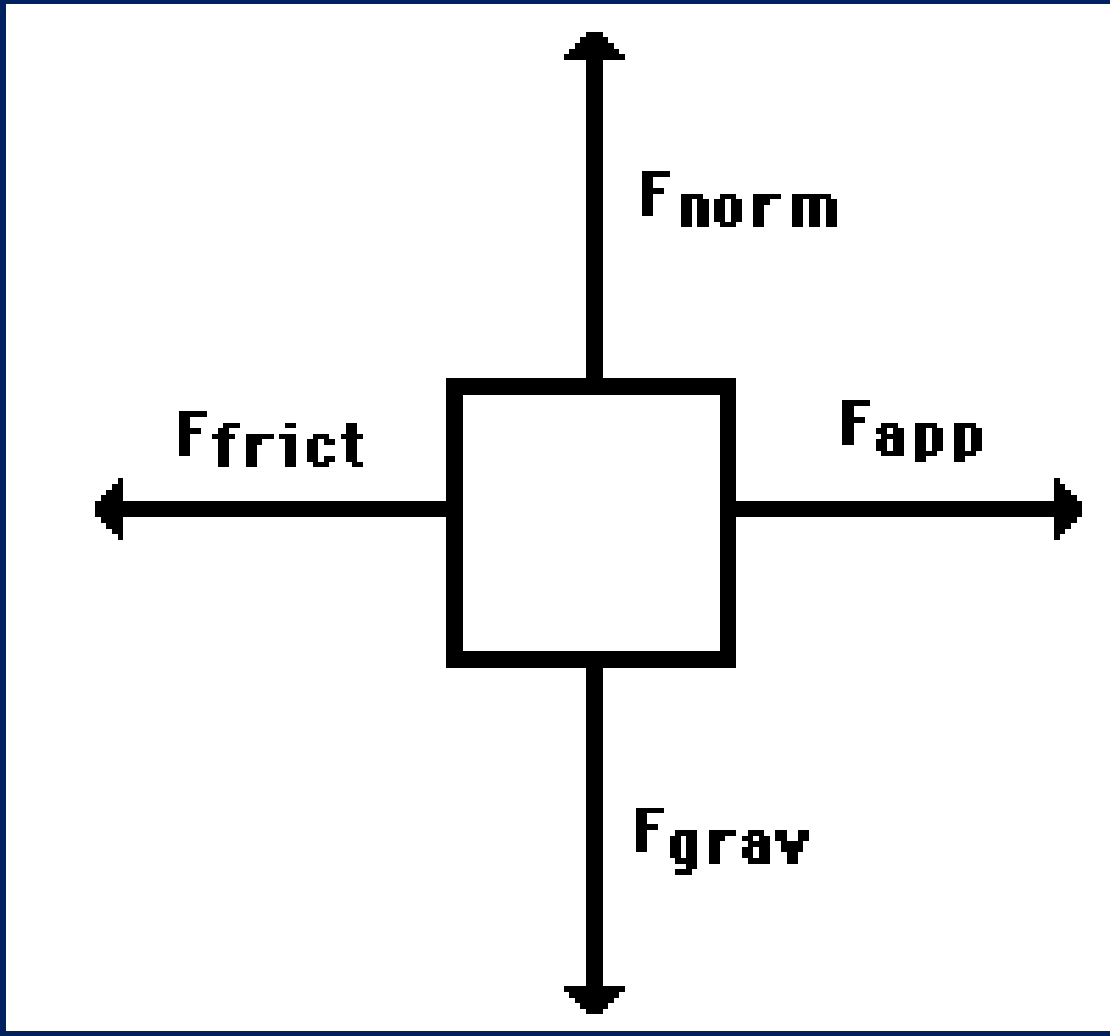
Free-body diagrams

Free-body diagrams are pictures that show the size and direction of all forces acting on an object.

