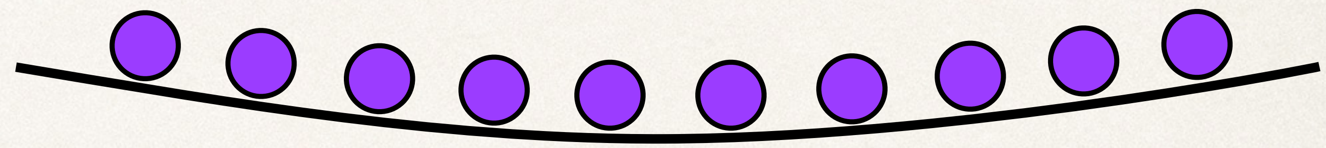
-1.1-

Physics 111/121

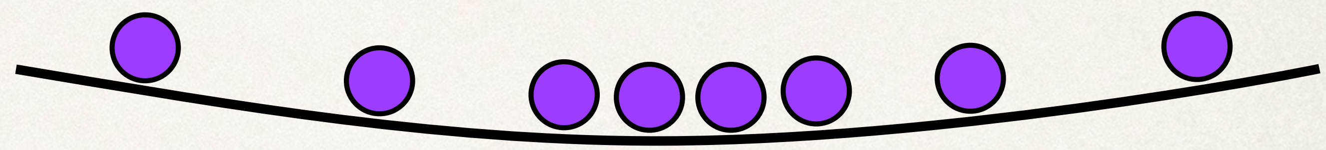
Motion in 1 dimension

Consider the motion you just observed; which motion diagram best represents what you saw?

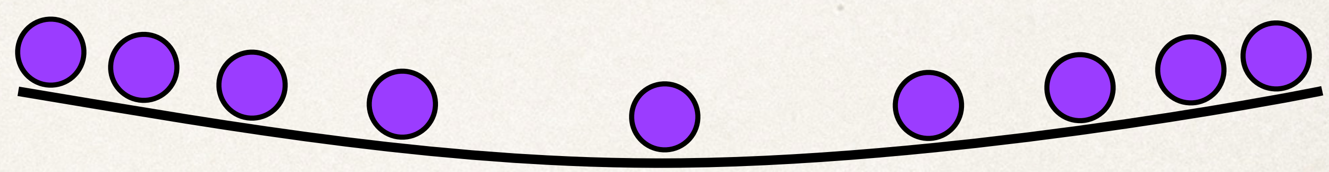
(a)



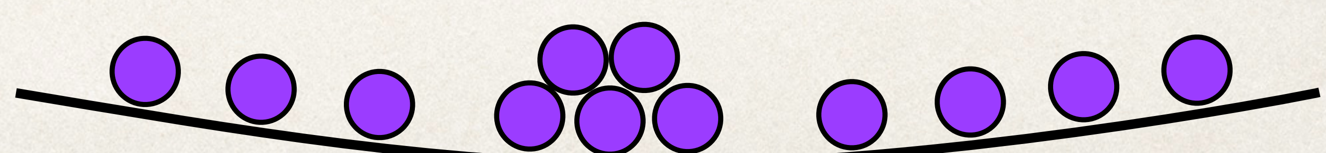
(b)



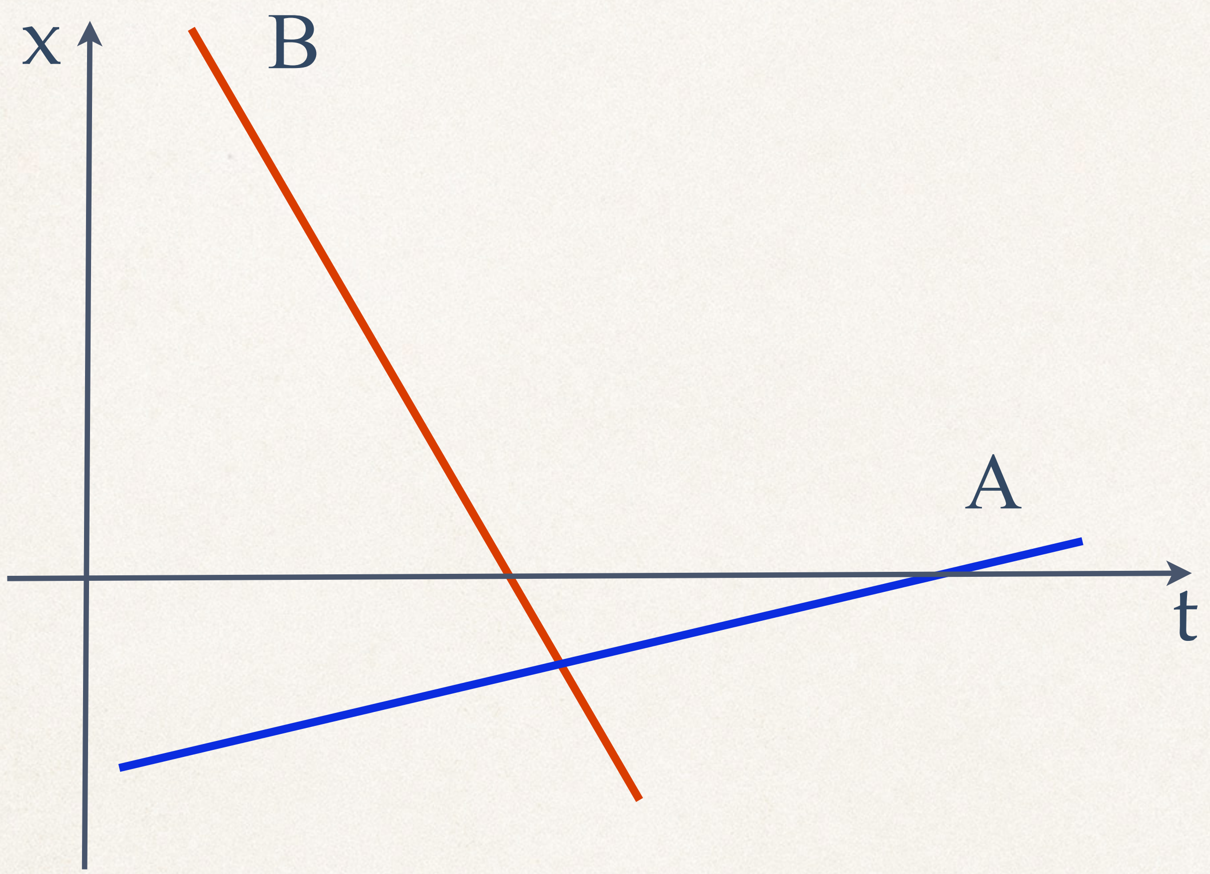
(c)



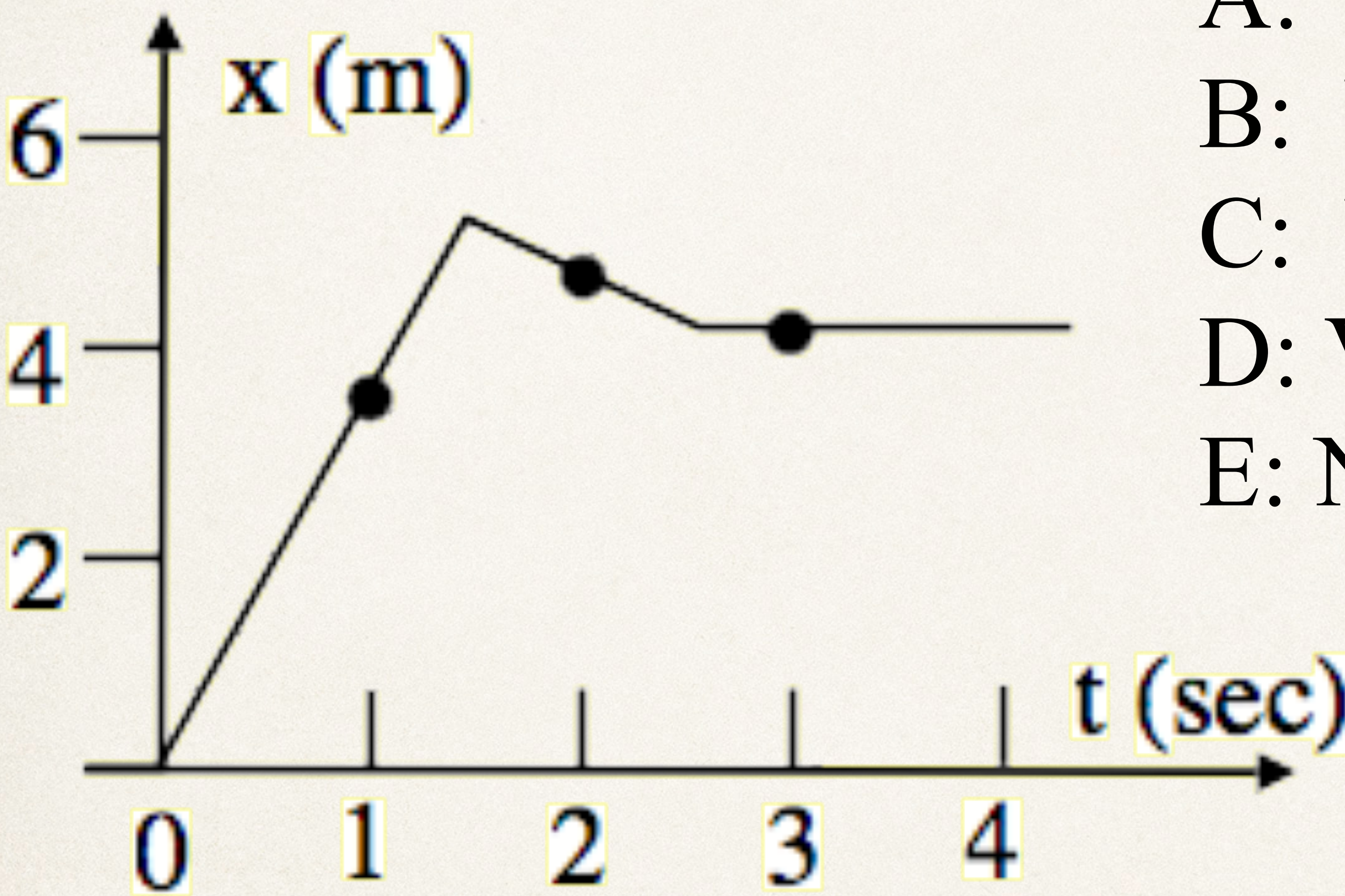
(d)



Which object, A or B, has the larger *velocity*?



Rank order the *speeds* at times 1, 2, and 3 from the slowest to the fastest:



A: V1 < V2 < V3

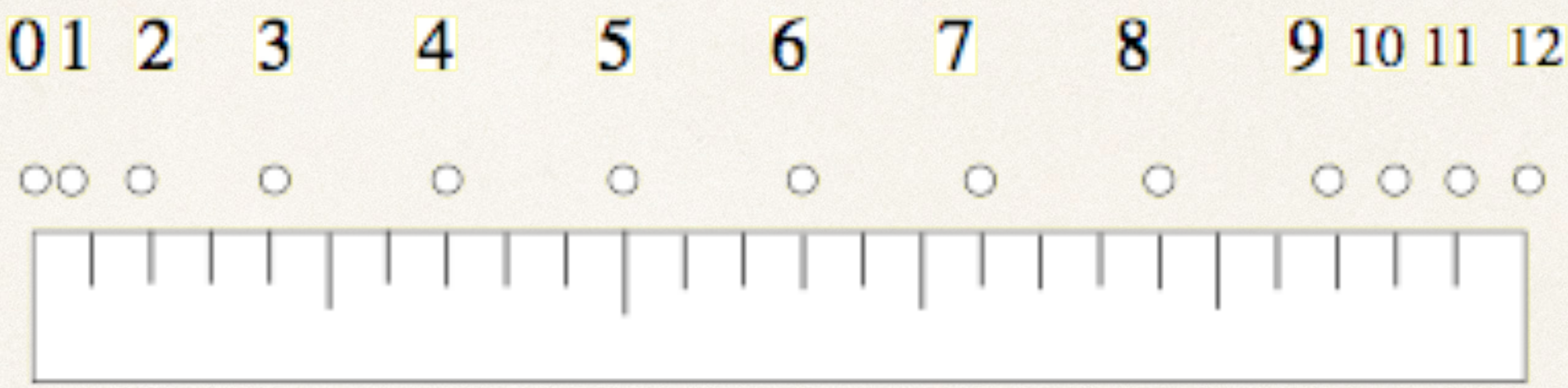
B: V2 < V1 < V3

C: V3 < V1 < V2

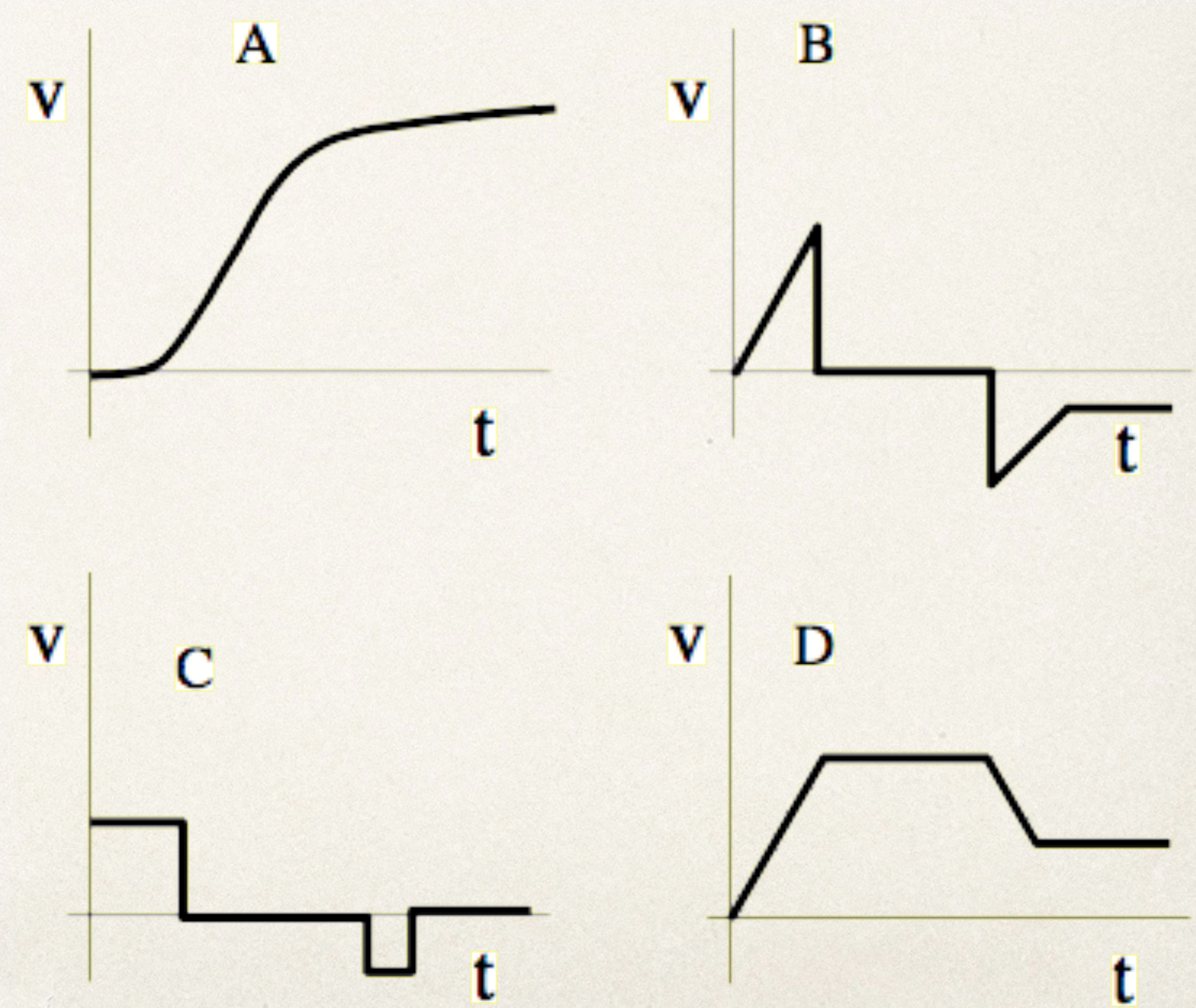
D: V3 < V2 < V1

E: None of these/ not sure

The "multiflash photograph" below shows a ball rolling along a surface. The camera flashed once a second, and the time is shown above each image.

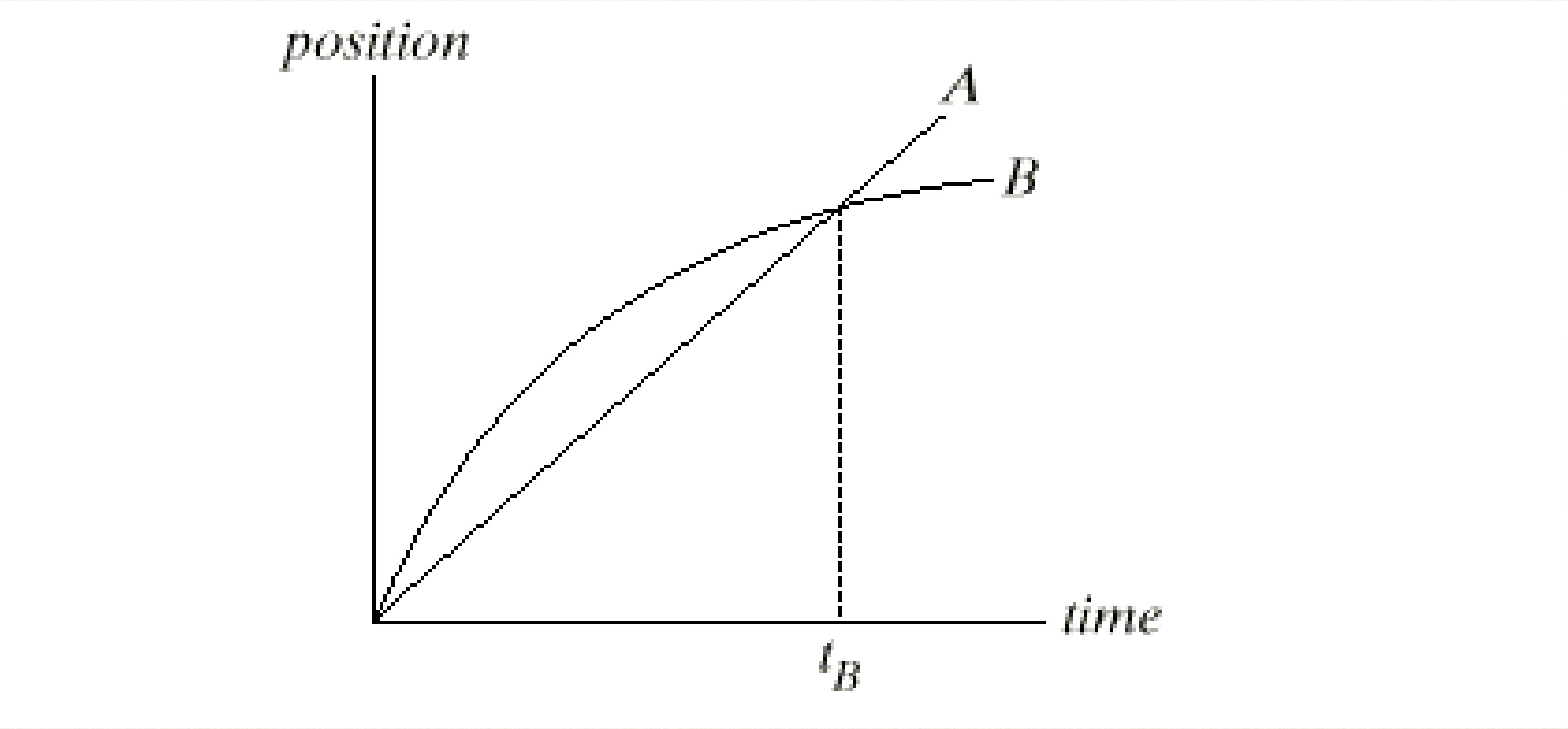


Which graph at the right best represents the ball's *velocity* as a function of time?



