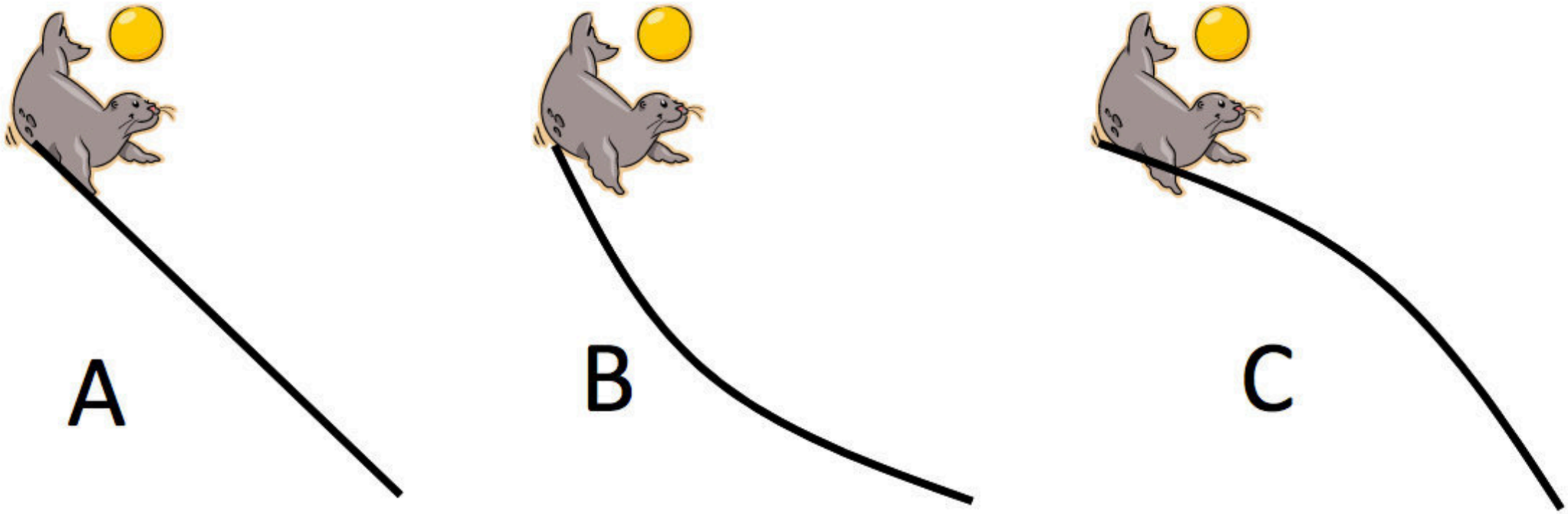
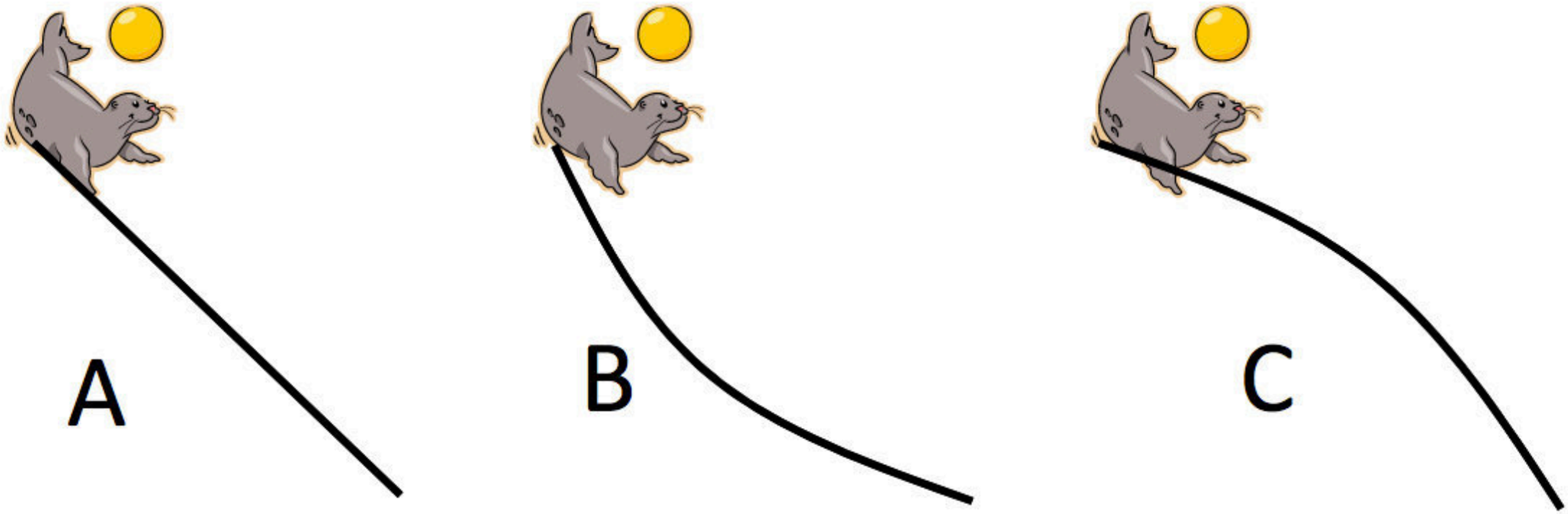


For which of the three slides is Flipper's speed at the bottom largest (assuming no friction)?

A) A B) B C) C D) same for all

E) It depends on the proportion of energy-rich prey species in Flipper's diet, which may in turn depend on natural or human-influenced variations in Flipper's ecosystem.

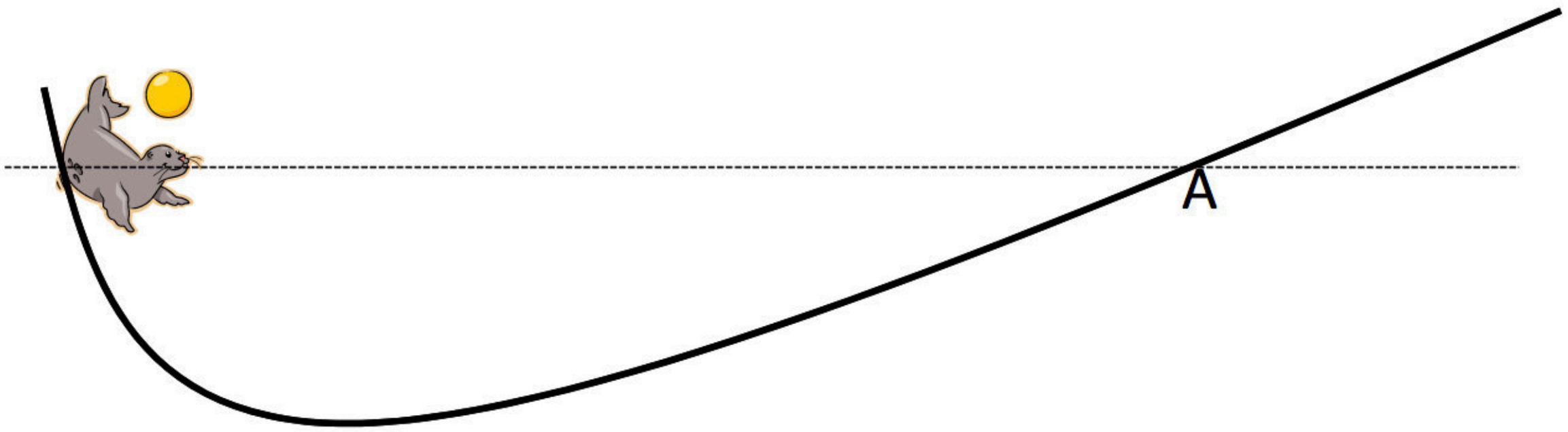
Extra: for which shape of slide does it take the least time to reach the bottom?



For which of the three slides is Flipper's speed at the bottom largest (assuming no friction)?

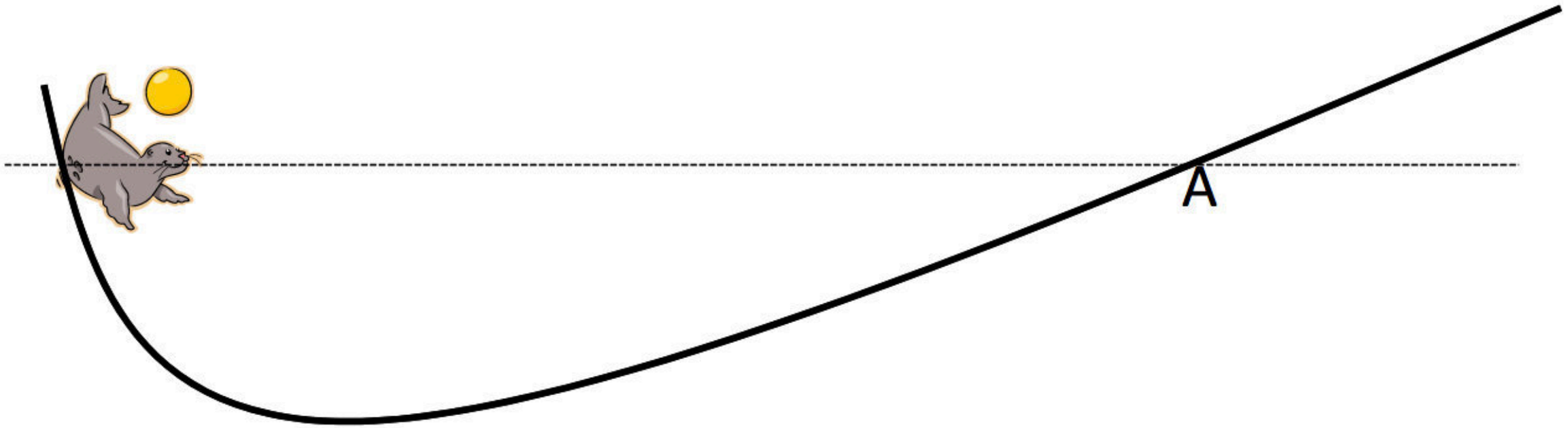
A) A B) B C) C D) same for all

Mechanical energy (kinetic plus potential energy) is conserved since there is no friction (we also ignore air drag). Potential energy decreases by the same amount in each case, since the change in height is the same. Therefore, kinetic energy must increase by the same amount in each case. The speed must be the same in all cases. (The time to reach the bottom is NOT the same for all).



Flipper catches her ball as she slides down the steep part of the ramp. As she slides up the other part, she will stop:

A) at point A
B) past point A
C) before point A
D) can't be determined



Flipper catches her ball as she slides down the steep part of the ramp. As she slides up the other part, she will stop:

A) at point A
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Simple answer: if we assume that mechanical is conserved, the potential energy of the initial configuration is higher than the potential energy of the seal and ball together at A, so they must have some kinetic energy remaining at this point.

In reality, the ball being caught by the seal is an inelastic collision, but one that increases the speed of the seal going down the ramp (since the ball must be moving faster than the seal. This extra kinetic energy results in the seal reaching a higher point than A.

Relative to the first configuration, the second configuration has:

A) Lower potential energy
B) Higher potential energy
C) The same potential energy
D) Cannot be determined unless we know the velocities of the particles

Come up with a convincing argument based on conservation of energy.

