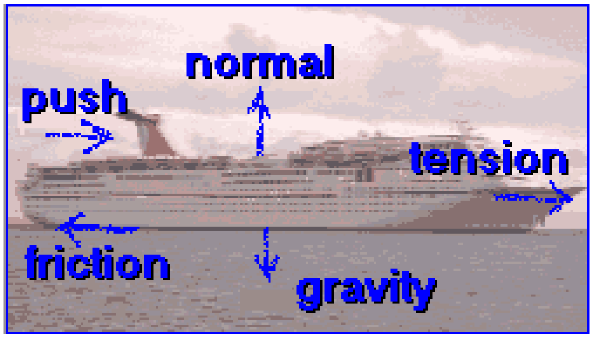
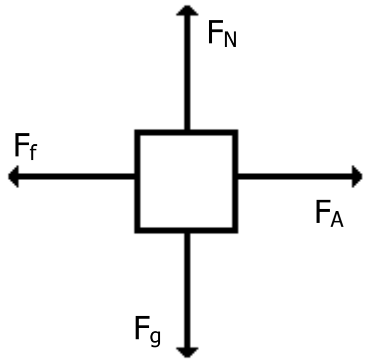
Physics

Free-Body Diagrams Worksheet

Name:____ Block:___________





No doubt you are aware of free body diagrams (otherwise known as FBD's). These are simplified representations of an object (the **body**) in a problem, and includes force vectors acting on the object. This body is **free** because the diagram will show it without its surroundings; i.e. the body is 'free' of its environment. This eliminates unnecessary information which might be given in a problem. Let's look at the individual forces that can act on an object:

Gravity
The first force we will investigate is that due to gravity, and we'll call it the **gravitational force**. We know that the acceleration due to gravity (if on Earth) is approximately **g** = -9.8 m/s. The force, by Newton's Second Law is **F** = m **g**

Normal
The **normal force** one which prevents objects from 'falling' into whatever it is they are sitting upon. It is always *perpendicular* to the surface with which an object is in contact. For example, if there is a crate on the floor, then we say that the crate experiences a normal force *by* the floor; and because of this force, the crate does not fall into the floor. The normal force on the crate points upward, perpendicular to the floor.

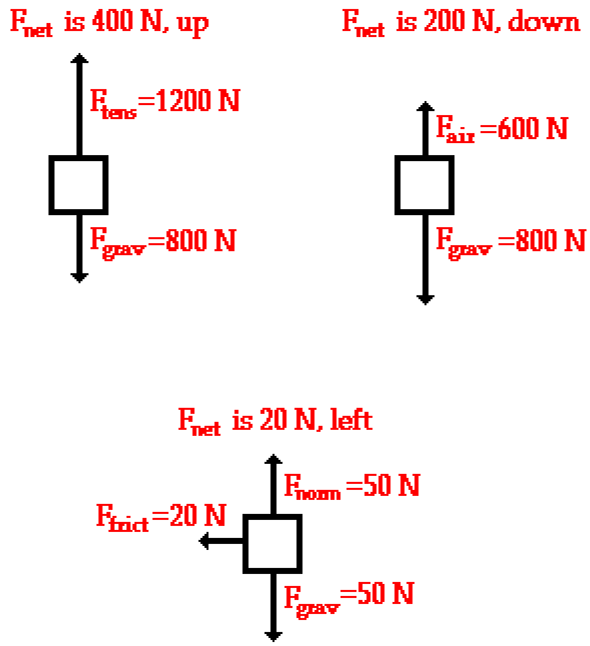
Friction
Related to the normal force is the **frictional force**. The two are related because they are both due to the surface in contact with the body. Whereas the normal force was perpendicular to the surface, the frictional force is parallel. Furthermore, friction opposes motion, and so its vector always points away from the direction of movement.

Push and Pull (Applied Force)
Another force which may act on an object could be any physical push or pull. This could be caused by a person pushing a crate on the floor, a child pulling on a wagon, or in the case of our example, the wind pushing on the ship.

Tension
Tension in an object results if pulling force act on its ends, such as in a rope used to pull a boulder. If no forces are acting on the rope, say, except at its ends, and the rope itself is in equilibrium, then the tension is the same throughout the rope.

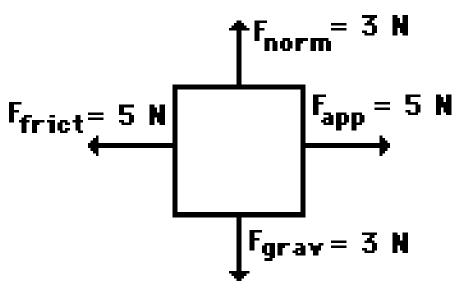
Net Force (ΣF)

The net force is the vector sum of all the forces which act upon an object. That is to say, the net force is the sum of all the forces, taking into account the fact that a force is a vector and two forces of equal magnitude and opposite direction will cancel each other out.

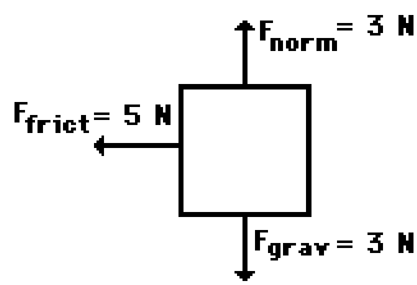


1. Free-body diagrams for four situations are shown below. For each situation, determine the net force acting upon the object.

