Today: 11.2

$\boxed{L2}$

$\boxed{L2}$

Today: 11.2

Wednesday: 11.2

$\boxed{L2}$

Today : 11.2

Wednesday : 11.2

HW#1 Due Friday

From last time:

$$v = \frac{dx}{dt}$$

From last time :

$v = \frac{dx}{dt}$, $a = \frac{dv}{dt}$

From last time:

$$v = \frac{dx}{dt}, \quad a = \frac{dv}{dt} = \frac{d^2x}{dt^2}$$

From last time:

$$v = \frac{dx}{dt}, \quad a = \frac{dv}{dt} = \frac{d^2x}{dt^2}$$

Going backwards:

From last time:

$$v = \frac{dx}{dt}, \quad a = \frac{dv}{dt} = \frac{d^2x}{dt^2}$$

Going backwards:

Start with $a(t) \longrightarrow$

From last time:

$v = \frac{dx}{dt}$, $a = \frac{dv}{dt} = \frac{d^2x}{dt^2}$

Going backwards:

Start with $a(t) \longrightarrow a = \frac{dv}{dt}$

From last time:

$$v = \frac{dx}{dt}, \quad a = \frac{dv}{dt} = \frac{d^2x}{dt^2}$$

Going backwards:

Start with $a(t) \longrightarrow \quad a = \frac{dv}{dt} \Rightarrow$

$$\int a\,dt = \int \frac{dv}{dt}\,dt$$

From last time:

$$v = \frac{dx}{dt}, \quad a = \frac{dv}{dt} = \frac{d^2x}{dt^2}$$

Going backwards:

Start with $a(t) \longrightarrow \quad a = \frac{dv}{dt} \Rightarrow$

$$\int a\,dt = \int \frac{dv}{dt}\,dt \Rightarrow \int a\,dt = \int dv$$

From last time:

$$v = \frac{dx}{dt}, \quad a = \frac{dv}{dt} = \frac{d^2x}{dt^2}$$

Going backwards:

Start with $a(t) \longrightarrow \quad a = \frac{dv}{dt} \Rightarrow$

$$\int a\,dt = \int \frac{dv}{dt}\,dt \Rightarrow \int a\,dt = \int dv$$

$$\Rightarrow \quad v - v_0 = \int_0^t a\,dt$$

Constant acceleration

Constant acceleration

if $a = \text{constant}$ $\frac{dv}{dt} = a \Rightarrow$

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$$\int_{v_0}^{v} dv = \int_0^t a\,dt$$

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$$\int_{v_0}^{v} dv = \int_0^t a\, dt \Rightarrow v - v_0 = at \Rightarrow$$

$$v = at + v_0$$

Constant acceleration

if $a = \text{constant}$ $\frac{dv}{dt} = a \Rightarrow$

$$\int_{v_0}^{v} dv = \int_0^t a\,dt \Rightarrow v - v_0 = at \Rightarrow$$

$$v = at + v_0$$ & $\frac{dx}{dt} = v \Rightarrow$

Constant acceleration

if $a = \text{constant}$ $\quad \frac{dv}{dt} = a \Rightarrow$

$$\int_{v_0}^{v} dv = \int_0^t a\,dt \Rightarrow v - v_0 = at \Rightarrow$$

$$v = at + v_0 \qquad \& \qquad \frac{dx}{dt} = v \Rightarrow$$

$$\int_{x_0}^{x} dx = \int_0^t v\,dt$$

Constant acceleration

if $a = \text{constant}$ $\quad \frac{dv}{dt} = a \Rightarrow$

$$\int_{v_0}^{v} dv = \int_0^t a\,dt \Rightarrow v - v_0 = at \Rightarrow$$

$$v = at + v_0 \quad \& \quad \frac{dx}{dt} = v \Rightarrow$$

$$\int_{x_0}^{x} dx = \int_0^t v\,dt \Rightarrow x - x_0 = \int_0^t (at + v_0)\,dt$$

