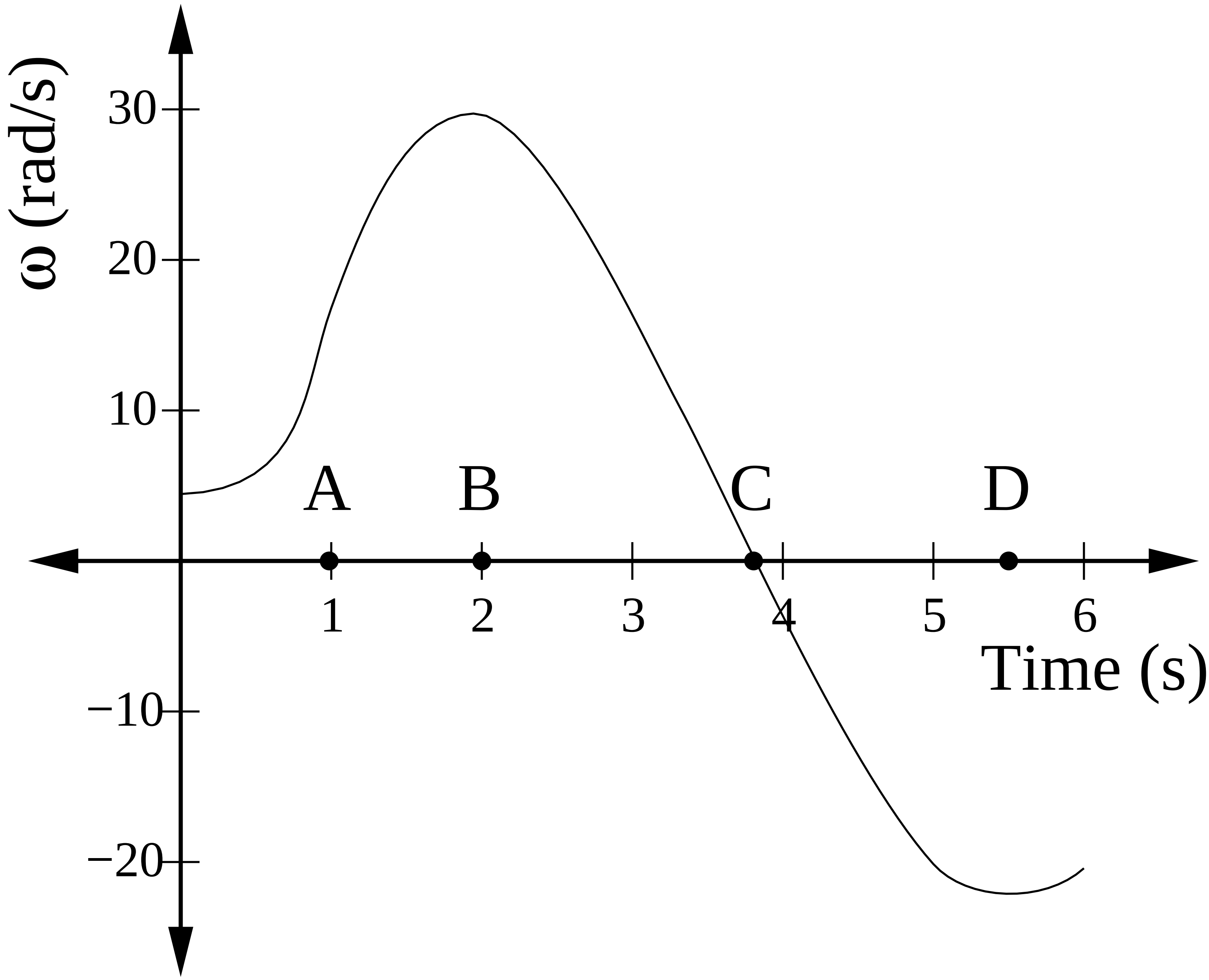
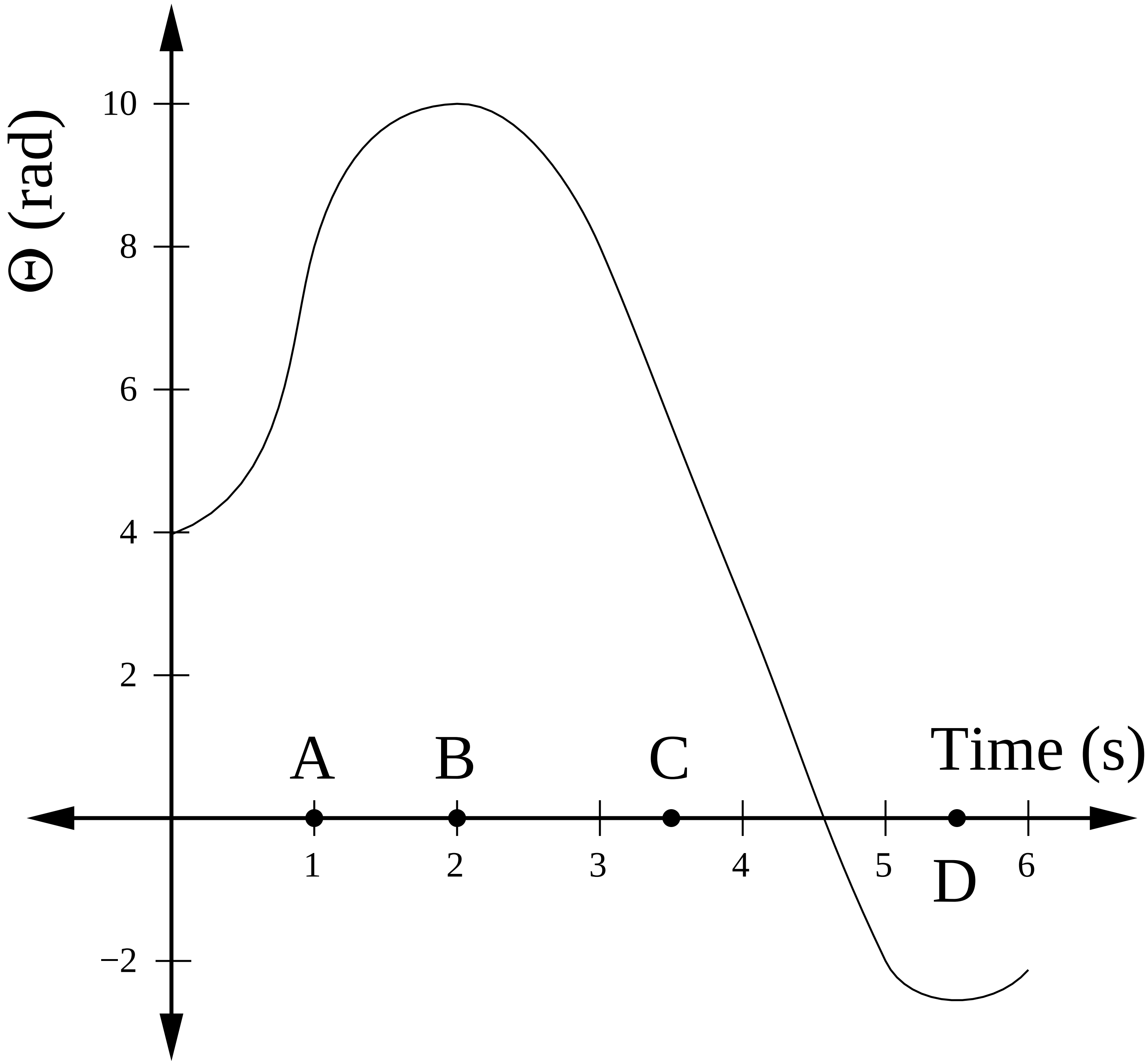
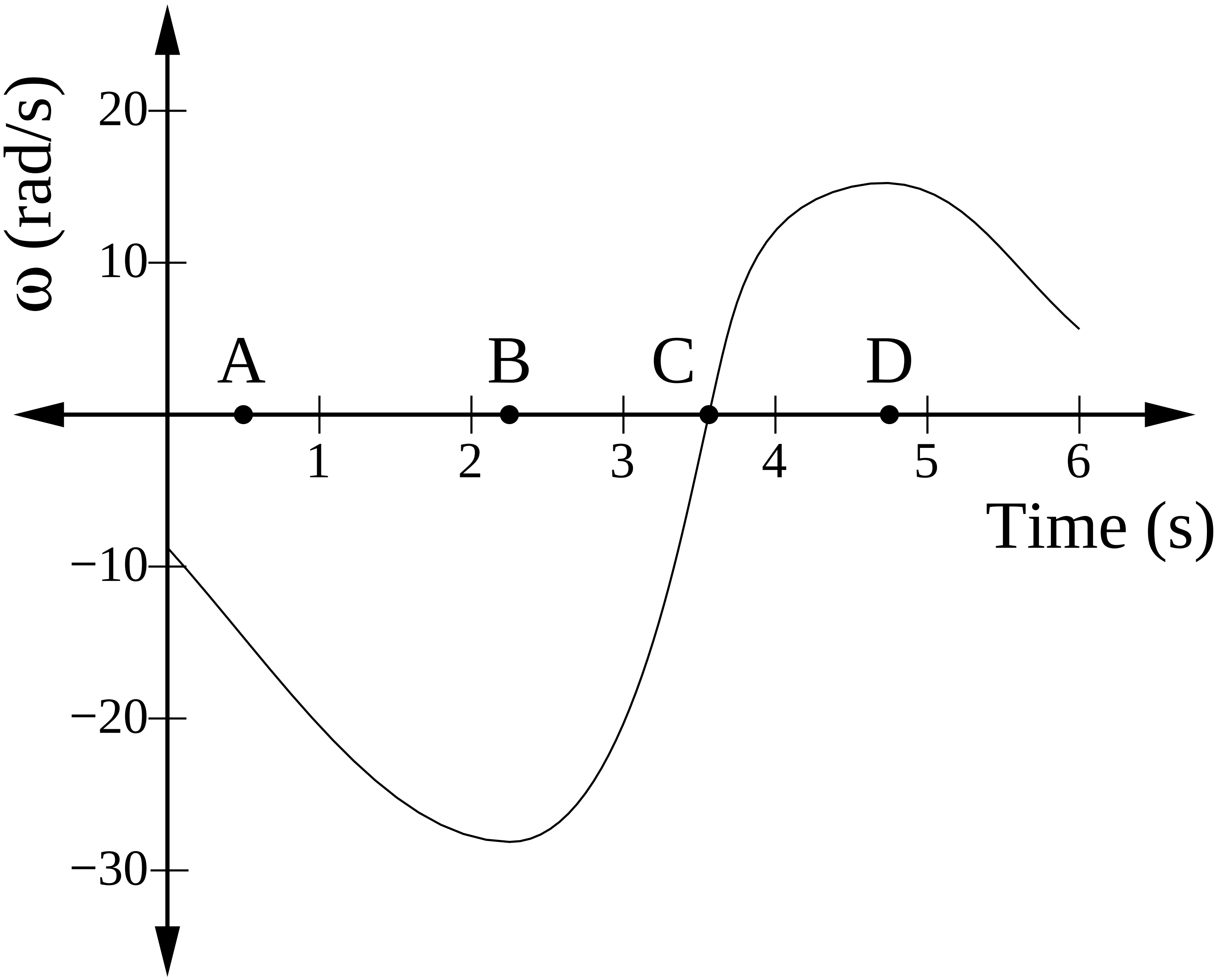
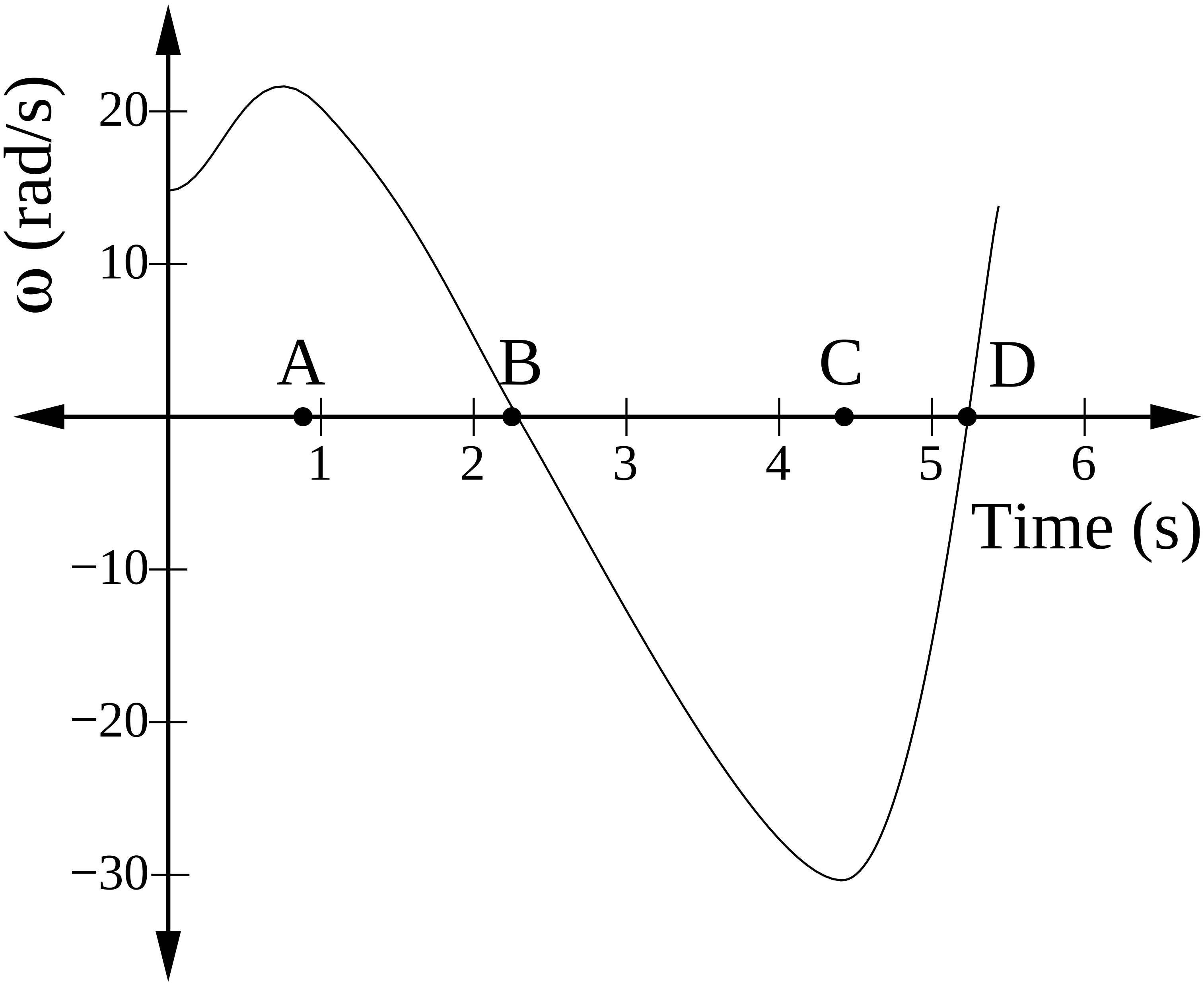