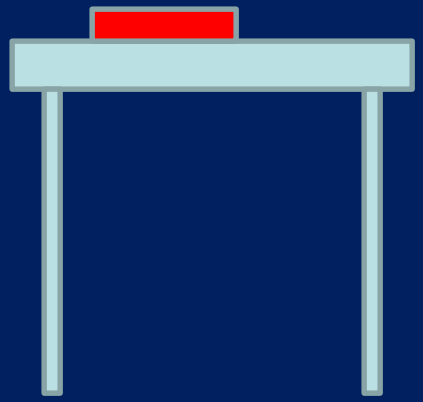


Steps to drawing a free body diagram

1. Pick one object to analyze
2. Draw a box to represent the object
3. Draw an arrow to represent each force acting on the object
4. Make sure the arrow shows the direction and relative size of the force

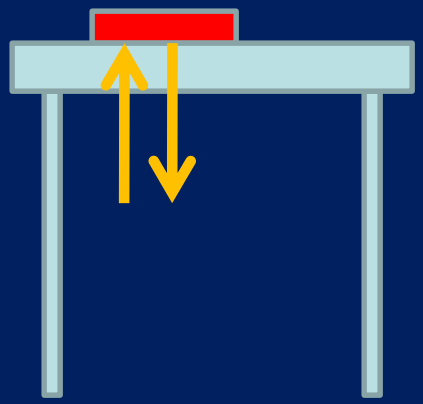
Problem 1

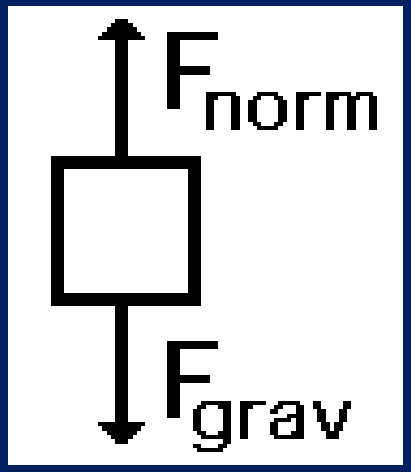
A book is at rest on a table top. Diagram the forces acting on the book.



Problem 1

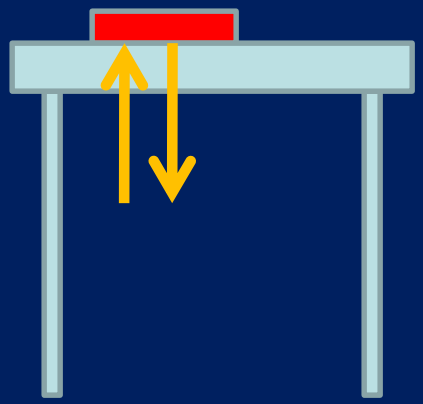
In this diagram, there are normal and gravitational forces on the book.

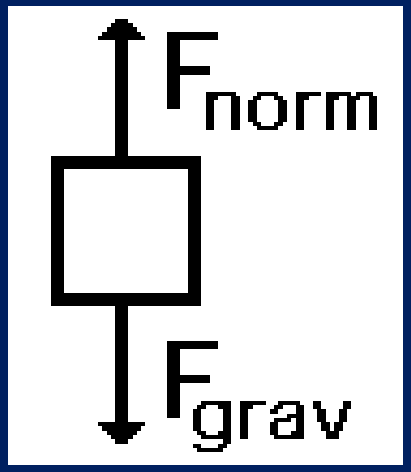




Problem 1

The forces are balanced (they cancel each other out)



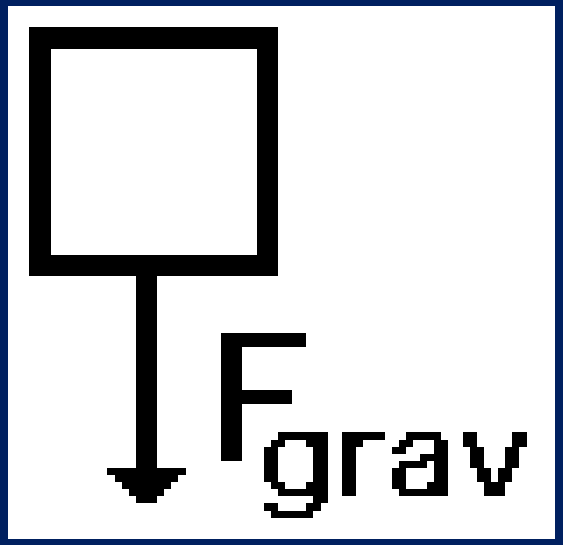


Problem 2

An egg is free-falling from a nest in a tree. Neglect air resistance. Draw a free-body diagram showing the forces involved.

