H. Trigonometry
Pd_____

Name_____
Date _____

Linear and Angular Speed Worksheet

DJ L-Boogie has a turntable that has two settings, 33 rpm or 45 rpm (revolutions per minute).

1. When the turntable is set at 33 revolutions per minute (rpm), what is its angular speed in radians per minute?

$\frac{\theta}{t} = \frac{33 \cdot 2\pi}{1 min} = 66\pi$ rad/min

2. When the turntable is set at 45 rpm, what is its angular speed in radians per minute?

$\frac{\theta}{t} = \frac{45 \cdot 2\pi}{1 min} = 90\pi$ rad/min

While a record is spinning, a ladybug lands on the turntable 10 inches from the center.

3. What is the linear speed (in inches per minute) of the ladybug when the turntable is set to:

a) 33 rpm

$10 \cdot 66\pi$

2073.45 inches/min

b) 45 rpm

$10 \cdot 90\pi$

2827.43 inches/min

4. The ladybug crawls towards the middle and is now 3 inches from the center, what is the linear speed (in inches per minute) of the ladybug when the turntable is set to:

a) 33 rpm

$3 \cdot 66\pi$

622.04 inches/min

b) 45 rpm

$3 \cdot 90\pi$

848.23 inches/min

5. Convert the speed of the bug in problem 3 at 33 rpm to miles per hour.

$\frac{2073.45 inches}{1 min} \cdot \frac{60 min}{1 hr} \cdot \frac{1 ft}{12 in} \cdot \frac{1 mile}{5280 ft} = \frac{124407}{63360} = 1.96$ mph

6. Convert the speed of the bug in problem 4 at 45 rpm to miles per hour.

$\frac{848.23 inches}{1 min} \cdot \frac{60 min}{1 hr} \cdot \frac{1 foot}{12 inches} \cdot \frac{1 mile}{5280 ft} = \frac{50893.8}{63360} = .80$ mph

7. A 16mm diameter shaft rotates at 1,500 rps (revolutions per second). Find the speed of a particle on its surface (to the nearest meter per second). Linear Speed $r = 8$mm

$\frac{r\theta}{t} = \frac{8 \cdot 1500(2\pi) mm}{1 sec} \cdot \frac{1 meter}{1000 mm} = 75.4$ meters/sec

Linear Speed

8. An earth satellite travels in a circular orbit at 20,000 mph. If the radius of the orbit is 4,300 mi, what angular velocity (in radians per hour, to one decimal place) is generated?

$\frac{r\theta}{t} = \frac{20000\ m}{1\ hr}$ $\quad 4300\,\theta = 20000$ miles/hr

$\theta = 4.7$ radians/hr

9. The earth revolves about the sun in an orbit that is approximately circular with a radius of 9.3×10^7 mi. The radius of orbit sweeps out an angle with what exact angular velocity (in radians per hour)? How fast (to the nearest hundred miles per hour) is the earth traveling around its orbit. Hint: it takes the earth 365 days to complete its orbit.

Angular $= \frac{\theta}{t} = \frac{2\pi}{365 days} \cdot \frac{1 day}{24 hrs} = \frac{2\pi}{8760} = \boxed{\frac{\pi}{4380} \text{ radians/hr}}$

Linear $= \frac{9.3 \times 10^7 \pi \text{ miles}}{4380 \text{ hour}} = \boxed{66705.05 \text{ mph}}$

10. The second hand on Mr. Incredible's watch is .25 inches long. How fast is the tip of the second hand moving? Give your answer in inches per second.

Linear speed $\frac{r\theta}{t} = \frac{.25(1)2\pi}{60 sec} = \boxed{.026 \text{ in/sec}}$

11. A neighborhood carnival has a Ferris wheel whose radius is 30 feet. You measure the time it takes for one revolution to be 70 seconds. What is the linear speed (in feet per second) of this Ferris wheel? What is the angular speed in radians per second?

Angular

$\frac{2\pi}{70} = \boxed{\frac{\pi}{35} \text{ radians/sec}}$

Linear

$\frac{30\pi}{35} = \boxed{2.6928 \text{ feet/sec}}$

12. A spin balancer rotates the wheel of a car at 480 revolutions per minute. If the diameter of the wheel is 26 inches, what road speed is being tested? Express your answer in miles per hour. At how many revolutions per minute should the balancer be set to test a road speed of 80 miles per hour?

See Attached

13. A Ford Expedition comes standard with tires that have a diameter of 25 inches. If the owner decided to upgrade to tires with a diameter of 30 inches without having the onboard computer updated, how fast will the Expedition actually be traveling when the speedometer reads 75 mph?

See Attached

(12) Linear (mph)

$$\frac{r\theta}{t} = \frac{13(2\pi)(480)\,in}{1\,min} \cdot \frac{60\,min}{1\,hr} \cdot \frac{1\,ft}{12\,in} \cdot \frac{1\,mile}{5280\,ft}$$

$$= 37.12\ mph$$

convert to inches/min

$$\frac{80\,miles}{1\,hr} = \frac{13(2\pi)X\,in}{1\,min}$$

Given linear speed find # of rotations

$$\frac{80\,miles}{1\,hr} \cdot \frac{1\,hr}{60\,min} \cdot \frac{5280\,ft}{1\,mile} \cdot \frac{12\,in}{1\,ft} = \frac{26\pi X\,in}{1\,min}$$

"X" is # of revolutions

$$\frac{84480\,in}{1\,min} = \frac{26\pi X\,in}{1\,min}$$

$$\frac{84480}{26\pi} = \frac{26\pi X}{26\pi}$$

$$1034.26\ rotations/min$$

(13) 25 in diam.

75 mph → linear speed

find # of rotations

- first convert linear speed to inches

$$\frac{75 \text{ miles}}{1 \text{ hr}} \cdot \frac{5280 \text{ ft}}{1 \text{ mile}} \cdot \frac{12 \text{ in}}{1 \text{ ft}}$$

$$4752000 \text{ in/hr}$$

$$\text{Linear} = \frac{r\theta}{t}$$

$$\frac{4752000 \text{ in}}{1 \text{ hr}} = \frac{12.5(2\pi) \text{ X in}}{1 \text{ hr}}$$

$$\frac{4752000 \text{ in}}{25\pi} = \frac{25\pi \text{ X in}}{25\pi}$$

$$\boxed{X = 60504.343 \text{ rotations/hr}}$$

30 in diam

$$\frac{15(2\pi)(60504.343) \text{ in}}{1 \text{ hr}}$$

$$\frac{1815130.29\pi \text{ in}}{1 \text{ hr}} \cdot \frac{1 \text{ ft}}{12 \text{ in}} \cdot \frac{1 \text{ mile}}{5280 \text{ ft}}$$

$$89.99$$

$$\boxed{\approx 90 \text{ mph}}$$