

## 2024Q7

## VOLUME, UNIT CONVERSIONS

Helloooooo, students! After evaluating the placement of a turbine near the customer's property, the next and most significant step is actually building it. While you might be used to seeing turbines high up in the air, the first step begins below the ground. They say a structure is only as strong as its foundation, and for our projects, the foundation is a large circular concrete base used to give the turbine stability. This makes it possible for turbines to stand their ground no matter how extreme the weather might get!



Figure 1: An Excavator loading dirt onto a dump truck.

Before the concrete can be poured, the site must be excavated, which involves creating a large cut, cavity, or depression in the Earth's surface. This is done with a large piece of machinery called – you guessed it – an excavator! First, the excavator will dig out the ground and dump it into a nearby dump truck. Once the dump truck is full, it will take its load and drop it onto a hill, also known as the “spoil” pile, and return to be refilled by the excavator.

The formulas below can be used to help solve the problems on the next page:

$$r = \frac{1}{2} D$$

$$V_{cylinder} = \pi r^2 h$$

$$part = \frac{percentage}{100} whole$$

$$1 \text{ yd} = 3 \text{ ft}$$

$$1 \text{ yd}^3 = 27 \text{ ft}^3$$

$$1 \text{ hr} = 60 \text{ min}$$

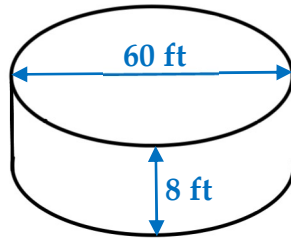
r = radius

D = diameter

V = Volume

h = height

**Level 1:** One Energy's newest client is planning to erect three wind turbines on their property. If it takes the excavator 10 minutes to dig out 1200 cubic feet of clay and it takes 5 minutes for the dump truck to drop that clay onto the spoils and come back, how many hours will it take to completely excavate the site for all three wind turbines? The hole being dug out for the foundation is in the shape of a cylinder with a 60-foot diameter and a depth of 8 feet in the ground, as shown below.



*Figure 2: Size of Foundation for a Wind Turbine*

**Level 2:** Now that the clay has been removed from the excavation site, the technicians will need to fill the foundation with layers of stone and concrete. If the stones make up 23% of the volume and the concrete makes up the other 77%, how much stone and concrete, in cubic yards, will need to be purchased for all three excavations to be filled?