Physics – Grade 9 – Advanced. Academic Year: 2022 - 2023 . . . Term 2
End of Term 2 Questions and Answers.

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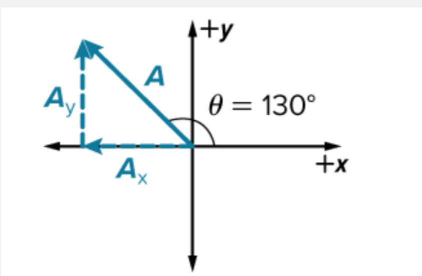
PART ONE – Multiple Choice Questions

(LO:1) Determine the components of a vector in cartesian coordinates system using trigonometry.

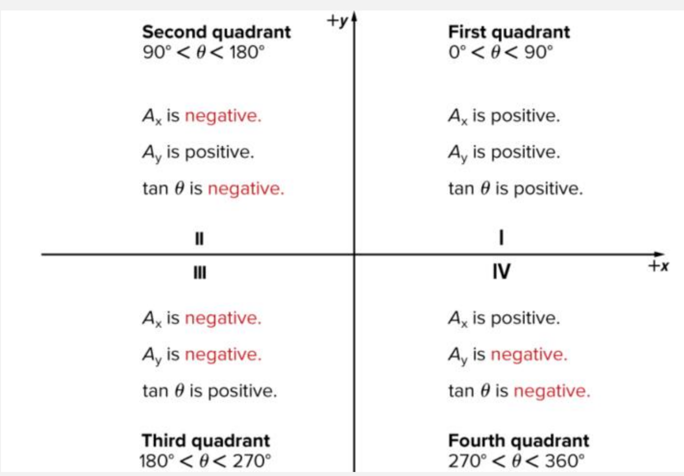
Part 1– Question 1: **Figure 5. P118:**

Find the x and y – components of the vector $\vec{A}$ in the next figure, given that $|\vec{A}| = 5.0\ N$?



Solution: **A** is in 2nd quadrant:
Expect A_x to be negative:
$A_x = A\,cos\theta = (5.0)\cos 130° = -3.2\ N$

Expect A_y to be positive:
$A_y = A\,\sin\theta = (5.0)\sin 130° = 3.8\ N$



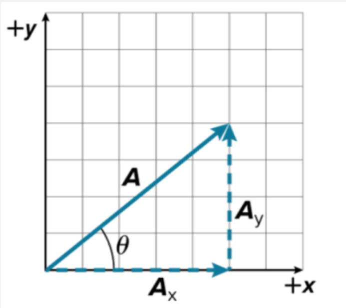
Additional problem:
Classify as positive or negative the components of a vector whose angle is 280°. In which quadrant does the vector lie?

Solution: $270° < 280° < 360°$, so
A_x is positive.
A_y is negative.

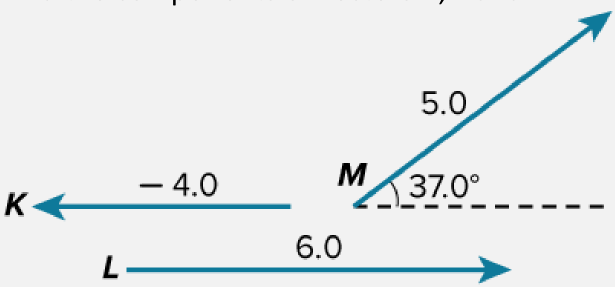
And the vector lies in the fourth quadrant.

(LO:2) Resolve a vector into two orthogonal vectors in cartesian coordinate system.

Part 1– Question 2: **As mentioned in the textbook. P117.**

	$A_x = A\ cos\theta$ $A_y = A\ \sin\theta$	Vector ***A*** is placed on a coordinate system. Notice in the right panel that A's direction is measured counterclockwise from the positive x-axis. A_x is parallel to the x-axis, and A_y is parallel to the y-axis.

Practice Problems.

Find the components of vectors ***K***, ***L*** and ***M***. 	Solution: $M_x = \ M\ cos\theta = \ (5.0)\cos 37° = \ 4.0\ N$ $M_y = M\ \sin\theta = \ (5.0)\sin 37° = \ 3.0\ N$ $L_x = \ L\ cos\theta = \ (6.0)\cos 0° = \ 6.0\ N$ $L_y = L\ \sin\theta = \ (6.0)\sin 0° = \ 0.0\ N$ $K_x = \ K\ cos\theta = \ \|(-4.0)\|\cos 180° = \ -4.0\ N$ $K_y = K\ \sin\theta = \ (\|-4.0\|)\sin 180° = \ 0.0\ N$

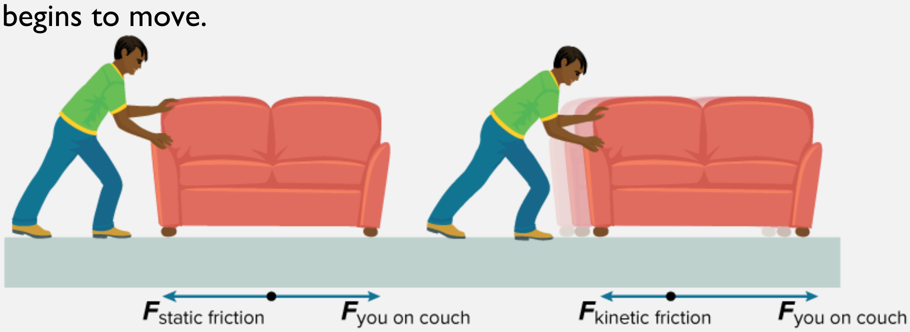
Additional Problem: Describe a vector whose y-component is zero

Any vector whose y – component is zero must lie completely along the x – axis.

