1. A particle moves according to the law of motion $s(t) = 2 - 15t + 4t^2 - \frac{1}{3}t^3$, for $t \geq 0$, where t is measured in seconds and s is measured in feet.

   (a) Find the velocity at time t.

$v(t) = s'(t) = -15 + 8t - t^2$

   (b) What is the velocity after 1 second?

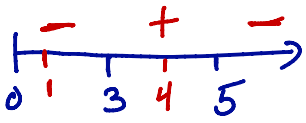
$v(1) = s'(1) = -15 + 8 - 1 = -8$ ft/sec

   (c) When is the particle at rest? Find t when $v = 0$.

$0 = -15 + 8t - t^2 = -(t-3)(t-5)$

$t = 3, 5$

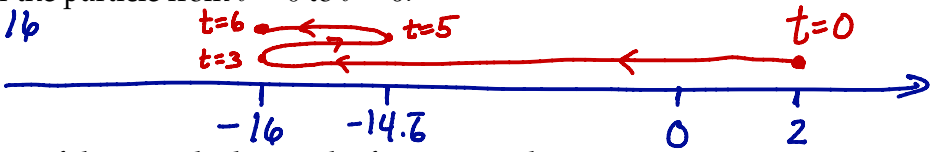
   (d) When is the particle moving in the positive direction?



on the interval between $t=3$ to $t=5$ or $(3,5)$

   (e) Draw a diagram of the particle from $t = 0$ to $t = 6$.

$s(0) = 2$
$s(3) = -16$
$s(5) = -14.66$
$s(6) = 16$



   (f) Find the *displacement* of the particle during the first 6 seconds.

-18 $\qquad$ $1\frac{1}{3}$

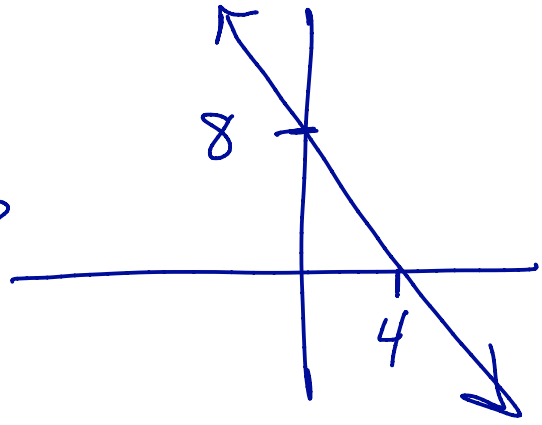
   (g) Find the *total distance traveled* by the particle during the first 6 seconds.

$18 + 2\left(\frac{4}{3}\right) = 18\frac{8}{3}$

   (h) Find the acceleration of the particle.

$a(t) = v'(t) = s''(t) = 8 - 2t$

   (i) Graph the acceleration function.

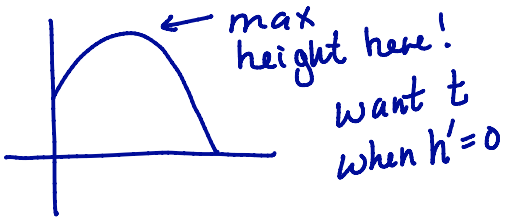


   (j) When is the particle speeding up?

$3 \leq t \leq 4$ and $t \geq 5$

2. The height (in meters) of a projectile shot vertically upward from a point 10 meters above ground lever with an initial velocity of 20 meters per second is $h = 10 + 20t - 4.9t^2$.

(a) When does the projectile reach its maximum height?



$h'(t) = 20 - 9.8t = 0$

$t = \frac{20}{9.8} = \frac{10}{4.9}$ sec $(\approx 2.04 s)$

(b) What is its maximum height?

$h\left(\frac{10}{4.9}\right) = 10 + 20\left(\frac{10}{4.9}\right) - 4.9\left(\frac{10}{4.9}\right)^2 = 30.408$ m

(c) When does the projectile hit the ground? Find t when $h = 0$.

Solve $0 = 10 + 20t - 4.9t^2$

$t = \frac{10}{49}\left(10 \pm \sqrt{149}\right)$. Chose positive answer: $t \approx 4.532$ s

(d) What what velocity does it hit the ground? $V(4.532) \approx -24.4136$ m/s

3. A tank holds 1000 gallons of a fluid, which drains from the bottom of the tank in 30 minutes. The function below give the volume of fluid remaining in the tank after t minutes:

$$V(t) = 1000\left(1 - \frac{1}{30}t\right)^2 \text{ for } 0 \le y \le 30$$

Find the rate at which the fluid is draining from the tank after 10 minutes. When is the fluid flowing the fastest? Slowest?

$V'(t) = 2000\left(1 - \frac{1}{30}t\right)\left(-\frac{1}{30}\right) = \frac{-200}{3}\left(1 - \frac{1}{30}t\right)$

$V'(10) = \frac{-200}{3}\left(1 - \frac{1}{3}\right) = \frac{-200}{3}\left(\frac{2}{3}\right) = \frac{-400}{9} \approx 44.44$ gal/min

$|V'(t)|$ largest when $t = 0$: $200/3$

$|V'(t)|$ smallest when $t = 30$: 0