

مراجعة الدرس الخامس Force Centripetal من الوحدة التاسعة منهج انسابير



تم تحميل هذا الملف من موقع المناهج الإماراتية

موقع المناهج ← المناهج الإماراتية ← الصف الحادي عشر المتقدم ← فيزياء ← الفصل الثالث ← ملفات متنوعة ← الملف

تاريخ إضافة الملف على موقع المناهج: 21:26:55 2025-06-09

ملفات اكتب للمعلم اكتب للطالب ا اختبارات الكترونية ا اختبارات ا حلول ا عروض بوربوينت ا أوراق عمل
منهج انجليزي ا ملخصات وتقارير ا مذكرات وبنوك ا الامتحان النهائي للمدرس

المزيد من مادة
فيزياء:

التواصل الاجتماعي بحسب الصف الحادي عشر المتقدم



صفحة المناهج
الإماراتية على
فيسبوك

الرياضيات

اللغة الانجليزية

اللغة العربية

التربية الاسلامية

المواد على تلغرام

المزيد من الملفات بحسب الصف الحادي عشر المتقدم والمادة فيزياء في الفصل الثالث

حل تجميعية مراجعة نهائية وفق الهيكل الوزاري منهج بريدج

1

تجميعية مراجعة نهائية وفق الهيكل الوزاري منهج بريدج بدون الحل

2

حل مراجعة نهائية وفق الهيكل الوزاري المسار C باللغتين العربية والانجليزية

3

مراجعة نهائية وفق الهيكل الوزاري المسار C باللغتين العربية والانجليزية

4

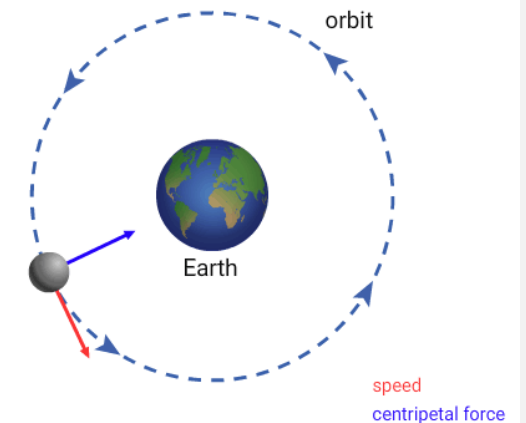
مراجعة الدرس الرابع من الوحدة التاسعة Acceleration Centripetal and Angular منهج انسابير

5

Unit 9: Circular motion

Section 9.5

Centripetal Force





Learning Objectives

Section 9.5 **Centripetal Force**

By the end of this section, you will be able to:

- 1) Define the centripetal force.
- 2) Identify the source of the centripetal force in different situations.
- 3) Solve problems to calculate the centripetal acceleration and centripetal force in real-world examples.



Keywords

Centripetal Force

2025

2024

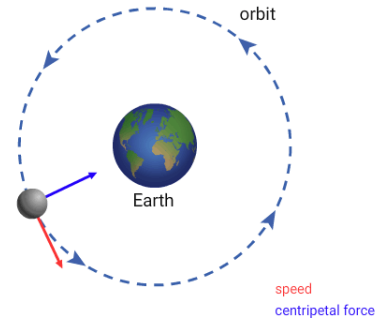


WARM UP



Discussion

Describe the velocity and acceleration of an object when it moves in **uniform circular motion**.



Its **velocity** is described as constant in magnitude but its **direction** is constantly changing to follow a circular path.

Its **acceleration** is constant, but its **direction** changes, always pointing towards the center of the circle.



Centripetal acceleration always points to the ____ of the circle.

- A. back
- ☒ B. center
- C. front
- D. outer edge



If an object moves along a circular path at a steady speed, it is in _____.

- A. uniform circular motion
- B. projectile motion
- C. relative motion
- D. accelerated motion



Test Knowledge

How far does an object in uniform circular motion travel during one period?

- A. $2\pi r$
B. πr^2
C. v^2/r
D. $2\pi\sqrt{r/a_c}$



The velocity vector for an object in uniform circular motion is ____.

- A. tangential to the circle
- B. directed toward the center of the circle
- C. directed away from the center of the circle
- D. proportional to the radius of the circle

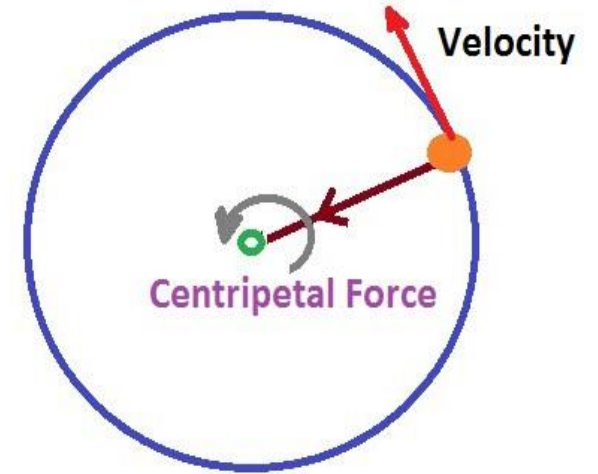


Test Knowledge

L.O: Define the centripetal force.

- The centripetal force \vec{F}_c is simply the net inward force needed to provide the centripetal acceleration necessary for circular motion.
- It has to point inward, toward the circle's center.
- Its magnitude is the product of the mass of the object and the centripetal acceleration required to force it onto a circular path:

$$F_c = ma_c$$



L.O: Define the centripetal force.

Is the centripetal force a
fundamental force in nature?

No, centripetal force is **not a fundamental force in nature.**

It is a **resultant force** that arises when one of the forces (such as gravity, tension, or electric force) acts to keep an object moving in a circular or curved path.

There are **four** fundamental forces in nature:

- Gravitational Force.
- Electromagnetic Force.
- Strong Nuclear Force.
- Weak Nuclear Force.

L.O: Identify the source of the centripetal force in different situations.

The centripetal force can be provided by different (sources).

According to the picture, what is the force that provides the source of the centripetal force here?

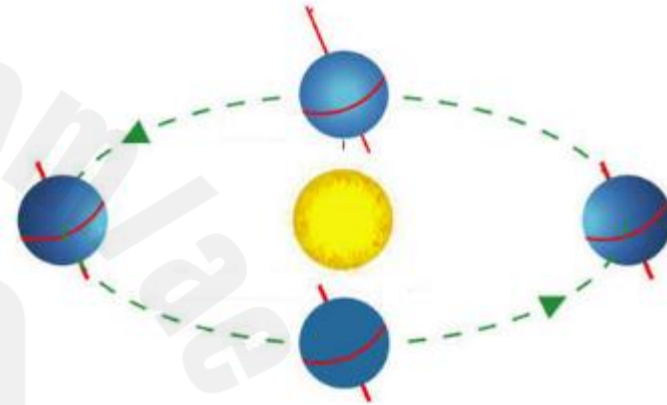


When a hammer thrower swings the hammer, as in Figure.

The centripetal force is represented by the **tension in the chain attached to the massive ball.**

L.O: Identify the source of the centripetal force in different situations.

**According to the picture,
what is the force that
provides the source of
the centripetal force
here?**



For Earth circling the Sun (**rotate around the Sun**).

The centripetal force is represented by **Sun's gravitational force on Earth.**

L.O: Identify the source of the centripetal force in different situations.

Check your understanding



For each situation a below, what provides the force that causes centripetal acceleration?

a. A ball on a string swinging in a circle in uniform circular motion.

Force providing centripetal acceleration: **Tension in the string.**

The string pulls the ball toward the center of the circular path, keeping it in motion.

b. Satellite moving around Earth in uniform circular motion.

Force providing centripetal acceleration: **Gravitational force between the satellite and Earth.**

Earth's gravity pulls the satellite toward the center of the planet, keeping it in orbit.

c. Car driving in a circle in uniform circular motion.

Force providing centripetal acceleration: **Friction between the tires and the road.**

The static friction between the tires and the road prevents the car from sliding outward and directs it toward the center of the curve.

d. An electron orbiting the nucleus in a hydrogen atom.

