Answering Calculation Questions

Physics Smart

These are the key things that you need to be able to do

- Know the symbol and units for each quantity
- Rearrange the equations
- Know how to use your calculator.

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These are some of the equations that you need to be able to use

$v = \frac{\Delta d}{\Delta t}$ $velocity = \frac{change\ in\ distance}{change\ in\ time}$ $a = \frac{\Delta v}{\Delta t}$ $acceleration = \frac{change\ in\ velocity}{change\ in\ time}$

$F = ma$ $Force = mass\ x\ acceleration$ $P = \frac{F}{A}$ $Pressure = \frac{Force}{Area}$

$E_p = mg\Delta h$ $Gravitional\ potential\ energy = mass\ x\ gravity\ x\ height$ $Units\ is\ Joules\ (J)$

$E_k = \frac{1}{2}mv^2$ $Kinetic\ Energy = \frac{1}{2}x\ mass\ x\ velocity^2$ $Units\ is\ Joules\ (J)$

$W = Fd$ $Work = Force\ x\ distance$ $Units\ is\ Joules\ (J)$

$Power = \frac{work}{time}$ $unit\ is\ Watts\ (W)$

Units

A number has a numerical value as well as a unit.

The unit tells you what quantity the number is, so you must know the units.

The SI units are the standard international units that are used in science.

These are the ones that you need to **know**. Put them in a list on the fridge, on the wall, on the mirror.

Quantity	**Symbol**	**Unit**		**Know it**
Velocity	v	ms^{-1}	Metres per second	
Acceleration	a	ms^{-2}	Metres per second squared	
Time	t	s	seconds	
Speed	s	ms^{-1}	Metres per second	
Distance	d	m	metres	
Force	F	N	Newtons	
Mass	m	kg	kilograms	
Power	P	W	Watts	
Work	W	J	Joules	
Energy	E	J	Joules	
Area	A	m^2	Metres squared	

How to solve the problem

1. Identify what are you given: use the units to identify what you are given.
2. Identify what are you asked for?
3. Pick the equation.
4. Rearrange the equation.
5. Put your values in: all at once.
6. Write your answer with a unit.
7. Think – is it a reasonable answer?

Example: A car travelling at $34ms^{-1}$ slows to a rest in 4 seconds. What is the cars acceleration?

Identify what you are given	**Identify what you need to find**
Velocity at the start $v_i = 34ms^{-1}$ velocity at the end $v_f = 0ms^{-1}$ time $t = 4s$	Acceleration a

Try these examples. Identity what you are given and what you are asked for in the following examples. No need to solve the problem.

Question 1: A bird flies 75 m at a constant velocity of 5.6 ms^{-1}. How long did it take for the bird to fly 75m?

Identify what you are given	**Identify what you need to find**

Question 2: A car accelerates from 0 ms^{-1} to 30 ms^{-1} in 9.5 s. What is the acceleration of the car?

Identify what you are given	**Identify what you need to find**

Question 3: A 58 kg child runs at 12 ms^{-1}. What is the kinetic energy of the child?

Identify what you are given	**Identify what you need to find**

Question 4: A 5kg box is lifted 3.2m. What is the energy gained by the box?

Identify what you are given	**Identify what you need to find**

Question 5: A force of 45 N is placed on a box of 12 kg. What is the acceleration of the box?

Identify what you are given	**Identify what you need to find**

Answers

1. A bird flies 75 m at a constant velocity of 5.6 ms^{-1}. How long did it take for the bird to fly 75m?

$$\boldsymbol{Given\ distance = 75\ m \quad velocity = 5.6 ms^{-1} \quad Asking\ for\ time}$$

2. A car accelerates from rest to 30 ms^{-1} in 9.5 s. What is the acceleration of the car?

$$\boldsymbol{Given: time = 9.5\ s \quad v_i = 0 ms^{-1} \quad v_f = 30 ms^{-1} Asking\ for acceleration, a}$$

3. A 58 kg child runs at 12 ms^{-1}. What is the kinetic energy of the child?

$$\boldsymbol{Given: mass = 58 kg \quad v = 12 ms^{-1}\ Asking\ for\ kinetic\ energy\ , E_K}$$

4. A 5kg box is lifted 3.2m. What is the energy gained by the box?

$$\boldsymbol{Given: mass = 5 kg \quad height = 3.2 m \quad Asking\ for\ energy\ , E_p}$$

5. A force of 45 N is placed on a box of 12 kg. What is the acceleration of the box?

$$\boldsymbol{Given: mass = 12 kg \quad force = 45 N \quad Asking\ for\ acceleration, a}$$

How to select the correct equation to use.

