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Friction

TOPICS COVERED

12.1 Friction

12.2 Fluid Friction, Ways of Increasing and Decreasing Friction

IMPORTANT POINTS TO REMEMBER

- When an object moves on a surface, a force is created between them. This force is called **force of friction or friction**.
- The irregularities on surfaces and pressure between two surfaces are the factors which affect friction.
- The minimum force required to make an object moving is called **static friction**.
- The minimum force required to keep a moving object moving at a constant speed is called **sliding friction**. Sliding friction is always less than static friction.
- When an object rolls over a surface, the friction between them is called **rolling friction**. Rolling friction is less than sliding friction.
- Friction results in wear and tear of shoes and tyres. It also results in wear and tear of machine parts; resulting in monetary loss.
- A significant amount of energy is wasted in overcoming friction.
- Friction generates heat which causes wastage of energy.
- Lubricating oil and grease are applied in machines to reduce friction between moving parts.
- Ball bearings are fitted in machine parts to reduce friction.
- When an object moves through a liquid or gas, these fluids create friction. Friction due to a fluid is called fluid friction or drag.
- A shape which is wide in middle and tapered at ends is called a **streamlined shape**. A streamlined body experiences less drag and can easily move through a fluid.

12.1 FRICTION

Friction: The force acting along the two surfaces in contact which opposes the motion of one body over the other is called the force of friction.

Example: A ball rolling along the ground gradually slows down and finally comes to rest.

When we stop pedalling a bicycle, it gradually slows down and finally comes to rest. This is due to the force of friction.

Cause of Friction: Due to interlocking of rough surfaces. The interlocking of two surfaces opposes the motion of one body over another and gives rise to frictional force.

Factors Affecting Friction

- (i) The nature of surfaces in contact with each other (rough surface offer more friction while smooth surface offers less friction).

- (ii) The weight of the body (more the weight more the friction, less weight implies less friction).

Types of Friction

Static Friction: The opposing force that comes into play when one body tends to move over the surface of another, but the actual motion has not started is called static friction.

Sliding Friction: The opposing force that comes into play when one body is actually sliding over the surface of another body is called sliding friction. *Example:* When a log of wood is moved on a flat surface, it slides. The opposing force is sliding friction.

Rolling Friction: The opposing force that comes into play when one body is actually rolling over the surface of another body is called rolling friction. *Example:* When a wheel or a log of wood rolls over a flat surface, the opposing force is the rolling friction.

Advantages of Friction (A Necessity)

It helps us walk: The friction between our feet and the ground helps us walk on the ground without slipping or falling.

Movement of vehicles: The friction between tyres of various vehicles like cars, trucks, tractors, bicycles and scooters and the ground helps them to move on the ground without slipping.

Spiked shoes for better grip: Spikes are provided in the shoes of players and athletes to increase the friction and provide a better grip on the ground and so as to prevent slipping.

Writing work: We are able to write because there is friction between the tip of pen and paper.

Application of Brakes: The brakes of car or any moving vehicle depends upon friction. When we apply brakes, the car stops due to friction between the brakes lining and drum of the wheel.

Friction is a Necessary Evil: It is useful to us and we cannot do anything without it. At the same time, it is an evil in some cases because it results in the loss of energy and wear and tear of the surface and machinery.

Disadvantages of Friction

Damage the Machines: When the moving parts of a machine are there, a lot of heat is produced due to friction which damages the machine gradually.

Wear and Tear: Friction causes wear and tear of the parts of the machine in contact. Thus the lifetime of a machine is reduced.

Loss of Energy: Extra energy is spent in overcoming friction.

Exercise 12.1

I. Very Short Answer Type Questions (1 Mark)

1. Give one word for the following:

- (a) Force which opposes the motion of one body over another.

- (b) Friction that comes into play when two bodies slide over one another at constant speed. _____
- (c) Friction experienced when a body is made to move over rollers. _____
- (d) Friction which does not allow the movement an object initially kept at rest. _____

2. Fill in the blanks:

- (a) Rolling friction is _____ than the sliding friction.
- (b) We make grooves in the tyres of bicycles to _____ friction.
- (c) _____ is a necessary evil.
- (d) _____ is a disadvantage of friction.
- (e) Friction helps us to _____ on ground.
- (f) Sprinkling of powder on the carromboard _____ friction. (NCERT)
- (g) Sliding friction is _____ than the static friction. (NCERT)

II. Short Answer Type Questions-1 (2 Marks)

3. What name is given to the maximum force which comes into play when one body just starts sliding upon another body? Explain.
4. State three effects which a force of friction can produce.
5. Why is friction considered a necessary evil?