Constant acceleration

if $a = \text{constant}$ $\quad \frac{dv}{dt} = a \Rightarrow$

$$\int_{v_0}^{v} dv = \int_0^t a\,dt \Rightarrow v - v_0 = at \Rightarrow$$

$$v = at + v_0 \quad \& \quad \frac{dx}{dt} = v \Rightarrow$$

$$\int_{x_0}^{x} dx = \int_0^t v\,dt \Rightarrow x - x_0 = \int_0^t (at + v_0)\,dt$$

$$\Rightarrow x = \frac{1}{2}at^2 + v_0 t + x_0$$

Constant acceleration

if $a = \text{constant}$ $\quad \frac{dv}{dt} = a \Rightarrow$

$$\int_{v_0}^{v} dv = \int_0^t a\,dt \Rightarrow v - v_0 = at \Rightarrow$$

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$$\int_{x_0}^{x} dx = \int_0^t v\,dt \Rightarrow x - x_0 = \int_0^t (at + v_0)\,dt$$

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If $a = -g$

Constant acceleration

if $a = \text{constant}$ $\quad \frac{dv}{dt} = a \Rightarrow$

$$\int_{v_0}^{v} dv = \int_0^t a\,dt \Rightarrow v - v_0 = at \Rightarrow$$

$$v = at + v_0 \quad \& \quad \frac{dx}{dt} = v \Rightarrow$$

$$\int_{x_0}^{x} dx = \int_0^t v\,dt \Rightarrow x - x_0 = \int_0^t (at + v_0)\,dt$$

$$\Rightarrow x = \frac{1}{2}at^2 + v_0 t + x_0$$

If $a = -g$

then $x = -\frac{1}{2}gt^2 + v_0 t + x_0$

Section 11.2

Section 11.2

Special cases & Relative motion

Section 11.2

Special cases & Relative motion

$v = \text{constant}$

Section 11.2

Special cases & Relative motion

$v = \text{constant} \Rightarrow a = 0$ & $x = vt + x_0$

Section 11.2

Special cases & Relative motion

$v = \text{constant} \Rightarrow a = \cancel{0}$ & $x = vt + x_0$

$a = \text{constant}$

Section 11.2

Special cases & Relative motion

$v = \text{constant} \Rightarrow a = 0$ & $x = vt + x_0$

$a = \text{constant} \Rightarrow v = at + v_0$ & $x = \frac{1}{2}at^2 + v_0 t + x_0$

Section 11.2

Special cases & Relative motion

$v = \text{constant} \Rightarrow a = 0$ & $x = vt + x_0$

$a = \text{constant} \Rightarrow v = at + v_0$ & $x = \frac{1}{2}at^2 + v_0 t + x_0$

Also $\quad a = v\frac{dv}{dx} \Rightarrow a\int_{x_0}^{x} dx = \int_{v_0}^{v} v\,dv$

Section 11.2

Special cases & Relative motion

$v = \text{constant} \Rightarrow a = \cancel{0}$ & $x = vt + x_0$

$a = \text{constant} \Rightarrow v = at + v_0$ & $x = \frac{1}{2}at^2 + v_0 t + x_0$

Also $a = v\frac{dv}{dx} \Rightarrow a\int_{x_0}^{x} dx = \int_{v_0}^{v} v\,dv$

$\Rightarrow a(x - x_0) = \frac{1}{2}(v^2 - v_0^2)$

Section 11.2

Special cases & Relative motion

$v = \text{constant} \Rightarrow a = \cancel{0}$ & $x = vt + x_0$

$a = \text{constant} \Rightarrow v = at + v_0$ & $x = \frac{1}{2}at^2 + v_0 t + x_0$