Relative to the first configuration, the second configuration has:

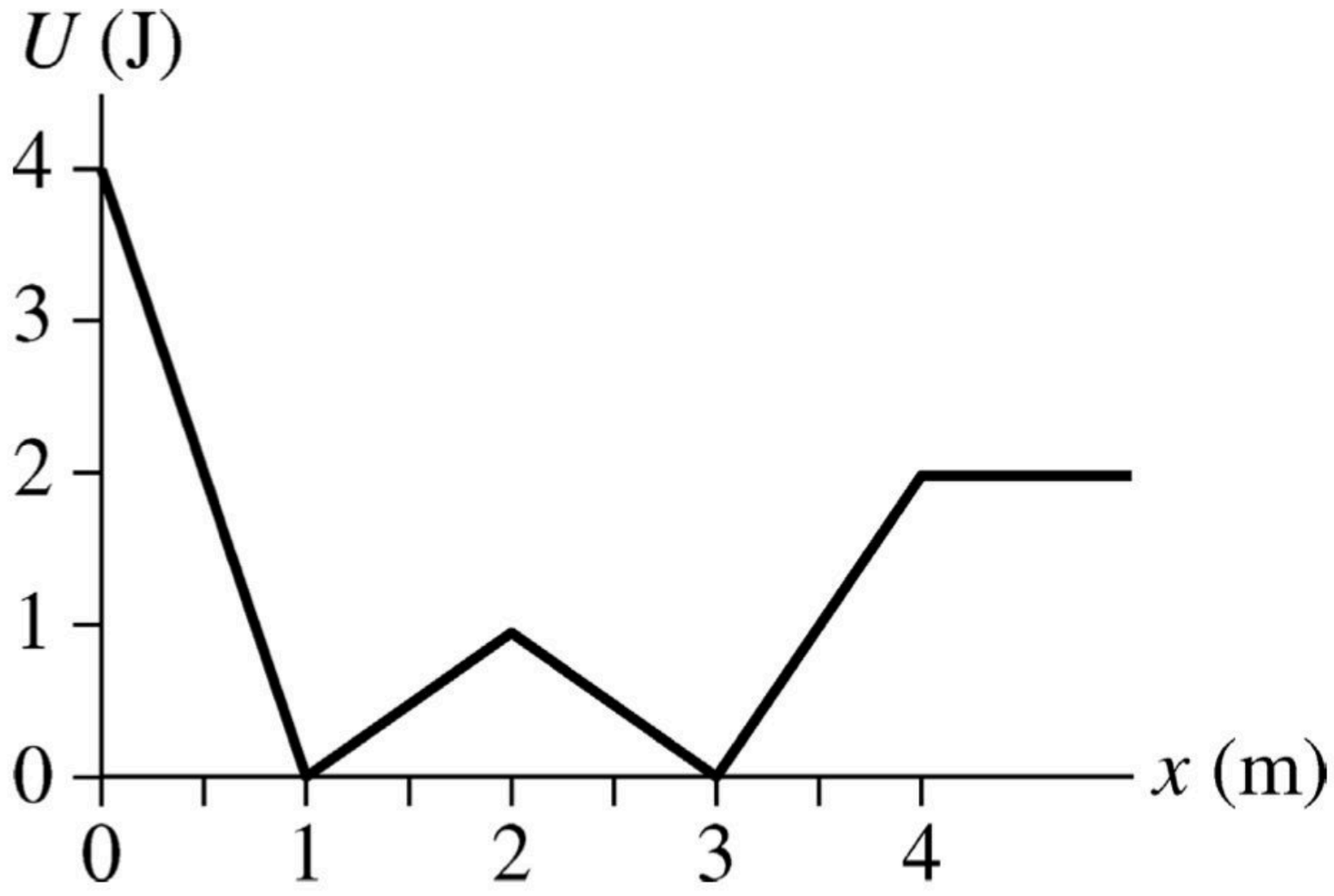
A) Lower potential energy
B) Higher potential energy
C) The same potential energy
D) Cannot be determined unless we know the velocities of the particles

Assuming that none of the particles are moving initially, the configuration on the left will lead to a greater kinetic energy when the particles collide than the one on the right, so it must have higher potential energy.

Alternatively, we would have to add energy to the configuration on the right to get to the configuration on the left (it takes some effort to pull the charges apart), so the configuration on the left must have higher potential energy.

Clicker Question

A particle with a total energy of 1.5 J is at x = 2 m and is traveling to the right. Locate the turning point of the particle.



A) 3 m

B) 3.25 m

C) 3.5 m

D) 3.75 m

E) no turning point

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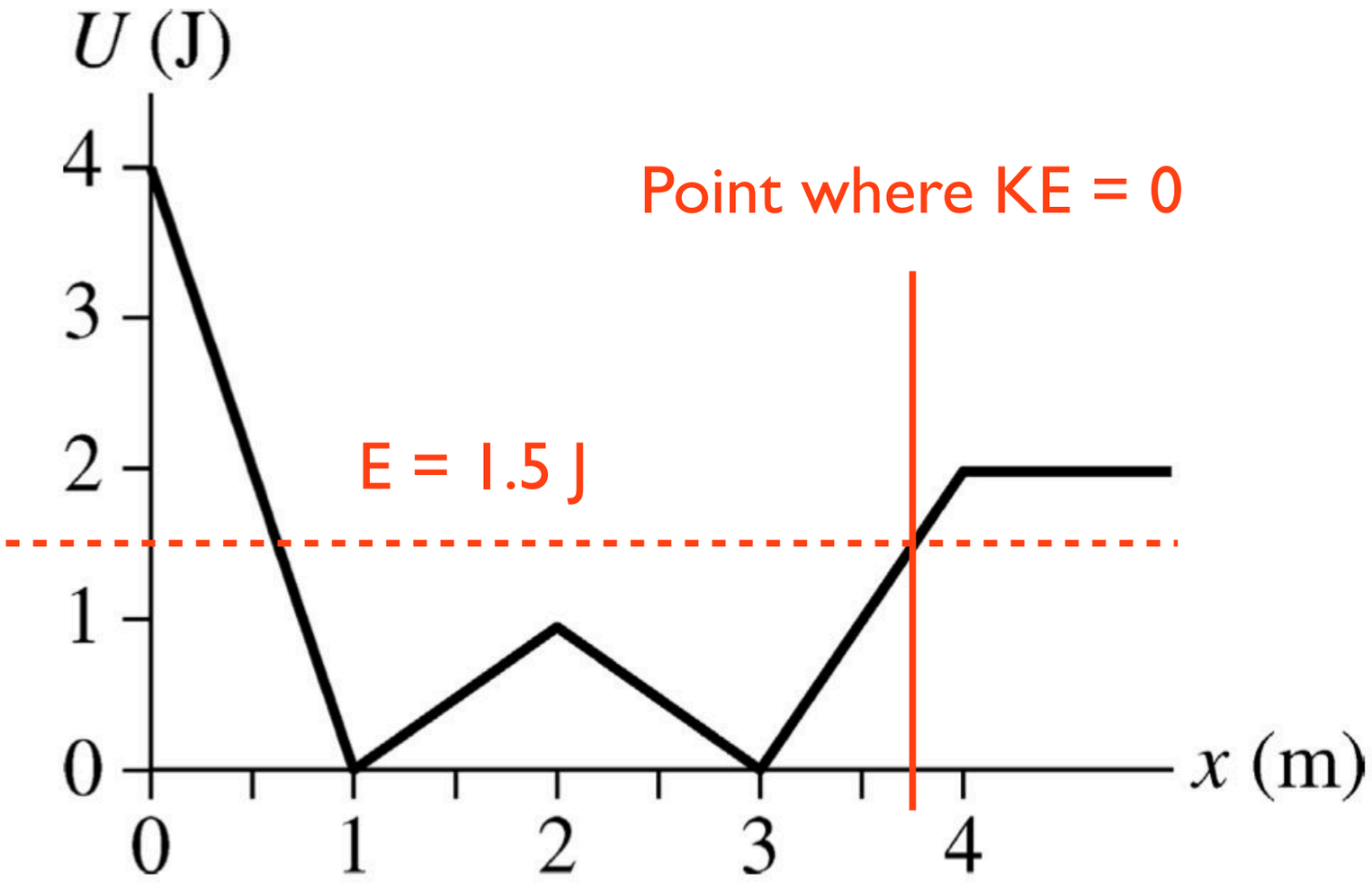
A particle with a total energy of 1.5 J is at x = 2 m and is traveling to the right. Where is the turning point of the particle?



A) 3 m

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E) no turning point

Clicker Question

An instructor pushes a table covered in Science One students across a carpeted floor.

The table is at rest before and after the push. We can say that

A) Mechanical energy of the table/students is not conserved but total energy of the table/students is conserved

B) Total energy of the table/students is not conserved, but total energy of the floor/table/students is conserved

C) Energy conservation does not apply in this situation.

D) None of the above statements are true.

Extra: describe all ways in which one form of energy is transformed to another form in this process

Clicker Question

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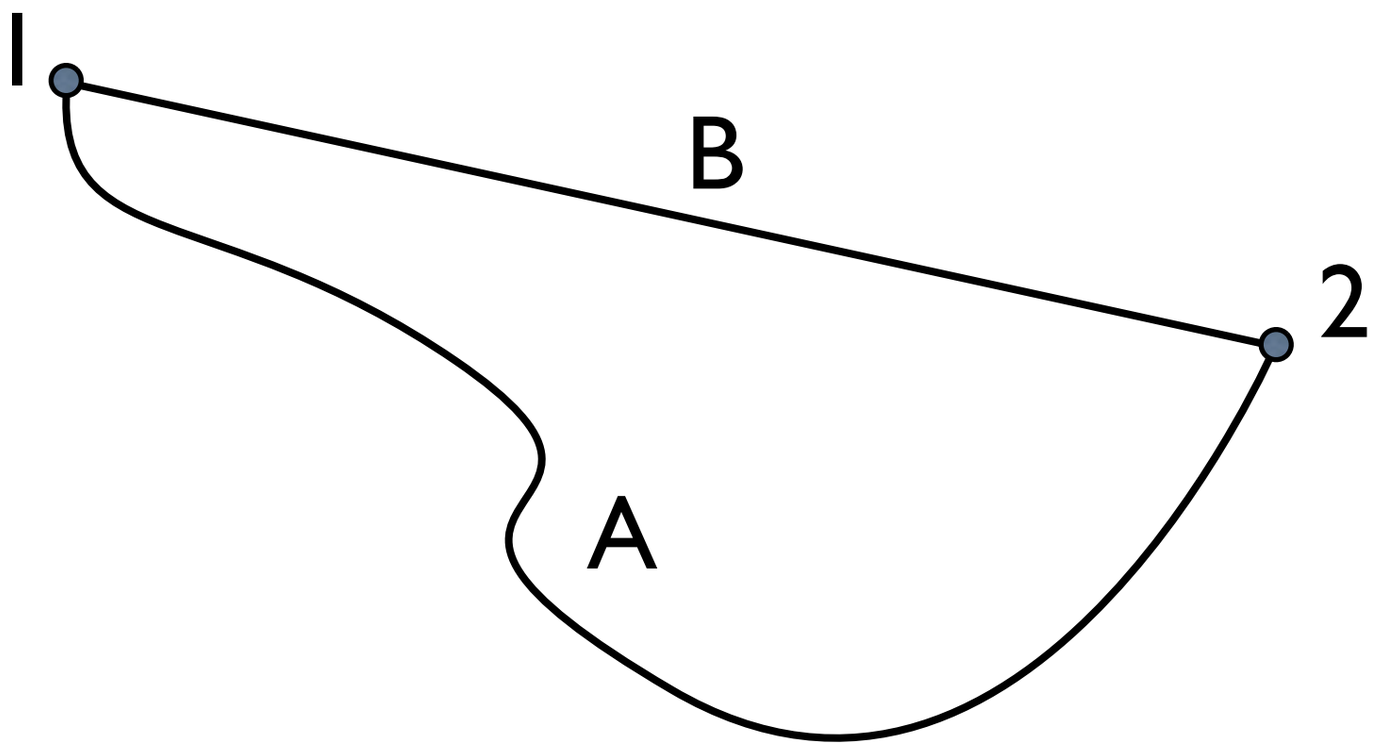
C) Energy conservation does not apply in this situation.

