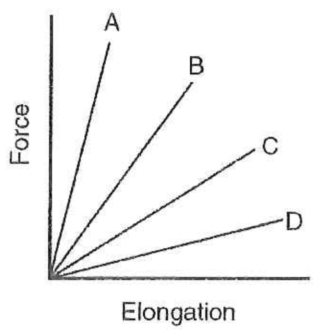
Skill 24-Spring Force

173. The graph below represents the relationship between the force applied to a spring and spring elongation for four different springs.

Force vs. Elongation



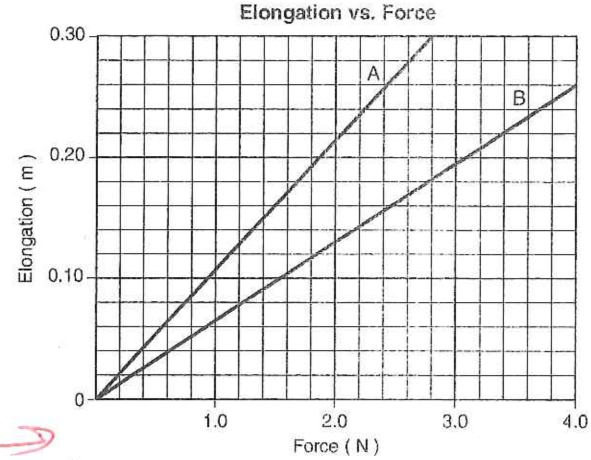
Which spring has the greatest spring constant?

(A) *A* B) *B* C) *C* D) *D*

$K = \frac{F_s}{x} = \text{slope}$

174. The graph below shows elongation as a function of the applied force for two springs, *A* and *B*.

Elongation vs. Force



axis are switched

Compared to the spring constant for spring *A*, the spring constant for spring *B* is

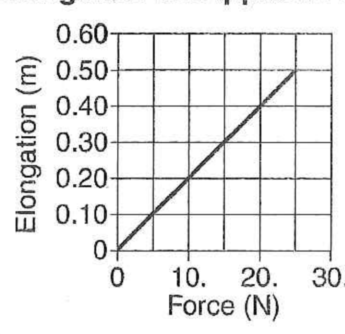
A) smaller (B) larger)
C) the same

$\frac{x}{F_s} = \frac{1}{K}$ so lowest slope = highest K

inverse of K

175. The graph below shows the relationship between the elongation of a spring and the force applied to the spring causing it to stretch.

Elongation vs. Applied Force



$\frac{x}{F_s} = \frac{1}{K}$

flip $\frac{F_s}{x} = K$

$\frac{20N}{.4m} = 50 N/m$

What is the spring constant for this spring?

A) 0.020 N/m B) 2.0 N/m
C) 25 N/m (D) 50. N/m)

Skill 25: Centripetal Motion

176. Determine the centripetal acceleration of a 4kg mass moving at a speed of 3m/s in a circle with a radius of 0.5 m.

$a_c = ?$
$m = 4kg$
$v = 3 m/s$
$r = .5 m$

$a_c = \frac{v^2}{r} = \frac{(3 m/s)^2}{.5m} = 18 m/s^2$

177. Determine the centripetal force acting on a 3kg mass which is moving at 2m/s around a circle with a radius of 1 m.

$F_c = ?$
$m = 3kg$
$v = 2 m/s$
$r = 1m$

$F_c = \frac{mv^2}{r} = \frac{(3kg)(2 m/s)^2}{1m} = 12N$

178. Determine the centripetal acceleration of a 5kg mass that completes a rotation around a circle with a radius of 0.75 m every 2 seconds.

$a_c = ?$
$m = 5kg$
$T = 2s$
$r = .75m$

$v = \frac{2\pi r}{T} = \frac{2\pi(.75m)}{2s} = 2.36 m/s$

$a_c = \frac{v^2}{r} = \frac{(2.36 m/s)^2}{.75m} = 7.43 m/s^2$

$a_c = \frac{v^2}{r}$
$F_c = \frac{mv^2}{r}$

179. Name the type of relationship for each of the following pairs.

a. Centripetal force and mass direct

b. Centripetal acceleration and mass none

c. Centripetal force and radius inverse

d. Centripetal acceleration and velocity direct square

e. Centripetal force and velocity direct square

180. If the radius of a circle is doubled and all other factors are held constant, the centripetal acceleration will halved. $r \times 2$ means $a_c \div 2$