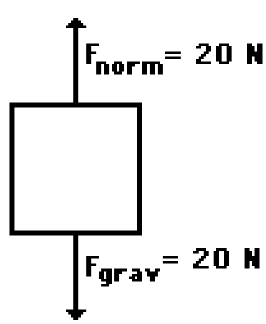
Situation A



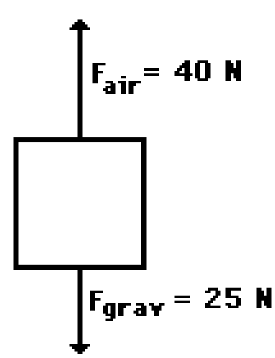
Situation B



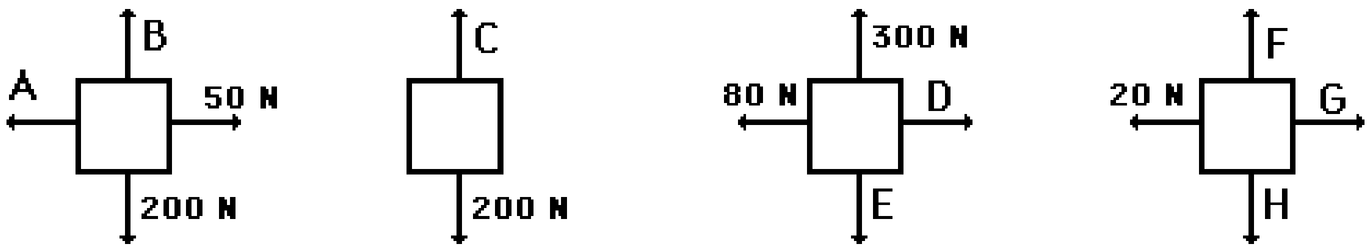
Situation C



Situation D



2. Free-body diagrams for four situations are shown below. The net force is known for each situation. However, the magnitudes of a few of the individual forces are not known. Analyze each situation individually and 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

3. A girl is suspended motionless from a bar which hangs from the ceiling by two ropes. A free-body diagram for this situation looks like this:

4. A college student rests a backpack upon his shoulder. The pack is suspended motionless by one strap from one shoulder. A free-body diagram for this situation looks like this:

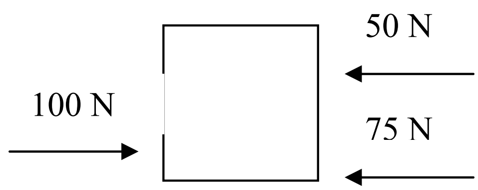
5. A skydiver is descending with a constant velocity. Consider air resistance. A free-body diagram for this situation looks like this:

6. A football is moving upwards towards its peak after having been *booted* by the punter. A free-body diagram for this situation looks like this:

Calculating Net Forces

Interpret each drawing of forces on the box. Calculate and write the resulting net force on the blank below the box (make sure to include the correct unit of measure). On the next blank, write the word balanced or unbalanced and circle the arrow for the direction of the resulting net force.

1.



Net Force ______________

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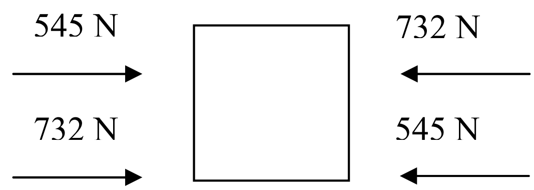
2.



Net Force ______________

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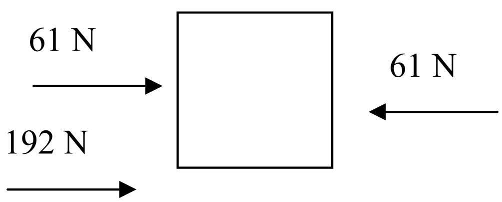
3.



Net Force ______________

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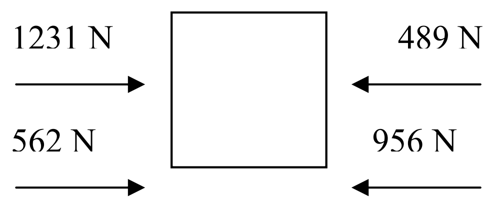
4.



Net Force ______________

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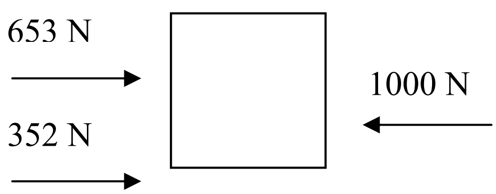
5.



Net Force ______________

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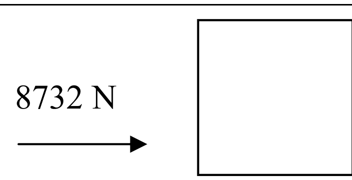
6.



Net Force ______________

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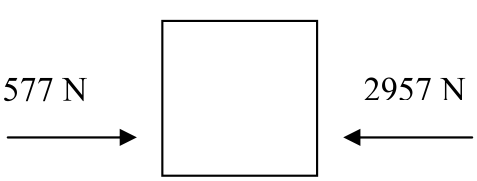
7.



Net Force ______________

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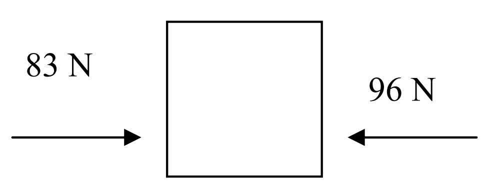
8.



Net Force ______________

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