Force providing centripetal acceleration: : The attractive **electric force** between the proton and electron provides the centripetal force.

L.O: Identify the source of the centripetal force in different situations.

To find the magnitude of centripetal force:

$$F_c = ma_c$$

$$F_c = mv\omega$$

$$F_c = m\frac{v^2}{r}$$

$$F_c = m\omega^2 r$$

$$F_c = ma_c = mv\omega = m\frac{v^2}{r} = m\omega^2 r.$$

L.O: Identify the source of the centripetal force in different situations.

- The figure shows a top view of a turntable with three pieces that are identical in everything (except color).
- **The black** piece is located **near the center**.
- The **red** piece is **near the outer edge**.
- The **blue** piece is **in the middle between the two pieces**.



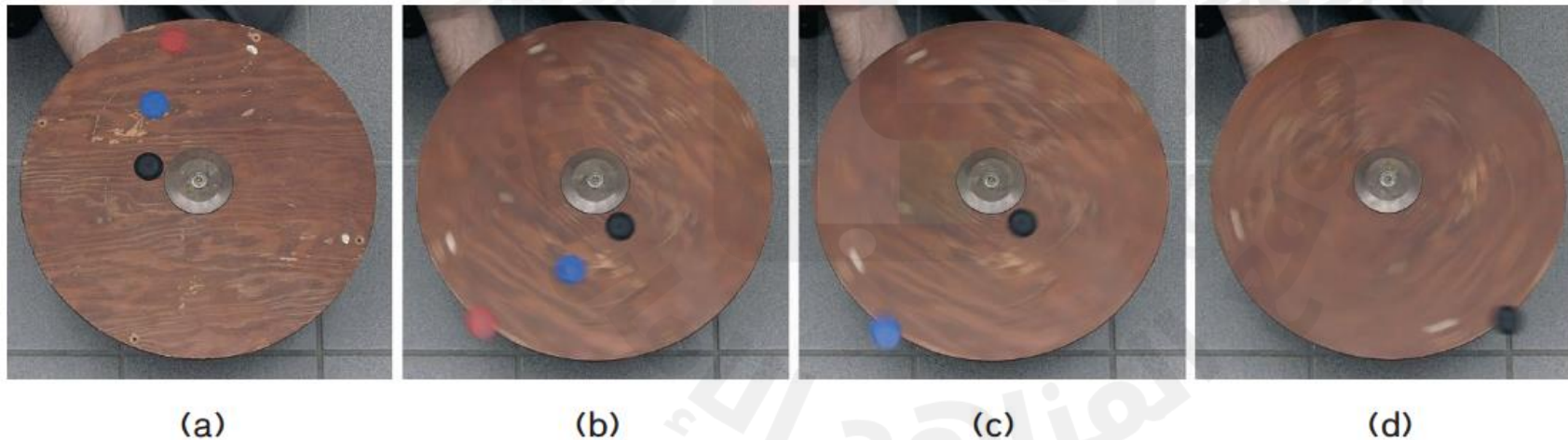
(a)

L.O: Identify the source of the centripetal force in different situations.

If we rotate the table slowly, as in part a, all three pieces will be in circular motion.

**** In your opinion, what is the force that provides the centripetal force for the three objects in this case?**

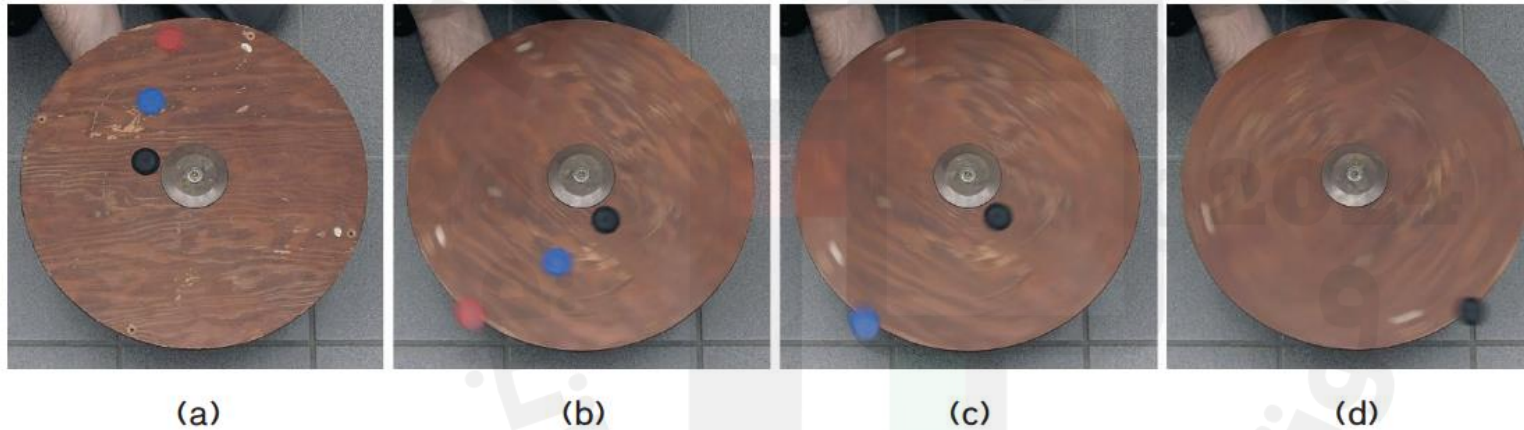
In this case, **the static frictional force** between the table and the pieces provides the centripetal force needed to keep the pieces in circular motion.



L.O: Identify the source of the centripetal force in different situations.

If the speed of the table's rotation is increased, what do you expect will happen to the three objects placed on it?

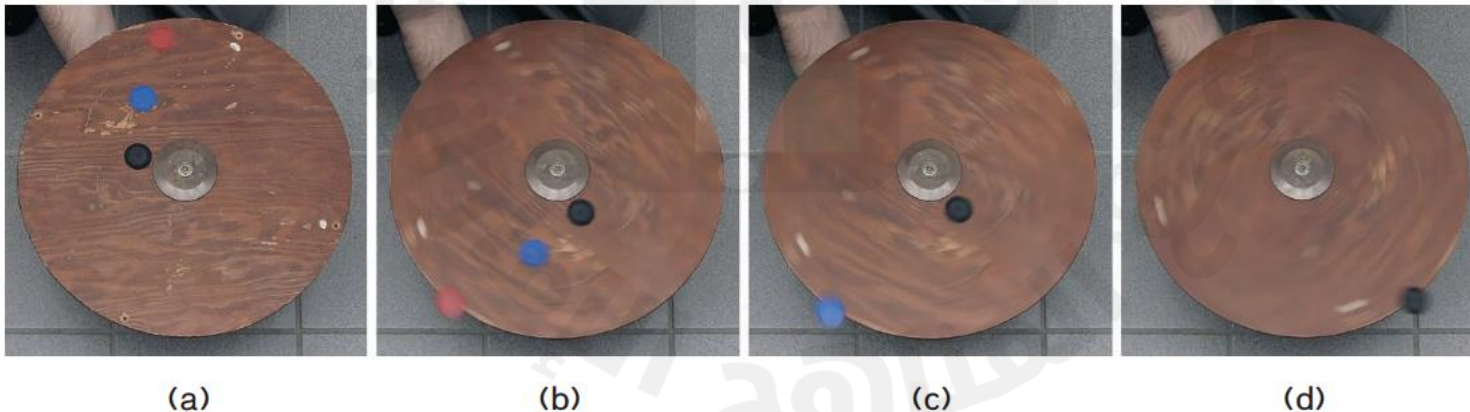
The objects will start to slide.



Why will the three objects start to slide despite the presence of static friction force?

L.O: Identify the source of the centripetal force in different situations.

- In figures b , c , and d the table rotates gradually faster.
- **Increasing speed** means **increasing the centripetal force** according to the equation:
$$F_c = mv\omega$$
- **The pieces slide** when **the frictional force is no longer strong enough to provide the necessary centripetal force.**



L.O: Identify the source of the centripetal force in different situations.