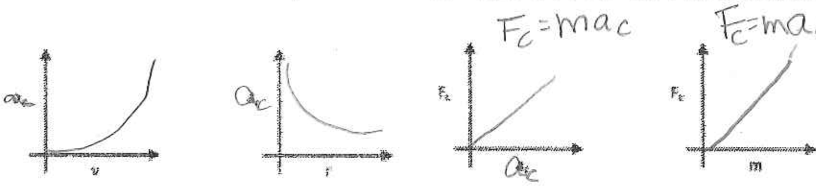
181. If the speed of an object is a circular path is tripled and all other factors are held constant, the centripetal acceleration will $\times 9$ $v \times 3$ means $a_c = 3^2$

182. If the mass of an object traveling in a circular path is doubled and all other factors are held constant, the centripetal force will double

183. If the radius of a circular path is halved and all other factors are held constant the force required to keep the object on the circular path will be double.

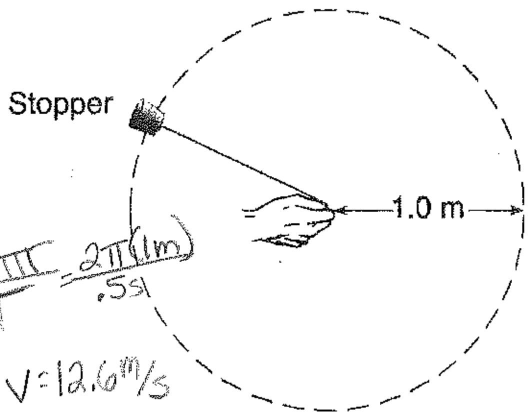
184. Sketch the relationship between the variables for the following axes.

$F_c = ma_c$ $F_c = ma_c$



Skill 25-Circular Motion

185. In an experiment, a 0.028-kilogram rubber stopper is attached to one end of a string. A student whirls the stopper overhead in a horizontal circle with a radius of 1.0 meter. The stopper completes 1 revolution in 0.5 seconds.



(Not drawn to scale)

Determine the speed of the whirling stopper.

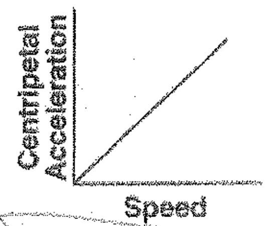
186. A 1.0×10^3-kilogram car travels at a constant speed of 20. meters per second around a horizontal circular track. The diameter of the track is 1.0×10^2 meters. The magnitude of the car's centripetal acceleration is

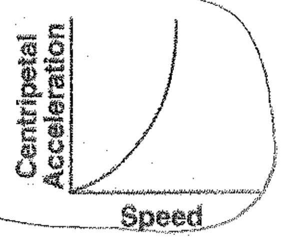
A) $0.20\ m/s^2$ B) $2.0\ m/s^2$
C) $8.0\ m/s^2$ D) $4.0\ m/s^2$

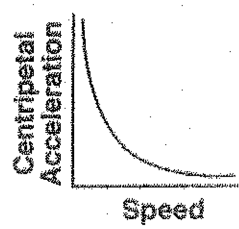
187. A 0.50-kilogram object moves in a horizontal circular path with a radius of 0.25 meter at a constant speed of 4.0 meters per second. What is the magnitude of the object's acceleration?

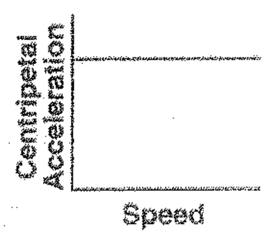
A) $8.0\ m/s^2$ B) $16\ m/s^2$
C) $32\ m/s^2$ D) $64\ m/s^2$

188. Which graph best represents the relationship between the magnitude of the centripetal acceleration and the speed of an object moving in a circle of constant radius?

A) 

B) 

C) 

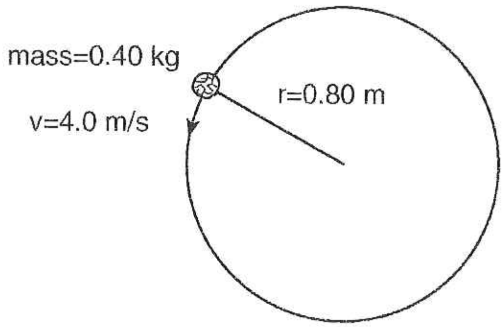
D) 

189. An object travels in a circular orbit. If the speed of the object is doubled, its centripetal acceleration will be

A) halved B) doubled
C) quartered D) quadrupled

Skill 25-Circular Motion

190. The diagram below represents a 0.40-kilogram stone attached to a string. The stone is moving at a constant speed of 4.0 meters per second in a horizontal circle having a radius of 0.80 meter.