The graph shows position as a function of time for two trains running on parallel tracks.

Which is true:



A: At time t_B , both trains have the same velocity.

B: Both trains speed up all the time.

C: Both trains have the same velocity at some time before t_B .

D: Somewhere on the graph, both trains have the same acceleration.

-1.2-

If x is in meters, A is in m/s, and B is in m/s^2, which of the following is dimensionally correct?

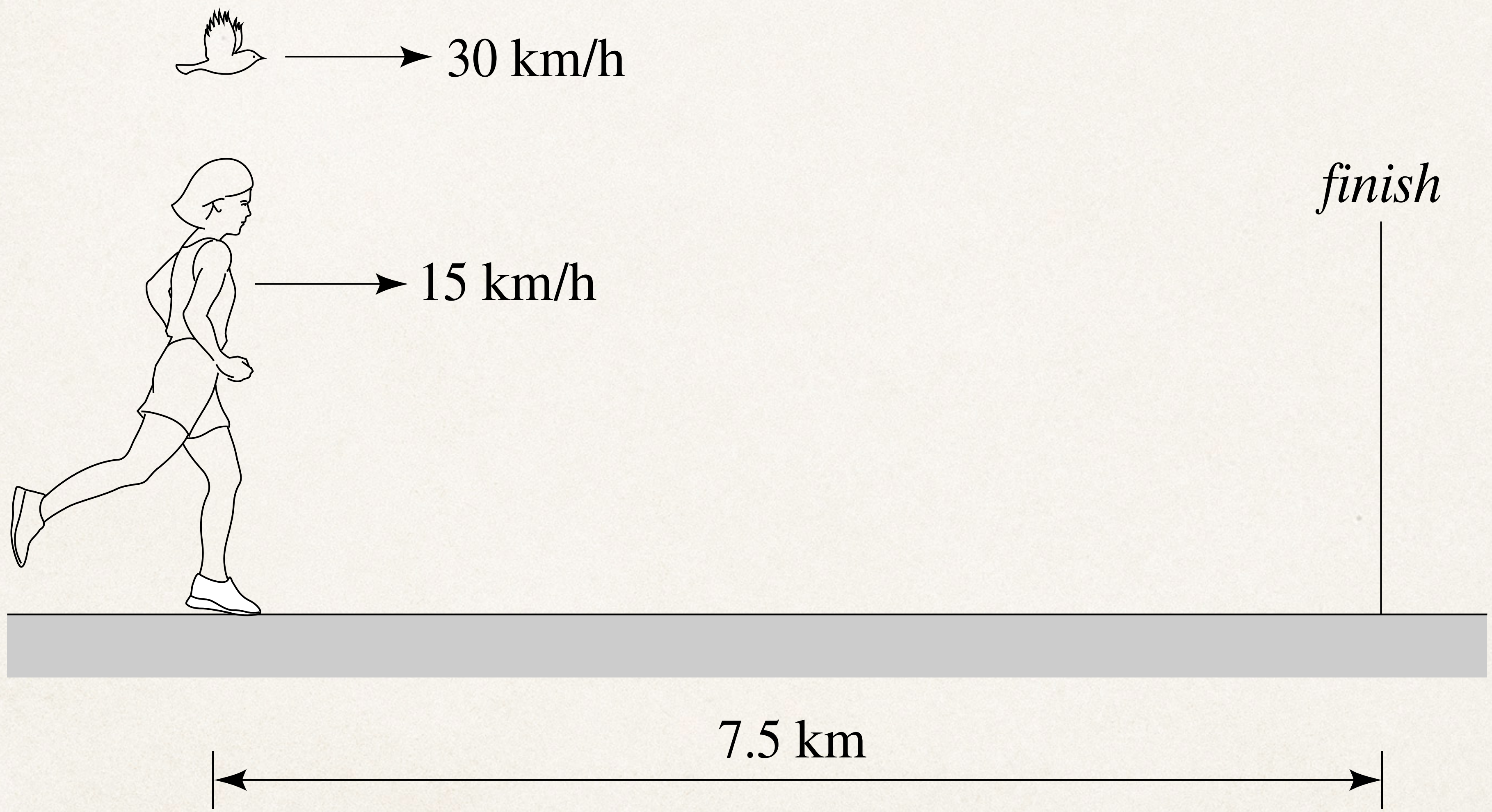
a) $x = At - Bt^3$

b) $x = \frac{A}{t} - Bt$

c) $x = Bt^2 - At$

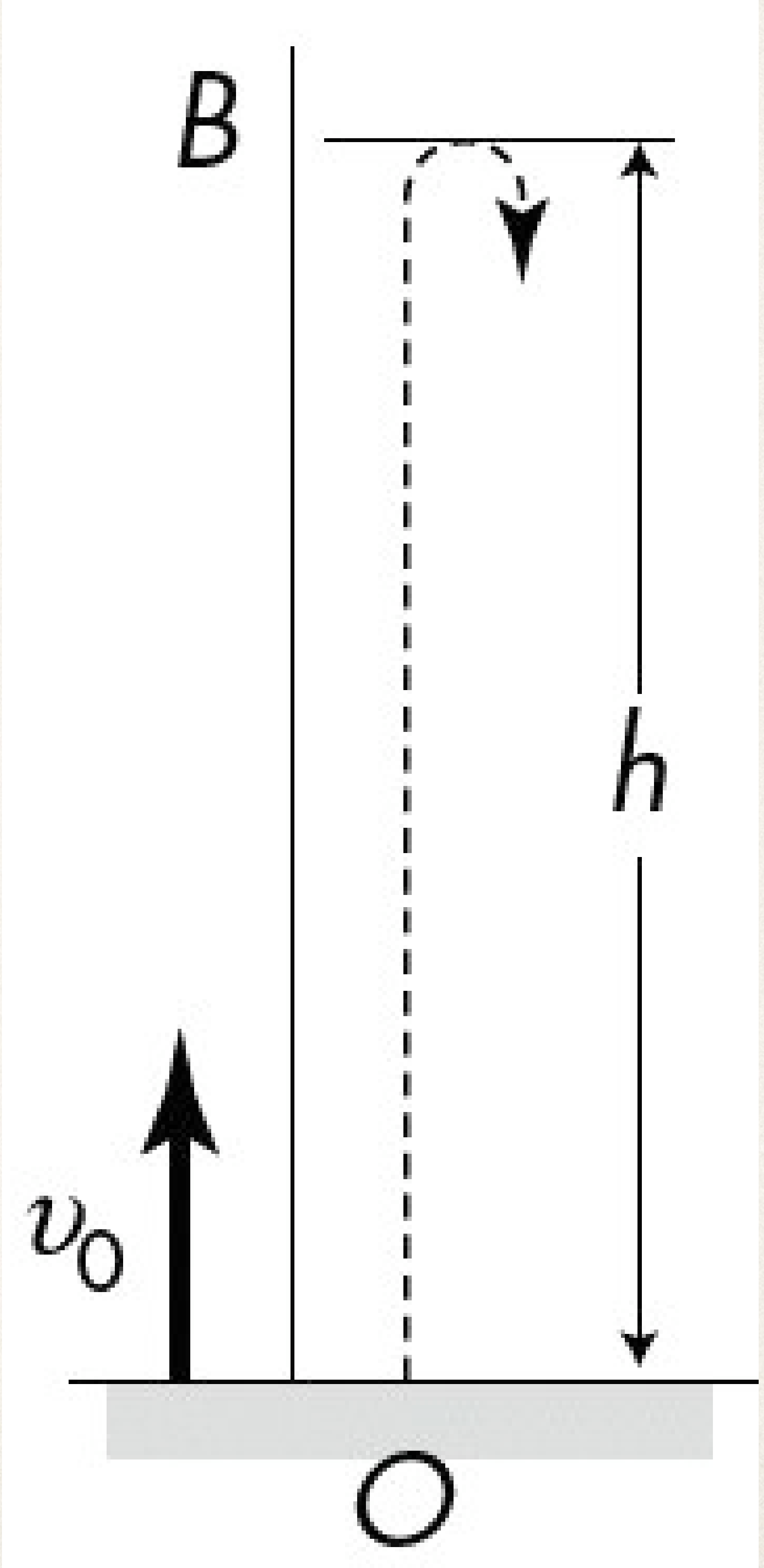
d) $x = At^2 + Bt$

A marathon runner runs at a steady 15 km/hr. When the runner is 7.5 km from the finish, a bird begins flying from the runner to the finish at 30 km/hr. When the bird reach- es the finish line, it turns around and flies back to the runner, and then turns around again, repeating the back-and-forth trips until the runner reaches the finish line. How many kilometers does the bird travel?



a) 10 km b) 15 km c) 20 km d) 30 km

A ball is thrown straight upward. At the top of its trajectory, its acceleration is:



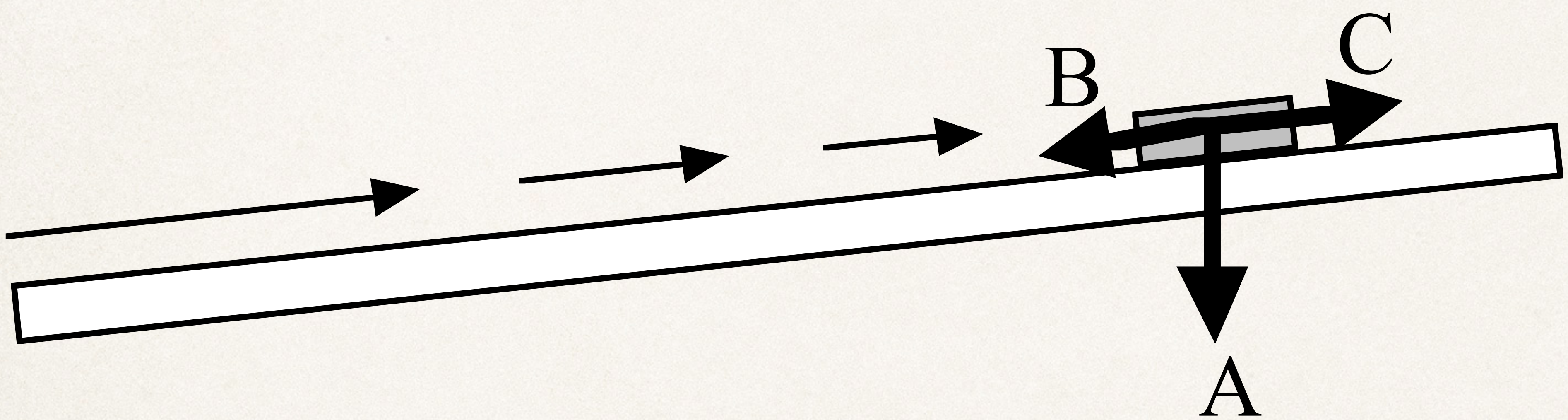
A: zero

B: straight up

C: straight down

D: depends on the mass of the ball

A glider on a tilted air track is given a brief push uphill. The glider coasts up to near the top end, stops, and then slides back down. When the glider is at the highest point of its path, its acceleration is..



A: straight down
B: downward along the track
C: upward along the track
D: no direction, the acceleration is zero.

If you drop an object in the absence of air resistance, it accelerates downward at 9.8 m/s^2. If instead you throw it downward, its downward acceleration after release is

1. less than 9.8 m/s^2.
2. 9.8 m/s^2.
3. more than 9.8 m/s^2.

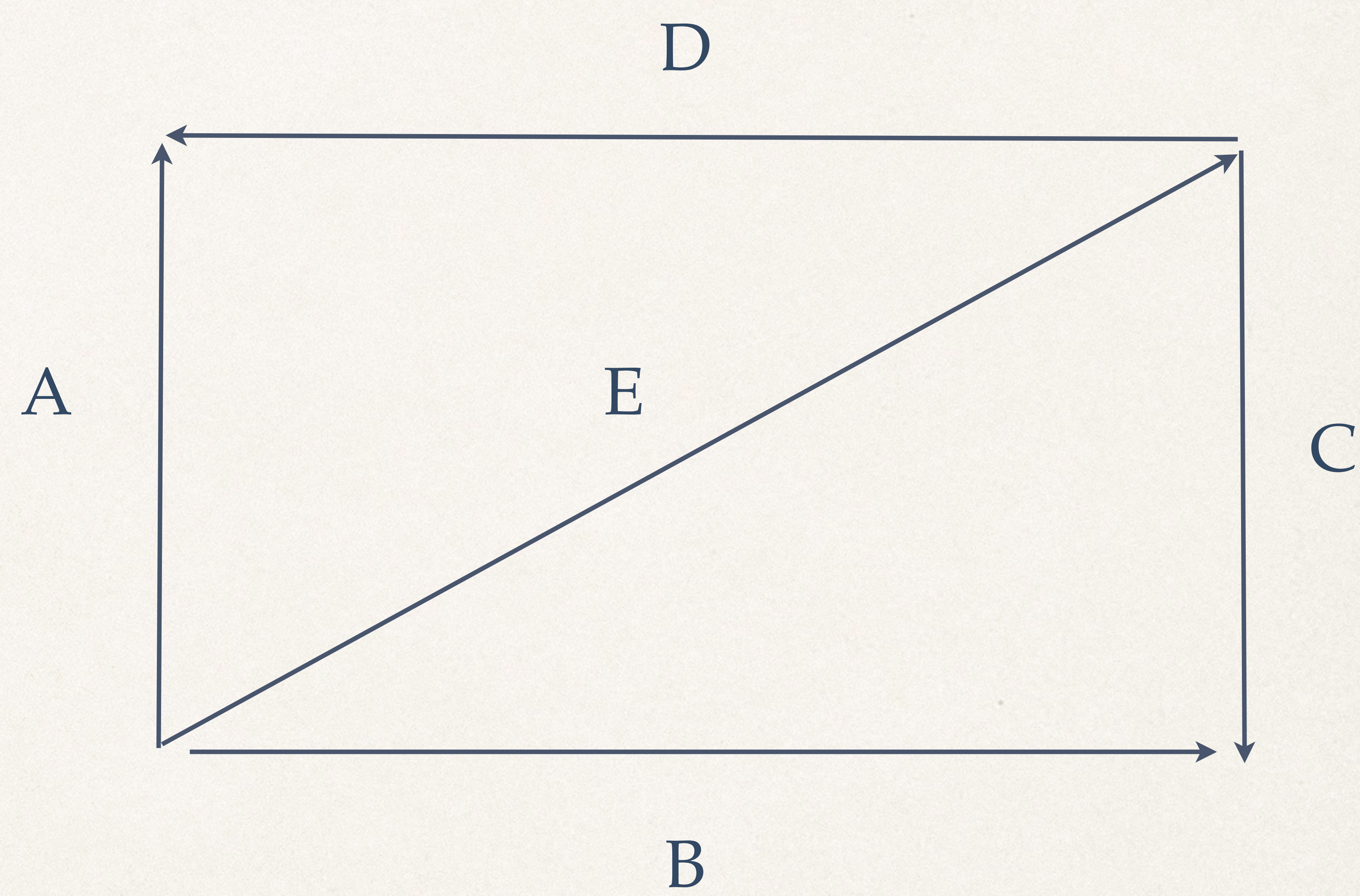
A person standing at the edge of a cliff throws one ball straight up and another ball straight down at the same initial speed. Neglecting air resistance, the ball to hit the ground below the cliff with the greater speed is the one initially thrown

1. upward.
2. downward.
3. neither—they both hit at the same speed.

