

RECOMMENDED PROBLEMS

CHAPTER 6



GENERALPHYSICSA

Physics A – Serway

إعداد

أ. إسماعيل جهاد تايه

أ. أنس فضل الشافعي

معيدي قسم الفيزياء في الجامعة الإسلامية

- 1.** A light string can support a stationary hanging load of 25.0 kg before breaking. An object of mass $m = 3.00$ kg attached to the string rotates on a frictionless, horizontal table in a circle of radius $r = 0.800$ m, and the other end of the string is held fixed as in Figure P6.1. What range of speeds can the object have before the string breaks?

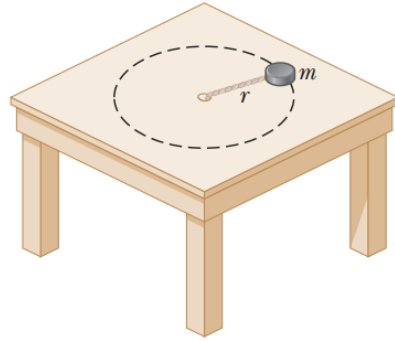


Figure P6.1

8. Consider a conical pendulum (Fig. P6.8) with a bob of mass $m = 80.0 \text{ kg}$ on a string of length $L = 10.0 \text{ m}$ that makes an angle of $\theta = 5.00^\circ$ with the vertical. Determine (a) the horizontal and vertical components of the force exerted by the string on the pendulum and (b) the radial acceleration of the bob.



Figure P6.8

9. A coin placed 30.0 cm from the center of a rotating, horizontal turntable slips when its speed is 50.0 cm/s. (a) What force causes the centripetal acceleration when the coin is stationary relative to the turntable? (b) What is the coefficient of static friction between coin and turntable?

10. Why is the following situation impossible? The object of mass $m = 4.00$ kg in Figure P6.10 is attached to a vertical rod by two strings of length $\ell = 2.00$ m. The strings are attached to the rod at points a distance $d = 3.00$ m apart. The object rotates in a horizontal circle at a constant speed of $v = 3.00$ m/s, and the strings remain taut. The rod rotates along with the object so that the strings do not wrap onto the rod. **What If?** Could this situation be possible on another planet?

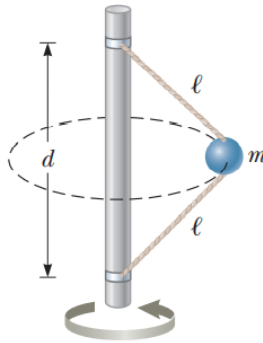


Figure P6.10

15. A child of mass m swings in a swing supported by two chains, each of length R . If the tension in each chain at the lowest point is T , find (a) the child's speed at the lowest point and (b) the force exerted by the seat on the child at the lowest point. (Ignore the mass of the seat.)

- 16.** A roller-coaster car (Fig. P6.16) has a mass of 500 kg when fully loaded with passengers. The path of the coaster from its initial point shown in the figure to point ② involves only up-and-down motion (as seen by the riders), with no motion to the left or right. (a) If the vehicle has a speed of 20.0 m/s at point ①, what is the force exerted by the track on the car at this point? (b) What is the maximum speed the vehicle can have at point ② and still remain on the track? Assume the roller-coaster tracks at points ① and ② are parts of vertical circles of radius $r_1 = 10.0$ m and $r_2 = 15.0$ m, respectively.

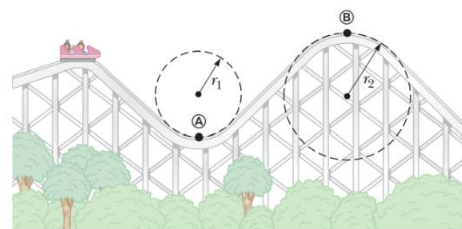


Figure P6.16 Problems 16 and 38.

17. A roller coaster at the Six Flags Great America amusement park in Gurnee, Illinois, incorporates some clever design technology and some basic physics. Each vertical loop, instead of being circular, is shaped like a teardrop (Fig. P6.17). The cars ride on the inside of the loop at the top, and the speeds are fast enough to ensure the cars remain on the track.



Figure P6.17

The biggest loop is 40.0 m high. Suppose the speed at the top of the loop is 13.0 m/s and the corresponding centripetal acceleration of the riders is $2g$. (a) What is the radius of the arc of the teardrop at the top? (b) If the total mass of a car plus the riders is M , what force does the rail exert on the car at the top? (c) Suppose the roller coaster had a circular loop of radius 20.0 m. If the cars have the same speed, 13.0 m/s at the top, what is the centripetal acceleration of the riders at the top? (d) Comment on the normal force at the top in the situation described in part (c) and on the advantages of having teardrop-shaped loops.

18. One end of a cord is fixed and a small 0.500-kg object is attached to the other end, where it swings in a section of a vertical circle of radius 2.00 m as shown in Figure P6.18. When $\theta = 20.0^\circ$, the speed of the object is 8.00 m/s. At this instant, find (a) the tension in the string, (b) the tangential and radial components of acceleration, and (c) the total acceleration. (d) Is your answer changed if the object is swinging down toward its lowest point instead of swinging up? (e) Explain your answer to part (d).

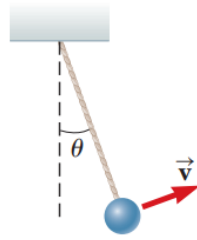


Figure P6.18

- 21.** An object of mass $m = 0.500$ kg is suspended from the ceiling of an accelerating truck as shown in Figure P6.21. Taking $a = 3.00$ m/s², find (a) the angle θ that the string makes with the vertical and (b) the tension T in the string.