ω (rad/s)
30
20
10
−10
−20
A
B
C
D
1
2
3
4
5
6
Time (s)

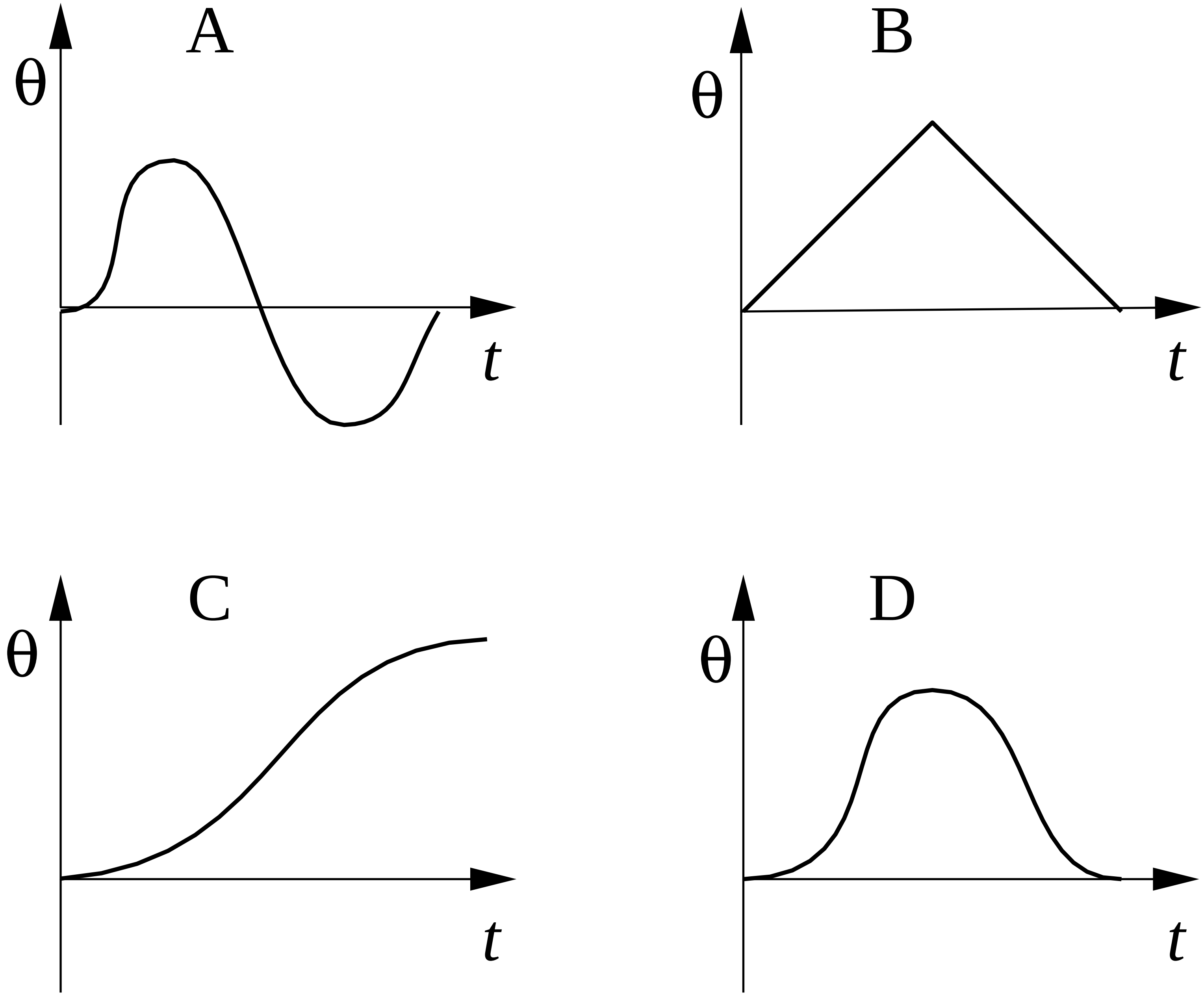

Θ (rad)
10
8
6
4
2
−2
A
B
C
D
Time (s)
1
2
3
4
5
6

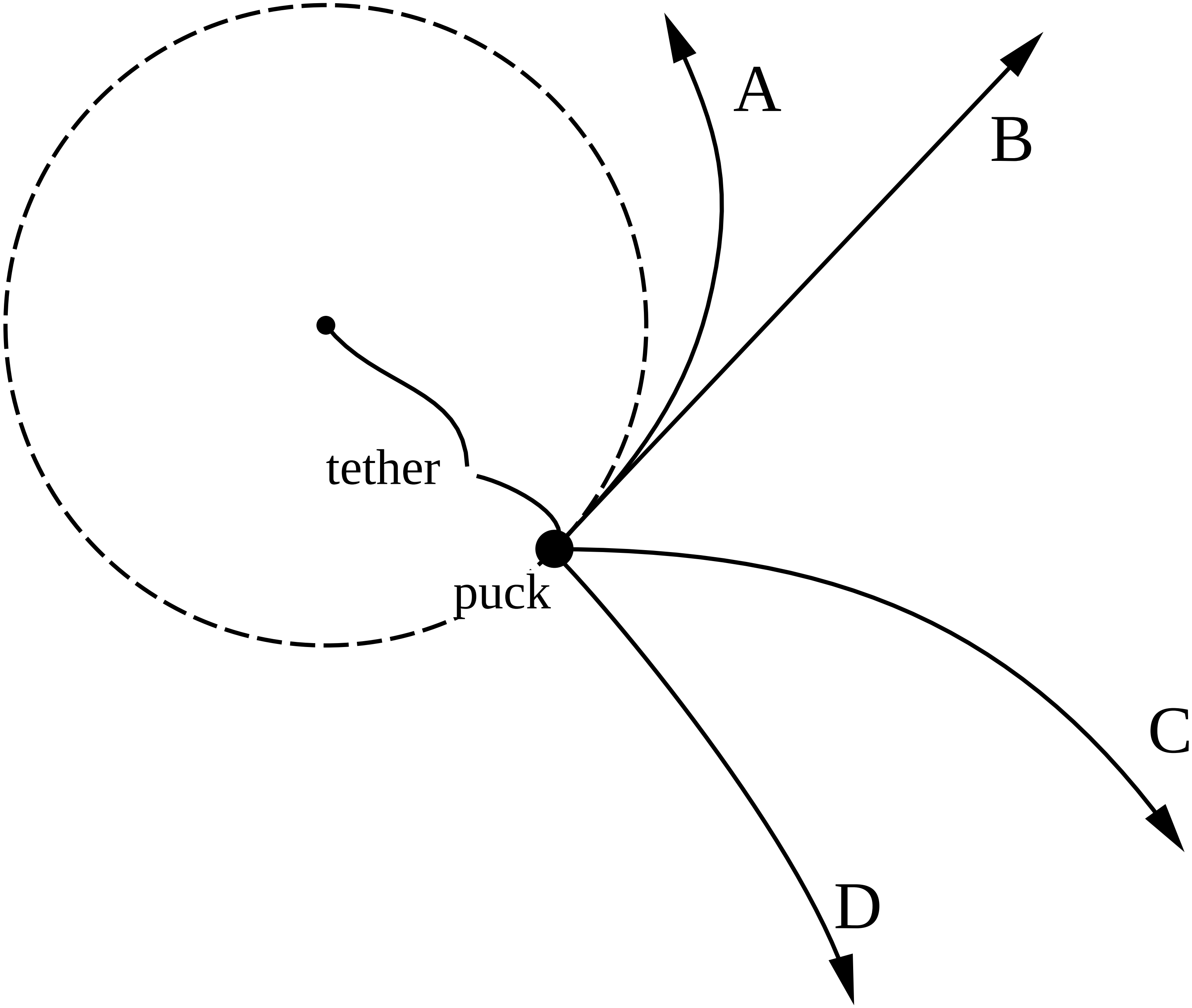


ω (rad/s)
20
10
−10
−20
−30
A
B
C
D
1
2
3
4
5
6
Time (s)



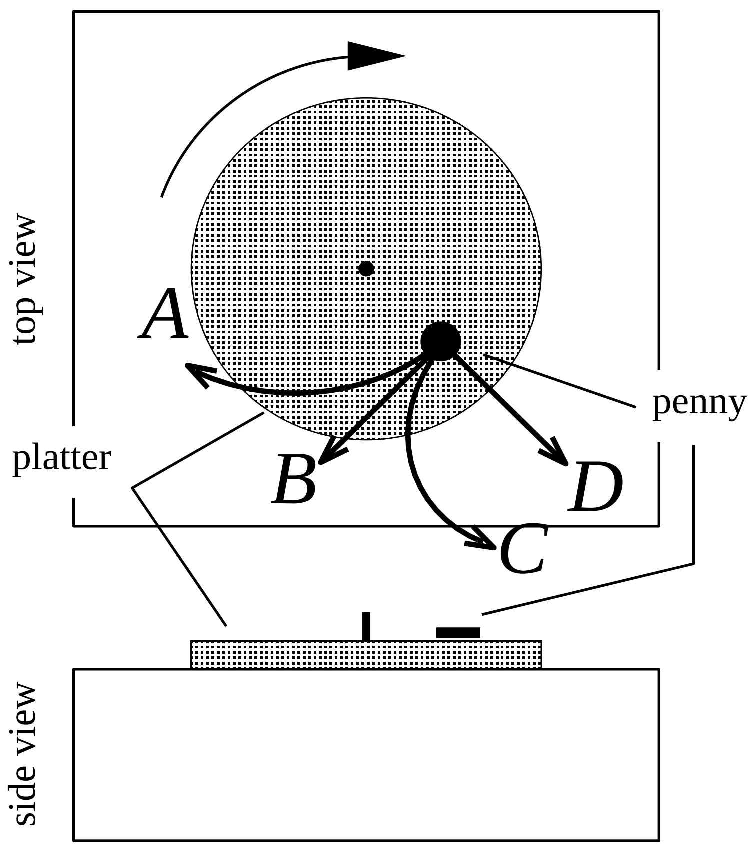
ω (rad/s)
20
10
−10
−20
−30
A
B
C
D
1
2
3
4
5
6
Time (s)

