Could I power my computer or my TV with a bicycle generator?

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To answer this question, you need to know two things:

1. How much power does a computer or a TV consume?
2. Can a person generate that much power with a bicycle?

If you have a normal desktop computer and monitor sitting on your desk, then it probably consumes something around 200 watts. With a bigger monitor, it probably pushes toward 250 watts, but 200 is a good average. A large color TV consumes about the same amount of power.

If you have read How Horsepower Works, you know that 1 horsepower is equal to 746 watts. So a person would have to generate about 0.27 horsepower to power a computer. Assuming that the generator is not 100-percent efficient, this means that a person would have to generate about a third of a horsepower to run a desktop PC.

If you look at the chart on this page, you can see that, unless you are an Olympic athlete, it would be tough for you to generate a third of a horsepower on a bicycle for any substantial length of time. A "normal person" might be able to sustain a third of a horsepower for half an hour before falling off the bike from exhaustion.

The solution to the problem would be to use a laptop computer instead of a desktop PC. Because laptops are designed to run off batteries, they are very efficient. A laptop might consume 15 watts. It would be extremely easy to generate 15 watts (0.02 horsepower) on a bicycle.

How many calories would you burn doing this? To generate 1 watt for an hour, you burn about 0.85 calories. Rounding up, that's about 1 calorie per watt-hour. So you would burn about 15 calories per hour using your bike to power your laptop. At that rate, a single 60-calorie chocolate-chip cookie could power a laptop for four hours!

Here are several interesting links:

- How Horsepower Works
- How Calories Work
- How Mountain Bikes Work
- Computer Power
- Watts your computer using?
- Human Powered Vehicles - graph of the power output that humans can generate

How Horsepower Works

by Marshall Brain

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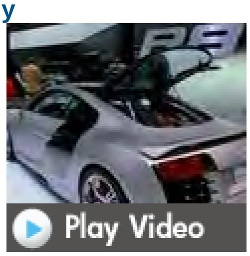
Inside this Article

Fast and Furious About Fuel Economy



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Sports Car Image Gallery

Alexandra Wyman/WireImage

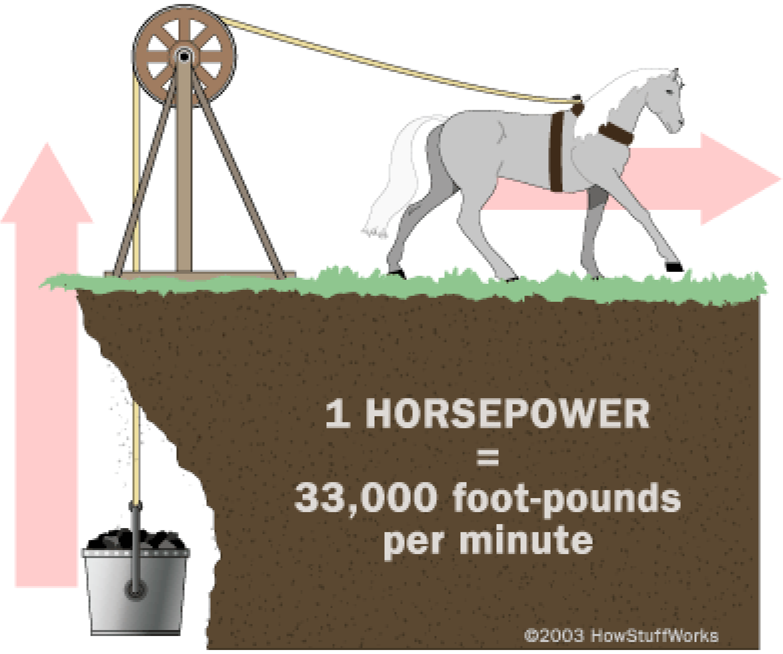
Two high-horsepower Dodge Challengers line up at the drag strip. See more sports car pictures.

Chances are you've heard about horsepower. Just about every car ad on TV mentions it, people talking about their cars bandy the word about and even most lawn mowers have a big sticker on them to tell you the horsepower rating.

But what is horsepower, and what does the horsepower rating mean in terms of performance? In this article, you'll learn exactly what horsepower is and how you can apply it to your everyday life.

The term **horsepower** was invented by the engineer James Watt. Watt lived from 1736 to 1819 and is most famous for his work on improving the performance of steam engines. We are also reminded of him every day when we talk about 60-watt light bulbs.

