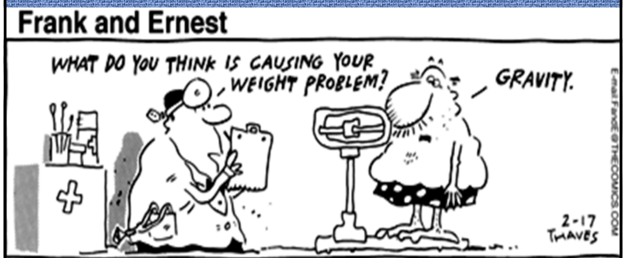


1

Mass and Weight

2

ConcepTest 1 **Mass and Weight**

An astronaut on Earth kicks a bowling ball and hurts his foot. A year later, the same astronaut kicks a bowling ball on the Moon with the same force. His foot hurts ...

1. more
2. less
3. the same

$F_{grav} = \text{"weight"} = mg$

0 of 5

3

Suppose you had a flying platform that can move straight up and down. For each of the cases below, is your apparent weight equal to, greater than, or less than your true weight?

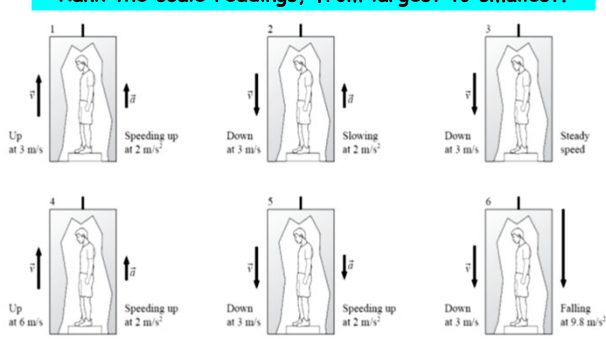
a) ascending and speeding up — N > W
b) descending and speeding up — N < W
c) ascending at constant speed — N = W
d) ascending and slowing down — N < W
e) descending and slowing down — N > W

5.16

PHYS 11: Chap. 5, Pg 4

4

You stand on a scale in six elevators moving as shown. Rank the scale readings, from largest to smallest.



(1=2=4) > 3 > 5 > 6

5.19

PHYS 21: Chap. 6, Pg 5

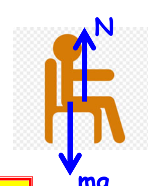
5

How much force does his chair exert on an 80 kg astronaut while he sits at rest on the launch pad?

F_1 = 784 N

How much force does his chair exert while he is accelerating straight up at 10 m/s^2?

F_2 = 1584 N



$$\sum F_y = N - mg = ma_y$$

$$N = mg + ma_y$$

$$= m(g + a_y)$$

$$= mg\left(1 + \frac{a_y}{g}\right)$$

3+2: 3

5.3, 5.19

PHYS 21: Chap. 6, Pg 6

6

This popular amusement park ride shoots you straight up with an acceleration of 4g.
As a result, you feel 5 times as heavy as usual.

Cedar Point (Ohio)

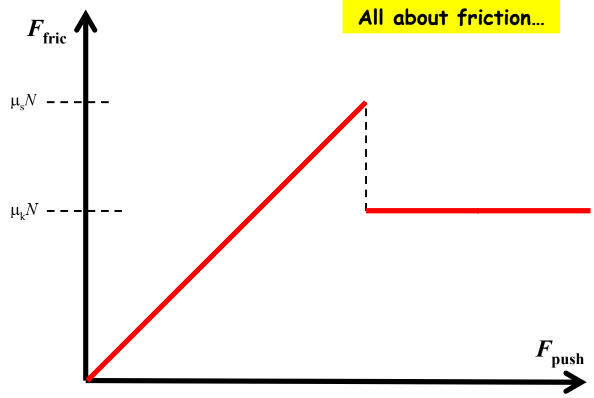
PHYS 21: Chap. 6, Pg 7

7

Friction

8

All about friction…



PHYS 21: Chap. 6, Pg 9

9

TACTICS BOX 5.1 Working with friction forces

❶ If the object is *not moving* relative to the surface it's in contact with, then the friction force is **static friction**. Draw a free-body diagram of the object. The *direction* of the friction force is such as to oppose sliding of the object relative to the surface. Then use Problem-Solving Approach 5.1 to solve for f_s. If f_s is greater than $f_{s\,max} = \mu_s n$, then static friction cannot hold the object in place. The assumption that the object is at rest is not valid, and you need to redo the problem using kinetic friction.