D) None of the above statements are true.

Energy from the man is transferred to kinetic energy of the students/table, but this energy goes into heating up the wheels and the floor via friction.

Work

You have to slide a box on the floor between points 1 and 2. Which path requires you to do the least work. Explain!



A) A

B) B

C) same

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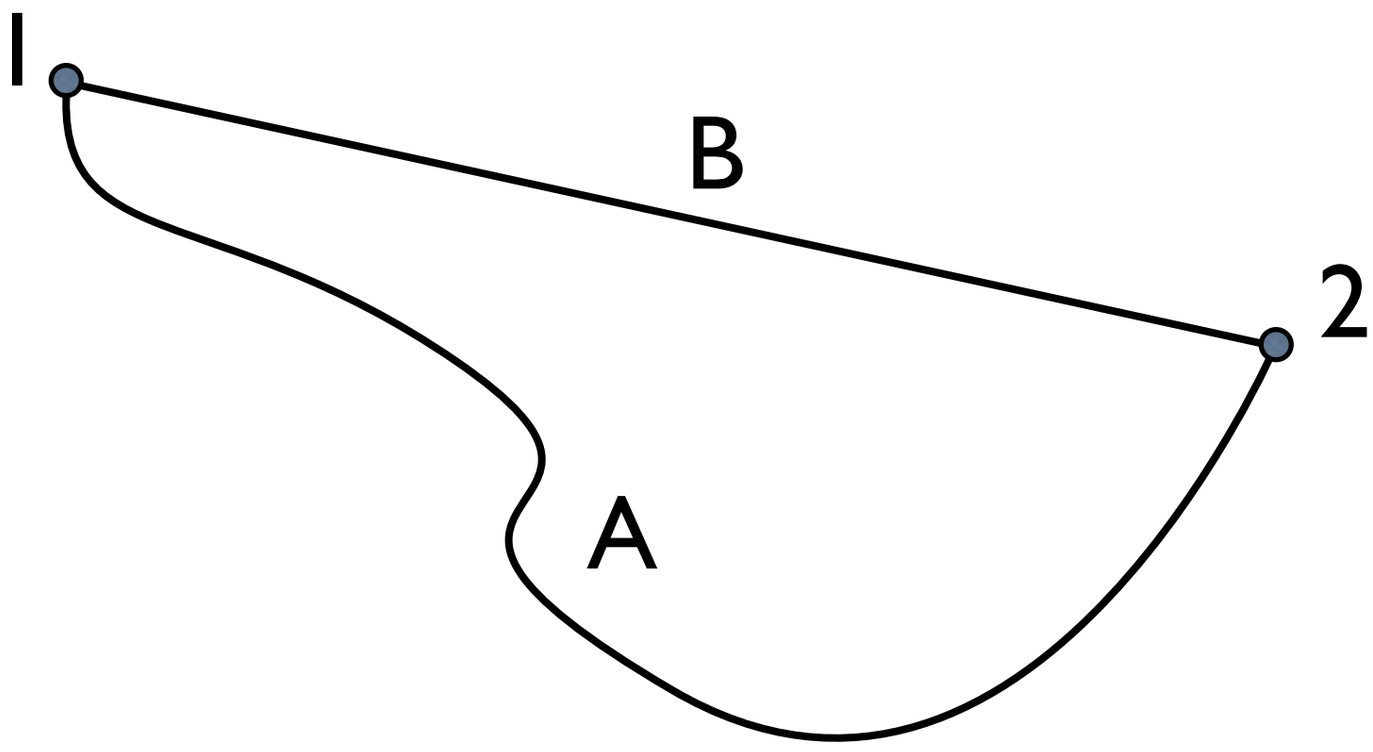


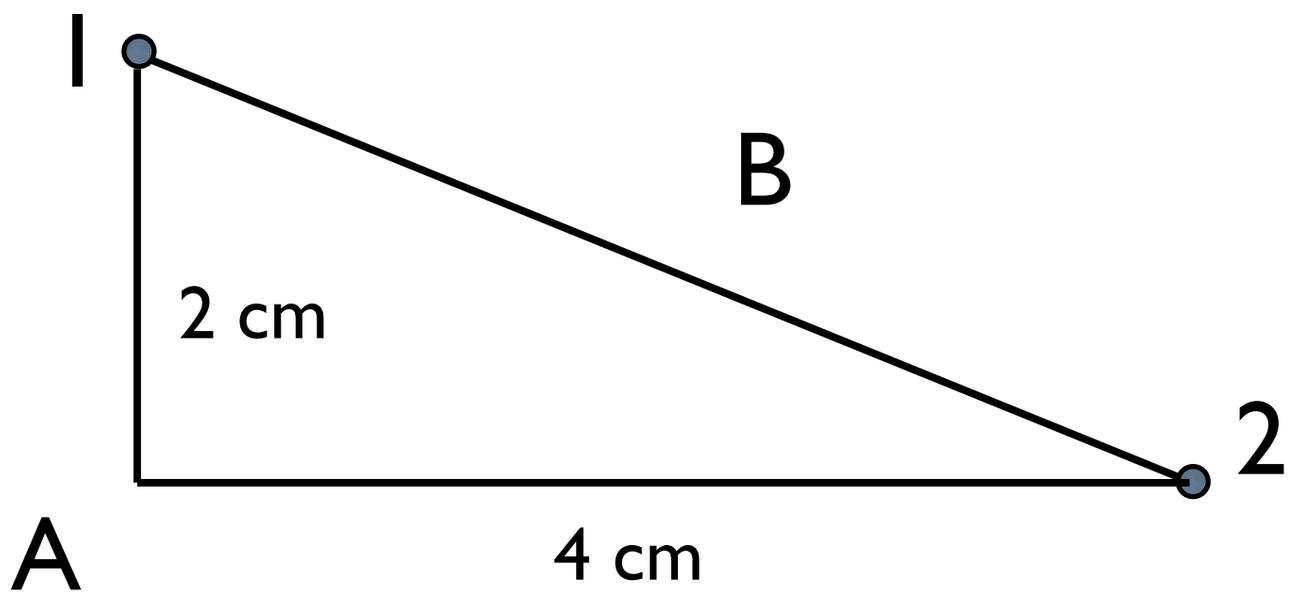
A) A

B) B

C) same

Work

A gravitational field is pointing downwards. You have to move a box from point 1 to point 2. Which path requires you to do the least work. Explain!



A) A

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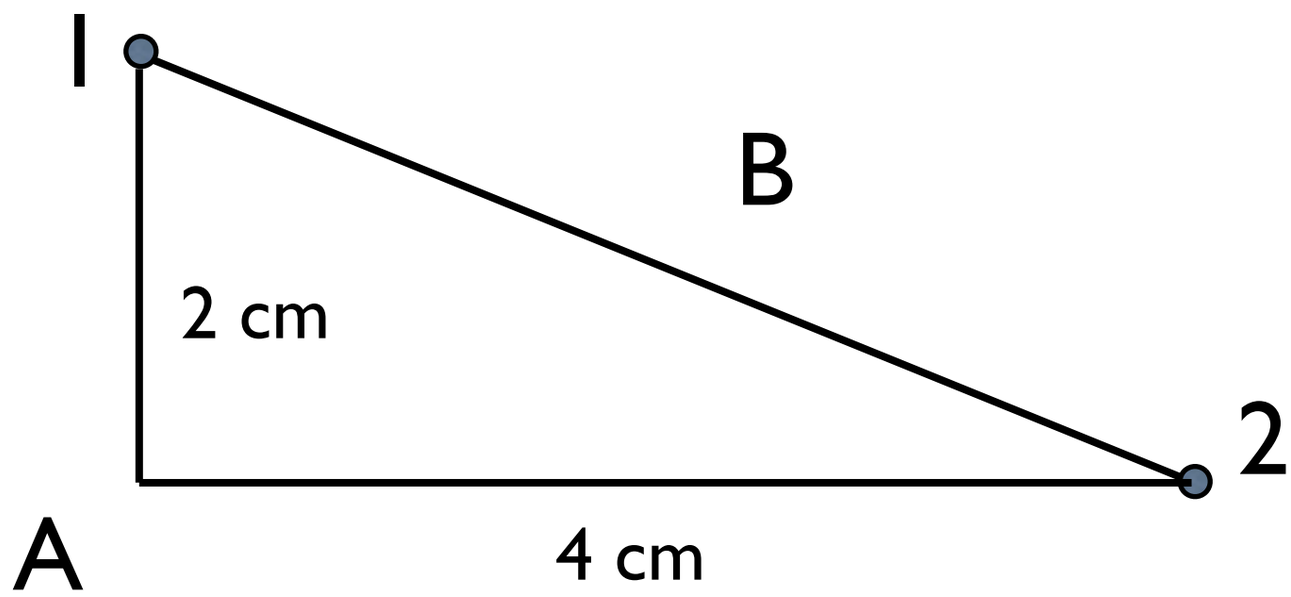