The story goes that Watt was working with ponies lifting coal at a coal mine, and he wanted a way to talk about the power available from one of these animals. He found that, on average, a mine pony could do 22,000 foot-pounds of work in a minute. He then increased that number by 50 percent and pegged the measurement of horsepower at 33,000 foot-pounds of work in one minute. It is that arbitrary unit of measure that has made its way down through the centuries and now appears on your car, your lawn mower, your chain saw and even in some cases your vacuum cleaner.



What horsepower means is this: In Watt's judgement, one horse can do 33,000 foot-pounds of work every minute. So, imagine a horse raising coal out of a coal mine as shown above. A horse exerting 1 horsepower can raise 330 pounds of coal 100 feet in a minute, or 33 pounds of coal 1,000 feet in one minute, or 1,000 pounds 33 feet in one minute. You can make up whatever combination of feet and pounds you like. As long as the product is 33,000 foot-pounds in one minute, you have a horsepower.

Next Up
How Force, Power, Torque and Energy Work
Engine Performance Quiz
TreeHugger.com: Top 5 Internal Combustion Engine Technologies

You can probably imagine that you would not want to load 33,000 pounds of coal in the bucket and ask the horse to move it 1 foot in a minute because the horse couldn't budge that big a load. You can probably also imagine that you would not want to put 1 pound of coal in the bucket and ask the horse to run 33,000 feet in one minute, since that translates into 375 miles per hour and horses can't run that fast. However, if you have read How a Block and Tackle Works, you know that with a block and tackle you can easily trade perceived weight for distance using an arrangement of pulleys. So you could create a block and tackle system that puts a comfortable amount of weight on the horse at a comfortable speed no matter how much weight is actually in the bucket.

Horsepower can be converted into other units as well. For example:

1 horsepower is equivalent to 746 watts. So if you took a 1-horsepower horse and put it on a treadmill, it could operate a generator producing a continuous 746 watts.

1 horsepower (over the course of an hour) is equivalent to 2,545 BTU (British thermal units). If you took that 746 watts and ran it through an electric heater for an hour, it would produce 2,545 BTU (where a BTU is the amount of energy needed to raise the temperature of 1 pound of water 1 degree F).

One BTU is equal to 1,055 joules, or 252 gram-calories or 0.252 food Calories. Presumably, a horse producing 1 horsepower would burn 641 Calories in one hour if it were 100-percent efficient.

In this article, you'll learn all about horsepower and what it means in reference to machines.

Measuring Horsepower

If you want to know the horsepower of an engine, you hook the engine up to a **dynamometer**. A dynamometer places a load on the engine and measures the amount of power that the engine can produce against the load.

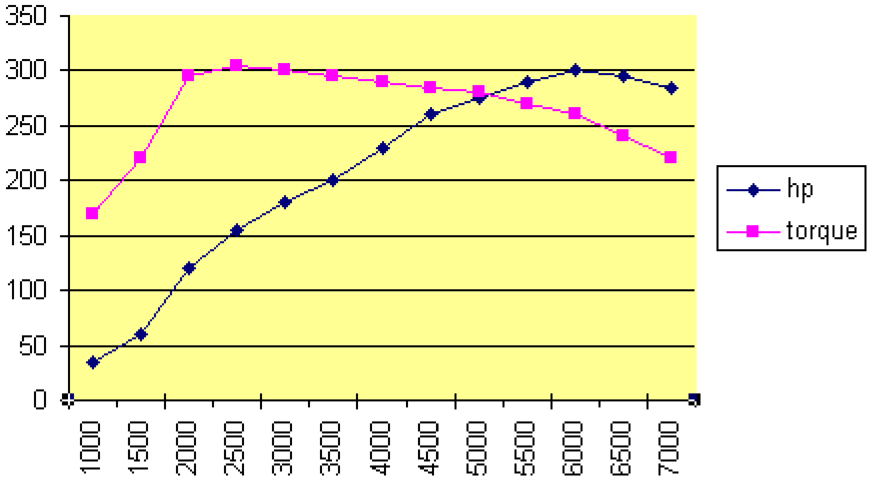
You can get an idea of how a dynamometer works in the following way: Imagine that you turn on a car engine, put it in neutral and floor it. The engine would run so fast it would explode. That's no good, so on a dynamometer you apply a load to the floored engine and measure the load the engine can handle at different engine speeds. You might hook an engine to a dynamometer, floor it and use the dynamometer to apply enough of a load to the engine to keep it at, say, 7,000 rpm. You record how much load the engine can handle. Then you apply additional load to knock the engine speed down to 6,500 rpm and record the load there. Then you apply additional load to get it down to 6,000 rpm, and so on. You can do the same thing starting down at 500 or 1,000 rpm and working your way up. What dynamometers actually measure is torque (in pound-feet), and to convert torque to horsepower you simply multiply torque by rpm/5,252.

