This print-out should have 32 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering.

001 (part 1 of 2) 10.0 points

Compare the gravitational force on a 41 kg mass at the surface of the Earth (with radius 6.4×10^6 m and mass 6×10^{24} kg) with that on the surface of the Moon $\left(\text{with mass } \frac{1}{81.3} M_E \text{ and radius } 0.27\, R_E\right)$.

What is the force on the Earth?

Answer in units of N.

002 (part 2 of 2) 10.0 points

What is it on the Moon?

Answer in units of N.

003 10.0 points

Which of the objects

a. a book
b. the nearest star
c. the Sun
d. a distant galaxy

exert(s) a gravitational force on you?

1. c

2. a and d

3. c and d

4. a and b

5. b, c and d

6. a, b, c and d

7. a, b and c

8. b

9. Another combination

10. a

004 10.0 points

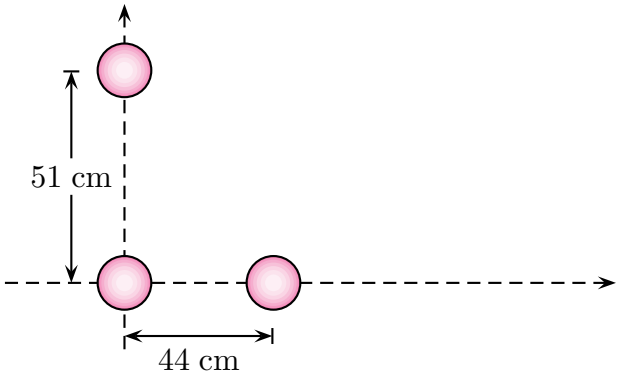
Mars has a mass of about 6.37×10^{23} kg, and its moon Phobos has a mass of about 9.2×10^{15} kg.

If the magnitude of the gravitational force between the two bodies is 4.92×10^{15} N, how far apart are Mars and Phobos? The value of the universal gravitational constant is $6.673 \times 10^{-11}\ \text{N} \cdot \text{m}^2/\text{kg}^2$.

Answer in units of m.

005 10.0 points

Three 5 kg masses are located at points in the xy plane.

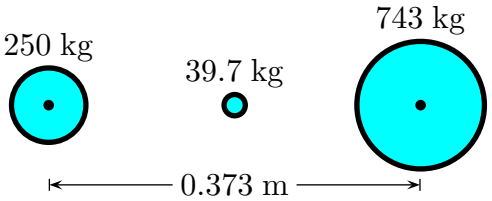


What is the magnitude of the resultant force (caused by the other two masses) on the mass at the origin? The universal gravitational constant is $6.6726 \times 10^{-11}\ \text{N} \cdot \text{m}^2/\text{kg}^2$.

Answer in units of N.

006 (part 1 of 2) 10.0 points

Objects with masses of 250 kg and 743 kg are separated by 0.373 m. A 39.7 kg mass is placed midway between them.



Find the magnitude of the net gravitational force exerted by the two larger masses on the 39.7 kg mass. The value of the universal gravitational constant is $6.672 \times 10^{-11}\ \text{N} \cdot \text{m}^2/\text{kg}^2$.

Answer in units of N.

007 (part 2 of 2) 10.0 points

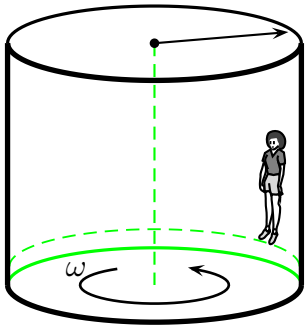
Leaving the distance between the 250 kg and the 743 kg masses fixed, at what distance from

the 743 kg mass (other than infinitely remote ones) does the 39.7 kg mass experience a net force of zero?

Answer in units of m.

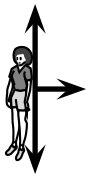
008 10.0 points

As viewed by a bystander, a rider in a "barrel of fun" at a carnival finds herself stuck with her back to the wall.



Which diagram correctly shows the forces acting on her?

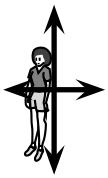
1.



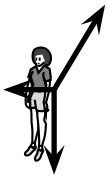
2.

3. None of the other choices

4.



5.

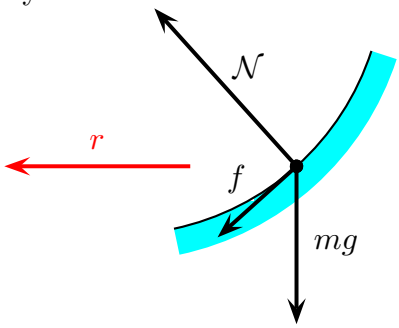


6.

009 10.0 points

A motorcyclist is able to ride on the vertical wall of a bowl-shaped track as shown. His weight is counteracted by the friction of the wall on the tires (vertical arrow).

