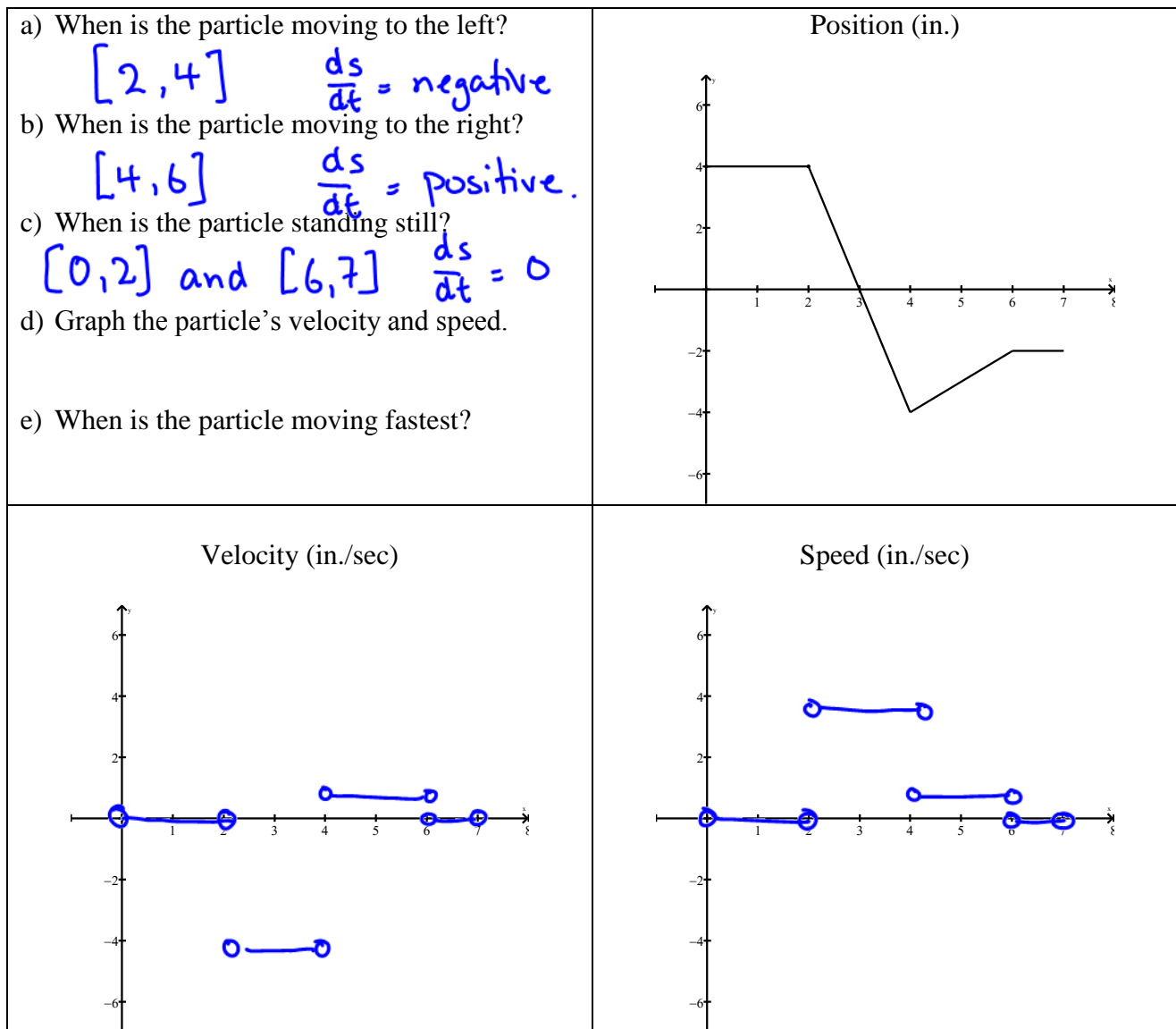


## Velocity, Speed and Acceleration

1. The graph shows the position  $s(t)$  of a particle moving along a horizontal coordinate axis.



2. A particle moves along a vertical coordinate axis so that its position at any time  $t \geq 0$  is given by the function  $s(t) = \frac{1}{3}t^3 - 3t^2 + 8t - 4$  where  $s$  is measured in centimetres and  $t$  is measured in seconds.

a) Find the displacement during the first 6 seconds.

$$\begin{aligned} s(6) - s(0) \\ = 8 - (-4) \\ = 12 \end{aligned}$$

c) Find expressions for the velocity and acceleration.

$$v(t) = t^2 - 6t + 8$$

$$a(t) = 2t - 6$$

b) Find the average velocity during the first 6 seconds.

