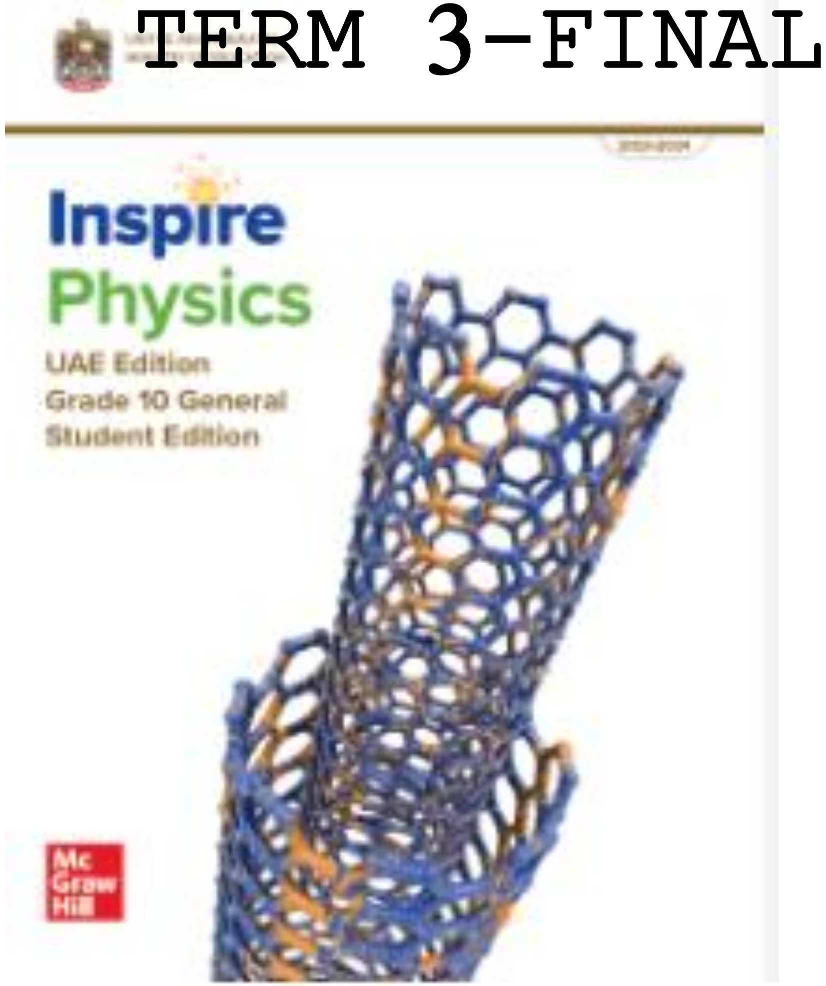
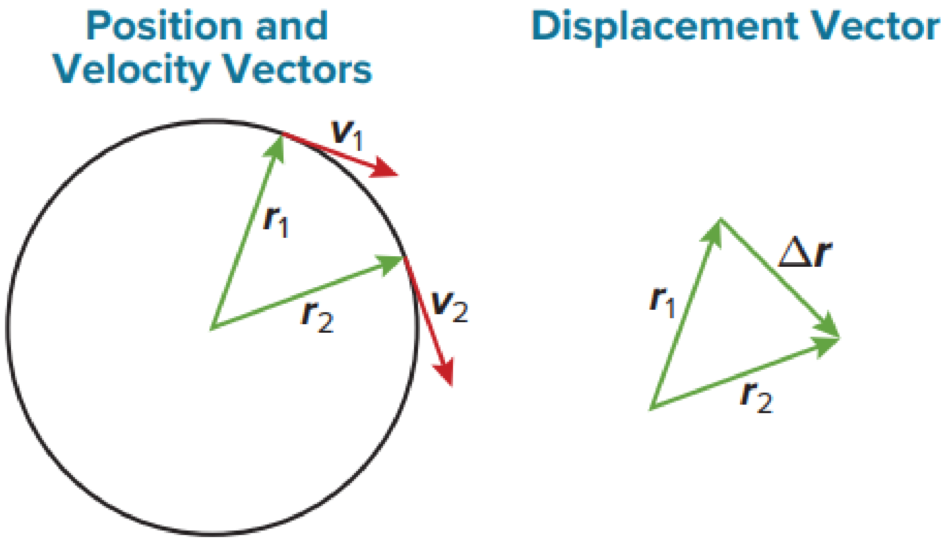
2023-2024/10 GENERAL /INSPIRE PHYSICS

TERM 3-FINAL EXAM/ REVIEW AS PER EOT



1	Define uniform circular motion.	Stu. textbook	146

Uniform circular motion is the movement of an object at a constant speed around a circle with a fixed radius. The position of an object in uniform circular motion, relative to the center of the circle, is given by the position vector $\boldsymbol{r}$. Remember that a position vector is a displacement vector with its tail at the origin. Two position vectors, $\boldsymbol{r}_1$ and $\boldsymbol{r}_2$, at the beginning and end of a time interval are shown on the left in **Figure 7.**



Position and Velocity Vectors

Displacement Vector

2	Relate the centripetal acceleration to the object's speed and the radius of the circular path ($a_c = \frac{v^2}{r}$).	Stu. textbook Practice problem **13**	**147** **149**

Centripetal Acceleration

Centripetal acceleration always points to the center of the circle. Its magnitude is equal to the square of the speed divided by the radius of motion.

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

13. An airplane traveling at $\underset{}{\overset{V}{\underline{201\ \text{m/s}}}}$ makes a turn. What is the smallest radius of the circular path ($r=?$) (in kilometers) the pilot can make and keep the centripetal acceleration under $\underset{a_c}{\underline{5.0\ \text{m/s}^2}}$?

Given

$V = 201\ m/s$

$a_c = 5.0\ m/s^2$

$r = ?$

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

$$5.0 = \frac{(201)^2}{r} = 8080\ m$$

In Kilometers $\frac{8080}{1000} = \underline{\underline{8.08\ Km}}$

3	Show how an object moving with a constant speed along a circle can have acceleration towards the centre of the circular path	Stu. textbook	147

Centripetal Acceleration

A velocity vector of an object in uniform circular motion is tangent to the circle. What is the direction of the acceleration? **Figure 8** shows the velocity vectors v_1 and v_2 at the beginning and end of a time interval. The difference in the two vectors (Δv) is found by subtracting the vectors, as shown at the bottom of the figure. The average acceleration $\left(\bar{a} = \frac{\Delta v}{\Delta t}\right)$ for this time interval is in the same direction as Δv. For a very small time interval, Δv is so small that $\boldsymbol{a}$ points toward the center of the circle. As the object moves around the circle, the direction of the acceleration vector changes, but it always points toward the center of the circle. For this reason, the acceleration of an object in uniform circular motion is called center-seeking or **centripetal acceleration.**

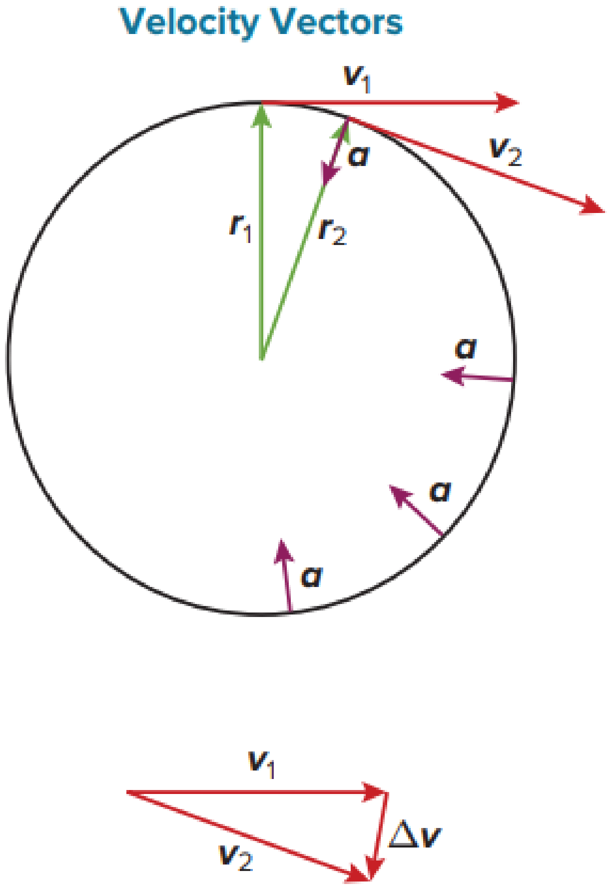


Figure 8 The acceleration of an object in uniform circular motion is the change in velocity divided by the time interval. The direction of centripetal acceleration is always toward the center of the circle.

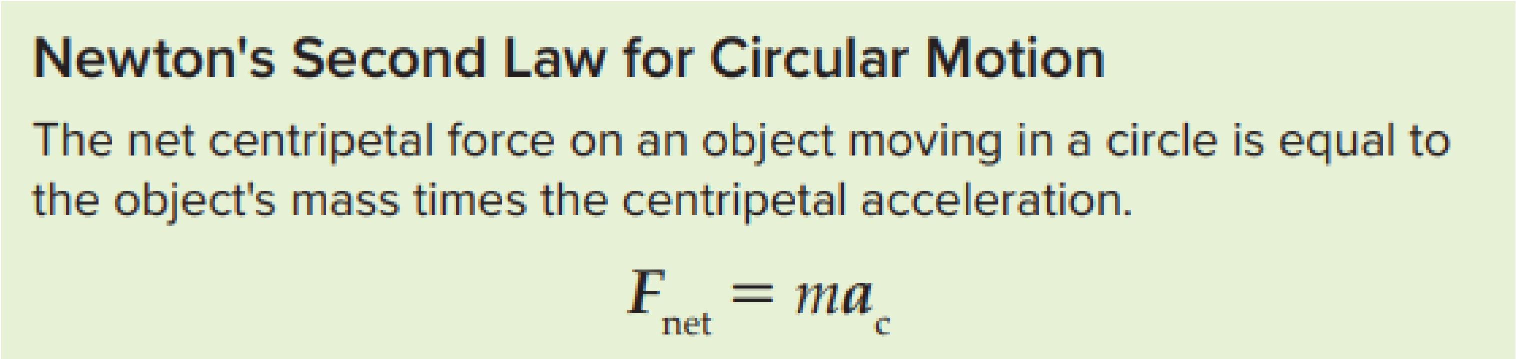
4	Define the centripetal/central force.	Stu. textbook	148

Centripetal force Because the acceleration of an object moving in a circle is always in the direction of the net force acting on it, there must be a net force toward the center of the circle. This force can be provided by any number of agents. For Earth circling the Sun, the force is the Sun's gravitational force on Earth. When a hammer thrower swings the hammer, as in **Figure 9**, the force is the tension in the chain attached to the massive ball. When an object moves in a circle, the net force toward the center of the circle is called the **centripetal force.** To accurately analyze centripetal acceleration situations, you must identify the agent of the force that causes the acceleration. Then you can apply Newton's second law for the component in the direction of the acceleration in the following way.

