Beginning at time $t = 0$, a particle moves along the number line so that its position after t seconds is

$$f(t) = t^3 - 15t^2 + 72t$$

a) Find the velocity and acceleration at time t.

b) At what time(s) is the particle moving 3 units/sec in the negative direction?

c) At what time(s) is the particle at rest?

d) When is the particle moving in the positive direction?

e) At what times is the particle speeding up?

Given on the board are the graphs of the **velocity** functions of two particles. For each particle, answer the following questions.

a) When is it speeding up? When is it slowing down?
b) When is it moving in the positive direction?
c) When is it at rest?

The cost, in dollars, of producing x yards of a certain fabric is $C(x) = 1300 + 14x - 0.1x^2 + .0005x^3$.

a) Find the marginal cost function.

b) Find $C'(300)$. This is the rate at which costs are increasing with respect to the production level. Use $C(300)$ and $C'(300)$ to estimate $C(301)$.

c) Find the actual value of $C(301)$ and compare.

If a ball is thrown vertically upward with a velocity of 128 ft/s, then its height after t seconds is $s = 128t - 16t^2$ ft.

a) What is the velocity and acceleration after t seconds?

b) What is the maximum height reached by the ball?

c) What is the velocity of the ball when it is 240 ft above the ground on its way up? (Consider up to be the positive direction.)

d) What is the velocity of the ball when it is 240 ft above the ground on its way down?

Sodium chlorate crystals are easy to grow in the shape of cubes by allowing a solution of water and sodium chlorate to evaporate slowly.

If V is the volume of such a cube with side length x, calculate the derivative when $x = 4$ mm. What's the physical interpretation of $V'(4)$, in plain English?

A stone is dropped into a lake, creating a circular ripple that travels outward at a speed of 60 cm/s.

a) Find the rate at which the area within the circle is increasing after t seconds.
b) Compare this rate at time t versus time $2t$. That is, after twice as much time has passed, how much faster is the area increasing?
c) When the radius of the circle has doubled, how much has the rate dA/dt increased?

A spherical balloon is being inflated. Find the rate of increase of the surface area ($S = 4\pi r^2$) with respect to the radius r when r is each of the following.

a) 1 ft

b) 5 ft

c) 8 ft

Newton's Law of Gravitation says that the magnitude F of the force exerted by a body of mass m on a body of mass M is

$$F = \frac{GmM}{r^2}$$

where G is the gravitational constant and r is the distance between the bodies.

a) Find dF/dr.
b) What's the physical interpretation of dF/dr, in plain English?
c) What does the minus sign indicate?

(The value of G depends on the units you're using. In case you're interested, in metric it's $6.67 \times 10^{-11} Nm^2/kg^2$. Note that 10^{-11} is really, really small.)