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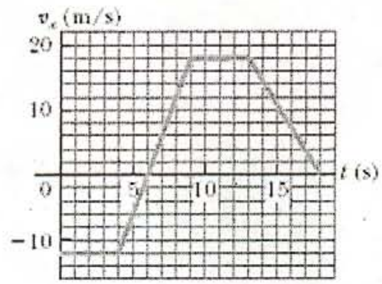
Homework 1 (503719)

About this Assignment

X

1. SerPSE7 2.P.049. [737450] Show Details

An object is at $x = 0$ at $t = 0$ an moves along the x axis according to the velocity-time graph shown below.



(a) What is the acceleration of the object between 0 and 4 s?
[0] m/s^2

(b) What is the acceleration of the object between 4 s and 9 s?
[6.0] m/s^2

(c) What is the acceleration of the object between 13 s and 18 s?
[-3.6] m/s^2

(d) What is the earliest time at which the object is moving with the lowest speed?
[6] s
What is the latest time at which the object is moving with the lowest speed?
[18] s

(e) At what time is the object farthest from $x = 0$?
[18] s

(f) What is the final position x of the object at $t = 18$ s?
[84] m

(g) Through what total distance has the object moved between $t = 0$ and $t =$

18 s?

[204] m

X

2. SerPSE7 2.P.051. [737441] Show Details

A test rocket is fired vertically upward from a well. A catapult gives it an initial speed of 80.8 m/s at ground level. Its engines then fire and it accelerates upward at 3.80 m/s^2 until it reaches an altitude of 1120 m. At that point its engines fail, and the rocket goes into free fall, with an acceleration of -9.80 m/s^2. (You will need to consider the motion while the engine is operating separate from the free-fall motion.)

(a) How long is the rocket in motion above the ground?

[43.2] s

(b) What is its maximum altitude?

[1.89] km ✓

(c) What is its velocity just before it collides with the Earth?

[-192] m/s

X

3. SerPSE7 2.P.055. [737465] Show Details

A commuter train travels between two downtown stations. Because the stations are only 1.38 km apart, the train never reaches its maximum possible cruising speed. During rush hour the engineer minimizes the travel interval Δt between the two stations by accelerating for a time interval Δt_1 at a_1 = 0.100 m/s^2 and then immediately braking with acceleration a_2 = -0.580 m/s^2 for a time interval Δt_2. Find the minimum time interval of travel Δt and the time interval Δt_1.

Δt = [180] s

Δt_1 = [153] s

4. P. 13

A particle moves along the x axis according to the equation $x = 2.10 + 2.98t - t^2$, where x is in meters and t is in seconds.

(a) At t = 2.70 s, find the position of the particle.

[2.86] m

(b) What is its velocity at t = 2.70 s?

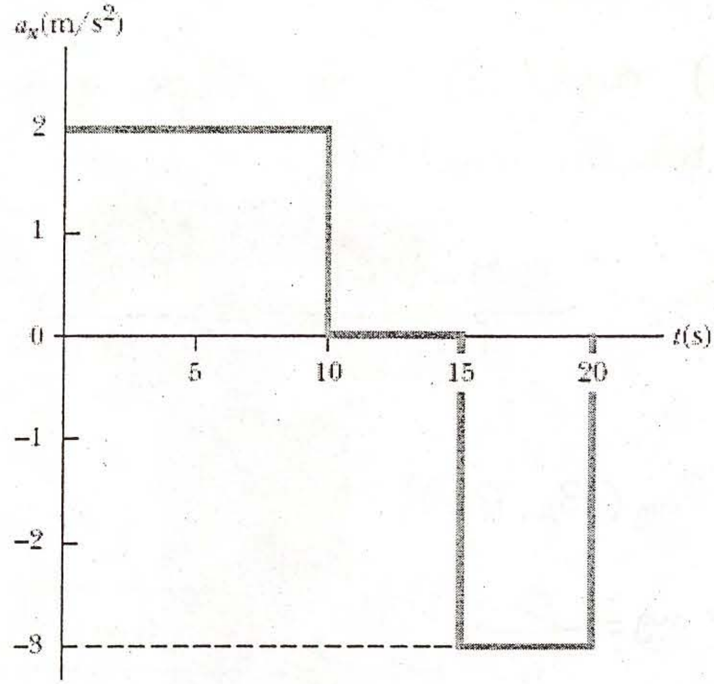
[-2.42] m/s

(c) What is its acceleration at t = 2.70 s?