1. What are you given: use the units to identify what you are given.
2. What are you asked for?
3. Pick the equation.
4. Rearrange the equation.

Once you have done the first two steps: identified what you have been given and what you need, the next thing to do is to pick an equation.

The equation you use depends on the quantities you are given and what you are looking for.

Example: A car travelling at 34ms^{-1} slows to a rest in 4 seconds. What is the cars acceleration?

What are you given? $v_i = 34ms^{-1}$ $v_f = 0ms^{-1}$ $t = 4s$

What is needed? Acceleration a

What equation to use? Both of the following equations have acceleration in them.

$$F = ma \quad a = \frac{\Delta v}{\Delta t}$$

$F = ma$ $-$ *we do not have force or mass*

$a = \frac{\Delta v}{\Delta t}$ *we have everything for this equation.*

The equation does not need to be rearranged

Now we will put the numbers in and get the right answer

$$a = \frac{\Delta v}{\Delta t} = \frac{0 - 34}{4} = -8.5\ ms^{-2}$$

Try these questions

1. A bird flies 75 m at a constant velocity of 5.6 ms^{-1}. How long did it take for the bird to fly 75m?

What is given?	What is asked for?
Which equation will you use?	Rearrange the equation
Put the numbers in and calculate the answer.	Write the answer and the unit.

2. A force of 65N is placed on a mass of 20 kg. What is the acceleration of the object?

What is given?	What is asked for?
Which equation will you use?	Rearrange the equation
Put the numbers in and calculate the answer.	Write the answer and the unit.

3. An object of 3.9 kg gains 92 kJ of gravitational potential energy which raises the object to a new height. What is the change in height of the object?

What is given?	What is asked for?
Which equation will you use?	Rearrange the equation
Put the numbers in and calculate the answer.	Write the answer and the unit.

Answers

1. A bird flies 75 m at a constant velocity of 5.6 ms^{-1}. How long did it take for the bird to fly 75m?

What is given?	What is asked for?
$v = 5.6ms^{-1}\ \ d = 75m$	$time$
Which equation will you use? $v = \frac{\Delta d}{\Delta t}$	Rearrange the equation $v = \frac{\Delta d}{\Delta t} \qquad t = \frac{\Delta d}{v}$
Put the numbers in and calculate the answer. $t = \frac{\Delta d}{v} = \frac{75}{5.6}$=13.4	Write the answer and the unit. $t = 13.4\ s$

2. A force of 65N is placed on a mass of 20 kg. What is the acceleration of the object?

What is given?	What is asked for?
$Force = 65\ N\ \ mass = 20\ kg$	$acceleration, a$
Which equation will you use? $F = ma$	Rearrange the equation $Leave\ the\ force\ and\ the\ aceleration.$ $Move\ the\ mass\ to\ the\ other\ side\ and\ divide.$ $\frac{F}{m} = a$
Put the numbers in and calculate the answer. $\frac{F}{m} = a = \frac{65}{20} = 3.25$	Write the answer and the unit. $a = 3.25\ ms^{-2}$

3. An object of 3.9 kg gains 92 J of gravitational potential energy which raises the object to a new height. What is the change in height of the object?

