = 100 kg**, we will use ***g* = 10.0 m/s²** so his weight ***Fg* =1000 N**. Air resistance ***Fair*** varies with speed and cross-sectional area as shown. *Circle the correct answers.*

1. When Bronco's speed is least, his acceleration is
   (least) (most)

2. In which position(s) does Bronco experience a downward acceleration?
   (a) (b) (c) (d) (e) (f)

3. In which position(s) does Bronco experience an upward acceleration?
   (a) (b) (c) (d) (e) (f)

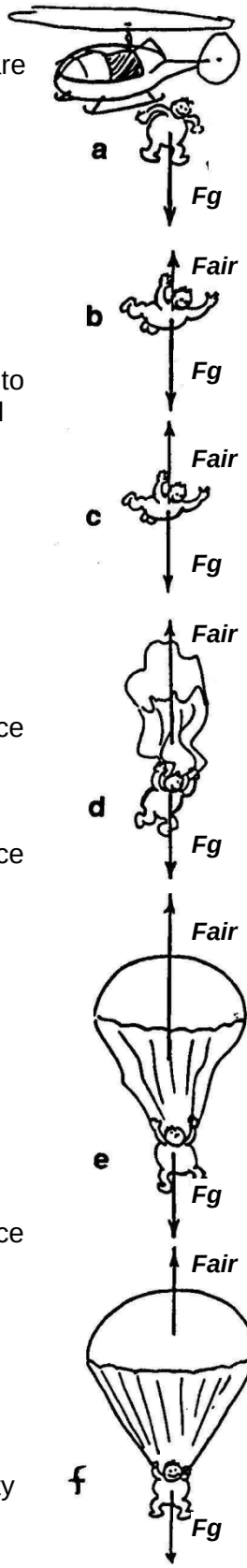
4. When Bronco experiences an upward acceleration, his velocity is
   (downward) (upward).

5. In which position(s) is Bronco's velocity constant?
   (a) (b) (c) (d) (e) (f)

6. In which position(s) does Bronco experience terminal velocity?
   (a) (b) (c) (d) (e) (f)

7. In which position(s) is terminal velocity greatest?
   (a) (b) (c) (d) (e) (f)

8. If Bronco were heavier, his terminal velocity would be
   (greater) (less) (the same).



Fair = 0
Fg = 1000 N
a= _____

Fair = 400 N
Fg = 1000 N
a= _____

Fair = 1000 N
Fg = 1000 N
a= _____

Fair = 1200 N
Fg = 1000 N
a= _____

Fair = 1800 N
Fg = 1000 N
a= _____

Fair = 1000 N
Fg = 1000 N
a= _____

Newton's Third Law Problems

1. A car is hit by a train with a force of 10,000 N, what force does the train experience?

   a. If the car's mass is 1000 kg and the trains mass is 100,000 kg what acceleration, if any does either experience?

2. It is the year 2050 and baseball is played on outer space. A 50 kg pitcher can throw a 1.0 kg ball, toward home plate at a velocity of 50 m/s. It takes the pitcher 1 second to accelerate the ball from rest to 50 m/s.

   a. What is the acceleration of the ball while it is being thrown?

   b. What is the force on the ball while it is being thrown?

   c. What is the force on the pitcher while the ball is being thrown?

   d. What is the acceleration of the pitcher while the ball is being thrown?

   e. What are the velocities of the ball and pitcher after 3 seconds?

1) 10 m/s^2, 0.01 m/s^2, 2) 50 m/s^2, 50 N, 50 N, 1 m/s^2, 50 m/s, 1 m/s

Newton's Laws Review

A) **Newton' First Law**

1. State Newton's first Law

2. What is meant by the an external force (net force)?

3. What is inertia and how is it measured?

4. Be able to explain the demonstrations from class. For example, why the dishes did not move when the tablecloth was pulled from under them.

B) **Newton's Second Law**

1. Be able to draw free body diagrams for many situations. For example, an elevator moving upward at a constant velocity or accelerating up or down or a car with its brakes applied

2. Be able to write Fnet equations from your free body diagrams and solve for unknowns

3. Solve problems where you use the following equations: Fnet=ma & Vi, Vf, D, a, t

A 2.800 Kg cart starts from rest and accelerates through a distance of 5.2 m in 3.5 s. What is the net force acting on the cart?

$V_i =$

$V_f =$

$d =$

$a =$

$t =$

A 4.5 kg cart is moving at 5.5 m/s when a net force of 2.5 N acts in the direction of movement. How fast will the cart be traveling after 15.0 s?

$V_i =$

$V_f =$

$d =$

$a =$

$t =$

~~4. Understand what terminal velocity is and how it is reached.~~

~~a. Who would be going faster when terminal velocity is reached (assuming the same surface area). Mr. Strzyinski 66 kg or Andre the Giant 300 kg. (why)~~

~~b. Which is any would have a higher terminal velocity, a sky diver falling head down or one falling spread eagle and why.~~

5. A book is pushed across a table. If μ=0.30 find the force of friction between a book and the table. (m_{book} = 5 kg, m_{table} = 40 kg)

   a. What force is required to keep the book moving at constant velocity?

   b. What force is required to accelerate the book at 1.75 m/s^2

   c. Find the new force of friction if you place a 2 kg mass on top of the book.

6. What is the difference between weight and the force of gravity?

   a. How much does a 588 N person weigh?

   b. What is the mass of a 588 N person?

   c. What is the mass of the same person on the moon?

   d. What is the force of gravity of the same person on the moon where g=1.6 m/s^2

7. A 45 kg astronaut pushes off a 340 kg satellite for a time of 2.0 seconds. Afterwards, the satellite is moving 0.5 m/s, what is the velocity of the astronaut?

8. A force of 36 N gives one mass (m_1) an acceleration of 4 m/s^2. The same force gives a second mass (m_2) an acceleration of 12 m/s^2. What acceleration will this force give to the two masses if they are fastened together?