Free body diagrams

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Newton's 1st Law

An object in motion stays in motion in a straight line, unless acted upon by unbalanced force. A push or pull will cause object to speed up, slow down, or change direction.

Review: Forces are Balanced

Object at Rest

V = zero m/s

$a = 0\ m/s^2$

Stay at Rest

Objects in Motion

V ≠ zero m/s

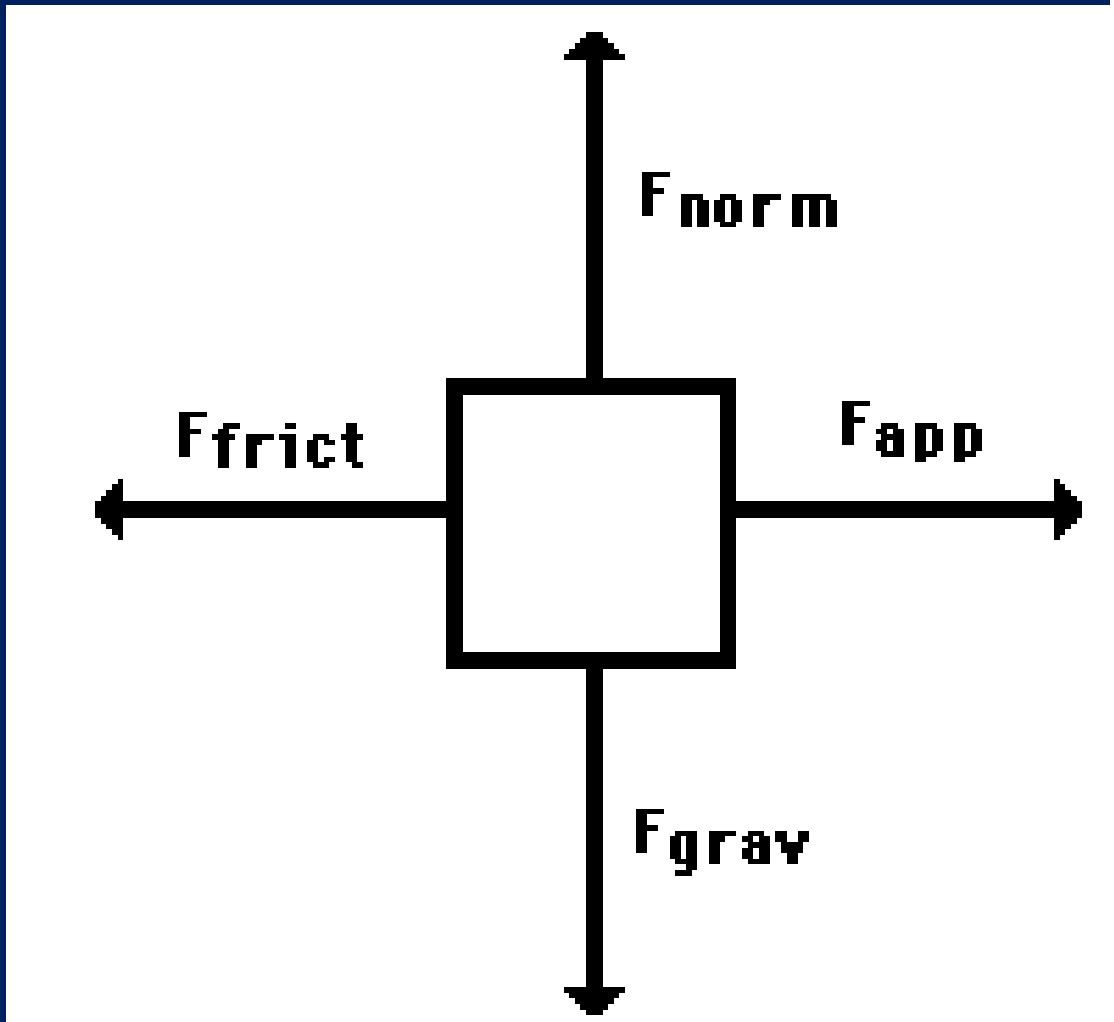
$a = 0\ m/s^2$

Stay in Motion (same speed and direction

Basically, objects just keep on doing whatever they are doing unless they are acted upon by an unbalanced force.