The magnitude of the centripetal acceleration of the stone is

A) 0.0 m/s² B) 2.0 m/s²
C) 5.0 m/s² D) 20. m/s²

$a_c = \frac{v^2}{r} = \frac{(4 m/s)^2}{.8 m} = 20 m/s^2$

191. What is the centripetal acceleration of a ball traveling at 6.0 meters per second in a circle whose radius is 9.0 meters?

A) 0.66 m/s² B) 1.5 m/s²
C) 15 m/s² D) 4.0 m/s²

$a_c = ?$
$v = 6 m/s$
$r = 9 m$

$a_c = \frac{(6 m/s)^2}{9 m} = \frac{36 m^2/s^2}{9 m} = 4 m/s^2$

192. An unbalanced force of 40. newtons keeps a 5.0-kilogram object traveling in a circle of radius 2.0 meters. What is the speed of the object?

A) 8.0 m/s B) 2.0 m/s
C) 16 m/s D) 4.0 m/s

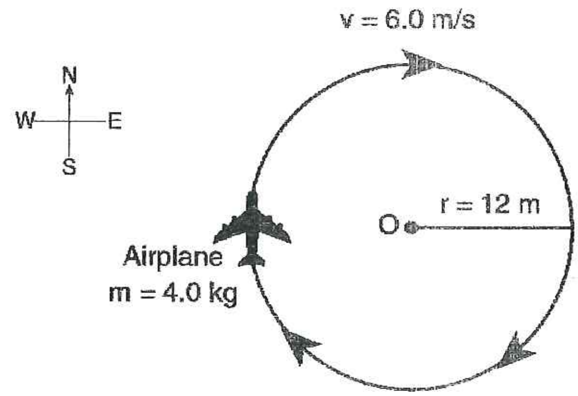
$F_c = 40 N$
$m = 5 kg$
$r = 2 m$
$v = ?$

$F_c = \frac{mv^2}{r}$ $\sqrt{\frac{(F_c)(r)}{m}} = v$

$v = \sqrt{\frac{(40 N)(2 m)}{5 kg}}$
$v = \sqrt{16 m^2/s^2}$
$v = 4 m/s$

193. Base your answer to the following question on the information and diagram below.

A 4.0-kilogram model airplane travels in a horizontal circular path of radius 12 meters at a constant speed of 6.0 meters per second.



What is the magnitude of the centripetal acceleration of the airplane?

A) 0.50 m/s² B) 2.0 m/s²
C) 3.0 m/s² D) 12 m/s²

$a_c = ?$
$r = 12 m$
$v = 6 m/s$
$m = 4 kg$

$a_c = \frac{v^2}{r} = \frac{(6 m/s)^2}{12 m} = 3 m/s^2$

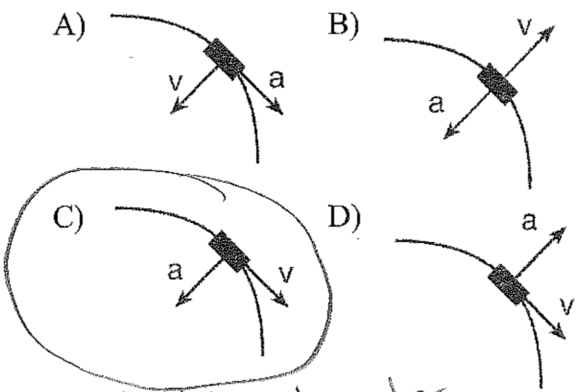
194. A 1750-kilogram car travels at a constant speed of 15.0 meters per second around a horizontal, circular track with a radius of 45.0 meters. The magnitude of the centripetal force acting on the car is