(LO:3) Draw the free – body diagram and apply Newton's Second Law for an object moving on a horizontal surface involving friction.

Part 1– Question 3: Figure 10, Page 122.

An applied force is balanced by static friction up to a maximum limit. When this limit is exceeded, the object begins to move.



Identify the type of friction force acting on the couch when it begins to move? Kinetic friction.

(LO:4) Define the coefficients of kinetic and static friction. Distinguish between static and kinetic friction.

Part 1– Question 4: Check your progress 23, Page 127.

Analyze. Compare static friction and kinetic friction. How are the frictional forces similar, and how do they differ?

Similarities	Differences
Static and kinetic frictional forces are always opposing the direction of motion. They both perpendicular to the normal force. They both are related to the normal force.	Static friction (f_s) exist once any two objects are in contact with each other. Kinetic friction (f_k) exist only once one object start sliding against other. $f_s = \mu_s N$ $f_k = \mu_k N$ $f_k \leq f_s$

(LO:5) Recall that for an object to be in equilibrium, the net forces actin on it should be zero.

Part 1– Question 5: Get it? Page 129.

Identify the relationship between the equilibrant and the resultant vector.

Answer: $Equilibrant = -Resultant\ vector$.

The equilibrant and the resultant vector have the same magnitudes but opposite direction.

(LO:6) Describe the trajectory of a projectile.

Part 1– Question 6: Figure 4, Page 145.

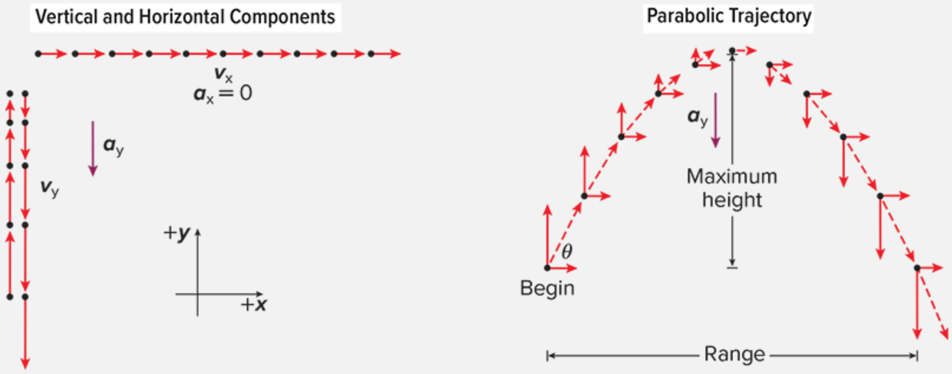


Figure 4: When a projectile is launched at an upward angle, its parabolic path is upward and then downward. The up-and-down motion is clearly represented in the vertical component of the vector diagram.

PART TWO – Multiple Choice Questions

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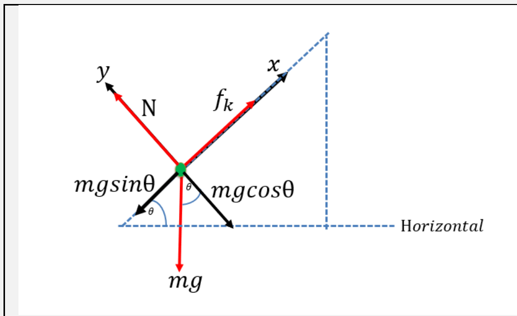
(LO:7) Solve problems related to friction.

Part 2– Question 7: Practice Problem 35, Page 133.

Stacie, who has a mass of 45 kg, starts down a slide that is inclined at an angle of 45° with the horizontal. If the coefficient of kinetic friction between Stacie's shorts and the slide is 0.25, what is her acceleration?

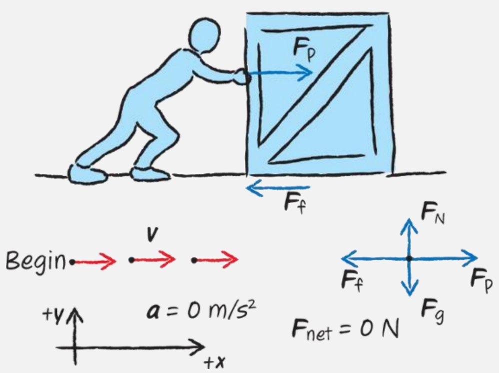
Free – Body Diagram	Solution
	Apply Newton's Second Law along the x – axis: $\boldsymbol{F}_{net} = m\,\boldsymbol{a} \quad \Longrightarrow \quad m\,g\sin\theta - f_k = m\,a$ Along y – axis the pair of forces are balanced: $N = m\,g\cos\theta$ And $f_k = \mu_k N \quad \Longrightarrow \quad f_k = \mu_k\,m\,g\cos\theta$ So, $m\,g\sin\theta - \mu_k\,m\,g\cos\theta = m\,a$

	$a = \; g\sin\theta - \mu_k \; g\cos\theta = (9.8 \; \times \; \sin 45°) - \; (0.25 \; \times 9.8 \; \times \cos 45°)$ $a = 5.2 \; m/s^2$

(LO:8) Apply the relationships that relate the normal force to maximum static friction and to kinetic friction to calculate unknown parameters like friction force, coefficient of friction or the normal force $(F_{static} = \; \mu_s \, N)$ and $(F_{kinetic} = \; \mu_k \, N)$.

Part 2– Question 8: Example Problem 3, Page 125. BALANCED FRICTION FORCES

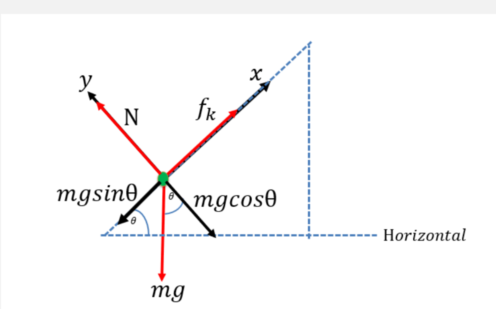
You push a 25.0 kg wooden box across a wooden floor at a constant speed of $1.0 \; m/s$. The coefficient of kinetic friction is 0.20. How large is the force that you exert on the box?

Diagram & Free – Body Diagram	Solution
	Along the y – axis: There is no acceleration: $(F_N = \; F_g \;) \; \Longrightarrow \; (F_N = \; m \, g)$ Along the x – axis: the speed is constant, so the acceleration is equal to zero: Apply Newton's Second Law: $F_{net} = \; m \, a \quad \Longrightarrow \; F_{net} = \; 0$ $F_P - \; F_f = 0 \quad \Longrightarrow F_P = \; F_f$ $F_P = \; \mu_k \, F_N \quad \Longrightarrow F_P = \; \mu_k \, m \, g$ $F_P = \; 0.20 \; \times 25.0 \; \times 9.80 = 49.0 \; N$

(LO:9) Apply Newton's Laws along x and y axes for an object that moves on an inclined plane with and without friction.

Part 2– Question 9: Practice Problem 31, Page 131.

Fernando, who has a mass of 43.0 kg, slides down the banister at his grandparents' house. If the banister makes an angle of 35.0° with the horizontal, what is the normal force between Fernando and the banister?

Free – Body Diagram	Solution
	Along y – axis the pair of forces are balanced: $N = \; m \, g \cos\theta$ $N = \; (43.0)(9.80)(\cos 35°) = 345.19 \; \approx 345 \; N \; (3 \; s.f)$

(LO:10) Explain the motion of horizontally launched projectiles and show schematically the components of velocity and acceleration throughout the motion.

Part 2– Question 10: figure 3, Page 142.

Vectors in Two Dimensions

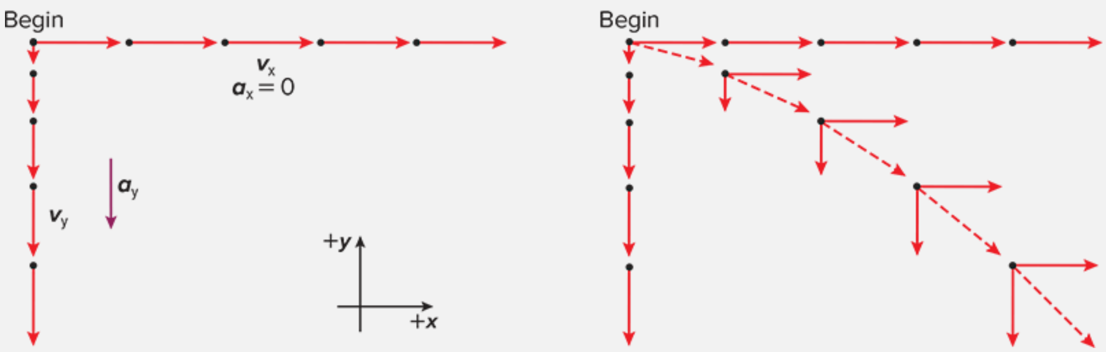


Figure 3: To describe the motion of a horizontally launched projectile, the x- and y-components can be treated independently. The resultant vectors of the projectile are tangent to a parabola.

