Force can cause an object to change its velocity or shape.

Forces push, pull, tug, heave, squeeze, stretch, twist or press.
Forces can change:

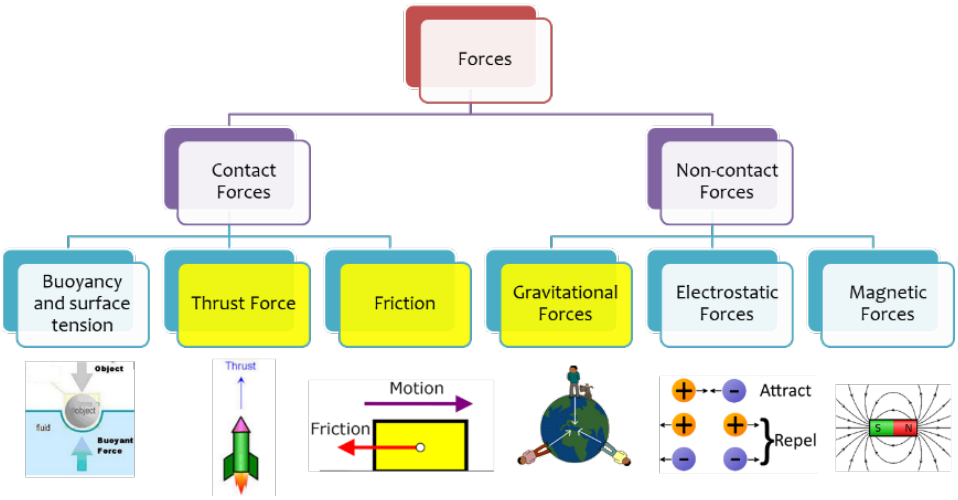
- The shape of an object
- The movement of an object
- The speed of an object
- The direction of an object

Not all forces can be seen but the effects can be measured. Forces can either be contact forces, where the force needs to be in contact with the object the force OR non-contact forces that will act on an object from a distance without touching it.

Units of Force, Motion and Energy in Science

Quantity	What is it measured in?	Symbol	Equipment used
Force (including weight)	Newton	N	Spring balance
Mass	kilograms	kg	scales
Velocity / speed	metres per second	ms^{-1}	Ticker timer
Acceleration (including gravitational acceleration)	metres per second per second	ms^{-2}	Ticker timer
Energy (including Work)	Joules	J	

Contact and non-contact forces



Pushes, pulls, friction and tension are contact forces. The object that causes the force touches the object it acts upon. Non-contact forces such as electrostatic forces, magnetic forces and gravitational forces act without contact between the object.

Gravity is a force, which acts between bodies even though they are not in contact

Objects create a gravitational field around them. Gravity gives objects of mass in the field a weight force.

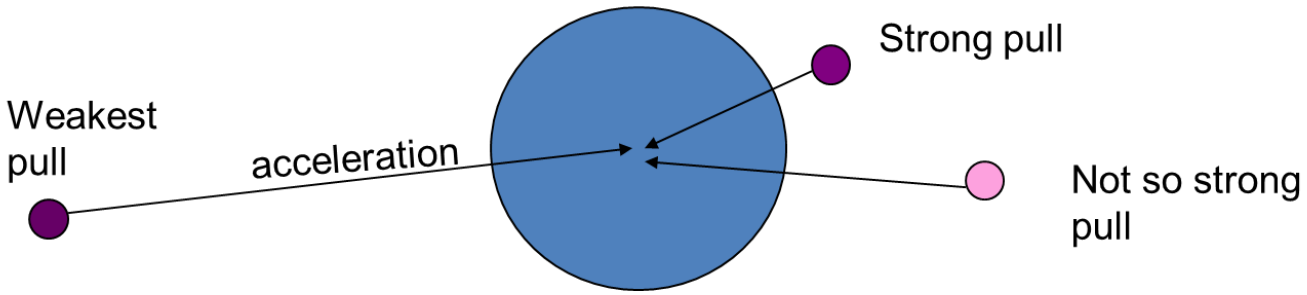
- the bigger the object; the stronger the field
- the further away from the object, the less gravitational pull

Any other object within the field is pulled to the center of the mass:

>accelerating

>feeling weight

When gravitational force is acting on an object then we can say the object has weight force