Figure 9 As the hammer thrower swings the ball around, tension in the chain is the force that causes the ball to have an inward acceleration.

Predict *Neglecting air resistance, how would the horizontal acceleration and velocity of the hammer change if the thrower released the chain?*

5	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 ($F_c = \frac{mv^2}{r}$).	Stu. textbook	**148**

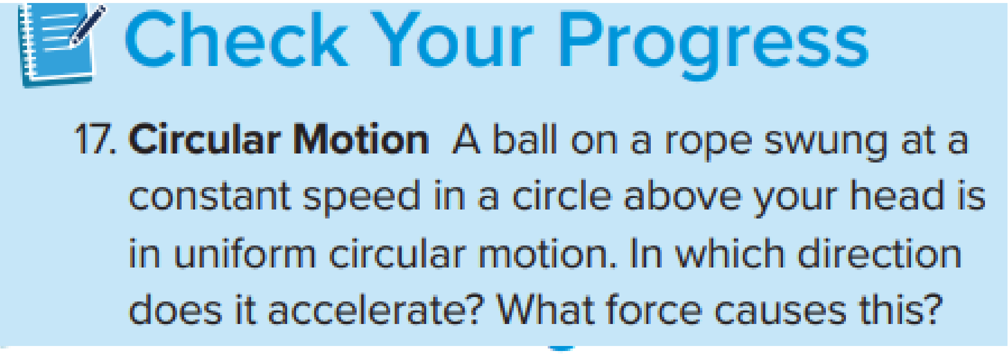


Newton's Second Law for Circular Motion

The net centripetal force on an object moving in a circle is equal to the object's mass times the centripetal acceleration.

$$F_{\text{net}} = ma_c$$

6	Identify forces like tension, gravity, and friction that cause centripetal acceleration.	Check your progress Q.17	150



Check Your Progress

17. **Circular Motion** A ball on a rope swung at a constant speed in a circle above your head is in uniform circular motion. In which direction does it accelerate? What force causes this?

17. The ball accelerates toward the center of the circle because of the centripetal force.

7	Relate the centripetal acceleration and the speed of an object in uniform circular motion to its period of revolution and use this relation to find unknown parameters ($v = \frac{2\pi r}{T}$, $a_c = \frac{4\pi^2 r}{T^2}$).	Check your progress Q.23	150

Period of revolution One way to describe the speed of an object moving in a circle is to measure its period (T), the time needed for the object to make one complete revolution. During this time, the object travels a distance equal to the circumference of the circle ($2\pi r$).

The speed, then, is represented by $v = \frac{2\pi r}{T}$. If you substitute for v in the equation for centripetal acceleration, you obtain the following equation:

$$a_c = \frac{(2\pi r/T)^2}{r} = \frac{4\pi^2 r}{T^2}.$$

23. **Amusement-Park Ride** A ride park has people stand around a 4.0-m radius circle with their backs to a wall. The ride then spins them with a 1.7-s period of revolution. What are the centripetal acceleration and velocity of the riders?

Given:

$r = 4.0\,m$

$T = 1.7\,s$

$a_c = ?$

$v = ?$

To find 'v'

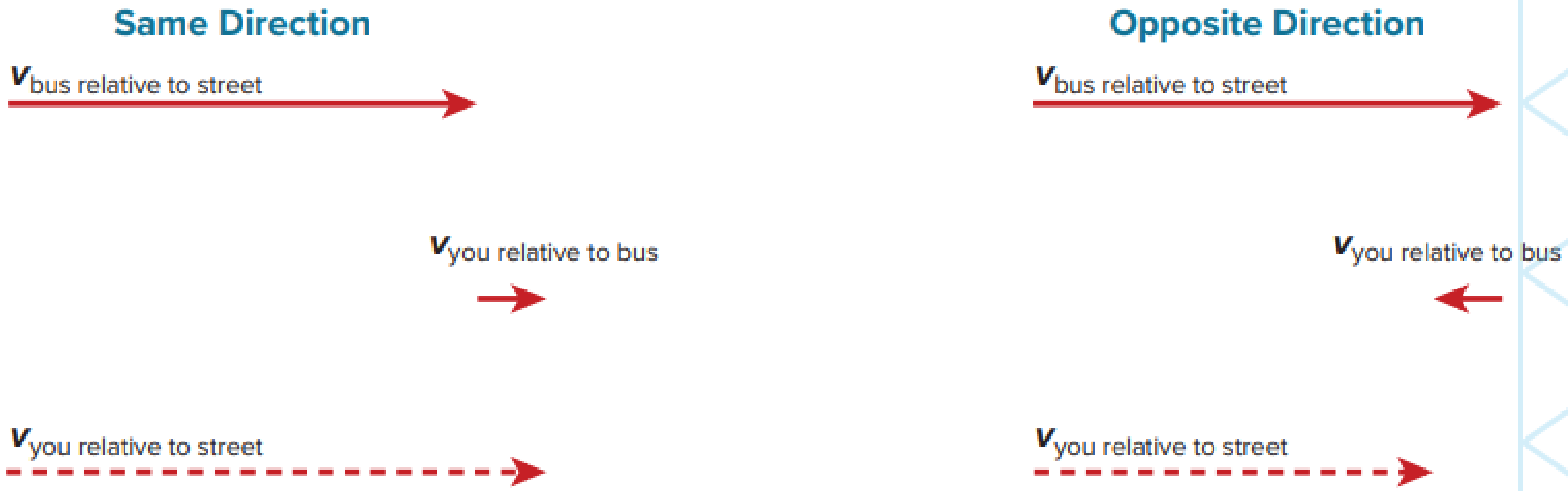
$$v = \frac{2\pi r}{T} = \frac{2\times 3.14 \times 4}{1.7} = \underline{\underline{14.78}}\ m/s$$

To find 'a_c'

$$a_c = \frac{4\pi^2 r}{T^2} = \frac{4\times 3.14^2 \times 4}{1.7^2} = \underline{\underline{54.59}}\ m/s^2$$

8	Define a frame of reference.	Stu. textbook	151
9	Describe velocity in different reference frames.	Stu. textbook	151

Different reference frames In this example, your motion is viewed from different coordinate systems. A coordinate system from which motion is viewed is a **reference frame.** Walking at 1 m/s toward the front of the bus means your velocity is measured in the reference frame of the bus. Your velocity in the road's reference frame is different. You can rephrase the problem as follows: given the velocity of the bus relative to the road and your velocity relative to the bus, what is your velocity relative to the road? A vector representation of this problem is shown in **Figure 13.** If right is positive, your speed relative to the road is 9 m/s, the sum of 8 m/s and 1 m/s.



10	Calculate relative velocity using vector addition and subtraction in one dimension $(v_{(a/b)}+v_{(b/c)}=v_{(a/c)})$	Stu. textbook (Get it)	152

Relative Velocity

The relative velocity of object a to object c is the vector sum of object a's velocity relative to object b and object b's velocity relative to object c.

$$v_{a/b} + v_{b/c} = v_{a/c}$$

Get It?

Explain A flea is running on the back of a dog that is running along a road. Write an equation to determine the velocity of the flea relative to the road.

$$v_{f/d} + v_{d/r} = v_{f/r}$$

$V_{f/d}$ = Velocity of flea relative to dog

$V_{d/r}$ = Velocity of dog relative to road

$V_{f/r}$ = Velocity of flea relative to road

11	Explain Kepler's First Law which states that the planets follow elliptical paths with the sun at one focus.	Stu. textbook	163

Kepler's first law states that the paths of the planets are ellipses, with the Sun at one focus. An ellipse has two foci, as shown in **Figure 2**.

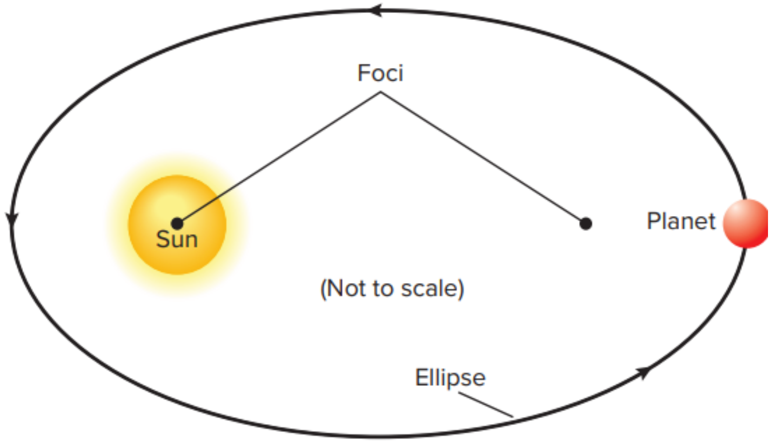
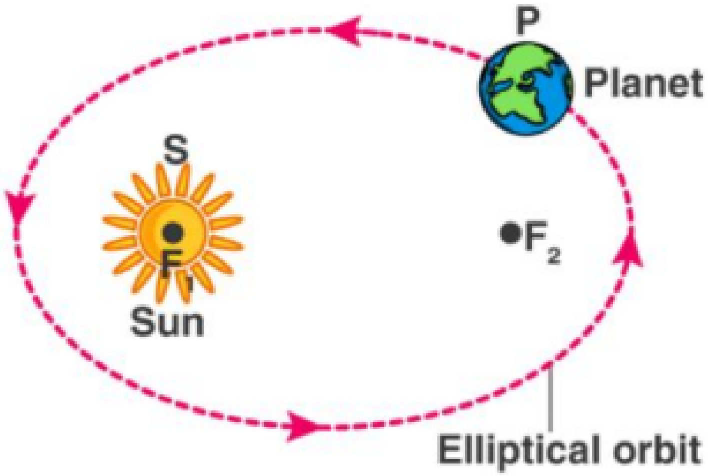


Figure 2 The orbit of each planet is an ellipse, with the Sun at one focus.

Describe the common feature that Kepler's first law found concerning the paths of orbiting objects around the Sun.

The paths of the planets are ellipses with the Sun at one focus.

Which of the following physics laws describes the planets orbits as represented by the figure below?



a. ○ **Kepler's First Law**

b. ○ **Kepler's Second Law**

c. ○ **Kepler's Third Law**

d. ○ **Newton's Universal Law of Gravitation**

12	Explain Kepler's Second Law which states that an imaginary line from the **Sun to a** planet sweeps out equal areas in equal time intervals.	Stu. textbook	163

ill Education

Kepler found that orbits might change due to gravitational effects from, or collisions with, other objects in the solar system. He also found that the planets move faster when they are closer to the Sun and slower when they are farther away from the Sun. **Kepler's second law** states that an imaginary line from the Sun to a planet sweeps out equal areas in equal time intervals, as illustrated in **Figure 3.**

Which of the following describes Kepler's Second law ?

a. ○ **The law of equal areas**

b. ○ **The law of orbits**

c. ○ **The law of Periods**

d. ○ **The Law of Gravitation**

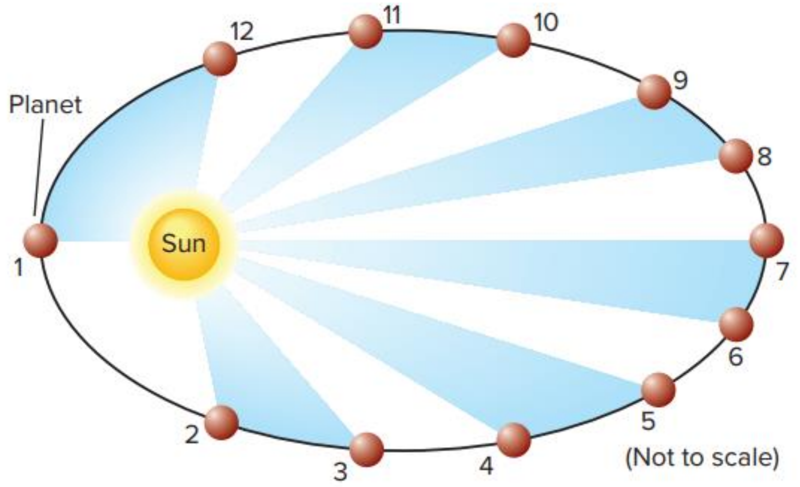
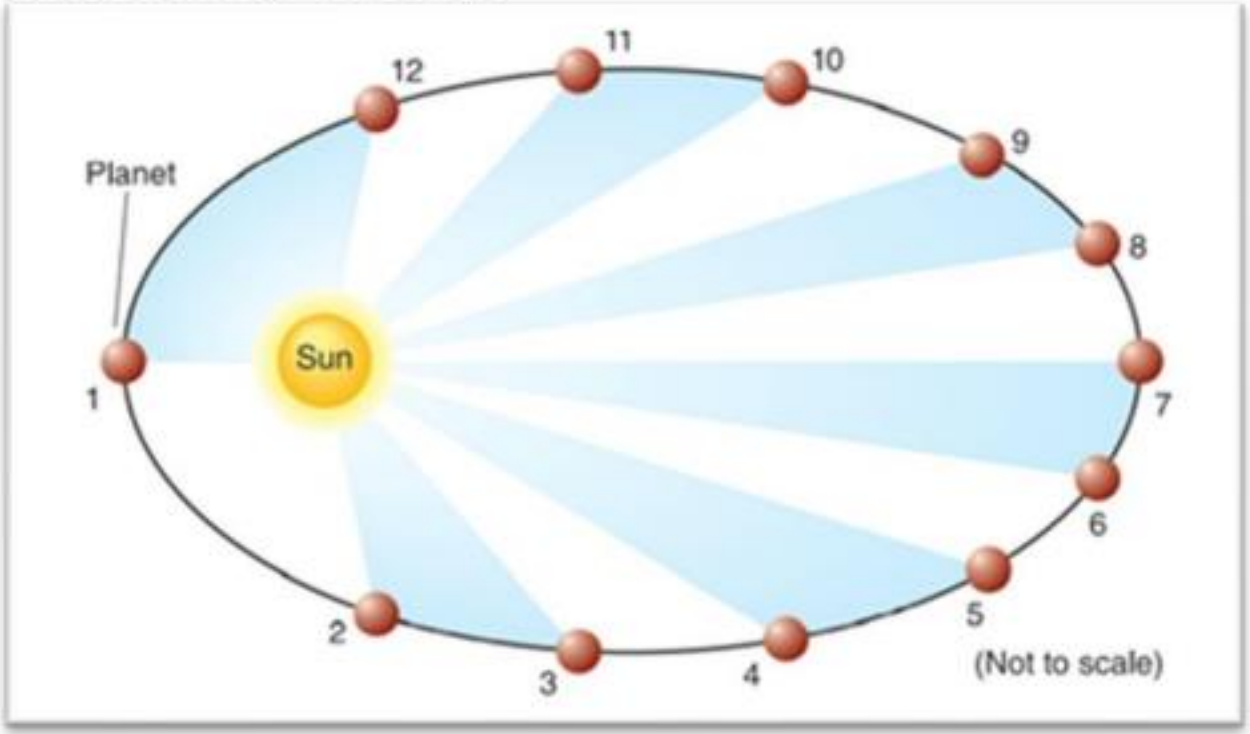


Figure 3 Kepler found that elliptical orbits sweep out equal areas in equal time periods.

Explain *why the equal time areas are shaped differently.*

The figure shows the path of Mars around the Sun, in which position does Mars have the greatest linear velocity?



1

2

7

4

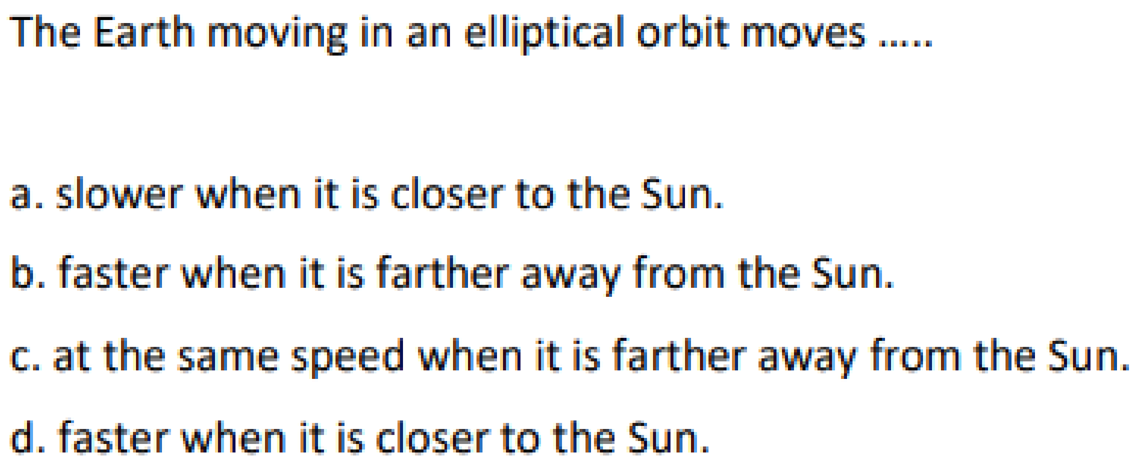
13	Explain Kepler's Third Law which states that the square of the ratio of the periods of any two planets revolving about the Sun is equal to the cube of the ratio of their average distances from the sun and write it in equation form $\left[\left(\frac{T_A}{T_B}\right)^2 = \left(\frac{r_A}{r_B}\right)^3\right]$.	Stu. textbook	164

Kepler's third law states that the square of the ratio of the periods of any two planets revolving about the Sun is equal to the cube of the ratio of their average distances from the Sun. Thus, if the periods of the planets are T_A and T_B and their average distances from the Sun are r_A and r_B, Kepler's third law can be expressed as follows.

Kepler's Third Law

The square of the ratio of the period of planet A to the period of planet B is equal to the cube of the ratio of the distance between the centers of planet A and the Sun to the distance between the centers of planet B and the Sun.

$$\left(\frac{T_A}{T_B}\right)^2 = \left(\frac{r_A}{r_B}\right)^3$$



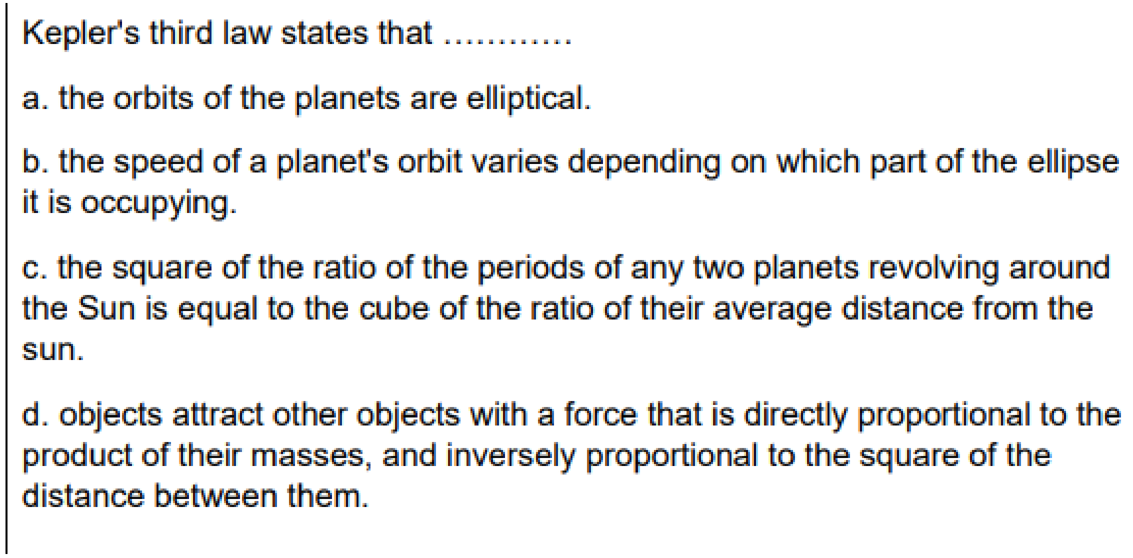
The Earth moving in an elliptical orbit moves .....

a. slower when it is closer to the Sun.

b. faster when it is farther away from the Sun.

c. at the same speed when it is farther away from the Sun.

d. faster when it is closer to the Sun.



