Math 3 Name: **KEY**

Unit 2.4 Linear and Angular Speed PRACTICE

Use the formula $\omega = \frac{\theta}{t}$ to find the value of the missing variable.

1) $\omega = \frac{2\pi}{3}$ radians per sec, t = 3 sec

2π *radians*

2) $\omega = \frac{\pi}{4}$ radians per min, t = 5 min

$\frac{5\pi}{4}$ *radians*

3) $\theta = \frac{3\pi}{4}$ radians, t = 8 sec

$\frac{3\pi}{32}$ *radians per sec*

4) $\theta = \frac{2\pi}{5}$ radians, t = 10 sec

$\frac{\pi}{25}$ *radians per sec*

5) $\theta = \frac{2\pi}{9}$ radians, $\omega = \frac{5\pi}{27}$ radians per min

$\frac{6}{5}$ *min*

6) $\theta = \frac{3\pi}{8}$ radians, $\omega = \frac{\pi}{24}$ radians per min

9 *min*

7) $\theta = 3.871142$, t = 21.4693 sec

0.180311 radians per sec

8) $\omega = 0.90674$ radians per min, t = 11.876 min

10.768 radians

Use the formula $v = r\omega$ to find the value of the missing variable.

9) $\omega = \frac{2\pi}{3}$ radians per sec, r = 12 m

8π *m per sec*

10) $\omega = \frac{9\pi}{5}$ radians per min, r = 8 cm

$\frac{72\pi}{5}$ *cm per sec*

11) v = 9 m per sec, r = 5 m

$\frac{9}{5}$ *radians per sec*

12) v = 18 ft per sec, r = 3 ft

6 *radians per sec*

13) v = 107.692 m per sec, r = 58.7413 m

1.83333 *radians per sec*

14) ω = 0.372914 radian per sec, r = 24.93215 cm

9.29755 *cm per sec*

The formula $\omega = \frac{\theta}{t}$ can be rewritten as $\theta = \omega t$. Using ωt for θ changes $s = r\theta$ to $s = r\omega t$.
Use the formula $s = r\omega t$ to find the value of the missing variable.

15) $\omega = \frac{\pi}{3}$ radians per sec, r = 6 cm, t = 9 sec

18π *cm*

16) $\omega = \frac{2\pi}{5}$ radians per sec, r = 9 yd, t = 12 sec

$\frac{216\pi}{5}$ *yd*

17) $\omega = \frac{\pi}{4}$ radians per sec, r = 2 cm, s = 6π cm

12 sec

18) $\omega = \frac{2\pi}{5}$ radians per sec, r = $\frac{3}{2}$ m, s = $\frac{12\pi}{5}$ m

4 sec

19) t = 4 sec, r = 2 km, s = $\frac{3\pi}{4}$ cm

$\frac{3\pi}{32}$ *radians per sec*

20) t = 12 sec, r = $\frac{4}{3}$ m, s = $\frac{8\pi}{9}$ m

$\frac{\pi}{18}$ *radians per sec*

Find ω for each of the following.

21) the hour hand of a clock

$\frac{\pi}{6}$ *radians per hour*

22) a line from the center to the edge of a CD revolving 300 times per min

600π *radians per min*

23) the minute hand of a clock $\frac{\pi}{30}$ *radians per min*

24) the second hand of a clock $\frac{\pi}{30}$ *radians per sec*

Find v for each of the following. (for #25 - #30)

25) the tip of the minute hand of a clock, if the hand is 7 cm long $\frac{7\pi}{30}$ $cm\ per\ min$

26) the tip of the second hand of a clock, if the hand is 28 mm long $\frac{14\pi}{15}$ $mm\ per\ sec$

27) a point on the edge of a flywheel of radius 2 m, rotating 42 times per min $168\pi\ m\ per\ min$

28) a point on the tread of a tire of radius 18 cm, rotating 35 times per minute $1260\pi\ cm\ per\ min$