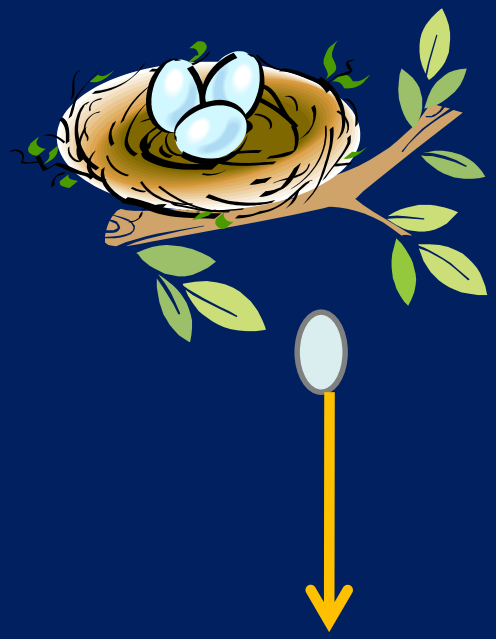
Problem 2

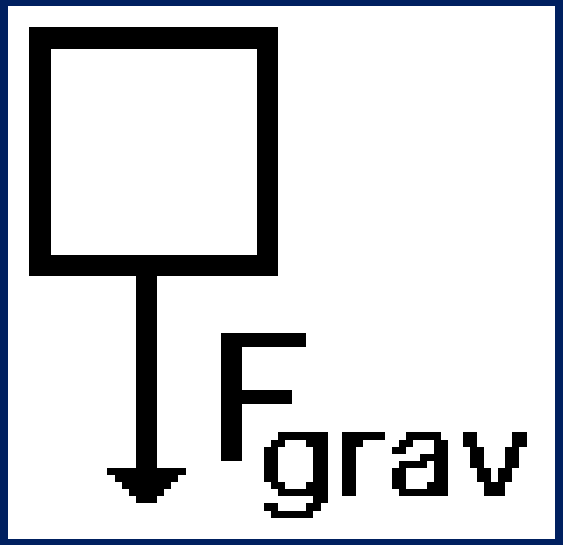
Gravity is the only force acting on the egg as it falls.



Problem 2

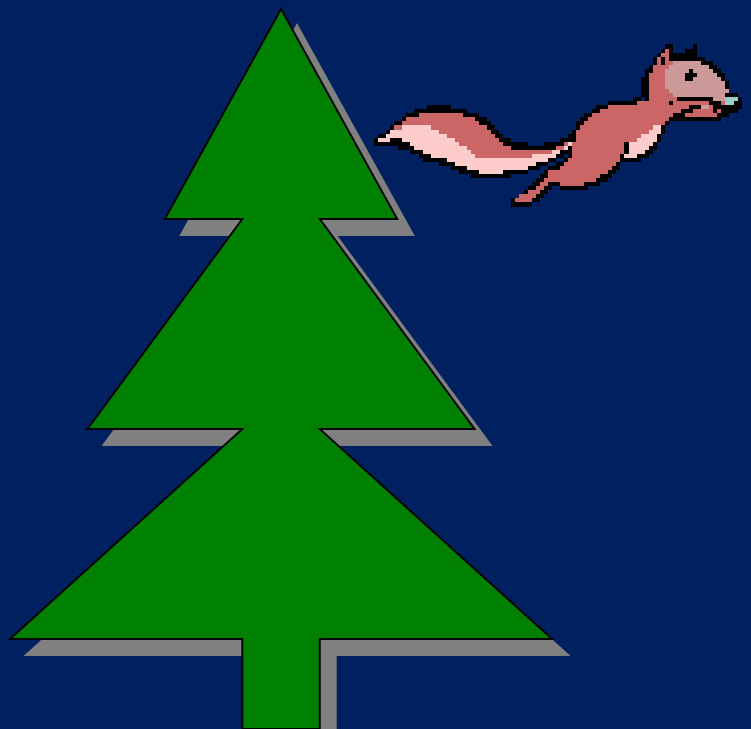
The forces are unbalanced, so the egg will accelerate downward.





