Today, we will:

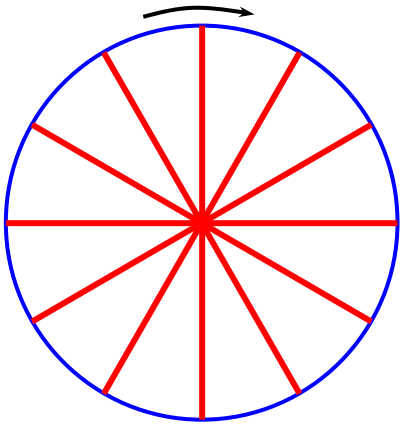
- Do some more example problems – rotation rate and stroboscopic tachometers
- Finish the pdf module: **Mechanical Measurements – Torque**, and do some examples

Example: RPM measurement

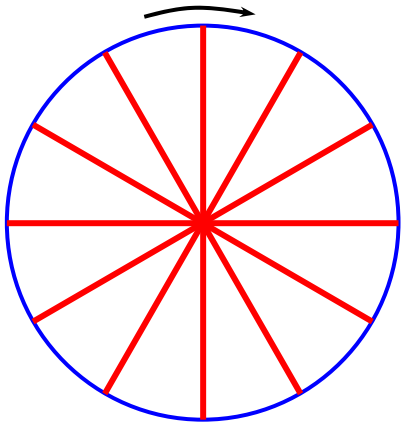
Given: A wagon wheel has 12 identical spokes, and rotates at 600 rpm. The rpm is measured with a stroboscopic tachometer in a room where it is dark except when the strobe light flashes. There are no painted dots anywhere, and *there is no way to distinguish one spoke from another*.

To do: Calculate the maximum strobe flashing frequency at which you could be fooled. In other words, calculate the maximum strobe flashing frequency at which you would see a wagon wheel that appears to be frozen (not rotating), and therefore you could be fooled into thinking that this is the correct rpm. *Give your answer as in integer in units of rpm.*

Solution:



$t = 0$



$t = \Delta t$

Example: RPM of car tire

Given: A car travels at 40 miles per hour. The outer diameter of its tires is 28 inches.

To do: Calculate the rotation rate of the wheel in units of rpm (rotations per minute).

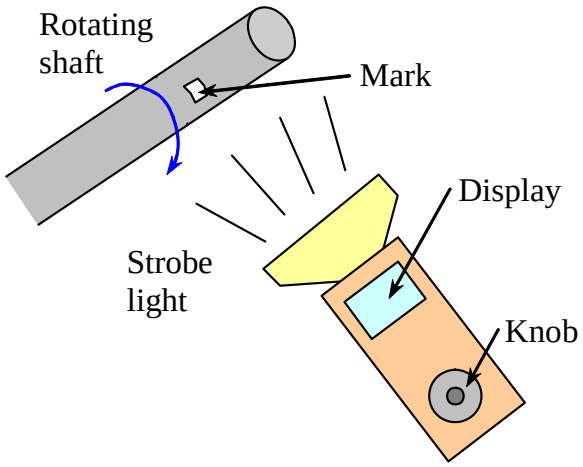
Solution:

Example: RPM measurement

Given: A white dot is painted on the shaft of a turbine. The shaft starts rotating at 860 rpm. Its rotational rate is measured by a stroboscopic tachometer.

(*a*) To do: Name at least two strobe settings (rpm) at which the strobotachometer would give a false reading of rotation rate (you are fooled).

Solution:



(*b*) To do: For the setup shown here, are there any strobe settings greater than 860 rpm at which the strobotachometer would give a false reading of rotation rate? Explain.

Solution:

Example: Dynamometer measurement

Given: Gerry is building a prony brake dynamometer to measure the torque output from a small (100 mL displacement) motorcycle engine. The maximum expected torque is 7.0 N·m, at a rotation rate of around 7500 rpm. Gerry has a fish-scale-type force gage with a range of 0 to 50 N. He would like to use this scale in his dynamometer.

(*a*) To do: Calculate the moment arm that Gerry should build for his dynamometer.

Solution:

(*b*) To do: Gerry tests the engine and finds that its maximum power output is 8.1 hp at 8500 rpm. Calculate the torque at this maximum-power operating condition.

Solution:

Example: Dynamometer measurement

Given: A prony brake dynamometer is used to test the output of a small engine:

- moment arm $r = 11.30$ cm $\pm$ 0.05 cm (measured with a ruler)
- force $F = 36.5 \pm 0.5$ N (measured with a fish scale)
- rotation rate of the engine shaft $N_{\text{rpm}} = 2012 \pm 1$ rpm (measured with a strobotach)

All measurements are to standard engineering (95%) confidence level.

To do: Calculate the engine shaft power (in units of watts) and its uncertainty.

Solution: