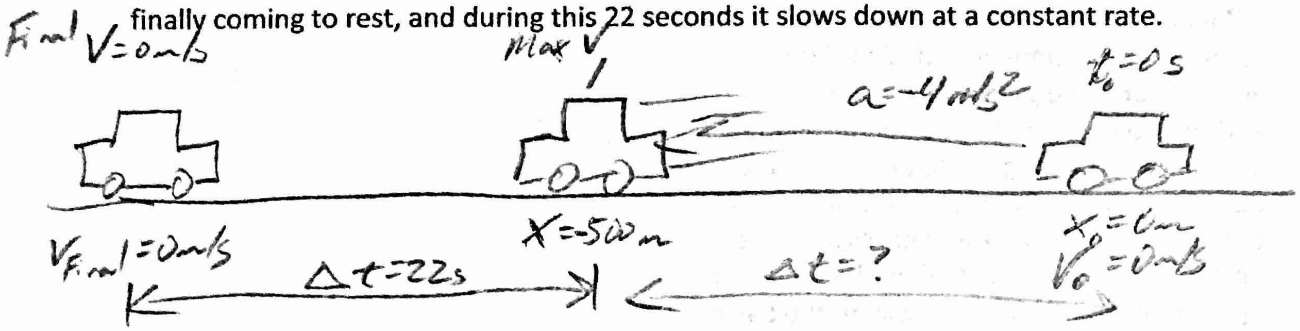
Physics 200 Name: Key

Chapter 2: Extended Kinematics Problems Practice

1. A car accelerates from rest at a constant rate of -4m/s^2. After accelerating at this rate for a distance of 500m, the car turns off its engine and begins to coast. The car coasts for 22 seconds before finally coming to rest, and during this 22 seconds it slows down at a constant rate.



a. What was the car's maximum speed during this event?

$V^2 = V_0^2 + 2a\Delta x$

$V^2 = 0 + 2(-4m/s^2)(-500m)$ → $V^2 = 4{,}000 \frac{m^2}{s^2}$

$V = 63.2 m/s$ → speed = 63.2 m/s

b. What was the car's velocity when it reached its maximum speed?

$-63.2 m/s$

c. At what time did the car reach that velocity?

$V = V_0 + at$

$-63.2 m/s = 0 + -4 m/s^2 (t)$

$t = 15.8 s$

d. What was the car's acceleration during its coasting period?

$V = V_0 + at$

$0 m/s = -63.2 m/s + a(22s)$ → $63.2 m/s = a(22s)$

$a = 2.87 m/s^2$

e. How far did the car travel after its motor turned off?

$\Delta x = V_0 t + \frac{1}{2} a t^2 = -63.2 m/s (22s) + \frac{1}{2}(2.87 m/s^2)(22s)^2$

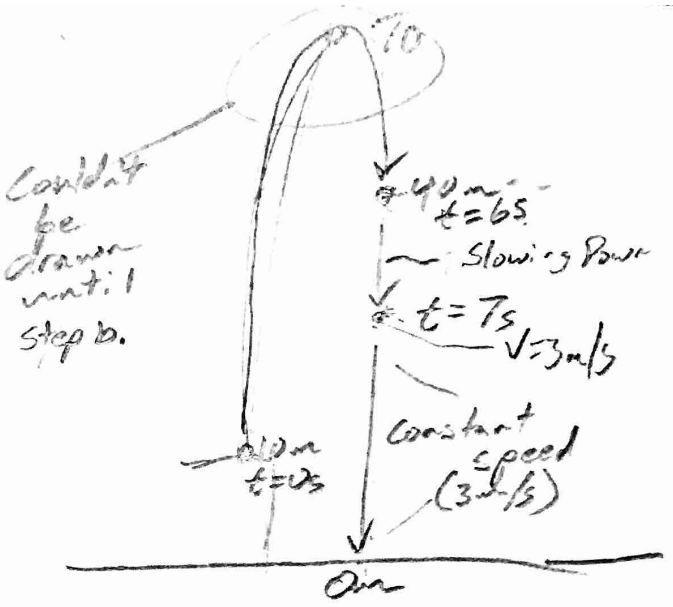
$\Delta x = -1390m + 695m = -695m$

f. What was the car's total displacement?

$-500m + -695m = -1195m$

✓ accel. period ✓ decel period

2. A plastic action figure is launched vertically upward from a point 10m above the ground [At t = 0s, the height of the action figure is 10m above the ground]. From t=0s to t=6s, the action figure travels solely under the influence of gravity. Air resistance can be ignored for this time period. At t=6s, the action figure's height is 40m. Between t=6s and t=7s, a parachute pops out of the figure and deploys, causing the figure's speed to decrease at a constant rate for that 6s to 7s time period. At t=7s, the figure's speed is 3m/s. From t=7seconds onward, the action figure floats the rest of the way to the Earth (height = 0m) at a constant speed of 3m/s.



a. What was the action figure's initial velocity?

$\Delta x = V_0 t + \frac{1}{2} a t^2$

$30m = V_0(6s) + \frac{1}{2}(-9.8 m/s^2)(6s)^2$

$30m = V_0(6s) - 176.4m$ → $206m = V_0(6)$

$V_0 = 34.3 m/s$

b. What was the action figure's velocity at t=6s?

$V = V_0 + at = 34.3 m/s + (-9.8 m/s^2)(6s)$

$V = 34.3 m/s - 58.8 m/s = -24.5 m/s$

c. What was the action figure's average acceleration between t=6s and t=7s?

$V = V_0 + at$

$-3 m/s = -24.5 m/s + a(1s)$ → $21.5 m/s = a(1s)$

$a = 21.5 m/s^2$

d. What was the action figure's displacement between t=6s and t=7s?

One way → $\Delta x = V_0 t + \frac{1}{2} a t^2$

$\Delta x = -24.5 m/s(1s) + \frac{1}{2}(21.5 m/s^2)(1s)^2$

$\Delta x = -24.5m + 10.75m = -13.75m$

Another way → $\bar{V} = \frac{V + V_0}{2} = \frac{-3 m/s + (-24.5 m/s)}{2}$

$\bar{V} = -13.75 m/s$

$\bar{V} = \frac{\Delta x}{\Delta t} \Rightarrow -13.75 m/s = \frac{\Delta x}{1s} \Rightarrow \Delta x = -13.75m$

e. What was the action figure's elevation at t=7s?

$40m - 13.75m = 26.25m$

f. How long did the entire trip last?

Final 26.25m traveled @ 3m/s

$\bar{V} = \frac{\Delta x}{\Delta t}$ $-3 m/s = \frac{-26.25m}{\Delta t} \Rightarrow \Delta t = 8.75s$

total $t = 7s + 8.75s = 15.75s$

**What was the action figure's average speed?

Ave speed = $\frac{\text{total Dist.}}{\text{total time}}$ Need to know max height.

$V^2 = V_0^2 + 2a\Delta x \Rightarrow (0 m/s)^2 = (34.3 m/s)^2 + 2(-9.8 m/s^2)(\Delta x)$

(V at top, V_0 initial, $-g$)

$\Delta x = 60.0m$ = max height

Total distance = 60m up, 70m down ⇒ 130m total

Ave speed = $\frac{130m}{15.75s} = 8.25 m/s$ (total t)