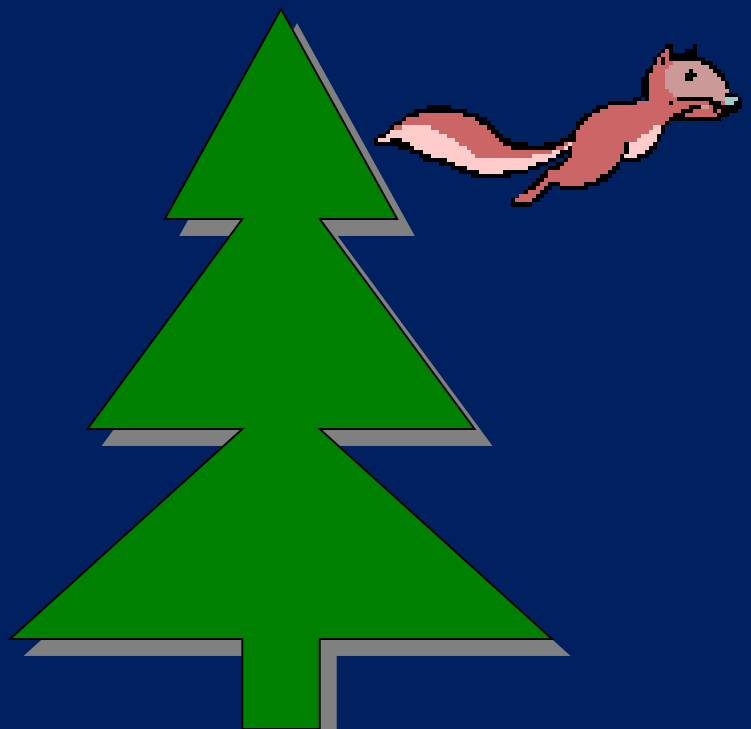
Problem 3

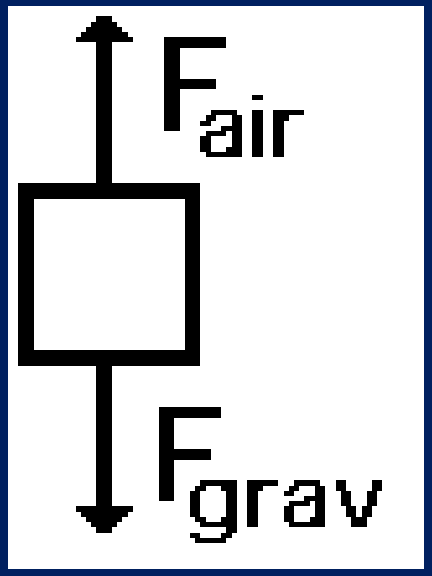
A flying squirrel is gliding (no wing flaps) from a tree to the ground at constant velocity. Consider air resistance. A free body diagram for this squirrel looks like…



Problem 3

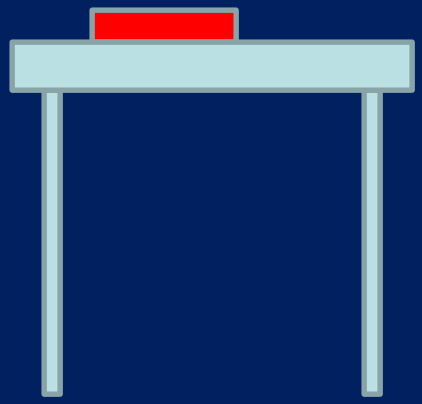
Gravity pulls down on the squirrel while air resistance keeps the squirrel in the air for a while.