-3-

Vectors

Several displacement vectors are shown below. Which of the following has the least *magnitude*:



a) A+B-D
b) C+D-B
c) A+B-D-C
d) C+D-E
e) A+B-E

What is the angle between the vectors A & B if

$$\vec{A} = 4\hat{i} - 6\hat{j} \qquad \vec{B} = 6\hat{i} + 4\hat{j} + 23\hat{k}$$

a) 0^o
b) 10^o
c) 45^o
d) 90^o
e) 120^o

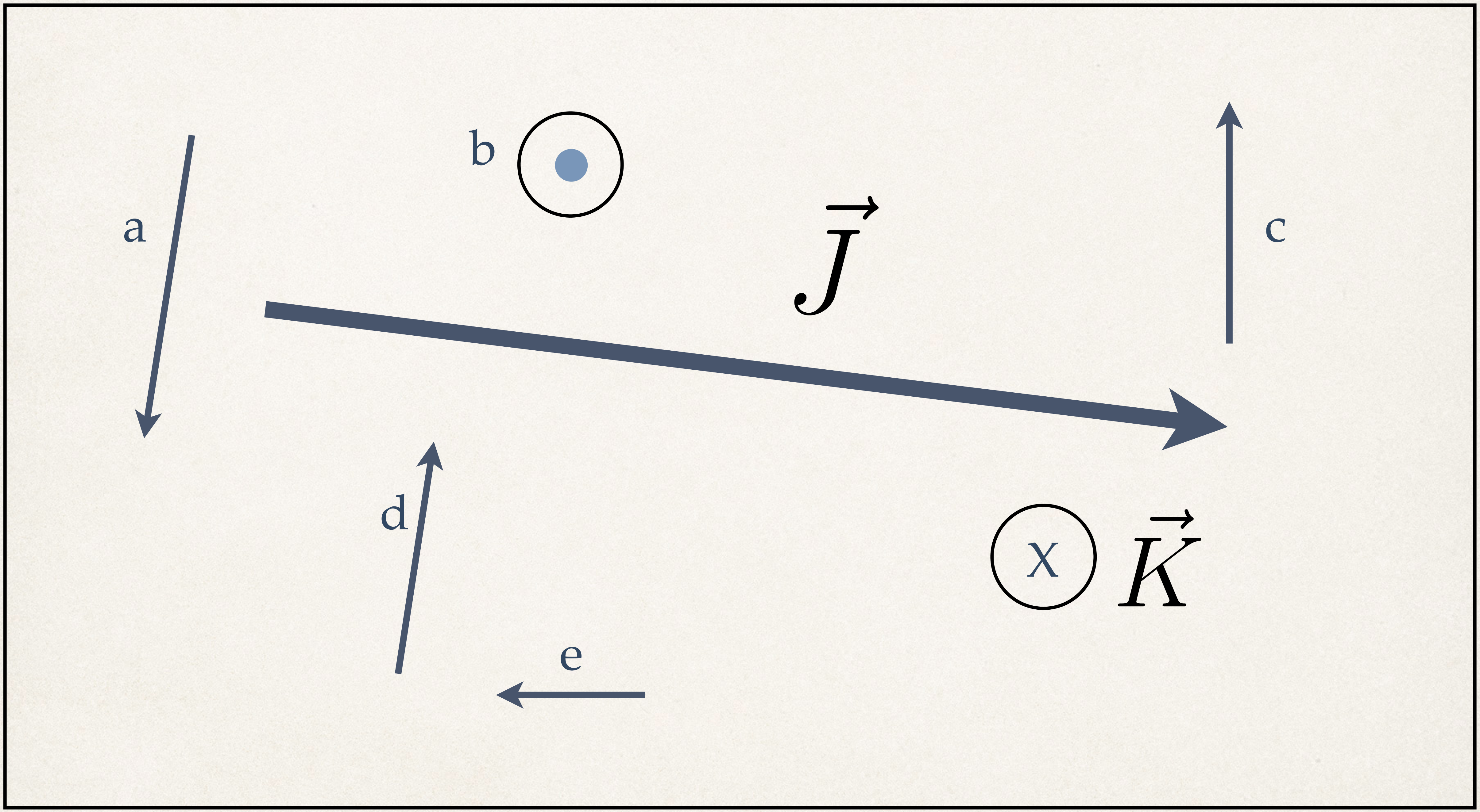
If the angle between the vectors A & B below is 180^o, which of the following is **not** a possible value of the x-component B_x?

$$\vec{A} = 4\hat{i} - 6\hat{j}$$

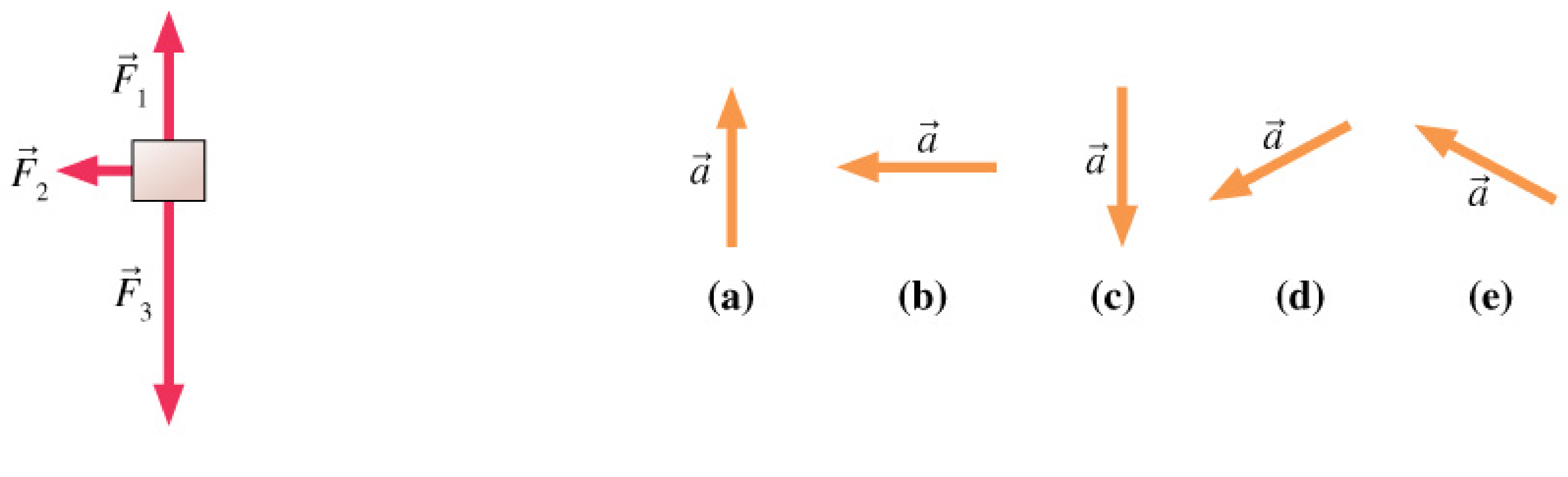
$$\vec{B} = B_x\hat{i} + 4\hat{j} + 23\hat{k}$$

a) 2.25 b) 3.00 c) 4.60 d) 5.75
e) 8.00

What is the direction of $\vec{J} \times \vec{K}$?



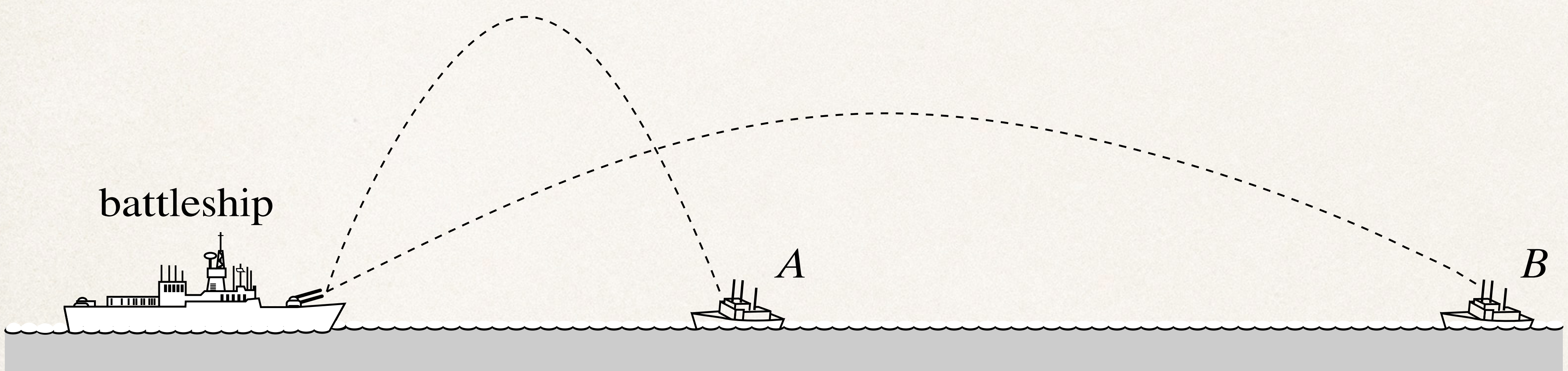
Three forces act on an object. In which direction does the object accelerate?



-4-

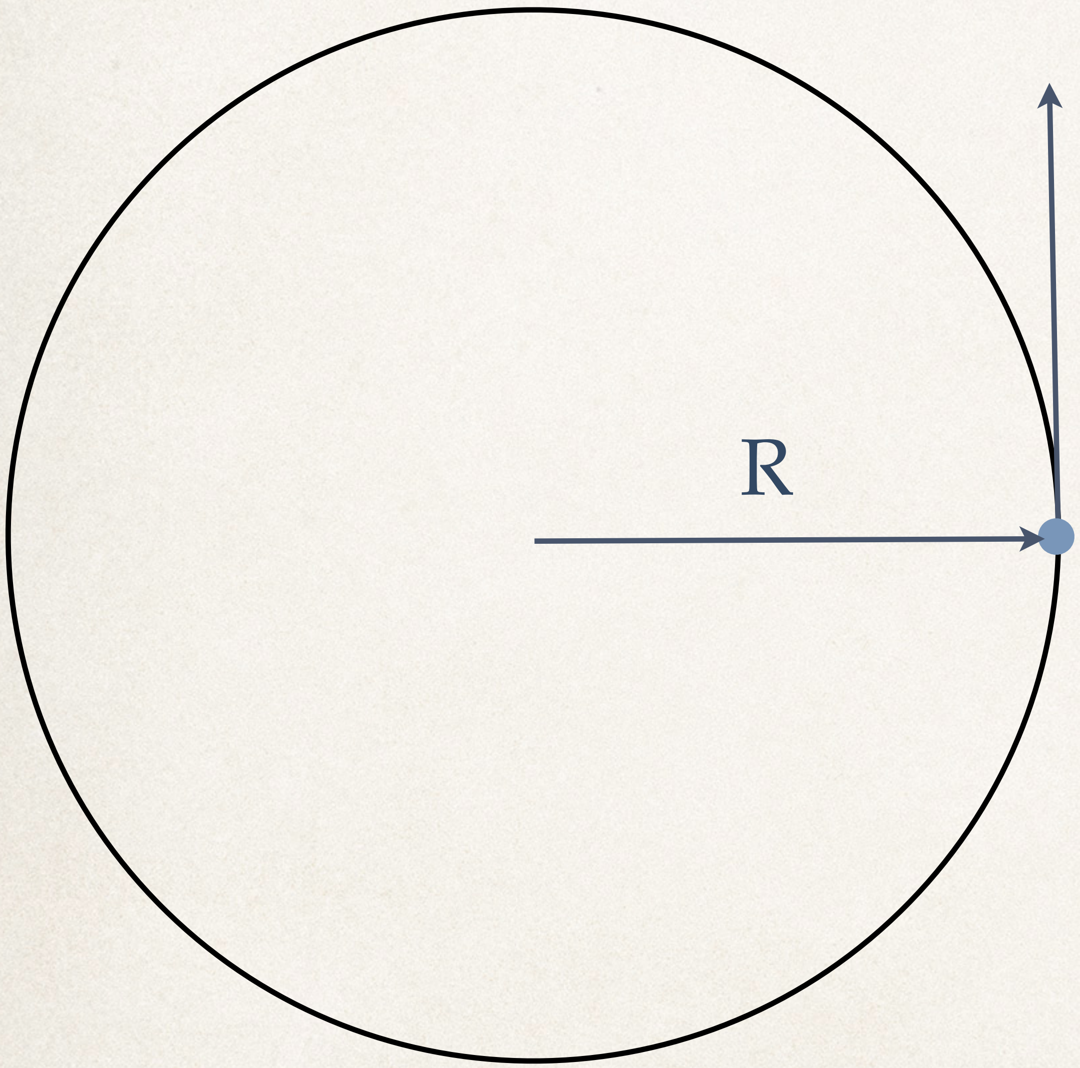
2D Kinematics

A battleship simultaneously fires two shells at enemy ships. If the shells follow the parabolic trajectories shown, which ship gets hit first?



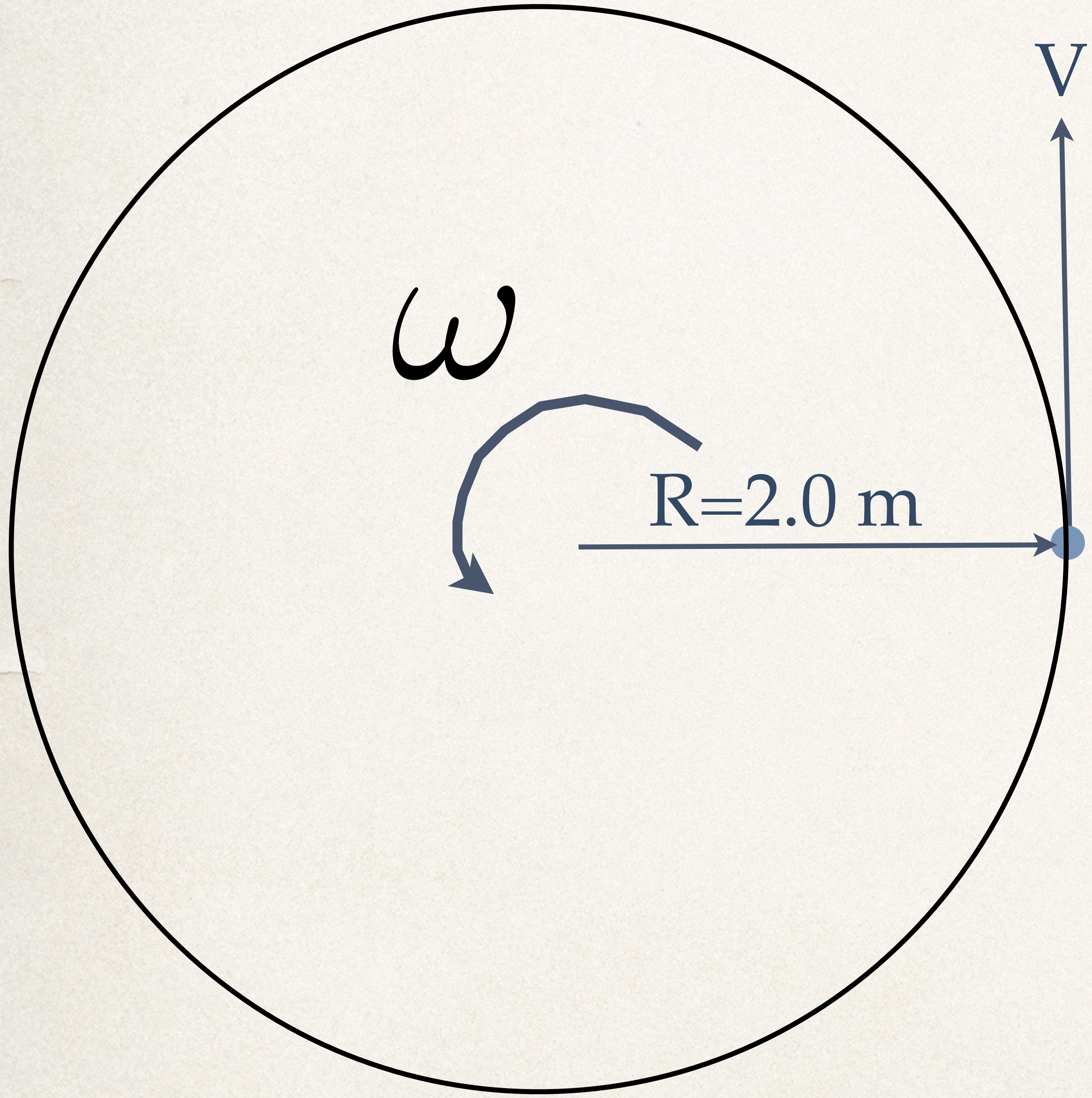
1. *A*
2. both at the same time
3. *B*
4. need more information

Suppose that you travel in a horizontal circle at constant speed v as shown below (looking down from above). What direction is your acceleration at the instant shown?



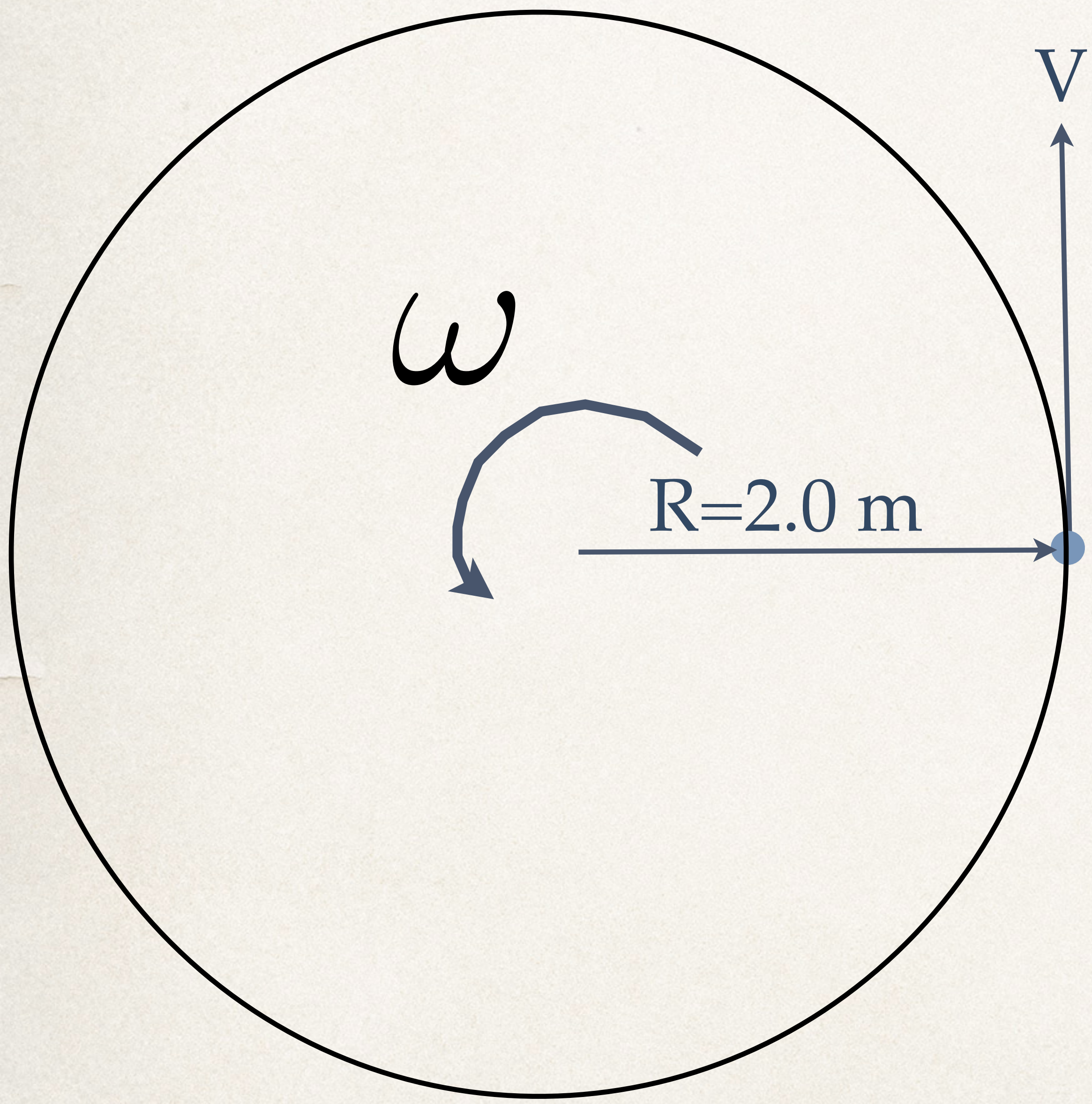
a) to the left
b) up
c) to the right
d) down
e) none of these

Suppose that you are sitting on a rotating merry-go-round which is turning at an angular velocity of 10 radians/sec. If you are at a distance of 2.0 meters from the axis of rotation, what is your centripetal acceleration in units of m/s^2?



