Chapter 09
Circular Motion

Part (3)
Multiple Choice Questions

9.16 Figure 9.16a shows the free-body diagram for the forces acting on a passenger in a roller coaster car at the top of the loop, where the normal force exerted by the track has a magnitude smaller than that of the gravitational force. If the speed of the car is 7.00 m/s, what does the radius of the loop have to be for that free-body diagram to be correct?

a) less than 5 m b) 5 m c) more than 5 m

$$\frac{mv^2}{R} = N + mg$$

$$\Rightarrow R = \frac{mv^2}{N + m\,g}$$

$$R = \frac{m(7)^2}{N + m\,g}$$

If N = 0 >>> R = 5

if N > 0 >>> R < 5

46. How far does a person in Dubuque, IA (latitude 42.5°) move in the 7.50 hours she sleeps? The radius of the Earth is 6378 km.

A. 4230 km
B. 4620 km
C. 9230 km
D. 8460 km
E. 12,500 km

$$\Delta_x = vt = \frac{(2\pi)(6378)\cos(42.5)}{24} \; x \; 7.50$$

$$= 9233 \text{ km}$$

47. A CD-ROM starts from rest and undergoes uniform angular acceleration until it reaches 26,000 rpm in 0.25 s. What is its angular acceleration?

A. 1.1×10^4 rad/s^2
B. 5.4×10^3 rad/s^2
C. 1.0×10^5 rad/s^2
D. 6.5×10^3 rad/s^2

$$\omega_f = \frac{2\pi(26000)}{60} = 2722.7 \; rad\backslash S$$

$$w_f = w_i + \alpha t$$
$$2722.7 = 0 + \alpha(0.25)$$
$$\alpha = 1.1 \; x \; 10^4 \; rad\backslash s^2$$

Bauer - Chapter 09 #37
Less difficult
Section: 09.06

48. A CD-ROM starts from rest and undergoes uniform angular acceleration until it reaches 26,000 rpm in 0.25 s. Through what angle does it rotate during this time?

A. 54 rad
B. 85 rad
C. 340 rad
D. 680 rad

$$(2722.7)^2 = 0 + 2(1.1\text{x}10^4)(\Delta\theta)$$
$$\Delta\theta = 337 \text{ rad} \sim 340 \text{ rad}$$

Bauer - Chapter 09 #38
Less difficult
Section: 09.06

49. A CD-ROM starts from rest and undergoes uniform angular acceleration until it reaches 26,000 rpm in 0.25 s. If its radius is 0.061 m, how far does a point on its edge travel during this time?

A. 3.3 m
B. 5.2 m
C. 21 m
D. 41 m

$$\Delta x = R\,\Delta\theta$$
$$= (0.061)(340)$$
$$= 20.74 \sim 21 \text{ m}$$

Bauer - Chapter 09 #39
Less difficult
Section: 09.06

50. A car drives along a country road at a constant speed of 26 m/s. When it encounters a hill, its tires just barely leave the pavement as the car passes over the top of the hill. What is the radius of curvature of the hill?

A. 69 m
B. 81 m
C. 250 m
D. Information about the mass of the car is needed.

Weightless means Normal Force = zero

$$v = \sqrt{gR}$$
$$26 = \sqrt{9.81 \times R}$$
$$R = 68.90 \text{ m}$$

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Less difficult
Section: 09.05

51. A 2.0-m long string is tied to a 3.0-kg rock and the rock is twirled around in a circle at a constant speed. The speed of the rock is such that the string makes an angle of 45 degrees with the horizontal. How long does it take the rock to complete one full circle?

A. 1.3 s
B. 1.9 s
C. 2.4 s
D. 2.8 s
E. 4.4 s

$$\omega = \frac{2\pi}{T} = \sqrt{\frac{g}{L\cos\theta}}$$

$$\frac{2^2\Pi^2}{T} = \frac{9.81}{2x\cos(45)}$$

$$T = 2.38 \text{ s} \sim 2.4 \text{ s}$$

Bauer - Chapter 09 #41
More difficult
Section: 09.05

Prepared by Amira Emam

53. A car with a mass of 1200 kg goes over a hill at a constant speed. The top of the hill can be approximated as an arc length of a circle with a radius of curvature of 210 m. What minimum speed must the car have as it passes over the top of the hill in order to become airborn?