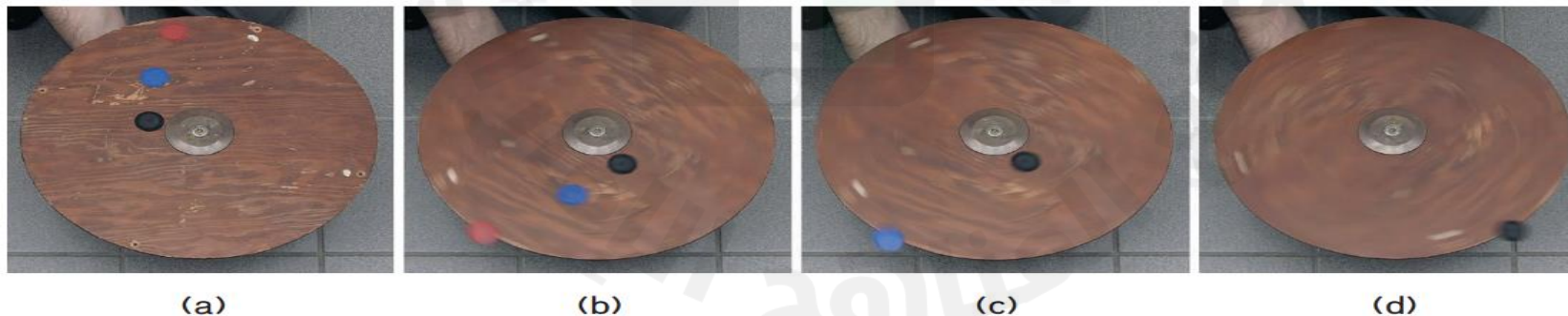
Which piece slides first?

- The outer piece slides in first and the inner piece slides in last.

Hint:

$$F_c = mr\omega^2$$

- For any given angular velocity, the centripetal force increases with distance from the center. $F_c = mr\omega^2$
- The angular velocity of all points on the rotating table surface is the same, because all points take the same amount of time to complete one rotation.

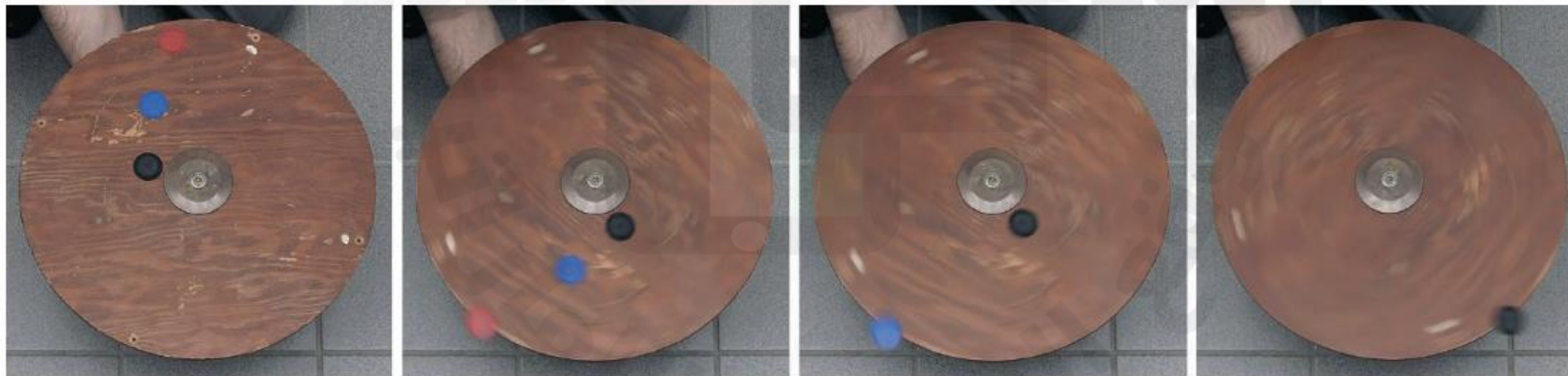


L.O: Identify the source of the centripetal force in different situations.

- So the centripetal force of the three pieces is directly proportional to their distance from the center, which explains why the red piece slides first and the black piece last.

$$F_c = m\omega^2 r$$

For greater distances from the center, the centripetal acceleration is higher, and so the force of friction becomes unable to hold the coin in place.



(a)

(b)

(c)

(d)

L.O: Identify the source of the centripetal force in different situations.

WS # 13:

The figure shows a top view of a rotating table with three identical pieces in all respects.

1) What is the source of the centripetal force that causes the three pieces to move in a circular motion when the table is rotated?

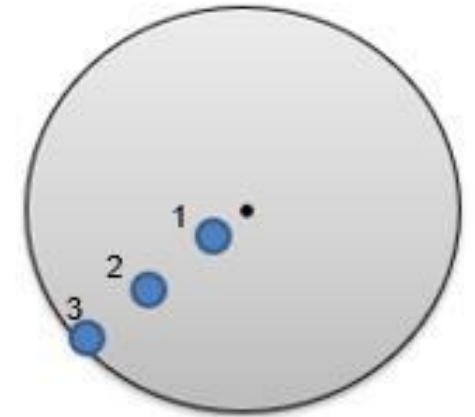
Static friction force between the table and the pieces.

2) If you increase the speed of rotating the table, what happens to the centripetal force?

Increasing speed means increasing the centripetal force according to the equation: $F_c = mv\omega$

3) In what condition do pieces slide off the turntable?

The pieces slide when the frictional force is no longer strong enough to provide the necessary centripetal force.



L.O: Identify the source of the centripetal force in different situations.

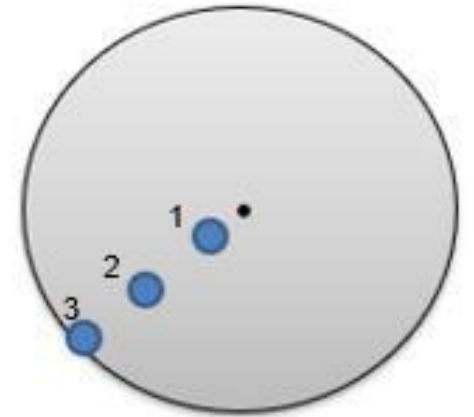
WS # 13:

4) Which piece slides first?

The outer piece slides in first and the inner piece slides in last.

5) For a given angular velocity, what happens to the centripetal force as the distance from the center increases?

Centripetal force increases with distance from the center. $F_c = m\omega^2 r$



L.O: Identify the source of the centripetal force in different situations.

WS#13

You are sitting on a carousel, which is in motion. Where should you sit so that the largest possible centripetal force is acting on you?

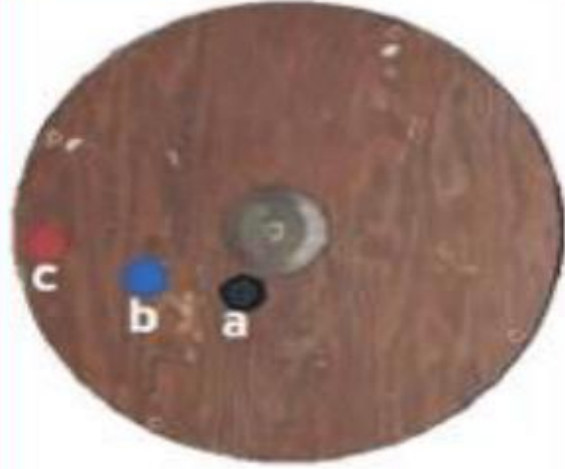
- a) close to the outer edge.
- b) close to the center.
- c) in the middle.
- d) The force is the same everywhere.

Answer:

a

L.O: Identify the source of the centripetal force in different situations.

WS#13



يوضح الشكل منظرًا علويًا لطاولة دوارة عليها ثلاث قطع ملونة متطابقة (a, b, c). إذا قمنا بتدوير الطاولة ببطء، أي من القوى التالية توفر قوة الجذب المركزية اللازمة لإبقاء القطع في حركة دائرية؟

The figure shows a top view of a spinning table with three identical colored markers (a, b, c) on it. If we spin the table slowly, which of the following forces provides the centripetal force required to keep the markers in circular motion?