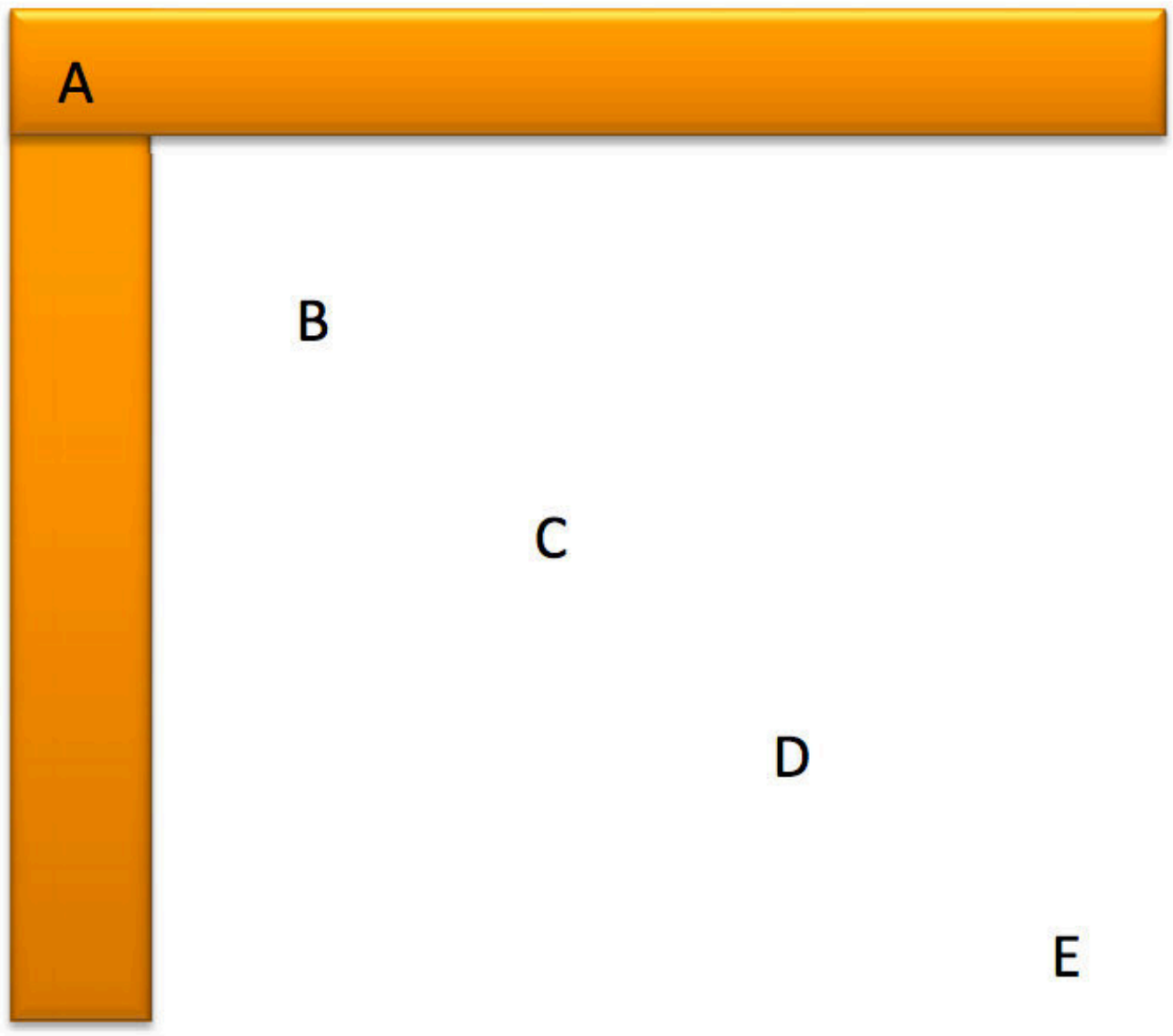
A) A

B) B

C) same

When the work doesn't depend on the path, it's called path independence. We say the force is conservative.

A crude boomerang is constructed by gluing two thin pieces of wood together as shown. Where is the center of mass?



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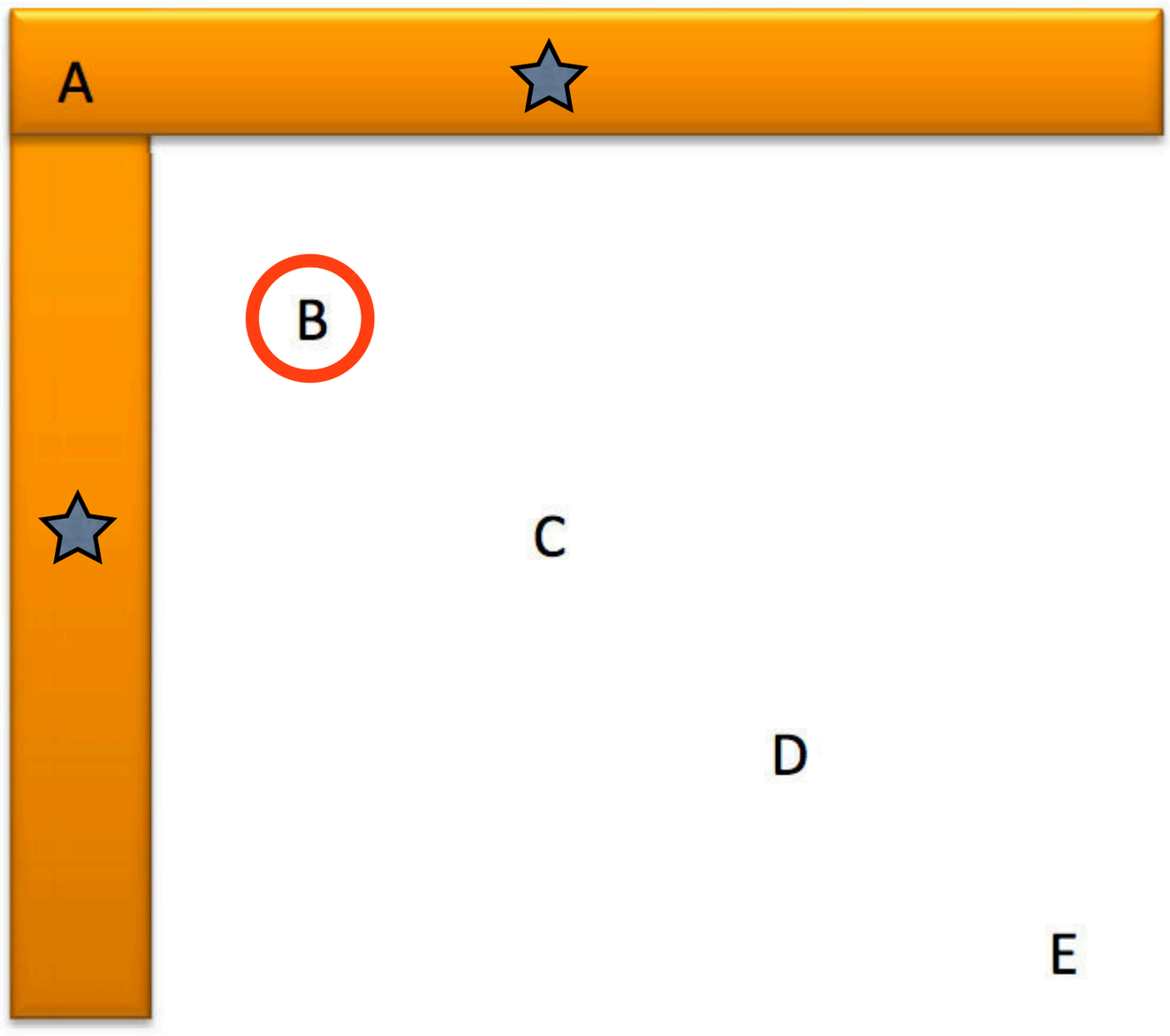
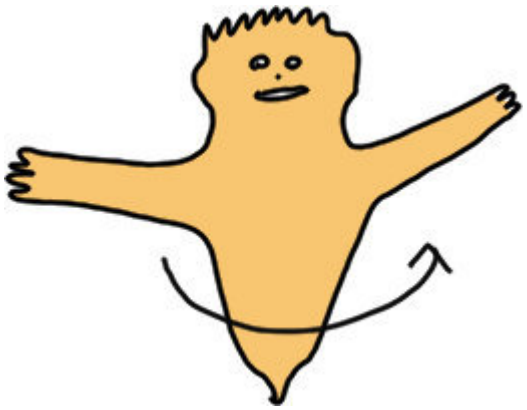
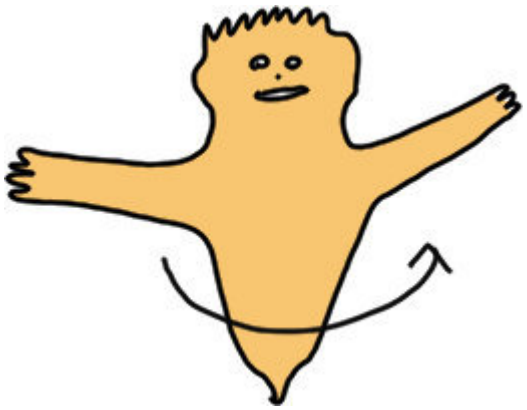


Stars indicate the center of mass for each piece. The center of mass for the whole object is the average of these positions.



Spinny Troll is spinning counterclockwise, but slowing down. If we say that a clockwise rotation corresponds to an increase in θ, we can say that

A) ω is positive and α is negative
B) ω is negative and α is positive
C) Both ω and α are positive
D) Both ω and α are negative
E) The sign of ω and α cannot be determined from the information provided



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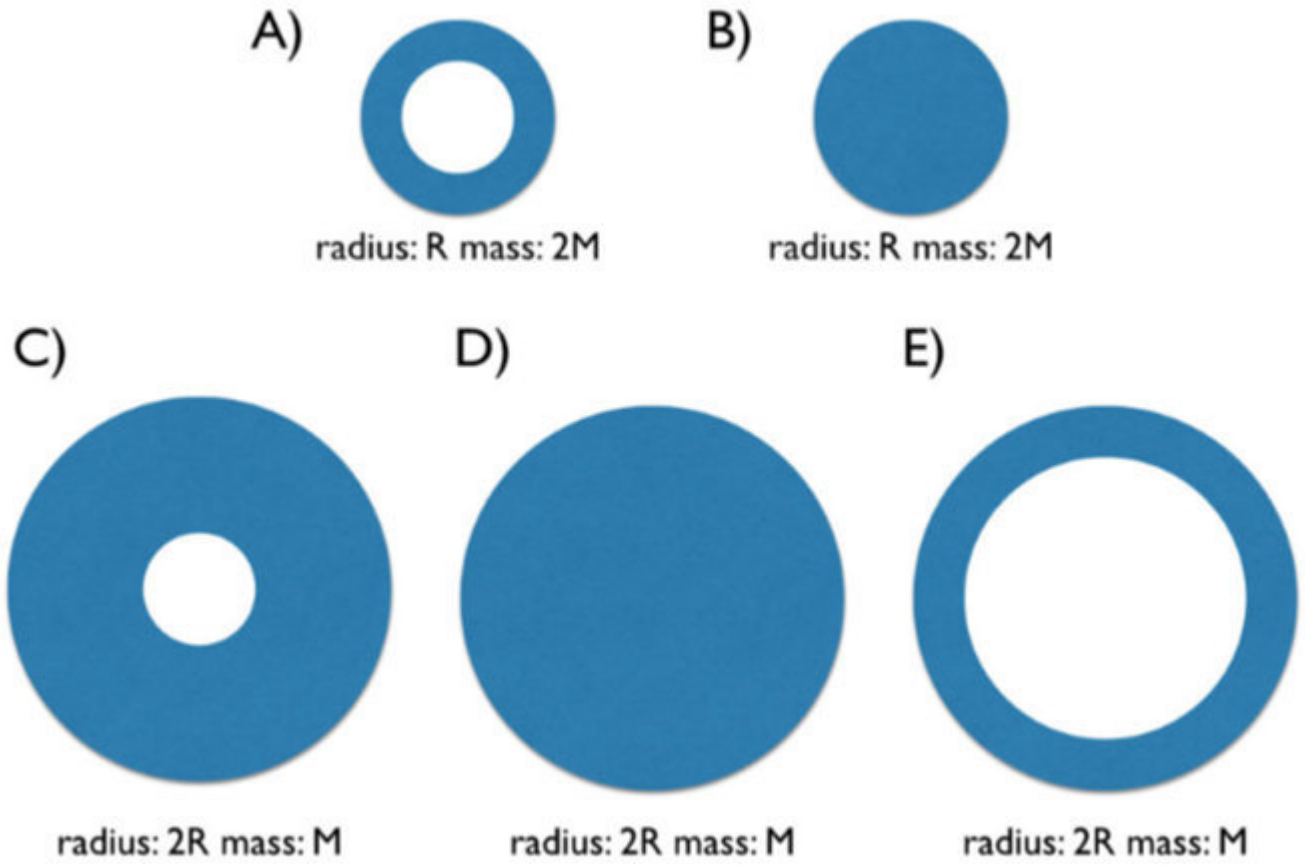
All the objects below are spinning at the same angular velocity. Which has the least angular momentum?