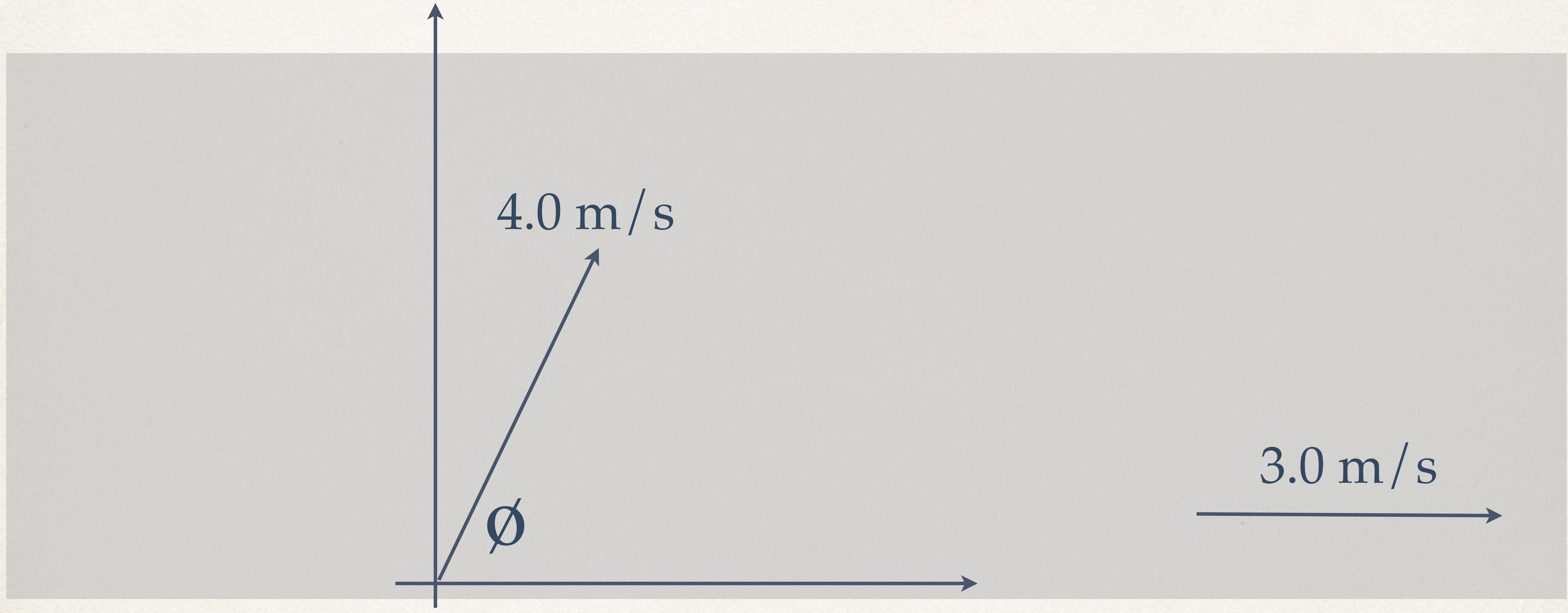
a) 200
b) 100
c) 50
d) 20
e) 5

Suppose that you are sitting on a rotating merry-go-round which is turning at a constant angular velocity of 10 radians/sec. If you are at a distance of 2.0 meters from the axis of rotation, and then you decrease your distance from the axis of rotation to 1.0 m, what happens to your centripetal acceleration?



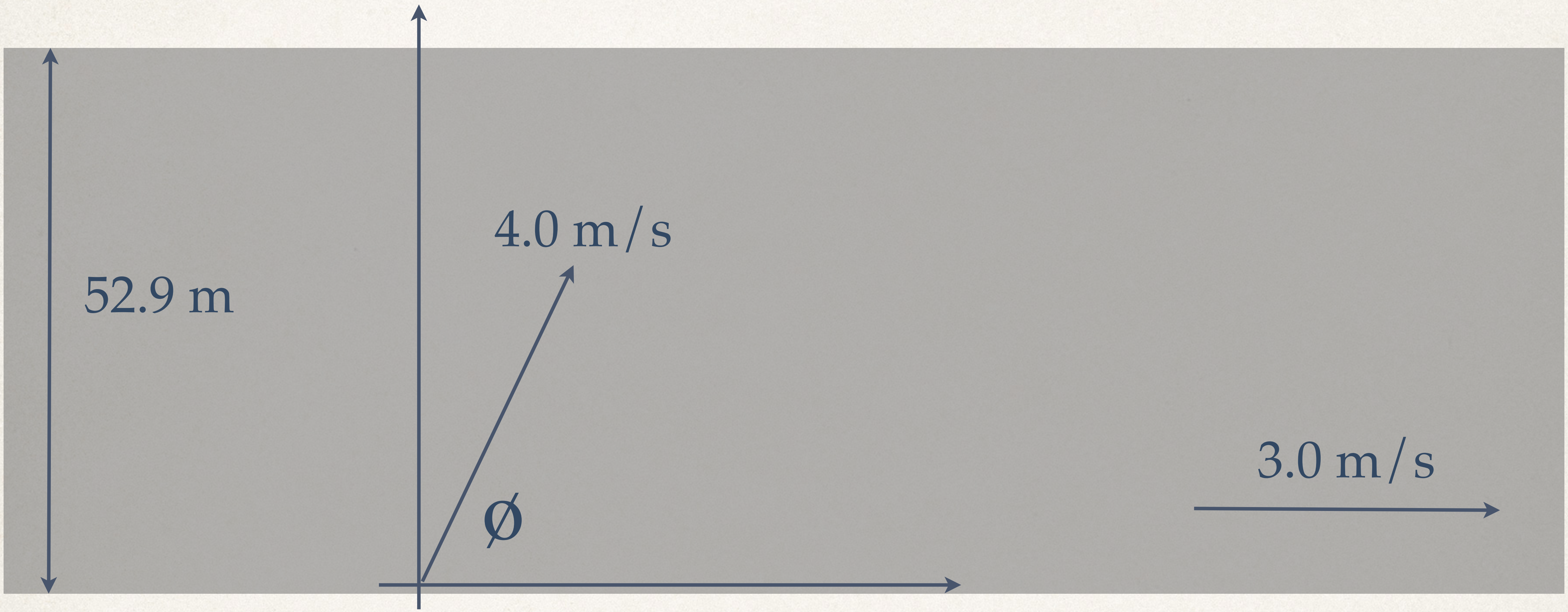
a) increases by factor of 2
b) remains the same
c) decreases by factor of 2
d) increases by factor of 4
e) decreases by factor of 4

Suppose you can paddle your kayak at 4.0 m/s in still water. If you now enter a river flowing at 3.0 m/s, what angle, ø, should you point your boat to travel straight across the river?



a) 46º b) 66º c) 119º d) 126º e)139º

For the previous question, how long would it take to cross the river? Enter your answer to the nearest second.

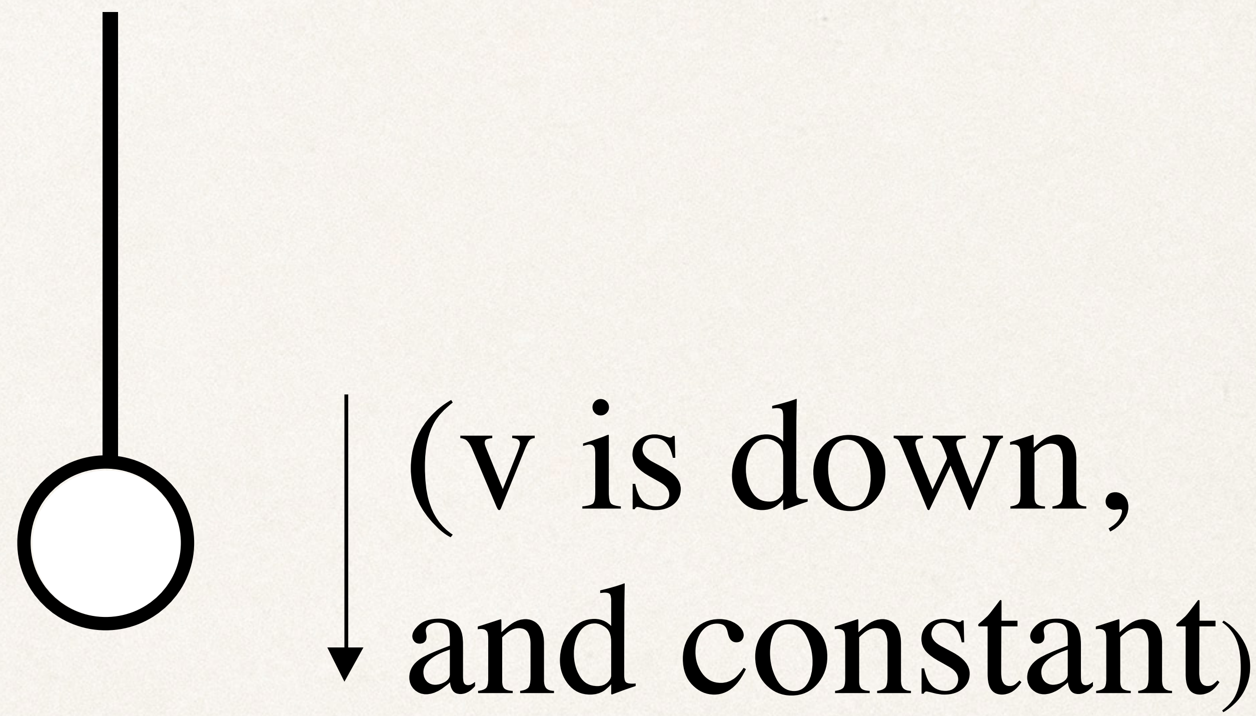


a) 5 s b) 10 s c) 15 s d) 20 s e) 25 s

-5-

Newton's Laws

An object is <u>lowered</u> by a rope at a <u>constant speed.</u> The net force on the object is



A: upward

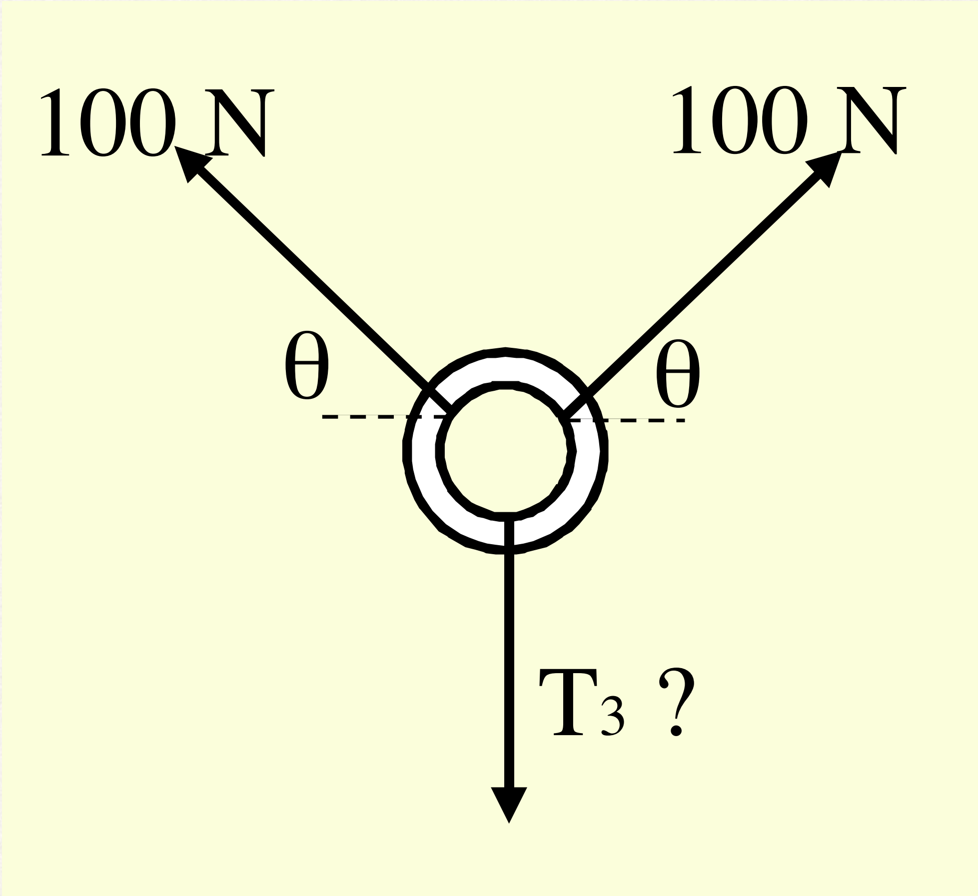
B: downward

C: zero

D: not enough information given.

Three people are pulling on a ring in a 2-D tug of war. The figure shows a plan view of the situation.
No one is winning - the ring is sitting still.

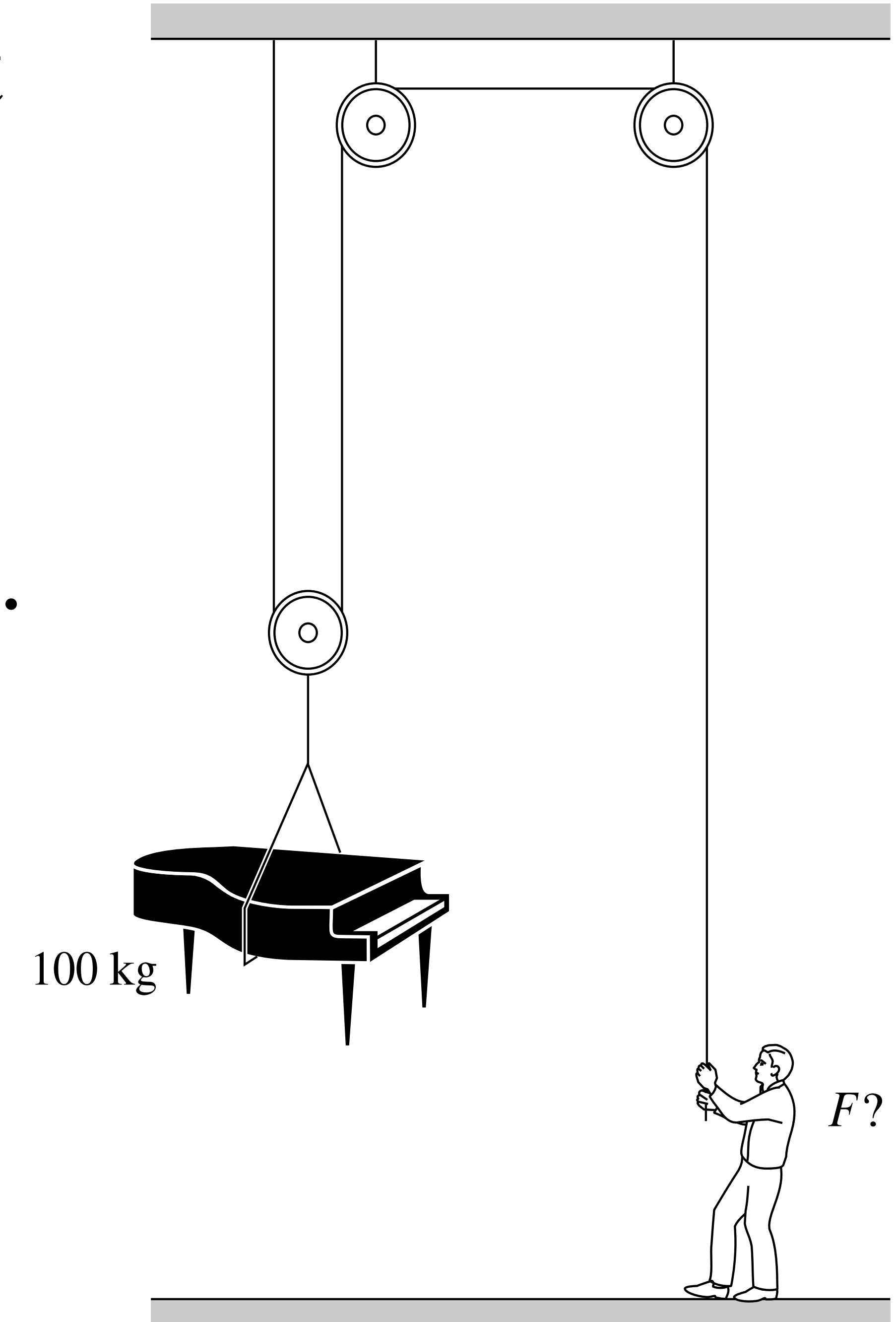
The pulls are configured as shown (teams 1 and 2 are each pulling with a force of 100 N. Team 3 pulls with unknown force T3)



What is the net force on the ring?

A) 0 N
B) 200 N
C) 200 sin(θ) N
D) 200 cos(θ) N
E) 100 sin(θ) N

A piano mover raises a 100-kg piano at a constant rate using the frictionless pulley system shown here. With how much force is he pulling on the rope? Ignore friction and assume $g = 10\ m/s^2$.

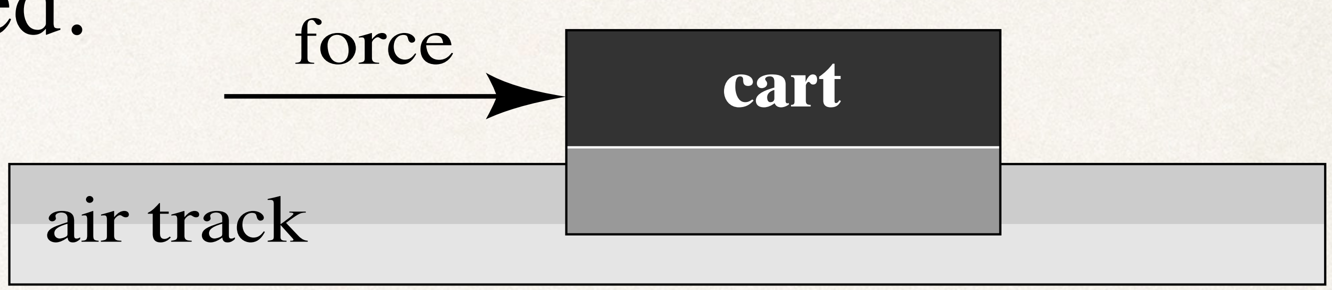


1.) 2,000 N 2.) 1,500 N 3.) 1,000 N

4.) 750 N 5.) 500 N 6.) 200 N

7.) 50 N 8.) impossible to determine

A constant force is exerted on a cart that is initially at rest on an air track. Friction between the cart and the track is negligible. The force acts for a short time interval and gives the cart a certain final speed.

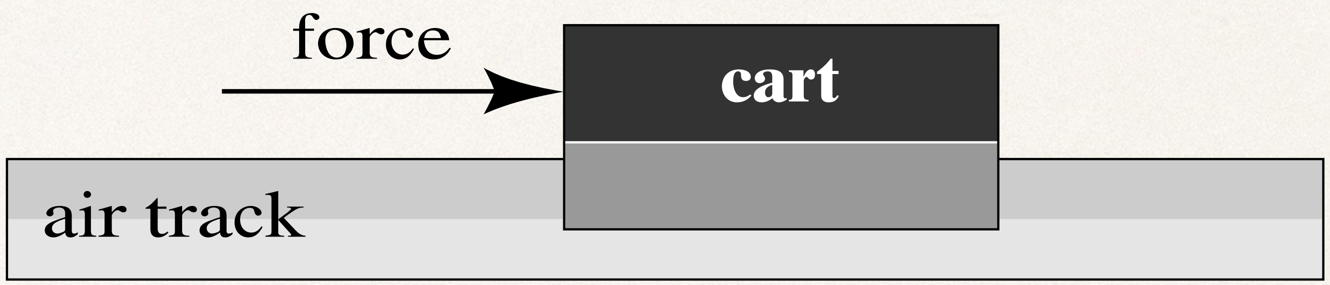


To reach the same final speed with a force that is only half as big, the force must be exerted on the cart for a time interval

a) four times as long as
b) twice as long as
c) equal to
d) half as long as
e) a quarter of

that for the stronger force.