29) the tip of an airplane propeller 3 m long, rotating 500 times per minute (Hint: r = 1.5 m)
$1500\pi\ m\ per\ min$

30) a point on the edge of a gyroscope of radius 83 cm, rotating 680 times per min
$112{,}880\pi\ cm\ per\ min$

31) The tires of a bicycle have a radius 13 in. and are turning at the rate of 200 revolutions per min. How fast is the bicycle traveling in miles per hour? (Hint: 5280 ft = 1 mile) 15.5 mph

32) Mars rotates on its axis at the rate of about 0.2552 radian per hr. Approximately how many hours are in a Martian day? 24.62 hr

33) Earth travels about the sun in an orbit that is almost circular. Assume that the orbit is a circle with radius 93,000,000 mi. Its angular and linear speeds are used in designing solar-power facilities.

a) Assume that a year is 365 days, and find the angle formed by Earth's movement in one day with the sun at the vertex. $\frac{2\pi}{365}$ $radians\ per\ 1\ day$

b) Give the angular speed in radians per hour. $\frac{\pi}{4380}$ $radians\ per\ hr$

c) Find the linear speed of Earth in miles per hour. 66,700 mph

34) A thread is being pulled off a spool at the rate of 59.4 cm per sec. Find the radius of the spool if it makes 152 revolutions per min. 3.73 cm

35) A 90-horsepower outboard motor at full throttle will rotate its propeller at 5000 revolutions per min. Find the angular speed of the propeller in radians per second. 523.6 radians per sec

Math 3 Name: KEY

Unit 2.4 Linear and Angular Speed

Use the formula $\boldsymbol{\omega = \frac{\theta}{t}}$ to find the value of the missing variable.

1) $\omega = \frac{2\pi}{3}$ radians per sec, t = 3 sec
Set-up $\frac{2\pi}{3} = \frac{\theta}{3}$ solve for θ $2\pi\ radians$

2) $\omega = \frac{\pi}{4}$ radians per min, t = 5 min
Set-up $\frac{\pi}{4} = \frac{\theta}{5}$ solve for θ $\frac{5\pi}{4}\ radians$

3) $\theta = \frac{3\pi}{4}$ radians, t = 8 sec
Set-up $\boldsymbol{\omega} = \frac{\frac{3\pi}{4}}{8}$ solve for $\boldsymbol{\omega}$ $\frac{3\pi}{32}\ radian\ per\ sec$

4) $\theta = \frac{2\pi}{5}$ radians, t = 10 sec
Set-up $\boldsymbol{\omega} = \frac{\frac{2\pi}{5}}{10}$ solve for $\boldsymbol{\omega}$ $\frac{\pi}{25}\ radian\ per\ sec$

5) $\theta = \frac{2\pi}{9}$ radians, $\omega = \frac{5\pi}{27}$ radians per min
Set-up $\frac{5\pi}{27} = \frac{\frac{2\pi}{9}}{t}$ solve for t $\frac{6}{5}\ min$

6) $\theta = \frac{3\pi}{8}$ radians, $\omega = \frac{\pi}{24}$ radians per min
Set-up $\frac{\pi}{24} = \frac{\frac{3\pi}{8}}{t}$ solve for t $9\ min$

7) $\theta = 3.871142$, t = 21.4693 sec
Set-up $\boldsymbol{\omega} = \frac{3.871142}{21.4693}$ solve for $\boldsymbol{\omega}$ 0.180311 radian per sec

8) $\omega = 0.90674$ radians per min, t = 11.876 min
Set-up $0.90674 = \frac{\theta}{11.876}$ solve for θ
10.768 radians

Use the formula $\boldsymbol{v = r\omega}$ to find the value of the missing variable.

9) $\omega = \frac{2\pi}{3}$ radians per sec, r = 12 m
Set-up $v = 12 \cdot \frac{2\pi}{3}$ solve for v $8\pi\ m\ per\ sec$

10) $\omega = \frac{9\pi}{5}$ radians per min, r = 8 cm
Set-up $v = 8 \cdot \frac{9\pi}{5}$ solve for v $\frac{72\pi}{5} cm\ per\ sec$

11) v = 9 m per sec, r = 5 m
Set-up $9 = 5 \cdot \boldsymbol{\omega}$ solve for $\boldsymbol{\omega}$ $\frac{9}{5}\ radians\ per\ sec$

12) v = 18 ft per sec, r = 3 ft
Set-up $18 = 3 \cdot \boldsymbol{\omega}$ solve for $\boldsymbol{\omega}$ $6\ radians\ per\ sec$

13) v = 107.692 m per sec, r = 58.7413 m
Set-up $107.692 = 58.7413 \cdot \boldsymbol{\omega}$ solve for $\boldsymbol{\omega}$
$1.83333\ radians\ per\ sec$

14) ω = 0.372914 radian per sec, r = 24.93215 cm
Set-up $v = 24.93215 \cdot 0.372914$ solve for v
$9.29755\ cm\ per\ sec$

The formula $\boldsymbol{\omega = \frac{\theta}{t}}$ can be rewritten as $\boldsymbol{\theta = \omega t}$. Using $\boldsymbol{\omega t}$ for $\boldsymbol{\theta}$ changes $\boldsymbol{s = r\theta}$ to $\boldsymbol{s = r\omega t}$.
Use the formula $\boldsymbol{s = r\omega t}$ to find the value of the missing variable.

15) $\omega = \frac{\pi}{3}$ radians per sec, r = 6 cm, t = 9 sec
Set-up $s = 6 \cdot \frac{\pi}{3} \cdot 9$ solve for $\boldsymbol{s}$ $18\pi\ cm$

16) $\omega = \frac{2\pi}{5}$ radians per sec, r = 9 yd, t = 12 sec
Set-up $s = 9 \cdot \frac{2\pi}{5} \cdot 12$ solve for $\boldsymbol{s}$ $\frac{216\pi}{5}\ yd$

17) $\omega = \frac{\pi}{4}$ radians per sec, r = 2 cm, s = 6π cm
Set-up $6\pi = 2 \cdot \frac{\pi}{4} \cdot t$ solve for $\boldsymbol{t}$ 12 sec

18) $\omega = \frac{2\pi}{5}$ radians per sec, r = $\frac{3}{2}$ m, s = $\frac{12\pi}{5}$ m
Set-up $\frac{12\pi}{5} = \frac{3}{2} \cdot \frac{2\pi}{5} \cdot t$ solve for $\boldsymbol{t}$ 4 sec

19) t = 4 sec, r = 2 km, s = $\frac{3\pi}{4}$ cm
Set-up $\frac{3\pi}{4} = 2 \cdot \boldsymbol{\omega} \cdot 4$ solve for $\boldsymbol{\omega}$ $\frac{3\pi}{32}\ radian\ per\ sec$

20) t = 12 sec, r = $\frac{4}{3}$ m, s = $\frac{8\pi}{9}$ m
Set-up $\frac{8\pi}{9} = \frac{4}{3} \cdot \boldsymbol{\omega} \cdot 12$ solve for $\boldsymbol{\omega}$ $\frac{\pi}{18}\ radian\ per\ sec$

Find ω for each of the following. we can use any angle but 1 full circle might be easiest, so use 2π for θ.
use $\omega = \frac{\theta}{t}$

21) the hour hand of a clock t=12 hours because it takes 12 hours for the hand to go around once in a full circle.

Set-up $\omega = \frac{2\pi}{12\ hours}$ solve for ω $\frac{\pi}{6}\ radian\ per\ hour$

22) a line from the center to the edge of a CD revolving 300 times per min

You get 300 full circles every 1 minute or in other words.