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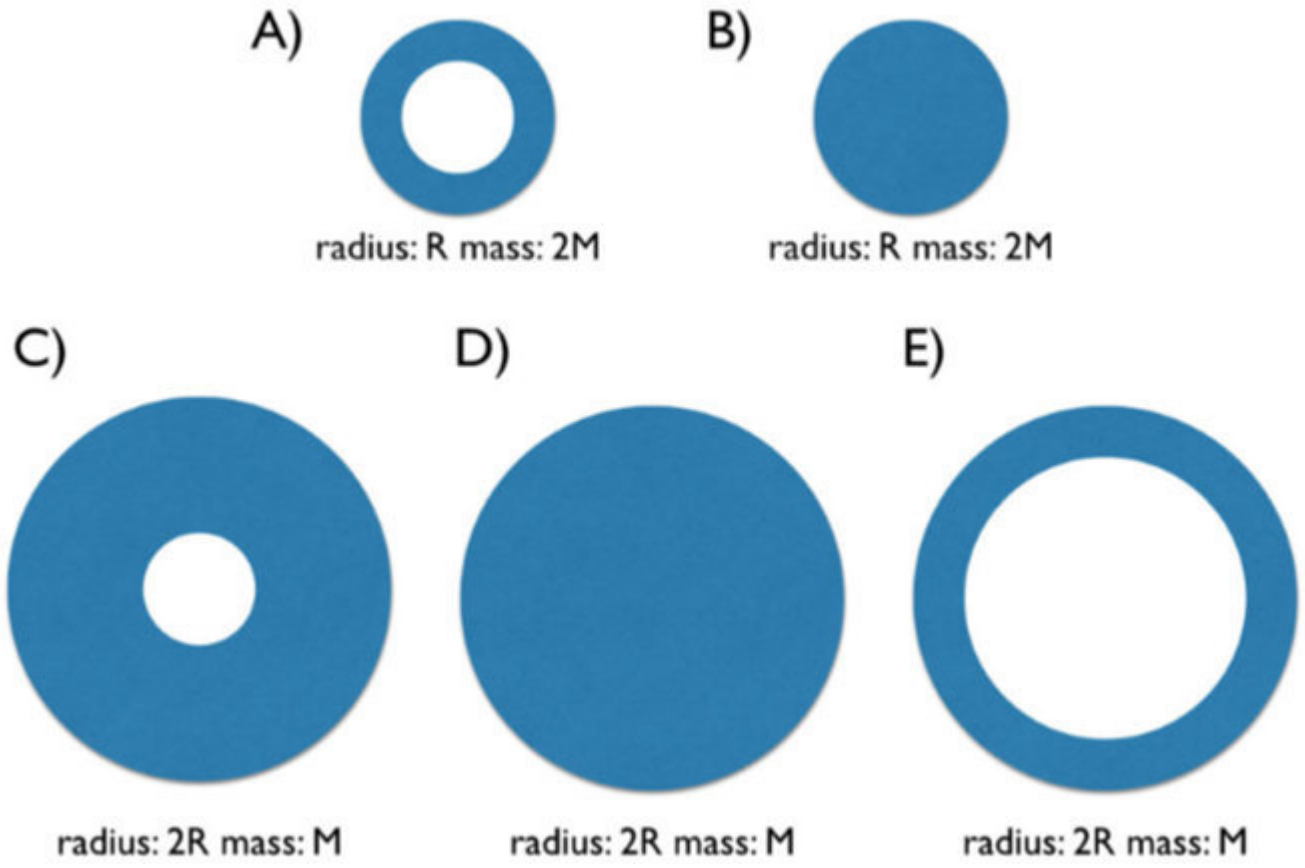

A rotating star shrinks due to gravitational collapse. We can say that its angular velocity

A) Increases
B) Decreases
C) Stays the same

Extra: if the star originally rotates (spins on its axis) once per week and the radius decreases by a factor of 10^4 how long does the final star take to rotate?

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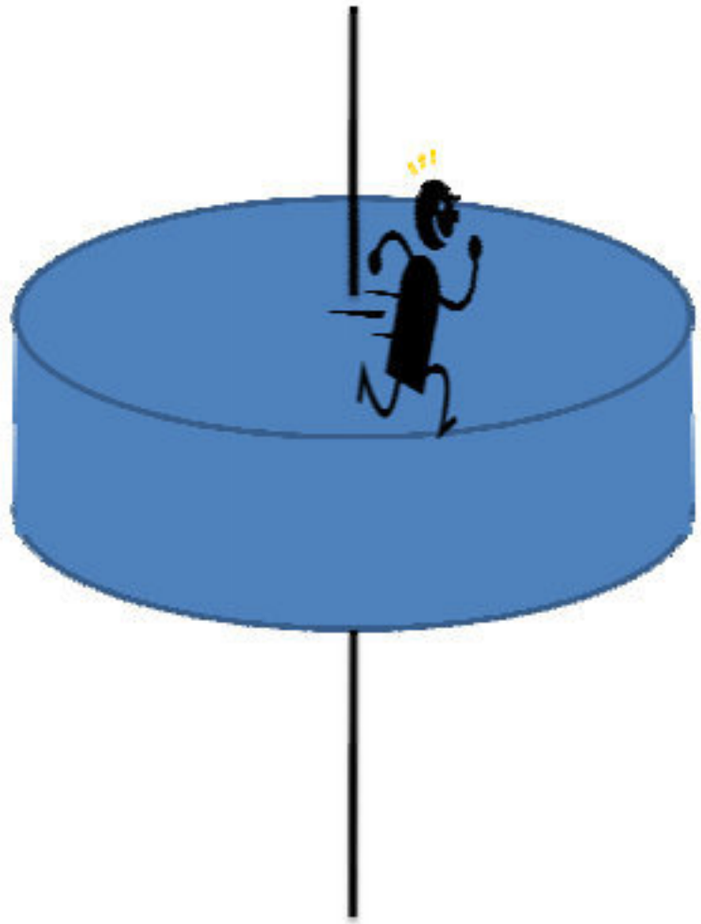
Clicker Question

A big solid disk sits on a frictionless axle. A man stands at the edge of the disk. If the man tries to run,

A) the man will stay in the same place and the disk will rotate under him.
B) the man will move counterclockwise around the axle, while the disk will rotate clockwise around the axle (viewed from the top).
C) the man and the disk will both start moving clockwise around the axis.
D) the man and the disk will both end up moving counterclockwise around the axis.



Ignore any effects associated with air resistance.

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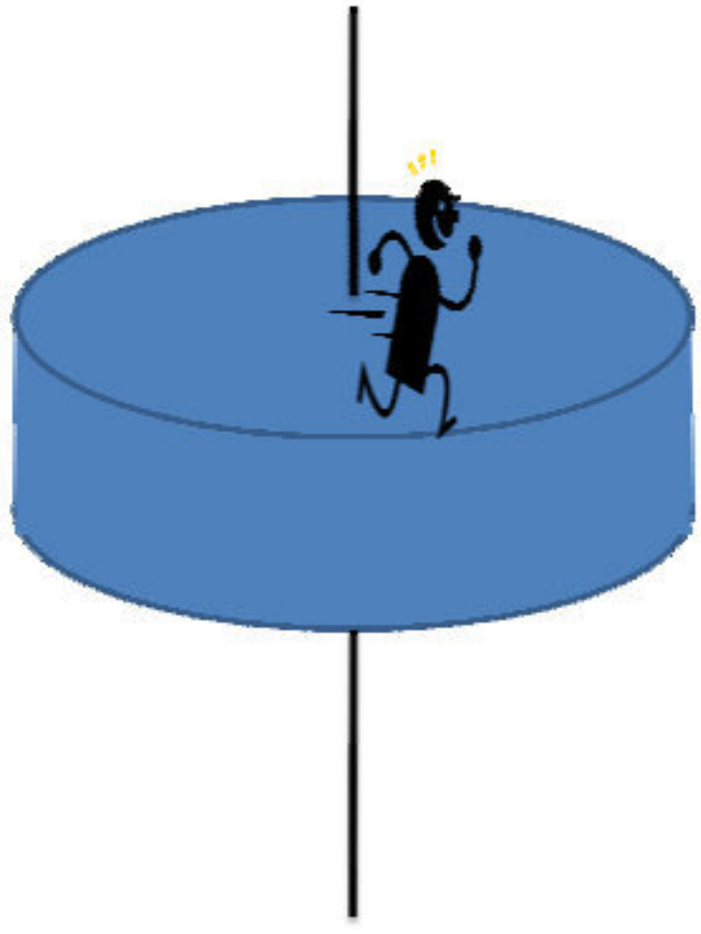
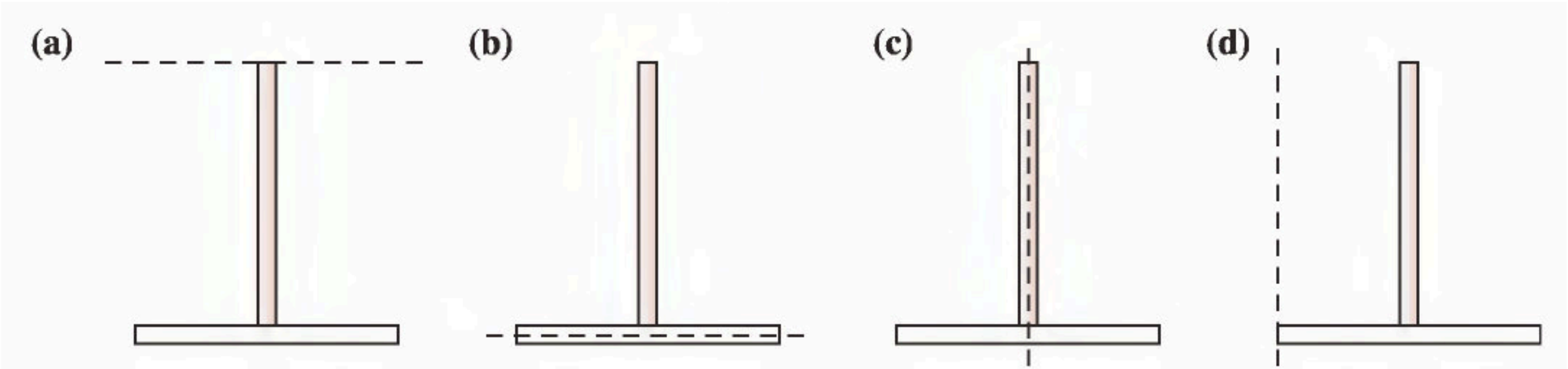


Ignore any effects associated with air resistance.