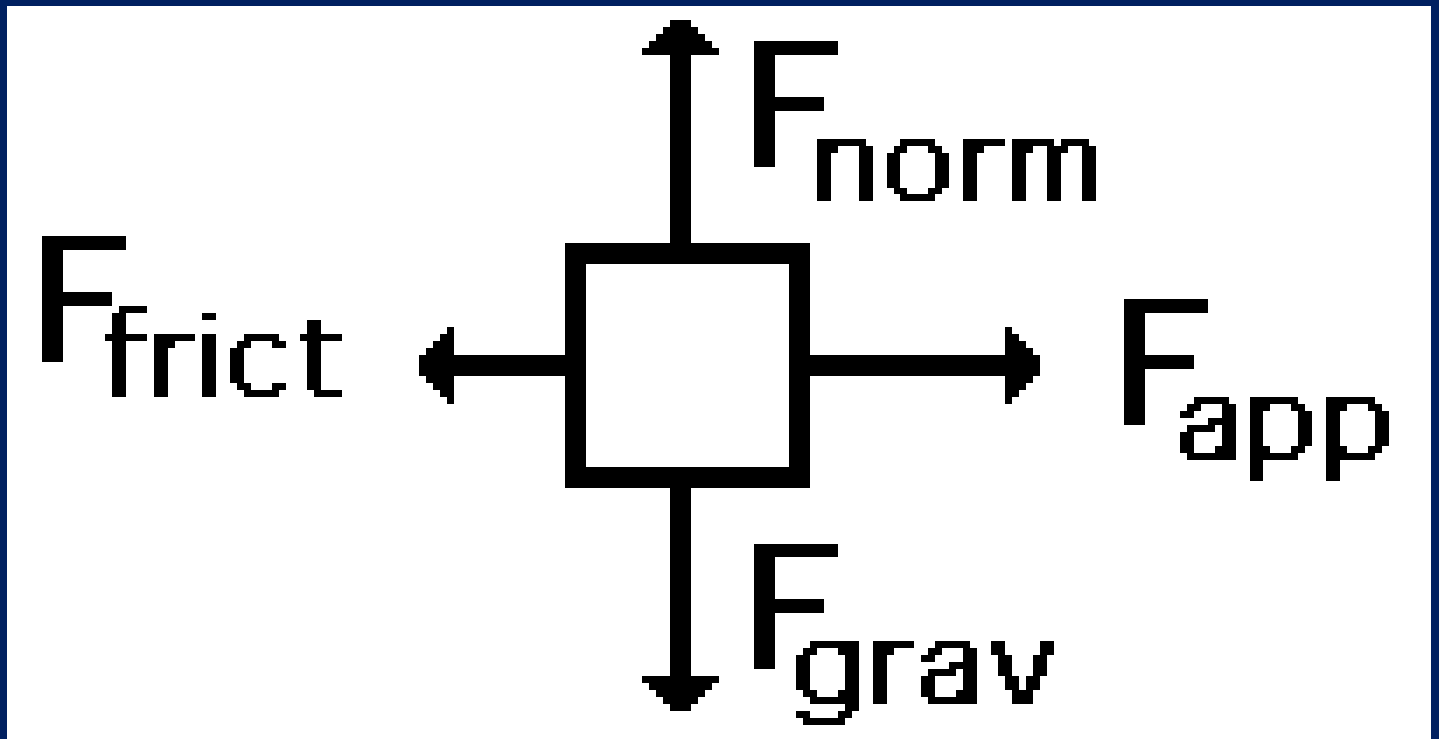


Problem 4

A rightward force is applied to a book at rest, in order to move it across a desk. Consider frictional forces. Neglect air resistance. Construct a free-body diagram for the book.



