Name:_____ Date:_____

Exploring Horsepower and Torque

The power of an engine may be measured or estimated at several points in the transmission of the power from its generation to its application. A number of names are used for the power developed at various stages in this process.

Indicated or gross horsepower (theoretical capability of the engine)

Brake / net / crankshaft horsepower (power delivered directly to and measured at the engine's crankshaft)

Shaft horsepower (power delivered to and measured at the output shaft of the transmission, when present in the system)

Effective or True (thp) or sometimes, wheel horsepower

All the above assumes that no power inflation factors have been applied to any of the readings. (minus frictional losses within the engine (bearings drag, rod and crankshaft windage losses, oil film drag, linkage etc.)

Mechanical horsepower

The most common definition of horsepower for engines is the one originally proposed by James Watt in 1782. Under this system, one horsepower is defined as:

1 hp = 33,000 ft·pound-force·min^{-1} = exactly 745.69987158227022 Watts

A common memory aid is based on the fact that Christopher Columbus first sailed to the Americas in 1492. The memory aid states that 1 hp = ½ Columbus or 746 W.

In fourteen hundred and ninety-two
Columbus sailed the ocean blue.
Divide that date of his by two
And that's the number of watts in a horsepower, too.

RAC horsepower (taxable horsepower)

This measure was instituted by the Royal Automobile Club in Britain and used to denote the power of early 20th century British cars.

Taxable horsepower does not reflect developed horsepower; rather, it is a calculated figure based on the engine's bore size, number of cylinders, and a (now archaic) presumption of engine efficiency. As new engines were designed with ever-increasing efficiency, it was no longer a useful measure, but was kept in use by UK regulations which used the rating for tax purposes.

RAC Horsepower = $Bore^2$ x n / 2.5	Bore of the cylinder in inches *n* is the number of cylinders

Drawbar horsepower (dbhp)

Drawbar horsepower is the power a railroad locomotive has available to haul a train or an agricultural tractor to pull an implement. This is a measured figure rather than a calculated one. A special railroad car called a dynamometer car coupled behind the locomotive keeps a continuous record of the drawbar pull exerted, and the speed. From these, the power generated can be calculated. To determine the maximum power available, a controllable load is required; this is normally a second locomotive with its brakes applied, in addition to a static load.

If the drawbar force is measured pounds-force (*F* / lbf) and speed is measured in miles per hour (*v* / mph), then the drawbar power in horsepower (*P* / hp) is:

$$\text{Horse Power} = \frac{F \times v}{375}$$

Example: How much drawbar power is needed to pull a cultivator load of 2025 pounds-force through medium soil at 5 miles per hour?

$$P/\text{hp} = \frac{2025 \times 5}{375} = 27$$

The constant "375" is because 1 hp = 375 lbf·mph. If other units are used, the constant is different. When using a coherent system of units, such as SI (watts, newtons, and metres per second), no constant is needed, and the formula becomes $P = Fv$.

Horsepower Formulas Using Torque and RPM's

For a given torque, the equivalent power may be calculated. The standard equation relating torque in foot-pounds, rotational speed in RPM and horsepower is:

$$\text{Horsepower} = (\text{torque} \times \text{rpm}) / 5252$$

Outside the United States most countries use the newton-meter as the unit of torque. Most automobile specifications worldwide have torques listed in newton-meters. The standard equation relating torque in newton-meters, rotational speed in RPM and horsepower is:

$$\text{Horsepower} = (\text{torque} \times \text{rpm}) / 7124$$

These are based on Watt's definition of the mechanical horsepower. The constants 5252 and 7124 are rounded; the exact values are 16,500/π and 22,380/π, respectively.