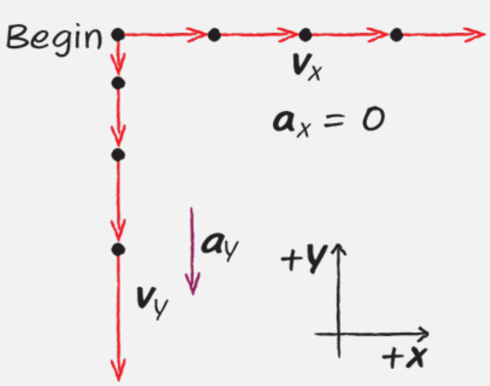
	Along x – axis	Along y – axis
Velocity	$v_x = constant$	$v_y = -9.8\,\mathrm{t} + v_i \sin\theta$
Acceleration	$a_x = 0$	$a_y = -9.80\ m/s^2$

(LO:11) Solve problems on horizontally launched projectiles using equations of motion and the conditions of velocity and acceleration $v_x = constant$ & $a_x = 0$.

Part 2– Question 11: Example 1 & Question 1, Page 144.

Example Problem 1: A SLIDING PLATE.

You are preparing breakfast and slide a plate on the countertop. Unfortunately, you slide it too fast, and it flies off the end of the countertop. If the countertop is 1.05 m above the floor and the plate leaves the top at 0.74 m/s, how long does it take to fall, and how far from the end of the counter does it land?

Diagram	Known and Unknown
	$\left(Known \quad \begin{matrix} x_i = y_i = 0 \\ v_{xi} = 0.74\ m/s \\ v_{yi} = 0\ m/s \\ a_x = 0\ m/s^2 \\ a_y = -9.8\ m/s^2 \\ y_i = -1.05\ m \end{matrix} \right)$ $\left(Unknown \quad \begin{matrix} t = ? \\ x_f = ? \end{matrix} \right)$

Time	Horizontal distance
Apply: $y_f = y_i + \frac{1}{2} a_y t^2$ $t = \sqrt{\frac{2(y_f - y_i)}{a_y}}$ $t = \sqrt{\frac{2(-1.05 - 0)}{-9.8}} = 0.46\ s$	Apply: $x_f = v_{xi} t$ $x_f = (0.74)(0.46)$ $x_f = 0.34\ m$ to the right of the counter.

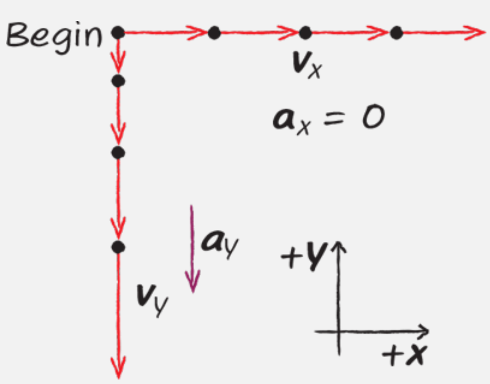
Practice Problem, Page 144:

You throw a stone horizontally at a speed of 5.0 m/s from the top of a cliff that is 78.4 m high.

a) How long does it take the stone to reach the bottom of the cliff?

b) How far from the base of the cliff does the stone hit the ground?

c) What are the horizontal and vertical components of the stone's velocity just before it hits the ground?

Diagram	Known and Unknown
	$Known \begin{pmatrix} x_i = y_i = 0 \\ v_{xi} = 5.0\ m/s \\ v_{yi} = 0\ m/s \\ a_x = 0\ m/s^2 \\ a_y = -9.8\ m/s^2 \\ y_i = -78.4\ m \end{pmatrix}$ $Unknown \begin{pmatrix} t = ? \\ x_f = ? \\ v_{xf} = ? \\ v_{yf} = ? \end{pmatrix}$

Time	Horizontal distance
Apply: $y_f = y_i + \frac{1}{2} a_y t^2$ $t = \sqrt{\frac{2(y_f - y_i)}{a_y}}$ $t = \sqrt{\frac{2(-78.4 - 0)}{-9.8}} = 4.0\ s$	Apply: $x_f = v_{xi} t$ $x_f = (5.0)(4.0)$ $x_f = 20.\ m$ from the base of cliff.

Horizontal velocity just before the stone hits the ground.	Vertical velocity just before the stone hits the ground.
Apply: $v_{xf} = v_{xi}$ $v_{xf} = 5.0\ m/s$ The velocity along x – axis is constant.	Apply: $v_{yf} = v_{yi} + g\,t$ $v_{yf} = 0 + (9.80)(4.0)$ $v_{yf} = 39.2\ m/s$

(LO:12) Classify forces as either contact forces or field forces and realize that they result from interactions caused by agents.

Part 2– Question 12: Get it question, Page 85.

Explain how contact forces are different from field forces.

A contact force exists when an object from the external world **touches** a system, exerting a force on it.

Field forces are exerted **without contact**.

Forces result from interactions; every contact and field force has a specific and identifiable cause, called the agent.

(LO:13) Apply the relation of centripetal acceleration, tangential speed, and radius of circular path to calculate unknown parameters.