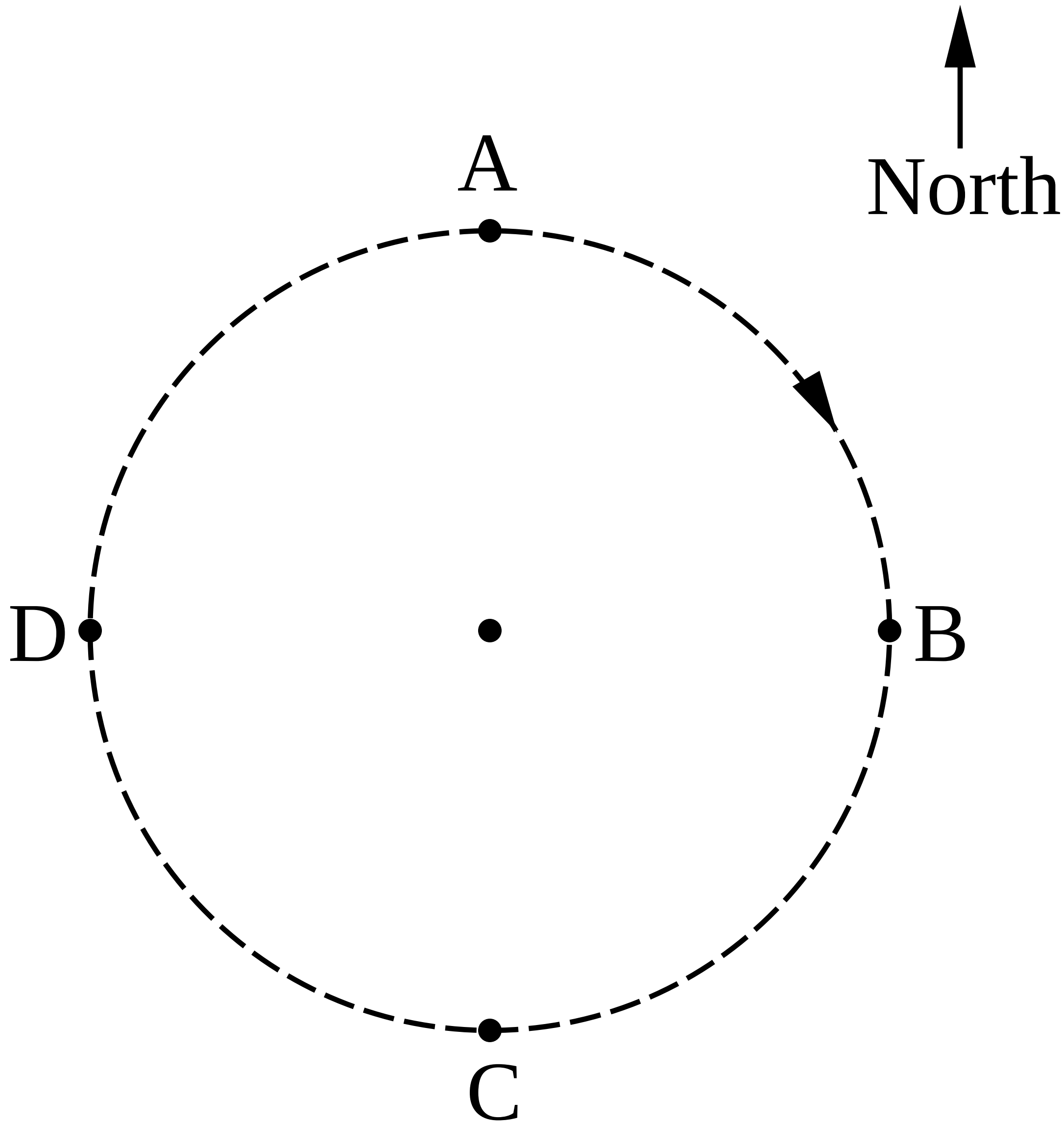

A
θ
t
B
θ
t
C
θ
t
D
θ
t



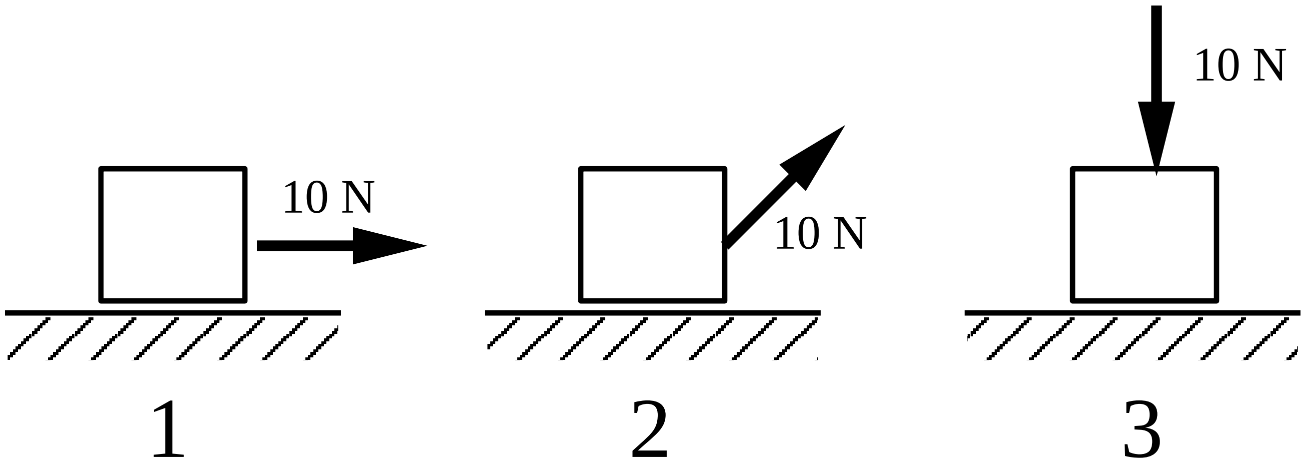
A
B
tether
puck
C
D

As a turntable speeds up, static friction is unable to keep a penny fixed on the platter. Which path displays the path the penny takes as it slips off the rotating platter?




A
North
D
B
C

A crate rests on a horizontal surface and a man pulls on it with a 10 N force. No matter what the orientation of the force, the crate does not move. Below are displayed three attempts to move the crate.



1) Rank the situations shown above according to the magnitude of the frictional force exerted by the surface on the crate, least to greatest.

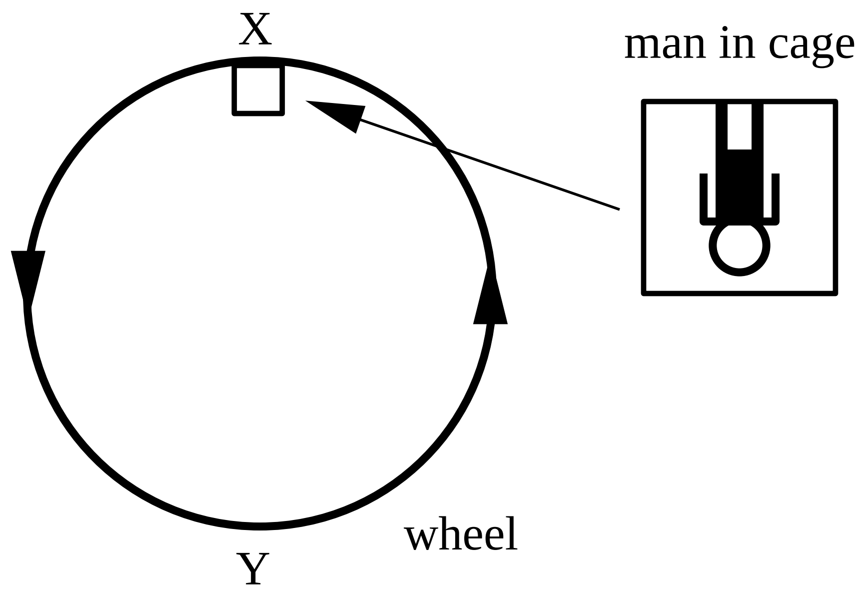
A. 1 < 2 < 3
B. 3 < 2 < 1
C. 2 < 1 < 3
D. 3 < 1 < 2

2) Rank the situations shown above according to the magnitude of the normal force exerted by the surface on the crate, least to greatest.

A. 1 < 2 < 3
B. 3 < 2 < 1
C. 2 < 1 < 3
D. 3 < 1 < 2

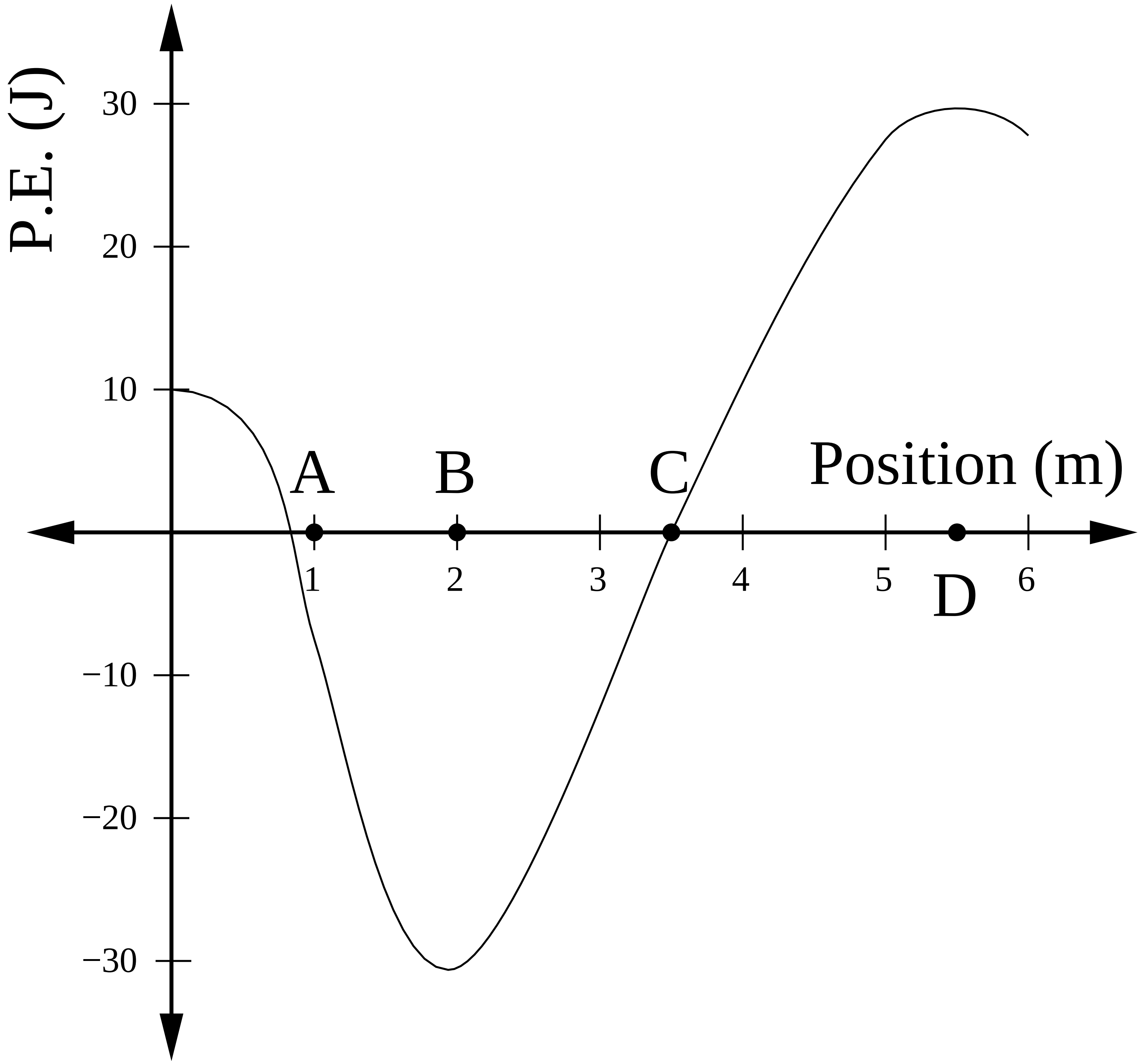
A giant wheel having a diameter of 40 m, is fitted with a cage and platform on which a man of mass *m* stands. The wheel is rotated at constant speed in a vertical plane at such a speed that the force exerted by the man on the platform is equal to his weight when the cage is at X, as shown. The net force on the man at the point X is:

A. zero
B. mg, down
C. mg, up
D. $2mg$, down



The net force on the man at point Y (the bottom of the wheel) is:

A. none of the below
B. mg, up
C. $2mg$, up
D. $2mg$, down



1) The force is zero at?:

2) The force is positive at?

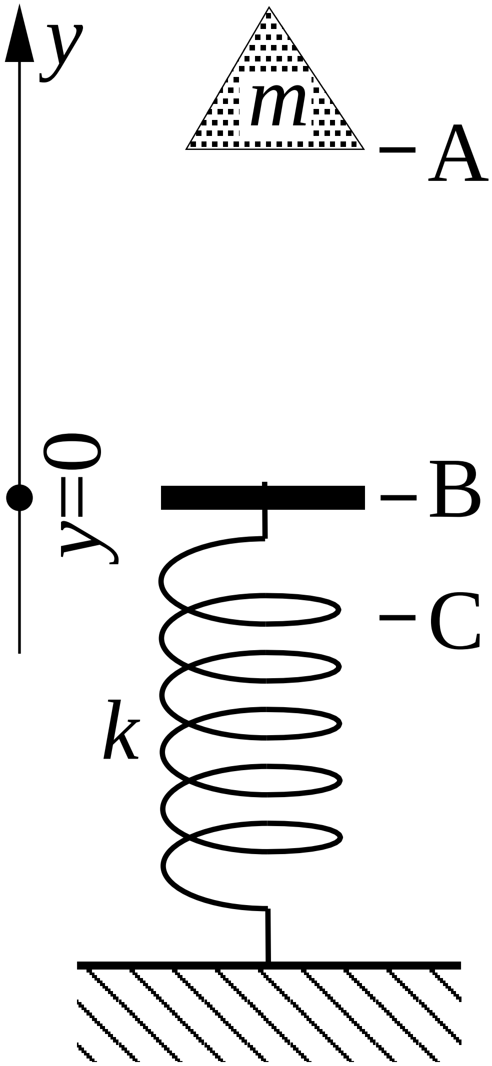
3) The force is negative at?

4) Stable equilibrium at?

5) Unstable equilibrium at?

Two carts (*A* with mass 2 kg and B with mass 3 kg) moving frictionlessly along a straight line have a head-on collision softened by spring bumpers. During the collision the springs compress, the carts reach minimum separation, and then the springs re-expand until the carts are again separated. During the instant when the carts reach minimum separation:

A. both carts have the same momentum
B. the potential energy of the system is a maximum
C. the kinetic energy of the system is a minimum
D. both B and C



A mass *m* is released from the point **A**. At point **B** it hits a previously uncompressed spring. The spring slows the mass reaching a maximum compression at point **C**, before it starts to push the mass back up.

point D: none of the above

1) Where is the K.E. zero?
2) Where is the gravitational P.E. zero?
3) Where is the spring P.E. zero?
4) Where is the K.E. a maximum?
5) Where is the gravitational P.E. a maximum?
6) Where is the spring P.E. a maximum?

Without peddling a bicyclist goes around a corner with speed hardly diminished. This is an example of approximate:

A. conservation of energy

B. conservation of momentum

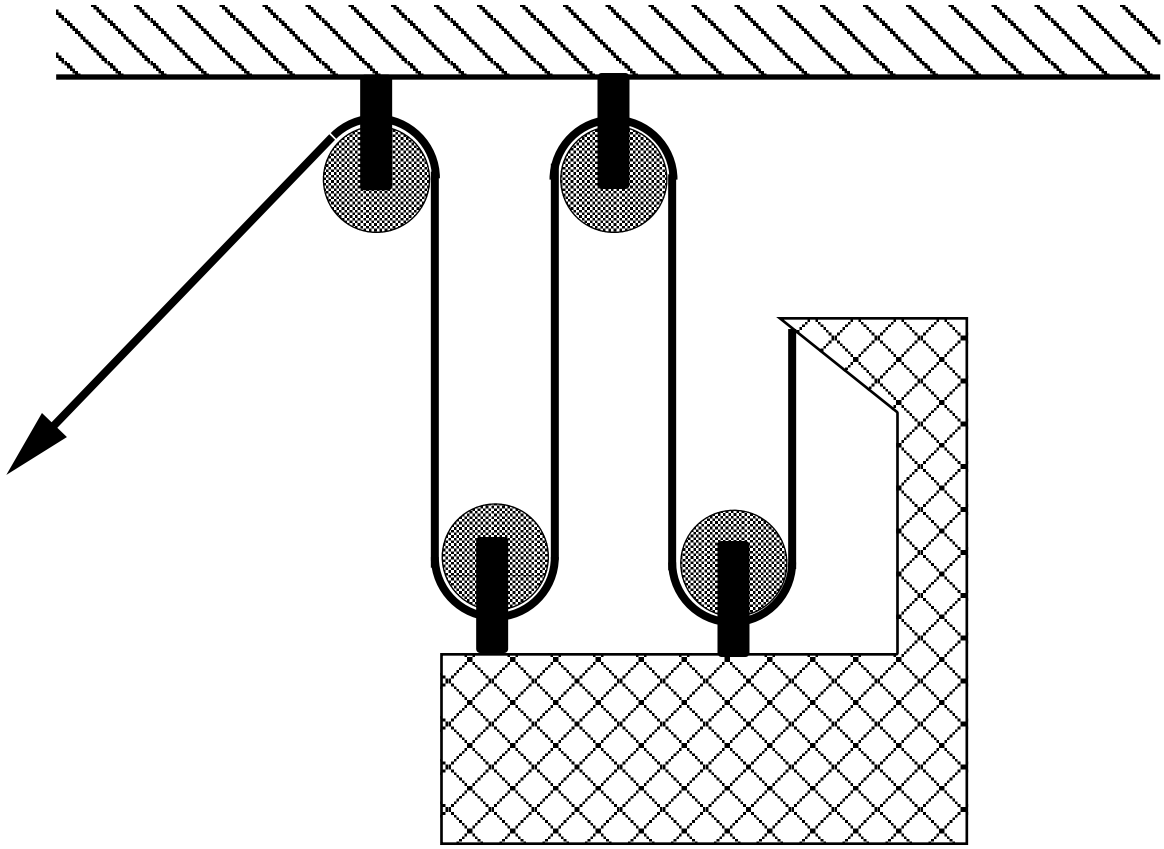
C. both of the above

D. none of the above

You wish to reduce the stress (which is related to centripetal foce) on high-speed racing tires, so you adopt

A. small radius tires because $a = r\,\omega^2$

B. large radius tires because $a = v^2 / r$



A single rope threads through four pulleys as shown above. An external force pulling on the rope (as shown by the arrow) pulls the elevator up. What is the mechanical advantage of this machine?

