# Appendix D: EQUATIONS OF MOTION

There are 4 equations which can be used whenever an object travels with **constant**, **uniform acceleration** in a straight line.

We write these equations using 5 symbols:

***s*** = distance traveled (in meters)
***u*** = initial velocity (in meters per second)
***v*** = final velocity (in meters per second)
***a*** = acceleration (in meters per second squared)
***t*** = time taken (in seconds)

Suppose an object is travelling at a velocity ***u*** and then moves with a uniform acceleration ***a*** for a time ***t***. Its velocity is then ***v*** and it has traveled a distance ***s***.

Next to the equation given below, interpret what it means in your own words:

$v = u + at$

$s = \frac{(u+v)}{2} t$

$s = ut + \frac{1}{2} at^2$

$v^2 = u^2 + 2as$

**Rearrange the formulas above to make the letters in brackets the subject of the formula. Record the solution from the TI-92. Determine if your result is equivalent to the one given by the TI-92, explaining fully. Show your working out. If it is not equivalent, attempt the problem again.**

1. $v = u + at, [a, t, u]$

2. $s = \frac{u+v}{2} t, [u, v, t]$

3. $s = ut + \frac{1}{2} at^2, [a, t, u]$

4. $v^2 = u^2 + 2as, [u, a, s]$

**For the following problems, use the appropriate formula from the original four or those you rearranged to solve them.**

1. A sports car accelerates from rest at 4 meters per second squared for 10 seconds. Calculate the final velocity.

2. A cheetah starts from rest, and accelerates at 2 meters per second squared for 10 seconds. Calculate:
(a) the final velocity and (b) the distance traveled.

3. A ball is thrown vertically upwards at 20 m/s. Ignoring air resistance and taking ***a*** to be the acceleration due to gravity (about 10 meters per second squared), calculate:
(a) how high it goes, (b) the time taken to reach this height, and (c) the time taken to return to its starting point.

4. A car with a crash-test dummy is travelling down a test track at a speed of 13 m/s. When the car hits the brick wall at the end of the track, it is as if it fell from the top of a house. Find the height of the house. (Use a = 10 m/s^2, the acceleration of free fall.)

The examples above were taken from:
Johnson, Keith [1996], Physics for You, Stanley Thornes (Publishers) Ltd, pages 133, 139.