

1. Convert the following angles:

a) from degrees ($^{\circ}$) to radians (rad):	360°	90°	30°	5.93°
b) from radians (rad) to degrees ($^{\circ}$):	2π	$\frac{\pi}{4}$	$\frac{3\pi}{5}$	5.93

2. A merry-go-round is executing a uniform circular motion. Where is the linear speed greater: closer to the center or farther away from it? Give reasons for your answer.

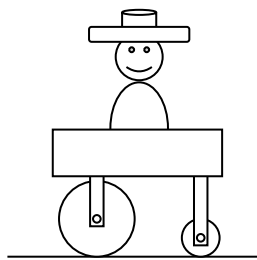
3. The largest railway station clock of Switzerland is in Aarau. The second hand on the clock is 2.2 m long.

- a) How long does one entire revolution of the clock's second hand take?
 - b) What is the distance covered by the second hand's tip during one entire revolution?
 - c) Determine the linear speed of the second hand's tip.
 - d) Determine the angle covered by the second hand during 15 seconds (in radians as well as in degrees).
 - e) What is the angular speed of the second hand?



4. A vehicle runs on wheels of two different sizes (see picture).

- a) Is the linear speed on the outside of the wheels the same? If no, where is it greater?
 - b) Do both wheels rotate at the same angular speed? If no, where is it greater?
 - c) Do both wheels rotate at the same period? If no, where is it greater?
 - d) Do both wheels rotate at the same frequency? If no, where is it greater?



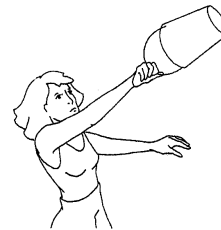
5. The radius of a car's tires is 28.0 cm, while the distance of the valve from the tire's center is 15.0 cm. The car is travelling at $100.0 \frac{\text{km}}{\text{h}}$.
 - a) What is the linear speed of a point on the outside of the tire (where it touches the road)?
 - b) What is the angular speed of the tire?
 - c) What is the frequency of the tire?
 - d) How long do ten revolutions of the tire take?
 - e) What is the linear speed of the valve?

6. The Earth orbits the Sun along an almost circular path of radius $1.5 \cdot 10^{11} \text{ m}$ (150 million kilometers). Determine the linear speed of the Earth.

7. The Earth (radius: 6378 km) rotates about its axis once every 24 hours.
 - a) Calculate the Earth's angular speed.
 - b) Determine the linear speed of a point on the equator.

8. The tip of the minute hand on a clock moves at $v = 1.5 \frac{\text{mm}}{\text{s}}$. How long is the clock's minute hand?

9. Complete the following sentences (using *a quarter / half / the same / twice / four times*):
- In order to keep an object of twice the mass moving along a circular path (without changing the radius and angular speed), the centripetal force is required.
 - In order to keep an object moving along a circular path at twice the angular speed (without changing the radius and mass), the centripetal force is required.
 - In order to keep an object moving along a circular path at twice the distance from the center (without changing the angular speed and mass), the centripetal force is required.
10. A person ($m = 75 \text{ kg}$) is at the equator (Earth's radius: 6378 km).
- How much centripetal force is needed for the person to move on a circular path about the Earth's center?
 - What force provides the centripetal force (that is, what force pulls the person towards the Earth's center)?
11. A small rock ($m = 200 \text{ g}$) is whirled about on a string of 50.0 cm length in a horizontal circular path. The maximum centripetal force that the string holds before it rips is 100.0 N . What is the maximum frequency?
12. Someone swings a bucket filled with water ($m = 4.5 \text{ kg}$) along a vertical circular path of radius 1.2 m (see picture). The linear speed is constant at $3.5 \frac{\text{m}}{\text{s}}$.
- Does the water stay in the bucket at its highest point? Give reasons for your answer.
 - Calculate the force that the girl's hand exerts on the bucket at its highest and at its lowest point.



solutions:

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|--|---------------------------------------|-------------------------------------|-------------------------------|-------------------------------------|
| 1. a) 6.28 | $\frac{\pi}{2} = 1.57$ | $\frac{\pi}{6} = 0.52$ | 0.103 | |
| b) 360° | 45° | 108° | 340° | |
| 3. a) 60 s | b) 14 m | c) $0.23 \frac{\text{m}}{\text{s}}$ | d) $\frac{\pi}{2} = 90^\circ$ | e) 0.105 s^{-1} |
| 5. a) $27.8 \frac{\text{m}}{\text{s}}$ | b) 99.2 s^{-1} | c) 15.8 mal | d) 0.63 s | e) $14.9 \frac{\text{m}}{\text{s}}$ |
| 6. $107 \cdot 10^3 \frac{\text{km}}{\text{h}}$ | | | | |
| 7. a) $72.7 \cdot 10^{-6} \text{ s}^{-1}$ | b) $1'670 \frac{\text{km}}{\text{h}}$ | | | |
| 8. 86 cm | | | | |
| 10. a) 2.5 N | | | | |
| 11. 5.03 Hz | | | | |
| 12. b) above: 1.8 N, below: 90 N | | | | |