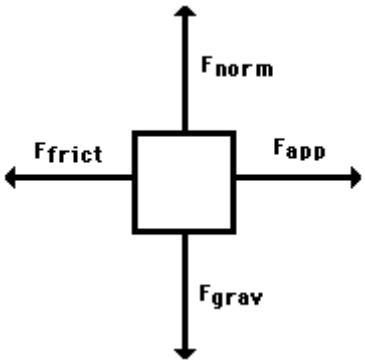
Name_____Period_____Date_____

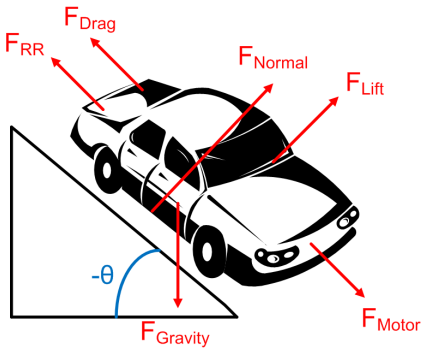
TWCP

Drawing Free-Body Diagrams

Free-body diagrams are diagrams used to show the relative magnitude and direction of all forces acting upon an object in a given situation. A free-body diagram is a special example of the use of vectors which were discussed in an earlier unit; these diagrams will be used throughout our study of physics. The size of the arrow in a free-body diagram is reflective of the magnitude of the force. The direction of the arrow reveals the direction which the force is acting. Each force arrow in the diagram is labeled to indicate the exact type of force. It is generally customary in a free-body diagram to represent the object by a box and to draw the force arrow from the center of the box outward in the direction that the force is acting. An example of a free-body diagram is shown at the right.



The free-body diagram shown above to the right depicts four forces acting upon the object. Objects do not necessarily always have four forces acting upon them. There will be cases in which the number of forces depicted by a free-body diagram will be one, two, or three. In other cases, there may be multiple forces going in the same direction. See the free body diagram of the car to the right. There is no hard and fast rule about the number of forces which must be drawn in a free-body diagram, nor is there a set rule on the naming of variables. The only *rule* for drawing free-body diagrams is to depict all the forces which exist for that object in the given situation. Thus, to construct free-body diagrams, it is extremely important to know the various types of forces. If given a description of a physical situation, begin by using your understanding of the force types to identify which forces are present. Then determine the direction in which each force is acting. Finally, draw a box or a dot and then add arrows for each existing force in the appropriate direction; label each force arrow according to its type.



As you become a more advanced student of free-body diagrams, you can draw force vectors in drawings or pictures as shown on the free body diagram of the car.

Examples of Force Vector Variables

Contact Forces

Frictional Force = F_{frict}

Tensional Force = F_{tens}

Normal Force = F_{norm}

Air Resistance Force = F_{air}

Applied Force = F_{app}

Spring Force= F_{spring}

Field Forces

Gravitational Force = F_{grav}

Electrical Force=F_{elec}

Magnetic Force=F_{mag}

Practice Problems

Apply the method described above to construct free-body diagrams for the various situations described below.

1. A book is at rest on a table top. Diagram the forces acting on the book.

2. A girl is suspended motionless from a bar which hangs from the ceiling by two ropes. Diagram the forces acting on the girl.

3. An egg is free-falling from a nest in a tree. Neglect air resistance. Diagram the forces acting on the egg as it is falling.

4. A flying squirrel is gliding (no *wing flaps*) from a tree to the ground at constant velocity. Consider air resistance. Diagram the forces acting on the squirrel.

5. A rightward force is applied to a book in order to move it across a desk with a rightward acceleration. Consider frictional forces. Neglect air resistance. Diagram the forces acting on the book.

6. A rightward force is applied to a book in order to move it across a desk at constant velocity. Consider frictional forces. Neglect air resistance. Diagram the forces acting on the book.

7. A sydiver is descending with a constant velocity. Consider air resistance. Diagram the forces acting upon the skydiver.

8. A football is moving upwards towards its peak after having been *booted* by the punter. Diagram the forces acting upon the football as it rises upward towards its peak. Neglect air resistance.

9. A car is coasting to the right and slowing down. Diagram the forces acting upon the car. (Consider frictional forces including air resistance)

10. A hockey puck is sliding freely across a pond of frictionless ice.