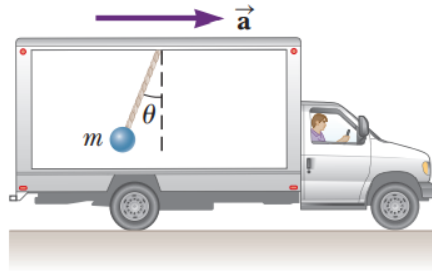
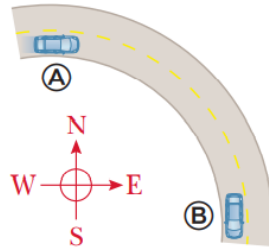


Figure P6.21

- 23.** A person stands on a scale in an elevator. As the elevator starts, the scale has a constant reading of 591 N. As the elevator later stops, the scale reading is 391 N. Assuming the magnitude of the acceleration is the same during starting and stopping, determine (a) the weight of the person, (b) the person's mass, and (c) the acceleration of the elevator.

M

37. A car travels clockwise at constant speed around a circular section of a horizontal road as shown in the aerial view of Figure P6.37. Find the directions of its velocity and acceleration at (a) position ① and (b) position ②.



39. A string under a tension of 50.0 N is used to whirl a rock in a horizontal circle of radius 2.50 m at a speed of 20.4 m/s on a frictionless surface as shown in Figure P6.39. As the string is pulled in, the speed of the rock increases. When the string on the table is 1.00 m long and the speed of the rock is 51.0 m/s, the string breaks. What is the breaking strength, in newtons, of the string?

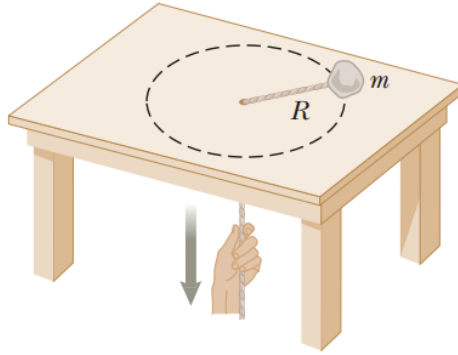


Figure P6.39

40. Disturbed by speeding cars outside his workplace, Nobel laureate Arthur Holly Compton designed a speed bump (called the “Holly hump”) and had it installed. Suppose a 1 800-kg car passes over a hump in a roadway that follows the arc of a circle of radius 20.4 m as shown in Figure P6.40. (a) If the car travels at 30.0 km/h, what force does the road exert on the car as the car passes the highest point of the hump? (b) **What If?** What is the maximum speed the car can have without losing contact with the road as it passes this highest point?

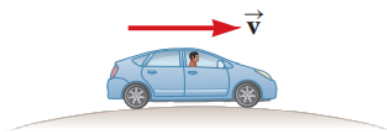


Figure P6.40
Problems 40 and 41.

- 42.** A child's toy consists of a small wedge that has an acute angle θ (Fig. P6.42). The sloping side of the wedge is frictionless, and an object of mass m on it remains at constant height if the wedge is spun at a certain constant speed. The wedge is spun by rotating, as an axis, a vertical rod that is firmly attached to the wedge at the bottom end. Show that, when the object sits at rest at a point at distance L up along the wedge, the speed of the object must be $v = (gL \sin \theta)^{1/2}$.

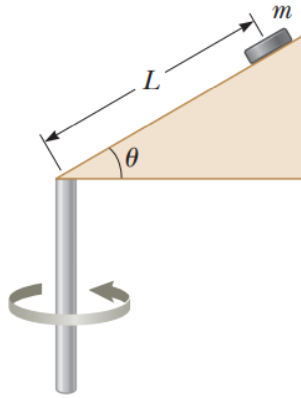


Figure P6.42

45. A ball of mass $m = 0.275$ kg swings in a vertical circular path on a string $L = 0.850$ m long as in Figure P6.45. (a) What are the forces acting on the ball at any point on the path? (b) Draw force diagrams for the ball when it is at the bottom of the circle and when it is at the top. (c) If its speed is 5.20 m/s at the top of the circle, what is the tension in the string there? (d) If the string breaks when its tension exceeds 22.5 N, what is the maximum speed the ball can have at the bottom before that happens?

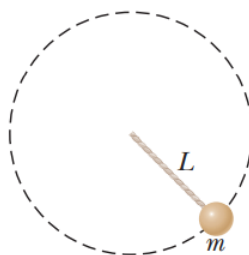


Figure P6.45

54. A puck of mass m_1 is tied to a string and allowed to revolve in a circle of radius R on a frictionless, horizontal table. The other end of the string passes through a small hole in the center of the table, and an object of mass m_2 is tied to it (Fig. P6.54). The suspended object

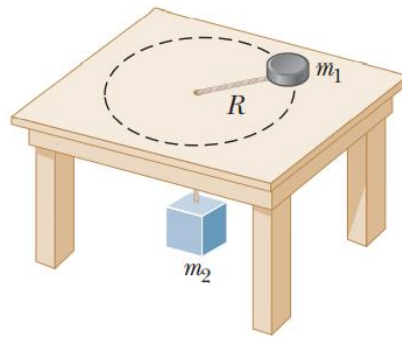


Figure P6.54

remains in equilibrium while the puck on the tabletop revolves. Find symbolic expressions for (a) the tension in the string, (b) the radial force acting on the puck, and (c) the speed of the puck. (d) Qualitatively describe what will happen in the motion of the puck if the value of m_2 is increased by placing a small additional load on the puck. (e) Qualitatively describe what will happen in the motion of the puck if the value of m_2 is instead decreased by removing a part of the hanging load.

57. Figure P6.57 shows
AMT a photo of a swing
W ride at an amusement
 park. The structure
 consists of a horizontal,
 rotating, circular
 platform of diameter
 D from which seats
 of mass m are sus-
 pended at the end
 of massless chains
 of length d . When
 the system rotates at

Stuart Gregory/Getty Images



Figure P6.57

constant speed, the chains swing outward and make an angle θ with the vertical. Consider such a ride with the following parameters: $D = 8.00$ m, $d = 2.50$ m, $m = 10.0$ kg, and $\theta = 28.0^\circ$. (a) What is the speed of each seat? (b) Draw a diagram of forces acting on the combination of a seat and a 40.0-kg child and (c) find the tension in the chain.