Set-up $\omega = \frac{300 \cdot 2\pi}{1\ minute}$ solve for ω $600\pi\ radians\ per\ min$

23) the minute hand of a clock

Set-up $\omega = \frac{2\pi}{60\ minutes}$ solve for ω $\frac{\pi}{30}\ radian\ per\ min$

24) the second hand of a clock

Set-up $\omega = \frac{2\pi}{60\ seconds}$ solve for ω $\frac{\pi}{30}\ radian\ per\ sec$

Find v for each of the following. (for #25 - #30)
use $v = \frac{s}{t}$, or $v = \frac{r\theta}{t}$, or $v = r\omega$

25) the tip of the minute hand of a clock, if the hand is 7 cm long

Use $v = \frac{r\theta}{t}$ $\boldsymbol{r = 7\ cm}$ $\boldsymbol{\theta = 2\pi\ for\ 1\ full\ circle}$ $\boldsymbol{t = 60\ minutes\ for\ 1\ full\ circle}$

Set-up $v = \frac{7 \cdot 2\pi}{60\ minutes}$ solve for v $\frac{7\pi}{30}\ cm\ per\ min$

26) the tip of the second hand of a clock, if the hand is 28 mm long

Use $v = \frac{r\theta}{t}$ $\boldsymbol{r = 28\ mm}$ $\boldsymbol{\theta = 2\pi\ for\ 1\ full\ circle}$ $\boldsymbol{t = 60\ seconds\ for\ 1\ full\ circle}$

Set-up $v = \frac{28 \cdot 2\pi}{60\ seconds}$ solve for v $\frac{14\pi}{15}\ mm\ per\ sec$

27) a point on the edge of a flywheel of radius 2 m, rotating 42 times per min

Use $v = \frac{r\theta}{t}$ $\boldsymbol{r = 2\ m}$ $\boldsymbol{\theta = 42 \cdot 2\pi\ for\ 42\ full\ circles}$
$\boldsymbol{t = 1\ min\ for\ 42\ full\ circles}$

Set-up $v = \frac{2 \cdot 42 \cdot 2\pi}{1\ minute}$ solve for v $168\pi\ m\ per\ min$

28) a point on the tread of a tire of radius 18 cm, rotating 35 times per minute

Use $v = \frac{r\theta}{t}$ $\quad\quad$ $\boldsymbol{r = 18\ cm \quad \theta = 35 \cdot 2\pi\ for\ 35\ full\ circles}$

$\boldsymbol{t = 1\ min\ for\ 35\ full\ circles}$

Set-up $\boldsymbol{v} = \frac{18 \cdot 35 \cdot 2\pi}{1\ minute}$ solve for $\boldsymbol{v}$ $\quad\quad$ $1260\pi\ cm\ per\ min$

29) the tip of an airplane propeller 3 m long, rotating 500 times per minute (Hint: r = 1.5 m)

Use $v = \frac{r\theta}{t}$ $\quad\quad$ $\boldsymbol{r = 1.5\ m \quad \theta = 500 \cdot 2\pi\ for\ 500\ full\ circles}$

$\boldsymbol{t = 1\ min\ for\ 500\ full\ circles}$

Set-up $\boldsymbol{v} = \frac{1.5 \cdot 500 \cdot 2\pi}{1\ minute}$ solve for $\boldsymbol{v}$ $\quad\quad$ $1500\pi\ m\ per\ min$

30) a point on the edge of a gyroscope of radius 83 cm, rotating 680 times per min

Use $v = \frac{r\theta}{t}$ $\quad\quad$ $\boldsymbol{r = 83\ cm \quad \theta = 680 \cdot 2\pi\ for\ 680\ full\ circles}$

$\boldsymbol{t = 1\ min\ for\ 680\ full\ circles}$

Set-up $\boldsymbol{v} = \frac{83 \cdot 680 \cdot 2\pi}{1\ minute}$ solve for $\boldsymbol{v}$ $\quad\quad$ $112{,}880\pi\ cm\ per\ min$

31) The tires of a bicycle have a radius 13 in. and are turning at the rate of 200 revolutions per min. How fast is the bicycle traveling in miles per hour? (Hint: 5280 ft = 1 mile)

