Title	Common misconceptions in frictional force among university physics students
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Common Misconceptions in Frictional Force among University Physics Students

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Many reports conducted in recent years have indicated a wide range of misconceptions in Physics which students have apparently formed even after receiving formal Physics instruction.

Most of the studies focused on force and motion in Mechanics but fewer attempts were made on frictional force. In fact, many students hold common misconceptions about frictional force especially the direction of the force.

Identification of Common Misconceptions - Frictional Force

This study focuses on the identification of common misconceptions about frictional force. In order to find out the misconceptions, an interview was conducted to a small group of students. From the results of the interview a pencil and paper test which consisted of ten items was constructed as shown in the Appendix. Each item of this misconception test consisted of: (a) a multiple-choice question with common or suspected misconceptions used as the distractors of the question so that the misconceptions could in some sense be summarized; (b) an explanation which required students to give their reasons for the answer which they had chosen in order to anlayse their misconceptions; and (c) an open option for students to respond to, if their answers were none of the options given, for the purpose of identifying more possible misconceptions held by the students. There were 42 students involved in this study. All of them have passed as least the first year university Physics course.

Results and Discussion

It is not uncommon that university students possess some common misconceptions in Physics. Frictional force is one of the topics that many university Physics students have misconceptions about. This fact is reflected in the test in which, for quite a number of items, the percentage of correct answers is less than 50%.

The results of the questionnaire are summarized in the table below:

Percentage of correct answers in each item of the test

Item	Group 1	Group 2
	(22 students) (%)	(20 students) (%)
1	68.2	60
2	31.8	75
3	95.5	100
4	72.7	60
5	31.2	30
6	54.7	35
7	86.4	80
8	18.2	35
9	81.8	75
10	36.4	20

Based on the response of students, a summary of common misconceptions regarding frictional force is given as follows:

Common Misconceptions	Comments
1. When a body remains at rest, frictional force always acts on the body with its magnitude equals to $f_f = \mu R$.	Students have not realized that frictional force equals to μR only at the situation when the body starts to move.
2. When an object remains at rest though there is an external force acting on it, the frictional force acting on the object is always equal to zero	Students do not understand that static frictional force is changed from zero to μR and is equal to the applied force but in the opposite direction when the object still remains at rest.
3. When a man is walking forward, frictional force acting on the man by the ground always points the backward direction.	Students have not captured the essence of the statement of frictional force which is valid only when it is applied to the relative motion of the two surfaces at contact.
4. When a person is pedalling a bicycle, the frictional force acting on the rear wheel of the bicycle is along the backward direction.	Students do not know that the forward frictional force exerting on the rear wheel of the bicycle is the only external force that pushes the bicycle forward.
5. When the rider turns his bicycle at the corner of the road, the frictional force acting on the front wheel is in the outward direction.	Students misunderstand that there is a "centrifugal force" acting on the front and the rear wheels of the bicycle.

Although most of the students provided correct answers about frictional forces acting along the backward direction, quite a number of them did not explain appropriately.

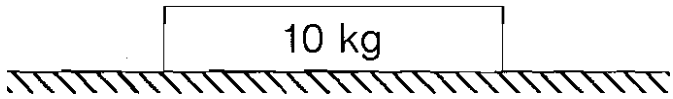
In Physics teaching, there is a need to find out common misconceptions among students and then follow up by designing instruction and teaching strategy based on the findings so that the instruction developed would provide meaningful learning experiences. Such a move will enable students to recognize their misconceptions, correct them & then consistently & successfully analyse & intepret more complicated Physics phenomena and problems.

Appendix

FRICTIONAL FORCE

1 – 4 A box of mass 10 kg will start to move when a force of 10 N acts on it.

