Circular Motion Problem SET 2020

1. A swing ride at a carnival consists of chairs that are swung in a circle by 12.0 m cables attached to a vertical rotating pole, as shown in the figure on the below. Suppose the total mass of a chair and its occupant is 220 kg.

2200

65°

(a) Determine that tension in the cable attached to the chair. (5102N)

(b) Find the speed of the chair. (15 m/s)

2. A downhill skier, who's mass is 50.0 kg, follows a near circular path down a slope as shown in the diagram below. She attains a speed of 21.0 m/s just as she reaches the point A. Determine the normal force acting on her skis at point A if the radius of her path is 27m. (1306N).



3. A 2100-kg demolition ball swings at the end of a 15-m cable on the arc of a vertical circle. At the lowest point of the swing, the ball is moving at a speed of 7.6 m/s. Determine the tension in the cable. (28666.4N)

4. A roller coaster at an amusement park has a dip that bottoms out in a vertical circle of radius *r*. A passenger feels the seat of the car pushing upward on her with a force equal to twice her weight as she goes through the dip. If r = 20.0 m, how fast is the roller coaster traveling at the bottom of the dip? (14m/s)

5. A car is traveling at a constant speed along the road ABCDE shown in the drawing. Sections AB and DE are straight. Rank the accelerations in each of the four sections according to magnitude, **smallest first**.



Answers to the following at end of problem set

1.

The diagram shows a student "twirling" a car key in a circular path on the end of a string.



If the string snaps at P, which path will the keys follow?

- A. WB. X
- C. Y
- D. Z

2.

An athlete runs, at a constant speed, around a circle of radius 5.0 m in 12 s. What are the athlete's speed and acceleration?

	SPEED	MAGNITUDE OF ACCELERATION	
А.	0.42 m/s	0.22 m/s ²	
В.	0.42 m/s	1.4 m/s^2	
C.	2.6 m/s	0.22 m/s ²	
D.	2.6 m/s	1.4 m/s^2	

Tarzan, of mass 85 kg, holds on to a horizontal vine of length 8.0 m and jumps off a cliff. What is the tension force in the vine as Tarzan passes the lowest point of his circular path?

- A. 830 N
- B. 1700 N
- C. 2 500 N
- D. 6700 N

3.



Which vector diagram best represents the acceleration, \vec{a} , and force, \vec{F} , for an object travelling along a circular path?

4.

The diagram shows a 52 kg child riding on a Ferris wheel of radius 12 m and period 18 s. What force (normal force) does the seat exert on the child at the top and bottom of the ride?



	Тор	Воттом
А.	76 N	76 N
В.	430 N	590 N
C.	510 N	510 N
D.	590 N	430 N

In a series of test runs, a car travels around the same circular track at different velocities. Which graph best shows the relationship between its centripetal acceleration, a_c , and its velocity, v?



6.

The diagram shows an object of mass 3.0 kg travelling in a circular path of radius 1.2 m while suspended by a piece of string of length 1.9 m. What is the centripetal force on the mass?



A. 19 NB. 23 N

- C. 24 N
- D. 29 N

A car travels at a uniform speed through a level circular curve in the road. Which of the following correctly describes the magnitude of the acceleration, velocity and force acting on the car?

	MAGNITUDE OF ACCELERATION	MAGNITUDE OF VELOCITY	MAGNITUDE OF FORCE
A.	constant	constant	constant
B.	constant	changing	changing
C.	constant	changing	constant
D.	changing	changing	changing

8.

A 65 kg pilot in a stunt plane performs a vertical loop with a 700 m radius. The plane reaches a speed of 210 m/s at the bottom of the loop. What is the upward force on the pilot at the bottom of the loop?

- A. 640 N
- B. 3 500 N
- C. 4 100 N
- D. 4700 N

In a popular amusement park ride, a large cylinder is set in rotation. The floor then drops away leaving the riders suspended against the wall in a vertical position as shown.



Which of the following is the correct free-body diagram for the person at the position shown?



10.

A 0.500 kg ball is swung in a horizontal circle of radius 1.20 m with a period of 1.25 s. What is the centripetal force on the ball?

- A. 0.384 N
- B. 15.2 N
- C. 18.9 N
- D. 30.3 N

A mass is suspended by a string attached to a spring scale that initially reads 14 N as shown in Diagram 1.



The mass is pulled to the side and then released as shown in Diagram 2.



As the mass passes point Q, how will the reading on the spring scale compare to the previous value of 14 N? Using principles of physics, explain your answer. (4 marks)

A test tube rotates in a centrifuge with a period of 1.20×10^{-3} s. The bottom of the test tube travels in a circular path of radius 0.150 m.



What is the centripetal force exerted on a 2.00×10^{-8} kg amoeba at the bottom of the tube?

- A. 9.86×10^{-5} N
- B. 2.08×10^{-3} N
- C. 8.22×10^{-2} N
- D. 4.11×10^6 N

13.

A physics student swings a 5.0 kg pail of water in a vertical circle of radius 1.3 m.



What is the minimum speed, v, at the top of the circle if the water is not to spill from the pail?

- A. 3.6 m/s
- B. 6.1 m/s
- C. 8.0 m/s
- D. 9.8 m/s

An empty 12 kg seat on a swing-type ride at the fairgrounds has a kinetic energy of 480 J.



What is the centripetal force on the empty seat?

- A. 1.2×10^2 N
- B. 1.4×10^2 N
- C. 8.2×10^2 N
- D. 5.8×10^3 N

15. **bonus**

A racetrack surface has the shape of an inverted cone on which cars race in horizontal circles. For a steady speed of 29 m/s, to what distance d should a driver take her car, if she wishes to stay on a circular path without friction?



A frictionless 3.0 kg cart rolls down an incline, and then "loops the loop."



From what minimum height, *h*, should the cart be released so that it does not fall off the circular track?

- A. 12.0 m
- B. 15.0 m
- C. 18.0 m
- D. 24.0 m

17.

An object travels along a circular path with a constant speed v when a force F acts on it. How large a force is required for this object to travel along the same path at twice the speed (2v)?

- A. $\frac{1}{2}F$
- **B**. *F*
- C. 2F
- D. 4*F*

18.

A student plots a graph of centripetal force F_c versus the square of velocity v^2 for an object in uniform circular motion.



What is the slope of this graph?

A. $\frac{m}{r}$ B. $\frac{r}{m}$ C. $\frac{4\pi^2 r}{T^2}$ D. $\frac{T^2}{4\pi^2 r}$

Answers:

1. b 2. D Mystery question: C (did in examples) 3. a 4. b 5. b 6. c 7. a 8. d 9. b 10. b 11. written response 12. c 13. a 14. b 15. 128.25m 16. b 17. d 18. a