[-2] m/s^2

5. SerPSE7 2.P.011. [737414] Show Details

A particle starts from rest and accelerates as shown in the figure below.



(a) Determine the particle's speed at t = 10.0 s.

[20] m/s

What is the speed at t = 20.0 s?

[5] m/s

(b) Find the distance traveled in the first 20.0 s.

[262] m

6. SerPSE7 2.P.021. [737410] Show Details

An object moving with uniform acceleration has a velocity of 17.0 cm/s in the positive x direction when its x coordinate is 3.00 cm. If its x coordinate 2.80 s later is -5.00 cm, what is its acceleration?

[-14.2] cm/s^2

7. SerPSE7 2.P.025. [737429] Show Details

The driver of a car slams on the brakes when he sees a tree blocking the road. The car slows uniformly with acceleration -5.25 m/s^2 for 4.10 s, making straight skid marks 63.0 m long ending at the tree. With what speed does the car then strike the tree?

[4.6] m/s

P49

(a) V_x = constant between $(0, 4s)$ $\rightarrow$ $\boxed{a_x = 0 \text{ m/s}^2}$

(b) $a_{avg}(4s, 9s)$ is the slope of the V_x vs. t graph between 4 and 9s

$$a_{x\,avg} = \frac{V(9) - V(4)}{9_s - 4_s} = \frac{18\text{ m/s} - (-12\text{ m/s})}{5\text{ s}} = \boxed{6\text{ m/s}^2}$$

(c) $a_{avg}(13s, 18s)$

$$a_{x\,avg} = \frac{0 - 18\text{ m/s}}{18s - 13s} = \boxed{-3.6\text{ m/s}^2}$$

(d) From the graph, the speed is zero at $\boxed{t = 6s}$ and $t = 18s$

minimum time

(e) The object moves away from $x = 0$ into negative coordinates from $t = 0s$ to $t = 6s$. Afterwards it moves into positive coordinates until $\boxed{t = 18s}$. This is the time at which the object is farthest from $x = 0$.

(f) $x(18s)$?

V = constant $(0, 4s)$ $\rightarrow$ $x(4) - \cancel{x(0)} = (-12\text{ m/s})\cdot(4s) = -48\text{ m}$

a = constant $(4s, 9s)$ $\rightarrow$ $x(9) - x(4) = (-12\text{ m/s})\cdot(5s) + \frac{1}{2}(6\text{ m/s}^2)(5s)^2 = 15\text{ m}$

$x(9) = -33\text{ m}$

V = constant $(9, 13s)$ $\rightarrow$ $x(13) - x(9) = (18\text{ m/s})\cdot(4s) = 72\text{ m}$

$\rightarrow x(13) = 39\text{ m}$

a = constant $(13s, 18s)$ $\rightarrow$ $x(18) - x(13) = (18\text{ m/s})\cdot(5s) + \frac{1}{2}(-3.6\text{ m/s}^2)(5s)^2 = 45\text{ m}$

$\underline{\underline{x(18)}} = 45\text{ m} + x(13s) = 45\text{ m} + 39\text{ m} = \boxed{84\text{ m}}$

