IMPORTANT FACTS

FORMULAS

Area in square inches of a circle : **3.14159 (pi) x (radius x radius)** Area in square inches of a square : **height x length**

Convert inches to millimeters : **inches x 25.4 = millimeters (mm)** millimeters to inches : **millimeters / 25.4 = inches**

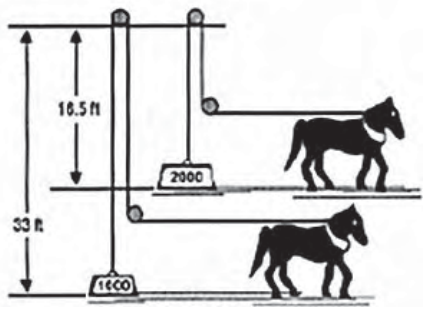
Engine size is measured by piston displacement: **CID = bore x bore x stroke x number of cylinders X .7854**

One standard horsepower is the work required to move 33,000 pounds a distance of 1-foot in one minute or:

$$\text{HP} = \frac{\text{ft-lbs per minute}}{33{,}000}$$

$$\text{Brake horsepower} = \frac{\text{torque x RPM}}{5252}$$

Brake horsepower is measured on a dynamometer.
If you know how much torque an engine is producing at a given RPM.



Volumetric Efficiency (VE) is the measure of an engine's ability to fill the cylinder with a fresh intake charge. The volumetric efficiency is measured per engine cycle and will vary throughout the engines operating range. It is the ratio between what is actually pumped into the engine and 100% of the actual cylinder volume.

Miles Per Hour: $$\text{MPH} = \frac{\text{overall tire dynamic diameter x achieved engine RPM}}{\text{differential ratio x achieved top gear ratio x 336}}$$ *

* - (1:1 No transmission or clutch slipage)

SOME AIR FACTS ... ALL ARE FOR DRY AIR

----- Related subject: see "AIR DENSITY" on Pages #190-192

$$\text{VE} = \frac{\text{Total Volume of intake charge}}{\text{Actual Cylinder Volume}}$$

One standard atmosphere (stp) is 59ºF and 29.92" Hg (14.694 PSI) ; this is 100% air density.
At stp, one pound of air = 13.07 ft^3, or .07651 pound/ft^3

Air density in lb/ft^3 at other temperature and pressure $= \frac{1.327 \times \text{"Hg}}{\text{Temp. ºR}}$ **(Note : ºR = ºF + 460)**

Percent air density (like reading on air density gauge) $= \frac{1734.7 \times \text{"Hg}}{\text{Temp. ºR}}$

Example : It is 82ºF, barometer is 27.84"Hg **Density** $= \frac{1734.7 \times 27.84}{82 + 460} = 89\%$

Example : A 6-71 blown engine has an intake manifold pressure of 22 PSI at 258ºF
Many racers would figure : $\frac{22 + 14.7}{14.7}$ **= 250% air density at the intake ports.**

Now lets see what it really is : $1734.7 \times \frac{(22 + 14.7) \times 2.037\text{"Hg/PSI}}{258 + 460} = 181\%$

Composition of air by weight : 75.8% nitrogen , 23.22% oxygen , 0.98% other gases.
It takes .240 Btu/lb of air to change the temp. 1ºF, while holding the pressure constant.
It takes .172 Btu/lb of air to change the temp. 1ºF, while holding the volume constant.

The air drag on a car goes up as the square of the car speed.
The horsepower to push the car through the air goes up as the cube of the car speed.
Example : Your car was going 80 MPH, now it is going 130 MPH... the drag increases $(130/80)^2 = (1.625)^2 = 2.6$
The horsepower increases $(130/80)^3 = (1.625)^3 = 4.29$
This is why it is easy to go 100 MPH, but very difficult to go 200 MPH; the car has four times the drag, and it takes eight times the power to push it through the air.

HORSEPOWER

The invention of the steam engine made it necessary to establish a unit of measurement that could be used to compare work done by competing engines. The unit chosen was related to the standard power source of the time - "horsepower".

After some creative testing, it was found that the average horse works at a rate of 33,000 ft-lb per minute. This is equivalent to lifting 1 ton (2,000 lb) a distance of 16.5 ft in one minute.

Horsepower is now the standard (in the Western Hemisphere) for measuring the rate at which motors and drives produce work. A 1-hp motor, for example, can produce 33,000 ft-lb of work in one minute.

Torque 'T' and horsepower 'HP' are related through speed 'S'.
HP = T x S/C where 'C' is a constant that depends on the units used for torque. If torque is given in lb-ft, then the value of 'C' is 5,252.

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PRESSURE VERSUS VELOCITY CHART .... for drag force on car bodies or pressure in air scoops.

Speed in MPH	40	60	80	100	120	140	160	180	200	250	300	400
PSI	.029	.064	.114	.178	.256	.348	.455	.577	.713	1.11	1.60	2.85

For other than stp conditions, multiply these values by the percent air density.
Air drag on a car body = frontal area x value in chart x % density x drag coefficient (Cd).
Cd is approximately: .65 - .75 for a tractor trailer truck, .60 - .70 for a convertible with top down, .55 - .70 for open wheel Indy Racing League car (this may appear like a high value, but it is due to down force from the front and rear wings for high MPH handling), .38 - .45 for an average sedan, .33 for a C5 Corvette, .15 - .20 for a streamliner.

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