A. 2

B. 3

C. 3½

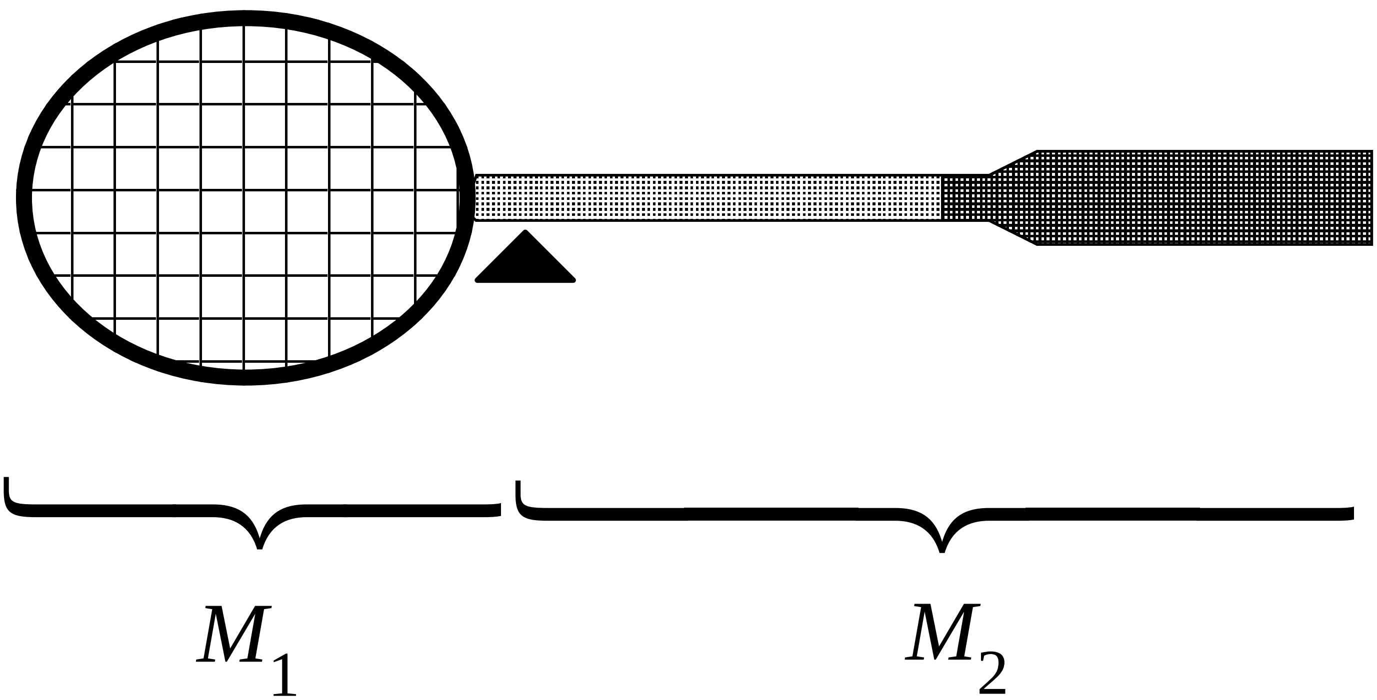
D. 4

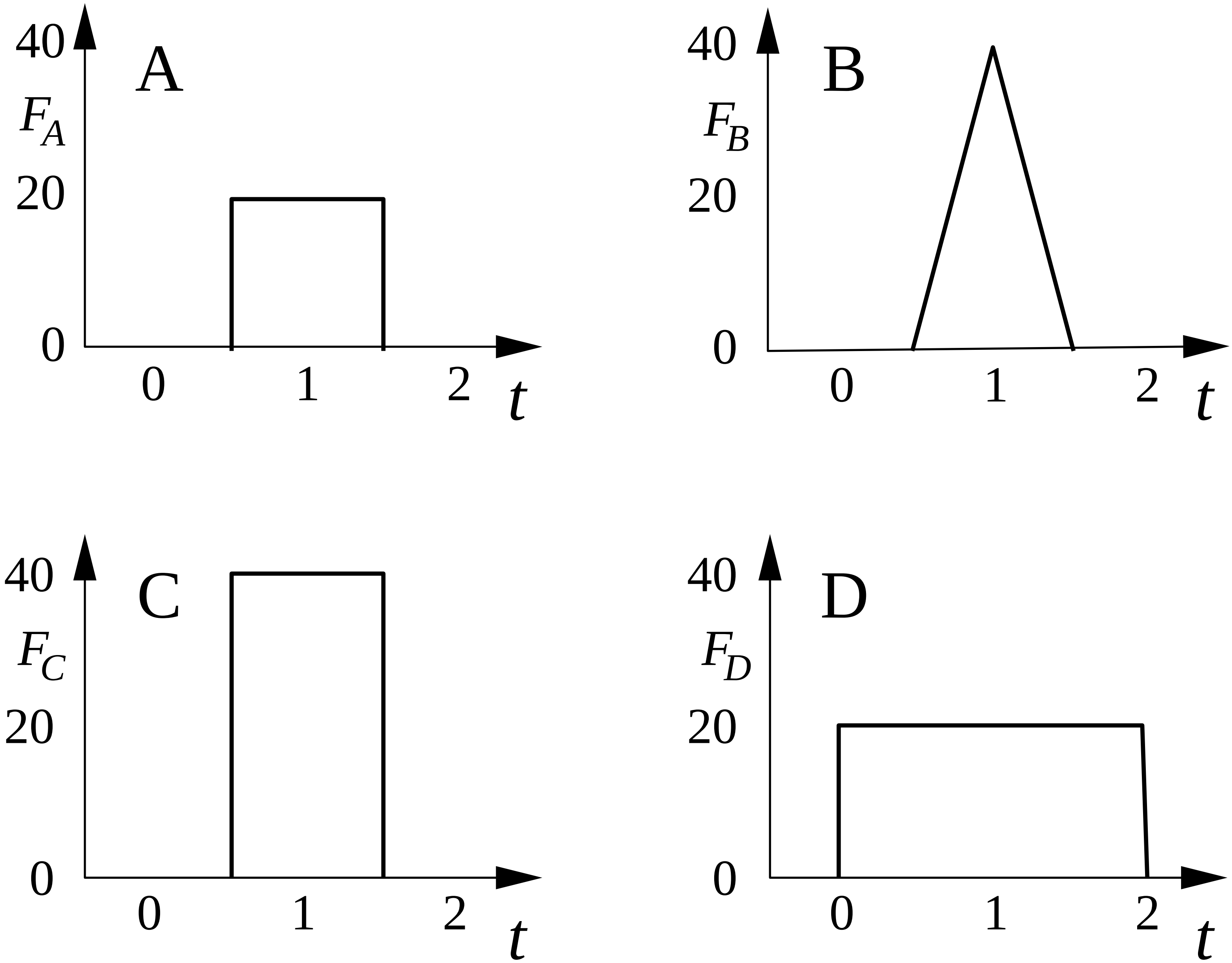
The below diagram shows a racket balanced on a point. How does the mass on one side of the balance point compare to the mass on the other?

A. $M_1 > M_2$

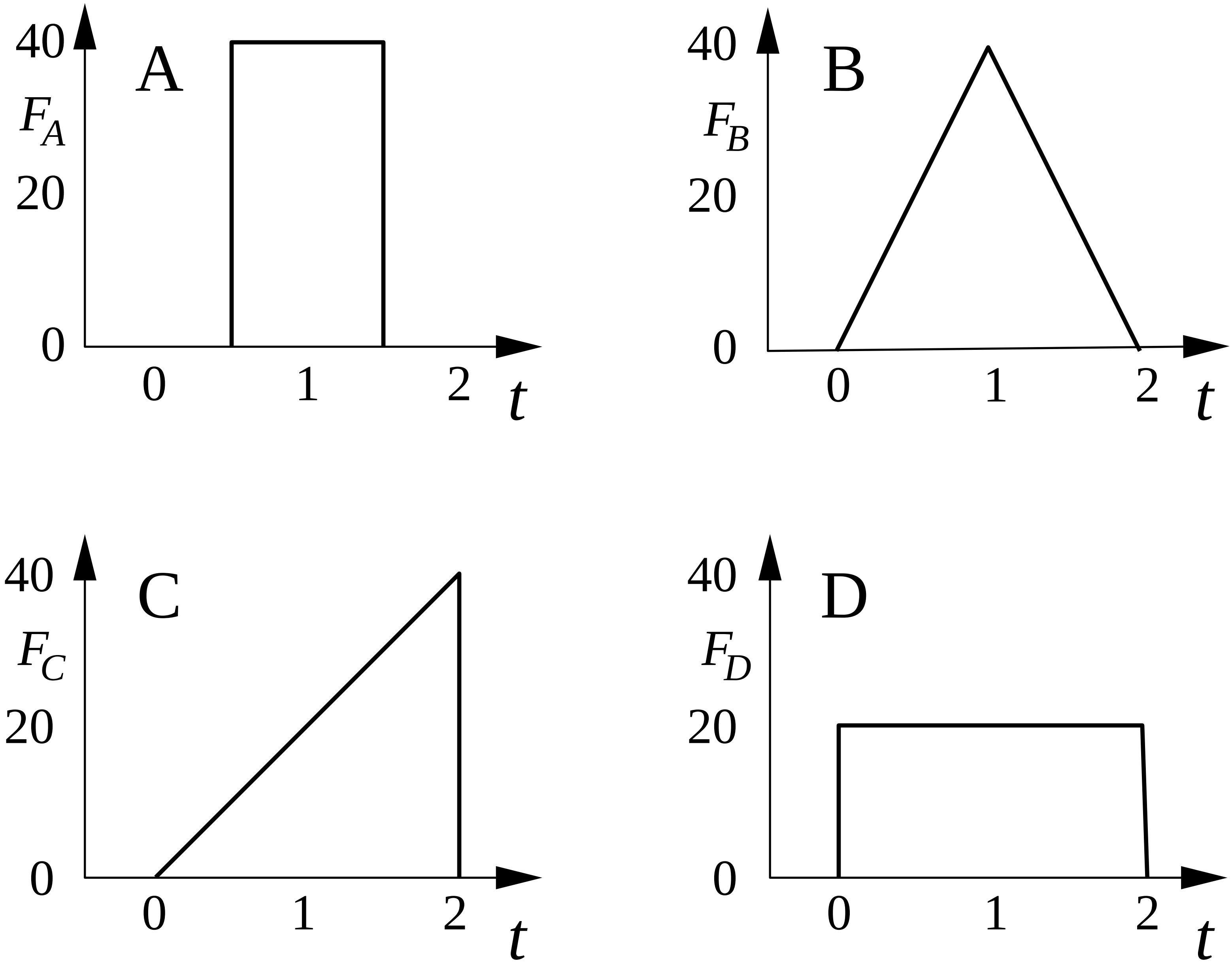
B. $M_1 = M_2$

C. $M_1 < M_2$

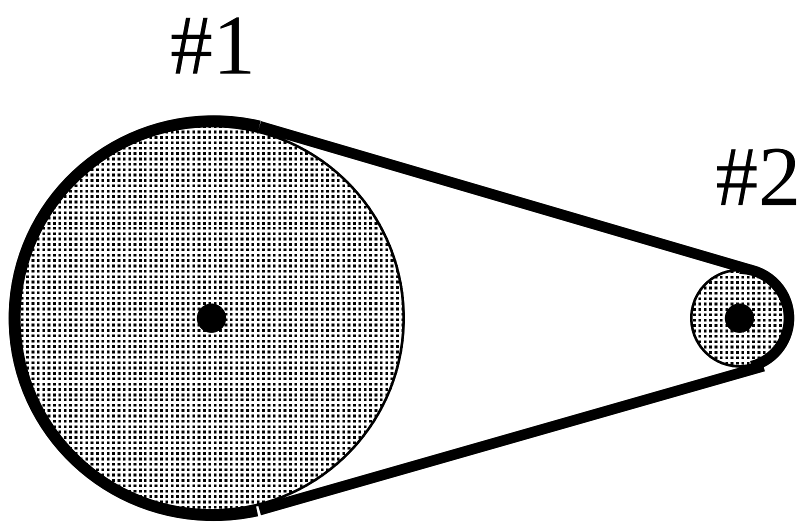




Which impulse is least?



Which impulse is greatest?