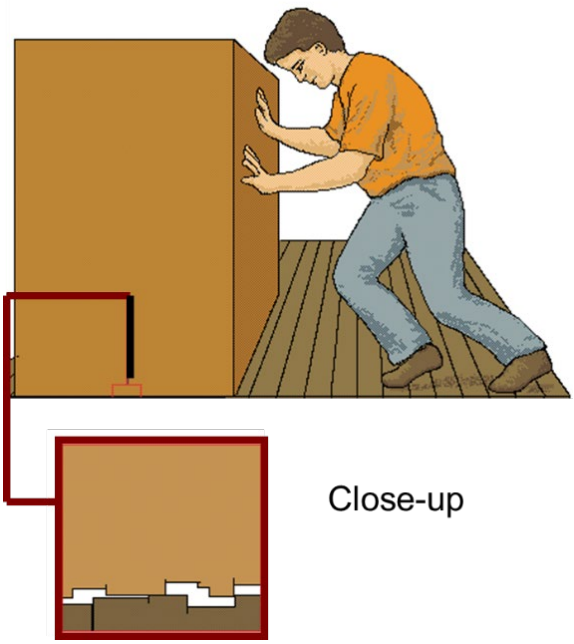


Thrust force

Thrust (or applied force) requires some parts of an object (whether gas, liquid or solid) being pushed forcefully from itself (rocket fuel from a rocket, for example). Once the rocket has left, the "thrust" is no longer present. It also requires reaction (actual touching) of the thrust medium against the object.

Acceleration is the state of an object, due to a force applied. It is dependent on the force, and on the mass of an object, but is not a force itself. Friction force opposes an object that is experiencing thrust force. Thrust and friction are "paired forces" that act in opposite directions on an object.

Friction often provides opposing force acting on moving bodies



Friction is a force that opposes motion. If an object has no motion, then there is no friction.

When friction occurs, and one surface moves against another, the movement causes Kinetic energy to be changed into heat energy.

Smooth surfaces create less friction than rough surfaces. Friction that occurs between air or water and a solid body is called resistance.

If friction and thrust forces are **equal and opposite,** then they are said to be **balanced.**

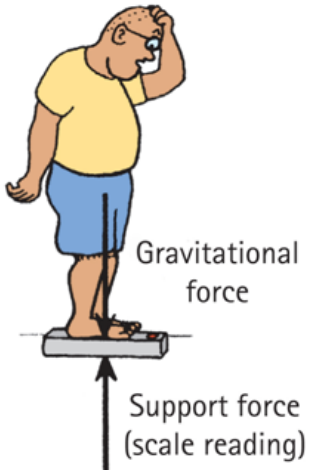
Situations where Friction is useful	
situation	Increased by
walking	Having grip on the soles of your shoes
cycling	Wider tyres with tread
driving	Good tread on tyres. Brake pads

Situations where Friction is unhelpful	
situation	decreased by
Friction in bearings	Oil around bearings
Drag on car	Aerodynamic design to reduce drag
Drag on snowboard	Smooth lacquered surface

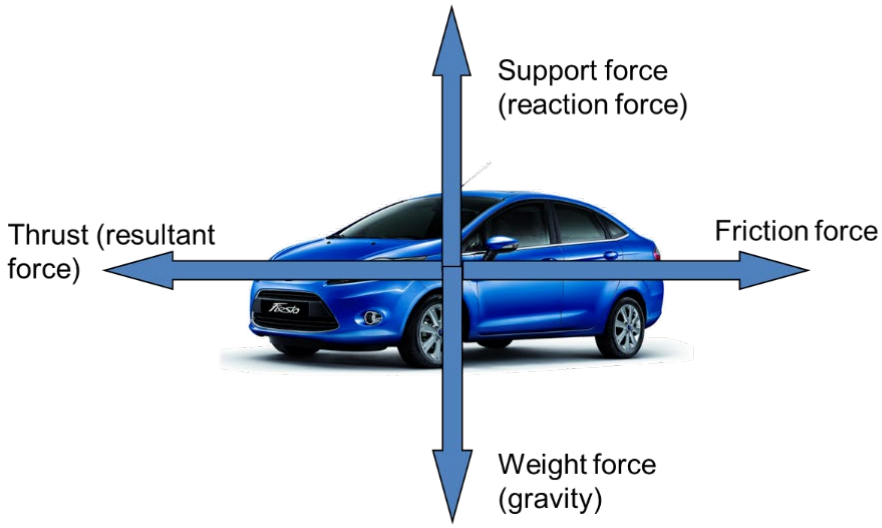
Support forces

Support forces are equal and opposite to an object experiencing weight if the forces are balanced. Support force in air is called lift and in water is called buoyancy.