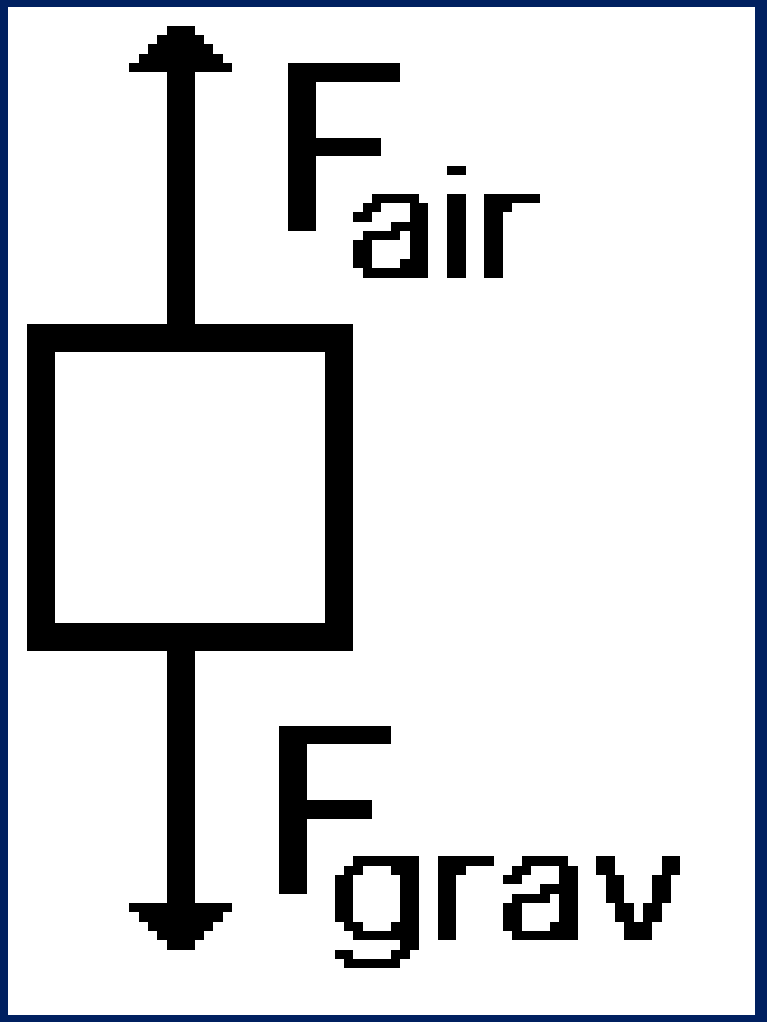
Note the applied force arrow pointing to the right. Notice how friction force points in the opposite direction. Finally, there are still gravity and normal forces involved.



Problem 5

A skydiver is falling with a constant velocity. Consider air resistance. Draw a free-body diagram for the skydiver.

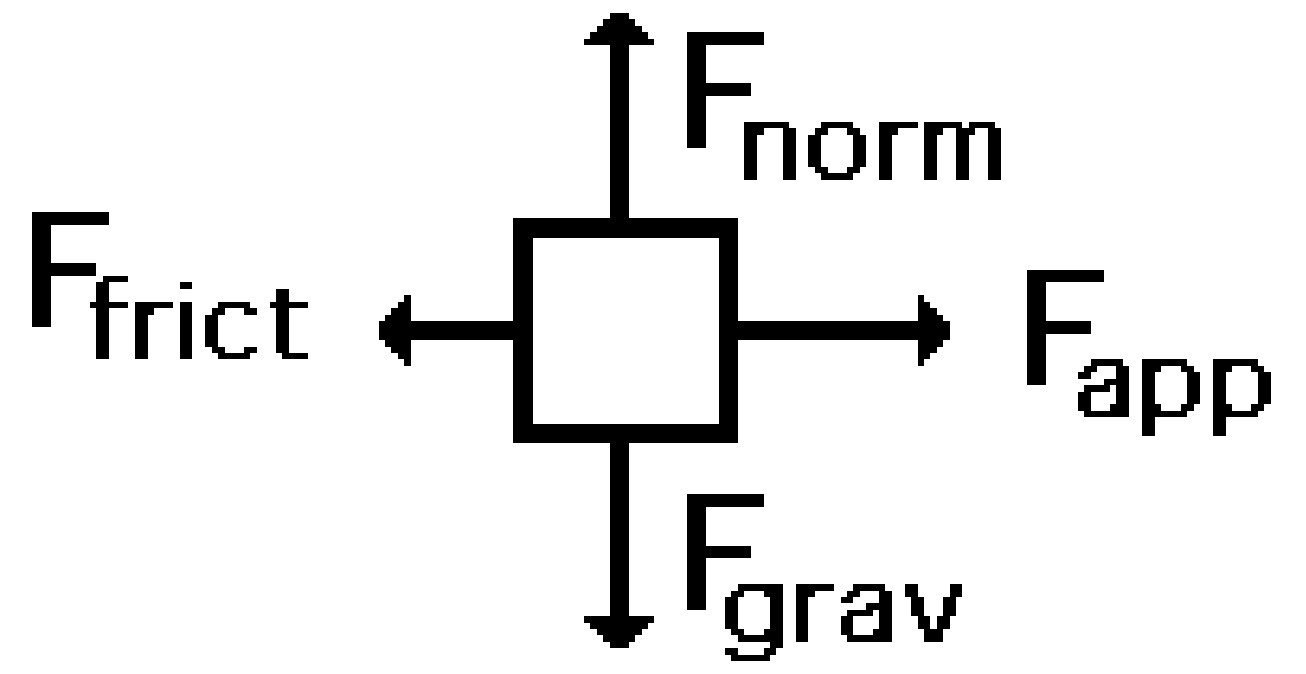
Gravity pulls down on the skydiver, while air resistance pushes up as she falls.