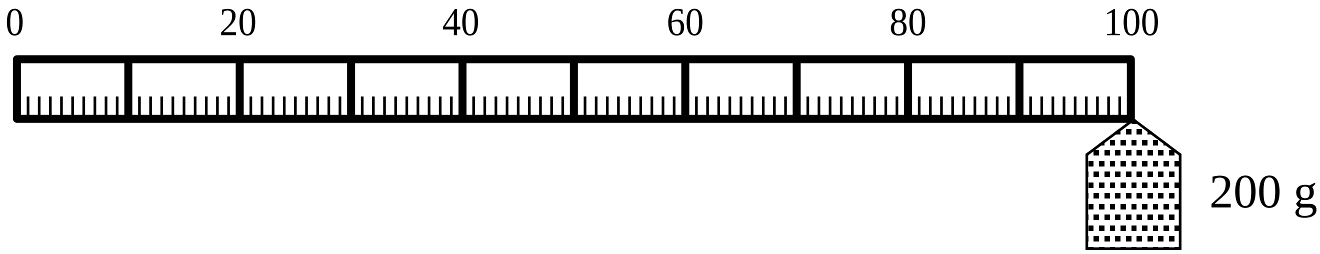
A belt drives (without slipping) a large radius pulley (#1) from a small radius pulley (#2) as shown above. Compare the angular velocity of each pulley (ω_1, ω_2) and the speed at the edge of each pulley (v_1, v_2). Which combination of statements is correct?

A. $\omega_1 < \omega_2$, $v_1 > v_2$

B. $\omega_1 = \omega_2$, $v_1 > v_2$

C. $\omega_1 < \omega_2$, $v_1 = v_2$

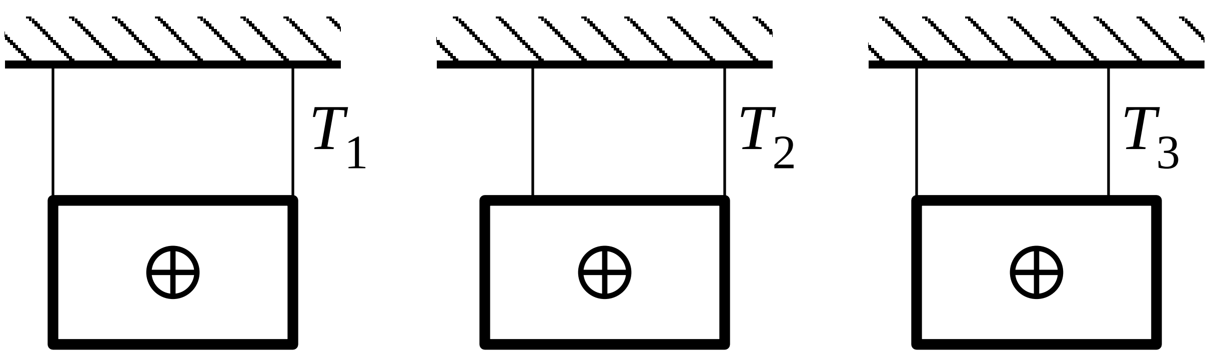
D. $\omega_1 = \omega_2$, $v_1 = v_2$



A 200 g mass is placed at the 100 cm mark of a 200 g meter stick. The system will be balanced if the fulcrum is placed:

A. 50 cm mark
B. 66 2/3 cm mark
C. 75 cm mark
D. None of the above

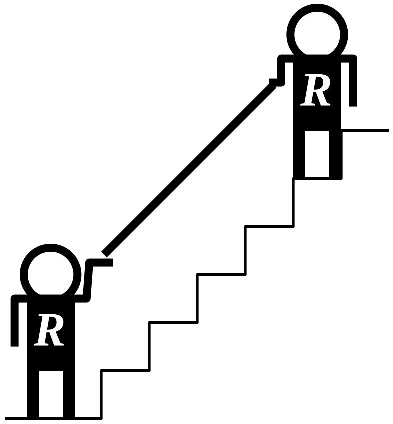
A picture is to be hung from the ceiling by means of two wires. Three different situations are considered (see below) . Rank the right wire tension in the three situations from least to greatest. The center of mass of the picture (labeled below ⊕) is in the center of the picture.

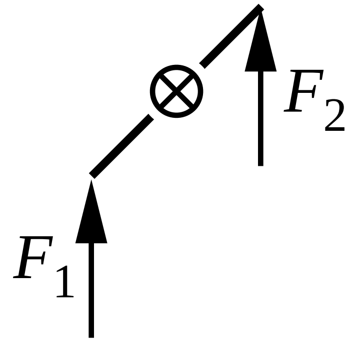


A. $T_1 < T_2 < T_3$
B. $T_2 < T_1 < T_3$
C. $T_3 < T_1 < T_2$
D. None of the above

Rhonda and Rupert carry a uniform pipe upstairs. The free body diagram shows the forces applied. Which relationship applies? (⊗ marks the location of the center of mass)

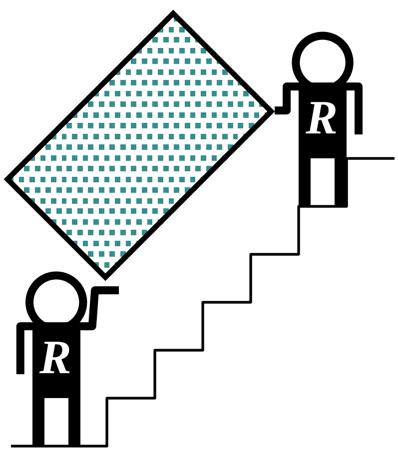
A. $F_1 > F_2$
B. $F_1 < F_2$
C. $F_1 \approx F_2$

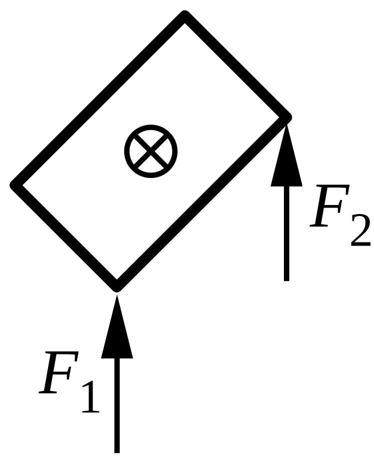




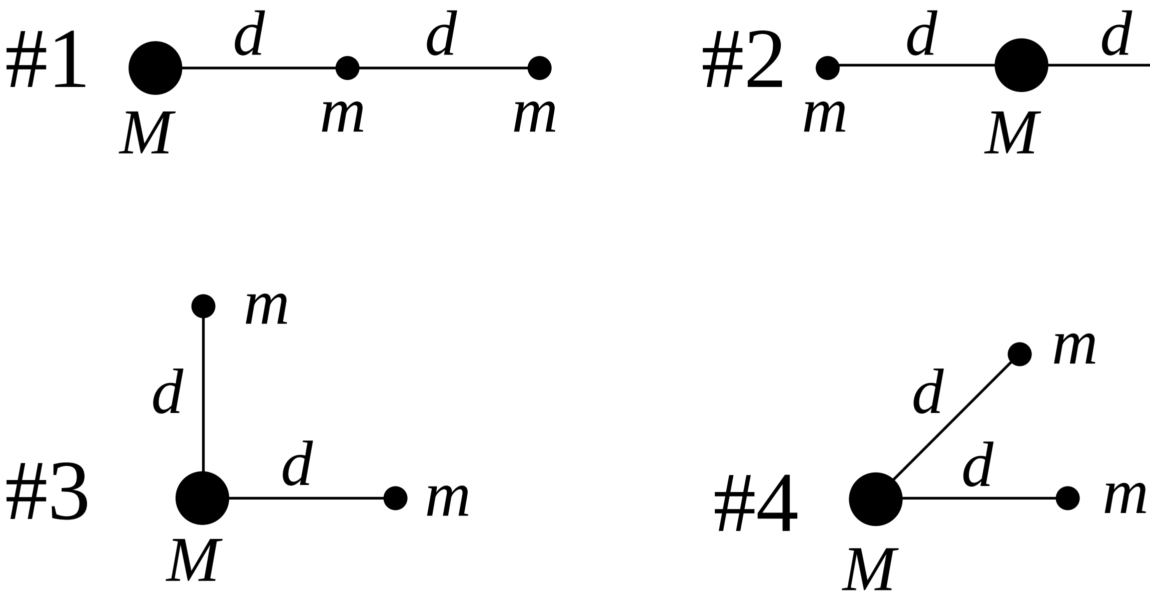
Rhonda and Rupert carry a framed picture up some stairs. The free body diagram shows the forces applied. Which relationship applies?

A. $F_1 > F_2$
B. $F_1 < F_2$
C. $F_1 \approx F_2$





Three particles, two with mass *m* and one with mass *M*, might be arranged in any of the four configurations shown below. Rank the configurations according to the magnitude of the gravitational force on *M*, least to greatest.

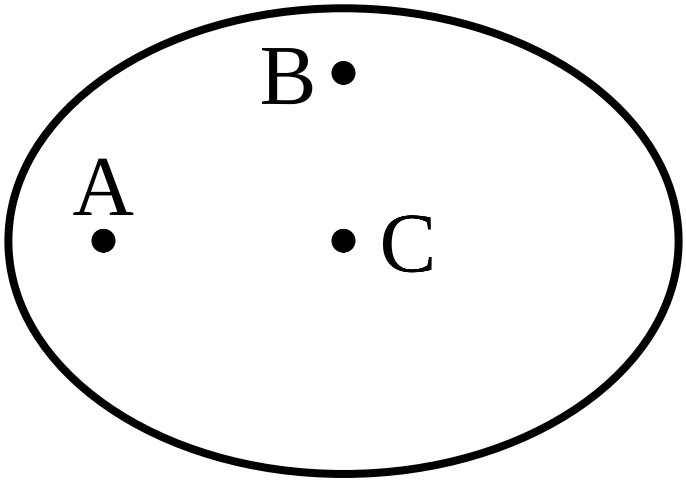


A. 1,2,3,4
B. 2,1,3,4
C. 2,1,4,3
D. 2,3,4,1

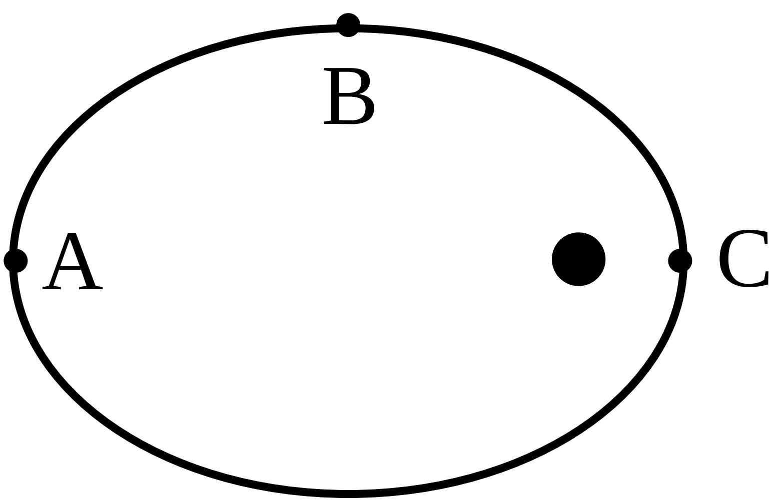
An astronaut is orbiting the Earth in the space shuttle. She feels "weightless" because:

A. she is beyond the range of gravity
B. centrifugal force is equal but opposite to gravity
C. she has no acceleration
D. the shuttle is falling at the same rate she is

The elliptical orbit of a meteoroid around the Sun is shown below.
Where is the Sun located?



D: none of the above



D: none of the above

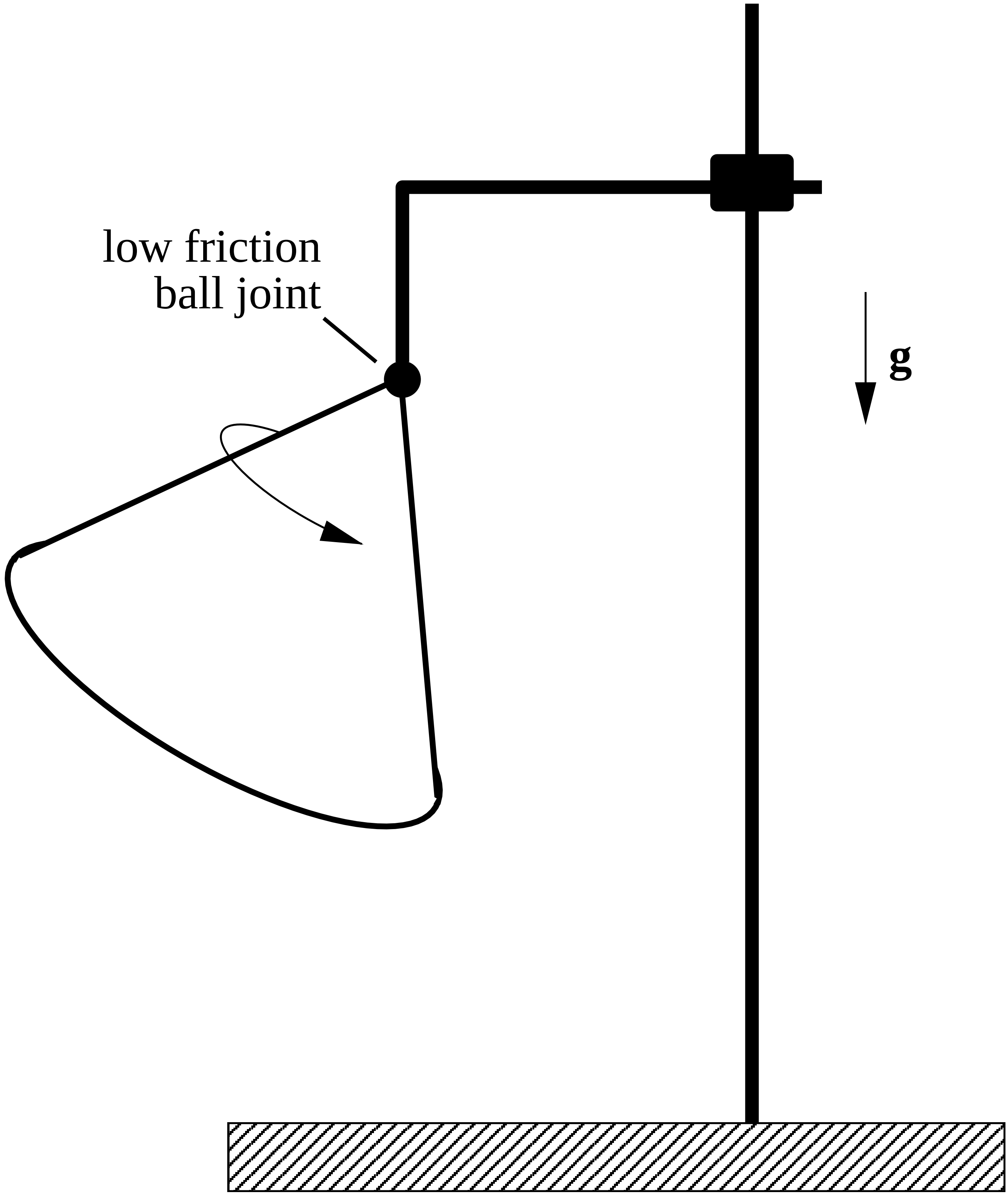
1) Where is the P.E. the least?

