# Free Body Diagrams I

The first step in solving problems involving Newton's Laws is to draw a diagram of the situation. By making a drawing showing all the forces acting on a body, and knowing something about the bodies motion, you can then write equations based on Newton's Second Law: $\sum F = ma$, sometimes written as $F_{net} = ma$.

*Part 1: Finding the Net Force.*
For each of the following situations, state the direction of the net force, if any.

1. A car driving to the right at constant speed.
2. A car driving to the right and speeding up.
3. A car driving to the left and slowing down.
4. A car driving up a straight steep hill at constant speed.
5. A car driving up a straight hill and slowing down.
6. A car driving in a circle at constant speed.
7. A helicopter hovering in the air.
8. A plane climbing at constant speed.
9. A plane climbing and speeding up.
10. An elevator going up at constant speed.

*Part II: Identifying the individual forces.*
For each of the situations below, draw all the individual force vectors, and then state what the net force is. Do not ignore air resistance or other forms of friction. If forces are of equal magnitude, draw them the same length. If not otherwise stated, assume motion is to the right.

1. A person standing still in the hallway.
2. A car traveling down the highway at constant speed.
3. A car traveling down the highway at increasing speed.
4. A person standing in an elevator that is not moving.
5. A person sitting in a wagon and being pulled to the left at an increasing velocity.

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6. A person coasting and slowing down on a bicycle.

7. An airplane flying at constant velocity.

8. An airplane flying with increasing speed.

9. A person riding an elevator up at constant velocity.

10. A helicopter hovering in the air.

11. A person riding an elevator traveling up at an increasing speed.

12. A car traveling down the road with a constant acceleration.

13. A helicopter coming down at constant speed.

14. A person traveling up in an elevator, but with a decreasing velocity.

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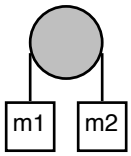
15. A box sitting at rest on hill.

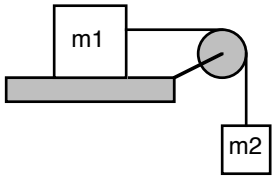
16. A box with an initial velocity up a hill, but slowing down. Include friction.

For each of the following diagrams, draw a free body diagram for each object. Correctly label each force in your diagram. (T = tension; W = weight; f = friction; N = normal force) All the pulleys are massless and frictionless, all the surfaces are frictionless.

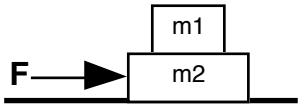
17. Two masses connected by a string around a pulley.



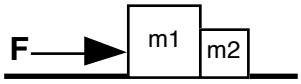

18. Little mass connected with a string to big mass on a horizontal table.




19. Little mass sitting on a big mass, which is on a table and being pushed to the right.




20. Little mass in front of a big mass which is being pushed to the right.




21. Do questions 18 to 20 again, but this time include a frictional force between any appropriate surfaces (but the pulleys are still frictionless and don't worry about air.)