Part 2 – Question 13: Figure 7 & 8, Pages 148 – 149.

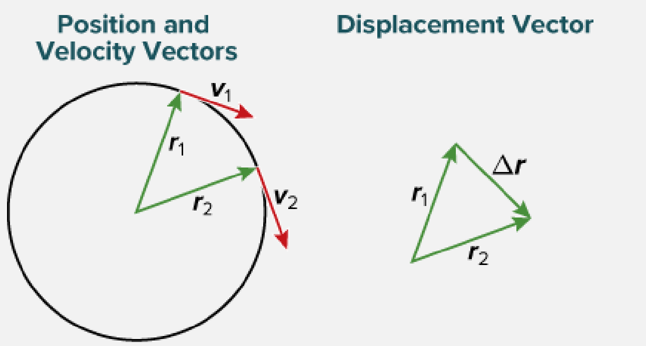


Figure 7 For an object in uniform circular motion, the velocity is tangent to the circle. It is in the same direction as the displacement.

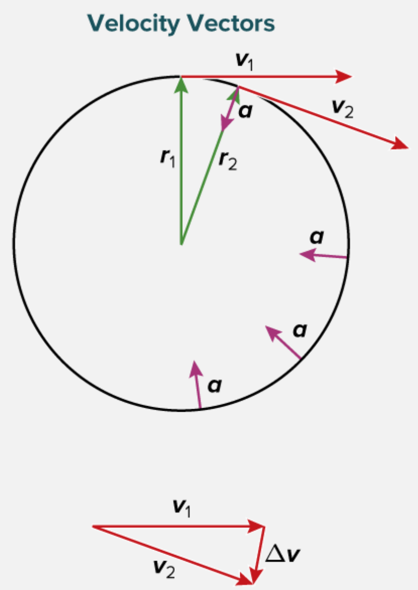


Figure 8 The acceleration of an object in uniform circular motion is the change in velocity divided by the time interval. The direction of centripetal acceleration is always toward the center of the circle.

Circular Motion:

Quantity	Description
Velocity	Tangent to the circle.
Acceleration	Toward the center of the circle.

(LO:14) Apply Newton's second law of motion to derive an expression for the centripetal/central force in terms of tangential speed and radius of the circular path.

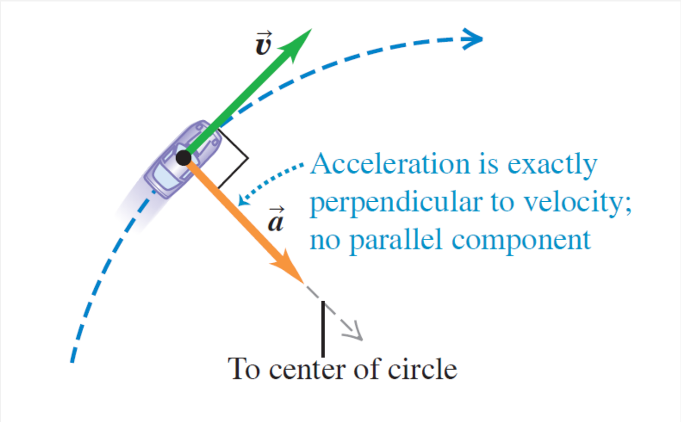
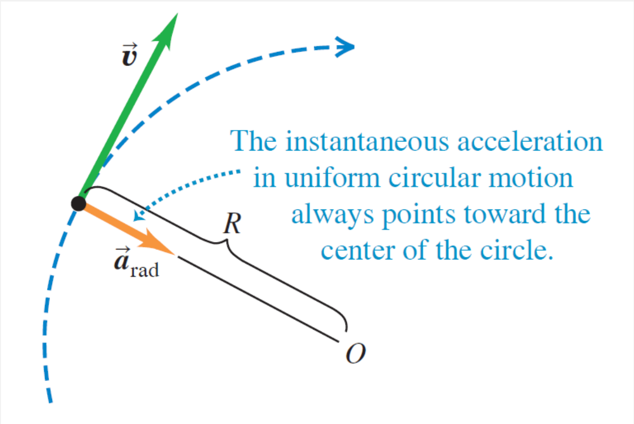
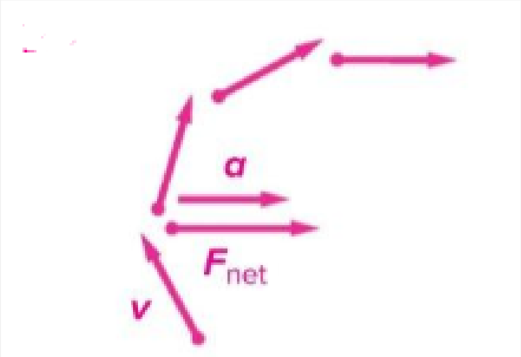
Part 2 – Question 14: Check Your Progress – 20, Page 152.

Free-Body Diagram. You are sitting in the back seat of a car going around a curve to the ***right***. Sketch motion and free-body diagrams to answer these questions:

a) What is the direction of your acceleration?

b) What is the direction of the net force on you?

c) What exerts this force?