A drawing of the vectors for the forces that acts on the cyclist is shown below. The vectors are drawn from the center of mass of the motorcyclist.



Which force(s) increase(s) or decrease(s) if he rides faster?

1. Only the frictional force decreases.

2. The frictional and normal forces decrease.

3. Only the frictional force increases.

4. Only the normal force decreases.

5. Only the normal force increases.

6. The frictional and normal forces increase.

010 (part 1 of 2) 10.0 points

Calculate the period of a ball tied to a string of length 0.2 m making 7.4 revolutions every second.

Answer in units of s.

011 (part 2 of 2) 10.0 points

Calculate the speed of the ball.

Answer in units of m/s.

012 (part 1 of 3) 10.0 points

According to the *Guinness Book of World Records* (1990 edition, p. 169), the highest rotary speed ever attained was 2010 m/s (4500 mph). The rotating rod was 15.3 cm (6 in) long. Assume the speed quoted is that of the end of the rod.

What is the centripetal acceleration of the end of the rod?

Answer in units of m/s^2.

013 (part 2 of 3) 10.0 points

If you were to attach a(n) 2.29 g object to the end of the rod, what force would be needed to hold it on the rod?

Answer in units of N.

014 (part 3 of 3) 10.0 points

What is the period of rotation of the rod?

Answer in units of s.

015 (part 1 of 2) 10.0 points

An airplane is flying in a horizontal circle at a speed of 101 m/s. The 72.0 kg pilot does not want the centripetal acceleration to exceed 6.22 times free-fall acceleration.

Find the minimum radius of the plane's path. The acceleration due to gravity is 9.81 m/s^2.

Answer in units of m.

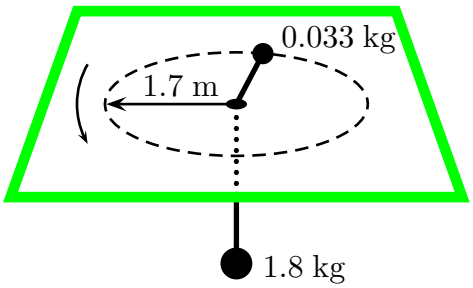
016 (part 2 of 2) 10.0 points

At this radius, what is the magnitude of the *net* force that maintains circular motion exerted on the pilot by the seat belts, the friction against the seat, and so forth?

Answer in units of N.

017 (part 1 of 2) 10.0 points

An air puck of mass 0.033 kg is tied to a string and allowed to revolve in a circle of radius 1.7 m on a frictionless horizontal surface. The other end of the string passes through a hole in the center of the surface, and a mass of 1.8 kg is tied to it, as shown. The suspended mass remains in equilibrium while the puck revolves on the surface.



What is the magnitude of the force that maintains circular motion acting on the puck? The acceleration due to gravity is 9.81 m/s^2.

Answer in units of N.

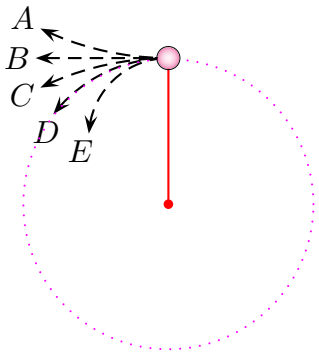
018 (part 2 of 2) 10.0 points

What is the linear speed of the puck?

Answer in units of m/s.

019 10.0 points

A steel ball is attached to a string and is swung in a horizontal circular path as illustrated in the figure. At point P, the string suddenly breaks near the ball.



If these events are observed from directly above, which path would the ball most closely follow after the string breaks?

1. (B)

2. (A)

3. (C)

4. (E)

5. (D)

020 10.0 points

A coin is placed 35 cm from the center of a horizontal turntable, initially at rest. The turntable then begins to rotate. When the speed of the coin is 110 cm/s (rotating at a constant rate), the coin just begins to slip.

The acceleration of gravity is 980 cm/s^2 .

What is the coefficient of static friction between the coin and the turntable?

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021 10.0 points

A ball of mass 24.2 g is attached to a cord of length 0.416 m and rotates in a vertical circle.

What is the minimum speed the ball must have at the top of the circle so the cord does not become slack? The acceleration of gravity is 9.8 m/s^2 .

Answer in units of m/s.

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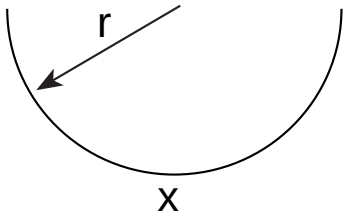
022 10.0 points

After coming down a steep hill at a constant speed of 18 m/s, a car travels along the circumference of a vertical circle of radius 647 m until it begins to climb another hill.



What is the magnitude of the resultant force on the 110 kg driver of the car at the lowest point on this circular path?

Answer in units of kN.