Or

Give example to show that friction is both a friend and a foe. (NCERT)

6. Which force comes into play when one body is made to slide upon another body? Define it.
7. A boy is moving from east to west on a road. In which direction is the force of friction acting on the soles of his shoes.
8. Explain why sportsmen use shoes with spikes? (NCERT)
9. Iqbal has to push a lighter box and Seema has to push a similar heavier box on the same floor. Who will have to apply a large force and why? (NCERT)
10. Why does friction damage the machines?

III. Short Answer Type Questions-2 (3 Marks)

11. Explain why sliding friction is less than static friction. [NCERT]
12. State the factors affecting friction.
13. Why are worn-out tyres discarded?
14. Why is a sewing machine often oiled?
15. Why does a ball rolling on the ground slow down?
16. The handle of a cricket bat or a badminton racquet is usually rough. Explain. [NCERT Exemplar]

IV. Long Answer Type Questions (5 Marks)

17. What is the force of friction? What is the cause of friction?
18. State the different types of friction giving one example each.
19. State one advantage and one disadvantage of friction.
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ANSWERS

1. (a) Friction (b) Sliding friction
(c) Rolling friction (d) Static friction
 2. (a) less (b) increase
(c) Friction (d) Wear and tear
(e) walk (f) reduces
(g) lower
 3. Sliding friction
 4. (a) Friction opposes motion
(b) Friction produces heat
(c) Friction causes wear and tear
 5. It is useful to us and we cannot walk, write and do other important things without it. At the same time, it is an evil in some cases because it results in the loss of energy and wear and tear of the surface and machinery.
 6. The opposing force that comes into play when one body is actually sliding over the surface of another body is called sliding friction. Example: When a log of wood is moved on a flat surface, it slides. The opposing force is sliding friction.
 7. Force of Friction → West to East
 8. Spikes are provided in the shoes of players and athletes to increase the friction and provide a better grip on the ground and so as to prevent slipping.
 9. Seema will have to apply a large force because more the weight, more the friction and less weight implies less friction.
 10. When the parts of a machine are moving a lot of heat is produced due to friction which can damage the machine gradually.
 11. When an object starts sliding, the contact points of its surface, do not get enough time to lock into the contact points on the floor. So sliding friction is less than static friction.
 12. (a) The nature of surfaces in contact with each other (rough surface offers more friction while smooth surface offers less friction).
(b) The weight of the body (more weight more friction, less weight less friction).
 13. Friction causes wear and tear and render them inappropriate.
 14. Oil acts as a lubricant and forms a thin layer between the two surfaces in contact which reduces friction.
 15. Due to the force of friction, which opposes its motion and brings it to a halt.
 16. The major reason for making the handle of a cricket bat or a badminton racquet rough is to increase friction for a better grip.
 17. The force acting along the two surfaces in contact which opposes the motion of one body over the other is called the force of friction. Due to interlocking of rough surfaces. The interlocking of two surfaces opposes the motion of one body over another and gives rise to frictional force.
 18. **Static Friction:** The opposing force that comes into play when one body tends to move over the surface of another, but the actual motion has not started is called static friction.
Example: When force is just applied on a log of wood lying on a flat surface to make it move but it is still not in motion.
Sliding Friction: The opposing force that comes into play when one body is actually sliding over the surface of another body is called sliding friction. *Example:* When a log of wood is moved on a flat surface, it slides. The opposing force is sliding friction.
Rolling Friction: The opposing force that comes into play when one body is actually rolling over the surface of another body is called rolling friction. *Example:* When a wheel or a log of wood rolls over a flat surface, the opposing force is the rolling friction.
 19. (a) **It helps us walk:** The friction between our feet and the ground helps us walk on the ground without slipping or falling.
(b) **Damage the machine:** When the moving parts of a machine are there, a lot of heat is produced due to friction which can damage the machine gradually.
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12.2 FLUID FRICTION; WAYS OF INCREASING AND DECREASING FRICTION

Fluid Friction: Liquids and gases exert friction on the solid bodies moving over them. This is called fluid friction. Liquid and gases exert lesser friction as compared to solid surfaces.