A constant force is exerted for a short time interval on a cart that is initially at rest on an air track. This force gives the cart a cer- tain final speed. The same force is exerted for the same length of time on another cart, also initially at rest, that has twice the mass of the first one.



The final speed of the heavier cart is

a) one-fourth
b) four times
c) half
d) double
e) the same as

that of the lighter cart.

Consider a person standing in an elevator that is accelerating upward. The upward normal force N exerted by the elevator floor on the person is

a. larger than
b. identical to
c. smaller than

the downward weight W of the person.

An object is held in place by friction on an inclined surface. The angle of inclination is increased until the object starts moving. If the surface is kept at this angle, the object

a. slows down.
b. moves at uniform speed.
c. speeds up.
d. none of the above

Work and Kinetic Energy

-6-

Work & Kinetic Energy

A block moves along a horizontal surface as shown below:

In terms of the mass of the block, m, what is the total (i.e. net) work done on the block?

a) +3m/2
b) +m/2
c) 0
d) -3m/2
e) -4m/2

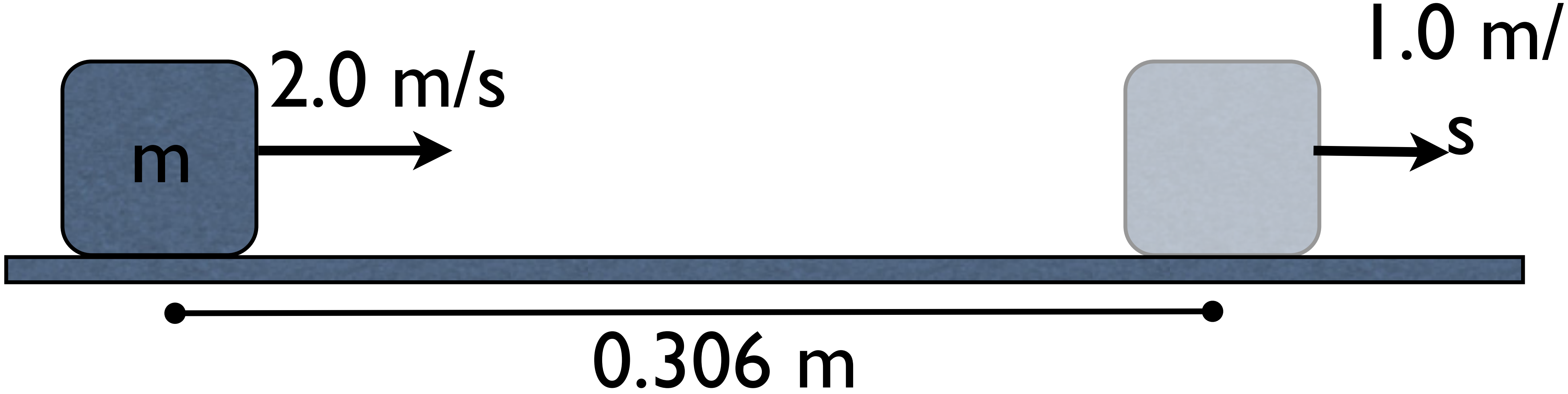
Two marbles, one twice as heavy as the other, are dropped to the ground from the roof of a building. Just before hitting the ground, the heavier marble has

1) as much kinetic energy as the lighter one.
2) twice as much kinetic energy as the lighter one.
3) half as much kinetic energy as the lighter one.
4) four times as much kinetic energy as the lighter one.
5)impossible to determine

A spring-loaded toy dart gun is used to shoot a dart straight up in the air, and the dart reaches a maximum height of 24 m. The same dart is shot straight up a second time from the same gun, but this time the spring is com- pressed only half as far before firing. How far up does the dart go this time, neglecting friction and assuming an ideal spring?

1. 96 m
2. 48 m
3. 24 m
4. 12 m
5. 6 m
6. 3 m
7. impossible to determine

A block moves along a horizontal surface as shown below:

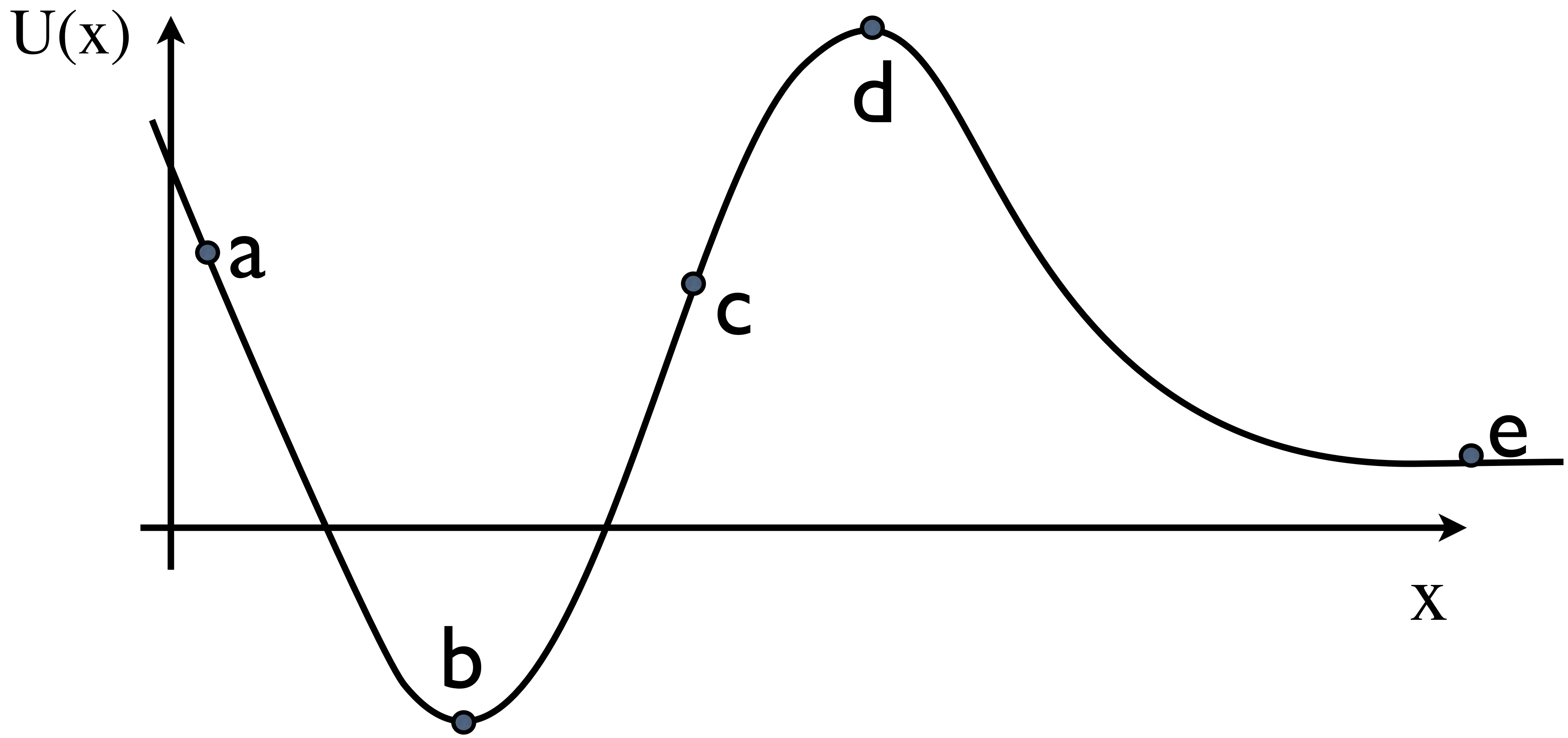


What is the coefficient of friction, μ_k ?

a) 0.1
b) 0.2
c) 0.5
d) 0.7
e) 0.9

Energy Conservation, Potential Energy and Forces

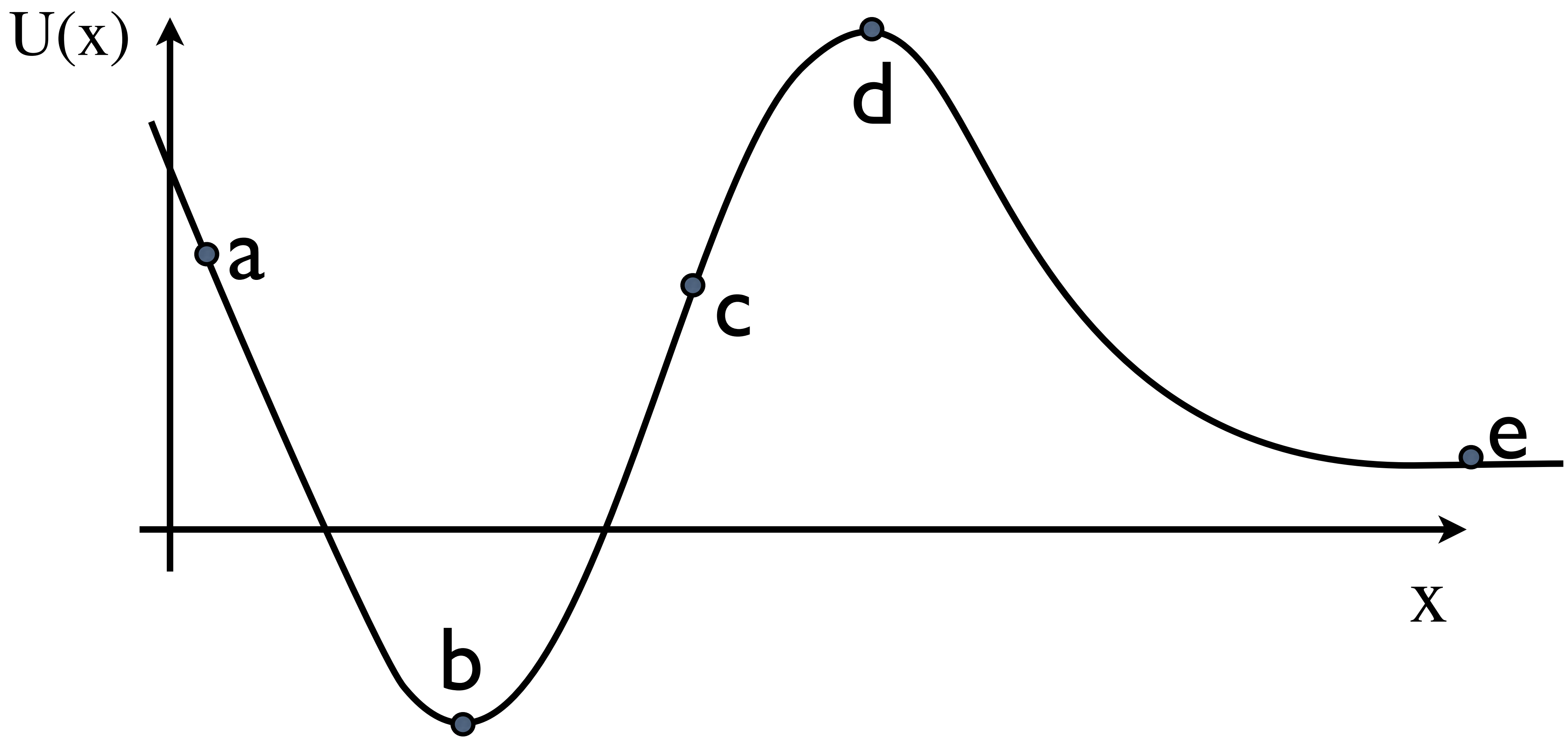
The potential energy curve for a particle in some system is shown below:



The force exerted on the particle is **positive** at what point(s)?

(1) a, c (2) a, c, e (3) c (4) b, d, e (5) a (6) e

The potential energy curve for a particle in some system is shown below:



At what point(s) is the particle in equilibrium?

(1) a, c (2) a, c, e (3) c (4) b, d, e (5) a (6) e

A cart on an air track is moving at 0.5 m/s when the air is suddenly turned off. The cart comes to rest after traveling 1 m. The experiment is repeated, but now the cart is moving at 1 m/s when the air is turned off. How far does the cart travel before coming to rest?

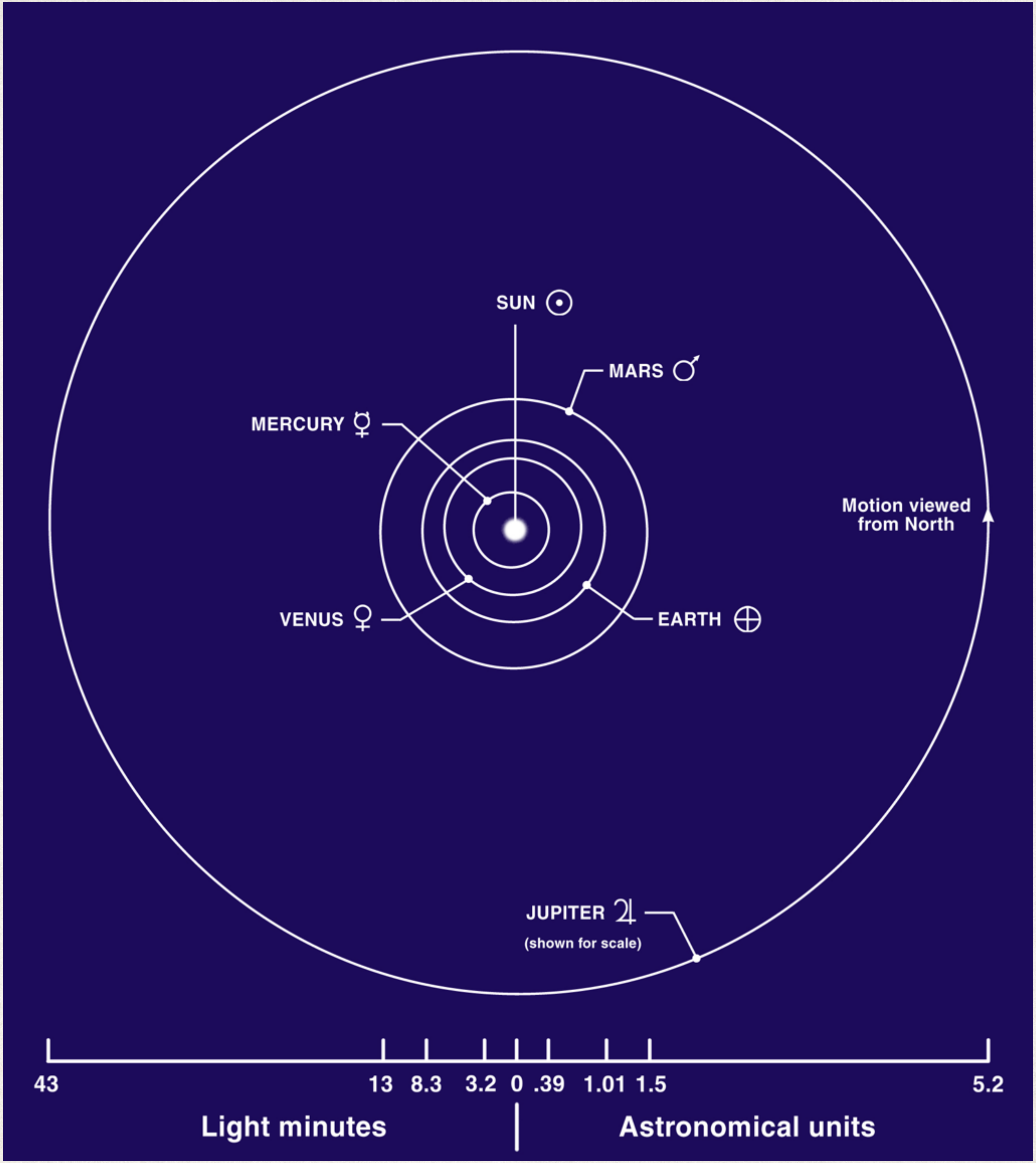
1. 1 m
2. 2 m
3. 3 m
4. 4 m
5. 5 m
6. impossible to determine

A stone is launched upward into the air. In addition to the force of gravity, the stone is subject to a frictional force due to air resistance. The time the stone takes to reach the top of its flight path is

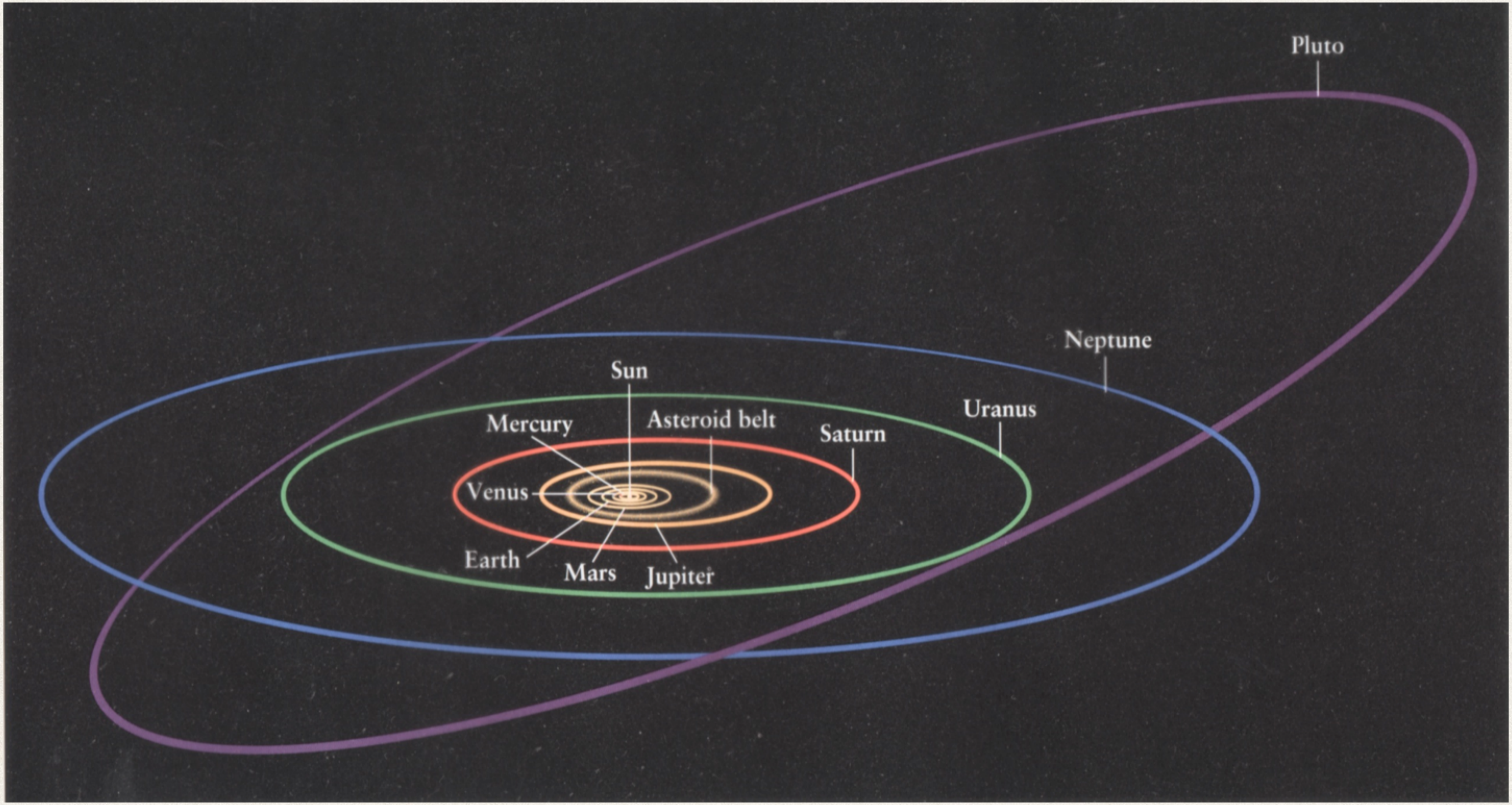
1. larger than
2. equal to
3. smaller than

