

# SPH3U UNIVERSITY PHYSICS

## FORCES

### Friction & Technology (P.106)

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### Friction & Technology

*Friction plays a major role in technology involved in designing roads, bridges, automobile tires, athletic shoes, and surfaces of playing fields. Without friction, driving on highways and running on playing fields would not only be dangerous, but simply impossible!*



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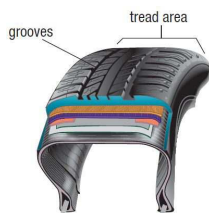
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### Friction & Technology – Car Tires

*Car tires need friction to provide traction for steering, speeding up, and stopping. The tires must be able to grip the road in all conditions, including rain and snow. If a film of water develops between the tires and the road, friction is reduced. As a result, tire treads are designed with small and large grooves to disperse the water so that friction will be well maintained.*



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### Friction & Technology – Car Tires

When driving at a low safe speed on a wet road, the water level in front of a passenger car tire is low. The water has time to move through the grooves in the tire tread and be squeezed out behind the tire. In this situation, friction from the road still acts on the tire.



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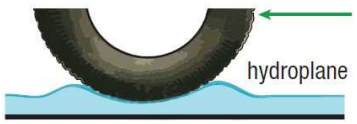
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### Friction & Technology – Car Tires

However, if the driver starts to speed up, some of the water in front of the tire will not have enough time to pass through the grooves. This causes the water level in front of the tire to increase which in turn causes the tire to start to lose contact with the road. If the speed of the car continues to increase, the excess water in front causes the tire to start to lose contact with the road completely – this is known as **hydroplaning**.



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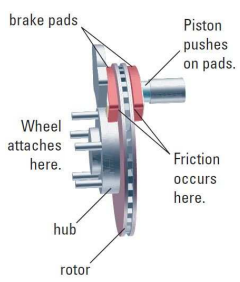
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### Friction & Technology – Brakes

Cars rely on friction for stopping. Most cars have **disc brakes**, especially on the front wheels, which operate in a way that resembles brakes on bicycles. When the brakes are applied, a piston pushes the brake pads toward a rotating disc. The disc is attached to the hub of the wheel, so exerting friction on the disc causes the wheel to slow down.



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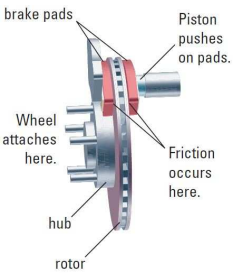
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### Friction & Technology – Brakes

One problem with disc brakes on cars is that the brake can stop the wheel from turning a lot faster than the friction from the road can stop the car from moving. This results in the wheels becoming locked and sliding across the road. So the car skids and the driver is unable to steer the car. The **antilock braking system (ABS)** on cars helps solve this problem.



Labels in diagram: brake pads, Wheel attaches here., hub, rotor, Friction occurs here., Piston pushes on pads.

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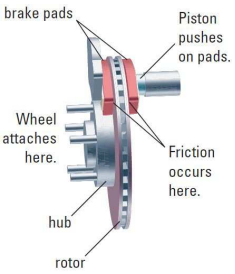
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### Friction & Technology – Brakes

**NOTE!**  
ABS uses a computer to monitor the speed of the car and if necessary changes the force on the brake pads very rapidly allowing the car to slow down without skidding.



Labels in diagram: brake pads, Wheel attaches here., hub, rotor, Friction occurs here., Piston pushes on pads.

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### Friction & Technology – Brakes

**PRACTICE**

1. Discuss the validity of the statement: "Car brakes slow the wheels down but friction from the road slows the car down."

this is true – brakes can stop/slow the wheels, however, without friction between the tires and the road, the car would never slow down/stop (i.e. hydroplaning)

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### Friction & Technology – Traction Control

Another safety feature on cars very similar to ABS is traction control. **Traction control** is actually the reverse of ABS. ABS comes into play when a car is slowing down and the tires start sliding. Traction control is used when the car is speeding up and the tires start turning faster than the car is moving. If this happens, the force of friction decreases and the driver can lose control of the vehicle.



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### Friction & Technology – Traction Control

Traction control involves sensors that detect the sliding tires. This information is sent to a computer, which decreases the amount of fuel to the engine. The computer may even use ABS to slow the wheels down. In either case, traction control helps the driver to maintain control of the vehicle while accelerating.



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### Friction & Technology – Footwear Design

In many sports, the **footwear** worn by an athlete is just as important as any other piece of equipment used in the game. Sometimes the footwear is designed to decrease the force of friction, as with skates. At other times, the frictional forces must be increased to help athletes stop and start quickly, as with running shoes.



