Problem 1* The position of a particle is given by the equation $s(t) = t^3 - t^2$, $t \geq 0$, where t is measured in seconds and s is measured in meters.

1. Find the velocity at time t.
2. When is the particle at rest?
3. When is the particle moving forward (that is, in the positive direction)?
4. Draw a diagram to represent the motion of the particle.
5. Find the total distance traveled by the particle during the first five seconds.
6. Find the acceleration at time t.
7. When is the particle speeding up? When is it slowing down?

Problem 2. The position of a particle is given by the equation $s(t) = t^4 - 4t^3 - 20t^2 + 20t$, $t \geq 0$, where t is measured in seconds and s is measured in meters.

1. At what time does the particle have a velocity of 20 m/s.
2. At what time is the acceleration 0?

Problem 3.* The area of a triangle with sides of lengths a and b and contained angle θ is given by

$$A = \frac{1}{2}ab\sin\theta\,.$$

If $a = 2cm$, $b = 3cm$ and θ increases at a rate of 0.2 rad/min, how fast is the area increasing when $\theta = \pi/3$?

Problem 4. If a snowball melts so that its surface area decreases at a rate of 1 cm^2/min, find the rate at which the diameter decreases when the diameter is 10 cm.

Problem 5. Find the differential dy of each function and evaluate dy for given values of x and dx.

1. * $y = \cos\pi x$, $x = 1/3$, $dx = -0.02$.
2. $y = \sqrt{3 + x^2}$, $x = 1$, $dx = -0.1$.
3. * $y = \dfrac{x+1}{x-1}$, $x = 2$, $dx = 0.05$.

Problem 6. Use differentials to estimate the amount of paint needed to apply a coat of paint 0.05 cm thick to a hemispherical dome with diameter 50 m.