1. What is the frictional force acting on the box when it is at rest?

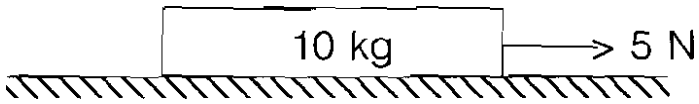


A. 10 N (---->)
B. 10 N (<----)
C. zero N
D. Others (specify)_____ ☐

Explain your answer _____

_____

2. Find the frictional force acting on the box when a force of 5 N is applied on it.

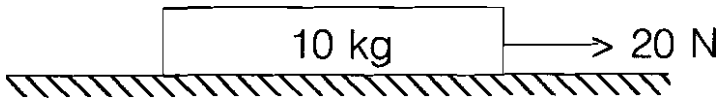


A. 10 N (---->)
B. 5 N (<----)
C. zero N
D. Others (specify)_____ ☐

Explain your answer _____

_____

3. What could be the frictional force acting on the box at the moment a force of 20 N is exerted on it?

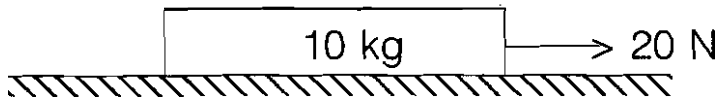


A. 10 N (---->)
B. 10 N (<----)
C. zero N
D. Others (specify) _____ [ ]

Explain your answer _____

_____

4. What could be the frictional force acting on the box when the box is accelerating by a force of 20 N?



A. 10 N (---->)
B. 20 N (<----)
C. Slightly less than 10 N (<----)
D. Others (specify) _____ [ ]

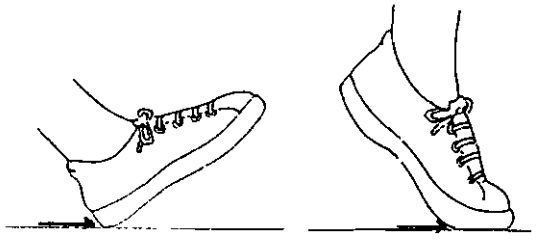
Explain your answer _____

_____

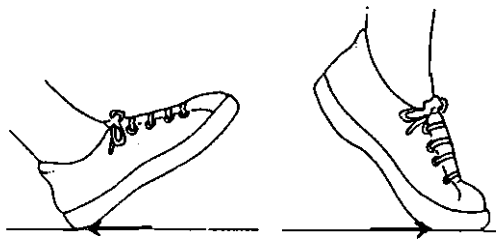
5 − 7 We are able to walk because there is friction between our feet (footwears) and the ground.

5. Which one of the following diagrams best shows the frictional force acting on the man when he is walking?

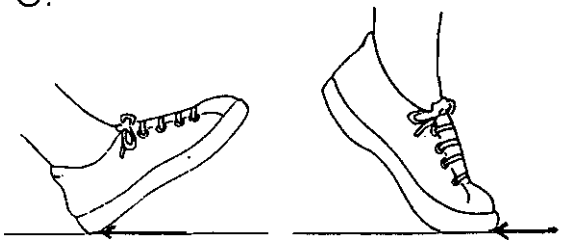
A.



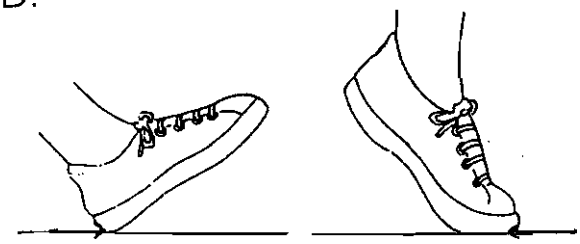
B.



C.



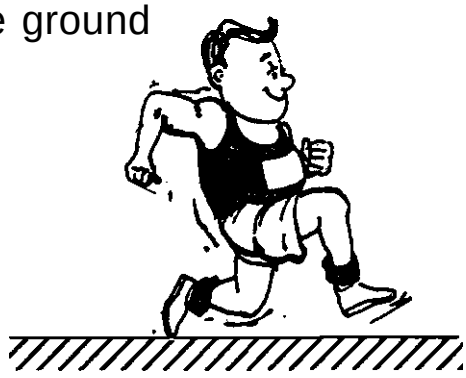
D.



Explain your answer _____

_____

6. When a man is walking forward, the net frictional force acting on the man by the ground



Forward direction

⇒

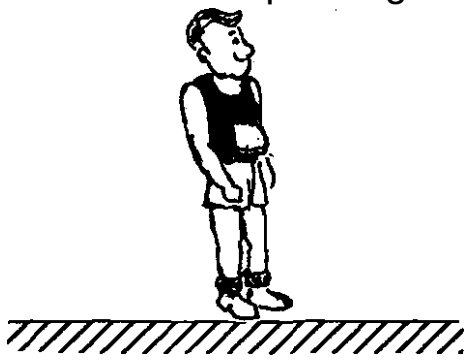
A. is in forward direction ---->
B. is in backward direction <----
C. has no definite direction
D. Others (specify) _____

Explain your answer _____

_____

_____

A man is walking across the road. What is the direction of the frictional force on the man by the road when he tries to stop walking forward as a car is passing in front of him?



A. Forward direction ---->
B. Backward direction <----
C. No definite direction
D. Others (specify) _____ [ ]

Explain your answer _____

_____

_____

8 − 9 A person is riding a bicycle.

Forward direction
---------->

8. In which directions will the frictional forces act on the wheels by the road when the person is pedalling the bicycle?

	Rear. wheel	Front wheel
A.	---->	<----
B.	<----	<----
C.	<----	---->

D. Others (specify) _____ [ ]

Explain your answer _____

_____

_____

In which directions will the frictional forces act on the wheels by the road when the person is NOT pedalling the bicylce?

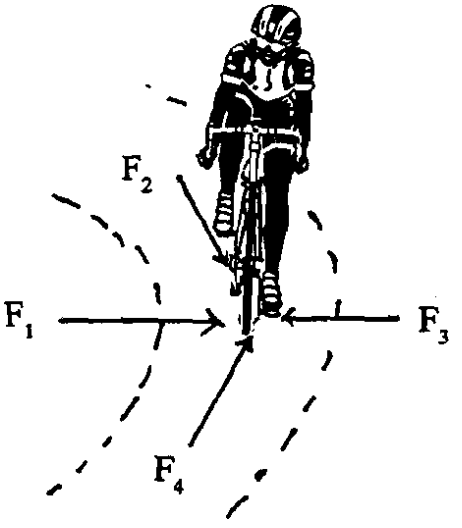
	Rear wheel	Front wheel
A.	---->	<----
B.	<----	<----
C.	<----	---->
D.	Others (specify) _____	

Explain your answer _____

_____

_____

1. A person is pedalling a bicycle. When the rider turns his bicycle at the corner as shown, which force F best indicates the frictional force acting on the front wheel that makes the bicycle turn at the corner?



A. F_1
B. F_2
C. F_3
D. F_4
E. Others (indicate the direction using arrow on the diagram). _____

Explain your answer _____

_____

_____

References

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