

## FRICTION.

A lubricant is a slippery substance which reduces the force of friction.

It can fill the rough parts of the surface. This has the effect of making the surface smoother and reduces the force of friction.

Friction is **resistive** force acting between any two surfaces in contact. It opposes the relative motion of two surfaces in contact. This means that it acts in the **opposite** direction to the relative movement of the two surfaces.

*Friction between two solid surfaces depends on two factors:*

- ✓ how **rough** the two surfaces are
- ✓ the size of the **force** between the two surfaces [how hard they are pressed together]

Ways of increasing Friction	Way of decreasing Friction
less aerodynamic	lubrication eg oil, wax, grease, soap
greater surface area	Streamlining
spoilers	more aerodynamic
increase mass	reduce mass
surface rough eg sand	rollers
gritting roads	layer of air
stickier surface	polystyrene beads
rougher tyres	smooth surface
	ice
	water on road
	LORRIES BOARD

## AIR RESISTANCE

Air resistance is caused by the frictional forces of the air against the vehicle. The faster the vehicle moves, the bigger the air resistance becomes. The top speed of a vehicle is reached when the force from the cyclist or engine is balanced by air resistance.



FIGURE2:HTTP://WWW.LUXURIOUSMAGAZINE.COM/WP-CONTENT/UPLOADS/2011/11/INFINITI-ELECTRIC-CONCEPT-1.JPG

the same amount of fuel.

## STREAMLINING

Racing cyclists crouch down low on their bikes to reduce the air resistance on them. This helps them to cycle faster. They also wear streamlined helmets. These have special, smooth shapes that allow the air to flow over the cyclist more easily. Modern cars are also streamlined. Their smooth shapes make the air resistance smaller, which allows them to travel further on



FIGURE 1 A STREAMLINED RACING CYCLIST

When there is a lot of friction between moving parts, energy is lost to the surroundings as **heat**.

## FORCE DIAGRAMS

When two forces acting on an object are equal in size but act in opposite directions, we say that they are balanced forces.

We can show the forces acting on an object using a force diagram. In a force diagram, each force is shown as a force arrow. An arrow shows:

- the size of the force (the longer the arrow, the bigger the force)
- the direction in which the force acts.

The arrow is usually labelled with the name of the force and its size in newtons. Text books often show a force with a thick coloured arrow, but it is best if you just use a pencil and ruler to draw an arrow with a single line.

If the forces on an object are balanced (or if there are no forces acting on it) this is what happens:

- an object that is not moving stays still
- an object that is moving continues to move at the same speed and in the same direction

So notice that an object can be moving even if there are no forces acting on it.

## STANDING ON THE GROUND



When an object rests on a surface such as the ground, its weight is balanced by the reaction force from the ground. The ground pushes up against the object.

The weight of a book lying on a table is balanced by the reaction force from the table top

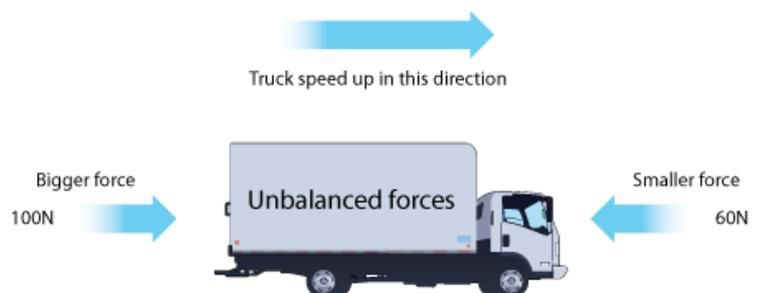
### UNBALANCED FORCES

When two forces acting on an object are not equal in size, we say that they are **unbalanced forces**.

If the forces on an object are unbalanced this is what happens:

- an object that is not moving starts to move
- an object that is moving changes speed or direction

Unbalanced forces make the truck speed up.



## RESULTANT FORCES

When several forces act on one object, they can be replaced by one force which has the same effect. This single force is called the resultant or unbalanced force.

The size of the overall force acting on an object is called the **resultant force**. If the forces are balanced, this is zero. In the example above, the resultant force is the difference between the two forces, which is  $100 - 60 = 40 \text{ N}$ .

## NEWTON'S FIRST LAW

“An object will remain at rest or move at a constant velocity in a straight line unless acted on by an unbalanced force”.

This means that if the forces acting on an object are balanced, then the object will remain stationary if it was already stationary. For a moving object, if the forces acting on it are balanced, then it will continue to move in a straight line at a constant velocity.

balanced forces  $\leftrightarrow$  Object at rest OR object moving at a constant velocity in a straight line

A vector is often drawn with an arrow to indicate its size and direction. The starting point of the arrow is called the “tail” and the arrow end is called the “head”.



Use arithmetic to find the resultant:

**Add together forces which act in the same direction**

e.g  $F_1 + F_2 = F_u$   $12 + 8 = \underline{20 \text{ N to the right}}$



**Subtract forces which act in the opposite direction**

e.g  $F_1 + F_2 = 12 - 8 = \underline{4 \text{ N to the right}}$