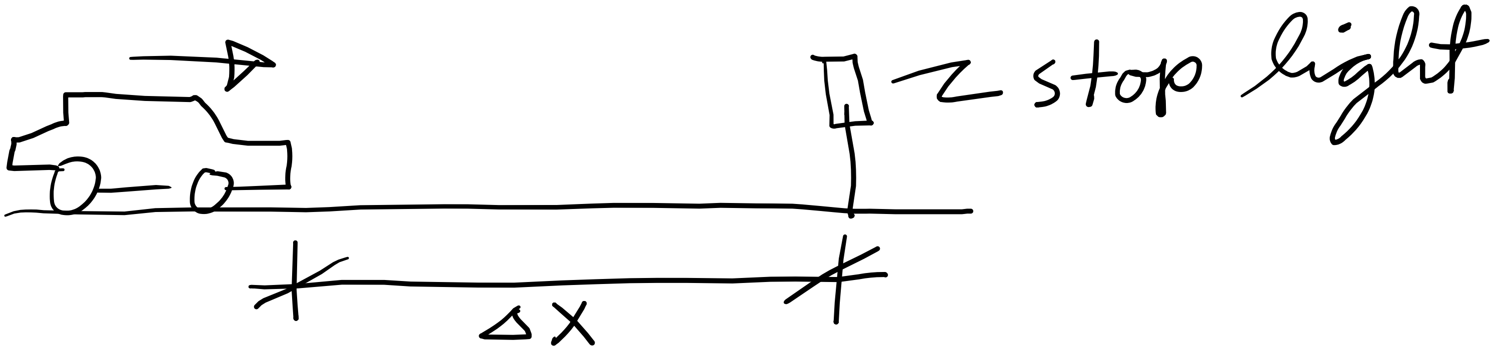
Also $a = v\frac{dv}{dx} \Rightarrow a\int_{x_0}^{x} dx = \int_{v_0}^{v} v\,dv$

$\Rightarrow a(x - x_0) = \frac{1}{2}(v^2 - v_0^2)$ or

$v^2 = 2a(x - x_0) + v_0^2$

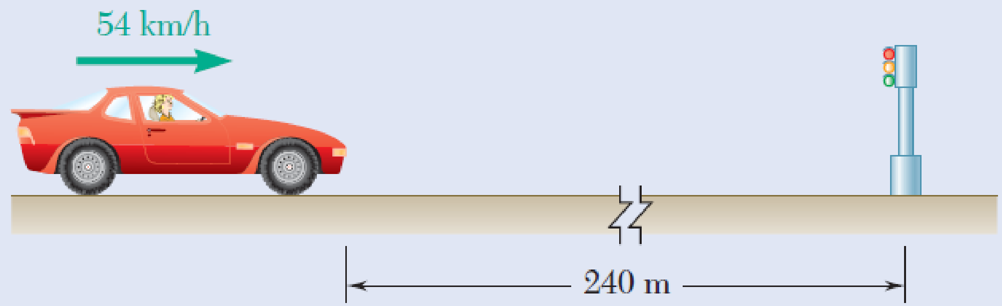
Notes on problems

Notes on problems : $\boxed{11.34}$



Given: $V_0 = 54\frac{km}{hr}$, $\Delta x = 240m$, $\Delta t = 24s$ & $a = const.$

11.34 A motorist is traveling at 54 km/h when she observes that a traffic light 240 m ahead of her turns red. The traffic light is timed to stay red for 24 s. If the motorist wishes to pass the light without stopping just as it turns green again, determine (*a*) the required uniform deceleration of the car, (*b*) the speed of the car as it passes the light.