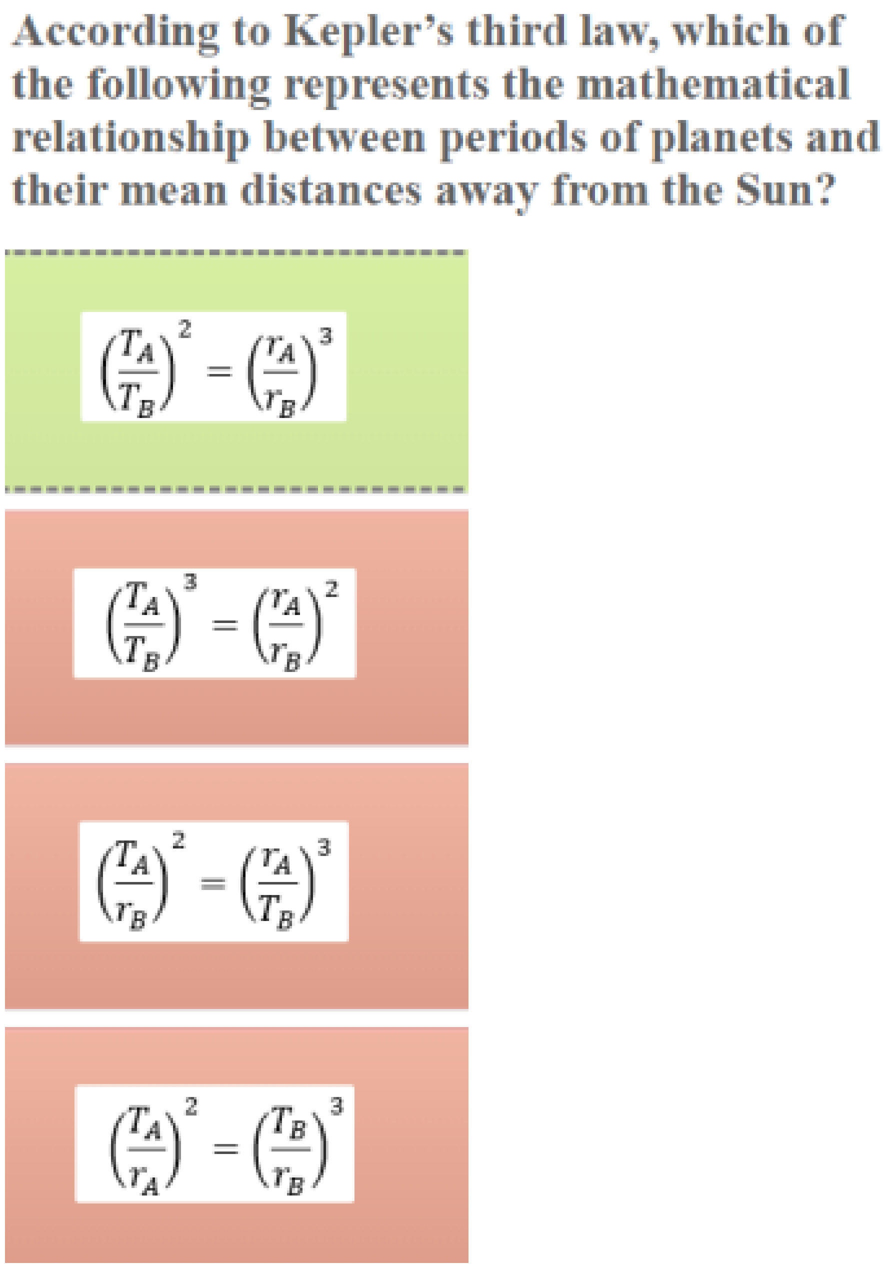
Kepler's third law states that ....

a. the orbits of the planets are elliptical.

b. the speed of a planet's orbit varies depending on which part of the ellipse it is occupying.

c. the square of the ratio of the periods of any two planets revolving around the Sun is equal to the cube of the ratio of their average distance from the sun.

d. objects attract other objects with a force that is directly proportional to the product of their masses, and inversely proportional to the square of the distance between them.



According to Kepler's third law, which of the following represents the mathematical relationship between periods of planets and their mean distances away from the Sun?

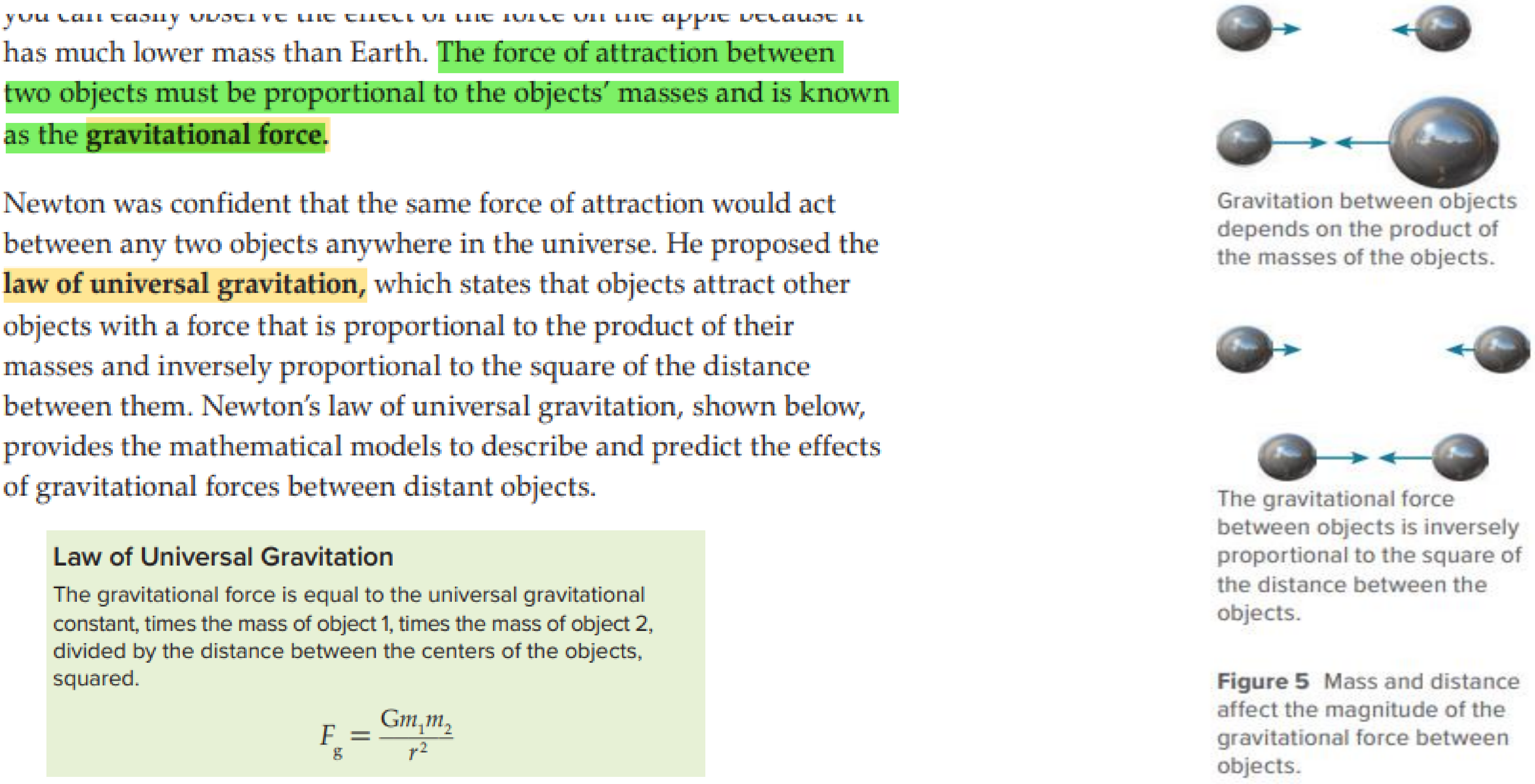
$$\left(\frac{T_A}{T_B}\right)^2 = \left(\frac{r_A}{r_B}\right)^3$$

$$\left(\frac{T_A}{T_B}\right)^3 = \left(\frac{r_A}{r_B}\right)^2$$

$$\left(\frac{T_A}{r_B}\right)^2 = \left(\frac{r_A}{T_B}\right)^3$$

$$\left(\frac{T_A}{r_A}\right)^2 = \left(\frac{T_B}{r_B}\right)^3$$

14	Define gravitational force as the force of attraction between two objects of given mass.	Stu. textbook	166



you can easily observe the effect of the force on the apple because it has much lower mass than Earth. The force of attraction between two objects must be proportional to the objects' masses and is known as the **gravitational force.**

Newton was confident that the same force of attraction would act between any two objects anywhere in the universe. He proposed the **law of universal gravitation,** which states that objects attract other objects with a force that is proportional to the product of their masses and inversely proportional to the square of the distance between them. Newton's law of universal gravitation, shown below, provides the mathematical models to describe and predict the effects of gravitational forces between distant objects.

Law of Universal Gravitation

The gravitational force is equal to the universal gravitational constant, times the mass of object 1, times the mass of object 2, divided by the distance between the centers of the objects, squared.

$$F_g = \frac{Gm_1m_2}{r^2}$$

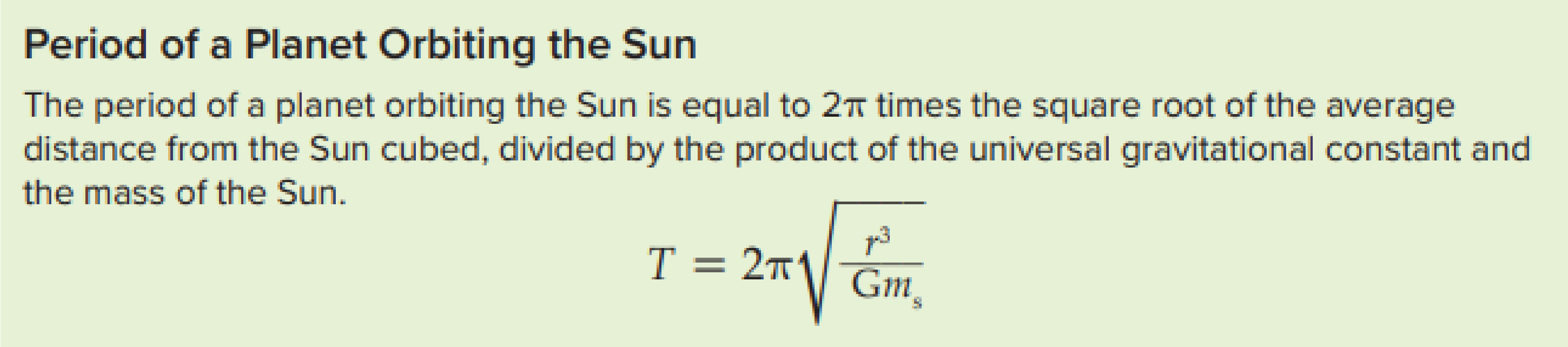
Gravitation between objects depends on the product of the masses of the objects.

