



PHYSICS

BOOKS - PRINCETON PHYSICS (ENGLISH)

CURVED AND ROTATIONAL MOTION

Examples

1. An object of mass 5 kg moves at a constant speed of 6 m/s in a circular path of radius 2m.

Find the magnitude of the object's acceleration and the net force responsible for its motion.



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2. A 10 kg mass is attached to a string that has a breaking strength of 1,500 N. if the mass is whirled in a horizontal circle of radius 90 cm, what is the maximum speed it can have ? (Neglect the effects of gravity).



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3. A roller-coaster car enters the circular-loop part of the ride. At the very top of the circle (where the people in the car are upside down), the speed of the car is v and the acceleration points straight down. If the radius of the loop is r and the total mass of the car (plus passenger) is m , find the magnitude of the normal force exerted by the track on the car at this point.



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4. In the previous example, if the net force on the car at its highest point is straight down, why doesn't the car fall straight down?



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5. In the previous example, what is the minimum speed necessary to keep the roller coaster on the track at all times?



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6. Object A, of mass 5 kg and object B, of mass 10kg, hang from light threads at the ends of a uniform bar length 18 and mass 15kg. The masses A and B are at distances 6 and 12, respectively, below the bar. Find the center of mass of this system.



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7. A man of mass 70 kg is standing at one end of a stationary, floating barge of mass 210 kg.

he then walks to the other end of the barge, a distance of 90 meters. Ignore any frictional effect between the barge and the water.

Q. How far will the barge move?



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8. A man of mass 70 kg is standing at one end of a stationary, floating barge of mass 210 kg. he then walks to the other end of the barge, a distance of 90 meters. Ignore any frictional effect between the barge and the water.

Q. If the man walks at an average velocity of 8m/s what is the average velocity of the barge?

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9. A student pulls down with a force of 40N on a rope that winds around a pulley of radius 5cm .



What's the torque of this force?

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10. The cylinder below is free to rotate around its center. What is the net torque on the cylinder?



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11. A block of mass M shown in the figure below hangs motionless. What's the tension in each of the ropes?





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12. The figure below shows a homogenous bar of mass M and length L , with one end attached to a hinge on a wall and the other end supported by a string. What's the tension in the string?



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13. A rotating, rigid body makes one complete revolution in 2s. What is its average angular velocity?



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14. The angular velocity of a rotating disk increases from 2 rad/s to 5 rad/s in 0.5s. What's the disk's average angular acceleration?



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15. Derive an expression for centripetal acceleration in terms of angular speed.



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Comprehensive Drill

1. An object of mass 0.5 kg, moving in a circular path of radius 0.25m, experiences a centripetal acceleration of constant magnitude 9 m/s^2 .

What is the object's angular speed?

A. $2.3\text{rad} / \text{s}$

B. $4.5\text{rad}/\text{s}$

C. $6\text{rad}/\text{s}$

D. $12\text{rad}/\text{s}$

Answer: C



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2. 

In an effort to tighten a bolt, a force F is applied as shown in the figure above. If the

distance from the end of the wrench to the center of the bolt is 20 cm and $F=20$ N, what is the magnitude of the torque produced by F ?

A. $0N \cdot m$

B. $1N \cdot m$

C. $2N \cdot m$

D. $4N \cdot m$

Answer: D



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3. 

In the figure above, what is the torque about the pendulum's suspension point produced by the weight of the bob, given that the mass is 40 cm to the right of the suspension point, measured horizontally, and $m = 0.50\text{kg}$?

A. $0.49\text{N} \cdot m$

B. $0.98\text{N} \cdot m$

C. $1.7\text{N} \cdot m$

D. $2.0\text{N} \cdot m$

Answer: D



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4. 

A uniform meter stick of mass 1 kg is hanging from a thread attached at the stick's midpoint. One block of mass $m=3$ kg hangs from the left end of the stick, and another block, of unknown mass M , hangs below the 80 cm mark on the meter stick. if the stick remains at

rest in the horizontal position shown above,
what is M ?

A. 4kg

B. 5kg

C. 6kg

D. 8kg

Answer: B



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5. An object moves at constant speed in a circular path. True statement about the motion include which of the following

I. the velocity is constant.

II. The acceleration is constant.

III. The net force on the object is zero since its speed is constant.

A. II only

B. I and III only

C. II and III only

D. NONE

Answer: D



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6. Three thin, uniform rods each of length L are arranged in the shape of an inverted U.



The rods on the arms of the U each have mass m , the third rod has mass $2m$. How far below

the midpoint of the horizontal rod is the center of mass of this assembly?

A. $\frac{L}{8}$

B. $\frac{L}{4}$

C. $\frac{3L}{8}$

D. $\frac{L}{2}$

Answer: B



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7. A satellite is currently orbiting Earth in a circular orbit of radius R , its kinetic energy is K_1 , if the satellite is moved and enters a new circular orbit of radius $2R$, what will be its kinetic energy?

A. $\frac{K_1}{4}$

B. $\frac{K_1}{2}$

C. K_1

D. $2K_1$

Answer: B



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8. A moon of Jupiter has a nearly circular orbit of radius R and an orbit period of T . Which of the following expressions gives the mass of Jupiter?

A. $\frac{2\pi R}{T}$

B. $\frac{4\pi^2 R}{T}$

C. $\frac{2\pi R^3}{(GT^2)}$

D. $\frac{4\pi^2 R^3}{(GT^2)}$.

Answer: D



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9. The mean distance from Saturn to the sun is 9 times greater than the mean distance from Earth to the sun. how long is a Saturn year?

- A. 18 Earth years
- B. 27 earths years
- C. 81 earth years
- D. 243 earth years

Answer: B



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10. Two satellites orbit the Earth in circular orbits, each travelling at a constant speed. The radius of satellite A's orbit is R , and the radius of satellite B's orbit is $3R$. Both satellites have the same mass. How does F_A , the centripetal force on satellite A, compare with F_B , the centripetal force on satellite B?

A. $F_A = 9F_B$

B. $F_A = 3F_B$

C. $F_A = F_B$

D. $F_B = 3F_A$

Answer: A



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11. An object of mass m is travelling at constant rate b in a circular path of radius r .

how much work is done by the centripetal force during one half of a revolution?

A. $\pi m v^2$

B. $2\pi m v^2$

C. 0

D. $\pi m v^2 r$

Answer: C



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