Friction Due to Water: When a person swims in water, the water opposes his motion, this is because water exerts a force of friction on the swimmer.

The special shape of a body or an object around which a fluid (liquid or air) can flow offering minimum friction is called *streamlined* shape – Bodies of ships and boats are streamlined so that they experience least amount of friction in water.

Friction Due to Air: Air exerts the force of friction on all bodies which move through it and opposes their motion. But the friction of air is so small that we are not able to experience its effect easily. *Example:* In nature, the bodies of birds are streamlined so that they experience least amount of friction in air.

Ways of Increasing Friction

By Making the Surfaces Rough: The surface of head of a matchstick and the sides of a match box are deliberately made rough to increase the friction to produce more heat because of which the matchstick lights easily.

By Making Grooves: By making grooves in tyres of bicycles, cars, buses, due to greater friction the tyres get a better grip on the road which prevent skidding of the vehicles.

Ways of Reducing Friction

By lubrication: By applying oil, grease, a thin layer of lubricant is formed and moving surface do not directly rub each other.

By polishing: When the surface are highly polished, the irregularities of the surfaces are covered making them smoother.

By using ball-bearings: Ball-bearing is a hollow, circular device containing small metal balls, which are fitted around the moving part of a machine. The ball-bearing reduces the friction by converting sliding friction into rolling friction. For example, when the axle of a machine fitted with ball-bearing rotates, then the metal balls also roll and hence friction is reduced.

By using rollers and wheels: Many heavy objects (big suitcases) are provided with small wheels to reduce friction, so that they may be carried easily by pulling.

By streamlined: The bodies of boats and ships are streamlined to reduce the friction of water.

Exercise 12.2

I. Very Short Answer Type Questions (1 Mark)

1. Give one word for the following:

(a) The force exerted by liquids and gases. _____

(b) Special shape given to a body so that it can easily flow in liquid. _____

(c) Repeated rubbing of two objects causes. _____

(d) Substances which reduce friction. _____

- (e) A hollow, circular device containing small metal balls which are fitted around the moving part of a machine. _____
- (f) Heavy objects are provided with small wheels. _____

2. Fill in the blanks:

- (a) The bodies of ships and boats are _____ to reduce friction of water.
- (b) Many heavy objects are provided with _____ to reduce friction.
- (c) When the surface is _____, the irregularities of the surface are covered, making them smooth.
- (d) By applying _____, a thin layer is formed and moving surfaces do not directly rub each other.
- (e) By making _____ on tyres of cars, trucks, due to greater _____, they get a better grip on the road.
- 3.** Suppose your writing desk is tilted a little. A book kept on it starts sliding down. Show the direction of frictional force acting on it. (NCERT)
- 4.** You spill a bucket of soapy water on a marble floor accidentally. Would it make easier or more difficult for you to walk on the floor? Why? (NCERT)

II. Short Answer Type Questions-1 (2 Marks)

- 5.** Give reasons for the following:
- (a) The bodies of birds are streamlined.
- (b) When we strike a matchstick against the rough surface, it catches fire.
- (c) Grooves are made in tyres.
- (d) A lubricant reduces friction.
- 6.** How does a ball-bearing reduce friction?
- 7.** You might have noticed that when used for a long time, slippers with rubber soles become slippery. Explain the reason. (NCERT Exemplar)
- 8.** Is there a force of friction between the wheels of a moving train and iron rails? If yes, name the type of friction. If an air cushion can be introduced between the wheel and the rail, what effect will it have on the friction? (NCERT Exemplar)
- 9.** Cartilage is present in the joints of our body, which helps in their smooth movement. With advancing age, this cartilage wears off. How would this affect the movement of joints? (NCERT Exemplar)
- 10.** While playing tug of war, Preeti felt that the rope was slipping through her hands. Suggest a way out for her to prevent this. (NCERT Exemplar)
- 11.** The handle of a cricket bat or a badminton racquet is usually rough. Explain the reason. (NCERT Exemplar)
- 12.** Explain why the surface of mortar and pestle (**silbatta**) used for grinding is etched again after prolonged use? (NCERT Exemplar)
- 13.** A marble is allowed to roll down an inclined plane from a fixed height. At the foot of the inclined plane, it moves on a horizontal surface (a) covered with silk cloth (b) covered with a layer of sand and (c) covered with a glass sheet. On which surface will the marble move the shortest distance. Give reason for your answer.
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14. A father and son pushed their car to bring it to the side of road as it has stalled in the middle of the road. They experienced that although they has to push with all their might initially to move the car, the push required to keep the car rolling was smaller, once the car started rolling. Explain.

