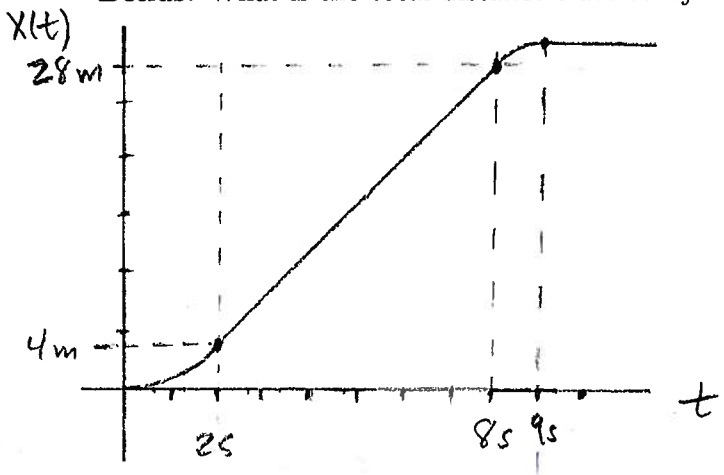
Physics 141 Summer 2010
Quiz 1 04/06/2010

Name: Solutions

Show all work clearly and justify all answers logically/mathematically. You have 10 minutes to complete this 10 point quiz.

1. (*10 points*) Below is a position-time graph, $x(t)$, fof an elevator cab that begins traveling upwards at $t = 0$ and then stops. Using the values on the $x(t)$ graph, carefully plot $v(t)$ and $a(t)$ over the time interval $0 \leq t \leq 9$ seconds. For full credit, be sure to label all important points on the graphs, such as the times at which transitions occur and the values of v and a.
Bonus: What is the total distance traveled by the elevator from $t = 0$ to $t = 9$ seconds?

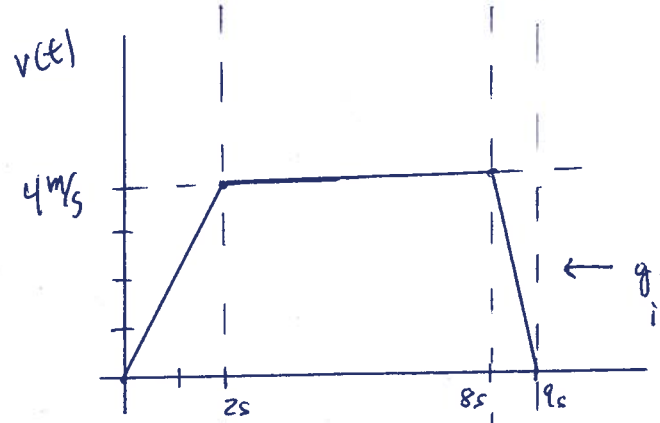


First calculate velocity during the interval $t = 2s$ to $t = 8s$.

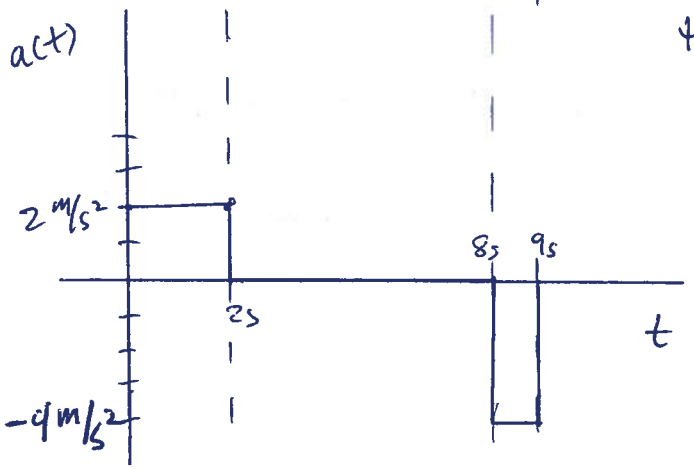
$$v_{avg} = v = \frac{\Delta x}{\Delta t} = \frac{24m}{6s} = 4\,m/s$$

⇒ Velocity - time graph is a horizontal line during this time w/ a value of $4\,m/s$.

⇒ Velocity must increase from $0\,m/s$ to $4\,m/s$ during first 2 seconds. It remains at a constant value for 6 s and then drops to zero from 8s to 9s.



← graph is this region is linear since acceleration is constant



For acceleration - time graph we need the value of acceleration in all three regions.

$$a_1 = \frac{\Delta v}{\Delta t} = \frac{4\,m/s - 0\,m/s}{2s} = 2\,m/s^2$$

$$a_2 = \frac{\Delta v}{\Delta t} = \frac{4\,m/s - 4\,m/s}{6s} = 0\,m/s^2$$

$$a_3 = \frac{\Delta v}{\Delta t} = \frac{0\,m/s - 4\,m/s}{1s} = -4\,m/s^2$$

Bonus: Two ways to approach this problem.

Method 1) At $t = 8\,s$, the elevator has traveled 28 m.
Therefore we need to calculate the displacement during $t = 8\,s$ to $t = 9\,s$.
During this time

$$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$$

$$= 4\,m/s\,(1\,s) - \frac{1}{2}(4\,m/s^2)(1\,s)^2$$

$$= 4m - 2m = 2m$$

$\Rightarrow$ total displacement is (and in this case distance)

$$\Delta x = 28m + 2m = \underline{30\,m}.$$

method 2) compute area under velocity-time graph.

Area of first triangle $A_1 = (4\,\frac{m}{s}) \times (2s) \times \frac{1}{2} = 4m$
(area of triangle = $bh\frac{1}{2}$)

" " second " $A_2 = (4\,\frac{m}{s}) \times (1s) \times \frac{1}{2} = 2m$

Area of rectangle $A_3 = (4\,m/s)(6\,s) = 24\,m$

$A_1 + A_2 + A_3$ = area under entire graph

$= 24m + 4m + 2m = 30\,m$