Torque

Imagine that you have a big socket wrench with a 2-foot-long handle on it, and you apply 50 pounds of force to that 2-foot handle. What you are doing is applying a **torque**, or turning force, of 100 pound-feet (50 pounds to a 2-foot-long handle) to the bolt. You could get the same 100 pound-feet of torque by applying 1 pound of force to the end of a 100-foot handle or 100 pounds of force to a 1-foot handle. Similarly, if you attach a shaft to an engine, the engine can apply torque to the shaft. A dynamometer measures this torque. You can easily convert torque to horsepower by multiplying torque by rpm/5,252.

Graphing Horsepower

If you plot the horsepower versus the rpm values for the engine, what you end up with is a **horsepower curve** for the engine. A typical horsepower curve for a high-performance engine might look like this (this happens to be the curve for the 300-horsepower engine in the Mitsubishi 3000 twin-turbo):



What a graph like this points out is that any engine has a **peak horsepower** -- an rpm value at which the power available from the engine is at its maximum. An engine also has a **peak torque** at a specific rpm. You will often see this expressed in a brochure or a review in a magazine as "320 HP @ 6500 rpm, 290 lb-ft torque @ 5000 rpm" (the figures for the 1999 Shelby Series 1). When people say an engine has "lots of low-end torque," what they mean is that the peak torque occurs at a fairly low rpm value, like 2,000 or 3,000 rpm.

Another thing you can see from a car's horsepower curve is the place where the engine has maximum power. When you are trying to accelerate quickly, you want to try to keep the engine close to its maximum horsepower point on the curve. That is why you often downshift to accelerate -- by downshifting, you increase engine rpm, which typically moves you closer to the peak horsepower point on the curve. If you want to "launch" your car from a traffic light, you would typically rev the engine to get the engine right at its peak horsepower rpm and then release the clutch to dump maximum power to the tires.

One of the areas where people talk most about horsepower is in the area of high-performance cars. In the next section, we'll talk about the connection there.

Horsepower in High-performance Cars

Take the Quiz

Which cars have the most horsepower? Test your knowledge with this quiz from **Turbo**:

Which Car Has More Horsepower Quiz

A car is considered to be "high performance" if it has a lot of power relative to the weight of the car. This makes sense -- the more weight you have, the more power it takes to accelerate it. For a given amount of power you want to minimize the weight in order to maximize the acceleration.

The following table shows you the horsepower and weight for several high-performance cars (and one low-performance car for comparison). In the chart you can see the peak horsepower, the weight of the car, the power-to-weight ratio (horsepower divided by the weight), the number of seconds the car takes to accelerate from zero to 60 mph, and the price.

	Horsepower	Weight (lbs)	Power:Weight	0-60 mph (seconds)	Price
Dodge Viper	450	3,320	0.136	4.1	$66,000
Ferrari 355 F1	375	2,975	0.126	4.6	$134,000
Shelby Series 1	320	2,650	0.121	4.4	$108,000
Lotus Esprit V8	350	3,045	0.115	4.4	$83,000
Chevrolet Corvette	345	3,245	0.106	4.8	$42,000
Porsche Carrera	300	2,900	0.103	5.0	$70,000
Mitsubishi 3000GT twin-turbo	320	3,740	0.086	5.8	$45,000
Ford Escort	110	2,470	0.045	10.9	$12,000

You can see a very definite correlation between the power-to-weight ratio and the 0-to-60 time -- in most cases, a higher ratio indicates a quicker car. Interestingly, there is less of a correlation between speed and price. The Viper actually looks like a pretty good value on this particular table!

If you want a fast car, you want a good power-to-weight ratio. You want lots of power and minimal weight. So the first place to start is by cleaning out your trunk.

For more information on horsepower and related topics, check out the links on the next page.