Moment of inertia makes it so the disc won't start rotating instantly.
Similar to how pushing against a mass in empty space makes you move.

Clicker Question

Four "T"s are made from two identical rods of equal mass and length. Which has the **second largest** moment of inertia for rotation about the dashed line.



A) (a)
B) (b)
C) (c)
D) (d)

Extra: rank them from largest to smallest.

Clicker Question

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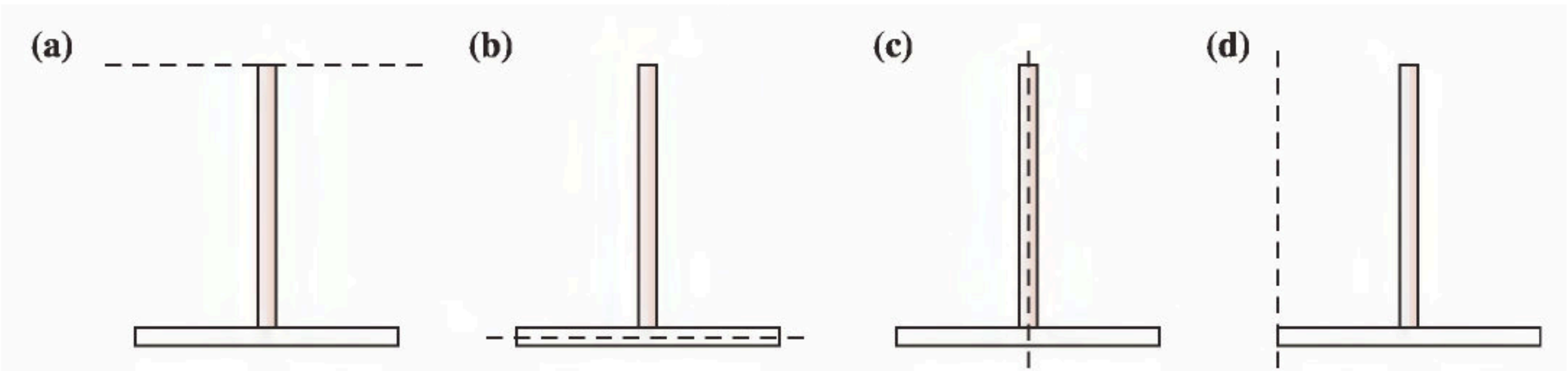

A) (a)
B) (b)
C) (c)
D) (d)

Part of the mass for (b) and (c) are on the axis, a thus doesn't really contribute much. So they're the lowest.

Both (a) and (d) have a rod rotating about one end, perpendicular to the axis, but the rod parallel to the axis in (d) is closer that the one is (a), so the moment is lower.

The ranking is (a) > (d) > (b) > (c).

A rotating star shrinks by a factor of 10^4 due to gravitational collapse. We can say that its angular velocity:

A) Increases by a factor of 10^8
B) Increases by a factor of 10^4
C) Increases by a factor of 10^2
D) Stays the same
E) Decreases

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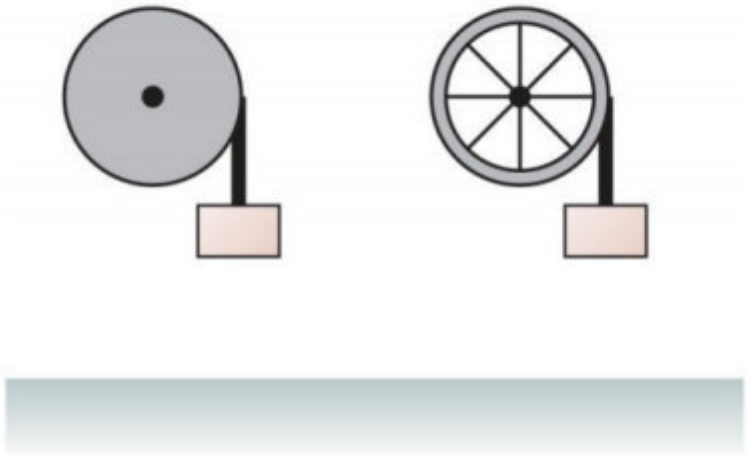
When the star shrinks by a factor of 10^4, it's moment of inertia decreases by 10^8 since I is proportional to R^2. Angular momentum $L = I \omega$ is conserved, so ω must increase by a factor of 10^8.

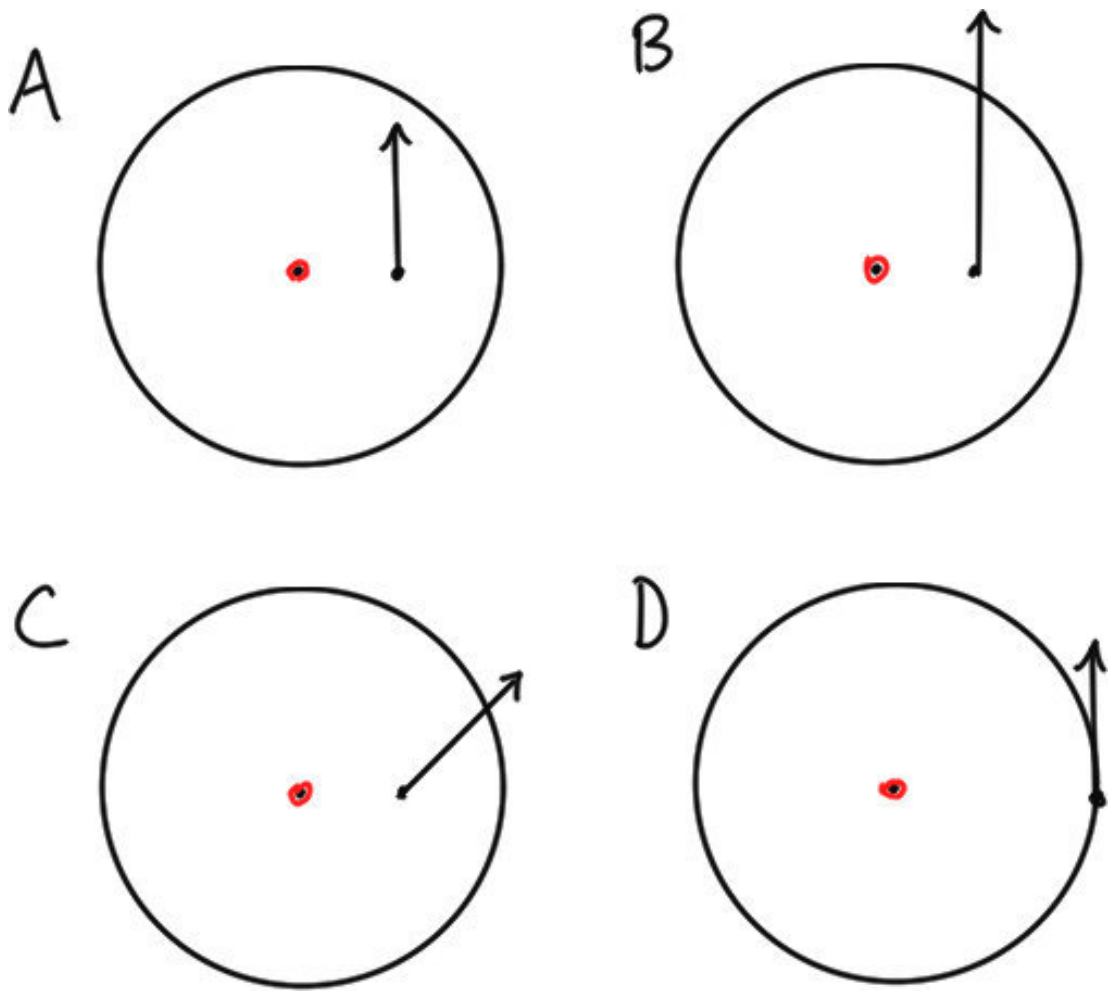
The solid disk and the hoop have the same mass, radius, and height above the ground and turn on frictionless horizontal axles. Ropes are wrapped around each and tied to blocks of the same mass. Which block hits the ground first?

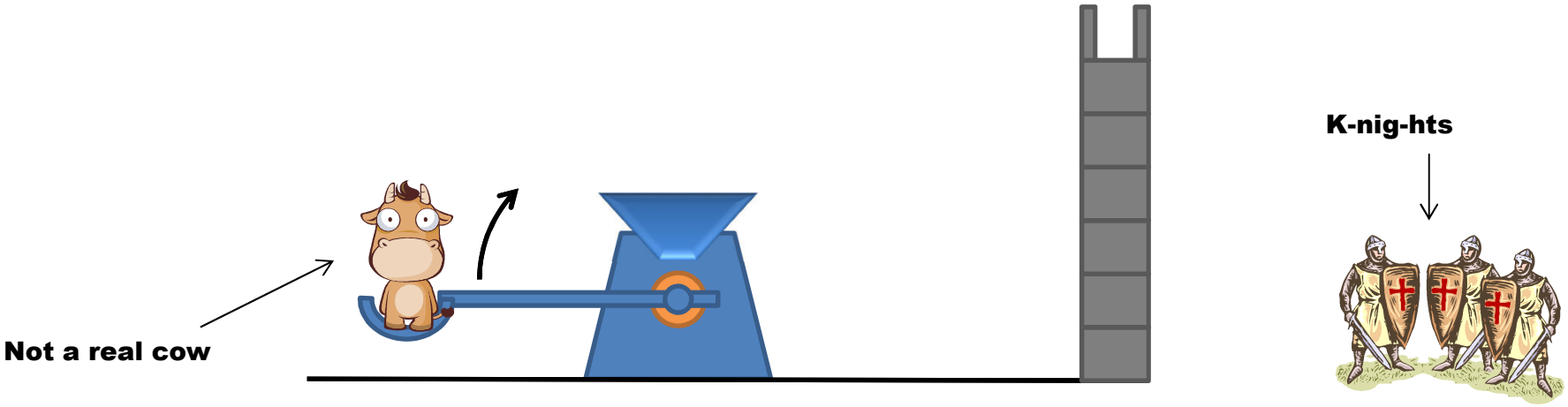


A) The one on the left
B) The one on the right
C) Same
D) Can't be determined

Extra: after the block starts falling, how does the angular velocity of the wheel relate to the velocity of the block?

Rank from smallest to largest the magnitude of the torque produced by the forces below.

