

2024 Q6

GEAR RATIOS

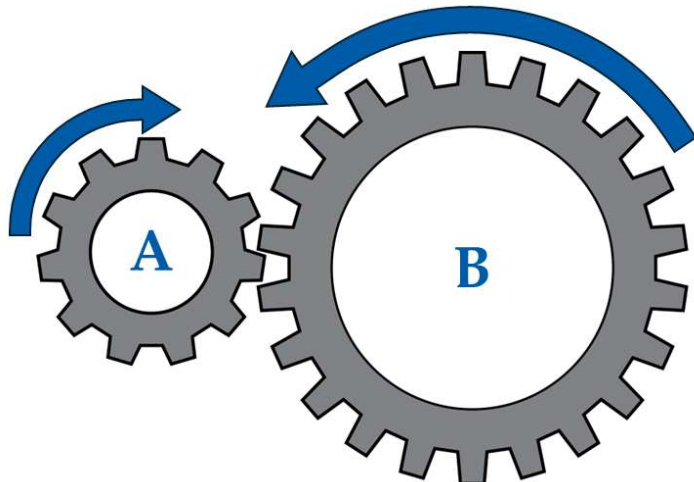
Hello students! Here at One Energy, we build, own, and operate megawatt-scale wind turbines for industrial customers. For these turbines to rotate around their Z-axis, three motors are dedicated to "yawing." Yawing is the process of turning the top of the turbine around the turbine's vertical axis to face directly into the wind and catch the wind more effectively. The combined weight of a turbine's nacelle, hub, generator, blades, and rotor can be upwards of 92 tons - so three small motors would struggle to yaw the entire assembly on their own. As a result, a gear ratio is used to facilitate this process, which increases the motor torque output while reducing turbine rotation speed. This means that the motors can spin many times with increased torque to achieve one revolution of the turbine hub.



A gear ratio refers to how many teeth a gear has, compared to how many teeth the gear it is meshing has. For example, if Gear A (shown below) has 11 teeth, and Gear B has 22 teeth, then the gear ratio would be 2:1 because Gear B has twice as many teeth as Gear A. What this means is that for every rotation of Gear A, Gear B only rotates half as much and at half the speed. To determine how a gear ratio will affect the output rotational speed a few equations and definitions can be considered.

RPM=Revolutions per Minute

$$RPM_A * Teeth_A = RPM_B * Teeth_B$$

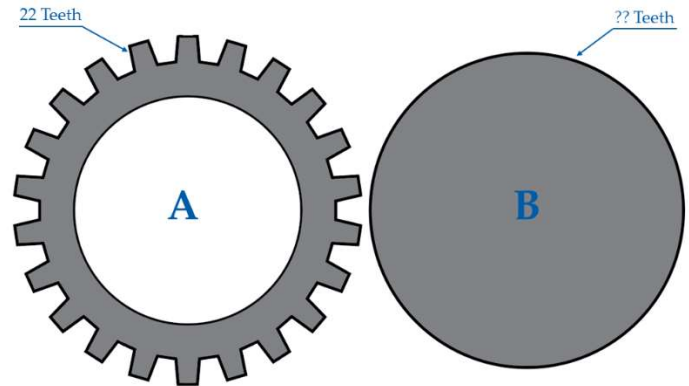


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Level 1: Gear A has 22 teeth and is rotated clockwise at 15 rpm.

Part A: How many teeth must gear two have in order to make an output of 10 rpm?



Part B: If a third gear were installed on the right side of Gear B, what direction would it be turning?

Level 2: Given that gear A is rotating at a rate of 16 rpm.

Find the rotational speed and direction of Gear C. Note that Gear B is connected such that both the 22-tooth gear and the 11-tooth gear rotate together.