$$\frac{8 - (-4)}{6 - 0} = 2 \text{ cm/s}$$

d) For what values of  $t$  is the particle moving downward?

$$\begin{aligned} \text{when is } v(t) < 0 \\ v(t) = t^2 - 6t + 8 = 0 \\ = (t-2)(t-4) = 0 \end{aligned}$$

$$t = 2 \text{ or } 4$$

$$2 < t < 4$$

3. The graph shows the velocity  $v = f(t)$  of a particle moving along a horizontal coordinate axis.

a) When does the particle reverse direction?

at 1s and 4.2 s

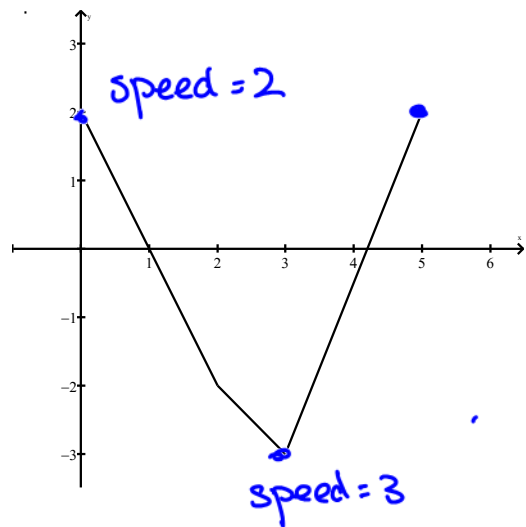
b) When is the particle moving at a constant speed?

never moving at a constant speed

c) When is the particle moving at its greatest speed?

at 3s, speed =  $| -3 |$   
= 3

Velocity (m/sec.)



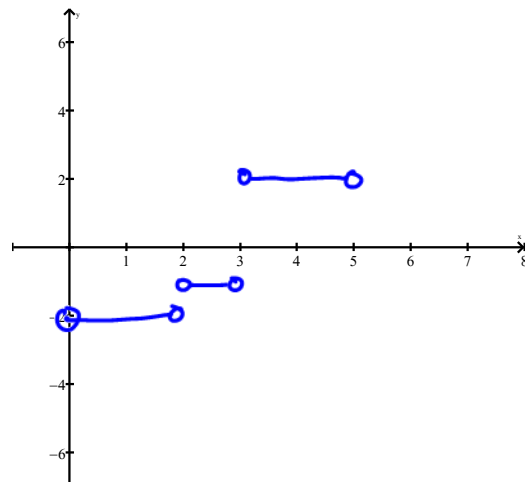
d) Graph the particle's acceleration. (where defined)

from 0-2s

$$\frac{\Delta v}{\Delta t} = \frac{-2 - 2}{2}$$

$$= -2$$

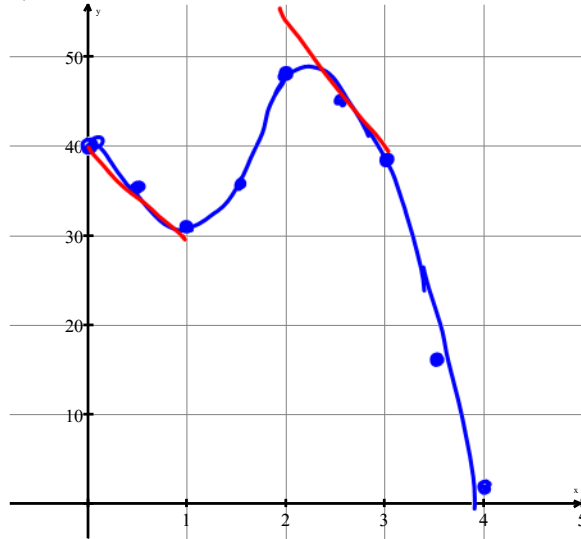
Acceleration (m/sec<sup>2</sup>)



4. The values of the coordinates  $s$  of a moving body for various values of  $t$  are given below.

$t$ (sec)	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
$s$ (m)	40.0	35.0	30.2	36.0	48.2	45.0	38.2	16.0	0.2

a) Plot  $s$  versus  $t$ , and sketch a smooth curve through the given points.



$$y = -4x^3 + 18.5x^2 - 19x + 39$$

b) Estimate the velocity at  $t = 0.5$  sec and at  $t = 2.5$  sec.

at 0.5s

$$\frac{30 - 40}{1 - 0} = -10 \text{ m/s}$$

at 2.5s

$$\frac{40 - 60}{3 - 2} = -20 \text{ m/s}$$

c) At what approximate value of  $t$  does the particle change direction?

at 1s and at 2.3s the derivative of position changes sign

d) At what approximate value of  $t$  is the particle moving at the greatest speed?

at approximately 4s  $|v|$  has greatest value.