A) 5.00 N B) 583 N
C) 8750 N D) 3.94 × 10⁵ N

$m = 1750 kg$
$v = 15 m/s$
$r = 45 m$
$F_c = ?$

$F_c = \frac{mv^2}{r}$
$F_c = \frac{(1750 kg)(15 m/s)^2}{45 m}$
$F_c = 8750 N$

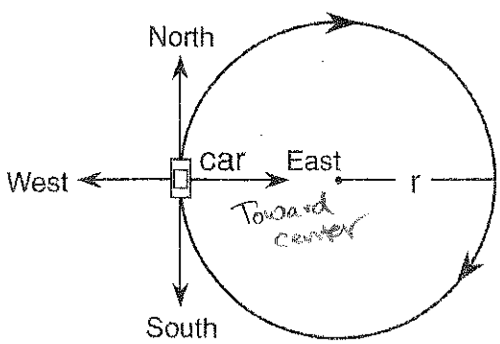
195. A car rounds a horizontal curve of constant radius at a constant speed. Which diagram best represents the directions of both the car's velocity, *v*, and acceleration, *a*?



a_c (+F_c) toward center

V is tangential

196. A car moves with a constant speed in a clockwise direction around a circular path of radius *r*, as represented in the diagram above.

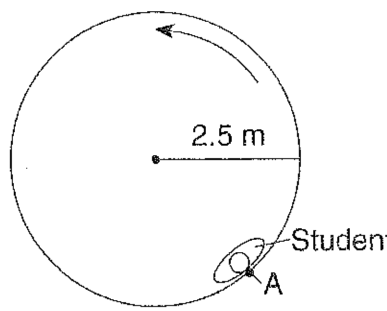


When the car is in the position shown, its acceleration is directed toward the

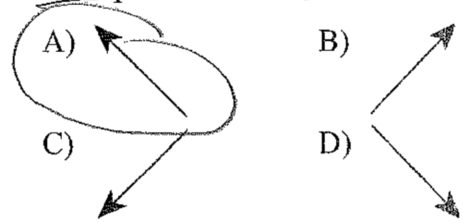
A) north
B) west
C) south
D) east

197. Base your answer to the following question on the information and diagram below.

The diagram shows the top view of a 65 -kilogram student at point *A* on an amusement park ride. The ride spins the student in a horizontal circle of radius 2.5 meters, at a constant speed of 8.6 meters per second. The floor is lowered and the student remains against the wall without falling to the floor.



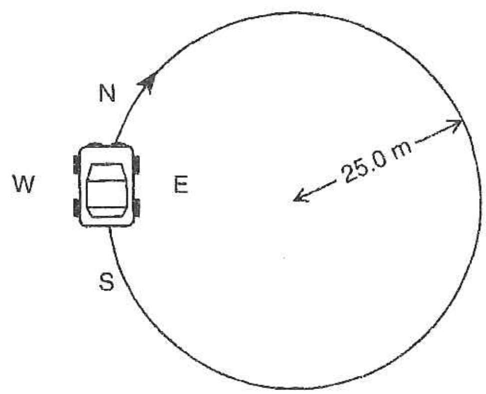
Which vector best represents the direction of the centripetal acceleration of the student at point *A*.



a_c toward center

198. Base your answer to the following question on the information and diagram below.

A 1.00×10^3 -kilogram car is driven clockwise around a flat circular track of radius 25.0 meters. The speed of the car is a constant 10.00 meters per second.



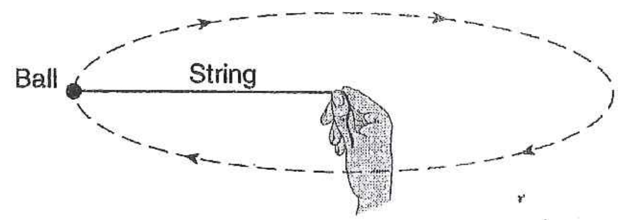
What minimum friction force must exist between the tires and the road to prevent the car from skidding as it rounds the curve?

A) 1.25×10^5 N
B) 9.80×10^4 N
C) 4.00×10^2 N
D) 4.00×10^3 N

$F_f = F_c = ?$
$m = 1\times10^3 kg$
$r = 25 m$
$v = 10 m/s$

$F_c = \frac{mv^2}{r} = \frac{(1\times10^3 kg)(10 m/s)^2}{25 m} = \frac{1\times10^5 kg\, m^2/s^2}{25 m} = 4\times10^3 N$

Base your answers to questions **199** and **200** on the diagram below. The diagram shows a student spinning a 0.10-kilogram ball at the end of a 0.50-meter string in a horizontal circle at a constant speed of 10. meters per second. [Neglect air resistance.]