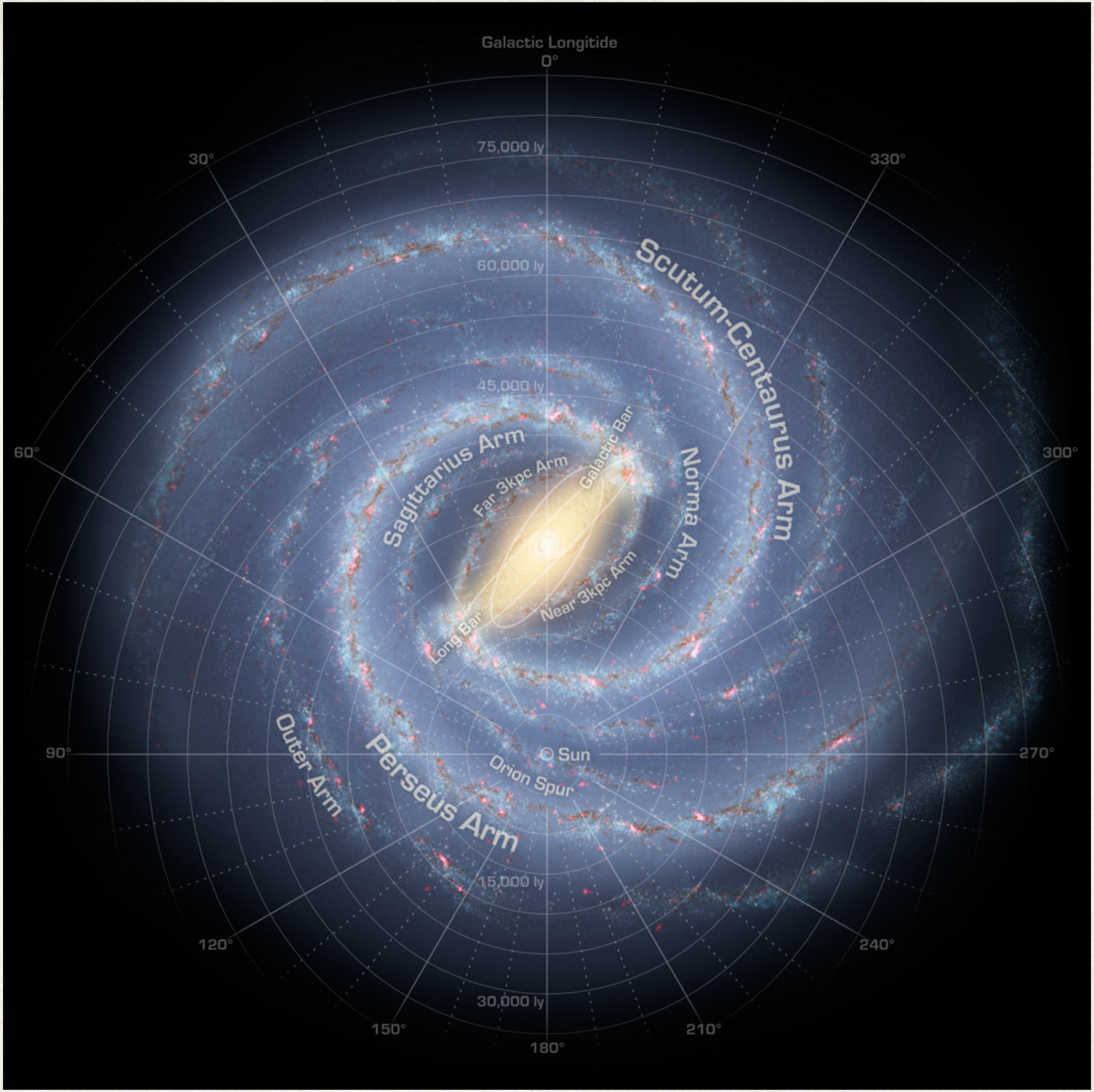
the time it takes to return from the top to its original position.

Gravitation

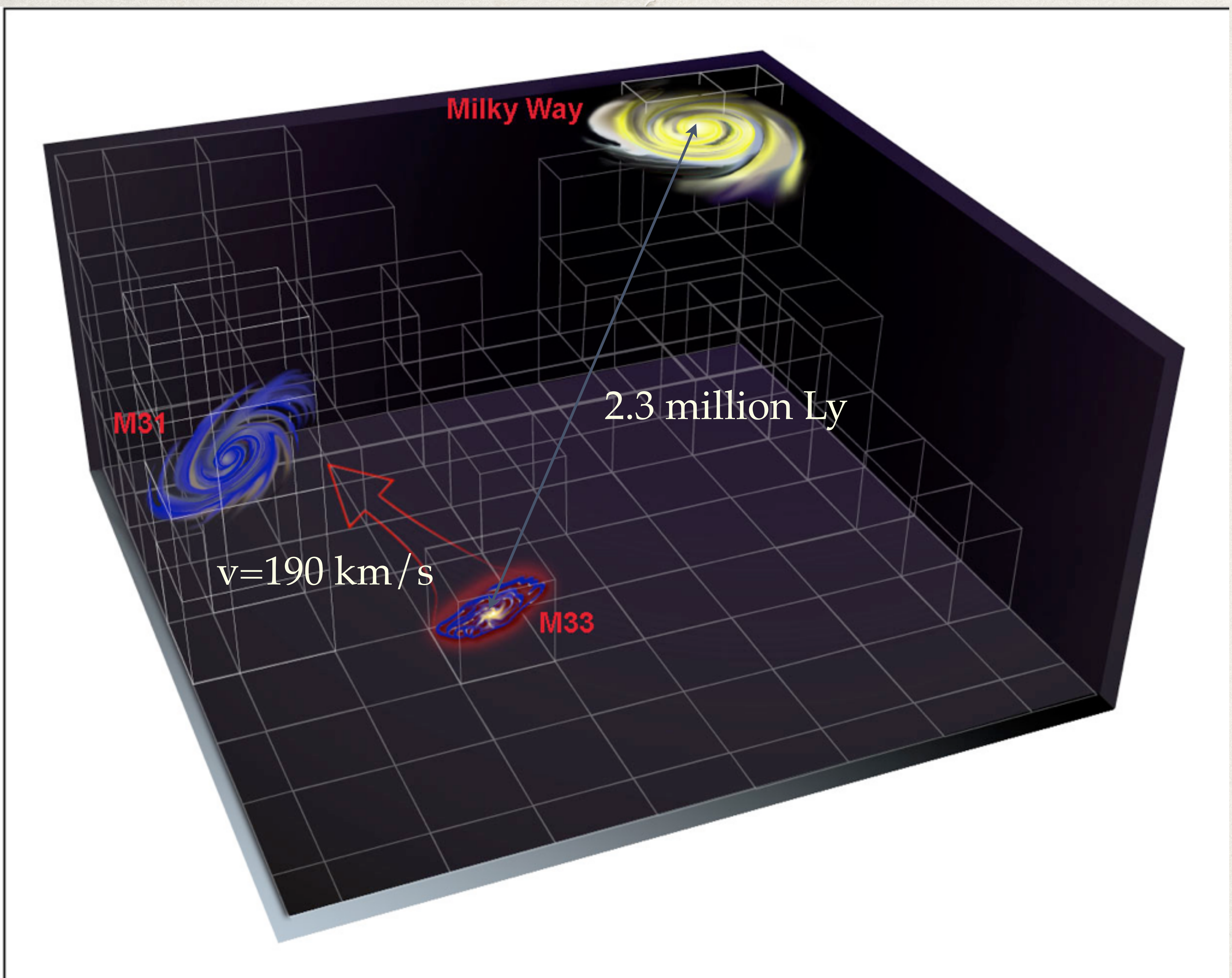


SUN
MARS
MERCURY
Motion viewed from North
VENUS
EARTH
JUPITER
(shown for scale)
43
13
8.3
3.2
0
.39
1.01
1.5
5.2
Light minutes
Astronomical units


Pluto
Neptune
Sun
Uranus
Mercury
Asteroid belt
Saturn
Venus
Earth
Mars
Jupiter



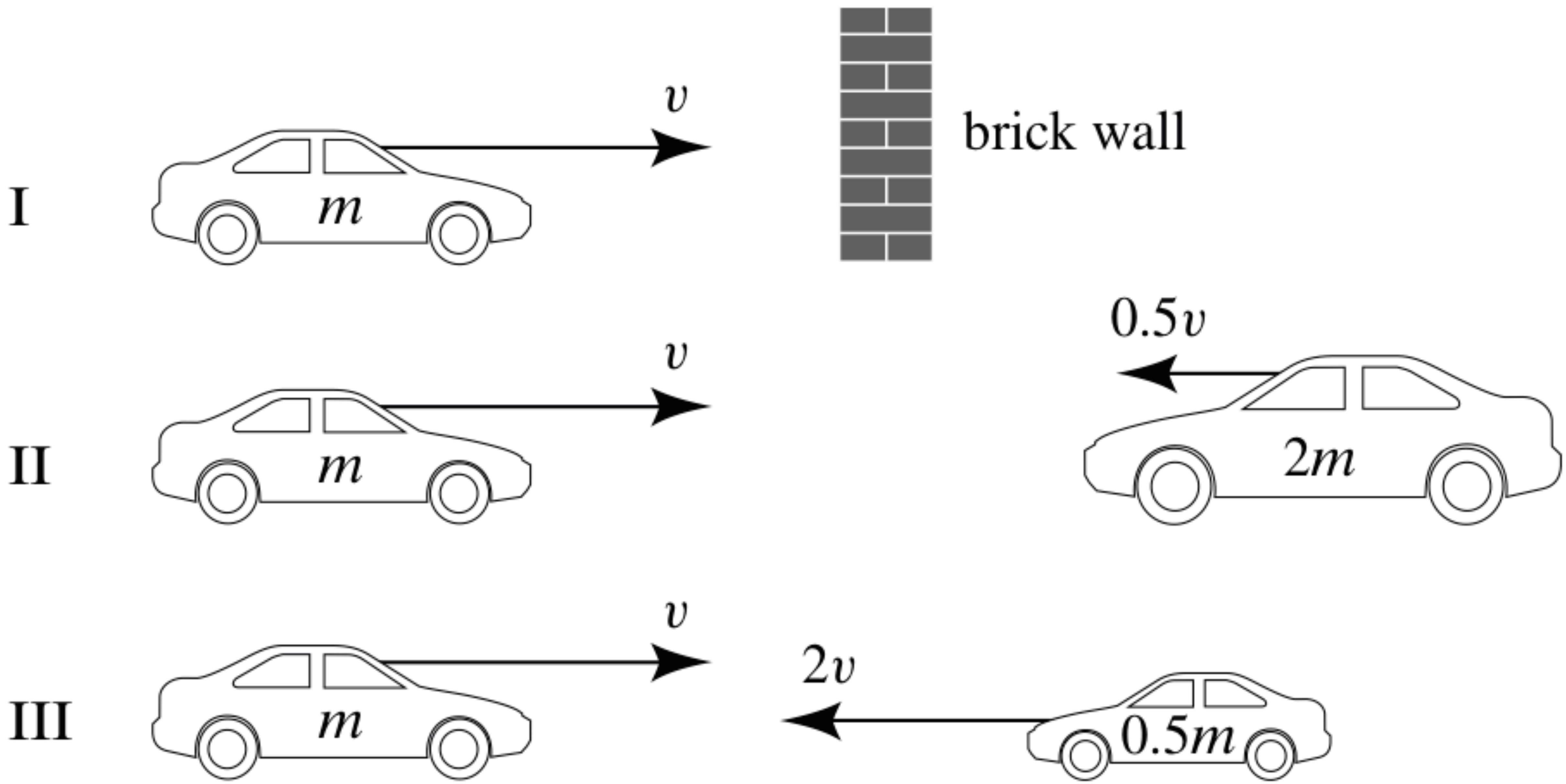
Galactic Longitide
0°
30°
330°
75,000 ly
60,000 ly
45,000 ly
Scutum-Centaurus Arm
60°
300°
Sagittarius Arm
Galactic Bar
Far 3kpc Arm
Norma Arm
Near 3kpc Arm
Long Bar
90°
Sun
270°
Outer Arm
Perseus Arm
Orion Spur
15,000 ly
120°
240°
30,000 ly
150°
210°
180°


Milky Way
M31
2.3 million Ly
v=190 km/s
M33

[redacted]

Momentum & Center of Mass

If all three collisions in the figure shown here are totally inelastic, which bring(s) the car on the left to a halt?

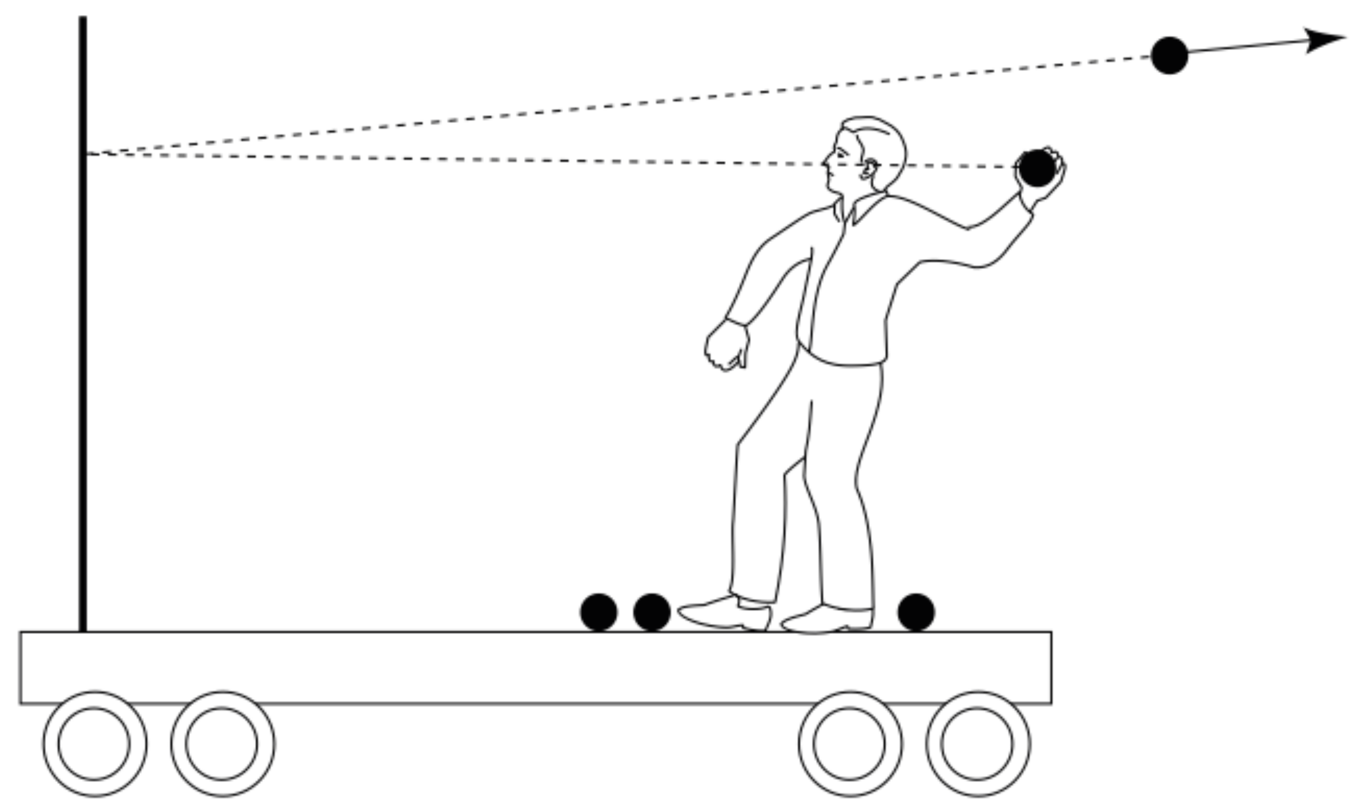


1. I 2. II 3. III 4. I,II 5. I,III 6. II,III 7. all three

Think fast! You’ve just driven around a curve in a narrow, one-way street at 25 mph when you notice a car identical to yours coming straight toward you at 25 mph.You have only two options: hitting the other car head on or swerving into a massive concrete wall, also head on. In the split second before the impact, you decide to

(1) hit the other car.
(2) hit the wall.
(3) hit either one—it makes no difference.
(4) consult your lecture notes.

Suppose you are on a cart, initially at rest on a track with very little friction. You throw balls at a partition that is rigidly mounted on the cart. If the balls bounce straight back as shown in the figure, is the cart put in motion?



1. Yes, it moves to the right.
2. Yes, it moves to the left.
3. No, it remains in place.

Suppose the entire population of the world gathers in one spot and, at the sounding of a prearranged signal, everyone jumps up. While all the people are in the air, does Earth gain momentum in the opposite direction?

(1) No; the inertial mass of Earth is so large that the planet's change in motion is imperceptible.
(2) Yes; because of its much larger inertial mass, however, the change in momentum of Earth is much less than that of all the jumping people.
(3) Yes; Earth recoils, like a rifle firing a bullet, with a change in momentum equal to and opposite that of the people.
(4) It depends.

Suppose rain falls vertically into an open cart rolling along a straight horizontal track with negligible friction. As a result of the accumulating water, the kinetic energy of the cart:

(1) increases.