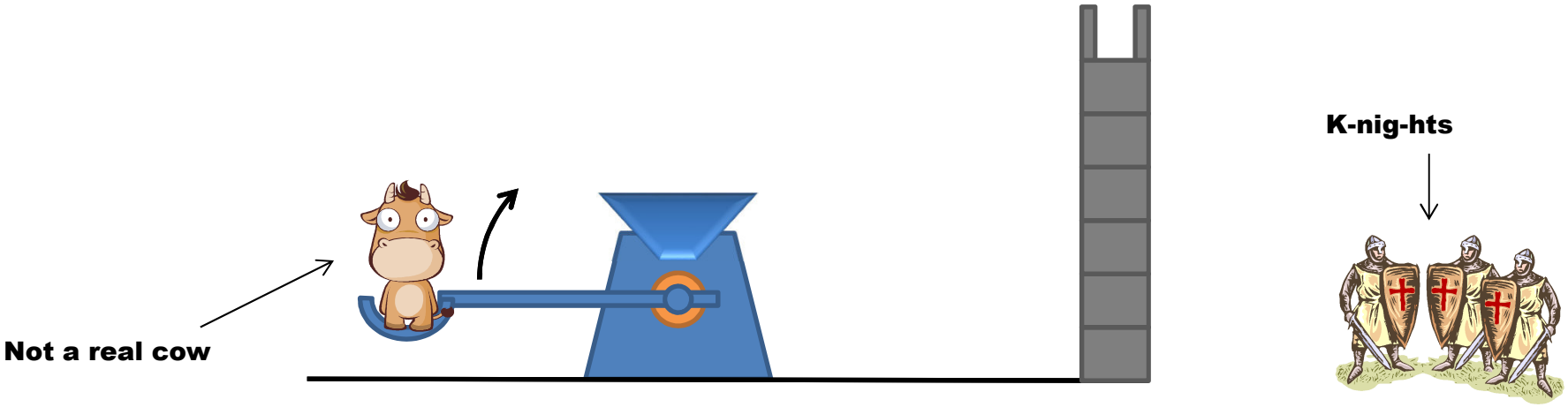




During the fictional defence of a French castle, a constant torque **τ** is exerted for a time **t** on a catapult arm loaded with a cow. If the arm was initially stationary, and the moment of inertia of the cow plus arm about the axis is **I**, the angular velocity of the arm after time t will be

A) $t\,\tau / I$
B) $t\,I / \tau$
C) $\tau\,I / t$
D) $\tau / (I\,t)$
E) I have no idea how to do this. Please take this question away or I shall taunt you a second time.

Extra: if the arm stops at this point, with what speed will the cow fly off?



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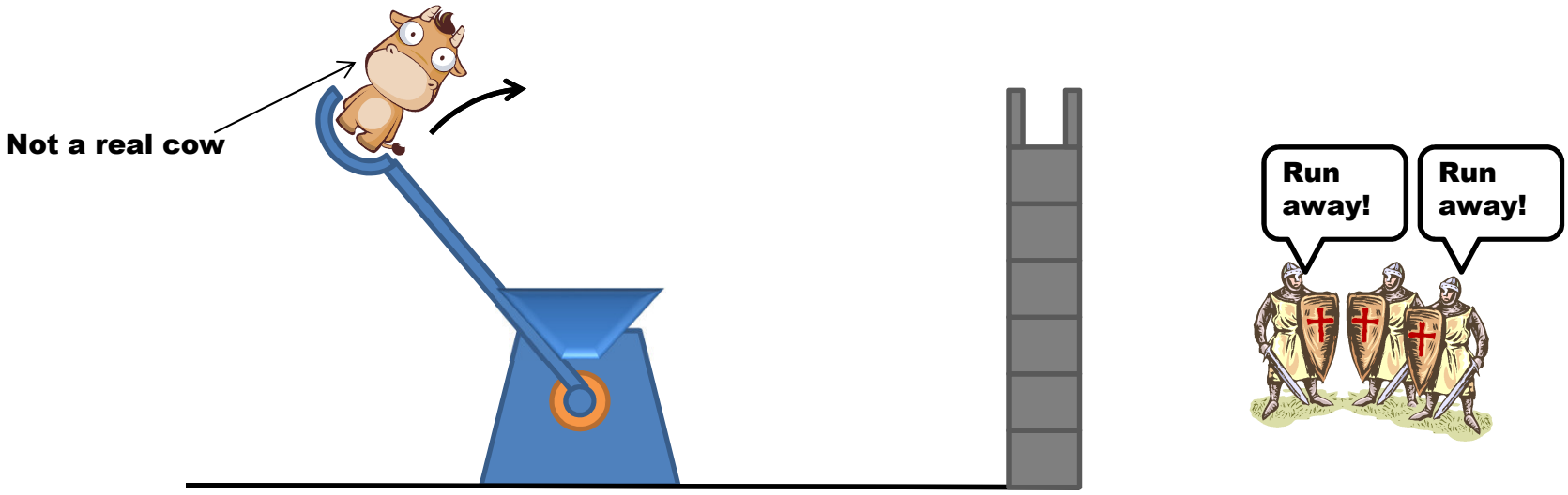
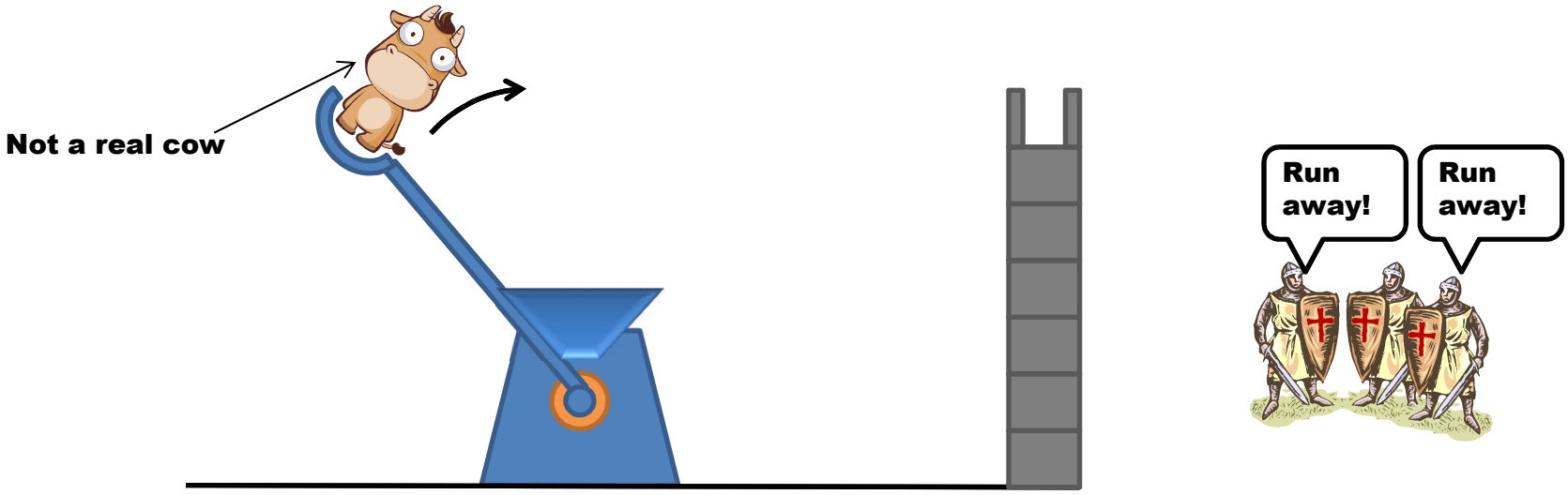


If the catapult arm (length R) plus cow are rotating about the axis at angular velocity ω just before the arm stops, with what speed does the cow fly off?

A) ω
B) ω R
C) ω / R
D) ω / $\sqrt{2}$
E) None of the above

Extra: in terms of the mass M, the radius R, and the speed v, what is the angular momentum of the cow about the axis just after it leaves the catapult?



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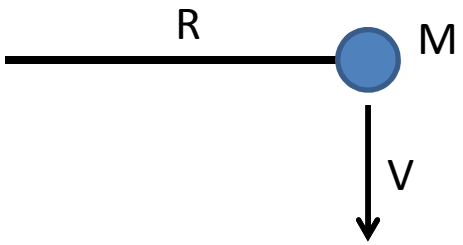
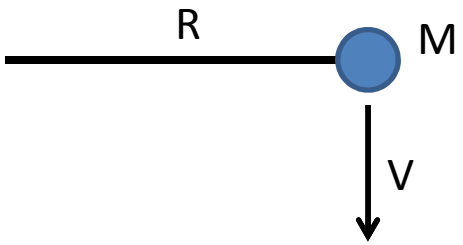


A ball of mass M revolves in a circular path on the end of a string. Using $L = I \omega$, calculate the angular momentum of the ball in terms of M, V, and R.



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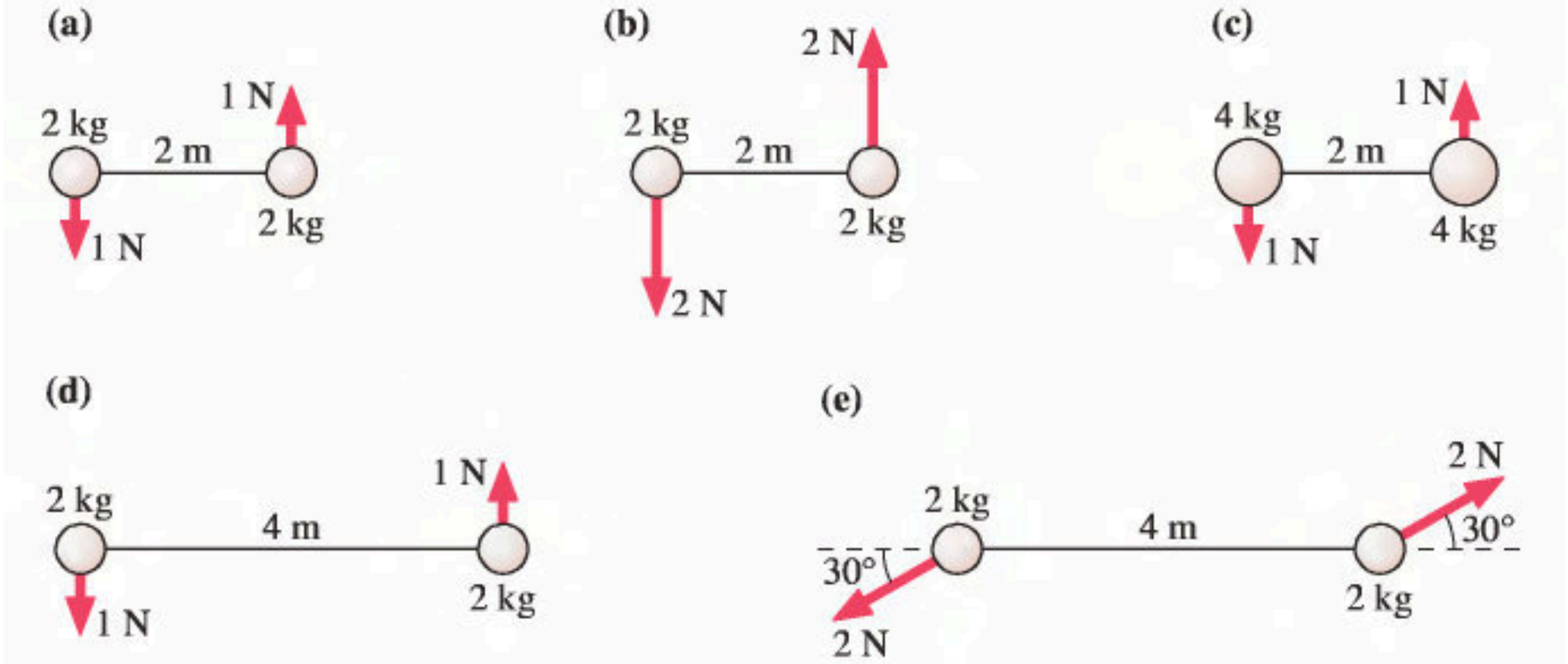
Clicker Question

Which configuration has the largest torque?