- 59.** An amusement park ride consists of a large vertical cylinder that spins about its axis fast enough that any person inside is held up against the wall when the floor drops away (Fig. P6.59). The coefficient of static friction between person and wall is μ_s , and the radius of the cylinder is R . (a) Show that the maximum period of revolution necessary to keep the person from falling is $T = (4\pi^2 R \mu_s / g)^{1/2}$. (b) If the rate of revolution of the cylinder is made to be somewhat larger, what happens to the magnitude of each one of the forces acting on the person? What happens in the motion of the person? (c) If the rate of revolution of the cylinder is instead made to be somewhat smaller, what happens to the magnitude of each one of the forces acting on the person? How does the motion of the person change?

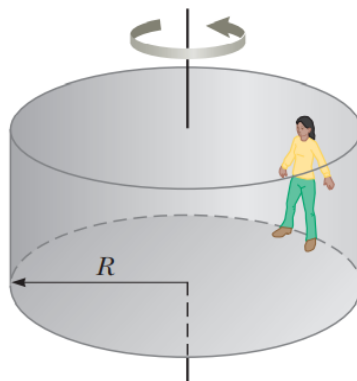


Figure P6.59

- 61.** A car rounds a banked curve as discussed in Example 6.4 and shown in Figure 6.5. The radius of curvature of the road is R , the banking angle is θ , and the coefficient of static friction is μ_s . (a) Determine the range of speeds the car can have without slipping up or down the road. (b) Find the minimum value for μ_s such that the minimum speed is zero.

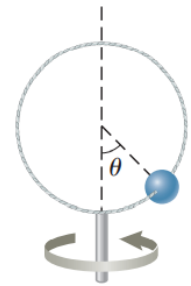


Figure P6.68

- 68.** A single bead can slide with negligible friction on a stiff wire that has been bent into a circular loop of radius 15.0 cm as shown in Figure P6.68. The circle is always in a vertical plane and rotates steadily about its vertical diameter with a period of 0.450 s. The position of the bead is described by the angle θ that the radial line, from the center of the loop to the bead, makes with the vertical. (a) At what angle up from the bottom of the circle can the bead stay motionless relative to the turning circle? (b) **What If?** Repeat the problem, this time taking the period of the circle's rotation as 0.850 s. (c) Describe how the solution to part (b) is different from the solution to part (a). (d) For any period or loop size, is there always an angle at which the bead can stand still relative to the loop? (e) Are there ever more than two angles? Arnold Arons suggested the idea for this problem.

Solution of recommended ques of chapter 6

Circular motion

١. أليس إقتناض
٢. أليس صواباً

- II A light string can support a stationary hanging load of 25 kg before breaking. An object of mass $m = 3$ kg attached to the string rotates on a frictionless, horizontal table in a circle of radius $r = 0.8$ m, and the other end of the string is held fixed. What range of speeds can the object have before the string breaks?

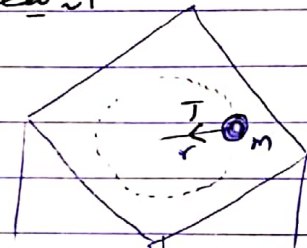
ما هو مدى السرعات التي يتحرك بها الجسم الذي يدور قبل أن ينقطع الحبل؟

$$\Sigma F_c = \frac{mv^2}{r}$$

القوة المركزية التي تتحكم به

هي قوة الشد فقط

$$T = \frac{mv^2}{r}$$



$$v^2 = \frac{rT}{m} \Rightarrow v = \sqrt{\frac{rT}{m}}$$

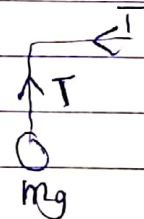
أما عند تحريك الحبل بأيدي الفيزياء فخاصة بالكتلة

$$T_{max} = mg = 25 \times 9.8 = 245 \text{ N}$$

$$v \leq \sqrt{\frac{r T_{max}}{m}}$$

$$v \leq \sqrt{\frac{0.8 \times 245}{3}} \leq 8.08 \text{ m/s}$$

$$0 \leq v \leq 8.08 \text{ m/s}$$



8) Consider a conical pendulum with a bob of mass $m = 80 \text{ kg}$ on a string of length $L = 10 \text{ m}$ that makes an angle of $\theta = 5^\circ$ with the vertical. Determine

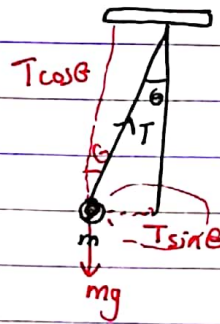
(a) the horizontal and vertical components of the force exerted by the string on the pendulum.
 مركبات القوة الشد في الليف.

$$\mathbf{F} = F_x \mathbf{i} + F_y \mathbf{j}$$

$$\sum F_y = m a_y = 0$$

$$mg - T \cos \theta = 0$$

$$T \cos \theta = mg$$



$$T = \frac{mg}{\cos \theta} = \frac{80 \times 9.8}{\cos 5} = 787 \text{ N}$$

$$F_x = T \sin \theta = 787 \times \sin 5 = 68.6 \text{ N}$$

$$F_y = T \cos \theta = 787 \times \cos 5 = 784 \text{ N}$$

$$\mathbf{T} = (68.6 \mathbf{i} + 784 \mathbf{j}) \text{ N}$$

#

(b) the radial acceleration of the bob.

$$\sum F_x = m a_c$$

$$T \sin \theta = m a_c \Rightarrow a_c = \frac{T \sin \theta}{m} = \frac{787 \times \sin 5}{80}$$

تسارع الجاذبية

$$a_c = 0.85 \text{ m/s}^2$$

toward to the center.

9] A coin placed 30 cm from the center of rotating horizontal turntable slips when its speed is 50 cm/s.

(a) What forces causes the centripetal acceleration when the coin is stationary relative to the turntable?

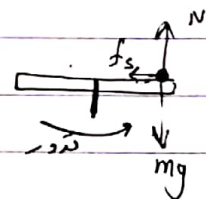
static force هي القوة التي تدير
انزلاقه للداخلية
السرعة الدورانية



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

$$\sum F_y = 0$$

$$N - mg = 0 \Rightarrow \boxed{N = mg}$$



$$\sum F_x = \frac{mv^2}{r} \Rightarrow f_s = \frac{mv^2}{r}$$

$$\mu_s * N = \frac{mv^2}{r} \Rightarrow \mu_s * mg = \frac{mv^2}{r}$$

$$\mu_s = \frac{v^2}{gr} = \frac{(50)^2}{980 * 30} = 0.08$$

(50) ←

هل يتحرك النظام حركة دورانية منتظمة .

10 Why is the following situation impossible? The object of mass $m = 4 \text{ kg}$ is attached to a vertical rod by two strings of length $L = 2 \text{ m}$. The strings are attached to the rod at points a distance $d = 3 \text{ m}$ apart. The object rotates in a horizontal circle at a constant speed of $v = 3 \text{ m/s}$ and the strings remain taut. The rod rotates along with the object so that the strings do not wrap onto the rod. What if? could this situation be possible on another planet?

$$mg = 4 \times 9.8 = 39.2 \text{ N}$$

المرة θ عند الجدار $\sin \theta$

$$\theta = \sin^{-1}\left(\frac{1.5}{2}\right) = 48.5^\circ$$

نصف القطر $r = 2 \times \cos 48.5 = 1.3 \text{ m}$

$$\sum F_c = \frac{mv^2}{r}$$

$$T_a \cos 48.5 + T_b \cos 48.5 = \frac{mv^2}{r}$$

$$T_a + T_b = \frac{4 \times (3)^2}{1.3 \times \cos 48.5} = 41.2 \text{ N}$$

$$\sum F_y = 0$$

$$T_a \sin 48.5 - mg - T_b \sin 48.5 = 0$$

$$T_a - T_b = \frac{39.2}{\sin 48.5} = 52.3 \text{ N}$$

$$T_a - T_b = 52.3 \quad (1)$$

$$T_a + T_b = 41.2 \quad (2)$$

$$T_a = \frac{93.8}{2} = 46.9 \text{ N}$$

$$T_b = -5.7 \text{ N}$$

(4)

تقريباً في هذه الحالة

طالما أن التفسير السليم فيزيائياً ومنه معاد الكلام أن السرعة صغيرة
مما يجعل الجيب يقرب من صفر (نقطة) - في هذه الحالة لن نأخذ بعين الاعتبار
السرعة (نقطة) - في هذه الحالة لن نأخذ بعين الاعتبار

$$\sum F_y = 0 \Rightarrow T_1 \sin \theta + T_2 \sin \theta + mg = 0$$

$$T_1 - T_2 = \frac{mg}{\sin 48.5} = \frac{41g}{\sin 48.5} = 5.34g \text{ N}$$

$$T_1 - T_2 = 5.34g \quad (1)^*$$

$$T_1 + T_2 = 41.2 \text{ N}$$

$$2T_1 = 41.2 + 5.34g$$

$$T_1 = \frac{41.2}{2} + \frac{5.34}{2}g$$

$$T_1 = 20.6 + 2.67g$$

$$T_2 = 41.2 - T_1$$

$$= 41.2 - (20.6 + 2.67g)$$

$$T_2 = 20.6 - 2.67g$$

وهذا يعني الجيب متروكاً لأنه أنه لن يكون $T_2 > 0$

$$20.6 - 2.67g > 0$$

$$\frac{20.6}{2.67} = \frac{2.67g}{2.67}$$

$$g = 7.7 \text{ m/s}^2$$

وهذه القيمة أكبر من الحد الأقصى

$$(5) \quad \mu = \mu_{\text{الحد الأقصى}} = 0.15$$

11) A crate of eggs is located in the middle of the flatbed of a pickup truck as the truck negotiates a curve in the flat road. The curve may be regarded as an arc of a circle of radius 35 m. If the coefficient of static friction between crate and truck is 0.6, how fast can the truck be moving without the crate sliding?

$$r = 35 \text{ m}, \quad \mu_s = 0.6$$

$$\sum F_x = ma_c$$

$$f_s = \frac{mv^2}{r}$$

$$\mu_s * N = \frac{mv^2}{r} \Rightarrow \mu_s N \leq \frac{mv^2}{r}$$

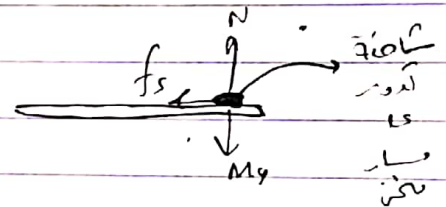
$$\mu_s * mg \leq \frac{mv^2}{r}$$

the maximum speed ... is

$$v \leq \sqrt{\mu_s * g * r} = \sqrt{0.6 * 9.8 * 35} = 14.3 \text{ m/s}$$

$$v \leq 14.3 \text{ m/s}$$

#



$$\sum F_y = 0$$

$$N = mg$$

- 15 A child of mass m swings in a swing supported by two chains, each of length R . If the tension in each chain at the lowest point is T , Find

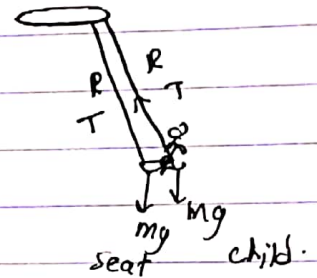
(a) the child's speed at the lowest point.

$$\Sigma F = \frac{mv^2}{r}$$

$$2T - (mg_{\text{child}} + mg_{\text{seat}}) = \frac{mv^2}{R}$$

$$v^2 = (2T - Mg) \frac{R}{M}$$

$$v = \sqrt{(2T - Mg) \frac{R}{M}}$$



(b) the force exerted by the seat on the child at the lowest point. (ignore the mass of seat).

القوة التي يمارسها

(ن) القوة التي يمارسها الطفل على الكرسي.

$$\Sigma F = \frac{mv^2}{R} \Rightarrow N - mg = \frac{mv^2}{R}$$

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

- 16) A roller-coaster car has a mass of 500 kg when fully loaded with passengers. The path of the coaster from its initial point shown to point (B) involves only up and down motion (as seen by riders), with no motion to the left or right.