(NCERT Exemplar)

III. Short Answer Type Questions-2 (3 Marks)

15. Explain 'friction due to water'.
16. What is a lubricant? How does a lubricant reduce friction?
17. Why is an aeroplane given special shape?

IV. Long Answer Type Questions (5 Marks)

18. Name four ways by which friction can be reduced between two surfaces in contact.
19. Name two ways by which we can increase friction between two surfaces in contact.
20. What do you understand by 'streamlined'? Name a few machines which use streamlined to reduce friction.
21. When the cutting edge of a knife is put against a fast rotating stone to sharpen it, sparks are seen to fly. Explain the reason. (NCERT Exemplar)
22. We have two identical metal sheets. One of them is rubbed with sand paper and the other with ordinary paper. The one rubbed with sand paper shines more than the other. Give reason. (NCERT Exemplar)

ANSWERS

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| <p>1. (a) Fluid friction (b) Streamline shape
(c) Wear and tear (d) Lubricant
(e) Ball-bearing (f) Rollers</p> <p>2. (a) streamlined (b) rollers
(c) polished (d) oil (e) grooves, friction</p> <p>3. The force of friction is opposite to the direction of motion i.e., in the upward direction.</p> <p>4. It is difficult to walk on a marble floor with soapy water as friction is very less.</p> <p>5. (a) Air exerts the force of friction on all bodies which move through it and opposes their motion. In nature, the bodies of birds are streamlined so that they experience least amount of friction in air.</p> <p>(b) The surface of head of a matchstick and the sides of a match box are deliberately made rough to increase the friction to produce more heat because of which the matchstick lights easily.</p> <p>(c) By making grooves in tyres of bicycles, cars, buses, due to greater friction the tyres get a better grip on the road which</p> | <p>prevent skidding of the vehicles.</p> <p>(d) By applying oil, grease, a thin layer is formed and moving surface do not directly rub each other.</p> <p>6. Ball-bearing is a hollow, circular device containing small metal balls, which are fitted around the moving part of a machine. The ball-bearing reduces the friction by converting sliding friction into rolling friction. For example, when the axle of a machine fitted with ball-bearing rotates, then the metal balls also roll and hence frictions is reduced.</p> <p>7. This is because the surfaces of the slippers become smooth due to loss of grooves in the sole which reduces the friction between the sole and the floor thus, slippers become slippery.</p> <p>8. Yes, this is known as rolling friction. Introducing air cushion between the wheel and the rails will decrease the friction.</p> <p>9. The wearing off of the cartilage will make the surfaces rough which in turn</p> |
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will increase the friction. This will lead to difficulty in movement of joints. If this continues for a longer time it may lead to joint pains.

10. She can rub her hands with soil to increase friction between the rope and her hand.
11. The handle of a cricket bat or a badminton racquet is usually rough to increase the force of friction between handle of the bat or a badminton racquet and hands, to get a better grip.
12. The surface of mortar and pestle (**silbatta**) used for grinding is etched again after prolonged use to increase the force of friction between the two surfaces to get effective grinding again.
13. Marble will move the shortest distance on the surface covered with a layer of sand because sand offers maximum friction against motion.
14. Because initially they had to apply force to set the car in motion by overcoming the static force of friction but as soon as the car starts to move, smaller force will be required to balance rolling friction between tyres of the car and road.
15. When a person swims in water, the water opposes his motion, this is because water exerts a force of friction on the swimmer.
The special shape of a body or an object around which a fluid (liquid or air) can flow offering minimum friction is called streamlined shape. Bodies of ships and boats are streamlined so that they experience least amount of friction in water.
16. A lubricant is a substance, which when applied between two surfaces in contact reduces the force of friction between them. By applying oil, grease or any other lubricant, a thin layer is formed between moving surfaces and they do not directly rub each other.
17. The bodies of aeroplane are in streamlined shape to reduce the friction of air.
18. **By lubrication:** By applying oil, grease etc. thin layer is formed and moving surface do not directly rub each other.