Buoyancy is an upward support force caused by a fluid that opposes the weight (gravitational force) of an object in the fluid, usually water. Once the object remains at a set depth then the support force and weight force are balanced.



Balanced and unbalanced forces

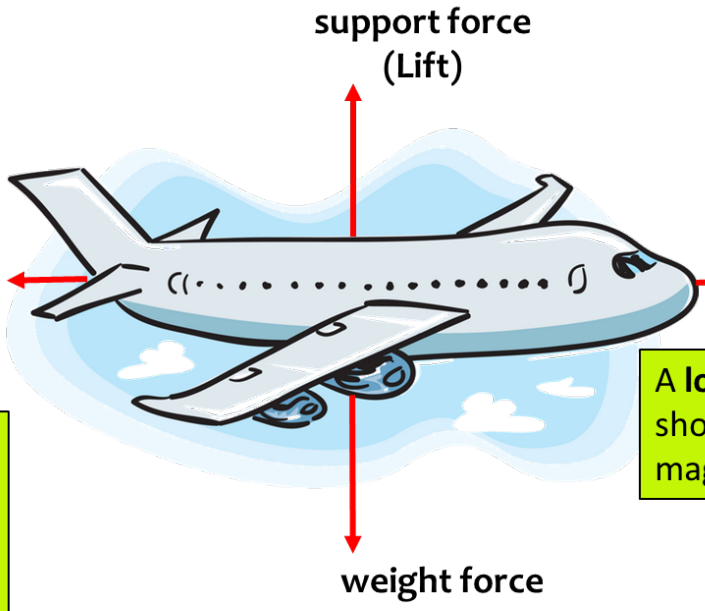


If pairs of forces acting on an object are **equal and opposite,** they are said to be **balanced**. The length of the arrow shows relative magnitude of the force. The arrows must start from the middle of the object.

Note: when an object is stationary there are **only 2 forces** acting upon the object; support and weight force. There is no thrust or friction force

Unbalanced forces change motion

Balanced forces cause no change in speed or direction, since they exert equal, but opposite, push/pull effects on an object. However, **Unbalanced forces** can change the speed and/or direction of an object. Unbalanced forces occur when **opposite forces** are of a **different magnitude** (size)



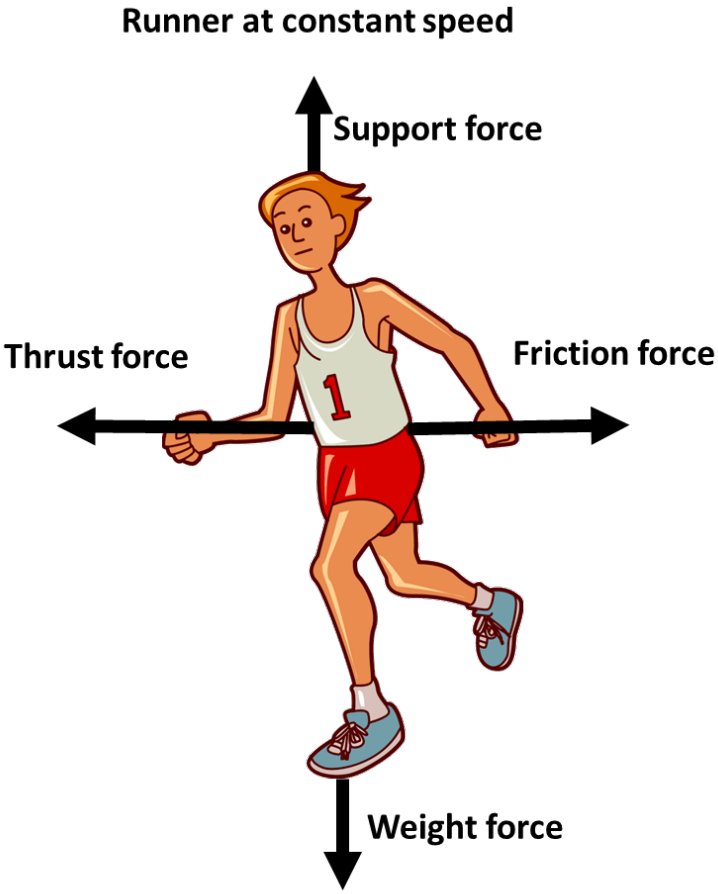
A **longer force arrow** shows a greater magnitude of force

Note: in air the type of support force is called **lift** and in water the support force is called **buoyancy**

Rules of Force Diagrams

We use force diagrams to show the direction and magnitude (size) of a force. Force diagrams have rules:

- ❑ The arrows showing a force must start (preferably) from the centre of an object, but at least touching it.
- ❑ Pairs of forces, such as support and weight, must be directly opposite each other
- ❑ Arrows must be pointing out.
- ❑ The length of an arrow indicates magnitude of a force. More force=longer arrow
- ❑ Pairs of balanced forces have equal length arrows.
- ❑ Pairs of unbalanced forces have different length arrows



Net Force

A net force is the resultant force when multiple forces interact. When forces are balanced on an object, the net force is **zero.** If there is zero net force, the object maintains **constant speed or is stationary.**

An object experiencing **unbalanced force** will have a net force greater or less than zero and will **accelerate** in the direction of the largest force.

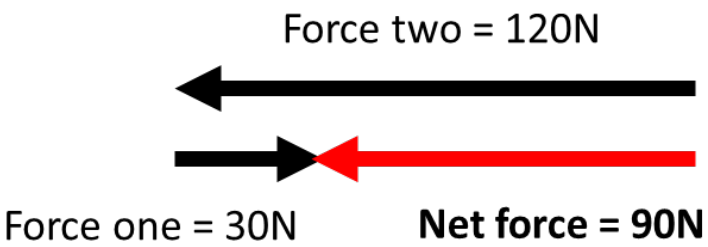
If the net force is pointing in the same direction as the direction of motion, the object accelerates. If the net force is pointing in the opposite direction to the direction of motion, the object decelerates.

Calculating Net Force

The net force can be **calculated** by subtracting the smaller force from the larger force. If the forces are pointing in the **same direction**, the **forces add**, giving a larger net force. If the forces are in **opposite direction**, the **forces subtract**, giving a smaller net force (including a zero net force).

Net force = 120N – 30N = 90N accelerating the object from right to left (forward)

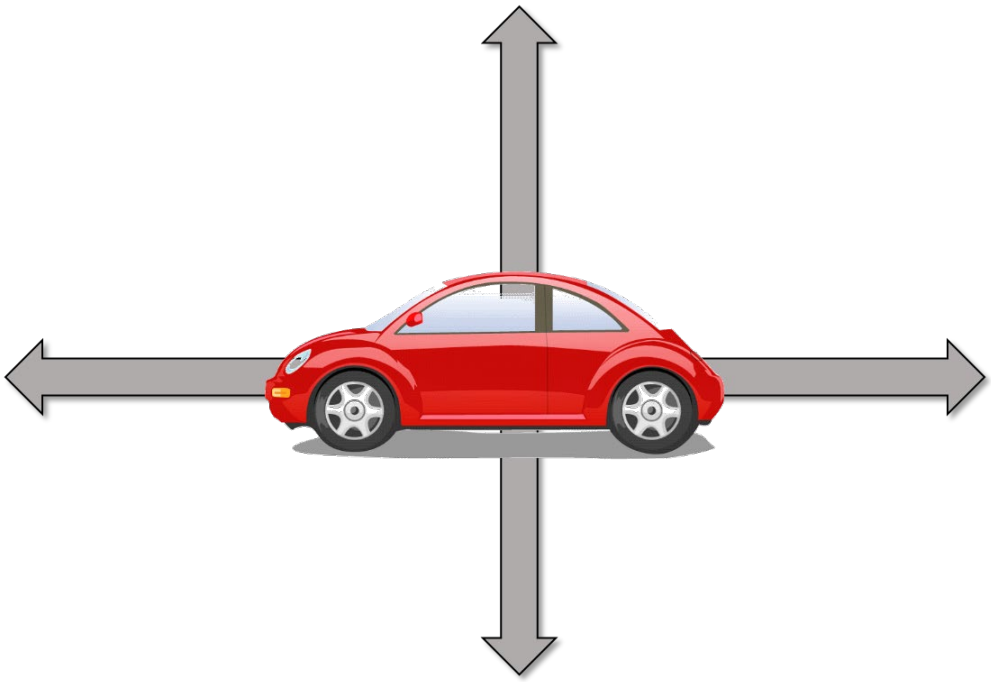
Note: if there are two or more forces acting in the same direction then they are added



1. Complete the chart with the missing information

Quantity	What is it measured in?	Symbol	Equipment used
Force (including weight)	Newton		
Mass		kg	scales
	metres per second	ms^{-1}	ticker timer
Acceleration	metres per second per second		ticker timer
		J	

2a. The car is moving to the left. **Label** all four forces.



2b. **Describe the motion** of the car and link to whether forces are balanced or unbalanced.