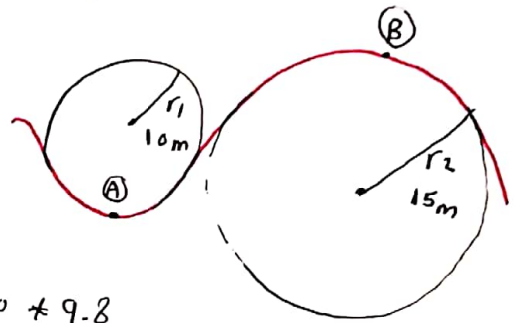
a) If the vehicle has a speed of 20 m/s at point (A) what is the force exerted by the track on the car at this point?

$$\Sigma F = \frac{mv^2}{r}$$

$$N - mg = \frac{mv^2}{r} \Rightarrow N = \frac{mv^2}{r} + mg$$

$$= \frac{500 \times (20)^2}{10} + 500 \times 9.8$$

$$\boxed{N = 24900 \text{ N}}$$



b) What is the maximum speed the vehicle can have at point (B) and still remain on the track?

$$\Sigma F = \frac{mv^2}{r}$$

$$mg - N = \frac{mv^2}{r}$$

$$N = \frac{mv^2}{r} - mg$$

$$N > 0$$

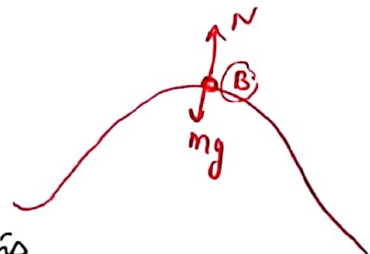
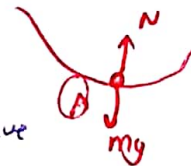
$$\frac{mv^2}{r} - mg \geq 0$$

$$m\left(\frac{v^2}{r} - g\right) \geq 0$$

$$\frac{v^2}{r} - g = 0$$

$$\frac{v^2}{r} = g \Rightarrow v^2 = rg \Rightarrow$$

$$v = \sqrt{rg} = \sqrt{r_2 g} = \sqrt{15 \times 9.8} = 12.1 \text{ m/s}$$

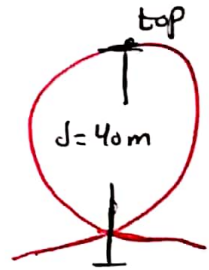


من يتبع الجسم على سطح
لاية انه تكون قوة السحب
السرعة < 0
 $\boxed{N \geq 0}$
 $\downarrow$
 $n = 0$
أقصى سرعة

(17)

 v at the top = 13 m/s

$a_c = 2g$



a) What is the radius of the arc of teardrop at the top?
 $r = ?$

$$a_c = \frac{v^2}{r} \Rightarrow r = \frac{v^2}{a_c} = \frac{13^2}{2g} = \frac{13^2}{2 \times 9.8} = 8.6 \text{ m}$$

b) If the total mass of a car plus the riders is M , what Force does the rail exert on the car at the top?

$$\Sigma F = \frac{mv^2}{r}$$

إدفع القوة التي ينشأها الكوكب على السكة الحديدية
 عليها؟ N ؟

$$Mg + N = \frac{mv^2}{r} \Rightarrow N = \frac{Mv^2}{r} - Mg$$

$$= Ma_c - Mg$$

$$N = M(2g) - Mg = Mg$$



downward

c) Suppose the roller coaster had a circular loop of radius 20 m. If the cars have the same speed 13 m/s at the top. What is the centripetal acceleration of the riders at the top?

$$a_c = \frac{v^2}{r} = \frac{13^2}{20} = 8.45 \text{ m/s}^2$$

d) Comment on the normal force at the top in situation described in part c and on the advantages of having teardrop-shaped loops.

لوجود حزام الأمان (belts) لرباس سيطر الكراب لذلك هذه قوة التماس، التمرير، التماس، الأرض،
 الشكل، إلكترونية، ياعد في تقليل نقص الضغط سبباً زيادة في تسارع المركزي.
 ولكنه عندما يرتفع الجسم (السائق) تقل سرعة ذلك بفعل الجاذبية، لا ضحية.
 فإذا زاد التسارع المركزي تزداد قوة التماس، بعددية التي (تجاهها) الأرض، وبالتالي
 لا بد من ربط حزام الأمان لنقل خطر القوة نحو الأرض.

(9)

- 18 One end of a cord is fixed and a small 0.5 kg object is attached to the other end, where it swings in a section of a vertical circle of radius 2 m, as shown, when $\theta = 20^\circ$ the speed of the object is 8 m/s. At this instant, find (a) the tension in the string

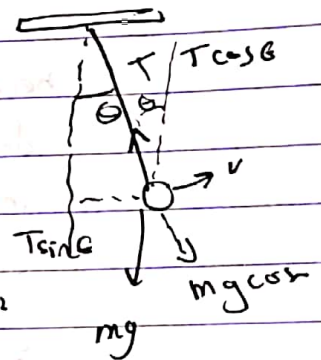
For radial forces.

$$\Sigma F_r = \frac{mv^2}{r}$$

$$T - mg \cos \theta = \frac{mv^2}{r}$$

$$T = mg \cos \theta + \frac{mv^2}{r} = 0.5 \times 9.8 \cos 20^\circ + \frac{0.5 \times 8^2}{2}$$

$$T = 20.6 \text{ N}$$



- (b) the tangential and radial component of acceleration a_r, a_t

$$a_r = \frac{v^2}{r} = \frac{8^2}{2} = 32 \text{ m/s}^2$$

$$a_t \Rightarrow \Sigma F_t = ma_t$$

$$mg \sin \theta = m a_t$$

$$a_t = g \sin \theta = 9.8 \times \sin 20^\circ$$

$$= 3.35 \text{ m/s}^2 \quad \text{downward}$$

$$\vec{a} = a_r \hat{r} + a_t \hat{\theta}$$

$$= (32 \hat{r} + 3.35 \hat{\theta}) \text{ m/s}^2$$

- (c) the total acceleration

$$a = \sqrt{a_r^2 + a_t^2} = \sqrt{32^2 + 3.35^2} = 32.2 \text{ m/s}^2$$

(10)

(19) عالم آثار مغامر. نزي طرازانه. (طفل الأرمال). An adventurous archaeologist ($m = 85 \text{ kg}$) tries to cross a river by swinging from a vine. The vine is 10 m long, and his speed at the bottom of the swing is 8 m/s . The archaeologist doesn't know that the vine has a breaking strength of 1000 N . Does he make it across the river without falling in?