The Pedal-A-Watt Stationary Bike Power Generator

As featured at Super Bowl XLII in Arizona, February 3rd, 2008

Have questions and want us to call you? Click here to send an email with your telephone number and preferred times to call

Not An Electrical Engineer? Do You Want the Pedal-A-Watt made easy for you? Then click here

Want to charge your Cell Phone, iPod, Blackberry, Garmin GPS, any GPS or any other device that you can plug into your car's cigarette lighter plug? - then Click Here

- **Creates 75 to 200 watts at 12 to 25 volts DC depending on rider's strength**
- **Bicycle easily disengages from stand for immediate road use**
- **Stand folds easily for transport**
- **Power small, household appliances such as a desktop PC, laptop, or stereo**

If you saw the Duracell Power Lodge powering the 2009 lighted sign on New Year's Eve then you'll be happy to know you too can create power with your bicycle and the Pedal-A-Watt.....

Click here to see a video of the Pedal-A-Watt in action producing visible power on a voltmeter

The Pedal-A-Watt bicycle stand keeps the user aerobically fit while creating power that may be used to power lights and/or other small appliances. The Pedal-A-Watt may also be used to charge a battery so that the power may be used at a later time (see the PowerPak under the Accessories page). The battery may then be tapped at a later time, after dark for example, when the energy is needed to power lights or appliances. The Pedal-A-Watt bicycle stand is an excellent addition to an existing battery system that may already be charged from the photovoltaic panels, 120 VAC grid power or wind power. The concept behind the Pedal-A-Watt bicycle is that electricity can be created from human effort and then stored in batteries.

Clean energy will become more and more important to our world in the future as more people, especially in up and coming countries like China, require more power that, unfortunately, creates pollution in many cases.

Click here to read why clean power is so important

Click here to see a comparison of our Pedal-A-Watt against the competition's product!

The average rider will produce between 125 and 200 watts using the Pedal-a-Watt. While this may not seem like much power, many pieces of equipment draw very little power and can be powered for long spans of time with small amounts of power.

Lights, laptops, and radios all draw small amounts of current at 12 volts DC. In addition, LED lighting and high efficiency fluorescent lighting now allow 200 watts to go a long way. A typical 25 watt fluorescent light bulb, which replaces a 100 watt incandescent bulb, will last 8 hours on 200 watts worth of power. LEDs (light emitting diodes) are even more efficient and will last days on 200 watts worth of power.

Want to know if you can power an appliance? Look at the label on the rear (usually by the power cord) and find out the "rating" which is in watts. For example, the label may read 30 W under electrical rating and this is 30 watts. If you are unsure, please email us with questions.

Power Consumption of Typical Appliances:

Small TV	**100 watts**
Large TV	**200 watts**
Laptop PC	**10 watts**
Desktop PC	**75 watts**
Stereo	**20 watts**
Charging a cellphone	**5 watts**
Hi Effic Desk lamp	**15 watts**

Any bicycle that is in good shape will suffice for mating to the Pedal-a-Watt platform. However, bicycles with wheels of larger diameters, such as 27 inches as opposed to 16 inches, create more mechanical advantage. Both street bikes, with very narrow, smooth tires, and mountain bikes, with wide, knobby tires, have been used with equal success.

Our plans include all suppliers and part numbers needed to order each component.

How It Works and What You Need

The Pedal-A-Watt produces energy in the form of electricity but you probably are wondering how to use that electricity.

If you want to use the energy to power typical, household appliances that "plug in" to a wall outlet you'll need the **PowerPak** (see Accessories) which stores the energy in a battery and also converts it to typical, 120 volt AC house power. The PowerPak has a regular "wall outlet" type plug and will allow you plug in a TV, stereo, extension cord, etc.

The DC **PowerCenter** is a voltage converter that is designed to power CD players, walkmans, video games, portable TVs, tape recorders, GPS, hand scanners and radios. Use it with your own battery or one of ours.

If you are a do-it-yourselfer, the Pedal-A-Watt produces 15 to 30 volts DC at up to 8 amperes. You may power suitable items directly and/or charge a 12 volt battery.

An Explanation of Watts vs. Watt-Hours

Watts is an instantaneous measure of power at any moment in time. Watt-hours is a measure of power over time.

For example, the Pedal-A-Watt, creates 200 watts of power. If you pedal for 2 hours, then you have created 400 watt-hours (200 watts x 2 hours) of power.