Motion Diagram	Free – Body Diagram
	 

a. The direction of acceleration is to the right.

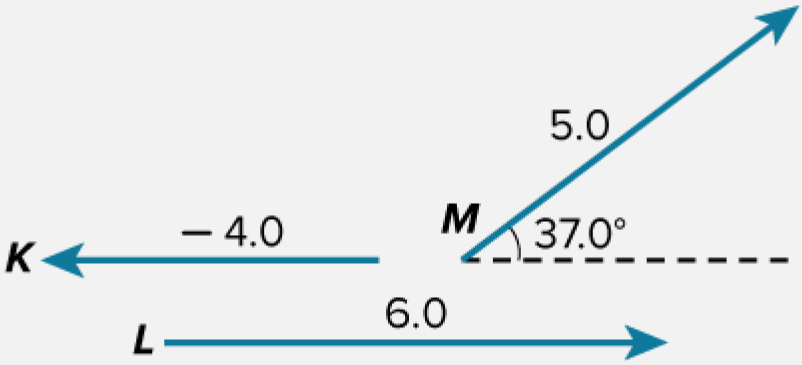
b. The direction of the net force is to the right as well, ($\boldsymbol{F}_{net} = m\,\boldsymbol{a}$) Newton's 2nd Law state that the net force and the acceleration of motion are always in the same direction.

c. The car seat is exerting the net force.

(LO:15) Find the equilibrant being the force having equal magnitude as the resultant force but opposite direction.

Part 2 – Question 15: Check Your Progress – 11, Page 121.

Equilibrant. Find the equilibrant of each of the three forces below.



Solution:

Force	Equilibrant
$F = 4.0\ left$	$F_{equilibrant} = 4.0\ N\ Right$
$F = 6.0\ Right$	$F_{equilibrant} = 6.0\ N\ Left$
$F = 5.0\ North\ of\ East$	$F_{equilibrant} = 5.0\ N\ South\ of\ West$

(LO:16) Relate the centripetal acceleration to the object's speed and the radius of the circular path.

Part 2 – Question 16: Practice Problem – 12, Page 151.

A runner moving at a speed of 8.8 m/s rounds a bend with a radius of 25 m. What is the centripetal acceleration of the runner, and what agent exerts the centripetal force on the runner?

Solution:

$$a_c = \frac{v^2}{R} \implies a_c = \frac{(8.8)^2}{25} = 3.0976 \approx 3.1\ m/s^2$$

Friction is the agent that exerts the centripetal force on the runner.

PART THREE – Written part

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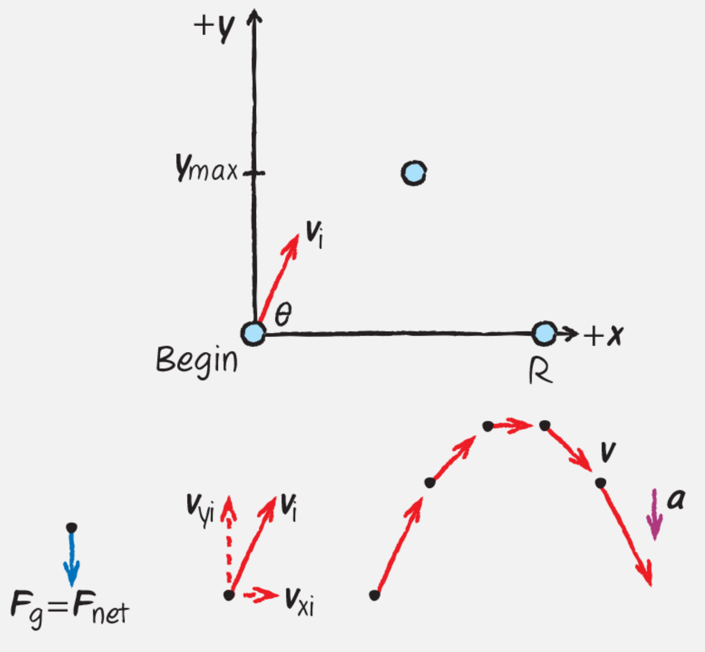
(LO:17) Solve problems on projectiles launched at an angle using equations of motion and the conditions of velocity and acceleration and given launching angle.

Part 3 – Question 17: Example Problem – 2, Page 146.