قوة الاحتكاك السكوني/Static friction force

قوة الاحتكاك الحركي/Kinetic friction force

قوة الجاذبية/Gravitational force

قوة العمودية/Normal force

قوة الاحتكاك السكوني/Static friction force

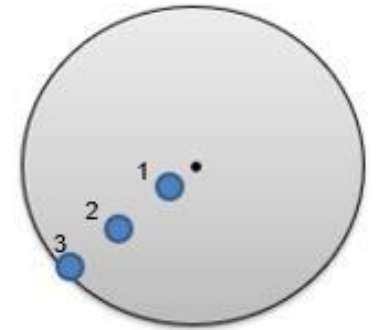
L.O: Identify the source of the centripetal force in different situations.

WS#13

**EXIT
CARD**

9.9 You put three identical coins on a turntable at different distances from the center and then turn the motor on. As the turntable speeds up, the outermost coin slides off first, followed by the one at the middle distance, and, finally, when the turntable is going the fastest, the innermost one. Why is this?

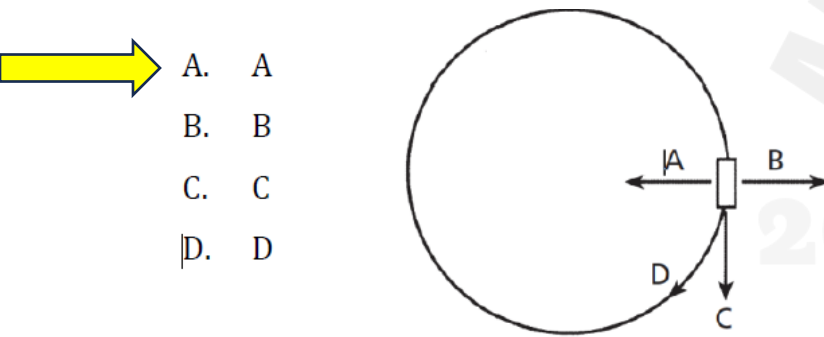
- ✓ a) For greater distances from the center, the centripetal acceleration is higher, and so the force of friction becomes unable to hold the coin in place.
- b) The weight of the coin causes the turntable to flex downward, so the coin nearest the edge falls off first.
- c) Because of the way the turntable is made, the coefficient of static friction decreases with distance from the center.
- d) For smaller distances from the center, the centripetal acceleration is higher.



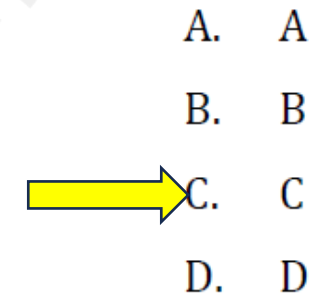
WS # 12: (Exercise 1)

In the diagram below, a cart travels clockwise at constant speed in a horizontal track.

At the position shown in the diagram, which arrow indicates the direction of the **centripetal acceleration** of the cart?



** At the position shown in the diagram, which arrow indicates the direction of the **tangential velocity** of the cart?



WS # 12: (Exercise 2)

* A carnival ride has a 3.0 m radius and rotates once 1.7 s.

What is the centripetal acceleration of the rider?

- A. 41 m/s² outwards
- B. 41 m/s² inwards
- C. 11 m/s² outwards
- D. 11 m/s² inwards

$$a_c = r\omega^2$$

$$a_c = 3 \times (3.7)^2 = 41.1 \text{ m/s}^2$$

$$\omega = \frac{\Delta\theta}{\Delta t} = \frac{2\pi}{1.7} = 3.7 \text{ rad/s}$$

** What is the speed of the rider?

- A. 9.4 m/s
- B. 3.4 m/s
- C. 5.0 m/s
- D. 11 m/s

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

$$41 = \frac{v^2}{3}$$

$$v = 11.1 \text{ m/s}$$

WS # 12: (Exercise 3)

An athlete performs a hammer throw as shown below. The mass of the hammer is 7.26 kg, its center is 0.50 m from the thrower, and it is moving at a speed of 1.5 m/s.

What is its centripetal acceleration?

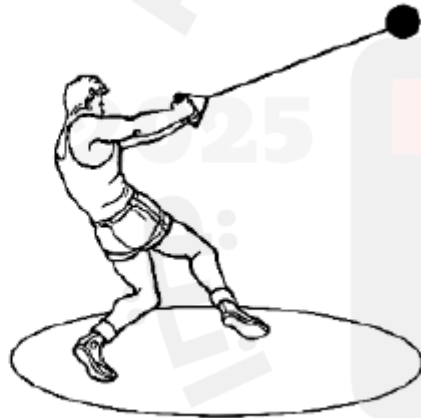
$a_c = ?$

A. 3.0 m/s²

→ B. 4.5 m/s²

C. 22 m/s²

D. 33 m/s²



What is the tension in the chain?

A. 3.0 N

B. 4.5 N

C. 22 N

→ D. 33 N

$$F_c = ma_c$$

$$F_c = 7.26 \times 4.5$$

$$F_c = 32.7 \text{ N}$$

$$a_c = \frac{v^2}{r} = \frac{1.5^2}{0.50} = 4.5 \text{ m/s}^2$$

WS # 14: (Exercise 4)

Centripetal Force The 40.0-g stone in Figure 12 is whirled horizontally at a speed of

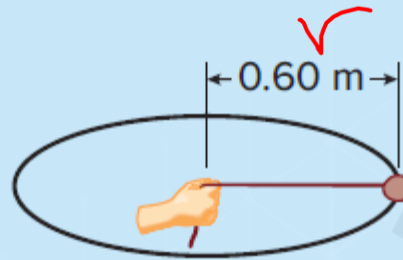


Figure 12

2.2 m/s. What is the tension in the string?

$$m = \frac{40}{1000} = 0.04 \text{ kg}$$

$$F_c = ma_c$$

$$F_c = 0.04 \times 8.07$$

$$F_c = 0.32 \text{ N}$$

$$a_c = \frac{v^2}{r} = \frac{(2.2)^2}{0.60} = 8.07 \text{ m/s}^2$$

L.O: Solve problems to calculate the centripetal acceleration and centripetal force in real-world examples.

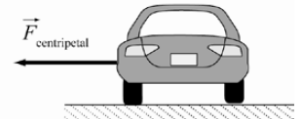
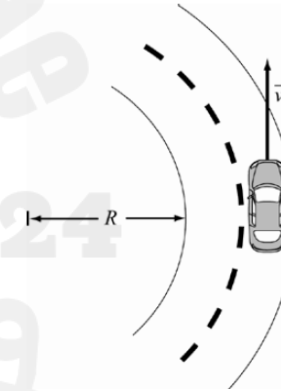
WS # 14: (Exercise 2)

$$F_c = ?$$

9.50 Calculate the centripetal force exerted on a vehicle of mass $m = 1500.$ kg that is moving at a speed of 15.0 m/s around a curve of radius $R = 400.$ m. Which force plays the role of the centripetal force in this case?

$$F_c = m \frac{v^2}{r}$$

$$= 1500 \times \frac{(15)^2}{400} = 843.75 \text{ N}$$



The force that keeps the vehicle from slipping out of the curve is the force of static friction.

WS # 14: (Exercise 3)



$$r = 0.42 \text{ m}$$

A dirham was placed at a distance of (42 cm) from the center of a circular disk rotating in a horizontal plane around an axis passing through its center. When the angular velocity of the disk became (3.7 rad/s), the dirham began to slide on the disk toward its center.

Calculate the coefficient of friction between the surface of the dirham and the surface of the disc.

$$\mu_s = ?$$

$$F_c = m r \omega^2$$

$$\mu_s = \frac{F_s}{F_N}$$

$$F_N = m g$$

$$\mu_s = \frac{m r \omega^2}{m g} = \frac{0.42 \times (3.7)^2}{9.81} = 0.586$$

Answer:
0.586

L.O: Solve problems to calculate the centripetal acceleration and centripetal force in real-world examples.