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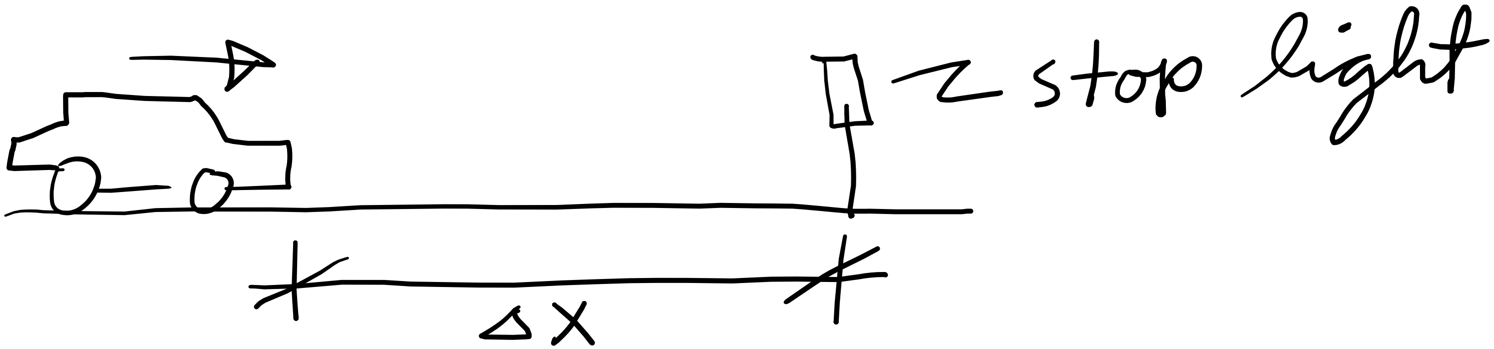
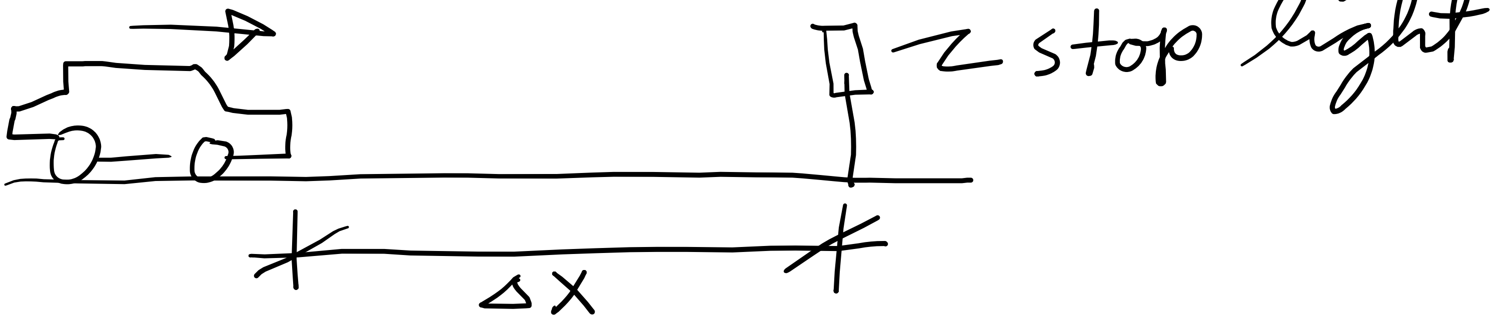
Notes on problems : $\boxed{11.34}$



Given: $V_0 = 54\,\frac{km}{hr}$, $\Delta x = 240\,m$, $\Delta t = 24\,s$ & $a = const.$

Note units !!

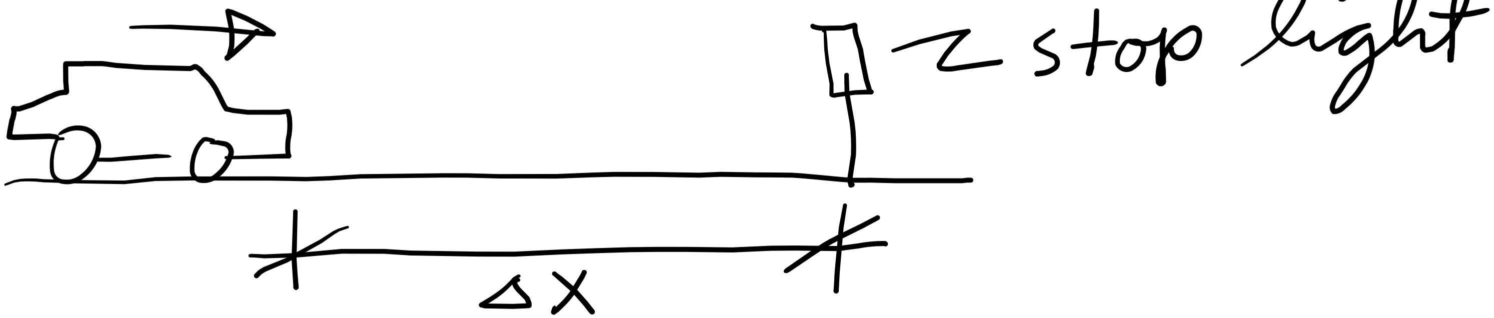
Notes on problems : $\boxed{11.34}$



Given: $V_0 = 54\frac{km}{hr}$, $\Delta x = 240m$, $\Delta t = 24s$ & $a = const.$

(a) Find a:

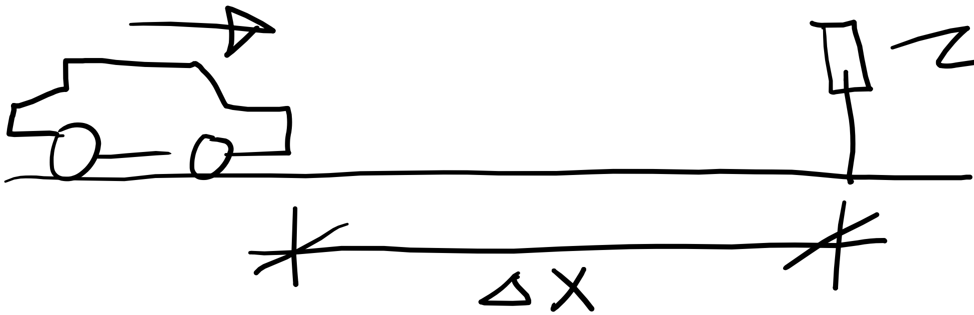
Notes on problems : $\boxed{11.34}$



Given: $V_0 = 54\frac{km}{hr}$, $\Delta x = 240m$, $\Delta t = 24s$ & $a = const.$

(a) Find a & Δx & Δt: We know $x = \frac{1}{2}at^2 + V_0 t + x_0$

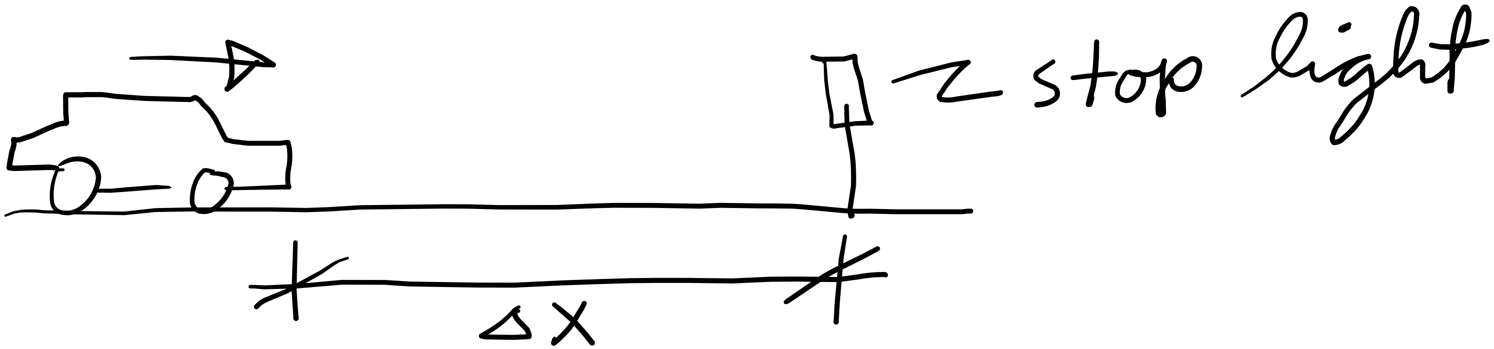
Notes on problems : $\boxed{11.34}$



Given: $V_0 = 54\frac{km}{hr}$, $\Delta x = 240m$, $\Delta t = 24s$ & $a = const.$

(a) Find a: We know $x = \frac{1}{2}at^2 + V_0t + x_0$ & Δx & Δt $\Rightarrow$ just need to dig out a