The gravitational force between objects is inversely proportional to the square of the distance between the objects.

Figure 5 Mass and distance affect the magnitude of the gravitational force between objects.

15	Calculate the orbital period of a planet orbiting the Sun.	Stu. textbook	168

The period of a planet orbiting the Sun can be expressed as follows.



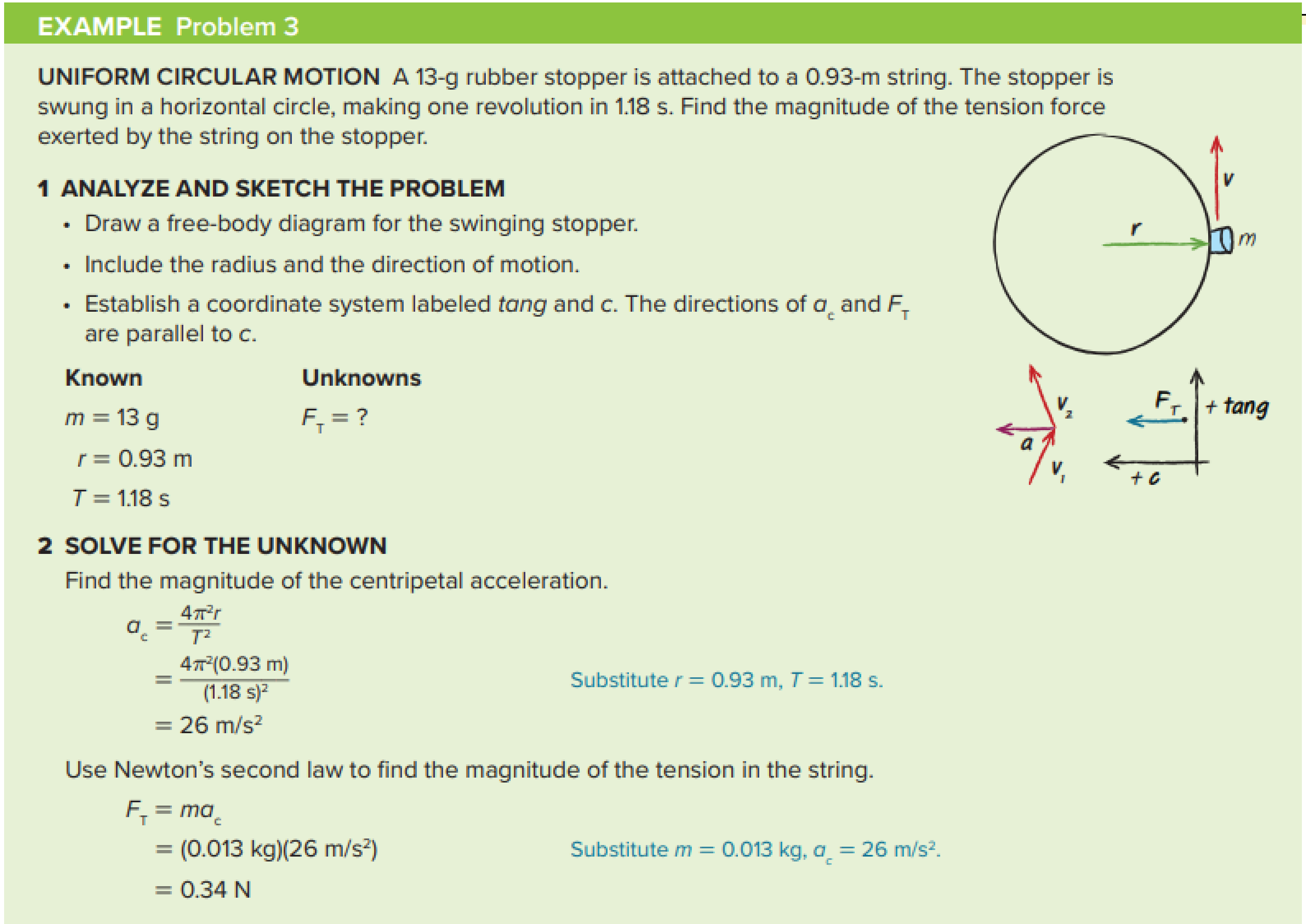
Period of a Planet Orbiting the Sun

The period of a planet orbiting the Sun is equal to 2π times the square root of the average distance from the Sun cubed, divided by the product of the universal gravitational constant and the mass of the Sun.

$$T = 2\pi\sqrt{\frac{r^3}{Gm_s}}$$

Paper based Questions- Free response questions

1	1) Apply the relation of centripetal acceleration, tangential speed, and radius of circular path to calculate unknown parameters. 2) Apply the expression for centripetal/central force to solve problems on relevant systems. 3) Demonstrate that the velocity vector at any time is tangent to the	Stu. textbook Example problem 3	146 149



EXAMPLE Problem 3

UNIFORM CIRCULAR MOTION A 13-g rubber stopper is attached to a 0.93-m string. The stopper is swung in a horizontal circle, making one revolution in 1.18 s. Find the magnitude of the tension force exerted by the string on the stopper.

1 ANALYZE AND SKETCH THE PROBLEM

- Draw a free-body diagram for the swinging stopper.
- Include the radius and the direction of motion.
- Establish a coordinate system labeled *tang* and *c*. The directions of a_c and F_T are parallel to *c*.

Known	**Unknowns**
$m = 13$ g	$F_T = ?$
$r = 0.93$ m	
$T = 1.18$ s	

2 SOLVE FOR THE UNKNOWN

Find the magnitude of the centripetal acceleration.

$$a_c = \frac{4\pi^2 r}{T^2}$$

$$= \frac{4\pi^2(0.93\text{ m})}{(1.18\text{ s})^2} \qquad \text{Substitute } r = 0.93\text{ m}, T = 1.18\text{ s.}$$

$$= 26\text{ m/s}^2$$

Use Newton's second law to find the magnitude of the tension in the string.

$$F_T = ma_c$$

$$= (0.013\text{ kg})(26\text{ m/s}^2) \qquad \text{Substitute } m = 0.013\text{ kg}, a_c = 26\text{ m/s}^2.$$

$$= 0.34\text{ N}$$

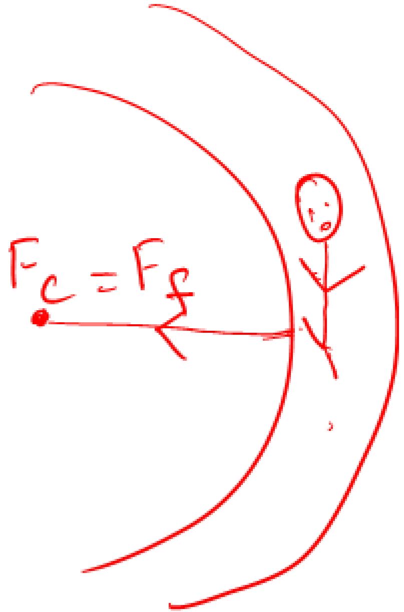
2	**1)** Relate the centripetal acceleration and the speed of an object in uniform circular motion to its period of revolution and use this relation to find unknown parameters ($v = \frac{2\pi r}{T}$, $a_c = \frac{4\pi^2 r}{T^2}$). **2)** Calculate relative velocity using vector addition and subtraction in one dimension ($v_{(a/b)}+v_{(b/c)} = v_{(a/c)}$).	Practice problem **12,16** Stu. textbook fig. **13** Practice problem **29**	**146** **151** **155**

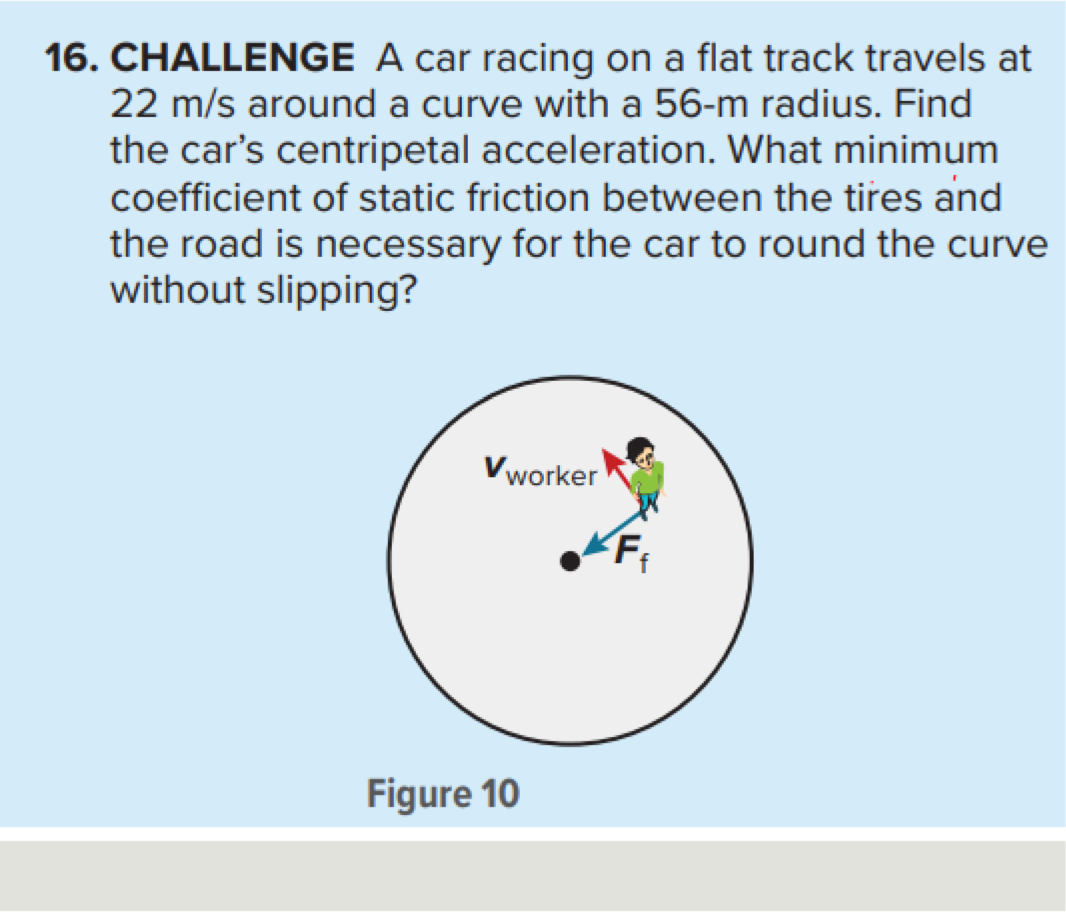
12. A runner moving at a speed of $\overset{v}{\underline{8.8}}$ m/s rounds a bend with a radius $\overset{r}{\text{of}}$ 25 m. What is the centripetal acceleration of the runner, and what agent exerts the centripetal force on the runner?

$$a_c = \frac{v^2}{r} = \frac{8.8^2}{25} = 3.09$$

$$= 3.1\ m/s^2$$

Friction force is equal to centripetal force





16. CHALLENGE A car racing on a flat track travels at 22 m/s around a curve with a 56-m radius. Find the car's centripetal acceleration. What minimum coefficient of static friction between the tires and the road is necessary for the car to round the curve without slipping?

