

SPH3U UNIVERSITY PHYSICS

FORCES

☛ Everyday Forces
(P.114-119)

Forces We Experience Daily

We experience several types of forces daily. Imagine two children playing outside with a wagon. One child pulls forward on a rope tied to the front, while the other pushes on the wagon from behind. What forces act on the wagon?



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Forces We Experience Daily

*In order to analyse the different types of forces acting in this situation two types of force diagrams – system diagrams and free-body diagrams – are useful. A **system diagram** (like the one below) is a sketch of all the objects involved in a situation.*



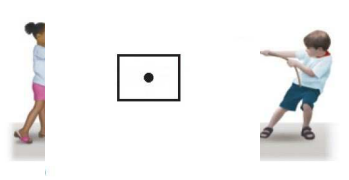
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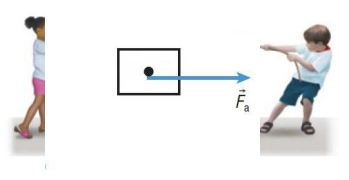
A **free-body diagram (FBD)** is a simple drawing representing the object being analyzed and all the forces acting on it. The object is typically shown as a rectangle or large dot with the forces drawn as arrows originating from the object and pointing away from the centre. Each force is labelled with the symbol F and an appropriate subscript that indicates the force.



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Forces We Experience Daily – Applied Force (F_a)

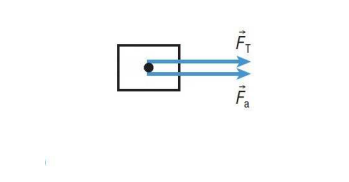
First consider the applied force. An **applied force (F_a)** results when one object is in contact with another object and either pushes or pulls on it. In our example, the child behind the wagon exerts an applied force on the wagon by pushing on the back.



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Forces We Experience Daily – Tension Force (F_T)

Another force is the tension force (often called tension). **Tension (F_T)** is a pulling force exerted on an object by a rope or a string. In our example, the child at the front of the wagon pulls on the rope, causing tension in the rope. The rope exerts tension on the wagon, pulling it forward.



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Forces We Experience Daily – Normal Force (F_N)

Whenever an object is in contact with a surface, the surface can exert two different forces on the object. One is called the normal force. The **normal force (F_N)** is a perpendicular force exerted on an object by the surface with which it is in contact. In our example, the ground is pushing up on the wagon.

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Forces We Experience Daily – Friction Force (F_f)

The other force exerted by a surface on an object is friction. **Friction (F_f)** is a force that resists the motion or attempted motion of an object and always acts parallel to the surface. In our example, if the wagon is moving right, then friction acts toward the left. Even if the wagon was at rest with the children pushing and pulling on it, friction would still be present.

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Forces We Experience Daily – DYK?

NOTE!
The forces described thus far require one object to be in contact with another. For this reason, they are called **contact forces**. Some forces, however, do not require contact. These action-at-a-distance forces are called **non-contact forces**.

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Forces We Experience Daily – Force of Gravity (F_g)

The **force of gravity (F_g)**, also called the gravitational force, is the force of attraction that exists between any two objects. The direction of this force is toward Earth's centre. In our example, the force of gravity pulls down on the wagon.

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Forces We Experience Daily – Force of Gravity (F_g)

NOTE!
The force of gravity (F_g) is an example of a non-contact force (i.e. it is a force that acts at a distance). To calculate the force of gravity acting on an object, you can use the equation,

$$\vec{F}_g = m\vec{g}$$

where m is the mass of the object (kg), and g is the acceleration due to gravity (m/s^2). We will study this topic in more detail later!

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Forces We Experience Daily

EVERYDAY FORCES

- ❖ Force of Gravity (F_g) ⇔ force of attraction between Earth and object
- ❖ Normal Force (F_N) ⇔ force \perp to surface upon which object rests
- ❖ Friction Force (F_f) ⇔ force that opposes (attempted) motion of object
- ❖ Applied Force (F_a) ⇔ force exerted on object
- ❖ Tension Force (F_T) ⇔ force exerted by string or rope on object

NOTE!

- The force of gravity is a **non-contact force** (i.e. it does not require contact in order to be experienced).
- $F_g = mg$

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External Forces & Internal Forces

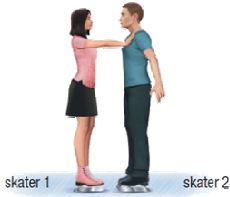
In this course, we will usually be concerned with external forces. **External forces** are those that are caused by one object pushing or pulling on another. An **internal force** occurs when an object exerts a force on itself. For example, when skater 1 pushes on skater 2, the force on skater 2 is external. If skater 1 pulls forward on her own arms, then it is an internal force.

EXTERNAL FORCE

- occurs when one object pushes/pulls on another object

INTERNAL FORCE

- occurs when an object exerts a force on itself



skater 1 skater 2

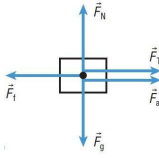
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Free-Body Diagrams

In order to study the effects of forces acting on any object the use of a free-body diagram (FBD) is necessary.

FREE-BODY DIAGRAM (FBD)

- simple drawing representing the object being analyzed and all the external forces acting on it

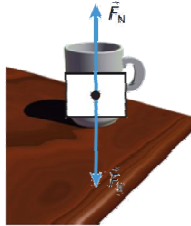


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Forces We Experience Daily & FBDs

PRACTICE

- Draw a FBD for the object in bold.
 - A **cup** is sitting at rest on a table.



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Forces We Experience Daily & FBDs

PRACTICE

1. Draw a FBD for the object in bold.

(b) A large **trunk** is pulled by a rope tied to the right side. The trunk does not move.

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Forces We Experience Daily & FBDs

PRACTICE

1. Draw a FBD for the object in bold.

(c) A **baseball player** is sliding to the left across the ground.

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Forces We Experience Daily & FBDs

PRACTICE

1. Draw a FBD for the object in bold.

(d) A **desk** is pushed to the left across the floor.

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 Forces We Experience Daily & FBDs

PRACTICE

2. For each situation described below, draw a FBD for object in bold. Be careful when deciding what forces are acting on each object. If you cannot think of a cause for the force, the force may not even exist.

(a) Your **textbook** resting on your desk.

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 Forces We Experience Daily & FBDs

PRACTICE

2. For each situation described below, draw a FBD for object in bold. Be careful when deciding what forces are acting on each object. If you cannot think of a cause for the force, the force may not even exist.

(b) A **tennis ball** falling through the air from the server's hand. Neglect air resistance.

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 Forces We Experience Daily & FBDs

PRACTICE

2. For each situation described below, draw a FBD for object in bold. Be careful when deciding what forces are acting on each object. If you cannot think of a cause for the force, the force may not even exist.

(c) A fully loaded **dog sled**, moving slowly along a flat but rough & snowy trail, is being pushed horizontally by the sled owner while being pulled horizontally by dogs attached to it by rope.

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 Forces We Experience Daily & FBDs

PRACTICE

2. For each situation described below, draw a FBD for object in bold. Be careful when deciding what forces are acting on each object. If you cannot think of a cause for the force, the force may not even exist.

(d) A **wagon** with a small child sitting in it is being pulled by a rope up a steep bumpy hill with the rope parallel to the hillside.

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 ✓ Check Your Learning

TEXTBOOK
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