This 400 watt-hours would power a 100 watt light bulb for 4 hours, a 200 watt large screen TV for 2 hours and so on.

For other Frequently Asked Questions (FAQs) click here

If you have further questions, feel free to email us at Support@econvergence.net

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Human Power Vehicles - 1 (Program: "hpv")

This exercise is the first of a sequence of six programming exercises based on a common theme (which we will develop and evolve throughout the rest of the quarter) in which we wish to evaluate the performance of human powered vehicles (hpv) for land transportation. Performance refers to the steady state velocity reached versus applied human power under constant specific conditions.

Background

Human powered vehicles have captured the imagination of designers, builders, and riders all over the world, for transportation, load carrying, socializing, racing, and touring. My favorite hpv link is the International Human Powered

Vehicle Association site which gives one a glimps into hpv activity throughout the world. A more general directory of cycling related websites is presented in Cycling Resources.

In 1992, the 200m world human powered land speed record was set by team Cheetah at 68.73mph. This record was broken by Canadian Sam Whittingham during the 2002 Human Powered Speed Championships in Battle Mountain, Nevada at 81.00mph! (This remarkable record has not been broken since - refer to the 2007 World Human Power Speed Challenge history of previous events). During the same event in 2002, Sam's wife, Andrea Blasecki, broke the women's human powered land speed record at 64.74mph. This remarkable husband and wife team from Victoria BC were both riding human powered vehicles built by Canadian sculptor/designer George Georgiev - Sam rode a Varna Diablo II and Andrea a Varna Mephisto, as shown below.

In the 2004 World Human Power Speed Challenge the women's land speed record was broken by Ellen van Vugt from Holland, who did the flying 200m run at 65.89mph! (see below)

 Ellen van Vugth showing her paces in the Varnowski bike. (Photo by Ruben Garcia from the Pictures of the 2004 WHPSC)	 Ellen van Vugt was jammed into the bike like a sardine. The bottom bracket was too close and her helmet was jammed into

	the canopy. (Photo by Brad Teubner from the Pictures of the 2004 WHPSC)

This record was subsequently broken in 2005 by Lisa Vetterlein riding in a Varna at 66.58 mph!

Human powered vehicles range in complexity from amateur homebuilt machines to exotic machines suitable for commuting or touring, such as the Danish Leitra shown below. The Leitra is an efficient, all weather machine, which includes a hand powered windshield wiper, a rear view mirror conveniently placed above your head, and a well designed ventilated cover which can be lifted on its hinge in a matter of seconds for easy entry or exit.

Typical of the amateur homebuilt machines is the front-wheel-drive Grasshopper I, as shown below: In this picture we see a famous racing rider in his finest hour - racing in the 1993 British Human Power Speed Championships (unfortunately he came last in this race). This was the precurser to the famous Grasshopper series of hpvs, of which the current version is Grasshopper 5.

I have a soft spot for front-wheel-drive human powered vehicles. They result in extremely compact and elegant designs, such as the beautiful Dutch Chinkara or the compact rear-wheel steered construction by Hans Ulrich Reimer. Notice the full suspension on both of these bikes. Another example of a very fast, compact design is the twisting chain front-wheel-drive bike by John Tetz. This is amateur building at its prime - John built both the bike and the fairing.

The Steady State Power Equation

In this first exercise we develop and test the basic power function which we will use without change throughout the exercise sequence.

We first develop the power equation and examine the limitations of the human engine. The word statement of the basic power equation follows:

Inertial power (for acceleration or deceleration)	=	Effective power applied at the pedals	-	Loss through air drag and surface wind	-	Loss through rolling resistance and ground slope

Recall that the kinetic energy of a mass m moving with velocity V is given by:

$$ke = \frac{m\,V^2}{2}$$

The inertial power is given by the time derivative of the kinetic energy, thus:

$$\frac{d}{dt}(ke) = m\,V\,\frac{dV}{dt}$$

Thus the complete power equation is given by:

$$m\ V\ \frac{dV}{dt} = P - \frac{\rho}{2}(V + Vw)^2\ V\ CdA - (Cr + slope)\ m\ g\ V$$

where:

m	[kg] is the total mass (rider plus hpv)
V	[m/s] is the hpv velocity
P	[W] is the drive power to the pedals
ρ	(Greek letter "rho") = 1.18 [kg/m^3] (standard sea level air density)
Vw	[m/s] is the wind velocity component (positive for headwind)
CdA	[m^2] is the effective frontal area, being the coefficient of drag (Cd) multiplied by the frontal area (A) (= 0.4 [m^2] for a touring bicycle, arms straight)
Cr	coefficient of rolling resistance (= 0.005 for high quality tires, smooth asphalt surface)
slope	is the road slope (elevation / distance)
g	= 9.81 [m/s^2] (standard acceleration due to gravity)