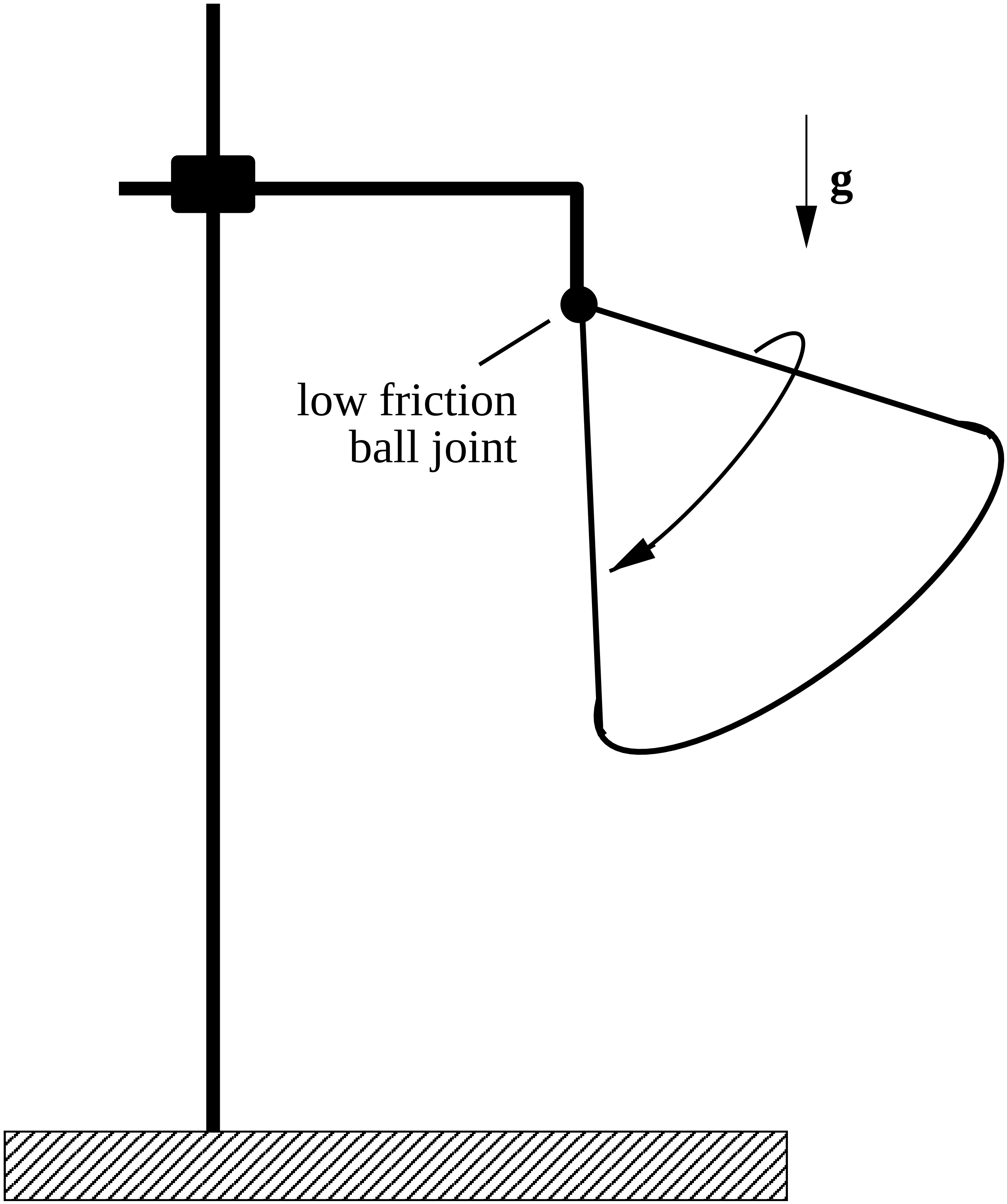
2) Where is the speed. the least?

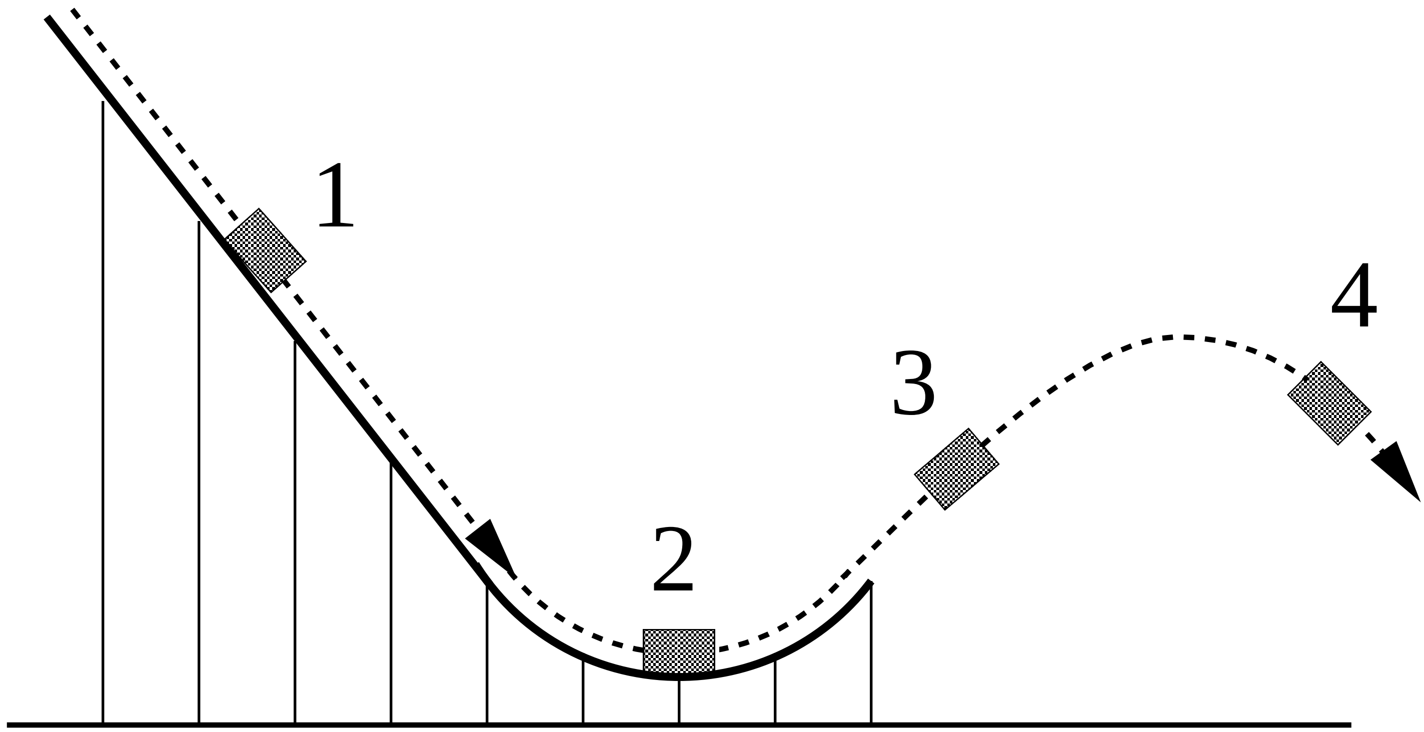
3) Where is the angular momentum the least?

4) Where is the angular speed the least?

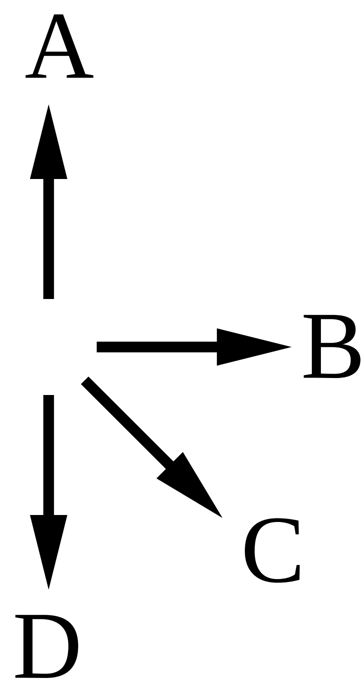
4) Where is the acceleration the least?

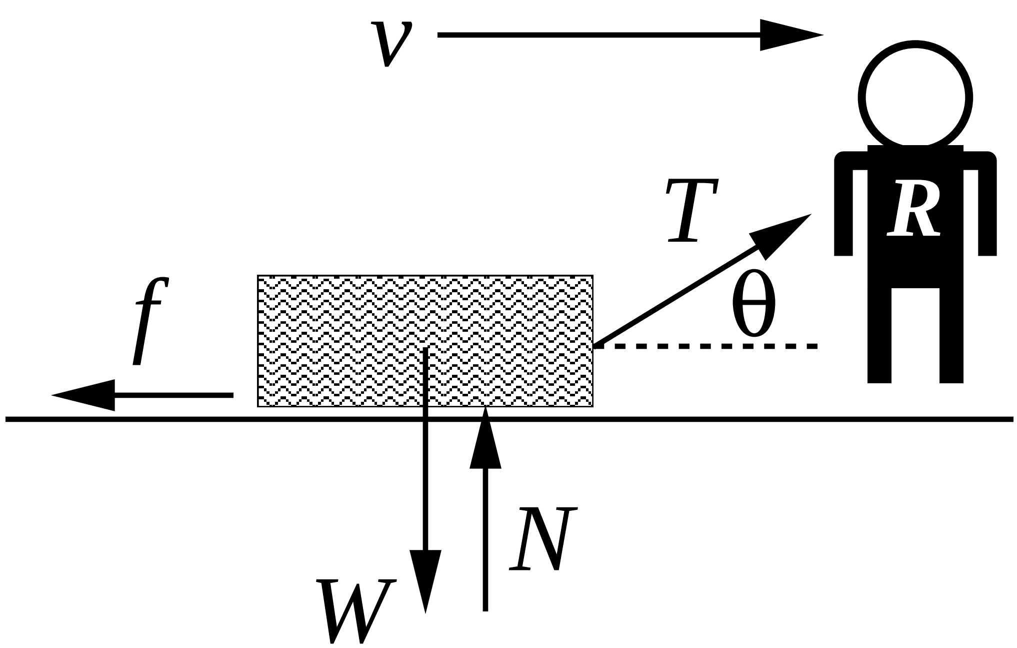

low friction
ball joint
g


g
low friction
ball joint



A package slides down a frictionless "ski jump". In which direction is the package's acceleration?





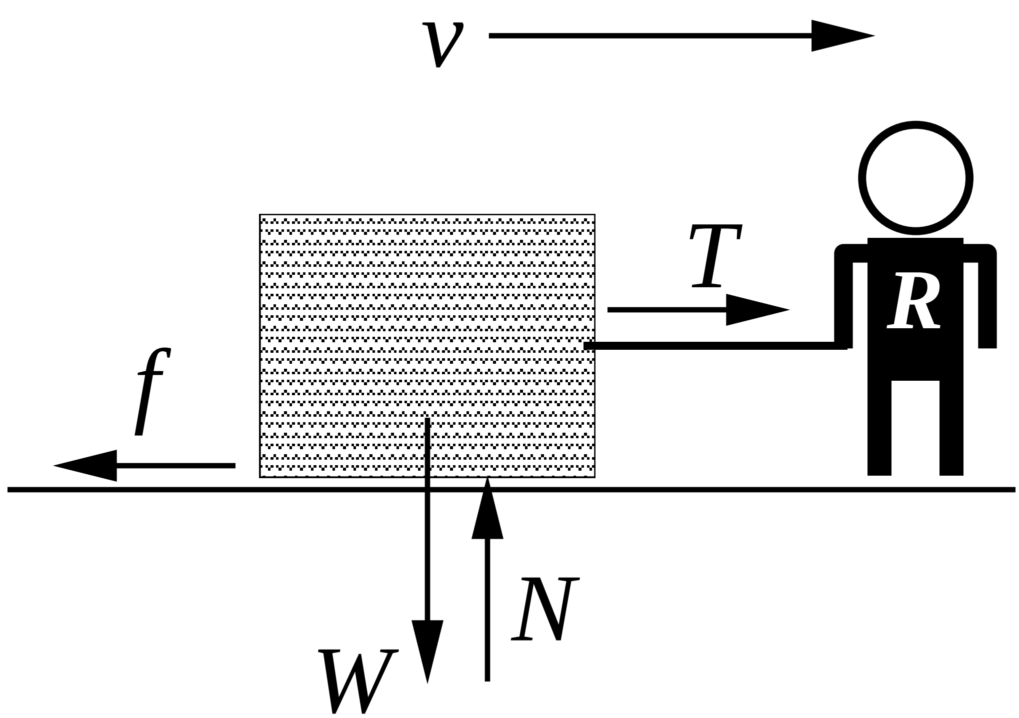
Rupert pulls a box across a horizontal surface at a constant velocity *v*, by pulling on a rope with tension *T*. Other forces (*W*: gravity, *N*: normal force, *f*: friction) act in the directions indicated. Which of the following relations among the force magnitudes must be true?