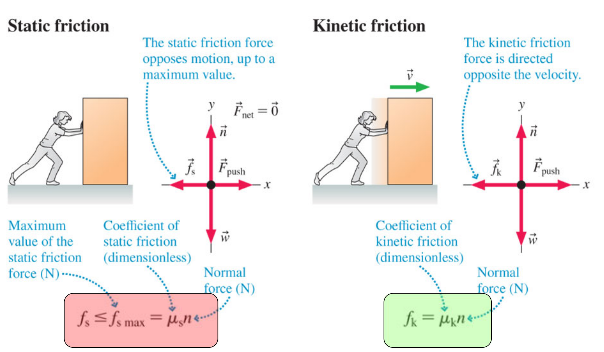
❷ If the object is *sliding* relative to the surface, then **kinetic friction** is acting. From Newton's second law, find the normal force n. Equation 5.10 then gives the magnitude and direction of the friction force.

❸ If the object is *rolling* along the surface, then **rolling friction** is acting. From Newton's second law, find the normal force n. Equation 5.10 then gives the magnitude and direction of the friction force.

... ***relative*** to the surface ...

PHYS 21: Chap. 6, Pg 10

10



PHYS 21: Chap. 6, Pg 11

11

Bonnie and Clyde are sliding a 300 kg bank safe across the floor to their getaway car. The safe slides at a constant speed if Clyde pushes from behind with 385 N of force while Bonnie pulls forward on a rope with 350 N of force.

What is the safe's coefficient of kinetic friction on the bank floor?

$\mu_k = 0.25$

3+2:3
5.25

PHYS 21: Chap. 6, Pg 12

12

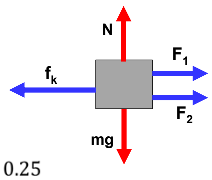
Bonnie and Clyde are sliding a 300 kg bank safe across the floor to their getaway car. The safe slides at a constant speed if Clyde pushes from behind with 385 N of force while Bonnie pulls forward on a rope with 350 N of force.

What is the safe's coefficient of kinetic friction on the bank floor?

$\mu_k = 0.25$

$$\sum F_y = N - mg = 0 \quad \Rightarrow \quad N = mg$$

$$\sum F_x = F_1 + F_2 - \mu_k N = 0$$



$$\mu_k = \frac{F_1+F_2}{N} = \frac{F_1+F_2}{mg} = \frac{735\ N}{2940\ N} = 0.25$$

3+2:3

5.25

PHYS 21: Chap. 6, Pg 13

13

You are pressing a book directly against the wall with your hand. The book is not moving.

a) Draw a free-body diagram for the book.

b) Now you decrease your push, but the book still does not slip. Do the following forces increase or decrease or remain the same? (write ↑ or ↓ or 0)

$\vec{F}_{push}$	$\vec{F}_{grav}$	$\vec{N}$	$\vec{f}_s$	$\vec{f}_{s(max)}$
↓	0	↓	0	↓

6.20

PHYS 21: Chap. 6, Pg 14

14

ConcepTest 2 Newton's 2nd Law

A block pushed along the floor with velocity v_0 slides a distance d after the pushing force is removed. If the mass of the block is doubled without changing v_0, what distance does the block slide?

1. 4d
2. 2d
3. d
4. $\frac{1}{2}$ d
5. $\frac{1}{4}$ d

0 of 5

PHYS 21: Chap. 6, Pg 15

15

ConcepTest 3 Newton's 2nd Law

A block pushed along the floor with velocity v_0 slides a distance d after the pushing force is removed. If the initial velocity is doubled without changing the mass, what distance does the block slide?

1. 4d
2. 2d
3. d
4. $\frac{1}{2}$ d
5. $\frac{1}{4}$ d

0 of 5

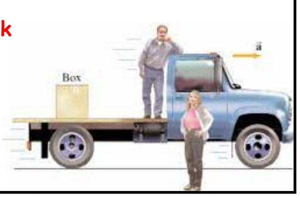
PHYS 21: Chap. 6, Pg 16

16

A box is sitting in the back of a flatbed truck.

a) If the truck gently accelerates, the box moves with the truck without slipping. Draw a free-body diagram for the box and identify specifically the force that makes the box move.

b) What happens if the truck accelerates too rapidly? Explain what is happening and why.



6.21

17

ConcepTest 4 Friction

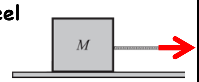
Can a frictional force ever act in the same direction as the motion of an object?

1. yes
2. no
3. I am not really sure

0 of 5

18

A 2 kg steel block is at rest on a steel table. A string pulls on the block.