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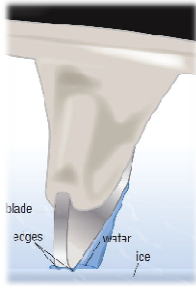
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**Friction & Technology – Footwear Design**

**NOTE!**  
 The coefficient of friction of a skate blade on ice may be as low as 0.005. At one time, physicists thought that this coefficient of friction was due to a very thin layer of water forming between the blade and the frozen ice due to the pressure of the blade pushing down on the ice. However, physicists have found that a thin liquid layer of slushy water exists naturally on the surface of ice rinks – and the layer gets thinner as the ice gets cooler. It is this slushy layer that reduces the coefficient of friction.



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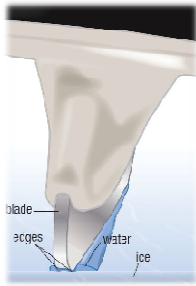
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**Friction & Technology – Footwear Design**

**PRACTICE**

2. (a) Why do skates slide so easily over ice?  
 (b) Why will skates not slide as easily over extremely cold ice?  
 (c) Why is the bottom of a skate curved?

(a) the water on top of the ice reduces the coefficient/force of friction  
 (b) as the ice gets cooler the layer of water gets thinner  
 (c) the edges help the skater dig into the ice to accelerate



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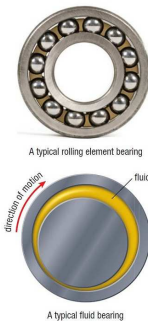
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**Friction & Technology – Bearing Design**

One way to reduce friction and increase efficiency of devices such as generators, motors, and fans is to use bearings. **Bearings** are devices that allow surfaces to slide or roll across each other while reducing the force of friction. A rolling element bearing uses balls or rollers to reduce friction. Fluid bearings use a film of fluid, such as air or oil, to separate two surfaces.

**NOTE!**  
 The fluid film in a fluid bearing reduces the force of friction in a similar way that a thin layer of water separates a skate blade on ice.



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### Friction & Technology – Bearing Design

**PRACTICE**

3. The ancient Egyptians used rolling logs to move large blocks of stone when building the pyramids. Why?

the logs served the same purposes as bearings used today – they changed the sliding friction to rolling friction which made it much easier to move the massive stones



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### Friction & Technology – Prosthesis Design

One area of interest currently in physics involves prosthesis design. A **prosthesis** is an artificial device that replaces a missing body part.

**NOTE!**

In 2000, researchers in Egypt, unearthed what they believe to be the oldest documented artificial body part – a prosthetic toe made of wood and leather attached to a nearly 3,000-year-old mummy. This is a good representation of how little prosthetic limbs have changed throughout history.



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### Friction & Technology – Prosthesis Design

Artificial limbs have seen many recent improvements, involving new materials that are lighter, more durable, and more flexible than previous materials. However, some people claim that these new materials and designs actually give an amputee a physical advantage over other athletes. For example, Oscar Pistorius of South Africa was not eligible to compete in the 2008 Summer Olympics because it was believed that his artificial legs gave him an unfair advantage.



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### Friction & Technology – Prosthesis Design

**PRACTICE**

4. A common use of prostheses today is the artificial hip. What characteristics do you think the materials used in a hip replacement must have to be able to function properly?

the material must have a very low coefficient of friction to help reduce the wear on the hip joint



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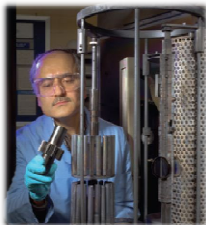
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### Friction & Technology – Material Design

Another area of interest of current research is in developing materials that have very low coefficients of friction. At one time, Teflon seemed to be the answer but now near-frictionless carbon is the frontrunner.

**NOTE!**  
Near-frictionless carbon has a coefficient of friction less than 0.001, whereas Teflon has a coefficient of 0.04 when tested under the same conditions.



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### Friction & Technology

**FRICION & TECHNOLOGY**

- ❖ tire treads are designed with small and large grooves to disperse water and prevent hydroplaning
- ❖ disc brakes on cars operate in a way that resembles bicycle brakes
- ❖ ABS uses a computer to adjust the braking and prevent the wheels from locking up and sliding during a stop
- ❖ traction control is the opposite of ABS – it helps the driver to maintain control of the vehicle while accelerating
- ❖ in many sports the footwear is designed to either increase or decrease the friction (i.e. running shoes vs. skates)
- ❖ bearings are used to decrease the friction and improve efficiency
- ❖ new research involves prosthesis design and materials such as near-frictionless carbon

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 **Check Your Learning**

**TEXTBOOK**  
P.188 Q.9,10

**WIKI (FORCES)**  
 3U2 - QUIZ#2 (Fg & Friction)

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