3. Draw the force diagrams (arrows and labels) for each of these situations

Accelerating truck 	Falling anvil (accelerating) 
Stationary cat 	Skydiver reaching terminal velocity (constant speed) 

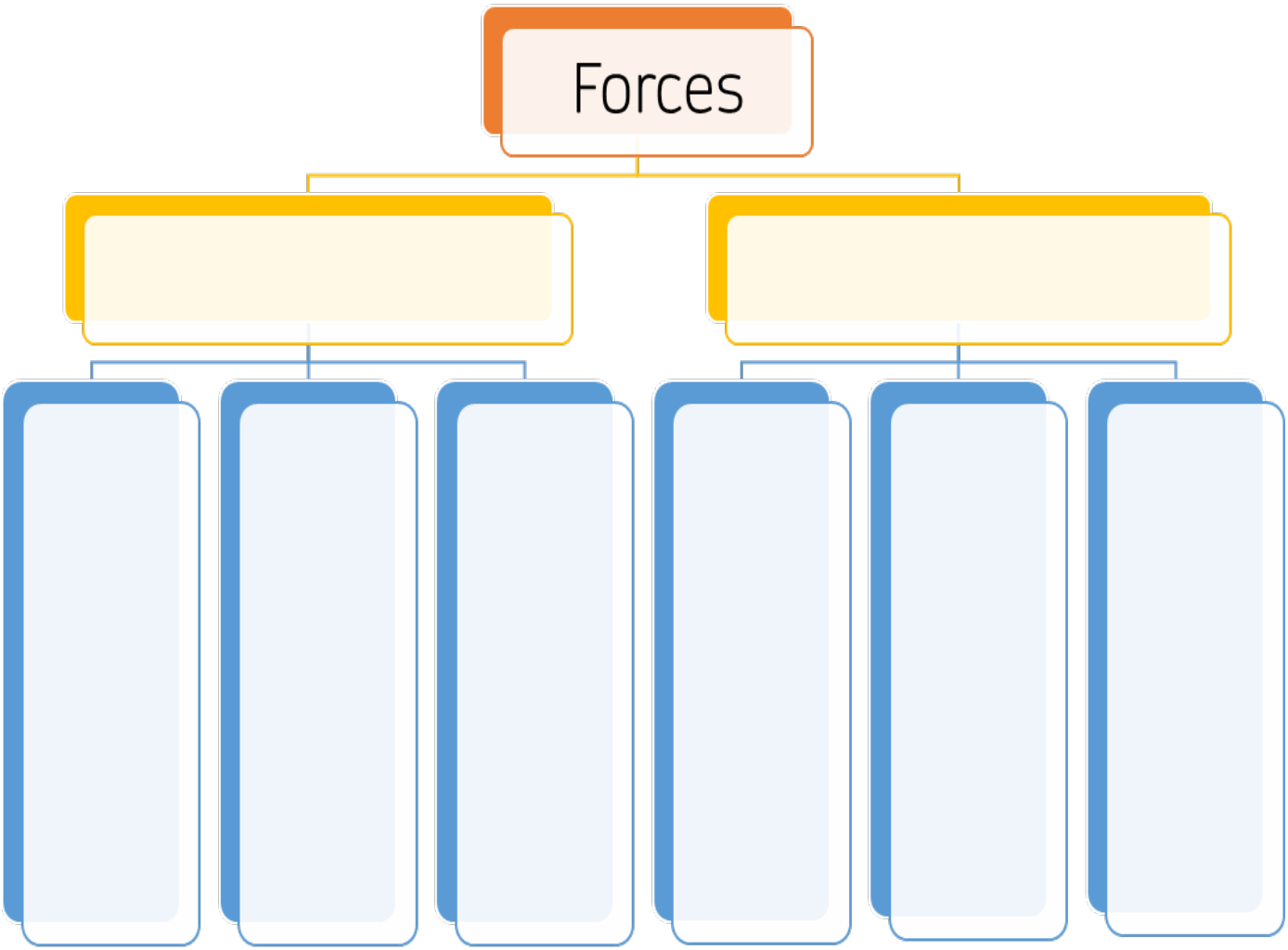
4. For each of these situations in a skate board, describe if friction is useful or not useful and explain why

Ball bearings in wheel

Rough surface on deck

5. Fill the organisational chart with the following terms and give an example for each type of force

contact force	non-contact force	magnetic	thrust	electrostatic	friction	gravitational	support



6. Calculate the **NET force** and **direction of movement** for each of the situations below.