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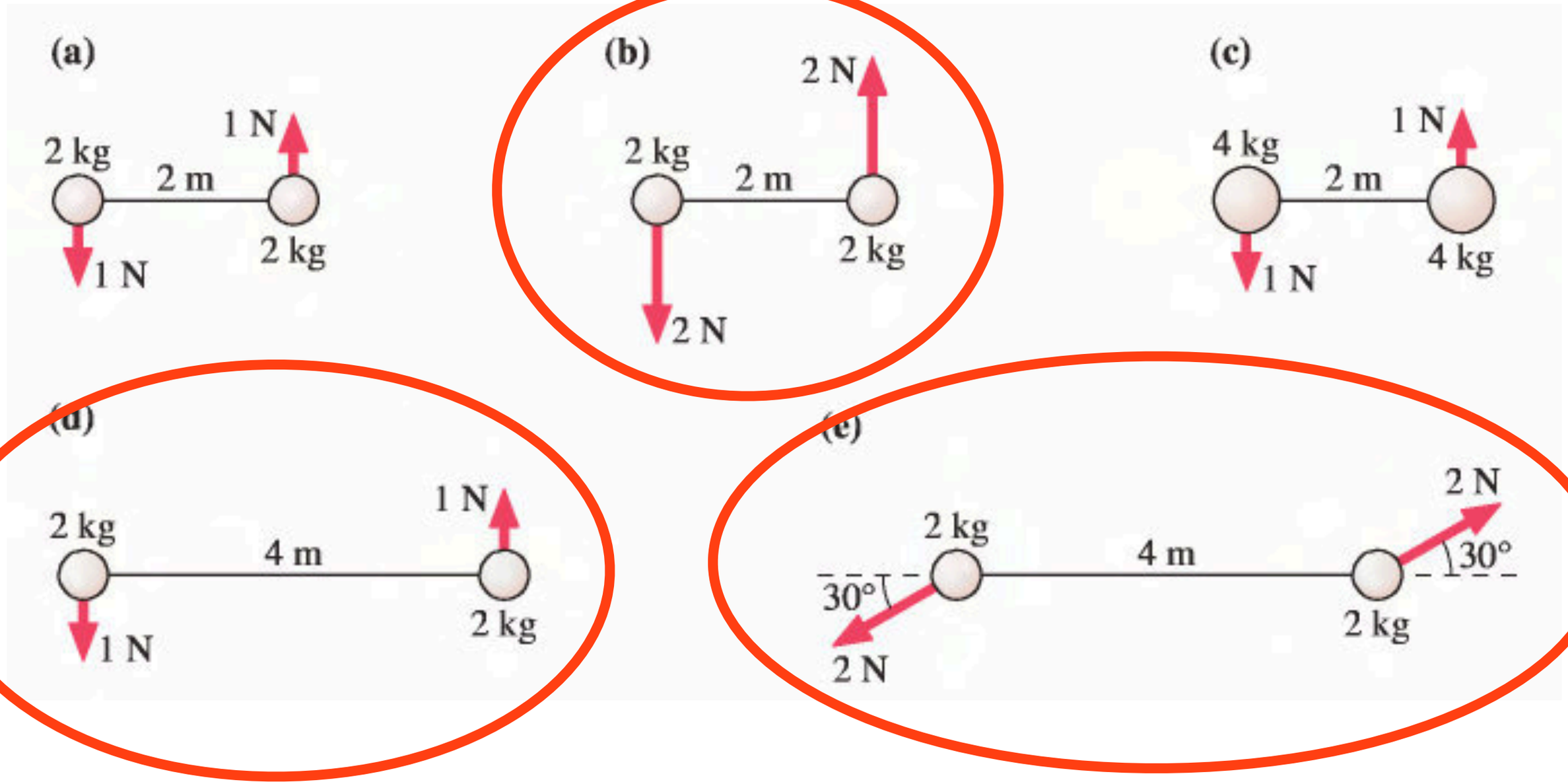
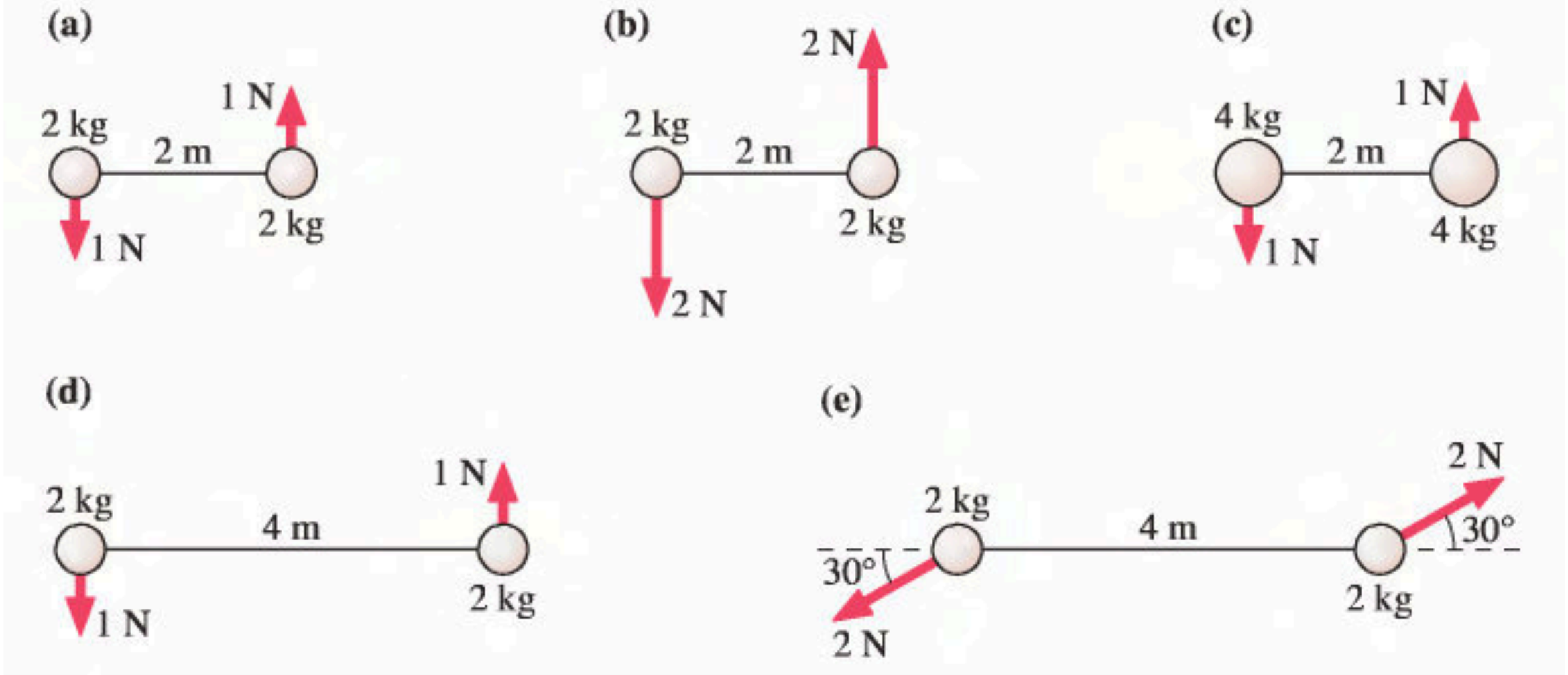


Clicker Question

Which configuration has the largest angular acceleration?



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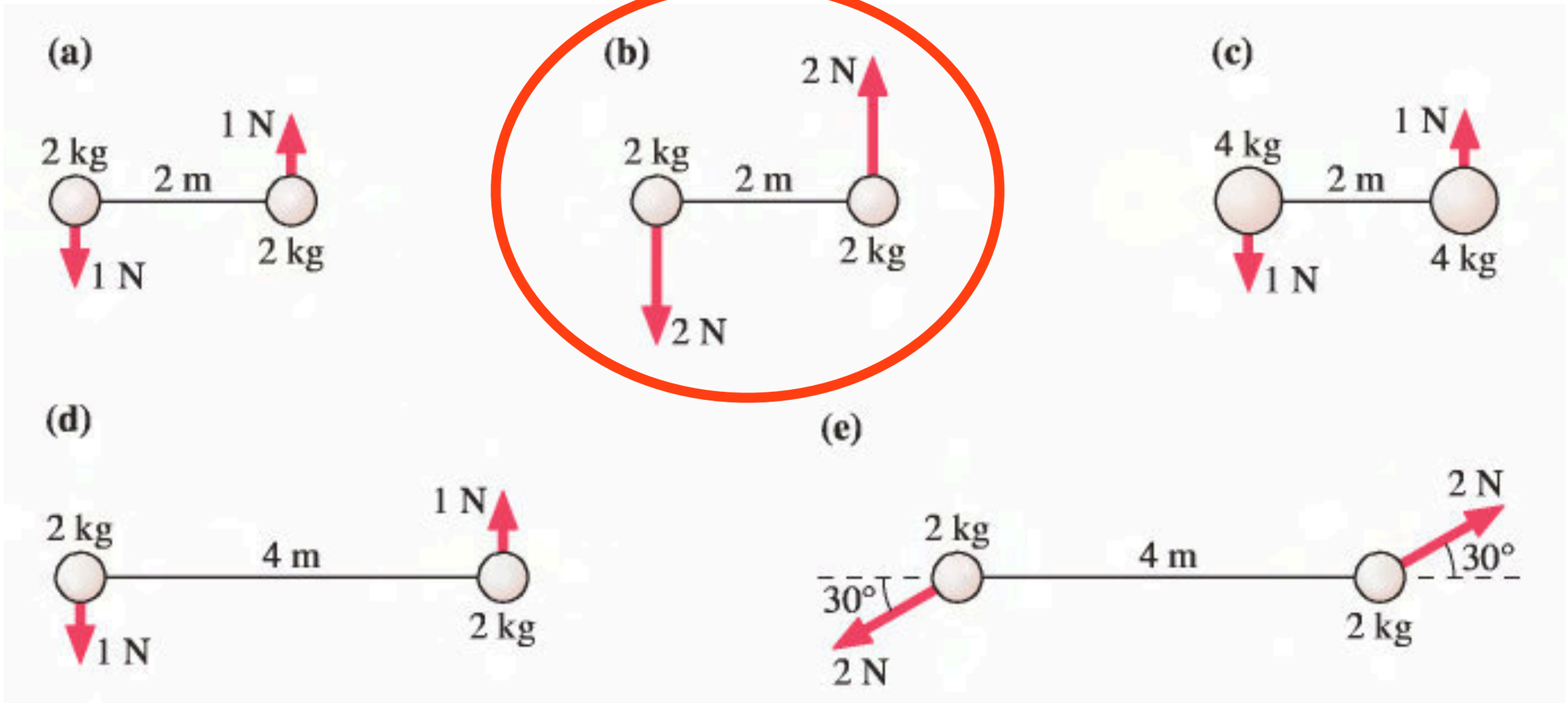

Clicker Question

A yo-yo held by its string and dropped falls

A) faster than
B) slower than
C) at the same speed as

one that is just dropped from the same height.

Ignore all friction effects.

Be prepared to explain your answer.