

## Rate In/ Rate Out



1.

$$a.) \int_0^{12} H(t) dt = 70.570 \text{ or } 70.571$$

A tank contains 125 gallons of heating oil at time  $t = 0$ . During the time interval  $0 \leq t \leq 12$  hours, heating oil is pumped into the tank at the rate

(in)  $H(t) = 2 + \frac{10}{(1 + \ln(t + 1))}$  gallons per hour.

During the same time interval, heating oil is removed from the tank at the rate

(out)  $R(t) = 12 \sin\left(\frac{t^2}{47}\right)$  gallons per hour.

- How many gallons of heating oil are pumped into the tank during the time interval  $0 \leq t \leq 12$  hours?
- Is the level of heating oil in the tank rising or falling at time  $t = 6$  hours? Give a reason for your answer.
- How many gallons of heating oil are in the tank at time  $t = 12$  hours?
- At what time  $t$ , for  $0 \leq t \leq 12$ , is the volume of heating oil in the tank the least? Show the analysis that leads to your conclusion.

\*See printout.

$$b) \quad H(b) = 5.394 \text{ in}$$

$$R(b) = 8.318 \text{ out}$$

Since  $R(b) > H(b)$  the oil level  
is falling

$$H(b) - R(b) = -2.924 < 0$$

Oil level is falling

$t$	
0	125
→ 11.318	$125 + \int_0^{11.318} (H(t) - R(t)) dt = 120.738$
12	122.026

$t = 11.318$

Compare gallons and write the time that is minimized

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$$H(t) = 2 + \frac{10}{(1 + \ln(t + 1))} \text{ gallons per hour.}$$

During the same time interval, heating oil is removed from the tank at the rate

$$R(t) = 12 \sin\left(\frac{t^2}{47}\right) \text{ gallons per hour.}$$

- How many gallons of heating oil are pumped into the tank during the time interval  $0 \leq t \leq 12$  hours?
- Is the level of heating oil in the tank rising or falling at time  $t = 6$  hours? Give a reason for your answer.
- How many gallons of heating oil are in the tank at time  $t = 12$  hours?
- At what time  $t$ , for  $0 \leq t \leq 12$ , is the volume of heating oil in the tank the least? Show the analysis that leads to your conclusion.

\*See printout.

c.) initial + net charge

$$125 + \int_0^{12} (H(t) - R(t)) dt$$

$$122.026$$

5.

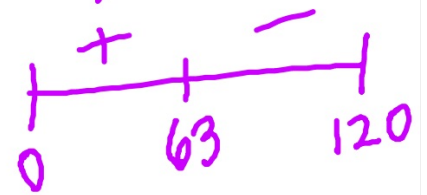
Water is pumped into an underground tank at a constant rate of 8 gallons per minute. Water leaks out of the tank at the rate of  $\sqrt{t+1}$  gallons per minute, for  $0 \leq t \leq 120$  minutes. At time  $t = 0$ , the tank contains 30 gallons of water.

- (a) How many gallons of water leak out of the tank from time  $t = 0$  to  $t = 3$  minutes?  
(b) How many gallons of water are in the tank at time  $t = 3$  minutes?  
(c) Write an expression for  $A(t)$ , the total number of gallons of water in the tank at time  $t$ .  
(d) At what time  $t$ , for  $0 \leq t \leq 120$ , is the amount of water in the tank a maximum? Justify your answer.

a.)  $\int_0^3 \sqrt{t+1} dt$       b.)  $30 + \int_0^3 (8 - \sqrt{t+1}) dt$

c.)  $A(t) = 30 + \int_0^t (8 - \sqrt{x+1}) dx$

d.)  $A'(t) = 8 - \sqrt{t+1}$   
 $64 = t+1$



*Since there is only one critical number ( $t = 63$ ) and  $a'(t)$  changes from positive to negative at  $t = 63$  on the interval  $(0, 120)$ ,  $t = 63$  is the absolute maximum.*