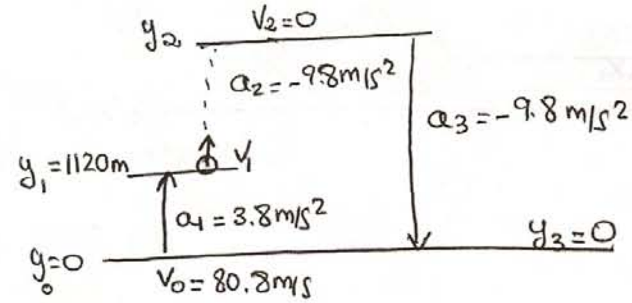
(g) Total distance $t = 0$ to $t = 18s$

Total displacement = $\Delta x = x(18) - x(0) = 84$ m

Total area = Total distance = 60 m + 144 m = $\boxed{204\text{ m}}$

[illegible]

P51



① $\begin{cases} y_1 - \cancel{y_0} = V_0 \cdot t_1 + \frac{1}{2}a_1 t_1^2 \\ a_1 = \dfrac{V_1 - V_0}{t_1 - 0} \end{cases}$ $\quad 1120 = 80.8t_1 + 1.9\,t_1^2 \rightarrow \boxed{t_1 \simeq 11\,s}$

$V_1 = V_0 + 3.8t_1 = 80.8\frac{m}{s} + (3.8\,\frac{m}{s^2})(11s) = \boxed{122.6\frac{m}{s}}$

② $\begin{cases} y_2 - y_1 = V_1 t_2 - \frac{1}{2}g\,t_2^2 \\ a_2 = -g = \dfrac{0 - V_1}{t_2} \end{cases}$ $\rightarrow y_2 = y_1 + V_1 t_2 - 4.9t_2^2 = 1120\,m + (122.6\frac{m}{s}) \cdot t_2 - 4.9t_2^2$

$\rightarrow t_2 = \dfrac{V_1}{g} = \dfrac{122.6\,m/s}{9.8\,m/s^2} = \boxed{12.5\,s}$

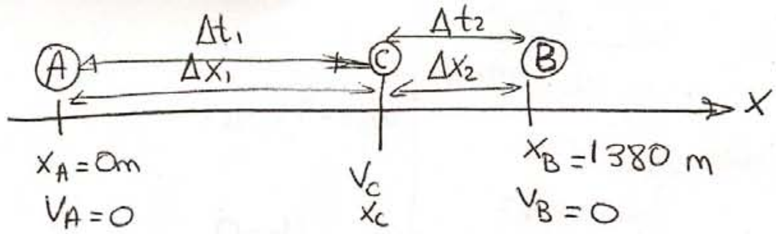
(b) $y_2 = 1120\,m + (122.6\,\frac{m}{\cancel{s}})(12.5\cancel{s}) - 4.9\frac{m}{\cancel{s^2}}(12.5\cancel{s})^2 = \boxed{1886.9\,m} \Rightarrow \simeq 1.89\,Km$

③ $\left\{ \cancel{y_3} - y_2 = \cancel{V_2 t_3} - \frac{1}{2}g t_3^2 \right.$ $\rightarrow -1886.9m = -4.9\,t_3^2 \Rightarrow \boxed{t_3 = 19.6s}$

(a) Total time $\quad t_T = t_1 + t_2 + t_3 = 11s + 12.5s + 19.6s = \boxed{43.1s}$

(c) V_3 ? $\quad a_3 = -g = \dfrac{V_3 - 0}{t_3} \Rightarrow V_3 = (-9.8\,m/s^2)(19.6s) = \boxed{-192\,m/s}$

P55



$\Delta t_1 \Rightarrow a_1 = 0.1 \, m/s^2$

$\Delta t_2 \Rightarrow a_2 = -0.58 \, m/s^2$

$$\begin{cases} \Delta x_{TOTAL} = \Delta x_1 + \Delta x_2 = 1380 \, m \\ \Delta t = \Delta t_1 + \Delta t_2 \end{cases}$$