Figure 10

Given:-

$V = 22\,m/s$

$r = 56\,m$

$$a_c = \frac{V^2}{r} = \frac{22^2}{56} = 8.6\,m/s^2$$

To find minimum coefficient of friction (μ_k)

$$F_c = F_f$$

$$\cancel{m} a_c = \mu_k \cancel{m} g$$

$$\mu_k = \frac{a_c}{g} = \frac{8.6}{9.8} = \underline{\underline{0.88}}$$

2) Calculate relative velocity using vector addition and subtraction in one dimension ($v_{(a/b)}+v_{(b/c)}=v_{(a/c)}$).	Stu. textbook fig. 13 Practice problem 29	151 155

Figure 13. If right is positive, your speed relative to the road is 9 m/s, the sum of 8 m/s and 1 m/s.

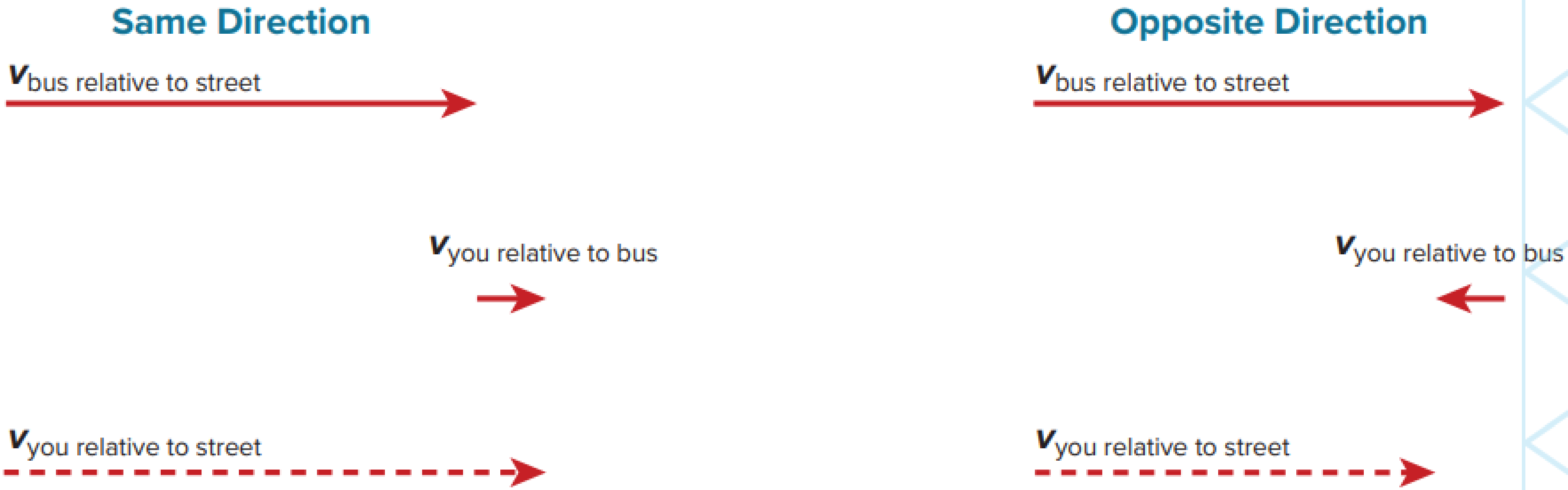


Figure 13 When an object moves in a moving reference frame, you add the velocities if they are in the same direction. You subtract one velocity from the other if they are in opposite directions.

$V_{b/s}$

25. You are riding in a bus moving slowly through heavy traffic at 2.0 m/s. You hurry to the front of the bus at 4.0 m/s relative to the bus. What is your speed relative to the street?

$V_{y/b}$ $V_{y/s}$

$$V_{y/s} = V_{b/s} + V_{y/b}$$

$$V_{y/s} = 2 + 4 = 6 m/s$$

$V_{b/s}$ = Velocity of bus relative to street

$V_{y/b}$ = Velocity of you relative to bus

$V_{y/s}$ = Velocity of you relative to street

26. Rafi is pulling a toy wagon through a neighborhood at a speed of 0.75 m/s. A caterpillar in the wagon is crawling toward the rear of the wagon at 2.0 cm/s. What is the caterpillar's velocity relative to the ground?

$V_{t/G}$ = Velocity of toy relative to Ground = 0.75 m/s

$V_{c/t}$ = velocity of Caterpillar relative to toy = 2.0 cm/s

$V_{c/t} = -2.0\ cm/s$ (Because it moves opposite to toy)

$= -2 \times 10^{-2}\ m/s$

$V_{c/G} = V_{c/t} + V_{t/G}$

$= (-2 \times 10^{-2}) + 0.75 = 0.73\ m/s$

$V_{b/w}$

27. A boat moves directly upriver at 2.5 m/s relative to the water. Viewers on the shore see that the boat is moving at only 0.5 m/s relative to the shore. What is the speed of the river? Is it moving with or against the boat?

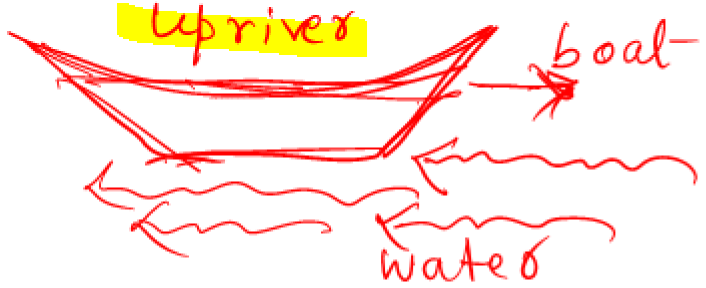
$V_{b/G}$

$V_{w/G}$

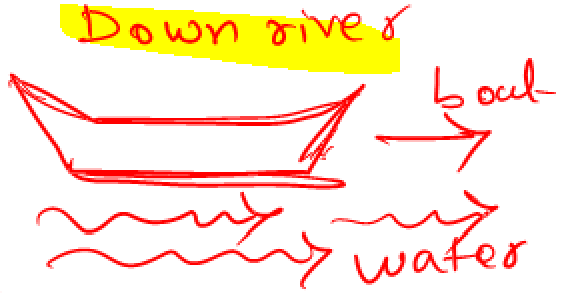
$V_{b/w} = 2.5\,m/s$

$V_{b/G} = 0.5\,m/s$

$V_{w/G} = ?$



$$V_{b/G} = V_{w/G} + V_{b/w}$$



$$2.5 = V_{w/G} + 0.5$$

$$2.5 - 0.5 = 2 = V_{w/G}$$

As the boat moving upriver, water moving opposite to boat

30. CHALLENGE The airplane in **Figure 16** flies at 200.0 km/h relative to the air. What is the velocity of the plane relative to the ground if it flies during the following wind conditions?

a. a 50.0-km/h tailwind

b. a 50.0-km/h headwind

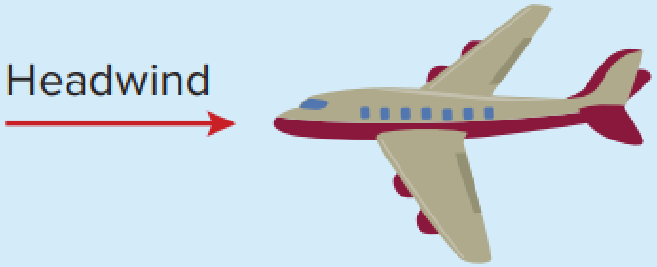
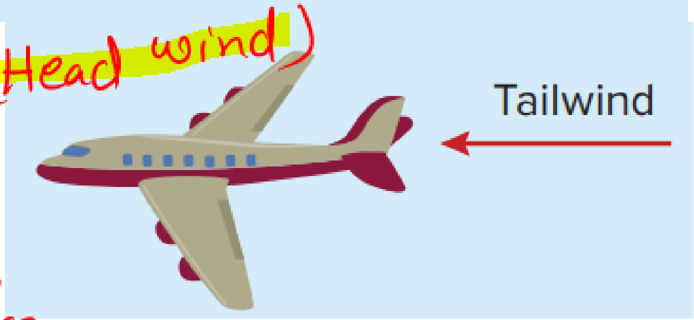


Figure 16



a) $V_{p/a} = 200.0 \, km/h$

$V_{a/G} = 50 \, km/h$ (tail wind)

$V_{p/G} = V_{p/a} + V_{a/G}$

$= 200 + 50$

$V_{p/G} = 250 \, km/h$

b) $V_{a/G} = -50 \, km/h$ (Head wind)

$V_{p/G} = V_{p/a} + V_{a/G}$

$= 200 - 50$

$V_{p/G} = 150 \, km/h$

3	1) Explain Kepler's First Law . 2) Explain Kepler's Second Law . 3) Explain Kepler's Third Law . 4) Explain the law of universal gravitation. 5) Calculate the orbital period of a planet orbiting the Sun.	Stu. textbook Check your progress Q.8	163-164 166 170

Kepler's Laws

In 1600 Tycho moved to Prague where Johannes Kepler, a 29-year-old German, became one of his assistants. Kepler analyzed Tycho's observations. After Tycho's death in 1601, Kepler continued to study Tycho's data and used geometry and mathematics to explain the motion of the planets. After seven years of careful analysis of Tycho's data on Mars, Kepler discovered the laws that describe the motion of every planet and satellite, natural or artificial. Here, the laws are presented in terms of planets.