WS # 14: (Exercise 4)

A curve on a road for cars has a radius of 100 m, and the speed limit is 16 m/s. **What is the required coefficient of friction** between the car tires and the road for the car to safely negotiate the curve at the specified speed? $\mu_s = ?$

منحنى على شارع للسيارات نصف قطره 100 m والسرعة عليه محددة بمقدار 16 m/s.
ما مقدار معامل الاحتكاك بين إطارات السيارة و الشارع لكي تجتاز السيارة المنحنى بالسرعة المحددة؟

$$g = 9.81 \text{ m/s}^2$$

$$F_c = m \frac{v^2}{r}$$

$$F_g = mg$$

$$\mu_s = \frac{F_s}{F_N}$$

$$\mu_s = \frac{\cancel{m} \frac{v^2}{r}}{\cancel{m} g} = \frac{(16)^2}{100 \cdot 9.81} = 0.26$$



0.51

0.72

0.26

0.40

WS # 14: (Exercise 5)

Which of the following is the correct unit for $(mv\omega)$?

- ☒ N (Newtons)
- ☐ Hz (Hertz)
- ☐ m/s (meters per second)
- ☐ m/s² (meters per second squared)



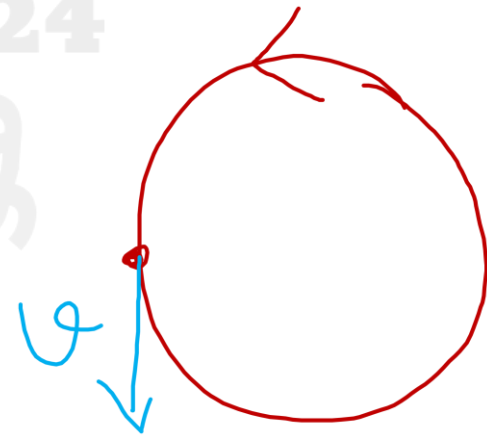
$$F_c = mv\omega$$

N ←

WS # 14: (Exercise 5)

9.1 An object is moving in a circular path. If the centripetal force is suddenly removed, how will the object move?

- a) It will move radially outward.
- b) It will move radially inward.
- c) It will move vertically downward.
- d) It will move in the **direction** in which its **velocity** vector points at the instant the centripetal force vanishes.



WS # 15:

10

Question

(1)

السؤال



تتحرك سيارة بسرعة ثابتة في اتجاه عقارب الساعة حول مسار دائري، نصف قطره 180 m على طريق أفقي كما هو موضح في المنظر العلوي المبين في الشكل. تكمل السيارة دورة واحدة خلال 75 s .

A car travels **clockwise** at **constant velocity** around a circular path of radius **180 m** on a horizontal road as shown in the top view Figure. The car completes **one turn** in **75 s** .

Draw arrows on the figure to show the following:

① حدد بأسمهم على الشكل كل من الآتي:

1] The direction of the car's velocity \vec{v} at a position (A).

1] اتجاه سرعة السيارة \vec{v} في الموقع (A).

2] The direction of the car's acceleration \vec{a} at position (B).

2] اتجاه عجلة (تسارع) السيارة \vec{a} في الموقع (B).

What is the magnitude of the tangential acceleration of the car? (Explain your answer)

② ما مقدار العجلة (التسارع) المماسية للسيارة؟ (فسر اجابتك)

$a_t = 0$ (The car travels at constant velocity).

Calculate the magnitude of the velocity \vec{v} of the car.

③ احسب مقدار سرعة السيارة \vec{v} .

$$\omega = \frac{\Delta\theta}{\Delta t} = \frac{2\pi}{75} = 0.084\text{ rad/s}$$

$$v = r\omega = 180 \times 0.084 = 15.12\text{ m/s}$$

Find the magnitude of the acceleration \vec{a} of the car.

④ اوجد مقدار عجلة السيارة \vec{a} .



Or any student write:

At Point (A) /direction of velocity: **East**.

At Point (B) /direction of the centripetal acceleration: **West**

This answer accepted.

$$a = \frac{v^2}{r} = \frac{(15.12)^2}{180} = 1.27\text{ m/s}^2$$

L.O: Solve problems to calculate the centripetal acceleration and centripetal force in real-world examples.

WS # 16:

Analysis of a Roller Coaster

One of the rides that might surprise you the most at an amusement park is on a roller coaster with a vertical loop in it (Figure 9.17), where passengers feel almost weightless at the top of the loop.

PROBLEM

Suppose the vertical loop has a radius of 5.00 m. What does the linear speed of the roller coaster have to be at the top of the loop for the passengers to feel **weightless**? (Assume that friction between roller coaster and rails can be neglected.)

SOLUTION

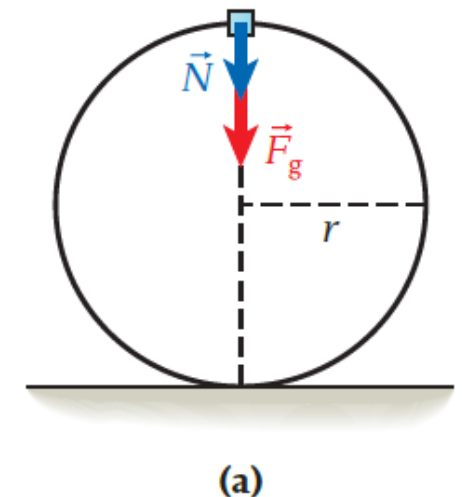
A person feels weightless when there is no supporting force, from a seat or a restraint, acting to counter his or her weight. For a person to feel weightless at the top of the loop, no normal force can be acting on him or her at this point.

centripetal force is equal to the net force (the sum of the normal force and the force of gravity):

$$\vec{F}_c = \vec{F}_{\text{net}} = \vec{F}_g + \vec{N}.$$



FIGURE 9.17 Modern roller coaster with a vertical loop.



WS # 16:

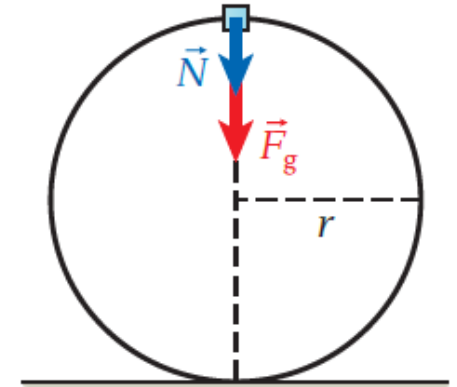
For the feeling of weightlessness at the top of the loop, we need $\vec{N} = 0$, and thus

$$\vec{F}_c = \vec{F}_g \Rightarrow F_c = F_g.$$

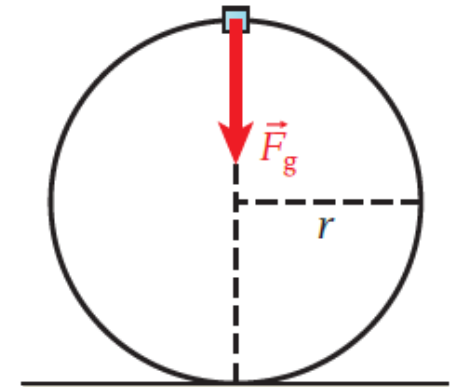
$$F_c = F_g \Rightarrow m \frac{v_{\text{top}}^2}{r} = mg \Rightarrow v_{\text{top}} = \sqrt{rg}.$$

$$v_{\text{top}} = \sqrt{(5.00 \text{ m})(9.81 \text{ m/s}^2)} = 7.00357 \text{ m/s}.$$

$$v_{\text{top}} = 7.00 \text{ m/s}.$$



(a)



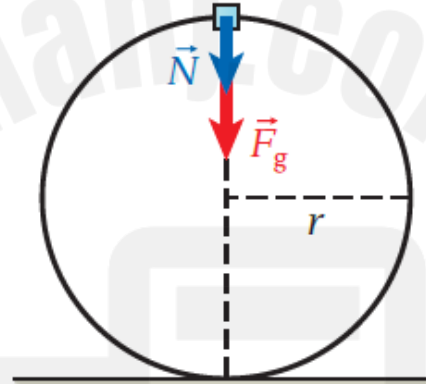
(b)

Analysis of a Roller Coaster

Concept Check 9.5

When you go through a vertical loop on a high-speed roller coaster, what keeps you in your seat?