THE FLIGHT OF A BALL. A ball is launched at $4.5\ m/s$ at 66° above the horizontal. It starts and lands at the same distance from the ground. What are the maximum height above its launch level and the flight time of the ball?



$$\left(Known \quad \begin{matrix} y_i = 0.0\ m \\ v_i = 4.5\ m/s \\ \theta_i = 66^{\circ} \\ a_y = -9.8\ m/s^2 \\ v_{y,max} = 0.0\ m/s \end{matrix} \right)$$

$$\left(Unknown \quad \begin{matrix} y_{max} = ? \\ t = ? \end{matrix} \right)$$

Maximum height: (y_{max})

$v_{yi} = v_i\,(\sin\theta_i) \quad \Longrightarrow \quad v_{yi} = (4.5)\,(\sin 66^{\circ}) = 4.1\ m/s$

By symmetry: $v_{yf} = -\,v_{yi} = -\,4.1\ m/s$

Apply:

$$(v_{y,max})^2 = (v_{yi})^2 + 2\,(a_y)\,(y_{max} - y_i)$$

$$(0.0)^2 = (v_{yi})^2 + 2\,(a_y)\,(y_{max} - 0.0)$$

$$y_{max} = -\frac{(v_{yi})^2}{2\,(a_y)} \quad \Longrightarrow \quad y_{max} = -\frac{(v_{yi})^2}{2\,(-\,9.8\,)} \quad \Longrightarrow \quad y_{max} = \frac{(v_i\,(\sin\theta_i))^2}{2\,(\,9.8\,)}$$

$$y_{max} = \frac{(v_i\,(\sin\theta_i))^2}{2\,(\,9.8\,)} \quad \Longrightarrow \quad y_{max} = \frac{((4.5)(\sin 66^{\circ}))^2}{2\,(\,9.8\,)} = 0.86\,m$$

Time of flight: (t_{tof})

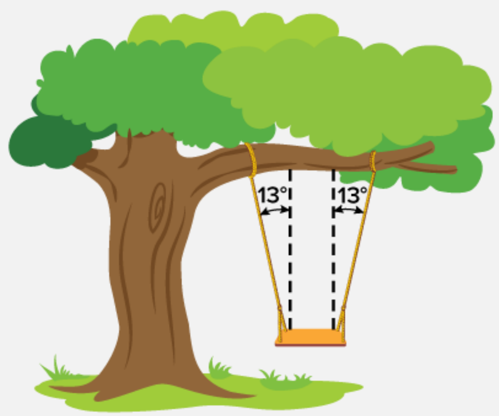
$$v_{yf} = v_{yi} + a_y\,t$$

$$t = \frac{v_{yf} - v_{yi}}{a_y} \quad \Longrightarrow \quad t = \frac{-\,v_{yi} - v_{yi}}{-\,9.8} \quad \Longrightarrow \quad t = \frac{2 \times v_i\,(\sin\theta_i)}{9.8}$$

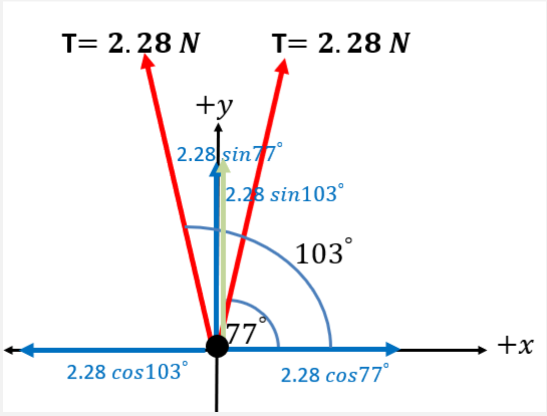
$$t = \frac{2 \times v_i\,(\sin\theta_i)}{9.8} \quad \Longrightarrow \quad t = \frac{2 \times (4.5)(\sin 66^{\circ})}{9.8} = 0.84\,s$$

(LO:18) Determine the resultant of two or more vectors algebraically by adding the components of the vectors and find its magnitude $\left(R^2 = R_x^2 + R_y^2\right)$ and direction $\left\{\theta = \tan^{-1}\left(\frac{R_y}{R_x}\right)\right\}$.

Part 3 – Question 18: Practice Problem 9. Page 121.
Two ropes tied to a tree branch hold up a child's swing as shown in Figure 7. The tension in each rope is 2.28 N. What is the combined force (magnitude and direction) of the two ropes on the swing?



Solution: Constructing a Free – body diagram:

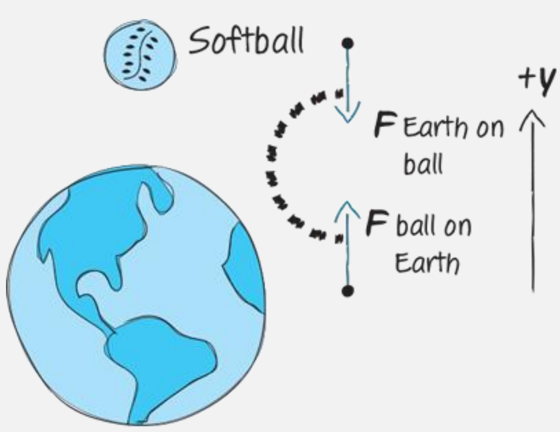


Along x – axis: the two components will cancel each other out.
$2.28 \cos 77° = +0.513\ N$ AND $2.28 \cos 103° = -\ 0.513\ N$
They represent pair of forces that are equal in magnitude and opposite in direction.