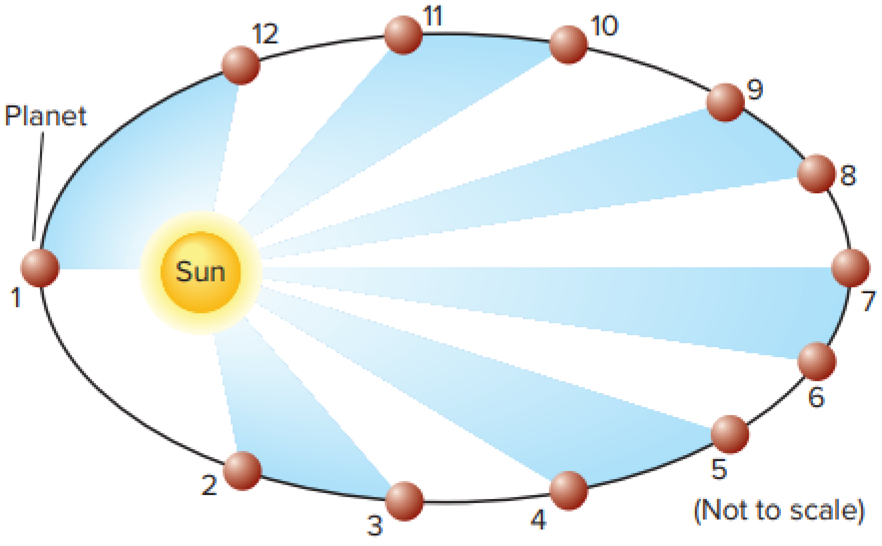


Figure 3 Kepler found that elliptical orbits sweep out equal areas in equal time periods.

Explain *why the equal time areas are shaped differently.*

Kepler's first law states that the paths of the planets are ellipses, with the Sun at one focus. An ellipse has two foci, as shown in **Figure 2**. Although exaggerated ellipses are used in the diagrams, Earth's actual orbit is very nearly circular. You would not be able to distinguish it from a circle visually.

Kepler found that orbits might change due to gravitational effects from, or collisions with, other objects in the solar system. He also found that the planets move faster when they are closer to the Sun and slower when they are farther away from the Sun. **Kepler's second law** states that an imaginary line from the Sun to a planet sweeps out equal areas in equal time intervals, as illustrated in **Figure 3.**

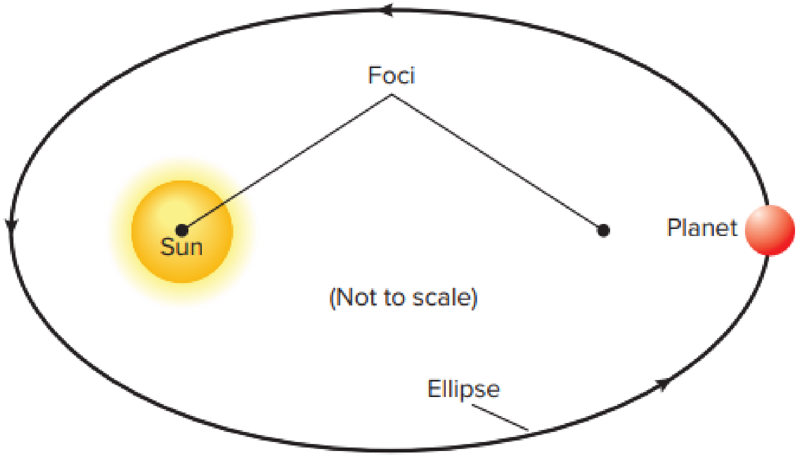


Figure 2 The orbit of each planet is an ellipse, with the Sun at one focus.

Hill Education

Which of the following is proportional to the square of the period of a planet orbiting the Sun?

أي مما يلي يتناسب طرديا مع مربع الزمن الدوري لكوكب يدور حول الشمس ؟

the product of the mass of the planet and the mass of the Sun
حاصل ضرب كتلة الكوكب وكتلة الشمس

the mass of the planet
كتلة الكوكب

the distance between the planet and the Sun cubed
مكعب المسافة بين الكوكب والشمس

the mass of the Sun
كتلة الشمس

Kepler's third law states that the square of the ratio of the periods of any two planets revolving about the Sun is equal to the cube of the ratio of their average distances from the Sun. Thus, if the periods of the planets are T_A and T_B and their average distances from the Sun are r_A and r_B, Kepler's third law can be expressed as follows.

Kepler's Third Law

The square of the ratio of the period of planet A to the period of planet B is equal to the cube of the ratio of the distance between the centers of planet A and the Sun to the distance between the centers of planet B and the Sun.

$$\left(\frac{T_A}{T_B}\right)^2 = \left(\frac{r_A}{r_B}\right)^3$$

Note that Kepler's first two laws apply to each planet, moon, and satellite individually. The third law, however, relates the motion of two objects around a single body. For example, it can be used to compare the planets' distances from the Sun, shown in **Table 1,** to their periods around the Sun. It also can be used to compare distances and periods of the Moon and artificial satellites orbiting Earth.

4	**1)** Apply the law of universal gravitation to calculate the gravitational force or other unknown parameters. **2)** Explain the law of universal gravitation and write it in equation form $\left[F_g=G\frac{m_1m_2}{r^2}\right]$.	Stu. textbook	166

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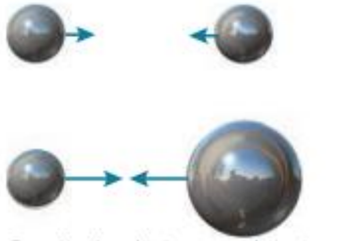
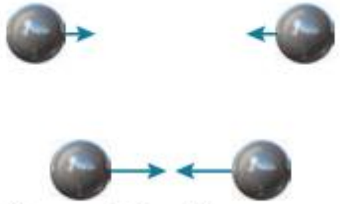
Newton's Law of Universal Gravitation



Gravitation between objects depends on the product of the masses of the objects.



The gravitational force between objects is inversely proportional to the square of the distance between the objects.

Figure 5 Mass and distance affect the magnitude of the gravitational force between objects.

In 1666, Isaac Newton began his studies of planetary motion. It has been said that seeing an apple fall made Newton wonder if the force that caused the apple to fall might extend to the Moon, or even beyond. He found that the magnitude of the force (F_g) on a planet due to the Sun varies inversely with the square of the distance (r) between the centers of the planet and the Sun. That is, F_g is proportional to $\frac{1}{r^2}$. The force ($\mathbf{F}_g$) acts in the direction of the line connecting the centers of the two objects, as shown in **Figure 5.**

Newton found that both the apple's and the Moon's accelerations agree with the $\frac{1}{r^2}$ relationship. According to his own third law, the force Earth exerts on the apple is exactly the same as the force the apple exerts on Earth. Even though these forces are exactly the same, you can easily observe the effect of the force on the apple because it has much lower mass than Earth. The force of attraction between two objects must be proportional to the objects' masses and is known as the **gravitational force.**

Newton was confident that the same force of attraction would act between any two objects anywhere in the universe. He proposed the **law of universal gravitation,** which states that objects attract other objects with a force that is proportional to the product of their masses and inversely proportional to the square of the distance between them. Newton's law of universal gravitation, shown below, provides the mathematical models to describe and predict the effects of gravitational forces between distant objects.

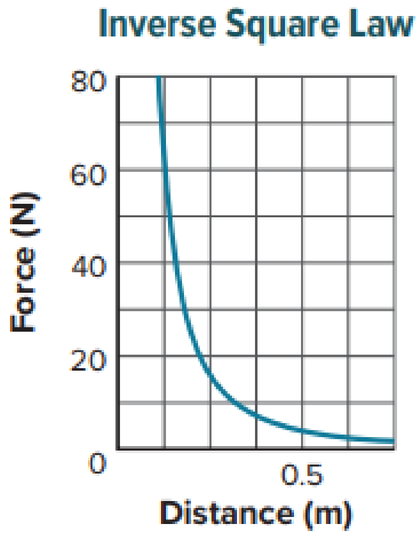


Figure 6 This is a graphical representation of the inverse square relationship.

Law of Universal Gravitation

The gravitational force is equal to the universal gravitational constant, times the mass of object 1, times the mass of object 2, divided by the distance between the centers of the objects, squared.

$$F_g = \frac{Gm_1m_2}{r^2}$$

When decreasing the distance between two bodies, the gravitational force between them ....

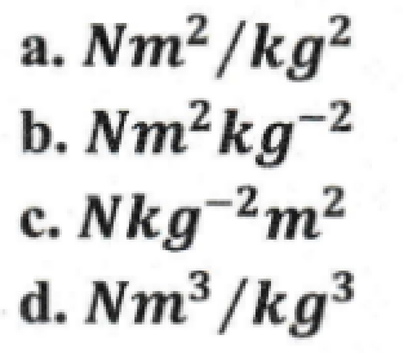
a. increases.

b. decreases.

c. remains constant.

d. becomes zero.

Which of the following is not a valid measuring unit of (G)



a. Nm^2/kg^2

b. Nm^2kg^{-2}

c. $Nkg^{-2}m^2$

d. Nm^3/kg^3

A piece of iron is placed (23 cm) away from a piece of nickel that has a mass of (46 kg) .) . Given that the force of gravity between them is (2.9 x 10^{-8} N), what is the mass of the piece of iron?

0.50 kg

0.90 kg

5.00 kg

2.50 kg

Two objects each with mass m at a distance r from each other. The gravitational force between them is F. If the masses of the objects are increased to be 3r, what will be the gravitational force between the objects?

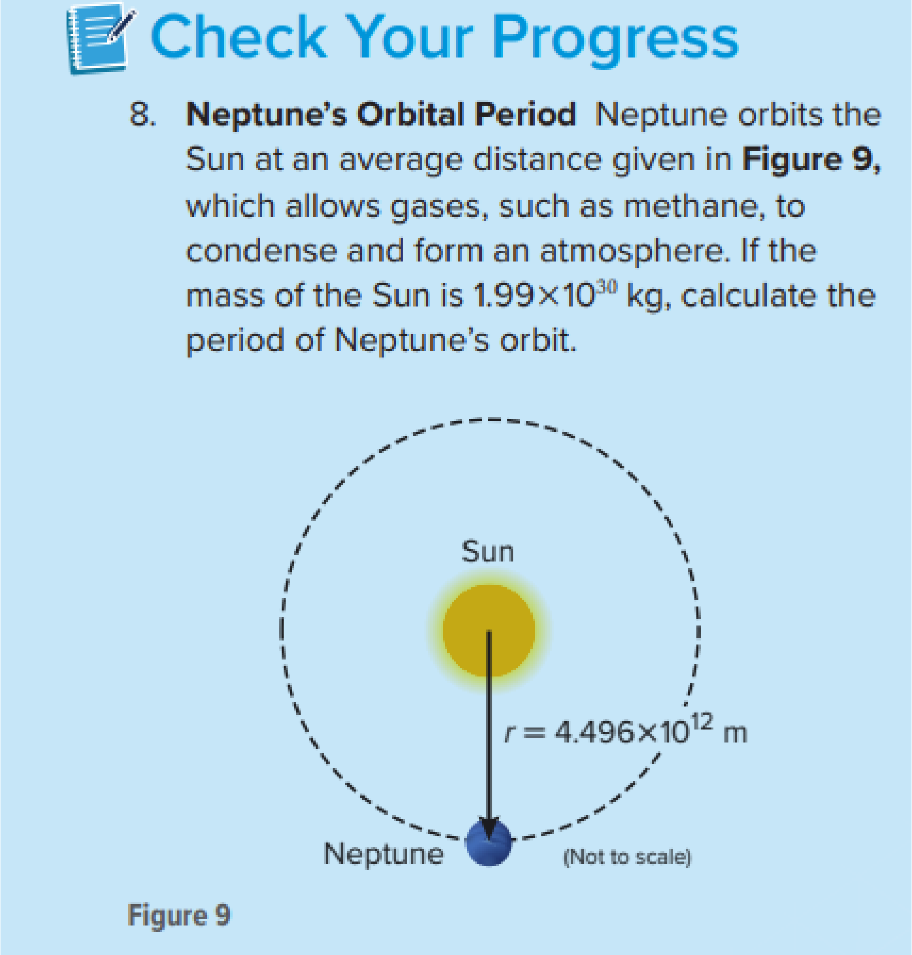
9F

F/9

3F

F/3

3	**1)** Explain Kepler's First Law .	Stu. textbook	**163-164**
	2) Explain Kepler's Second Law .		**166**
	3) Explain Kepler's Third Law .		
	4) Explain the law of universal gravitation.	Check your progress Q.**8**	**170**
	5) Calculate the orbital period of a planet orbiting the Sun.		



