

An ant of mass m clings to the rim of a flywheel of radius r , as shown above. The flywheel rotates clockwise on a horizontal shaft S with constant angular velocity ω . As the wheel rotates, the ant revolves past the stationary points I, II, III, and IV. The ant can adhere to the wheel with a force much greater than its own weight.

12. It will be most difficult for the ant to adhere to the wheel as it revolves past which of the four points?
 (A) I (B) II (C) III (D) IV
 (E) It will be equally difficult for the ant to adhere to the wheel at all points.

Questions 26-27

A particle moves in a circle in such a way that the x and y -coordinates of its motion are given in meters as functions of time t in seconds by:

$$x = 5 \cos(3t) \quad y = 5 \sin(3t)$$

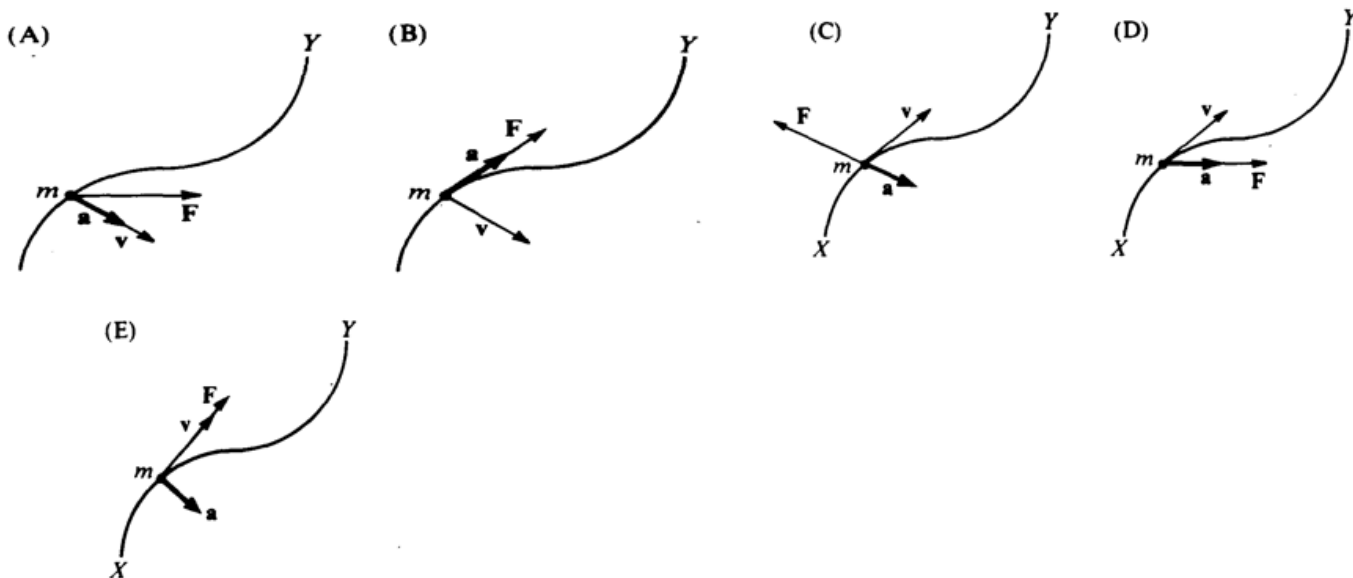
26. What is the period of revolution of the particle?

(A) $1/3$ s (B) 3 s (C) $2\pi/3$ s (D) $3\pi/2$ s (E) 6π s

27. Which of the following is true of the speed of the particle?

(A) It is always equal to 5 m/s. (B) It is always equal to 15 m/s.
 (C) It oscillates between 0 and 5 m/s. (D) It oscillates between 0 and 15 m/s.
 (E) It oscillates between 5 and 15 m/s.