By polishing: When the surface are highly polished, the irregularities of the surfaces are covered making them smoother.

By using ball-bearings: Ball-bearing is a hollow, circular device containing small metal balls, which are fitted around the moving part of a machine. The ball-bearing reduces the friction by converting sliding friction into rolling friction. For example, when the axle of a machine fitted with ball-bearing rotates, then the metal balls also roll and hence friction is reduced.

By using rollers and wheels: Many heavy objects (big suitcases) are provided with small wheels to reduce friction, so that they may be carried easily by pulling.

By streamlined: The bodies of boats and ships are streamlined to reduce the friction of water.

19. **By making the surfaces rough:** The surface of head of a matchstick and the sides of a match box are deliberately made rough to increase the friction to produce more heat because of which the matchstick lights easily.

By making grooves: By making grooves in tyres of bicycles, cars, buses. Due to greater friction the tyres get a better grip on the road which prevent skidding of the vehicles.

20. Giving a shape to the bodies, such that they offer the least resistance to air and water is called streamlining. *Example:* Modern aircrafts, boats and ships are streamlined so as to reduce friction.
21. When the cutting edge of a knife is put against a fast rotating stone to sharpen it the friction between grinding stone and the cutting edge of the knife produces a large amount of heat and is seen as flying sparks.
22. The sand paper being rough than ordinary paper exerts greater frictional force between sand paper and metal sheet that removes the outer dull layer from the metal sheet more efficiently and makes it acquire a shining appearance.

Did You Know?

- The shooting stars (meteors) when enter the atmosphere at very high speed catch fire and burn completely before reaching the surface of the earth. This is because that at such a speed the friction between the meteors and the earth's atmosphere is extremely high.
- There is a heat shield at the nose of the spaceships. This is done so that when spaceships enter the atmosphere they do not catch fire due to the friction fair.

HOTS & VALUE BASED QUESTIONS

1. Why do carrom coins move faster on the carrom board when dusted with talcum powder? **(HOTS)**
2. Which one is easy to hold, a glass tumbler or an earthen pot in hands? Give reasons? **(HOTS)**
3. Why are big heavy suitcases provided with rollers? **(HOTS)**
4. Why is a ceiling fan fitted with ball-bearings? **(HOTS)**
5. Rahul played football in his usual shoes and usually he used to slip on the ground. His friend Raman asked him to buy spiked shoes to avoid slipping.
(a) What was the reason behind Raman's advice?
(b) What values are shown by Raman? **(VBQ)**
6. Vineet was going to school but he saw that the chain of bag was not working. His sister advised him to rub wax on it and when Vineet did this he was able to close the chain of the bag.
(a) Here what is the work of wax?
(b) What values are shown by Vineet's sister? **(VBQ)**
7. Nikita is getting late so she drives her car in high speed. Suddenly, she sees a small child crossing the road. She immediately applies brakes and saves the child.
(a) What happens when she applies brakes.
(b) What can we learn from Nikita. **(VBQ)**

ANSWERS

1. Friction is reduced by the talcum powder which acts as a lubricant.
2. Due to the force of friction, which opposes its motion and brings it to a halt.
3. Many heavy objects (big suitcases) are provided with small wheels to reduce friction by converting sliding friction into rolling friction, so that they may be carried easily by pulling.
4. Ball-bearing is a hollow, circular device containing small metal balls, which are fitted around the moving part of a machine. The ball-bearing reduces the friction by converting sliding friction into rolling friction. When the ceiling fan fitted with ball-bearing rotates, then the metal balls also roll and hence frictions is reduced.
5. (a) Spikes are provided in the shoes of players and athletes to increase the friction and provide a better grip on the ground and so as to prevent slipping.
(b) Intelligent, smart, scientific bent of mind.
6. (a) It acts as a lubricant to reduce friction.
(b) She is sensible, smart, intelligent and has scientific bent of mind.
7. (a) The brake leathers used in the braking system of the cars are provided with rough surfaces, so that they provide maximum friction, when brakes are applied.
(b) She is alert, vigilant, presence of mind.