A. $T=f$ and $N=W$

B. $T>f$ and $N<W$

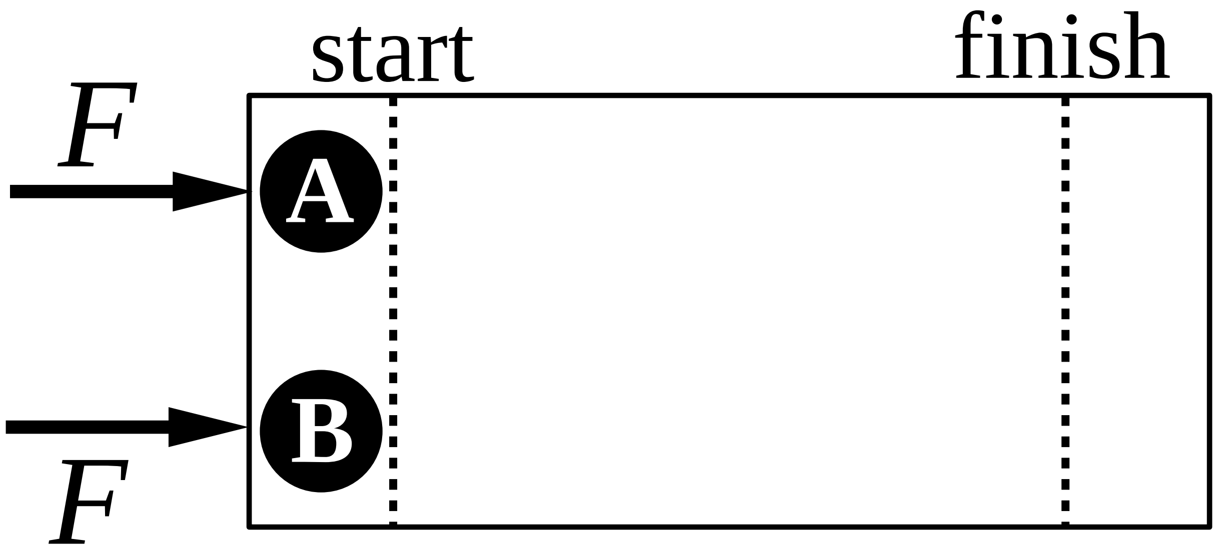
C. $T>f$ and $N=W$

D. $T=f$ and $N<W$



Rupert pulls a box across a horizontal surface at a constant velocity v, by pulling on a rope with tension T. Other forces (W: gravity, N: normal force, f: friction) act in the directions indicated. Which of the following relations among the force magnitudes must be true?

A. $T=f$ and $N=W$
B. $T>f$ and $N<W$
C. $T>f$ and $N=W$
D. $T=f$ and $N<W$



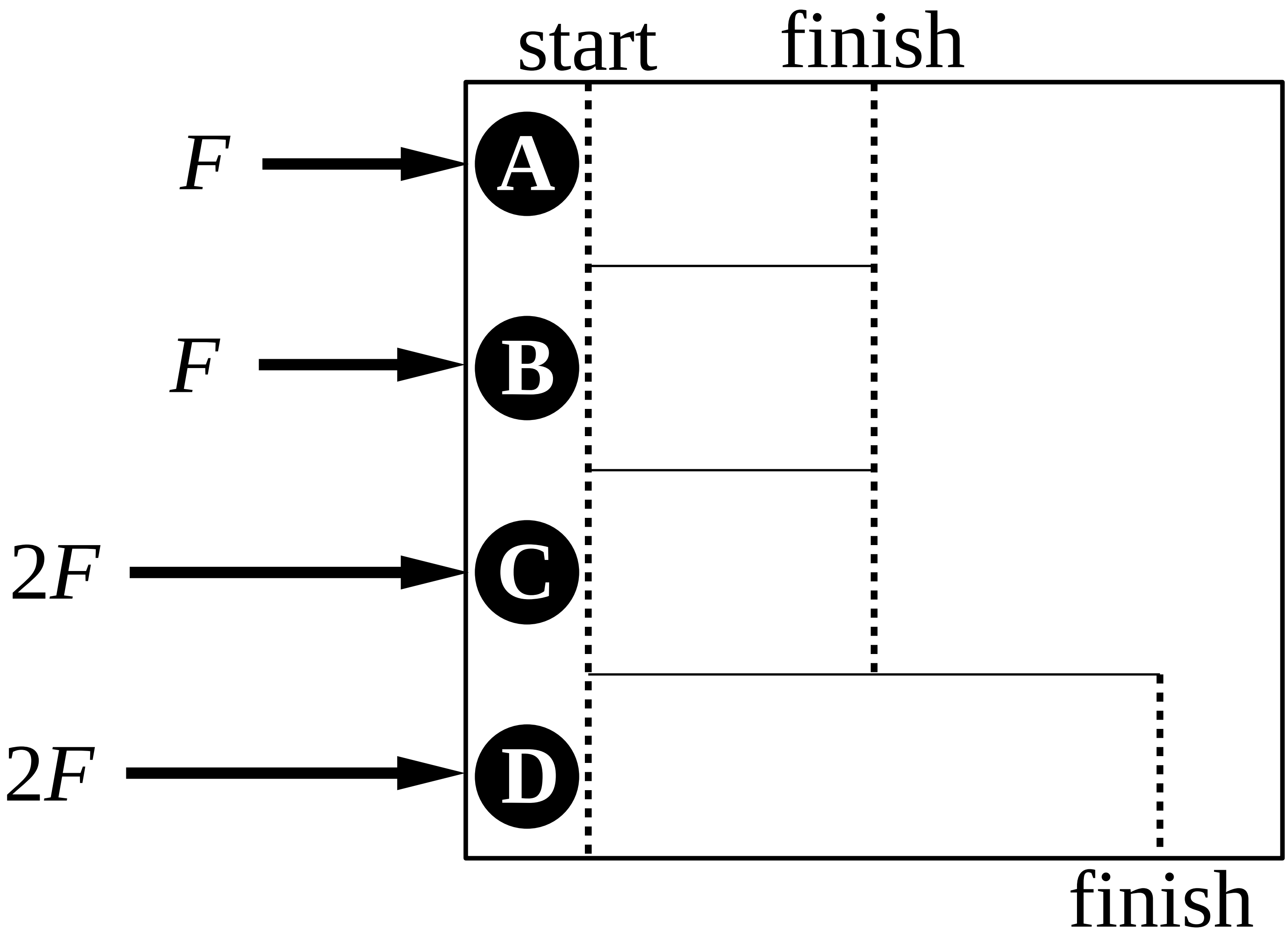
Two hockey pucks race on a frictionless surface. Puck **A** is made of lead; Puck **B** is made of rubber. Starting from rest, the pucks are pushed from start to finish by equal forces F.

1) Which puck wins the race?

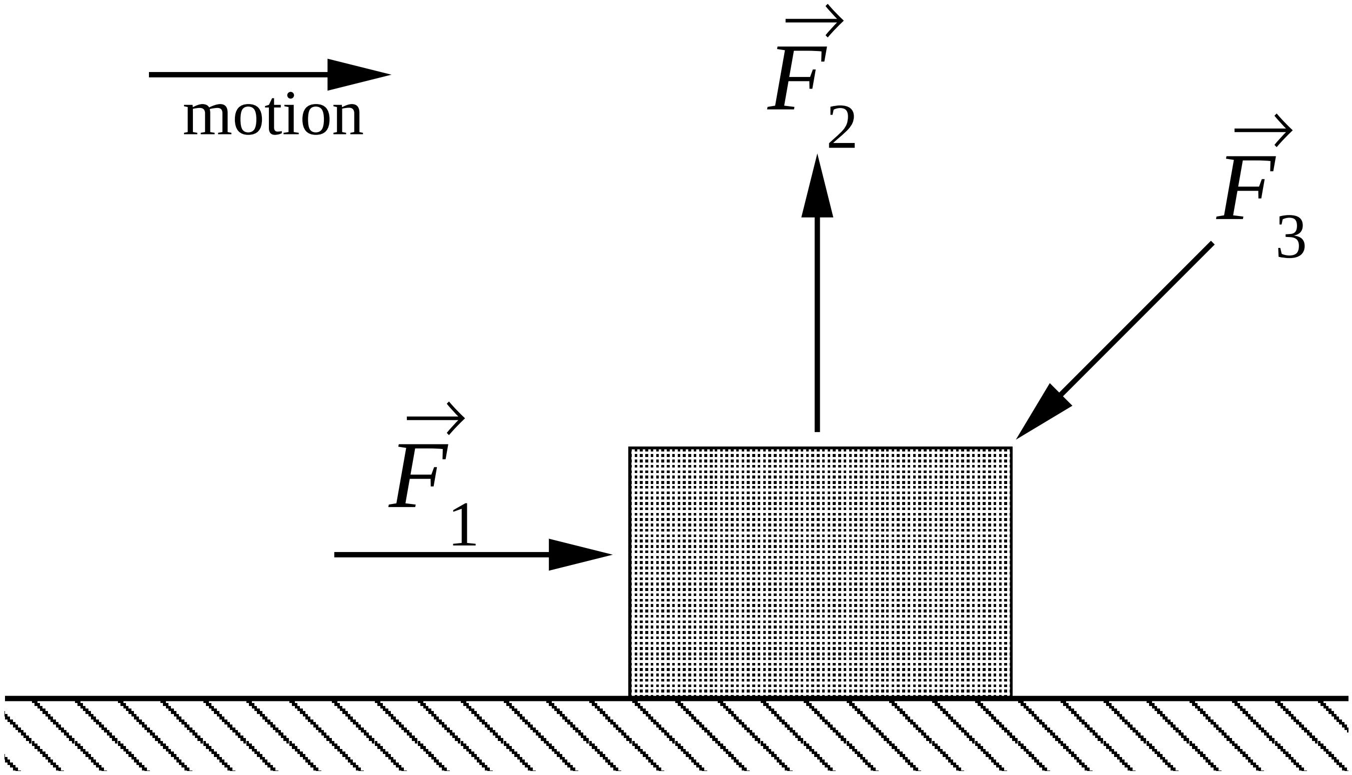
2) Which force does more work?

3) Which puck has more KE when it crosses the finish line?

4) Which puck has more momentum when it crosses the finish line?



Four pucks race on a frictionless surface. The pucks have masses: M_A=1, M_B=2, M_C=3, M_D=4 (each in kg). As shown above, they are subjected to different forces and race lengths. Which puck has the largest kinetic energy when it crosses its finish line?



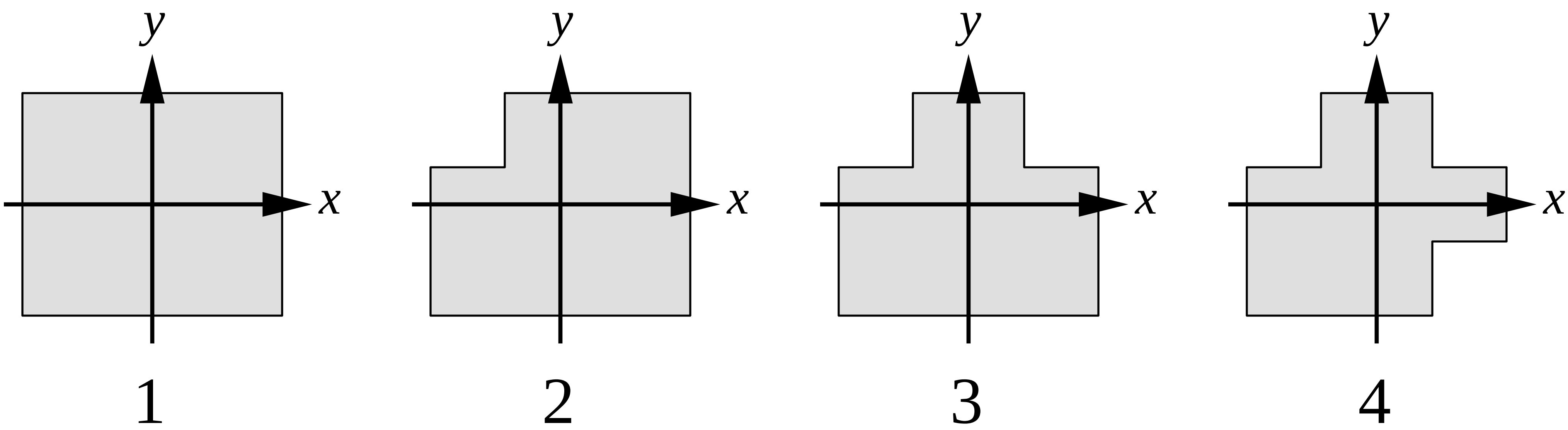
Three forces of equal magnitude but different direction act on a block as shown above. The block moves 3 m to the right. Rank the work done by each force. (The work done by force F_1 is W_1, etc.)

A. $W_1 > W_2 > W_3$

B. $W_2 > W_3 > W_1$

C. $W_3 > W_1 > W_2$

D. $W_3 > W_2 > W_1$



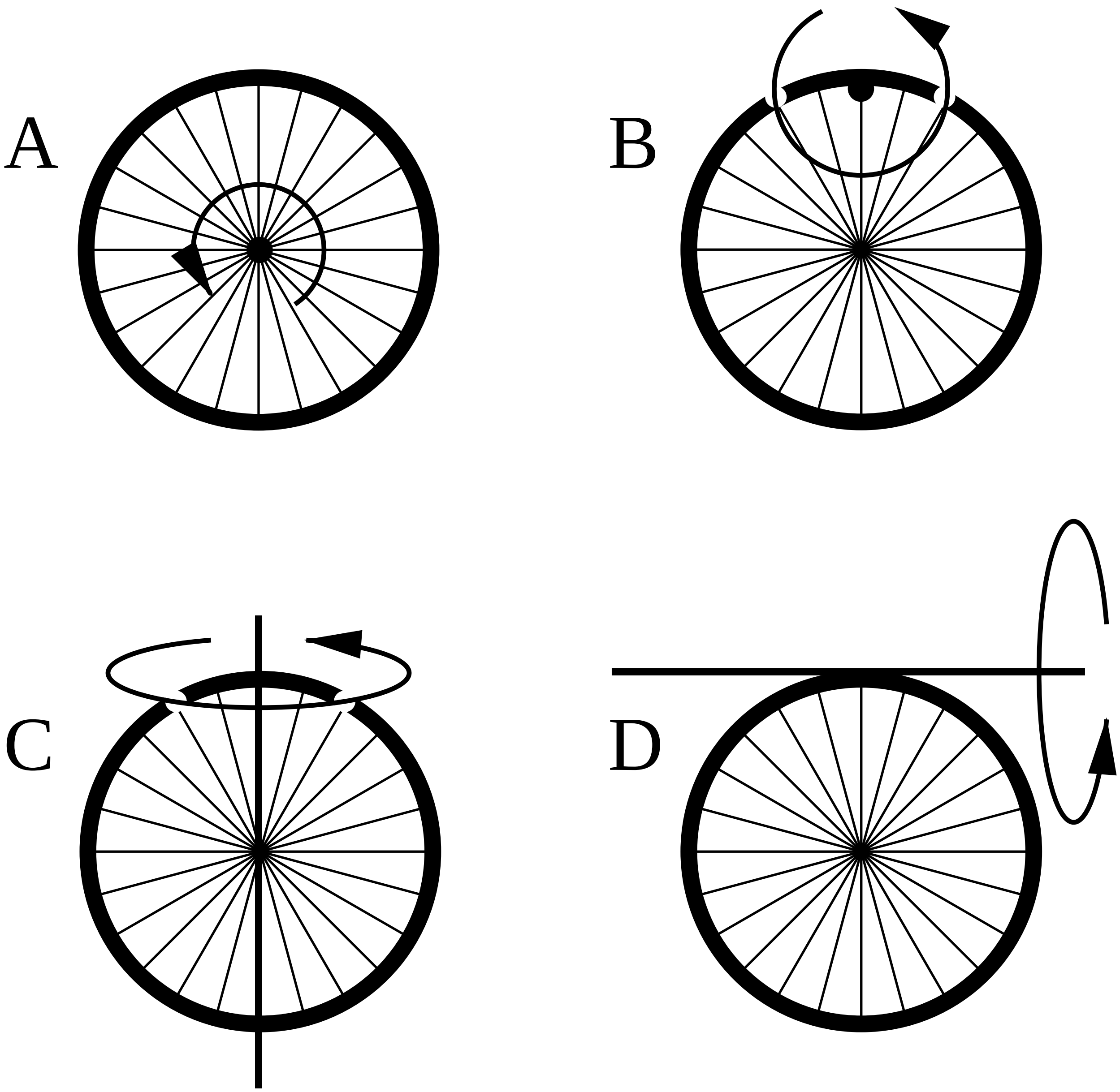
A machinist starts with a uniform sheet of steel and successively cuts out a square piece from each corner. Rank the plates according to the *x* coordinate of the center of mass.