A. 9.8 m/s
B. 11 m/s
C. 37 m/s
D. 45 m/s
E. 56 m/s

Normal Force = zero

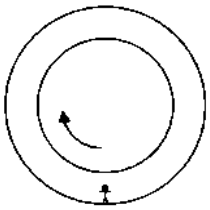
$$v = \sqrt{gR}$$

$$V = \sqrt{9.81 \times 210}$$

$$R = 45 \ \ m$$

Bauer - Chapter 09 #42
Less difficult
Section: 09.05

54. An orbital space station generates "artificial" gravity by spinning. Consider a 100-kg person standing against the outside wall of a doughnut shaped space station with an outer diameter of 2.0 km. What is the period of rotation for the space station such that the space station exerts a force on the person equal to the weight of the person on the surface of the Earth?



A. 4.8 s
B. 31 s
C. 63 s
D. 90 s
E. 640 s

$$mg = F_c$$

$$mg = \frac{m(\omega^2 R^2)}{R}$$

$$g = \frac{(\omega^2 R^2)}{R}$$

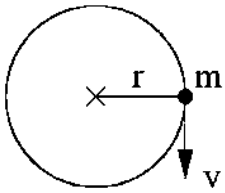
$$9.81 = \omega^2 \ (1x10^3)$$

$$\omega = 0.099 \text{ rad\s}$$

$$T = 2\pi \setminus 0.099 = 63 \text{ s}$$

Bauer - Chapter 09 #43
Less difficult
Section: 09.05

59. A small object with a mass of m = 658 g is whirled at the end of a rope in a vertical circle with a radius of r = 137 cm. When it is at the location shown, (mid-height), and its speed is v = 5.54 m/s. Determine the tension in the rope. (in N)



A. 1.47×10^1
B. 1.67×10^1
C. 1.88×10^1
D. 2.13×10^1
E. 2.40×10^1
F. 2.72×10^1
G. 3.07×10^1
H. 3.47×10^1

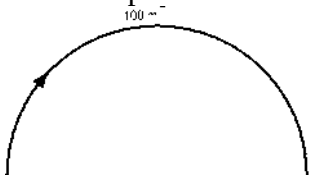
$$T = F_c$$

$$T = \frac{m(v^2)}{R}$$

$$T = \frac{0.658x(5.54)^2}{1.37}$$

$$T = 14.7\ N$$

63. It takes a runner 10 seconds to run the curve (100 meter arc length, semicircle) in a race. The centripetal acceleration acting on her is



A. 1.00 m/s^2.
B. 1.57 m/s^2.
C. 1.92 m/s^2.
D. 3.14 m/s^2.
E. 3.59 m/s^2.

$$a_c = \omega^2 R = \frac{4\pi^2}{T}\left(\frac{s}{\theta}\right)$$

$$a_c = \frac{4\Pi^2}{20^2}\left(\frac{100}{\pi}\right)$$

$$= 3.14\ m\backslash s^2$$

Bauer - Chapter 09 #48
Less difficult
Section: 09.04

64. A toy train moves with uniform speed on a circular track. Which of the following statements is true?
A. The angular acceleration is always positive.
B. The angular acceleration is always negative.
C. The angular acceleration can either be positive or negative, depending if the train runs clockwise or counter-clockwise.
D. The centripetal acceleration is 0.
E. The centripetal acceleration does not change in magnitude.

67. Somewhere on the surface of the Earth a yo-yo with m = 0.050 kg is swung in a vertical circle with radius r = 0.40 m. Find the tension on the string at the top if the speed at that point is v = 2.0 m/s.
A. 3.0 N
B. 27.0 N
C. 81.0 N
D. 0.333 N
E. 0.0095 N

$$T = F_c - mg = \frac{mv^2}{R} - mg$$

$$T = \frac{0.050\ x\ 2^2}{0{,}40} - (0.050\ x\ 9 \cdot 81)$$

T = 9.5 x 10^-3 N

Bauer - Chapter 09 #51
Less difficult
Section: 09.05

68. A flatbed truck goes around a curve of radius R with speed V. There is a box on the truck of M kg mass. Which statement is correct concerning the **net horizontal** force on the box, if the box *does not slide*?
A. It is MV^2/R outward from the center of the curve.
B. It is zero.
C. It is MV^2/R inward towards the center of the curve.
D. It is MgR outward from the center of the curve.
E. It is MgR inward towards the center of the curve.

Bauer - Chapter 09 #52
Less difficult
Section: 09.05