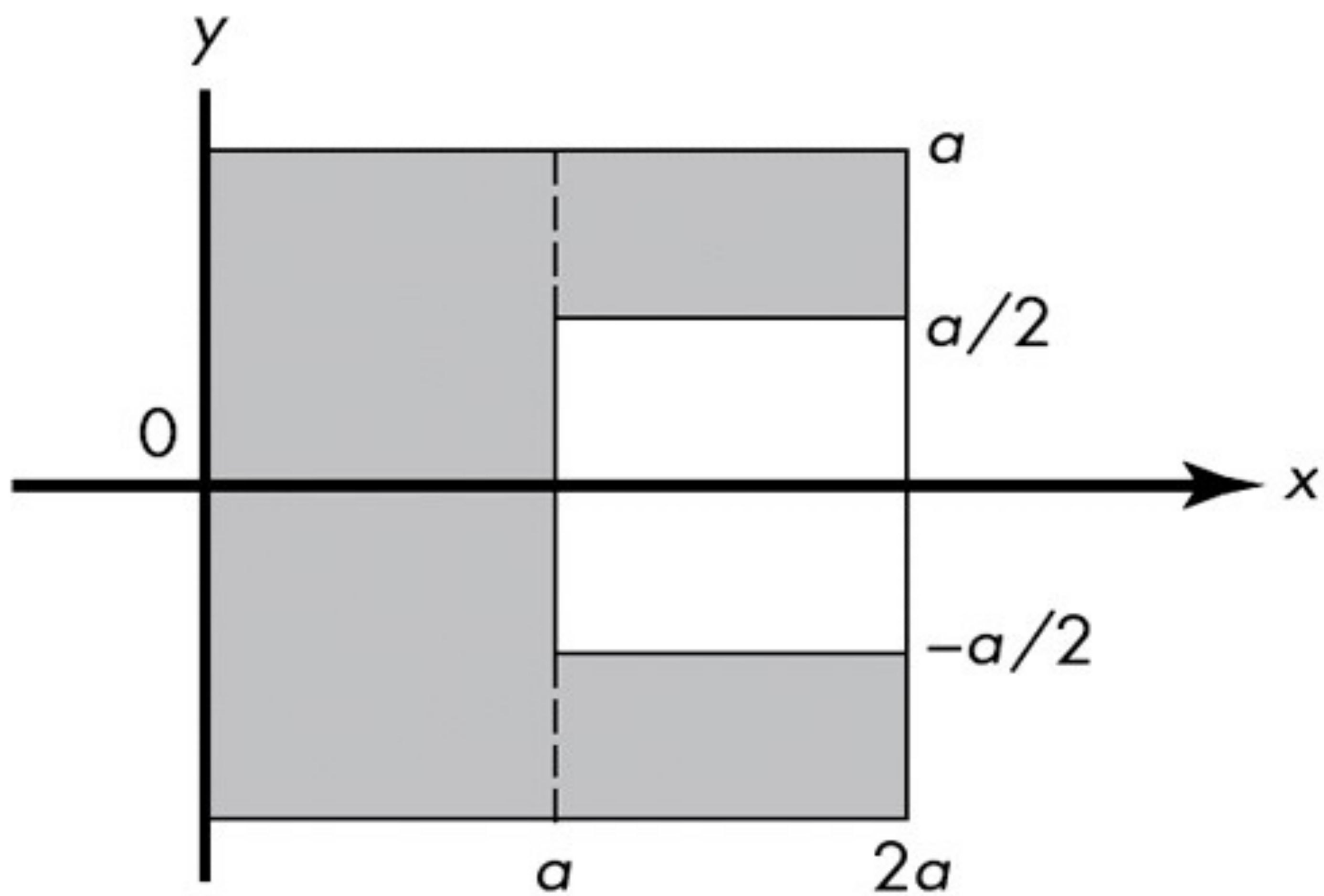
(2) does not change.

(3) decreases.

Consider two carts, of masses m and 2m, at rest on an air track. If you push first one cart for 3 s and then the other for the same length of time, exerting equal force on each, the momentum of the light cart is

(1) four times
(2) twice
(3) equal to
(4) one-half
(5) one-quarter

the momentum of the heavy cart.

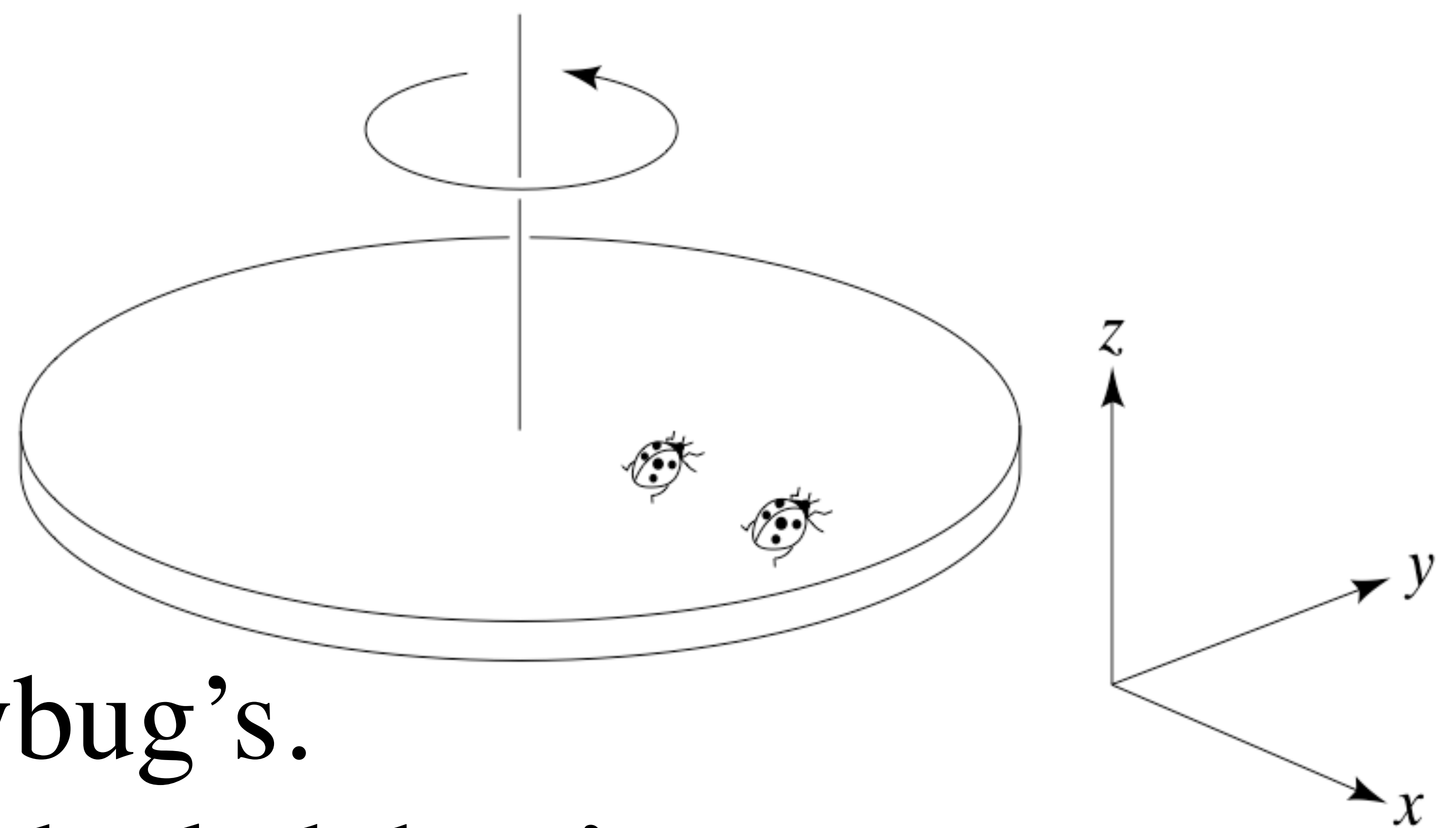


Consider a letter "C" that is obtained by cutting a large square plate $2a \times 2a$ and removing a square $a \times a$ from the side, as shown in the sketch. Determine the x coordinate of the center of mass, x_{CM}:

(1)	(2)	(3)
$x_{CM} < a$	$x_{CM} = a$	$x_{CM} > a$

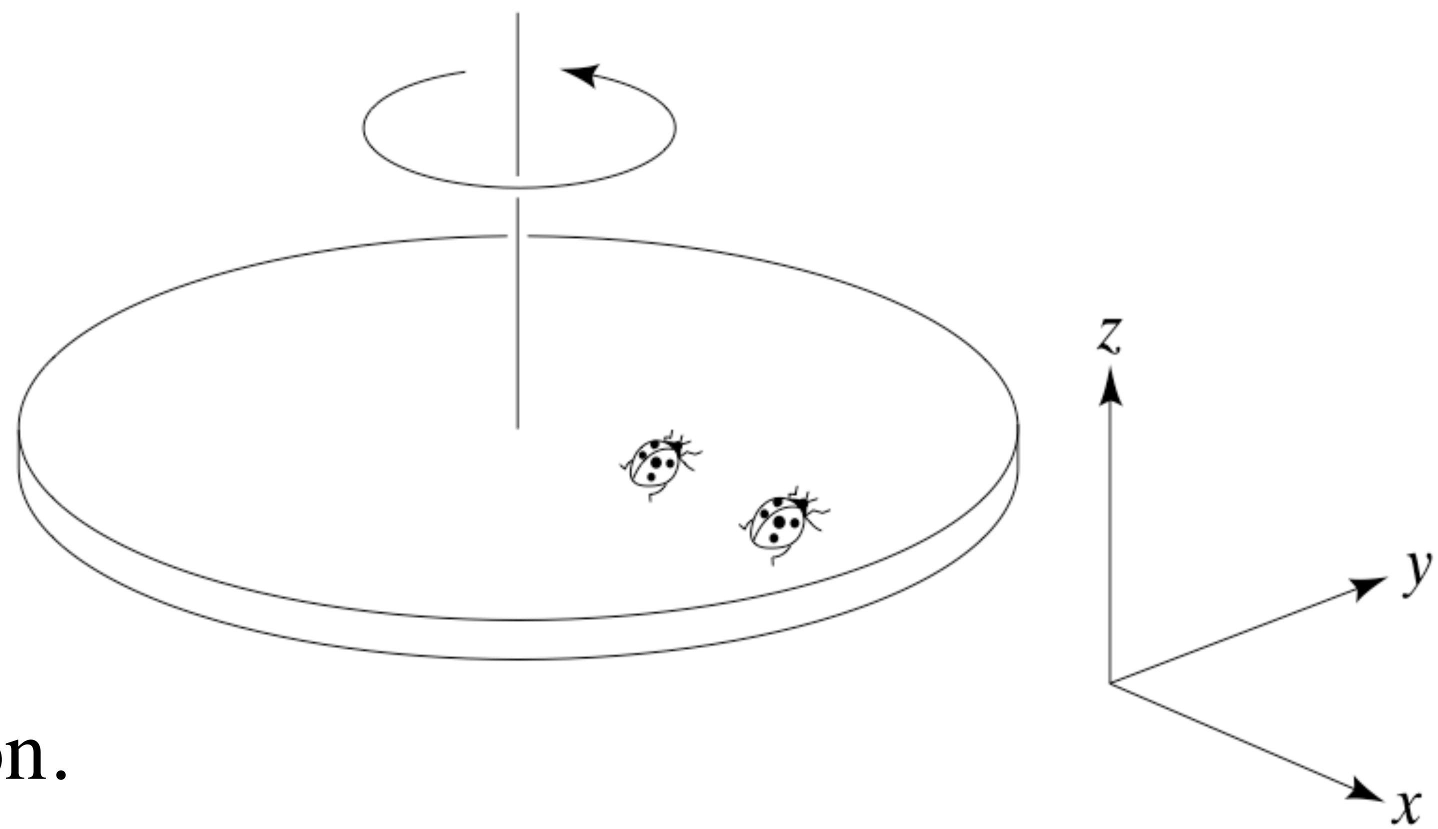
Rotational Motion

A ladybug sits at the outer edge of a merry-go-round,and a gentleman bug sits halfway between her and the axis of rotation. The merry-go-round makes a complete revolution once each second. The gentleman bug's angular speed is



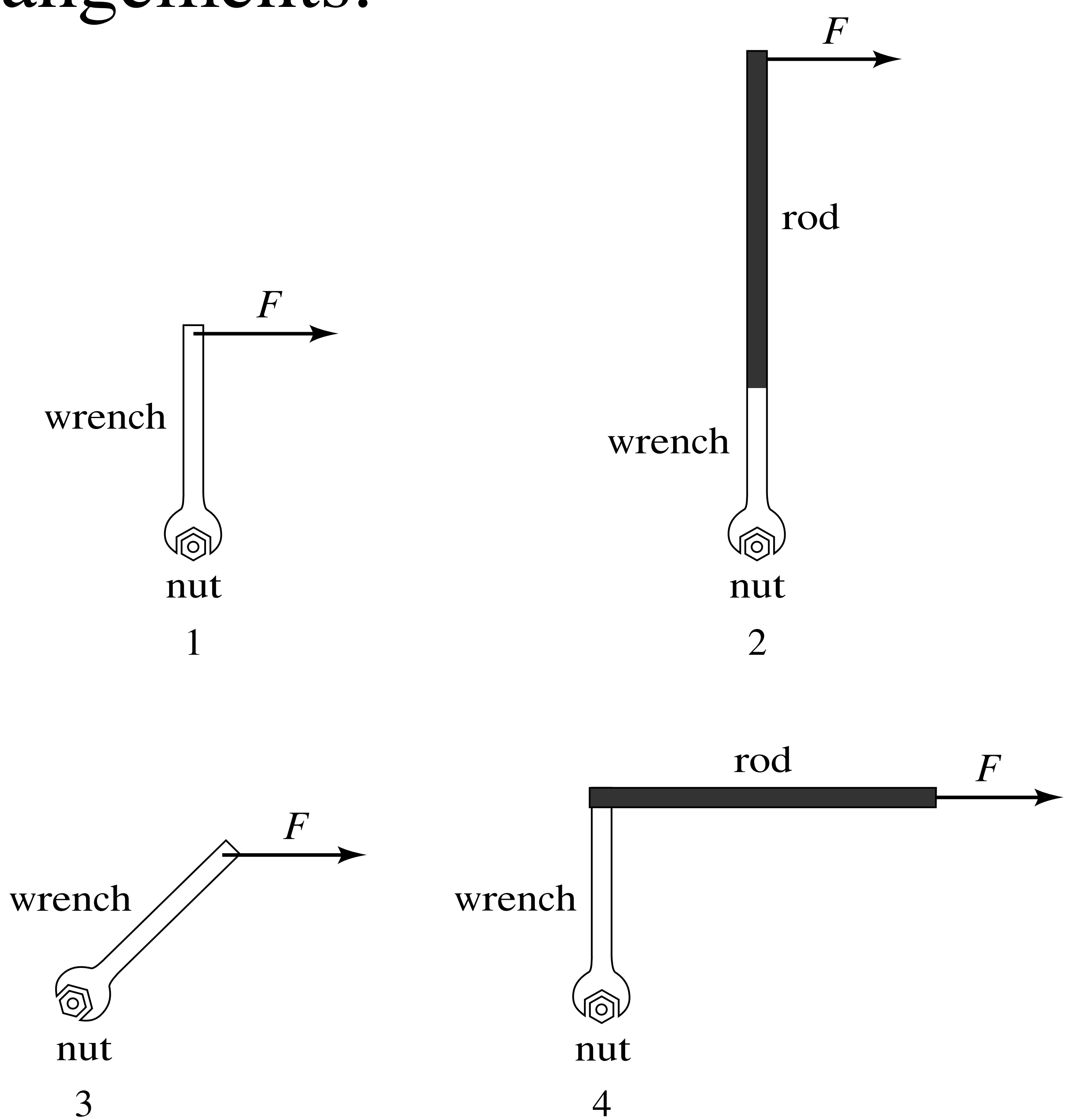
1. half the ladybug's.
2. the same as the ladybug's.
3. twice the ladybug's.
4. impossible to determine

A ladybug sits at the outer edge of a merry-go-round, that is turning and slowing down. At the instant shown in the figure,the radial component of the ladybug's (Cartesian) acceleration is



1. in the +xdirection.
2. in the –xdirection.
3. in the +ydirection.
4. in the –ydirection.
5. in the +zdirection.
6. in the –zdirection.
7. zero.

You are using a wrench and trying to loosen a rusty nut. Which of the arrangements shown is most effective in loosening the nut? List in order of descending efficiency the fol- lowing arrangements:



A figure skater stands on one spot on the ice (assumed frictionless) and spins around with her arms extended. When she pulls in her arms, she reduces her rotational inertia and her angular speed increases so that her angular momentum is conserved. Compared to her initial rotational kinetic energy, her rotational kinetic energy after she has pulled in her arms must be

1. the same.
2. larger because she’s rotating faster.
3. smaller because her rotational inertia is smaller.

Static Equilibrium
&
Oscillations

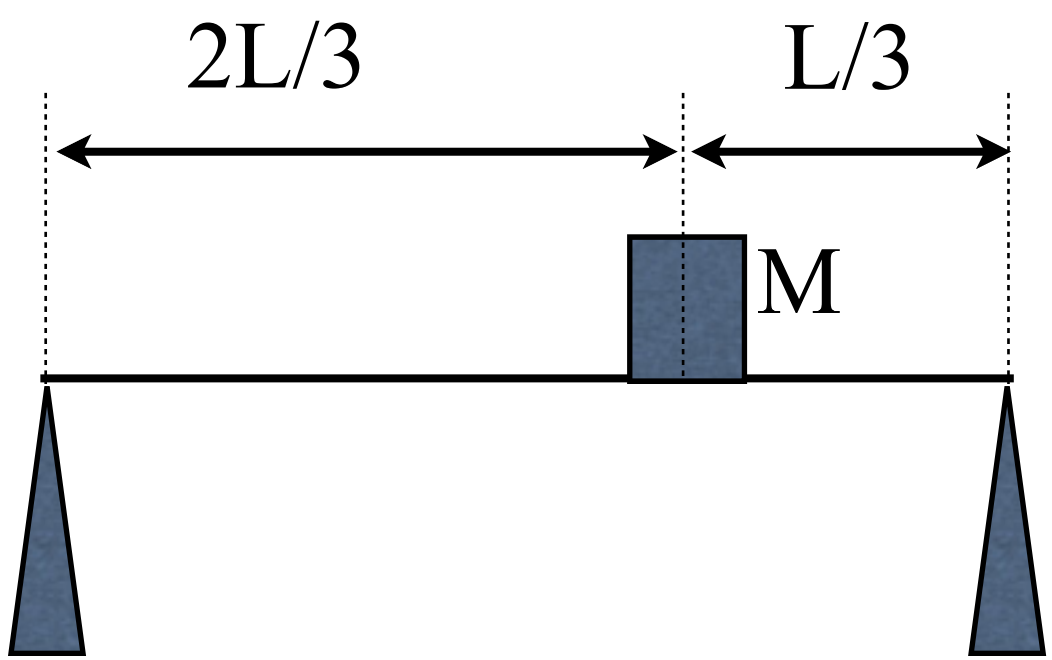
An object is in equilibrium when the net force and the net torque on it is zero. Which of the following statements is/are correct for an object in an inertial frame of reference?