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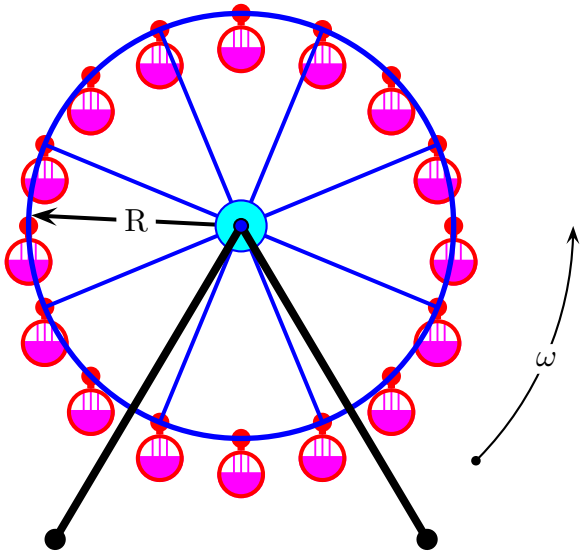
023 10.0 points

The following figure shows a Ferris wheel that rotates 3 times each minute and has a diameter of 25 m.

The acceleration of gravity is 9.8 m/s^2 .



What force does the seat exert on a 55 kg rider at the lowest point of the ride?

Answer in units of N.

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024 10.0 points

Tarzan (m = 83 kg) tries to cross a river by swinging from a 14 m long vine. His speed at the bottom of the swing (as he just clears the water) is 8.2 m/s.

The acceleration of gravity is 9.8 m/s^2 .

What should be the breaking strength of the vine is so that Tarzan can make it safely across the river?

Answer in units of N.

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025 (part 1 of 2) 10.0 points

An 2030 kg car passes over a bump in a road that follows the arc of a circle of radius 60.5 m.

The acceleration of gravity is 9.8 m/s^2 .

What force does the road exert on the car as the car passes the highest point of the bump if the car travels at 18.6 m/s?

Answer in units of N.

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026 (part 2 of 2) 10.0 points

What is the maximum speed the car can have as it passes this highest point before losing contact with the road?

Answer in units of m/s.

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027 10.0 points

A(n) 0.2 kg object is swung in a vertical circular path on a string 0.1 m long.

The acceleration of gravity is 9.8 m/s^2 .

If a constant speed of 6.03 m/s is maintained, what is the tension in the string when the object is at the top of the circle?

Answer in units of N.

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028 10.0 points

A friend incorrectly says that a body cannot be rotating when the net torque acting on it is zero.

What is the correct statement?

1. The original statement made by the friend is actually correct.

2. A body can have an angular velocity only when a non-zero net torque is acting on it.

3. Once a body starts rotating the net torque is zero.

4. A body's angular velocity cannot change if the net torque acting on it is zero and the moment of inertia does not change.

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029 10.0 points

How does the net torque change when a partner on a seesaw stands or hangs from her end instead of sitting?

1. The net toque increases.

2. The net torque decreases.

3. It depends on the mass.

4. The net torque remains the same.

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030 10.0 points

When you push on an object such as a wrench, a steel pry bar, or even the outer edge of a door, you produce a torque equal to the force applied times the lever arm.

At what angle to the lever arm should a force be applied to produce maximum torque and why?

1. 90°; the force would be parallel to the lever arm, so the torque is constant.

2. 90°; this maximizes the effective length of the lever arm.

3. 180°; this maximizes the effective force.

4. 0°; this maximizes the effective length of the lever arm.

5. 180°; this maximizes the effective length of the lever arm.

6. At any angle; the torque is zero under all situations.

7. 0°; this maximizes the effective force.

8. At any angle; the torque equals the force times the lever arm, and both of these remain the same.

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031 10.0 points

Find the magnitude of the torque produced by a 3.5 N force applied to a door at a perpendicular distance of 0.39 m from the hinge.

Answer in units of $\mathrm{N \cdot m}$.

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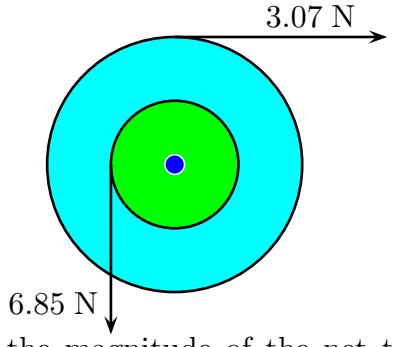
032 10.0 points

A one-piece cylinder has a core section protruding from the larger drum and is free to rotate around its central axis. A rope wrapped around the drum of radius 1.06 m exerts a force of 3.07 N to the right on the cylinder. A rope wrapped around the core of radius 0.47 m exerts a force of 6.85 N downward on the cylinder.



What is the magnitude of the net torque acting on the cylinder about the rotation axis?

Answer in units of $\mathrm{N \cdot m}$.