199. If the magnitude of the force applied to the string by the student's hand is increased, the magnitude of the acceleration of the ball in its circular path will

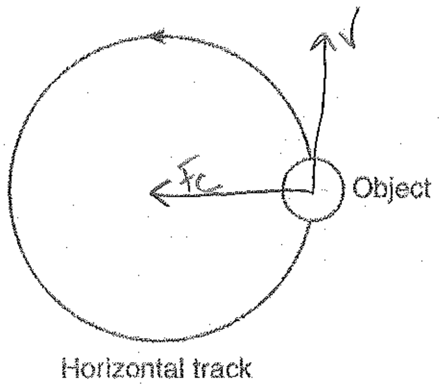
A) decrease
B) increase
C) remain the same

F_c and a_c always behave the same

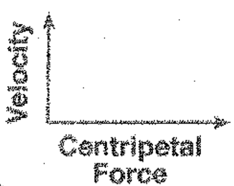
200. Which is the best description of the force keeping the ball in the circular path? F_c

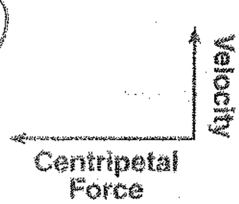
A) perpendicular to the circle and directed toward the center of the circle
B) perpendicular to the circle and directed away from the center of the circle
C) tangent to the circle and directed in the same direction that the ball is moving
D) tangent to the circle and directed opposite to the direction that the ball is moving

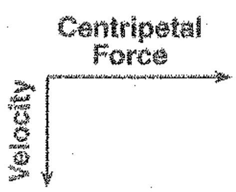
201. The diagram below shows an object moving counterclockwise around a horizontal, circular track.

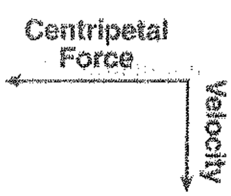


Which diagram represents the direction of both the object's velocity and the centripetal force acting on the object when it is in the position shown?

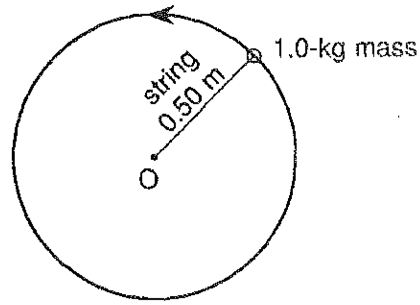
A)


B)


C)


D)


202. Base your answer to the following question on the diagram below which shows an object with a mass of 1.0 kilogram attached to a string 0.50 meter long. The object is moving at a constant speed of 5.0 meters per second in a horizontal circular path with center at point *O*.



If the string is cut when the object is at the position shown, the path the object will travel from this position will be

A) toward the center of the circle
B) a curve away from the circle
C) a straight line tangent to the circle

Skill 26: Universal Gravitation

203. Solve for the strength of the gravitation field "g" for any object on Earth by combining these two equations for Force due to gravity. For m_1 you may use the mass of any object on the Earth. The mass of the Earth (m_2) and the radius of the Earth (r) can be found on the reference table.

$F_g = mg$ and $F_g = G\frac{m_1 m_2}{r^2}$

To find F_g when the gravitational field strength "g" is known.	To find F_g when the distance between centers is large; find F_g when the object is outside of the uniform gravitational field.

$$m_1 g = G\frac{m_1 m_2}{r^2}$$

$g = \frac{(6.67\times10^{-11}\,Nm^2/kg^2)(5.98\times10^{24}\,kg)}{(6.37\times10^6\,m)^2}$

$= 9.83\,N/kg$ slightly higher due to 3 sig fig in values from ref table

204. Determine the force of gravitational attraction between 2 protons separated by a distance of 1m.

$m = 1.67\times10^{-27}\,kg$ (each)
$r = 1m$
$G = 6.67\times10^{-11}\,Nm^2/kg^2$
$F_g = ?$

$F_g = G\frac{m_1 m_2}{r^2}$

$= \frac{(6.67\times10^{-11}\,Nm^2/kg^2)(1.67\times10^{-27}\,kg)(1.67\times10^{-27}\,kg)}{1m^2}$

$= 1.86\times10^{-64}\,N$

205. What is the force of gravitational attraction between two asteroids separated by 3000 meters if they have masses of 4 x 10^5kg and 6 x 10^6kg?