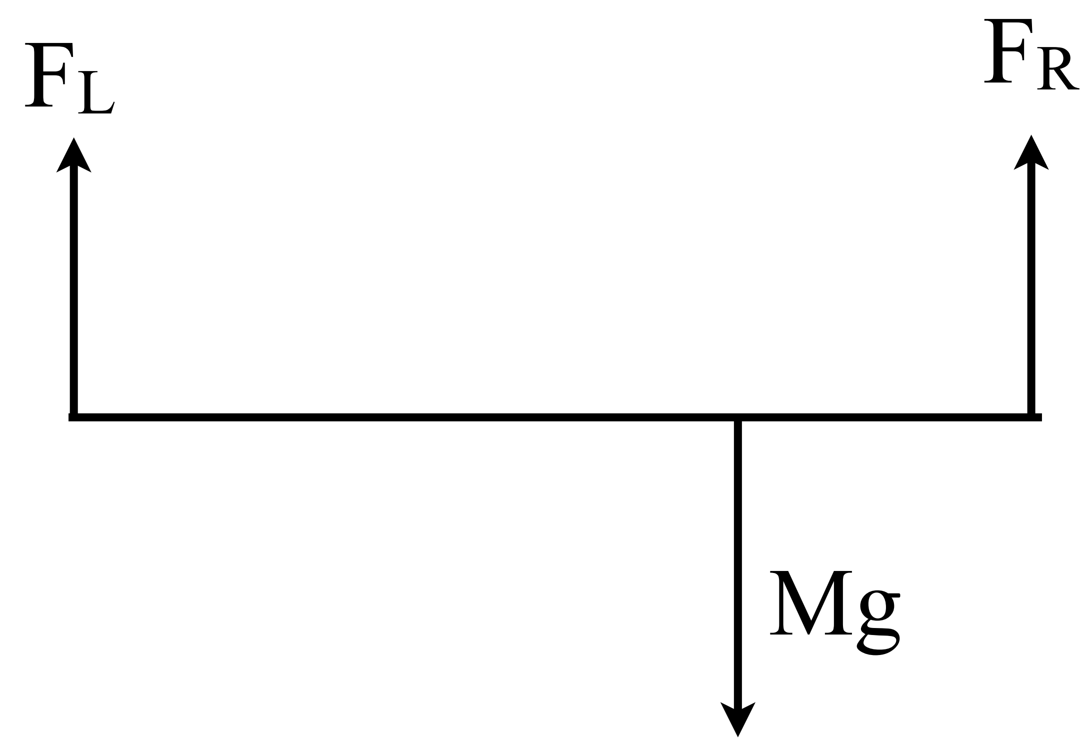
A. Any object in equilibrium is at rest.

B. An object in equilibrium need not be at rest.

C. An object at rest must be in equilibrium.

A block of mass M is placed on a very light board supported at the ends, as shown. The free-body diagram shows directions of the forces, but not their correct relative sizes.

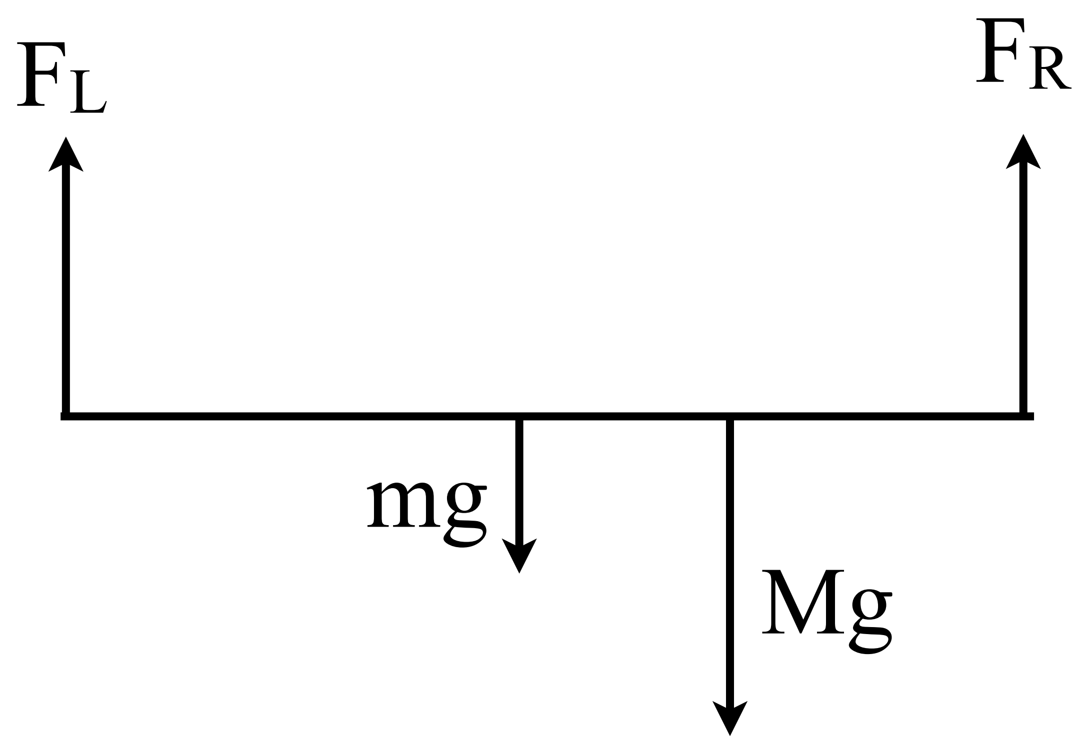




What is the ratio (F_R/F_L)?

A) 2/3 B) 1/3 C) 1/2 D) 2

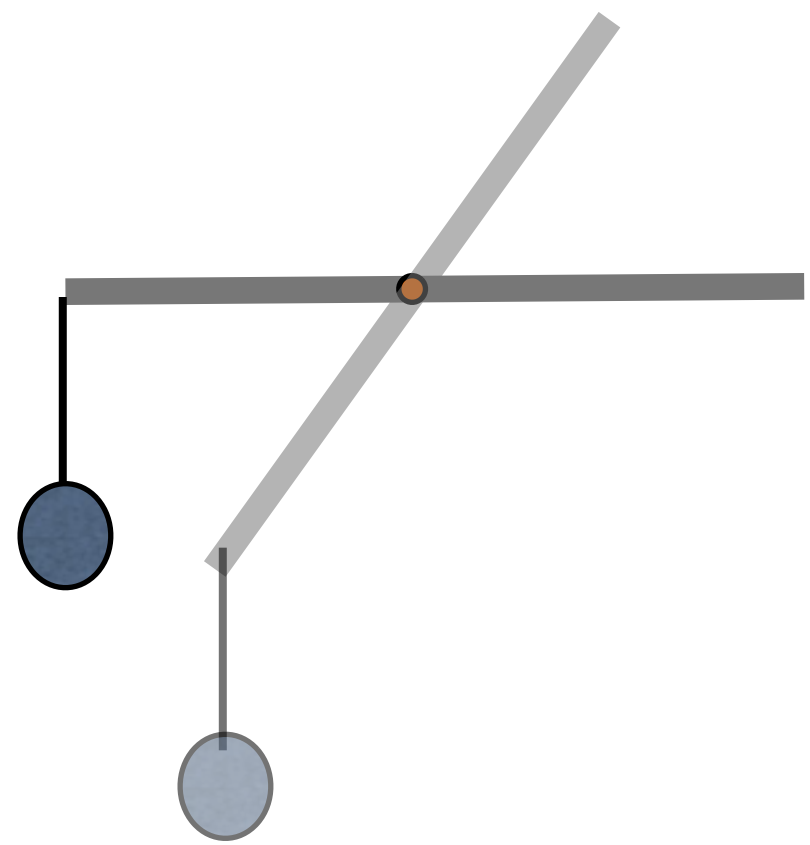
Suppose now the board has mass m, so the free-body diagram is now as shown.



Compared to when the board had no mass, the force F_R is now:

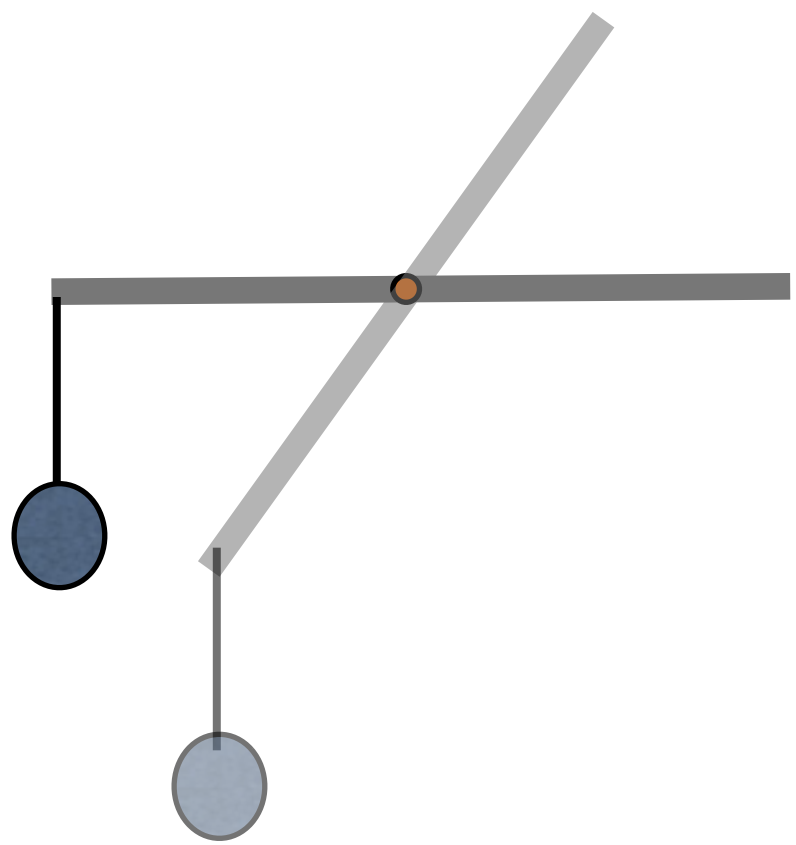
A) greater   B) less   C) the same.

A mass is hanging from the end of a horizontal bar which pivots about an axis through it center, but is initially stationary. The bar is then released and begins to rotate. As the bar rotates from horizontal to vertical, the magnitude of the torque on the bar about the axis:



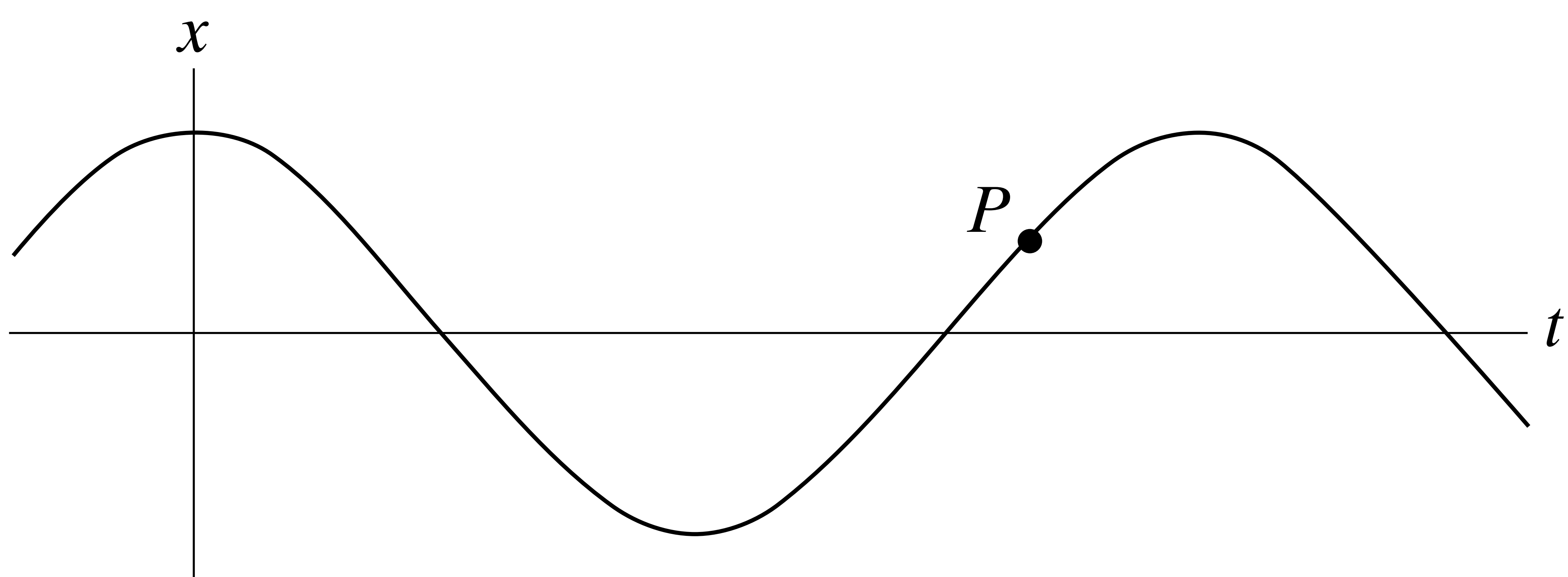
A) increases B) decreases C) remains constant

A mass is hanging from the end of a horizontal bar which pivots about an axis through it center, but is initially stationary. The bar is then released and begins to rotate. As the bar rotates from horizontal to vertical, the magnitude of the angular acceleration of the bar about the axis:



A) increases B) decreases C) remains constant

A mass attached to a spring oscillates back and forth as indicated in the position vs. time plot below. At point P, the mass has



1. positive velocity and positive acceleration.
2. positive velocity and negative acceleration.
3. positive velocity and zero acceleration.
4. negative velocity and positive acceleration.
5. negative velocity and negative acceleration.

A person swings on a swing. When the person sits still, the swing oscillates back and forth at its natural frequency. If, instead, two people sit on the swing, the new natural frequency of the swing is

1. greater.

2. the same.

3. smaller.

Survey Questions

I am taking physics 123 next semester:

a) yes - I’m so excited!
b) yes - reluctantly :-(
c) no - I’m so relieved!
d) no - but I wish I could.

For those of you who are taking 123 next semester, indicate your preference:

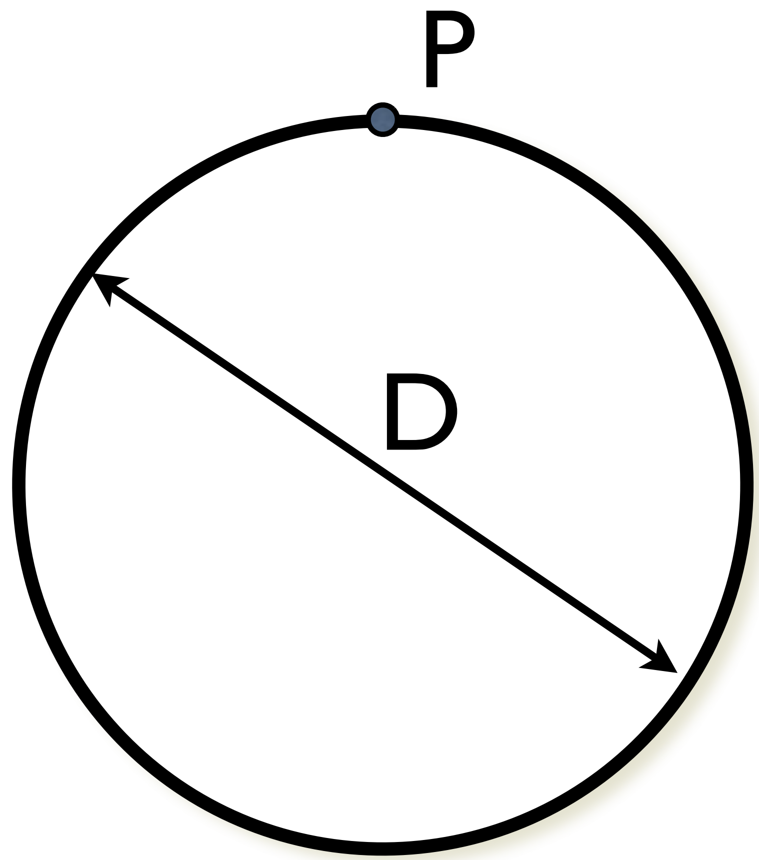
a) I prefer to watch Walter Lewin's lectures and have class be just problem solving and discussion.

b) I want you to lecture and leave Walter's lectures as an available outside resource.

c) I want some other scenario.

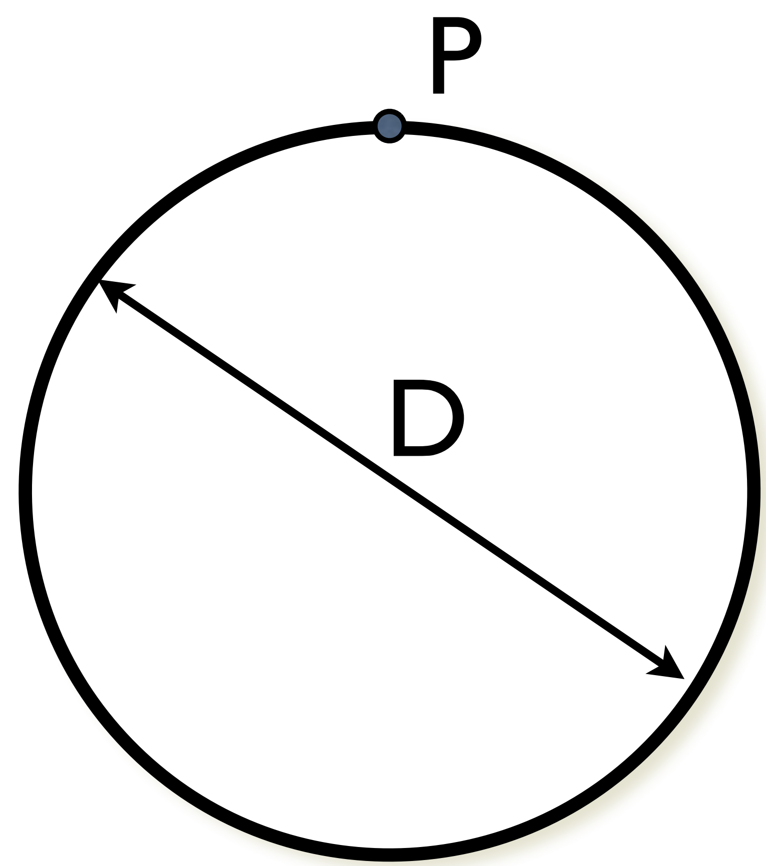
Longer Problems

A thin hoop oscillates about a point P at its rim. What is the moment of inertia of the hoop about an axis through the point P and perpendicular to the plane of the page ?



a) 0.5mr^2   b) 1.0 mr^2   c) 1.5 mr^2   d) 2.0mr^2

A thin hoop oscillates about a point P at its rim. If the period for small oscillations about the point P is measured to be 2.00 seconds, what is the *diameter* of the hoop?



a) 2.0 m b) 1.5 m c) 1.0 m d) 0.5 m e) 0.25 m

Suppose a mass of 2.0 kg is attached to a spring with spring constant 128 N/m. If I push on the block and compress the spring by 0.10 m and the initial velocity of the block at release is +0.20 m/s, what is the equation of motion of the block?