4.1 – Rates of Change in the Natural and Social Sciences

1. A metal rod is placed in a cooling bath after mechanical processing. The following table indicates the temperature T, measured in $°F$, of the bar at various times t, measured in minutes, over a 30-minute interval.

t	0	8	15	21	30
T	118	108	101	96	92

Approximate $\left.\dfrac{dT}{dt}\right|_{t=17}$ and describe its meaning in the context of the problem.

Rectilinear Motion

- Position – location of an object with respect to an established origin; Common notations: $x(t)$, $y(t)$, $s(t)$
- Velocity – instantaneous rate of change of an object; measures both speed and direction; Common notation: $v(t)$
- Acceleration – instantaneous rate of change of velocity; Common notation: $a(t)$

Relationship to differentiation: Given position function $s(t)$, the velocity of an object is $v(t) = s'(t)$ and the acceleration of an object is $a(t) = v'(t) = s''(t)$.

2. A particle moves along a vertical line according to the position function $y(t) = t^3 - 12t + 3$ for all $t \geq 0$, where s is measured in meters and t is measured in seconds.

   a. Find the velocity and acceleration of the particle as a function of t and evaluate each at $t = 2$ seconds.

b. When is the particle at rest? When is the particle moving upward? When is the particle moving downward?

c. When is the particle speeding up? When is the particle slowing down?

d. Find the total distance traveled by the particle on the interval [0, 3].

e. Calculate the position of the object each time the velocity is 36 m/s.