هل السرعة التي تحرك بها عالم الآثار على نوص النهر كافية دونه انه ينقطع الحبل فيه؟

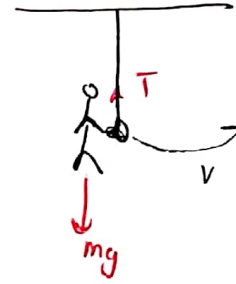
$$\Sigma F = \frac{mv^2}{r}$$

$$T - mg = \frac{mv^2}{r} \Rightarrow T = \frac{mv^2}{r} + mg$$

$$= \frac{85 \times 8^2}{10} + 85 \times 9.8$$

$$T = 1377 > 1000 \text{ N}$$

هو للأسف ينقطع به الحبل ويَسْطَل في البركة (النهر).



تخلوا ان
استل الحبل
ويستطعن فيه
هههه.

- 21) An objective of mass $m = 0.5 \text{ kg}$ is suspended from the ceiling of an accelerating truck as shown, Taking $a = 3 \text{ m/s}^2$, Find.
- a) the angle θ that the string makes with the vertical

$$\sum F_x = ma_x \quad \text{هذا هو القوة باتجاه اليمين}$$

$$T \sin \theta = ma \rightarrow (1)$$

$$\sum F_y = 0$$

$$T \cos \theta - mg = 0 \quad \text{لا يوجد حركة في الاتجاه العمودي}$$

$$T \cos \theta = mg \rightarrow (2)$$

$$\frac{(1)}{(2)} \quad \text{نقسم}$$

$$\frac{T \sin \theta}{T \cos \theta} = \frac{ma}{mg}$$

$$\tan \theta = \frac{a}{g} \Rightarrow \theta = \tan^{-1} \left(\frac{a}{g} \right) = \tan^{-1} \left(\frac{3}{9.8} \right) = \underline{\underline{17^\circ}}$$

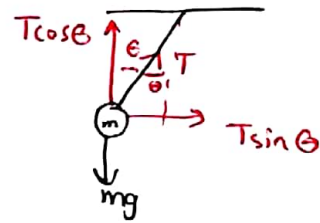
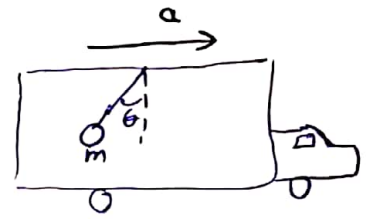
- b) the tension T in the string.

نخضع (1) ضلأ

$$T \sin \theta = ma$$

$$T = \frac{ma}{\sin \theta} = \frac{0.5 \times 3}{\sin 17} = \underline{\underline{5.1 \text{ N}}}$$

P. أن فنزل الشايف
P. أن فنزل الشايف



23) A person stands on a scale in an elevator. As the elevator starts, the scale has a constant reading of 591 N. As the elevator later stops, the scale reading is 391 N. Assuming the magnitude of the acceleration is the same during starting and stopping, determine.

a) the weight of the person.

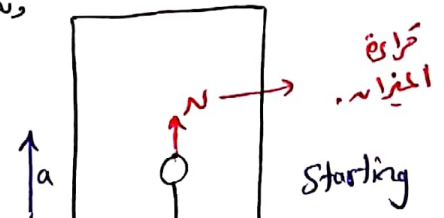
عندما يبدأ المصعد الحركة فإنه يوجد تسارع.
وتكون قسمة قوة التماس أكبر مما تكون عندما يكون المصعد ساكناً.

$$\Sigma F_y = ma$$

$$N - mg = ma$$

$$591 - mg = ma \quad \Rightarrow (1)$$

عند بداية الحركة كانت قوة التماس
العدد 591 N

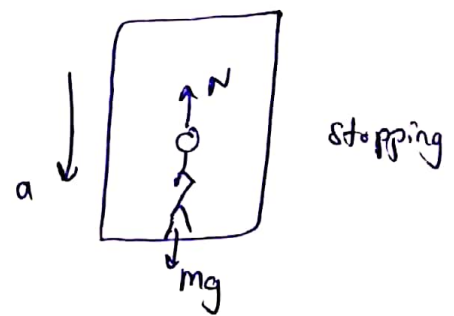


عندما توقف المصعد فإنه يوجد تسارع.
وتكون قسمة قوة التماس أقل مما تكون عندما يكون المصعد ساكناً.

$$\Sigma F_y = ma$$

$$mg - N = ma$$

$$mg - 391 = ma \quad \Rightarrow (2)$$



we adding the two equations . 1+2

$$591 - mg = ma$$

$$mg - 391 = ma$$

$$\frac{200}{2} = \frac{2}{2}ma \quad \Rightarrow \quad ma = 100$$

نخضع في معادلة (1) قسماً

$$591 - mg = ma = 100$$

$$591 - 100 = 491 \text{ N} = mg$$

b) the person's mass

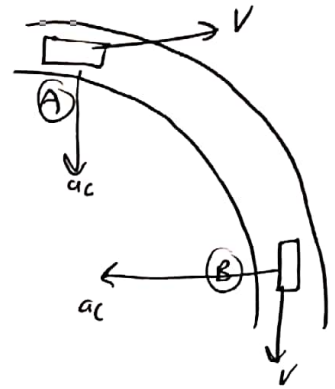
$$mg = 491 \quad \Rightarrow \quad m = \frac{491}{g} = \frac{491}{9.8} = 50.1 \text{ kg}$$

c) the acceleration of the elevator.

$$ma = 100 \quad \Rightarrow \quad a = \frac{100}{m} = \frac{100}{50.1} = 1.99 \text{ m/s}^2 \quad (13)$$

- 37) A car travels clockwise at constant speed around a circular section of a horizontal road as shown in Fig. Find the direction of velocity and acceleration at (a) position A

direction of velocity to the east
direction of acceleration to the south



- (b) at position B
direction of velocity to the south
direction of acceleration to the west-

40

Suppose a 1800 kg car passes over a hump in a roadway that follows the arc of a circle of radius 20.4 m as shown in Fig.