- a) centrifugal force
- ✓ b) the normal force from the track
- c) the force of gravity
- d) the force of friction
- e) the force exerted by the seat belt



مراجعة المفاهيم 9.5

عندما تكون في حلقة رأسية في عربة أفروانية عالية السرعة، ما الذي يبقيك في مقعدك؟

- (a) القوة الطاردة المركزية
- (b) القوة المتعامدة المتولدة من المسار
- (c) قوة الجاذبية
- (d) قوة الاحتكاك
- (e) القوة التي يبذلها حزام الأمان

Page 269:**Concept Check 9.6**

At the top of a vertical loop in a roller coaster, what condition must be met for the car to stay on the track?

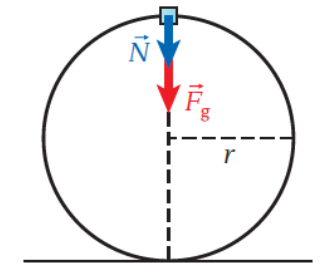
- a) The centrifugal force acting on the car must equal the centripetal force.
- b) The normal force exerted by the track on the car must be equal to the force of gravity.
- c) The normal force exerted by the track on the car must be in the direction opposite to the force of gravity.
- ✓ d) The centripetal force required to keep the car moving in a circle must be equal to or greater than the force of gravity.
- e) The normal force exerted by the track on the car must be zero.

$$\vec{F}_c = \vec{F}_{\text{net}} = \vec{F}_g + \vec{N}.$$

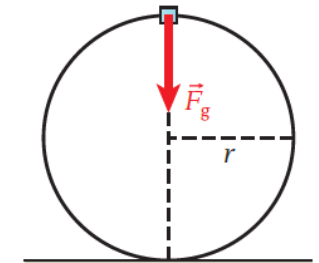
مراجعة المفاهيم 9.6

في أعلى الحلقة الرأسية للعبة الأفعوانية، ما الشرط الذي يجب تحقيقه كي تبقى العربة على المسار؟

- (a) يجب أن تكون القوة الطاردة المركزية المؤثرة في العربة مساوية للقوة المركزية.
- (b) يجب أن تكون القوة المتعامدة التي يبذلها المسار على العربة مساوية لقوة الجاذبية.
- (c) يجب أن تكون القوة المتعامدة التي يبذلها المسار على العربة في الاتجاه المقابل لقوة الجاذبية.
- (d) يجب أن تكون القوة المركزية المطلوبة للحفاظ على حركة العربة في دائرة مساوية لقوة الجاذبية أو أكبر منها.
- (e) يجب أن تكون القوة المتعامدة التي يبذلها المسار على العربة صفرًا.



(a)

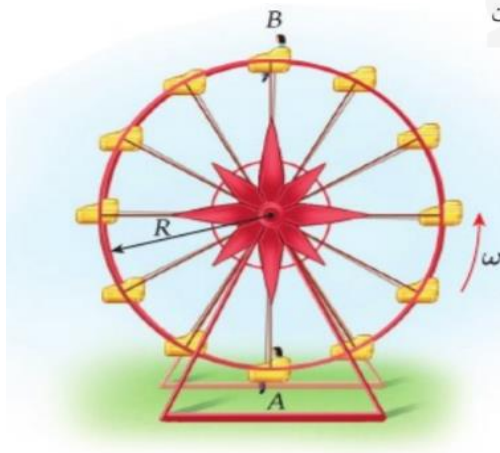


(b)

Page 278:

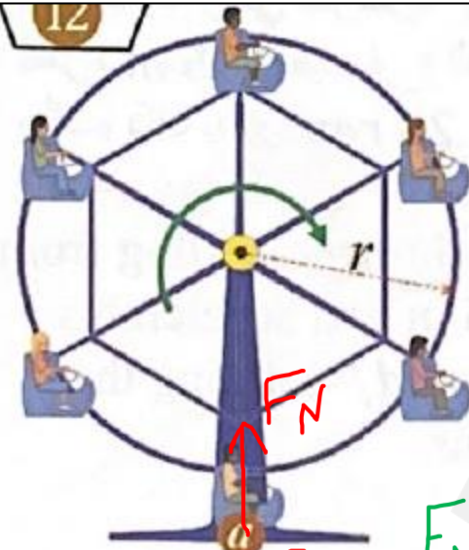
9.5 A Ferris wheel rotates slowly about a horizontal axis. Passengers sit on seats that remain horizontal on the Ferris wheel as it rotates. Which type of force provides the centripetal acceleration on the passengers when they are at the top of the Ferris wheel?

- a) centrifugal
- b) normal
- ✓ c) gravity
- d) tension



9.5 تدور العجلة الدوّارة ببطء حول محور أفقي. فإذا كان الركاب يجلسون على المقاعد التي تظل أفقية على العجلة الدوّارة أثناء دورانها، فما نوع القوة التي توفر العجلة المركزية للركاب عندما يكونون في أعلى العجلة الدوّارة؟

- (a) الطرد المركزي
- (b) المتعامدة
- (c) الجاذبية
- (d) الشدّ



يبين الشكل دولاب دوّار نصف قطره 10.0 m . يتحرك الدولاب في مسار دائري رأسي بسرعة ثابتة 3.00 m/s .

A Ferris wheel of radius 10.0 m is shown in the Figure. The Ferris wheel moves in a vertical circle at a constant speed of 3.00 m/s .

Calculate the normal force exerted by the seat on a 36.0 kg child at the bottom of the wheel at position a.

احسب القوة العمودية التي يؤثر بها المقعد على طفل كتلته 36.0 kg عند اخفض نقطة للدولاب عند الموقع a.

$$F_{\text{net}} = F_N - F_g = F_c$$

$$F_c = m \frac{v^2}{r}$$

$$= 36 \times \frac{(3)^2}{10} = 32.4\text{ N}$$

$$F_N = F_c + F_g$$

$$= 32.4 + (36 \times 9.81)$$

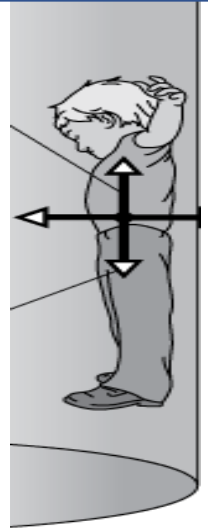
$$F_N = 385.6\text{ N}$$

SOLVED PROBLEM 9.2

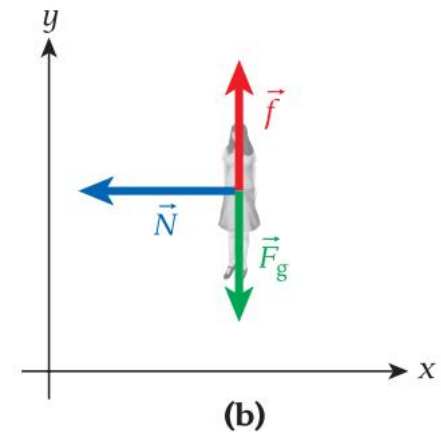
Carnival Ride

PROBLEM

One of the rides found at carnivals is a rotating cylinder. The riders step inside the vertical cylinder and stand with their backs against the curved wall. The cylinder spins very rapidly, and at some angular velocity, the floor is pulled away. The thrill-seekers now hang like flies on the wall. If the radius of the cylinder is $r = 2.10$ m, the rotation axis of the cylinder remains vertical, and the coefficient of static friction between the people and the wall is $\mu_s = 0.390$, what is the minimum angular velocity, ω , at which the floor can be withdrawn?