(a) What is the minimum string tension needed to move the block? T_{min} = 15.7 N

(b) If the string tension is 20 N, what is the block's speed after moving 1 m? v_1 = 2.9 m/s

(c) If the tension is 20 N and the table is coated with oil, what is the block's speed after moving 1 m? v_2 = 4.4 m/s

3+2:3

6.40

steel on steel (dry): $\mu_s = 0.8$ and $\mu_k = 0.6$

steel on steel (with oil): $\mu_s = 0.1$ and $\mu_k = 0.05$

19

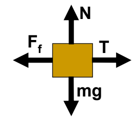
A 2 kg steel block is at rest on a steel table.

A horizontal string pulls on the block. T_{min} = 15.7 N

(a) What is the minimum string tension needed to move the block?

(b) If the string tension is 20 N, what is the block's speed after moving 1 m? v_1 = 2.9 m/s

(c) If the tension is 20 N and the table is coated with oil, what is the block's speed after moving 1 m? v_2 = 4.4 m/s



SOLUTION

$\sum F_y = N - mg = 0$ $\quad N = mg$

$\sum F_x = T - \mu_s N = T - \mu_s mg = 0$ $\quad T = \mu_s mg = (0.8)(2kg)g = 15.7N$

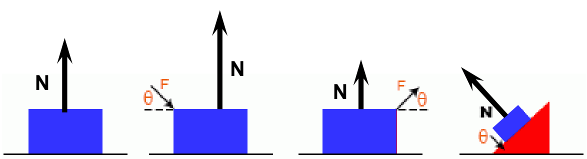
$\sum F_x = 20 - \mu_k mg = ma_x \rightarrow a_x = \frac{20 - \mu_k mg}{m} = \frac{20 - (0.6)(2kg)g}{2kg} = 4.12 m/s^2$

$v_f^2 = v_0^2 + 2a_x(\Delta x) = 0 + 2a_x(\Delta x) \rightarrow v_f = \sqrt{2a_x(\Delta x)} = 2.9 m/s$

$oil: \mu_k = 0.05 \rightarrow a_x = 9.51 m/s^2 \rightarrow v_f = 4.4 m/s$

20

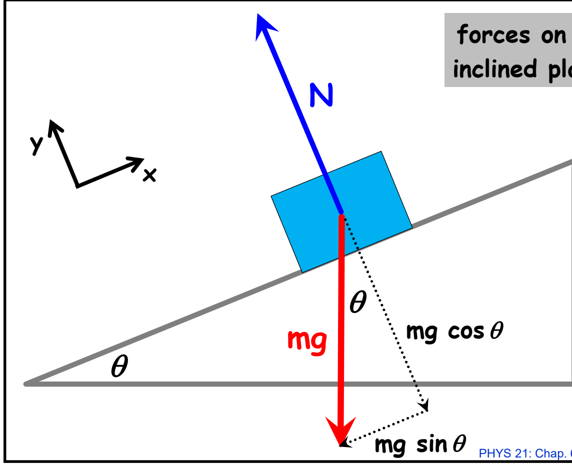
Normal force depends on the situation.



For an object sitting on a flat surface, the normal force is just its weight.	If a force acts downward on the object, the normal force is greater than the weight.	If a force pulls upward on the object, the normal force is less than the weight.	For an object sitting on an incline, the normal force is less than the weight.

21

forces on an inclined plane



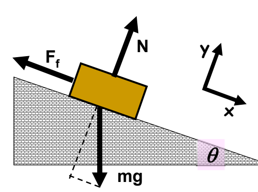
22

A block is placed on a plank of wood, and then one end of the plank is slowly lifted until the box starts to slide. If the coefficient of static friction is μ_s, what is the angle at which the box just begins to slip?

3+2:3

23

A block is placed on a plank of wood, and then one end of the plank is slowly lifted until the box starts to slide. If the coefficient of static friction is μ_s, what is the angle at which the box just begins to slip?