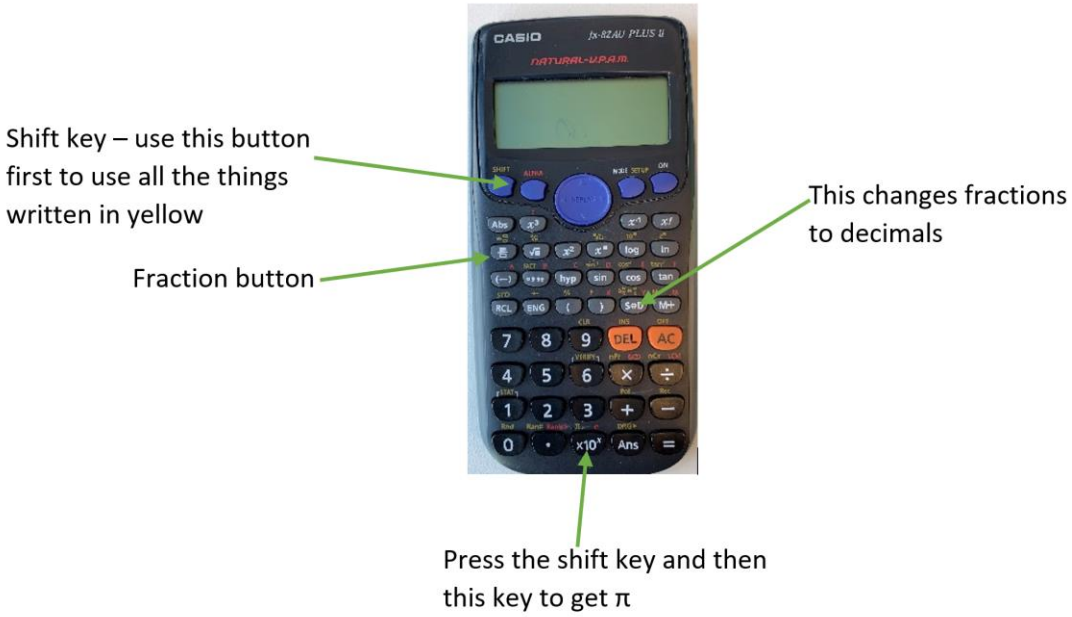
What is given? $Energy = 92\ J\ mass = 3.9\ kg$ gravity	What is asked for? Change in height
Which equation will you use? $E_p = mgh$	Rearrange the equation $Leave\ the\ energy\ and\ the\ height.$ $Move\ the\ mass\ and\ gravity\ to\ the\ other\ side\ and\ divide.\ \frac{E_p}{mg} = \Delta h$
Put the numbers in and calculate the answer. $\frac{E_p}{mg} = \Delta h = \frac{92}{3.9\ x\ 10} = 2.4\ m$	Write the answer and the unit. $\Delta h = 2.4\ m$

Using your calculator

It is always best to put everything into your calculator at once. This avoids any rounding errors and also means that you can easily check and correct your working.

Your calculator has the ability to do several things at once.

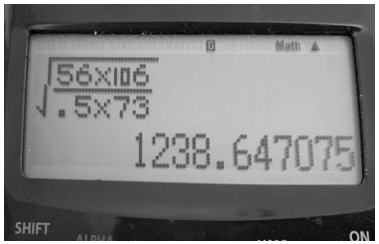
My preferred calculator is the Casio fx AU Plus II



Some examples

1. An object of 73 kg has kinetic energy of 56 MJ. What is the object's velocity?

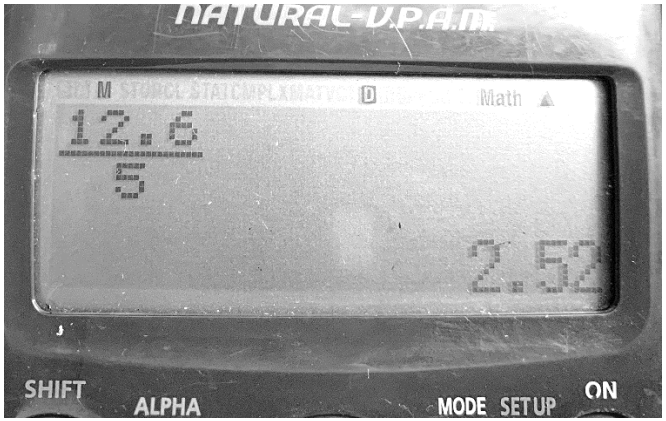
$$E_k = \frac{1}{2}mv^2 \qquad v = \sqrt{\frac{E_K}{\frac{1}{2}m}} = \sqrt{\frac{56\ x\ 10^6}{\frac{1}{2}x\ 73}} = 1238.65\ J$$



Process

1) Square root key
2) Fraction key
3) Top line 56 x10^x 6
4) Bottom line 0.5 x73
5) Equals 1238.647 rounded to 1238.65 J

2. A dog runs 12.6 m in 5 s, what is the speed of the dog?



Process

1) Fraction key
2) 12.6 on top
3) Down arrow to get to the bottom of the fraction.
4) 5
5) Equals 2.52 ms^{-1}