Along y – axis: the two components will add up.
$2.28 \sin 77° = +2.22\ N$ AND $2.28 \sin 103° = +2.22\ N$
They represent pair of forces that are equal in magnitude, and they are in the same direction.
$F_{net} = 2.22\ N + 2.22\ N = 4.44\ N$ along the positive y – axis.

(LO:19) Apply Newton's laws to solve problems involving normal and tension forces including systems of objects connected by strings and Atwood's machine.

Part 3 – Question 19: Example Problem 4. Page 92**. EARTH'S ACCELRATION.**
A softball has a mass of 0.18 kg. What is the gravitational force on Earth due to the ball, and what is the Earth's resulting acceleration?
Earth's mass is $6.0 \times 10^{24}\ kg$.



Solution:
Apply Newton's 2nd Law ($\boldsymbol{F}_{net} = m\,\boldsymbol{a}$) to find the weight of the ball: $\boldsymbol{F}_{Earth\ on\ ball} = m_{ball}\ \mathbf{g}$
$\boldsymbol{F}_{Earth\ on\ ball} = (0.18)(-9.8) = -1.764 = -1.8\ N\ (2\ s.f)$

Apply Newton's 3rd Law ($\boldsymbol{F}_{Ball\ on\ Earth} = -\boldsymbol{F}_{Earth\ on\ ball}$)
$\boldsymbol{F}_{Ball\ on\ Earth} = -(-1.8) = +1.8\ N$

Use Newton's second law to find $\boldsymbol{a}_{Earth}$.

$$\boldsymbol{a}_{Earth} = \frac{\boldsymbol{F}_{net}}{m_{Earth}} = \frac{1.764\ N}{6.0 \times 10^{24}} = 2.9 \times 10^{-25}\ m/s^2$$

(LO:20) Apply the relation of centripetal acceleration, tangential speed, and radius of circle path to calculate unknow parameters.

Part 3 – Question 20. Check Your Progress 19. Page 152. **Centripetal Acceleration.**

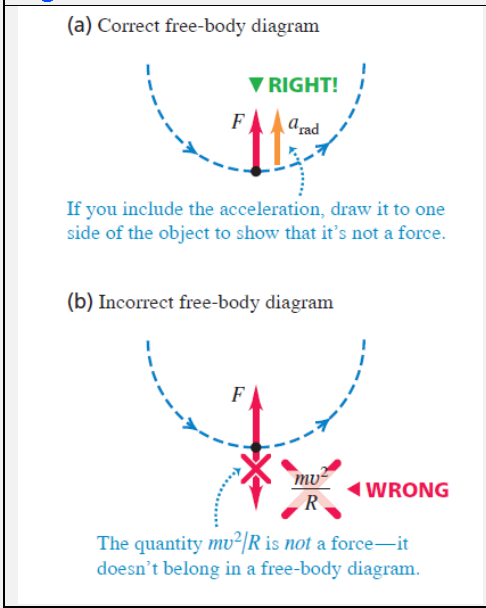
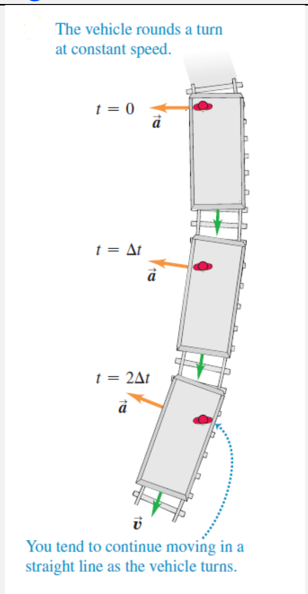
Newspaper article states that when turning a corner, a driver must be careful to balance the centripetal and centrifugal forces to keep from skidding. Write a letter to the editor that describes physics errors in this article.

Solution: There are three reasons not to include such an outward force, called centrifugal force ("centrifugal" means "fleeing from the center").

First, the object does not "stay out there": It is in constant motion around its circular path. Because its velocity is constantly changing in direction, the object accelerates and is not in equilibrium.

Second, if there were an outward force that balanced the inward force, the net force would be zero and the object would move in a straight line, not a circle.

Third, the quantity $(m\,v^2/R)$ is not a force; it corresponds to the $(m\,\vec{a})$ side of $\left(\Sigma\,\vec{F} = m\,\vec{a}\right)$ and does not appear in $\left(\Sigma\,\vec{F}\right)$ Figure (1).

Figure 1	Figure 2
	

It's true that when you ride in a car that goes around a circular path, you tend to slide to the outside of the turn as though there was a "centrifugal force." You tend to keep moving in a straight line, and the outer side of the car "runs into" you as the car turns (Figure 2). In an inertial frame of reference there is no such thing as "centrifugal force."

Alternative answer:

There is an acceleration because the direction of the velocity is changing. There must be a net force toward the center of the circle. The road supplies that force, and the friction between the road and the tires allows the force to be exerted on the tires. The seat exerts the force on the driver towards the center of the circle. Centrifugal force is NOT a real force.

Part 3 – Question 21. unannounced

Part 3 – Question 22. unannounced

THE END