- ❖ At the **minimum angular velocity** required to prevent the rider from falling, the **magnitude of the static frictional force** between the rider and the wall is **equal** to the **magnitude of the force of gravity** acting on the rider.
- ❖ In the x-direction, the perpendicular force exerted by the wall on the rider **provides** the **centripetal force** that makes the rider move in a circle.
- ❖ In the y-direction, the **rider sticks** to the wall only if the **upward force of static friction** between the rider and the wall balances the **downward force of gravity**.



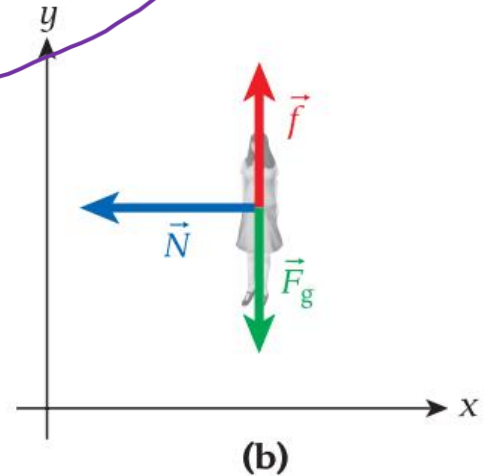
L.O: Solve problems to calculate the centripetal acceleration and centripetal force in real-world examples.

WS # 17:

$$F_c = mr\omega^2 \Rightarrow \omega = \sqrt{\frac{F_c}{mr}} = \sqrt{\frac{F_N}{mr}}$$

$$f_s = F_g$$
$$\mu_s F_N = mg \Rightarrow F_N = \frac{mg}{\mu_s}$$

$$\omega_{\min} = \sqrt{\frac{\cancel{m}g/\mu_s}{\cancel{m}r}} = \sqrt{\frac{g}{\mu_s r}}$$



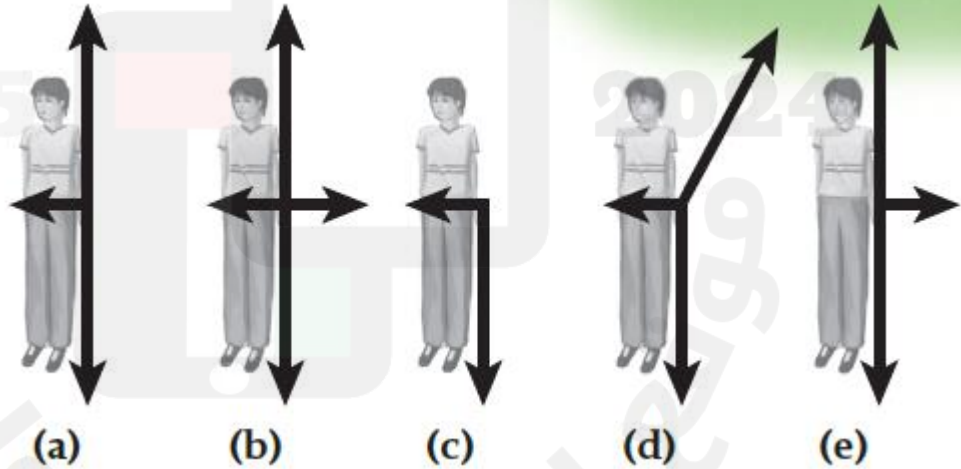
Thus, the minimum value of the angular velocity is given by

$$\omega_{\min} = \sqrt{\frac{g}{\mu_s r}}$$

9.11 The figure shows a rider stuck to the wall without touching the floor in the Barrel of Fun at a carnival. Which diagram correctly shows the forces acting on the rider?



9.11 يوضح الشكل راكبًا مستندًا إلى حائط لعبة ترفيهية في الملاهي دون أن يلمس الأرض. ما المخطط الذي يوضح القوى المؤثرة في الراكب بشكل صحيح؟



L.O: Solve problems to calculate the centripetal acceleration and centripetal force in real-world examples.

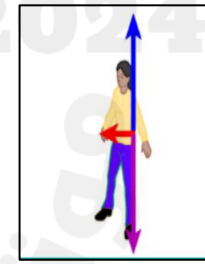
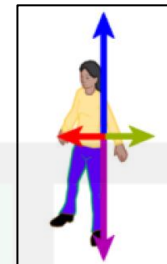
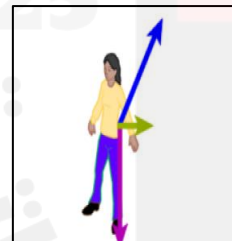
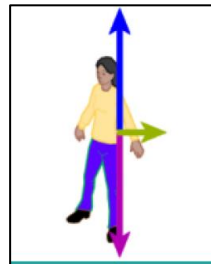
WS # 17:



يُظهر الشكل متسابقة تلتصق بجدار أسطوانة دوارة في إحدى حدائق الألعاب.
أي من المخططات الآتية يوضح بشكل **صحيح** القوى المؤثرة على المتسابقة؟

The figure shows a rider stuck to the wall without touching the floor in the barrel of fun at a carnival.
Which diagram **correctly** shows the forces acting on the rider?

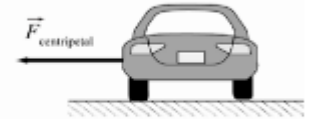
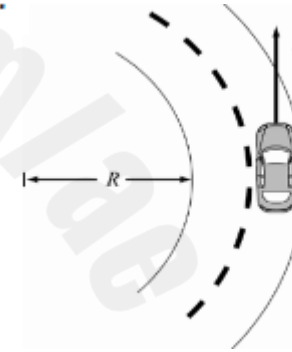
Circular Motion/Physics for Scientists & Engineers



WS # 17:

●9.54 A race car is making a U-turn at constant speed. The coefficient of friction between the tires and the track is $\mu_s = 1.20$. If the radius of the curve is 10.0 m, what is the maximum speed at which the car can turn without sliding? Assume that the car is undergoing uniform circular motion.

●9.54 تتحرك سيارة سباق عبر مسار منحنٍ بسرعة ثابتة. ومعامل الاحتكاك بين الإطارات والمضمار $\mu_s = 1.20$. إذا كان نصف قطر المنحنى 10.0 m، فما أقصى سرعة يمكن أن تنعطف بها السيارة دون أن تنزلق؟ افترض أن السيارة تسير بحركة دائرية منتظمة.



$$F_c = m \frac{v^2}{r}$$

$$F_s = \mu_s F_N = \mu_s mg$$

$$F_c = F_s$$

$$m \frac{v^2}{r} = \mu_s mg$$

$$\Rightarrow \frac{v^2}{10} = 1.20 \times 9.81 \Rightarrow v = 10.85 \text{ m/s}$$

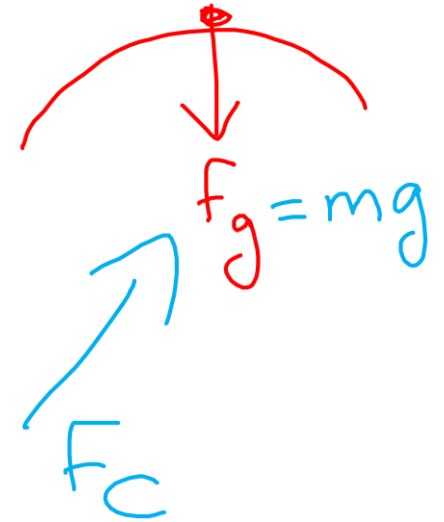
Answer:

10.85 m/s

WS # 17:

●9.55 A car speeds over the top of a hill. If the radius of curvature of the hill at the top is 9.00 m, how fast can the car be traveling and maintain constant contact with the ground?