Notes on problems: $\boxed{11.34}$

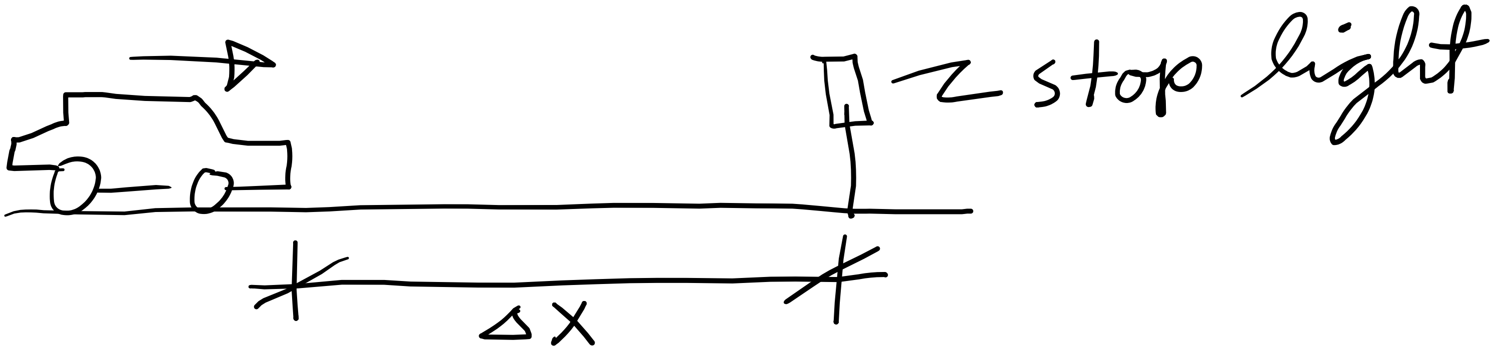


Given: $V_0 = 54 \frac{km}{hr}$, $\Delta x = 240m$, $\Delta t = 24s$ & $a = $ const.

(a) Find a: We know $x = \frac{1}{2}at^2 + V_0 t + x_0$ & Δx & Δt $\Rightarrow$ just need to dig out a

(b) Find v at $t = 24s$:

Notes on problems: $\boxed{11.34}$



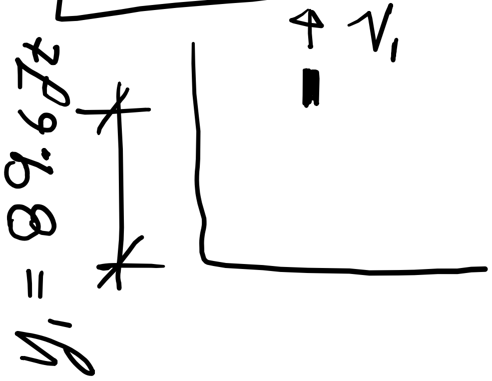
Given: $V_0 = 54\,\frac{km}{hr}$, $\Delta x = 240m$, $\Delta t = 24s$ & $a = const.$

(a) Find a: We know $x = \frac{1}{2}at^2 + V_0 t + x_0$ & Δx & Δt $\Rightarrow$ just need to dig out a

(b) Find v at $t = 24s$: $v = \frac{dx}{dt} \Rightarrow$

$$v(t=24s) = \left.\frac{dx}{dt}\right|_{t=24s}$$

$\boxed{11.36}$



Lands 16s later

so
$$\begin{cases} y_1 = 89.6\,ft, & t_1 = 0 \\ y_f = 0\,ft, & t_f = 16\,s \\ a = -g = -32.2\,ft/s^2 \end{cases}$$

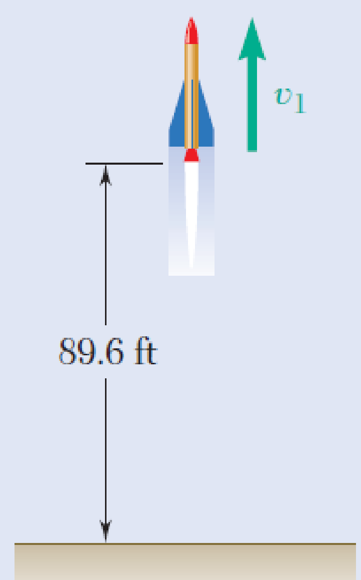
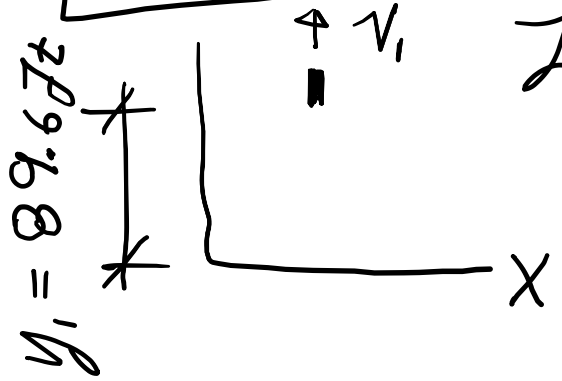


Fig. P11.36

11.36 A group of students launches a model rocket in the vertical direction. Based on tracking data, they determine that the altitude of the rocket was 89.6 ft at the end of the powered portion of the flight and that the rocket landed 16 s later. Knowing that the descent parachute failed to deploy so that the rocket fell freely to the ground after reaching its maximum altitude and assuming that $g = 32.2$ ft/s^2, determine (*a*) the speed v_1 of the rocket at the end of powered flight, (*b*) the maximum altitude reached by the rocket.