- (a) If the car travels at 30 km/h , what forces does the road exert on the car as the car passes the highest of the hump.

$N =$ القوة رد الفعل

$$\Sigma f = \frac{mv^2}{r}$$

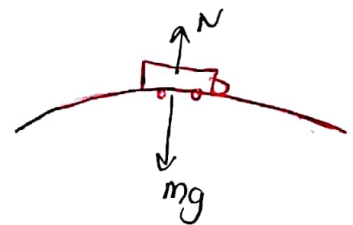
$$mg - N = \frac{mv^2}{r}$$

$$N = mg - \frac{mv^2}{r}$$

$$= 1800 \times 9.8 - \frac{1800 \times (8.33)^2}{20.4}$$

$$N = 11517.45\text{ N}$$

- الناتج



$$V = 30 \frac{\text{km}}{\text{h}} = \frac{30 \times 10^3}{3600}$$

$$V = 8.33\text{ m/s}$$

39

A string under a tension of 50 N is used to whirl a rock in a horizontal circle of radius 2.5 m at a speed 20.4 m/s on a frictionless surface as shown. As the string is pulled in the speed of the rock increases, when the string on the table is 1 m along and the speed of the rock is 51 m/s , the string breaks. What is the breaking strength in newtons of the string?

$$r_1 = 2.5 \text{ m}$$

$$v_1 = 20.4 \text{ m/s}$$

$$r_2 = 1 \text{ m}$$

$$v_2 = 51 \text{ m/s}$$

$$T_2 = \frac{mv_2^2}{r_2}$$



$$\sum F_x = ma_x$$

$$T_1 = \frac{mv_1^2}{r_1}$$

$$T_2 = \frac{mv_2^2}{r_2}$$

$$\frac{T_1}{T_2} = \frac{\frac{mv_1^2}{r_1}}{\frac{mv_2^2}{r_2}} = \frac{(20.4)^2}{(2.5)} \times \frac{1}{(51)^2} = 0.06$$

$$\frac{T_1}{T_2} = 0.06 \Rightarrow T_2 = \frac{T_1}{0.06} = \frac{50}{0.06} = 735.29 \text{ N}$$

(42)

A child's toy ^{لعبة أطفال} consists of a small ^{قيد} wedge that has an acute angle θ . The ^{جانب} sloping side of wedge is ^{قيد} frictionless, and an object of mass m on it remains at constant height if wedge is ^{يدور} spun at a certain constant speed. The wedge is spun by rotating, as an axis, a vertical rod that is ^{مستقر} firmly attached to wedge at the bottom end. show that when the object sits at rest at a point at distance L up along the wedge, the speed of the object must be $v = (gL \sin \theta)^{1/2}$

$$\sum F_c = ma_c = \frac{mv^2}{r}$$

$$\boxed{n \sin \theta = \frac{mv^2}{r}} \rightarrow (1)$$

$$\sum F_y = 0$$

$$N \cos \theta - mg = 0$$

$$\boxed{n \cos \theta = mg} \rightarrow (2)$$

$$\frac{(1)}{(2)} \quad \text{بقسمة المعادلتين}$$

$$\frac{n \sin \theta}{n \cos \theta} = \frac{\frac{mv^2}{r}}{mg} \Rightarrow \tan \theta = \frac{v^2}{rg}$$

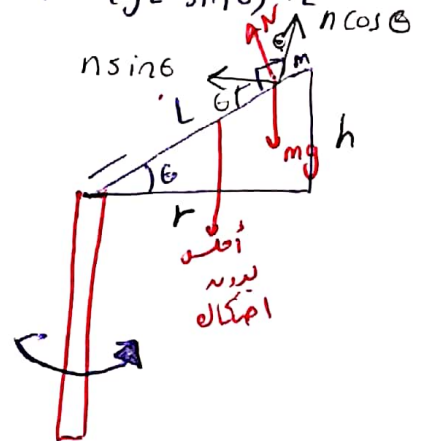
$$v^2 = rg \tan \theta$$

$$= \frac{rg \sin \theta \times L}{r}$$

$$v^2 = gL \sin \theta \Rightarrow v = \sqrt{gL \sin \theta}$$

$$v = (gL \sin \theta)^{1/2}$$

##



$$\tan \theta = \frac{\sin \theta}{\cos \theta}$$

$$\boxed{\tan \theta = \frac{\sin \theta}{\frac{r}{L}} = \frac{\sin \theta \times L}{r}}$$

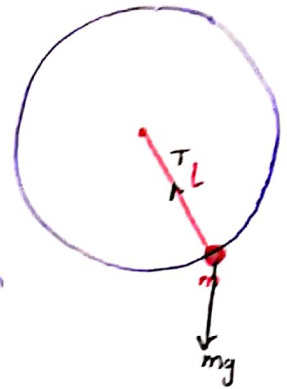
(15)

45) A ball of mass $m = 0.275 \text{ kg}$ swings in a vertical circular path on a string $L = 0.85 \text{ m}$ long as in Fig.

a) What are the forces acting on the ball at any point on the path?

① gravitational force (weight)
downward -
سحب

② Tension force ~~to~~ toward the center -
باتجاه المركز



b) Draw force diagram for the ball when it's at the bottom of a circle and when it's at the top.



(top)



(bottom)

c) If its speed is 5.2 m/s at the top of the circle, what is the tension in the string there?