Free-body diagrams

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



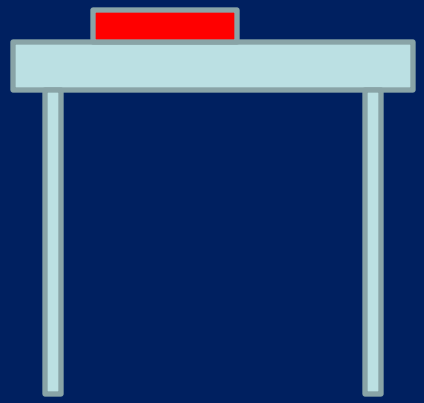
Steps to drawing a free body diagram

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

Force	Symbol	Definition	Direction
Friction	F_f	The contact force that acts to oppose sliding motion between surfaces	Parallel to surface & opposite direction of sliding
Normal	F_N	The contact force exerted by a surface on an object	Perpendicular to & away from the surface
Spring	F_{sp}	A restoring force, that is, the push or pull a spring exerts on an object	Opposite the displacement of the object at end of spring
Tension	F_T	The pull exerted by a string, rope, or cable when attached to a body & pulled taut	Away from object & parallel to spring, rope or cable at point of attachment
Thrust	F_{thrust}	A general term for the forces that move objects such as rockets, planes, cars & people	In same direction as acceleration of object
Weight	F_g	A long-range force due to gravitational attraction between two objects, generally Earth & an object	Straight down toward center of Earth

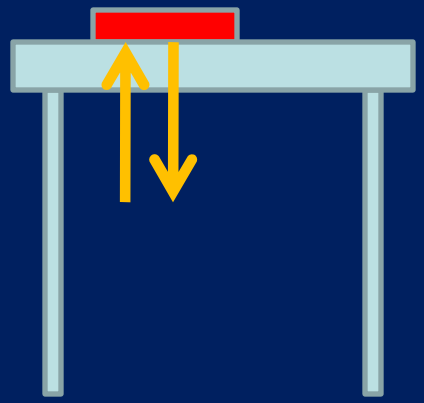
Problem 1

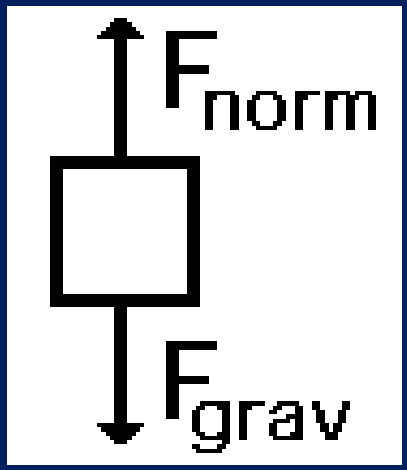
A book is at rest on a table top. Diagram the forces acting on the book.



Problem 1

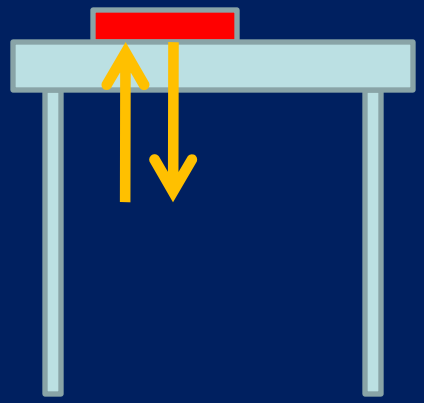
In this diagram, there are normal and gravitational forces on the book.