STEP 1 $\Rightarrow$

$$\begin{cases} \Delta x_1 = \cancel{V_A} \cdot \Delta t_1 + \frac{1}{2} a_1 (\Delta t_1)^2 \longrightarrow \boxed{\Delta x_1 = \frac{1}{2} a_1 (\Delta t_1)^2} \quad (1) \\ a_1 = \frac{V_c - \cancel{V_A}}{\Delta t_1} \Rightarrow \boxed{V_c = a_1 \cdot \Delta t_1} \quad (2) \end{cases}$$

STEP 2

$$\Rightarrow \begin{cases} \Delta x_2 = V_c \cdot (\Delta t_2) + \frac{1}{2} \overset{<0}{a_2} (\Delta t_2)^2 \\ a_2 = \frac{\overset{V_B}{0} - V_c}{\Delta t_2} \Rightarrow \boxed{V_c = -a_2 \Delta t_2} \quad (3) \end{cases} \longrightarrow a_1 \cdot \Delta t_1 = -a_2 \Delta t_2 \Rightarrow$$

$$\Rightarrow \boxed{\Delta t_2 = -\frac{a_1}{a_2} \Delta t_1} \quad (4)$$

$$\Delta x_2 = \underbrace{(+a_1 (\Delta t_1))}_{= V_c} (\Delta t_2) + \frac{1}{2} a_2 (\Delta t_2)^2 = +a_1 (\Delta t_1) \left(-\frac{a_1}{\cancel{a_2}} \Delta t_1\right) + \frac{1}{2} a_2 \left(-\frac{a_1}{a_2} \Delta t_1\right)^2$$

$$\Rightarrow \Delta x_2 = -\frac{a_1^2}{a_2} (\Delta t_1)^2 + \frac{1}{2} \frac{a_1^2}{a_2} (\Delta t_1)^2 = \boxed{-\frac{1}{2} \frac{a_1^2}{a_2} (\Delta t_1)^2 = \Delta x_2} \quad (5)$$

From eq. (1) and (5):

$$\Delta x_{TOTAL} = \Delta x_1 + \Delta x_2 = 1380 m = \frac{1}{2} a_1 (\Delta t_1)^2 - \frac{1}{2} \frac{a_1^2}{a_2} (\Delta t_1)^2$$

$$\Delta x_{TOTAL} = \frac{1}{2} (\Delta t_1)^2 \left[a_1 - \frac{a_1^2}{a_2}\right] = \frac{1}{2} a_1 (\Delta t_1)^2 \left[1 - \frac{a_1}{a_2}\right]$$

$$\Rightarrow (\Delta t_1)^2 = \frac{2 \Delta x_{TOTAL}}{a_1 \left[1 - \underbrace{\frac{a_1}{a_2}}_{\rightarrow \text{negative}}\right]} \Rightarrow \boxed{\Delta t_1 \simeq 153.48}$$

From (4)

$$\Delta t_2 = -\frac{a_1}{a_2} \Delta t_1 = \cancel{-} \left(\frac{0.1 \, m/s^2}{\cancel{-}0.58 \, m/s^2}\right) \cdot (153 \, s) = \underline{26.38 \, s}$$

$$\Delta t = \Delta t_1 + \Delta t_2 = 153.4 \, s + 26.4 \, s = \boxed{179.8 \, s}$$

$\boxed{P13}$ $x = 2.10 + 2.98t - t^2$

(a) $t = 2.7s \rightarrow x(2.7) = 2.10m + (2.98)(2.7) - (2.7)^2 = \boxed{2.86m}$

(b) $v(2.7s)$?

$$V(t) = \frac{dx(t)}{dt} = 2.98 - 2t$$

$$V(2.7s) = 2.98 - 2*(2.7s) = \boxed{-2.42\ m/s}$$

(c) $a(2.7s)$

$$a(t) = \frac{dv(t)}{dt} = \frac{d^2x}{dt^2} = \boxed{-2\ m/s^2} = \text{constant}$$