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

$$T + \underbrace{mg}_{-mg} = \frac{mv^2}{r} \Rightarrow T = \frac{mv^2}{r} - mg$$

$$= \frac{0.275 \times (5.2)^2}{0.85} - 0.275 \times 9.8$$

$$\boxed{T = 6.05 \text{ N}}$$



d) If the string breaks when its tension exceeds 22.5 N , what is the maximum speed the ball can have at the bottom before that happens?
ما هو أقصى سرعة يمكن أن يكون لها قبل أن ينقطع الحبل.

$$F_c = \frac{mv^2}{r} \Rightarrow T - mg = \frac{mv^2}{r} \Rightarrow \frac{(T - mg) \times r}{m} = \frac{mv^2}{m}$$

$$v^2 = \frac{r}{m} (T - mg) \Rightarrow v = \sqrt{\frac{r}{m} (T - mg)}$$

$$v = \sqrt{\frac{0.85}{0.275} (22.5 - 0.275 \times 9.8)} = 7.82 \text{ m/s}$$

(17)



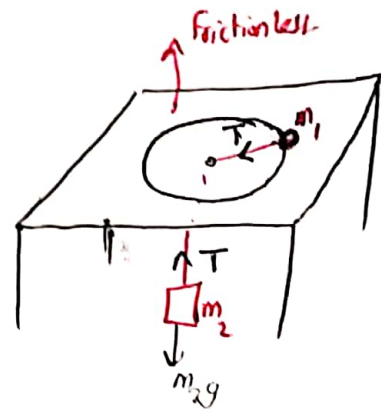
(54)

a) Find the tension in the string?

$$\sum F_y = ma = 0$$

$$T - m_2 g = 0 \Rightarrow \boxed{T = m_2 g}$$

في حالة الاتزان



b) the radial force acting on the puck.

القوة الجاذبة نحو المركز هي القوة المركزية، هي التوتر.

$$\boxed{F_c = T = m_2 g} \quad N$$

c) the speed of the puck

$$\sum F_r = \frac{mv^2}{r} \Rightarrow T = \frac{mv^2}{r}$$

$$m_2 g = \frac{mv^2}{r}$$

$$v^2 = \frac{r m_2 g}{m_1} \Rightarrow \boxed{v = \sqrt{r \frac{m_2}{m_1} g}} \quad \text{m/s}$$

d) Qualitatively describe what will happen in the motion ~~of the puck~~ of the puck if the value of m_2 is increased by placing a small additional load on the puck.

ماذا يحدث لو زدنا كتلة (m_2).

يقل نصف قطر الدوران، ويتحرك الجسم (m_1) حركة دائرية لأعلى ويزداد سرعته.

The puck will move in spiral motion. toward center, Speed increases

e) Qualitatively describe what will happen in the motion of puck if the value of m_2 is instead decreased by removing a part of the hanging load.

ماذا يحدث لو نقصنا كتلة (m_2).

يزداد نصف قطر الدوران، ويتحرك الجسم (m_1) حركة دائرية للخارج وتقل سرعته.

The puck will move in spiral motion away from the center and speed decreases.

(18)

(57)

المسألة

$$D = 8 \text{ m}$$

$$d = 2.5 \text{ m}$$

$$m = 10 \text{ kg}$$

$$\theta = 28^\circ$$

a) What is the speed of each seat?

$$\sum F_c = \frac{mv^2}{r}$$

$$T \sin \theta = \frac{mv^2}{r} \Rightarrow \frac{r T \sin \theta}{m} = \frac{mv^2}{m}$$

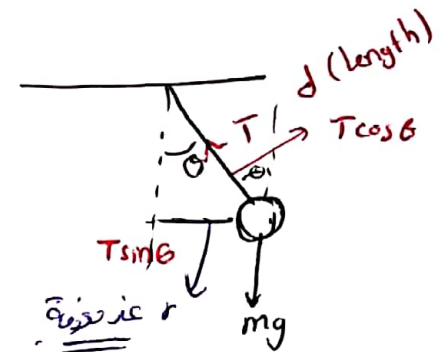
$$v^2 = \frac{r T \sin \theta}{m}$$

$$= \frac{5.4 \times \sin 28 \times T}{10}$$

$$= \frac{5.4 \times \sin 28 \times 110.9}{10}$$

$$v^2 = 26.5$$

$$v = \sqrt{26.5} = 5.1 \text{ m/s}$$



$$8 \text{ m} = \text{قطر المقعر}$$

$$4 \text{ m} = \text{نصف قطر المقعر}$$

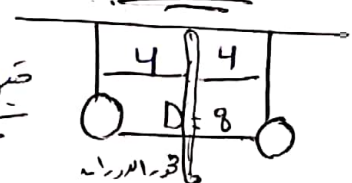
$$\sum F_y = 0$$

$$T \cos \theta = mg$$

$$T = \frac{mg}{\cos \theta} = \frac{10 \times 9.8}{\cos 28}$$

$$T = 110.9 \text{ N}$$

for only seat.



b) Draw a diagram of forces acting on the combination of a seat and a 40 kg child.

قبل الدوران

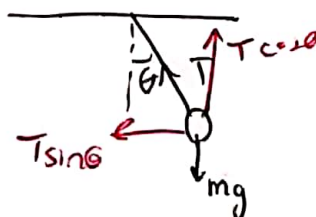
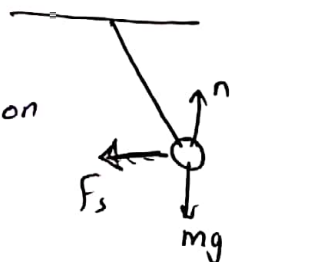
4) Find the tension on the chain.

$$T \cos \theta = mg$$

$$T \cos \theta = (m_{\text{child}} + m_{\text{seat}})g \quad \text{on the child}$$

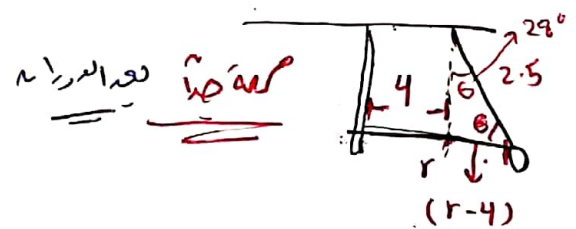
$$T = \frac{(10 + 40) \times 9.8}{\cos 28}$$

$$T = 554.9 \text{ N}$$



on the seat

(19)



$$\sin \theta = \frac{\text{مقابل}}{\text{وتر}}$$

$$\sin 28 = \frac{r-4}{2.5}$$

$$r-4 = \sin 28 (2.5)$$

$$r = 4 + \sin 28 \times 2.5$$

$$r = 5.1 \text{ m}$$

#