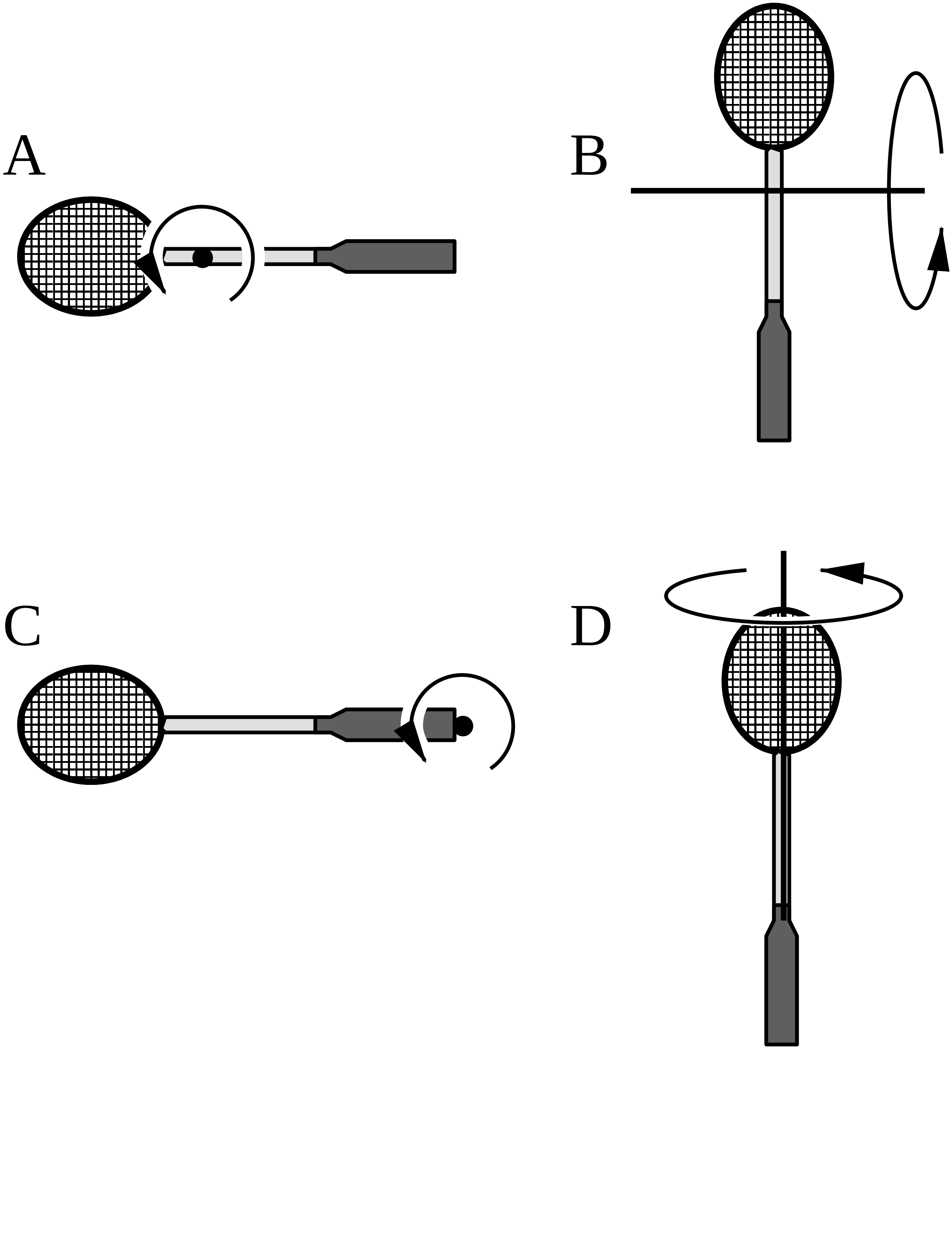
A. $X_{cm}1 > X_{cm}2 > X_{cm}3 > X_{cm}4$

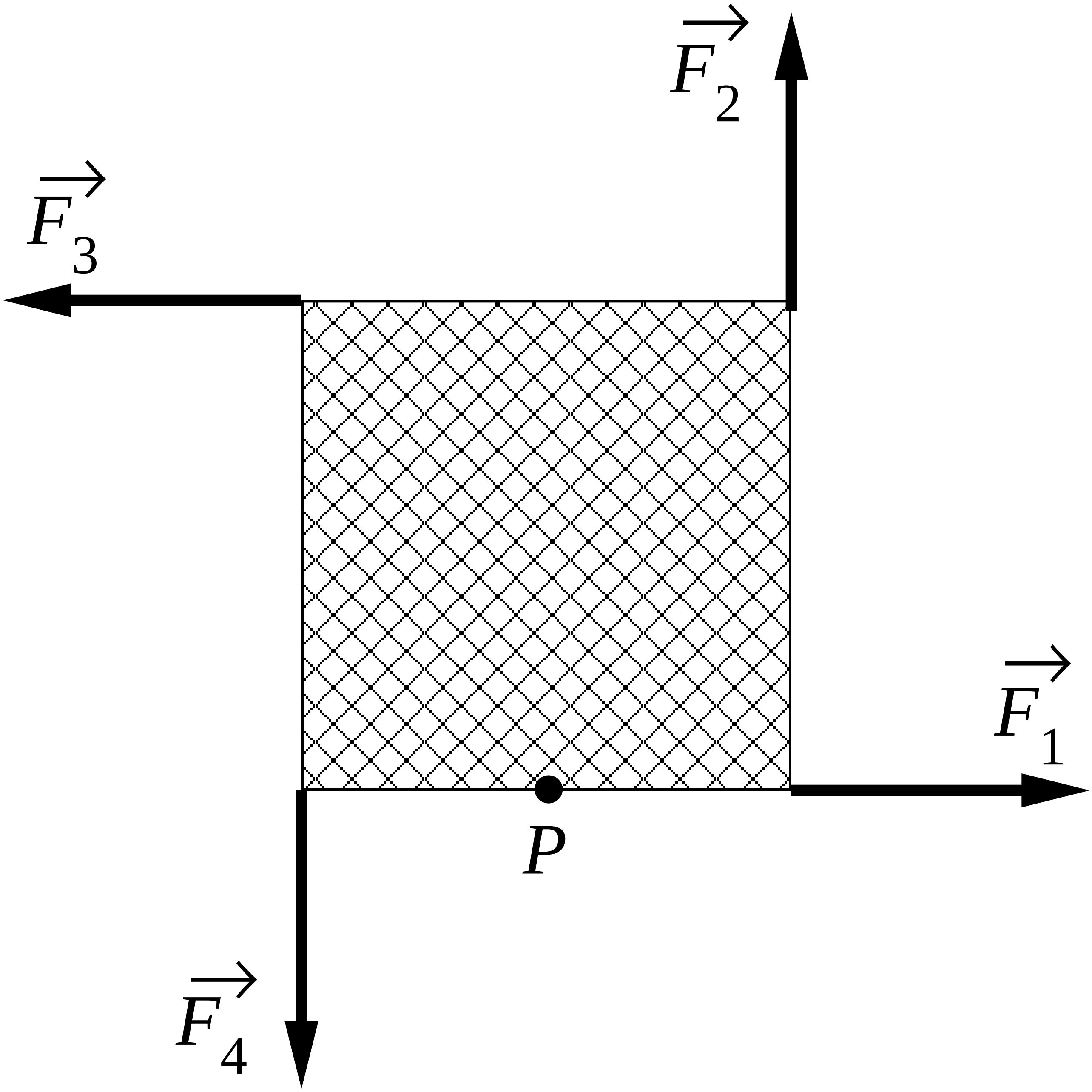
B. $X_{cm}4 > X_{cm}3 > X_{cm}2 > X_{cm}1$

C. $X_{cm}2 > X_{cm}1 = X_{cm}3 > X_{cm}4$

D. None of the above


A
B
C
D


A
B
C
D



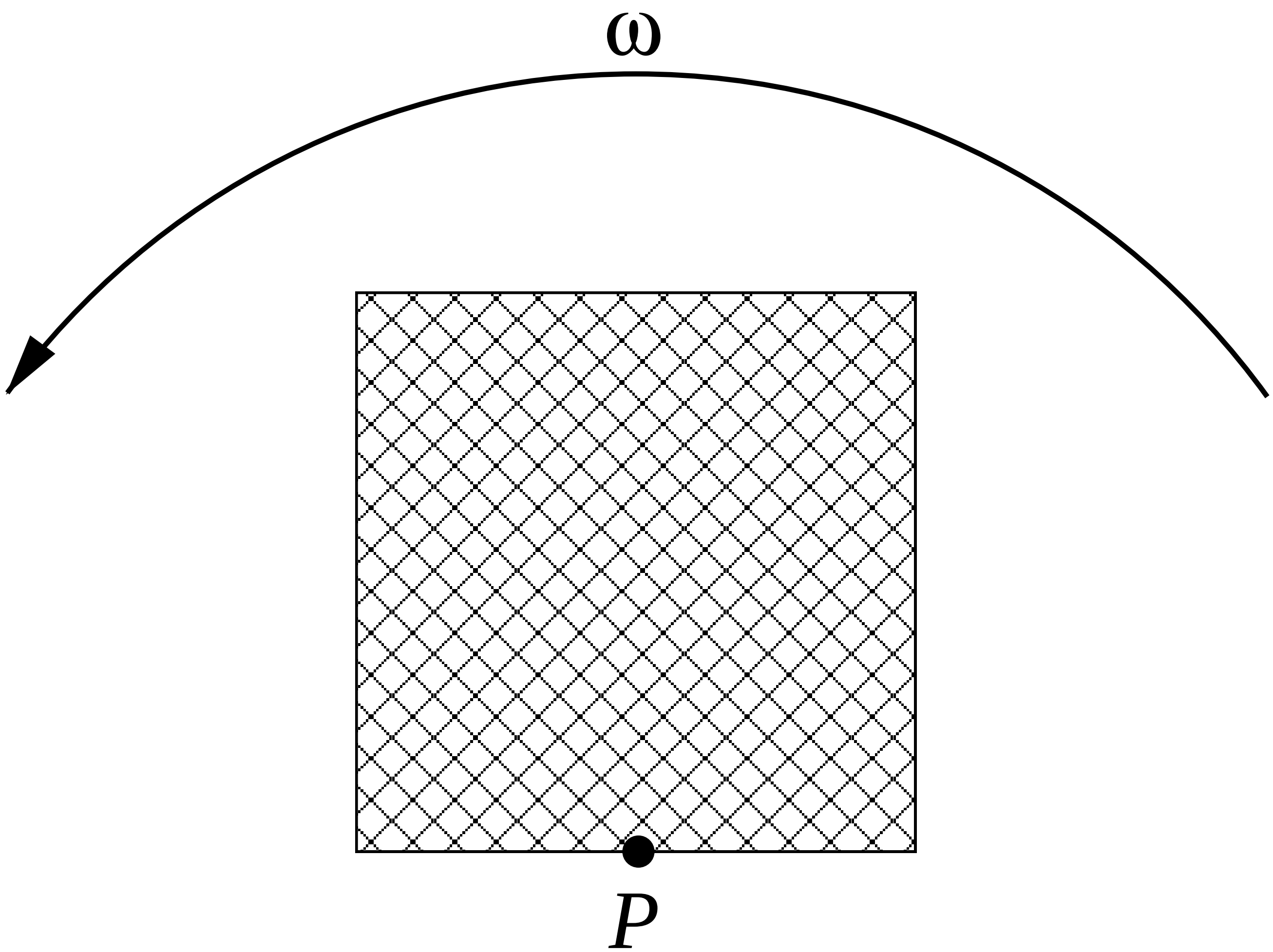
Four forces of equal magnitude but with directions as shown below act at the corners of a square. The square has a fixed pivot point P. Rank (from least to greatest) the torque produced by these forces about the pivot point. We define a positive torque as one in the counter-clockwise direction.

A. $\tau_1 < \tau_4 < \tau_2 < \tau_3$

B. $\tau_1 < \tau_2 = \tau_4 < \tau_3$

C. $\tau_1 = \tau_2 = \tau_3 = \tau_4$

D. $\tau_4 < \tau_1 < \tau_2 < \tau_3$



A uniform square is spinning at a constant rate about the pivot point P on a frictionless surface. No forces are acting on square, except perhaps at the pivot point. The force at the pivot point:

A provides a torque to maintain the spin.
B points down the page at the instant shown.
C points to the left at the instant shown.
D is in fact zero.