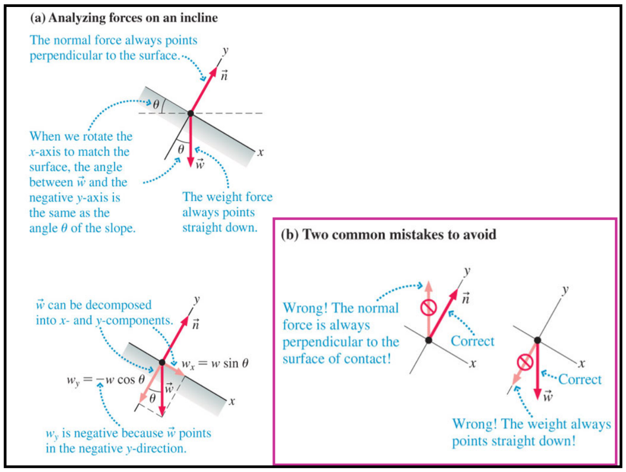
SOLUTION

$\sum F_x = mg\sin\theta - \mu_s N = 0$

$\sum F_y = N - mg\cos\theta = 0 \rightarrow N = mg\cos\theta$

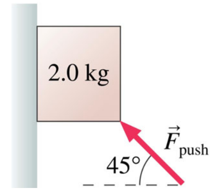
$mg\sin\theta = \mu_s N = \mu_s mg\cos\theta \rightarrow \tan\theta = \frac{\mu_s mg}{mg} = \mu_s$

24



25

A **2.0 kg** wood box slides down a vertical wood wall while you push upward on it at a **45°** angle. For wood on wood, the coefficient of kinetic friction is μ_k **= 0.20**.



What magnitude of force should you apply to cause the box to slide down at constant speed?

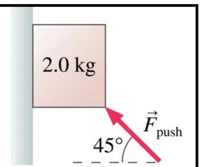
F_{push} = 23.1 N

6.54

PHYS 21: Chap. 6, Pg 26

26

A **2.0 kg** wood box slides down a vertical wood wall while you push upward on it at a **45°** angle. For wood on wood, the coefficient of kinetic friction is μ_k **= 0.20**.



What magnitude of force should you apply to cause the box to slide down at constant speed?

F_{push} = 23.1 N

SOLUTION

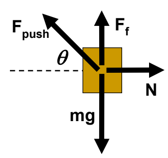
$$\sum F_x = N - F_{push}\cos\theta = 0$$

$$N = F_{push}\cos\theta$$

$$\sum F_y = \mu_k N + F_{push}\sin\theta - mg = 0$$

$$\mu_k F_{push}\cos\theta + F_{push}\sin\theta = mg$$

$$F_{push} = \frac{mg}{\mu_k\cos\theta + \sin\theta} = \frac{(2kg)g}{(0.2)\cos 45° + \sin 45°} = 23.1N$$

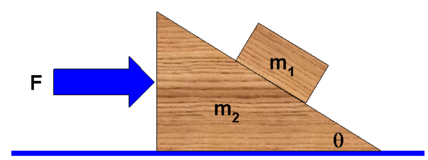


PHYS 21: Chap. 7, Pg 27

27

What horizontal force F must be applied to the wedge such that the mass m_1 does not slip either up or down along the surface of the plane? All surfaces are frictionless.

$F_{push} = (m_1+m_2)\, g \tan\theta$



PHYS 21: Chap. 7, Pg 28

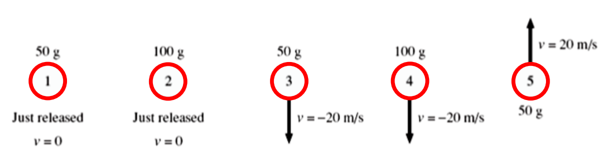
28

Drag

29

Five balls move through the air as shown.
All five have the same size and shape.
Do not ignore air resistance!

Rank in order, from largest to smallest, the magnitude of their accelerations.



5 > (1=2) > 4 > 3

5.26

PHYS 21: Chap. 6, Pg 30

30

ConcepTest 4 Free Fall

A 1 kg wood ball and a 5 kg steel ball have identical shapes and sizes. If they are dropped simultaneously from a tall building, which ball has the larger force on it? (neglect air resistance)

1. wood ball
2. steel ball
3. both the same

0 of 5

31

ConcepTest 4 Free Fall

A 1 kg wood ball and a 5 kg steel ball have identical shapes and sizes. If they are dropped simultaneously from a tall building, which ball has the larger acceleration? (neglect air resistance)

1. wood ball
2. steel ball
3. both the same

Do the balls hit the ground at the same time? If not, which hits the ground first?

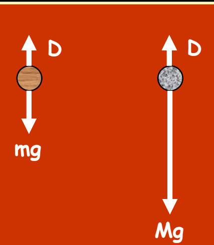
0 of 5

32

ConcepTest 5 Drag

A 1 kg wood ball and a 5 kg steel ball have identical shapes and sizes. If you do not ignore air resistance, which ball has the larger acceleration? (draw a free-body diagram!)

1. wood ball
2. steel ball
3. both the same



Do the balls hit the ground at the same time? If not, which hits the ground first?

33