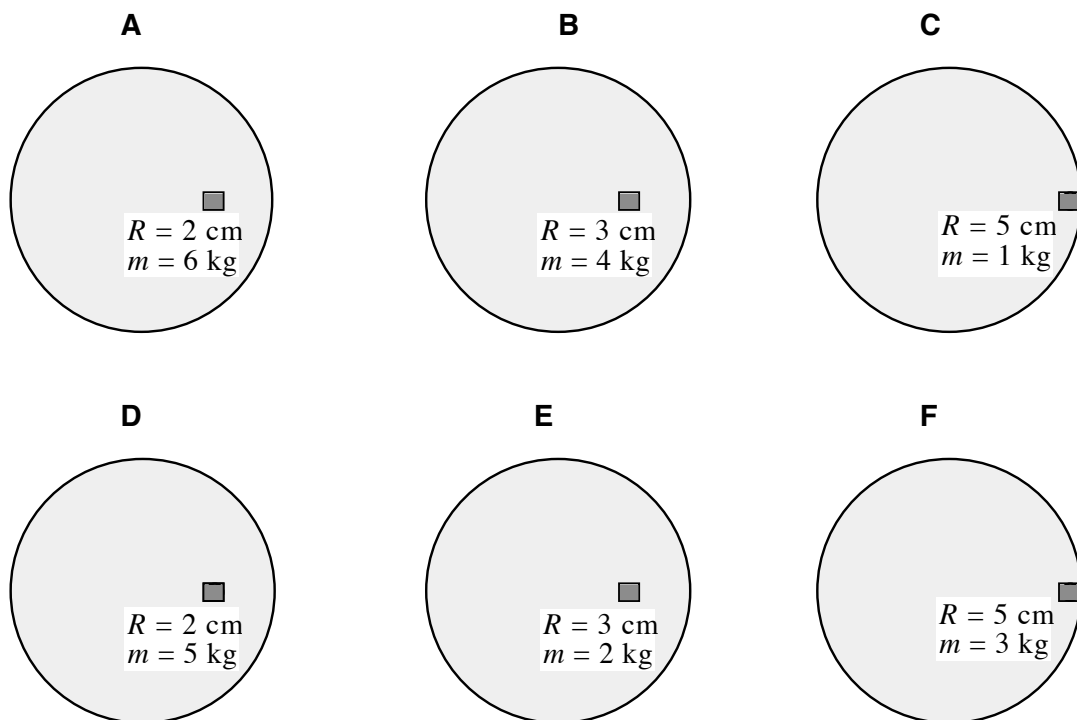
25. A mass m moves on a curved path from point X to point Y . Which of the following diagrams indicates a possible combination of the net force F on the mass, and the velocity v and acceleration a of the mass at the location shown?



Blocks on Rotating Turntables—Horizontal Force⁸⁹

Shown below in a top view are six blocks that are sitting at rest on rotating turntables. All of the turntables have the same rotation rate. The masses of the blocks and how far out from the center they sit varies. Specific values of the variable are given in the figures.

Rank these blocks, from greatest to least, on the basis of the magnitude of the horizontal forces holding the blocks on the turntables. That is, put first the block that has the largest force holding it on the turntable and put last the block that has the weakest force holding it on the turntable.



Greatest 1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____ Least

Or, all of these blocks are held by equal strength forces. _____

Please carefully explain your reasoning.

How sure were you of your ranking? (circle one)

Basically Guessed

Sure

Very Sure

1 2 3 4 5 6 7 8 9 10

⁸⁹ C. Hieggelke, D. Maloney, T. O’Kuma

Which one(s) represent(s) uniform circular motion?

A

$$x = 5 \sin(4t)$$

$$y = 3 \cos(4t)$$

B

$$x = 5 \sin(6t)$$

$$y = 5 \cos(6t)$$

C

$$x = 4 \sin(2t)$$

$$y = 4 \sin(2t)$$

D

$$x = 3 \sin(4t)$$

$$y = 3 \cos(5t)$$

E

$$x = 2 \cos(4t)$$

$$y = 2 \cos(5t)$$

F

$$x = 5 \cos(7t)$$

$$y = 5 \sin(7t)$$

Hints Page

12. In what position(s) does mg help keep the bug in the circle, and in what position(s) does it make it more difficult to hold on?

26. Identify ω and then use it to find T .

27. Can you get r and ω ? How do they relate to v ?

25. v is always tangent to the path. If F_{net} points a certain way, which way does a point?

Ranking Task - Horizontal Force: The horizontal force provides the centripetal force. Which ones require the most mv^2/r ? BE CAREFUL - same rotation means same ω , not same v .

Equations: Circular Motion requires sine and cosine and the same r . Uniform Circular Motion requires the same ω .

Answers Page

12. C

26. C

27. B

25. D

Ranking Task - Horizontal Force:

greatest - F, [A, B], D, E, C - least

Equations: Only B and F, although B starts at the top of the circle at $t = 0$, while F starts at the right hand side.