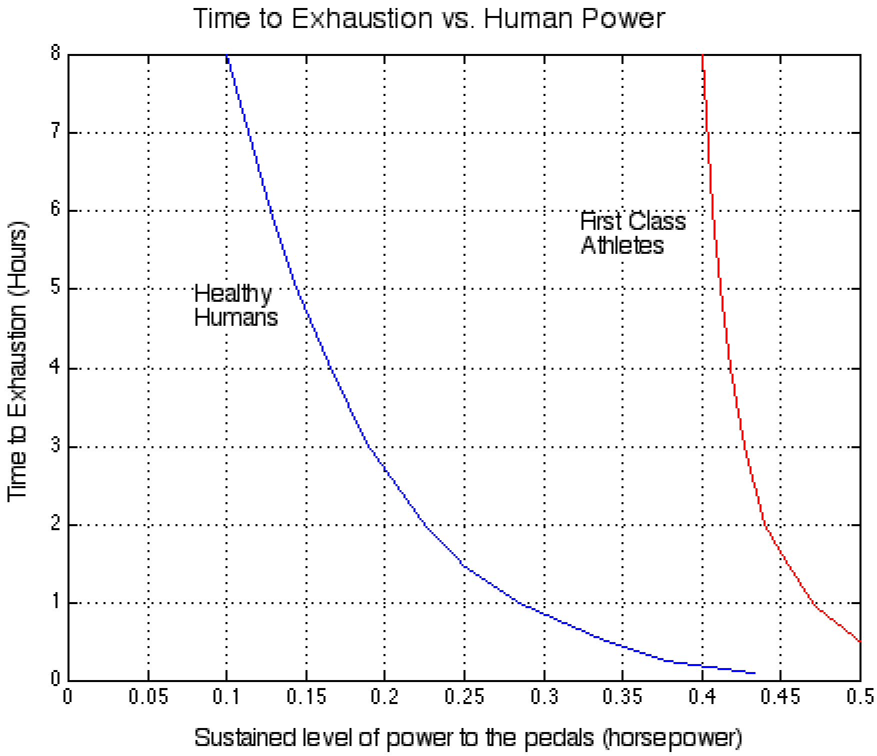
Note that the above equation is a nonlinear differential equation in velocity V and can only be solved by numerical techniques for the nonsteady conditions of acceleration or deceleration.

Under steady state (constant velocity) the power equation can be written as follows:

$$P = \frac{\rho}{2}(V + Vw)^2\ V\ CdA + (Cr + slope)\ m\ g\ V$$

The Human Engine

Consider now the human engine. In 1983 Douglas Malewicki gave a landmark paper at the International Human Powered Vehicle Association Scientific Symposium, in which he presented a graph showing the maximum duration of human effort for various steady power levels. This graph has been reproduced below for convenience. Notice from the graph that an average "healthy human" can produce a steady 0.1 horsepower for a full eight hour period, while a "first class athlete" can produce 0.4 horsepower for a similar period. Note that each data point on the curves represents an exhausted human. No more power is available without some rest and recovery. Thus at 0.4 hp the "healthy human" becomes exhausted within 10 minutes! Try to decide where you fit in this curve.



Note that in the power equation the units of power is watts (W), however we can apply the conversion 0.1 hp = 75 W (approximately) in reading the graph. Once you have decided the steady power level that you can comfortably apply at the pedals, it would be of interest to know the velocity that you will achieve at steady state when all other parameters are maintained at constant values. Unfortunately the steady state power equation above cannot be solved explicitly for velocity, thus we will develop a root finding technique to solve this problem in a forthcoming exercise. This first exercise introduces modular programming using functions, and is much less ambitious:

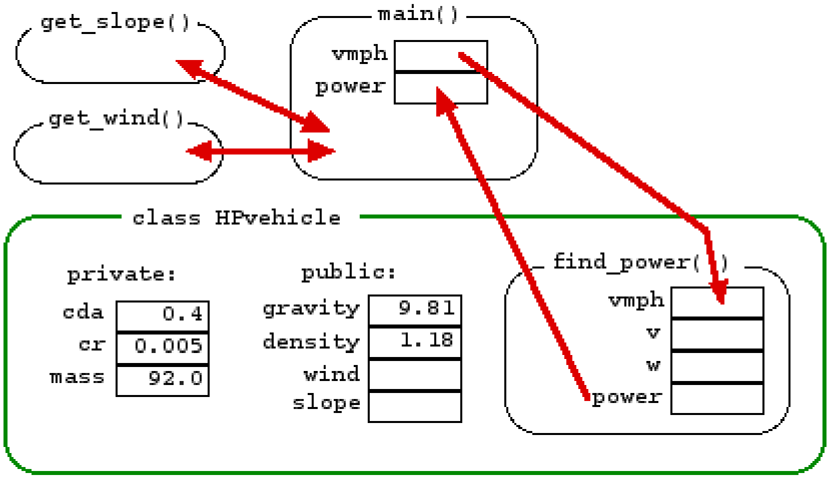
The Computer Program

There are two parts to this exercise, the computer program to evaluate the applied power as a function of velocity, and a graph which you will plot by hand on regular graph paper.

- Write a program that defines a class **`HPvehicle`** based on the steady state power equation above. The various relevant parameters used in the equation should be declared as private or public variables, as shown in the structure diagram below. The default constructor should initialise the variables as shown, including the total mass (choose a value based on your own mass and the mass of your bicycle). After declaring a **`HPvehicle`** object, the main function should first invoke two functions

`get_wind` and **`get_slope`**, in order to obtain respective values for the wind velocity and the slope. Subsequently the main function should get a value of hpv velocity from the keyboard, and invoke the function **`find_power`** to evaluate and return the applied power using the steady state power equation given above, and display both on the screen. A typical flow diagram of the program is shown below:

hpv - structure diagram



Note that the equations are given in SI units, in which power has units of watts (W) and velocity has units of meters per second (m/s). Most Americans find it more intuitive to consider velocity in units of miles per hour (mph). Thus we will allow the user to enter the data in mph, and convert it to m/s using the following approximate conversion:

9 mph = 4 m/s (approximately)

Thus the function 'find_power' should have only one argument, being the hpv velocity in mph. Within the function both the hpv velocity and the wind velocity should be converted from mph to m/s, prior to evaluating the steady state power equation.

We have to standardize on the order of entering data on the keyboard, since your programs will be tested automatically. The first data item should be the wind velocity (mph), followed by the slope, and the last item should be the hpv velocity (mph).

The source code should be in your home directory and named **`hpv.cpp`**. A typical output follows. Notice that the three data items entered from the keyboard are shown in *italics*.

```
evaluate hpv power as a function of velocity
hpv initialised as follows:
mass (hpv + rider): 92[kg]
cda (coeff.drag*area): 0.4[sq.m]
cr (coeff.rolling resist): 0.005
```

```
     enter wind velocity [mph] - positive for
headwind
     -1
     value entered is -1[mph]
     enter slope (height/distance) - positive for
uphill
     -0.02
     value entered is -0.02
     local conditions:
     wind velocity = -1[mph]
     slope = -0.02
     gravity acceleration = 9.807[m/s/s]
     air density = 1.18[kg/cu.m]
     enter hpv velocity [mph]
     20
     value entered is 20[mph]
     for velocity of 20[mph],
     applied power is 29.2905[watts]
```

- You will need to execute the program as many times as required to obtain enough points in order to plot a suitable power vs velocity graph. For each execution the values of wind velocity and slope should remain the same, according to the first two non-zero values of your Oak ID 6-digit number. Thus for a typical Oak ID number (say) iu035102, choose a wind velocity of -3 mph (negative means tailwind) and a slope of -0.05 (negative means downhill slope).

  From the above curve of time to exhaustion vs sustained level of power, decide on a level of power which is comfortable for you, and draw the equivalent horizontal line on your graph. From your graph determine and write down the steady state velocity that you will attain when you apply this level of power as well as the steady state downhill coasting velocity (no power applied).

Notice that in this exercise we have used the computer in a very unsophisticated role - as a mere calculator. In the coming exercises we will successively (and joyfully) relinquish all of the manual processes above (multiple execution of the program, drawing the graph, determining the steady state velocity for a specified applied power) to the computer.