Use $v = \frac{r\theta}{t}$ $\quad\quad$ $\boldsymbol{r = 13\ in \quad \theta = 200 \cdot 2\pi\ for\ 200\ full\ circles}$

$\boldsymbol{t = 1\ min\ for\ 200\ full\ circles}$

Set-up $\boldsymbol{v} = \frac{13 \cdot 200 \cdot 2\pi}{1\ minute}$ solve for $\boldsymbol{v}$ $\quad\quad$ $\boldsymbol{v = 5200\pi}$ **inches per min. or 16,336.2818 inches per min**

Do unit conversions: $\frac{16{,}336.2818\ \cancel{inches}}{1\ \cancel{minutes}} \cdot \frac{1\ \cancel{ft}}{12\ \cancel{inches}} \cdot \frac{1\ mile}{5280\ \cancel{ft}} \cdot \frac{60\ \cancel{minutes}}{1\ hour} = \frac{15.46996383\ miles}{1\ hours}$ $\quad\quad$ 15.5 mph

32) Mars rotates on its axis at the rate of about 0.2552 radian per hr.
Approximately how many hours are in a Martian day?

use $\boldsymbol{\omega = \frac{\theta}{t}}$ $\quad\quad$ Set-up $0.2552 = \frac{2\pi}{t}$ solve for $\boldsymbol{t}$ $\quad\quad$ 24.62 hr

33) Earth travels about the sun in an orbit that is almost circular. Assume that the orbit is a circle with radius 93,000,000 mi. Its angular and linear speeds are used in designing solar-power facilities.

a) Assume that a year is 365 days, and find the angle formed by Earth's movement in one day with the sun at the vertex.

Well, if 2π is 1 full circle for 1 year I can write this as: $\frac{2\pi}{1\ year}$

I need this in days not years so I will do a conversion: $\frac{2\pi}{1\ year} \cdot \frac{1\ year}{365\ days} = \frac{2\pi}{365\ days}$ $\frac{2\pi}{365}\ radians\ per\ 1\ day$

b) Give the angular speed in radians per hour.

Do more conversions: $\frac{2\pi}{365\ days} \cdot \frac{1\ day}{24\ hours} = \frac{\pi}{4380\ hours}$ $\frac{\pi}{4380}\ radian\ per\ hr$

c) Find the linear speed of Earth in miles per hour.

use $v = r\omega$ we just found ω in radians per hour, it was $\frac{\pi}{4380}$, and r is in the problem, it was 93,000,000 mi.

so, $v = 93{,}000{,}000 \cdot \frac{\pi}{4380} = 66{,}705.04949$ 66,700 mph

34) A thread is being pulled off a spool at the rate of 59.4 cm per sec. Find the radius of the spool if it makes 152 revolutions per min.

First get things into the same units by changing 59.4 cm per sec to cm per minute

Do a conversion: $\frac{59.4\ cm}{1\ second} \cdot \frac{60\ seconds}{1\ minute} = 3564\ cm\ per\ minute$

Use $\boldsymbol{v = \frac{r\theta}{t}}$ $\boldsymbol{v = 3564\ cm\ per\ minute}$ $\boldsymbol{\theta = 152 \cdot 2\pi\ for\ 152\ full\ circles}$

$\boldsymbol{t = 1\ min\ for\ 152\ full\ circles}$

Set-up $\boldsymbol{3564} = \frac{r \cdot 152 \cdot 2\pi}{1}$ solve for $\boldsymbol{r}$ 3.73 cm

35) A 90-horsepower outboard motor at full throttle will rotate its propeller at 5000 revolutions per min. Find the angular speed of the propeller in radians per second.

use $\omega = \frac{\theta}{t}$ Set-up $\omega = \frac{5{,}000 \cdot 2\pi}{1\ minute} = 10{,}000\pi\ radians\ per\ minute$

solve for t then convert to units per second

Do a conversion: $\frac{10{,}000\pi\ radians}{1\ minute} \cdot \frac{1\ minutes}{60\ seconds} = 523.5987756$ 523.6 radians per sec