Problem 6

A man drags a sled across loosely packed snow with a rightward acceleration. Draw a free-body diagram of the forces acting on the sled.

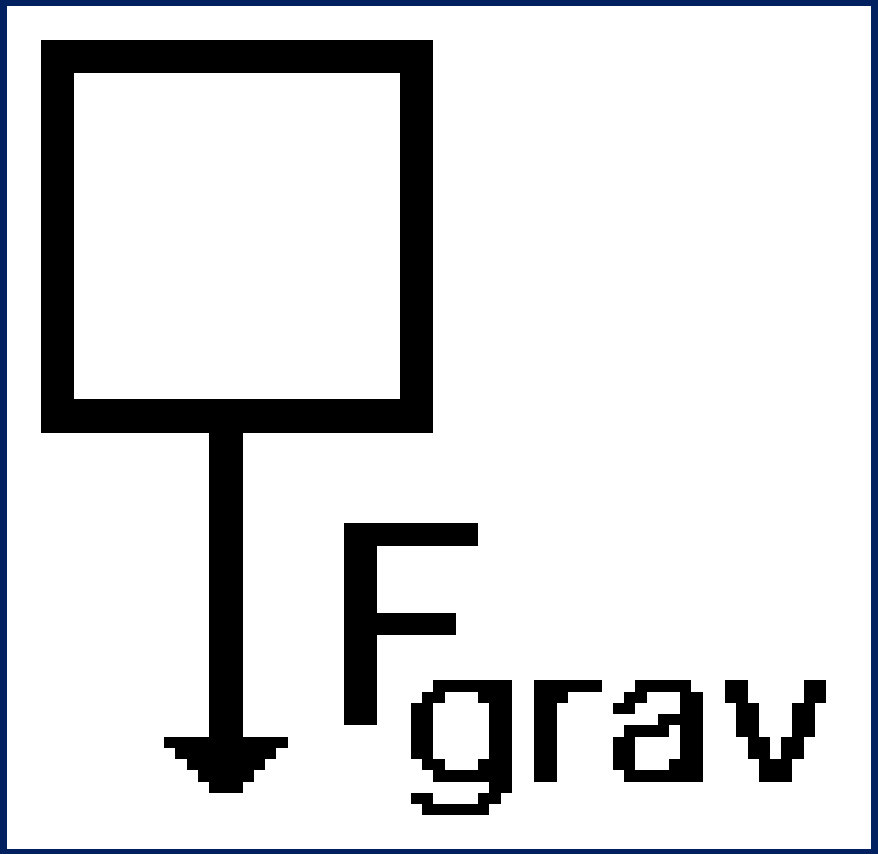
The rightward force arrow points to the right. Friction slows his progress and pulls in the opposite direction. Since there is not information that we are in a blizzard, normal forces still apply as does gravitational force since we are on planet Earth.



Problem 7

A football is moving upwards toward its peak after having been booted by the punter. Neglect air resistance. Draw a free-body diagram of the football in mid-air.

The force of gravity is the only force described. It is not a windy day (no air resistance).



Problem 8

A car runs out of gas and coasts to a stop on flat ground. Draw a free body diagram of the forces acting on the car.

Even though the car is coasting down the hill, there is still the dragging friction of the road (left pointing arrow) as well as gravity and normal forces.