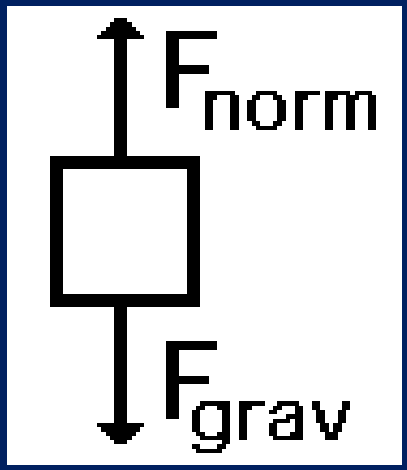




Problem 1

The forces are balanced (they cancel each other out)



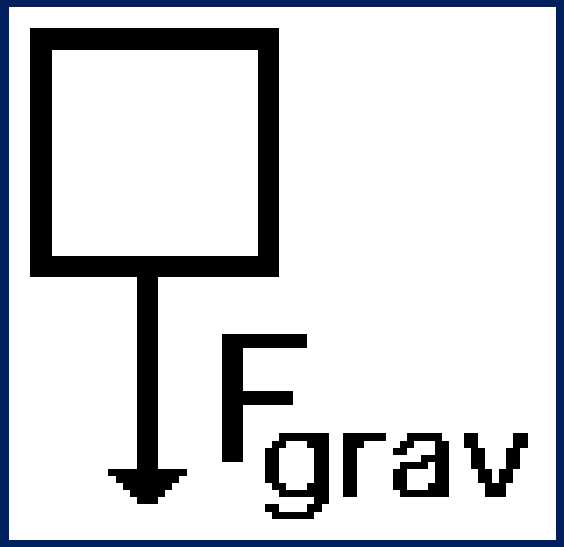


Problem 2

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

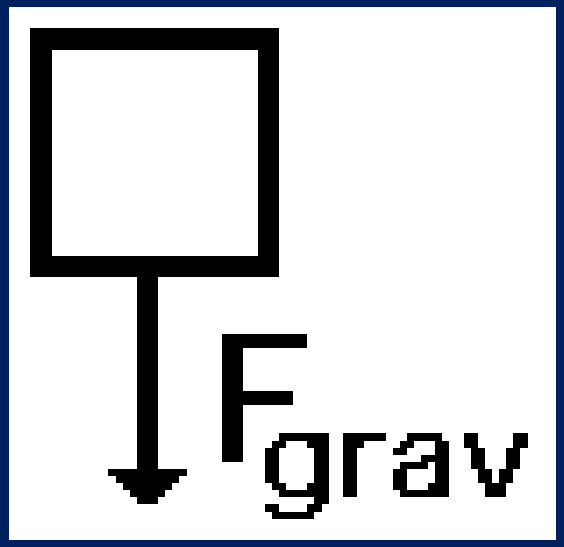
Problem 2

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



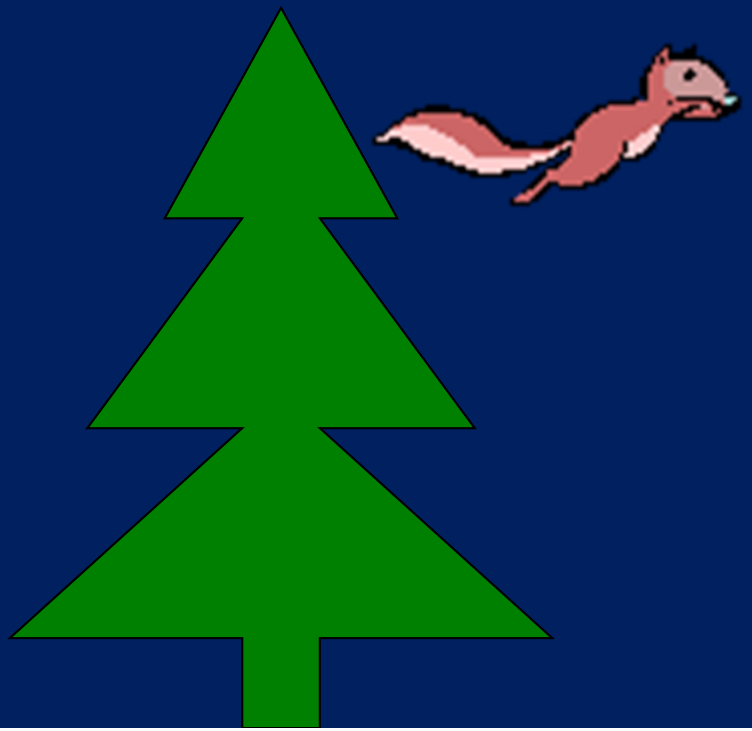
Problem 2

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.