9.55● تتحرك سيارة بسرعة فوق قمة أحد التلال. إذا كان نصف قطر انحناء قمة التل 9.00 m، فما السرعة التي يمكن أن تتحرك بها السيارة مع الحفاظ على ملامستها للأرض بصورة مستمرة؟



$$F_c = m \frac{v^2}{r}$$

$$\cancel{mg} = \cancel{m} \frac{v^2}{r}$$

$$\Rightarrow v = \sqrt{rg}$$

$$= \sqrt{9 \times 9.81}$$

$$= 9.4 \text{ m/s}$$

Answer:

$$v_{\text{max}} = 9.4 \text{ m/s}$$

عندما تتركب سيارة كمسافر وتدخل السيارة إلى منعطف،

أي الآتية الأكثر دقة لما سيحدث لك؟

When you travel in a car on a roundabout, **which of the following is most accurate?**

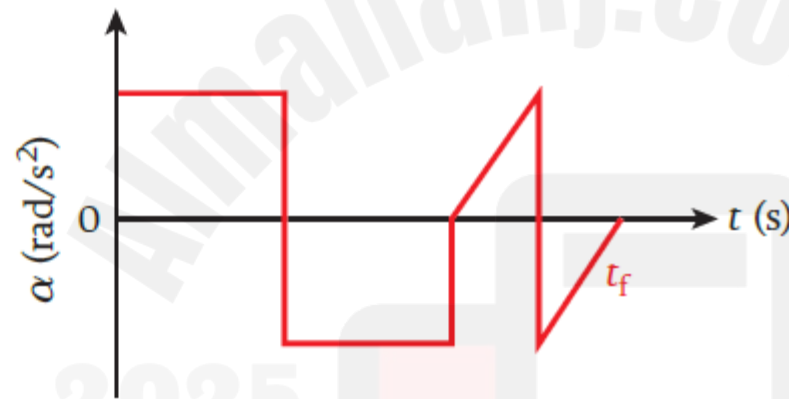


1. تستمر في الحركة في خط مستقيم.
You keep travelling in a straight line.
2. تؤثر أنت على باب السيارة بقوة احتكاك.
You exert frictional force on the car's door.
3. قوة الاحتكاك بينك وبين مقعد السيارة تدفعك باتجاه مركز الدوار .
The frictional force between you and the car seat pulls you toward the center of the roundabout.
4. تؤثر فيك قوة مركزية تدفعك باتجاه الخارج.
The central force pushes you in the outward direction.

Page 278:

9.2 The angular acceleration for an object undergoing circular motion is plotted versus time in the figure. If the object started from rest at $t = 0$, the net angular displacement of the object at $t = t_f$

- a) is in the clockwise direction.
- b) is in the counterclockwise direction.
- ✓ c) is zero.
- d) cannot be determined.



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9.7 A ball attached to the end of a string is swung around in a circular path of radius r . If the radius is doubled and the linear speed is kept constant, the centripetal acceleration

- a) remains the same.
- b) increases by a factor of 2.
- c) decreases by a factor of 2.
- d) increases by a factor of 4.
- e) decreases by a factor of 4.

9.7 تتأرجح كرة مربوطة في طرف خيط في مسار دائري نصف قطره r . فإذا تضاعف نصف القطر وظلت السرعة الخطية ثابتة، فإن العجلة المركزية

- (a) تظل كما هي.
- (b) تزيد بمقدار المثل.
- (c) تقل بمقدار النصف.
- (d) تزيد بمقدار 4 أمثال.
- (e) تقل بمقدار الربع.

Page 278:

9.8 The angular speed of the hour hand of a clock (in radians per second) is

a) $\frac{\pi}{21,600}$

c) $\frac{\pi}{3600}$

e) $\frac{\pi}{60}$

b) $\frac{\pi}{7200}$

d) $\frac{\pi}{1800}$

9.8 السرعة الزاوية لعقرب الساعة (بوحدة الراديان في الثانية)

$\frac{\pi}{60}$ (e)

$\frac{\pi}{3600}$ (c)

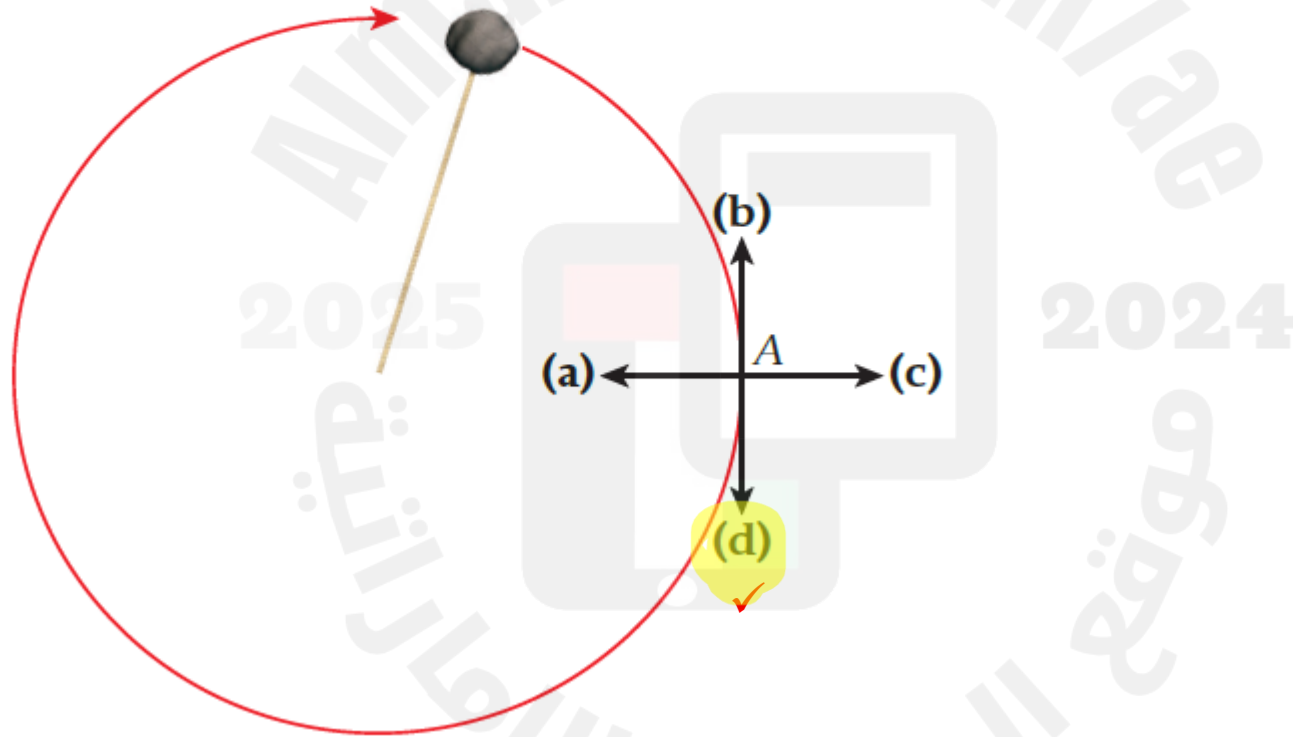
$\frac{\pi}{21,600}$ (a)

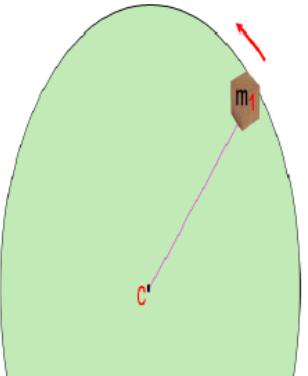
$\frac{\pi}{1800}$ (d)

$\frac{\pi}{7200}$ (b)

Page 278:

9.4 A rock attached to a string moves clockwise in uniform circular motion. In which direction from point A is the rock thrown off when the string is cut?





يوضح الشكل منظرًا علويًا لطاولة دائرية قطرها 2.4 m، وتدور بسرعة زاوية ثابتة، يستقر مكعب خشبي كتلته $m_1 = 0.75 \text{ kg}$ على الحافة الخارجية للطاولة، على أي بعد من مركز الدوران، يجب وضع مكعب خشبي ثانٍ كتلته $m_2 = 2.25 \text{ kg}$ بحيث قوة الجذب المركزية المؤثرة عليه تساوي قوة جذب المركزية المؤثرة على المكعب الأول m_1 ؟

The figure shows a top view of a circular table of diameter of 2.4 m spinning with constant angular velocity. A wooden cube of mass

a.

0.8 m

b.

0.4 m

c.

0.2 m

d.

1.0 m