$F_g = ?$
$m_1 = 4\times10^5\,kg$
$m_2 = 6\times10^6\,kg$
$r = 3\times10^3\,m$

$F_g = G\frac{m_1 m_2}{r^2} = \frac{(6.67\times10^{-11}\,Nm^2/kg^2)(4\times10^5\,kg)(6\times10^6\,kg)}{(3\times10^3\,m)^2}$

$= 1.78\times10^{-5}\,N$

206. The equation $F_g = G\frac{m_1 m_2}{r^2}$ reveals a direct relationship between F_g and the product of the masses and a Inverse square relationship between F_g and the distance between the centers of two masses (r).

207. What is the effect on the gravitational force if

a. Both masses are multiplied by 3

$F_g \times 9$ direct to product of masses

b. The distance between centers is X4

$\frac{F_g}{16}$ inverse square to r

c. One mass is X2 and the other X3

$F_g \times 6$ direct to product of masses

d. The distance is divided by 2

$4F_g$ inverse to r so $r \div 2$ become $F_g \times 2^2$

e. The distance is divided by 2 and one mass X3

$12F_g$ $r \div 2 = F_g \times 2^2 = 4F_g$; $m \times 3 = F_g \times 3$ $= 3F_g$ $= 12F_g$

208. Two masses are attracted by a force of 20N.

a. What would the force between them be if both masses were tripled?

$m \times 9 = F_g \times 9$ so 180N ($20N \times 9$)

b. What would the force between them be if the distance separating them were doubled?

$r \times 2 = \frac{F_g}{4}$ so $\frac{20N}{4} = 5N$

209. An astronaut with a mass of 50 kg is standing on the Earth's surface.

a. Calculate her weight while on the Earth's surface.

$F_g = mg = (50kg)(9.81m/s^2) = 490.5N$

b. The astronaut moves to an altitude that is one Earth radius above the surface of the Earth. Calculate her weight at this altitude.

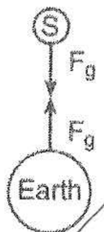
$r \times 2$ so $\frac{F_g}{4}$ $\frac{490.5N}{4} = 122.6N$

Skill 26-Universal Gravitation

210. Which diagram best represents the gravitational forces, F_g, between a satellite, *S*, and Earth?

A) 

B) 

C) 

D) 

always attractive & equal

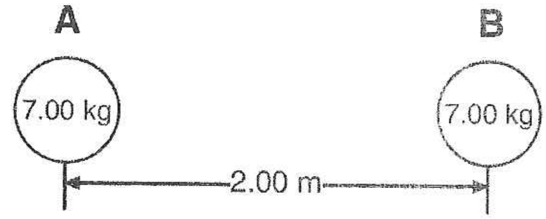
211. Gravitational forces differ from electrostatic forces in that gravitational forces are

A) attractive, only
B) repulsive, only
C) neither attractive nor repulsive
D) both attractive and repulsive

212. If the mass of one of two objects is increased, the force of attraction between them will

A) decrease
B) increase
C) remain the same

213. The diagram shows two bowling balls, *A* and *B*, each having a mass of 7.00 kilograms, placed 2.00 meters apart.



What is the magnitude of the gravitational force exerted by ball *A* on ball *B*?

A) 8.17×10^{-9} N
B) 1.63×10^{-9} N
C) 8.17×10^{-10} N
D) 1.17×10^{-10} N

$F_g = ?$
$G = 6.67 \times 10^{-11}$ N m²/kg²
$m_1 = 7$ kg $m_2 = 7$ kg
$r = 2$ m
$F_g = \frac{G m_1 m_2}{r^2}$

214. The centers of two 15.0-kilogram spheres are separated by 3.00 meters. The magnitude of the gravitational force between the two spheres is approximately

A) 1.11×10^{-10} N
B) 3.34×10^{-10} N
C) 1.67×10^{-9} N
D) 5.00×10^{-9} N

$m_1 = 15$ kg
$m_2 = 15$ kg
$r = 3$ m
$F_g = ?$

215. The radius of Mars is approximately one-half the radius of Earth, and the mass of Mars is approximately one-tenth the mass of Earth. Compared to the acceleration due to gravity on the surface of Earth, the acceleration due to gravity on the surface of Mars is

A) smaller
B) larger
C) the same

r ÷ 2 means g × 4   g = 4/10
m ÷ 10 means g ÷ 10