P11 (a) Speed at t=10 s

(a) $V = \cancel{V_0} + a \cdot t = (2\,m/s^2) \cdot (10s) = \boxed{20\,m/s}$

From $t = 10s$ to $t = 15s$ constant speed because $a = 0$

$V(15s) = V(10s) = 20\,m/s$

From $t = 15\,s$ to $t = 20s \Rightarrow a = -3\,m/s^2$

$V(20\,s) = V(15s) + a \cdot (20_s - 15_s) = 20\,m/s - \left(3\frac{m}{\cancel{s^2}}\right) \cdot 5\cancel{s} = \boxed{5\,m/s}$

(b) Distance in the first 20 s = Total distance.

$(0, 10\,s) \Rightarrow a_x = \text{constant} \Rightarrow x_{f_1} - \cancel{x_0}^{0} = \cancel{V_0 t}^{0} + \frac{1}{2} \overset{2m/s^2}{a_1} t^2 = \frac{1}{\cancel{2}}\left(\cancel{2}\frac{m}{s^2}\right) 10^2_s$

$\underline{x_{f_1} = 100\,m}$

$(10, 15s) \Rightarrow a = 0 \Rightarrow x_{f_2} - x_{f_1} = V_1 \cdot t = (20\,m/s) \cdot (5s) \Rightarrow$

$x_{f_2} = x_{f_1} + 100\,m = \underline{200\,m}$

$(15s, 20s) \Rightarrow a_x = \text{constant} \Rightarrow x_{f_3} - x_{f_2} = V_2 t + \frac{1}{2} a_2 t^2 = (20\,m/s) \cdot (5s) + \frac{1}{2}\left(-3\frac{m}{s^2}\right)(5s)^2$

$\Rightarrow \underline{\underline{x_{f_3}}} = 200\,m + 100\,m - 37.5\,m = \boxed{262.5\,m}$

P21

$V_1 = 17\,cm/s \ , \ x_1 = 3cm \quad t_1 = 0\,s$

$x_2 = -5cm \ , \ t_2 = 2.8\,s$

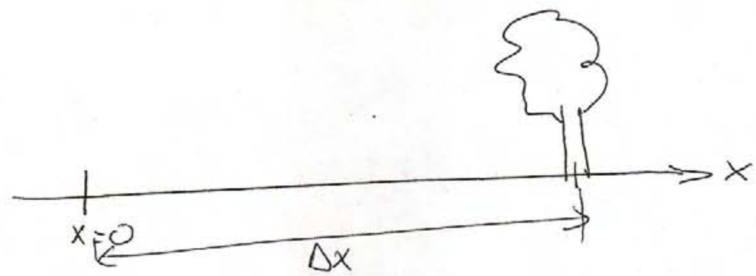
$\underline{\underline{a}}$?

$x_2 - x_1 = V_1 t_2 + \frac{1}{2} a t_2^2$

$-5cm - 3cm = (17cm/s)(2.8s) + 0.5\,a\,(2.8s)^2 \Rightarrow -8cm = 47.6cm + 3.9$

$\Rightarrow \boxed{a = -14.2\,m/s^2}$

P25



$a = -5.25\,m/s^2 \ ; \quad \Delta t = 4.10s = t$

$\Delta x = 63m$

V_f ?

(1) $\boxed{\Delta x = 63m = V_0 \cdot t + \frac{1}{2} a t^2} = V_0 \cdot (4.10s) + \frac{1}{2}\left(-5.25\frac{m}{s^2}\right)(4.10s)^2$

$a = \frac{V_f - V_0}{t} \Rightarrow \boxed{V_f = V_0 + a \cdot t}$ (2)

From (1) $\quad 63m = 4.10\,V_0 - 44.126 \Rightarrow \underline{V_0 = 26.13\,m/s}$

$\underline{\underline{V_f}} = 26.13\,m/s - (5.25\,m/s^2) \cdot (4.10s) = \boxed{4.6\,m/s}$