Check Your Progress

8. **Neptune's Orbital Period** Neptune orbits the Sun at an average distance given in **Figure 9,** which allows gases, such as methane, to condense and form an atmosphere. If the mass of the Sun is 1.99×10^{30} kg, calculate the period of Neptune's orbit.

Figure 9

Given:

$m = 1.99\times10^{30}\,kg$

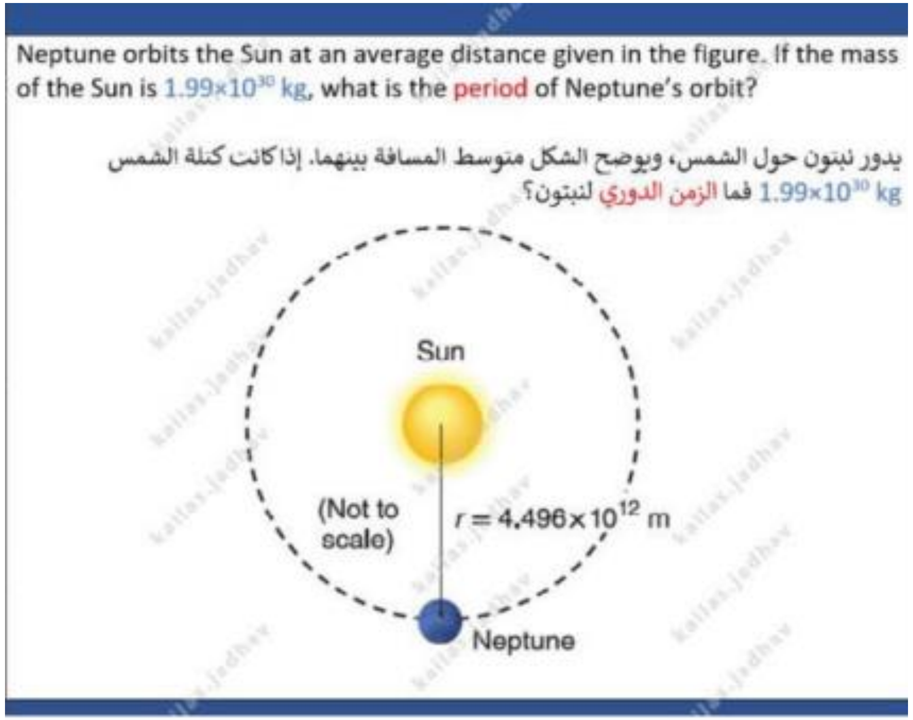
$r = 4.496\times10^{12}\,m$

$$T = 2\pi\sqrt{\frac{r^3}{Gm}}$$

$G = 6.67\times10^{-11}\,Nm^2/kg^2$

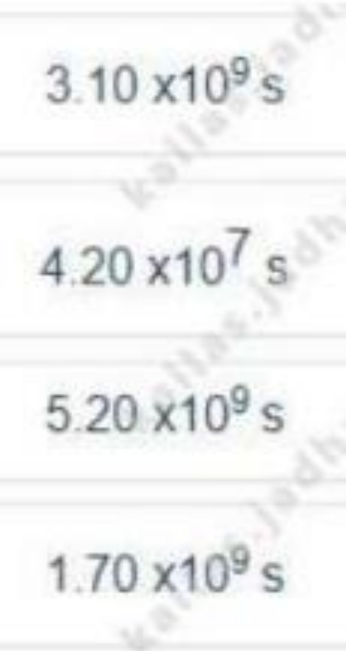
$$T = 2\times3.14\sqrt{\frac{(4.496\times10^{12})^3}{6.67\times10^{-11}\times1.99\times10^{30}}}$$

$T = 5.19\times10^{9}\,s = \underline{5.20\times10^{9}s}$



Neptune orbits the Sun at an average distance given in the figure. If the mass of the Sun is 1.99×10^{30} kg, what is the **period** of Neptune's orbit?

يدور نبتون حول الشمس، ويوضح الشكل متوسط المسافة بينهما. إذا كانت كتلة الشمس 1.99×10^{30} kg فما **الزمن الدوري** لنبتون؟



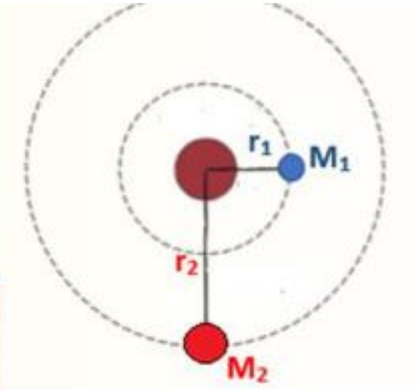
3.10×10^{9} s

4.20×10^{7} s

5.20×10^{9} s

1.70×10^{9} s

Two moons M_1, M_2 with different masses are moving in their orbits around a planet, as shown in the figure. Which of the following is true for their periods in their orbits?



a. M_2 has a smaller period than M_1

b. M_2 has a greater period than M_1

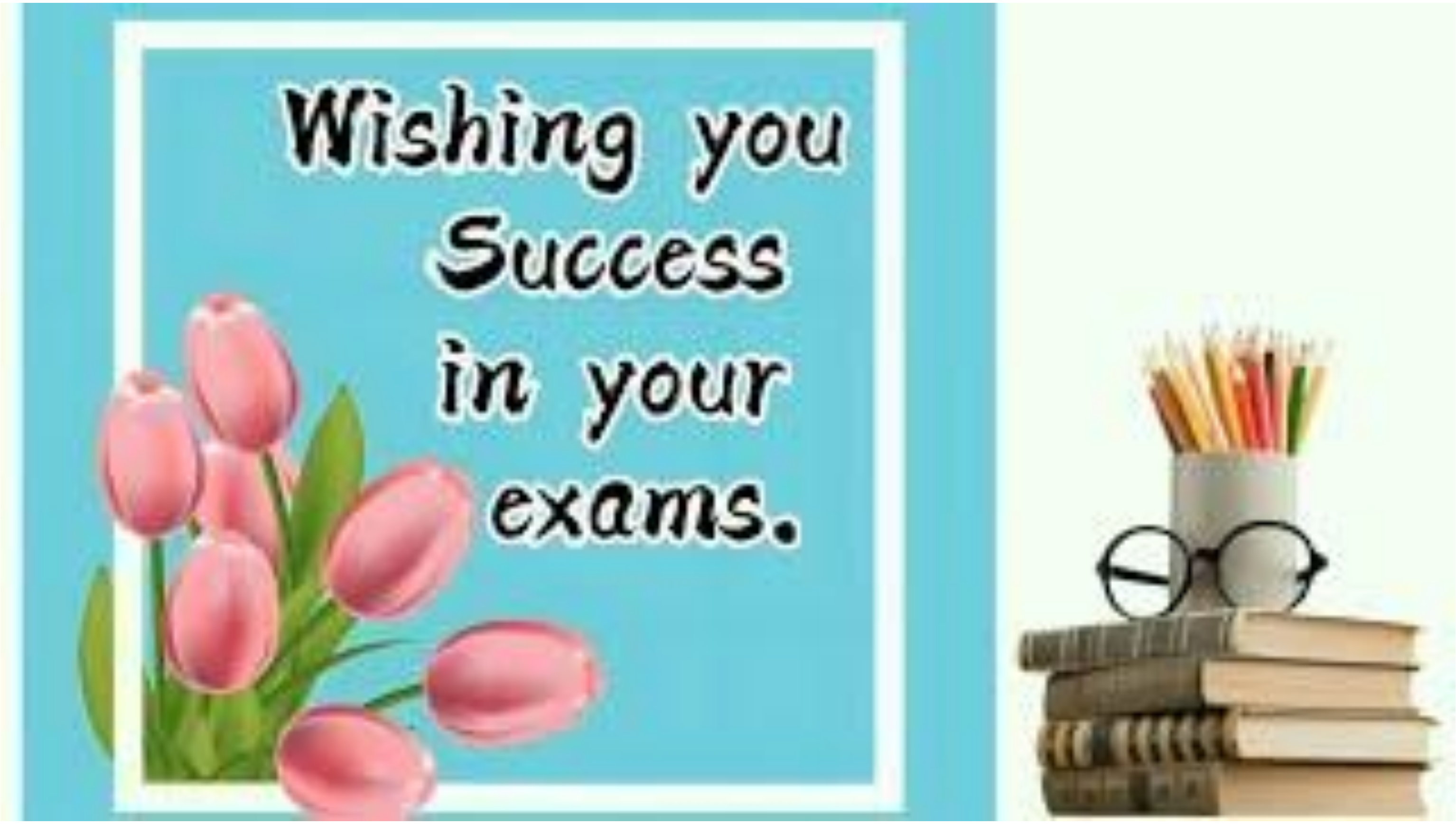
c. M_2 and M_1 have the same period

d. It can't be determined

19- Mercury orbits the Sun with an orbital radius of (5.8×10^{10} m). Given that the mass of the Sun is (2.0×10^{30} kg), and the mass of Mercury is (3.3×10^{23} kg).

- Calculate the period of Mercury's orbit.

- Calculate the gravitational force between Mercury and the Sun.


Wishing you
Success
in your
exams.