$\boxed{11.36}$



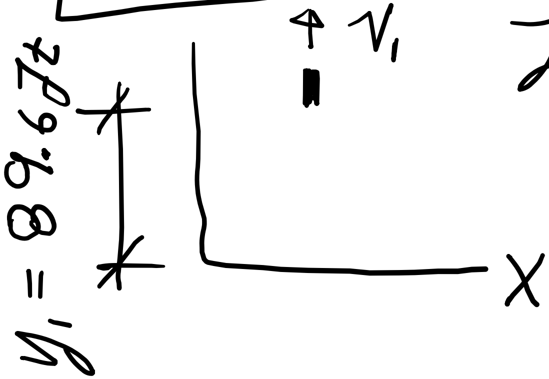
Lands 16 s later

so

$$\begin{cases} y_1 = 89.6\,ft, & t_1 = 0 \\ y_f = 0\,ft, & t_f = 16\,s \\ a = -g = -32.2\,ft/s^2 \end{cases}$$

(a) Find v_1

$\boxed{11.36}$



Lands 16 s later

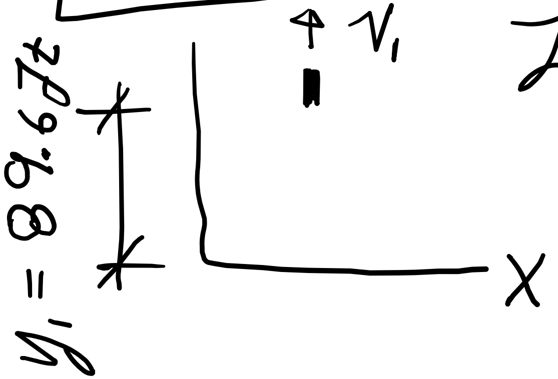
so

$$\begin{cases} y_1 = 89.6\,ft, & t_1 = 0 \\ y_F = 0\,ft, & t_F = 16\,s \\ a = -g = -32.2\,ft/s^2 \end{cases}$$

(a) Find v_1

$$y_F = -\frac{1}{2} g t^2 + v_1 t_F + y_1$$

$\boxed{11.36}$



Lands 16 s later

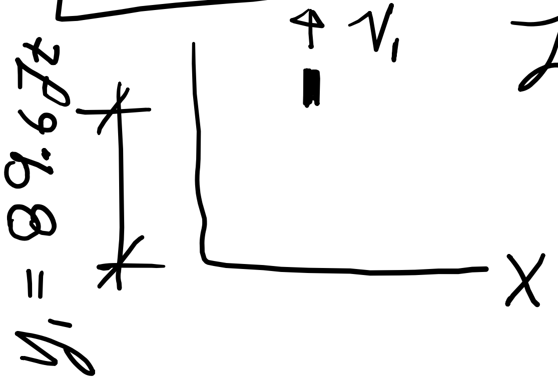
so
$$\begin{cases} y_1 = 89.6\,ft, & t_1 = 0 \\ y_F = 0\,ft, & t_F = 16\,s \\ a = -g = -32.2\,ft/s^2 \end{cases}$$

(a) Find v_1

$y_F = -\frac{1}{2} g t^2 + v_1 t_F + y_1$ we know t_F, y_F & y_1

so just need to dig out v_1

$\boxed{11.36}$



Lands 16 s later

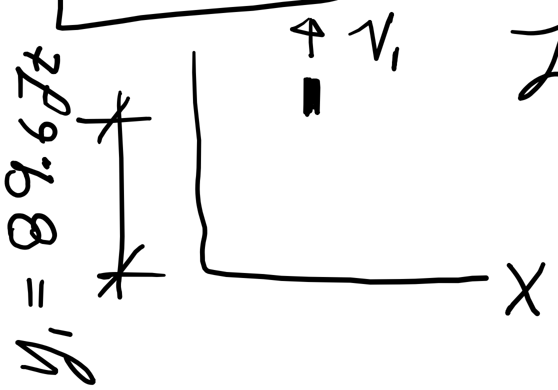
so
$$\begin{cases} y_1 = 89.6\,ft, & t_1 = 0 \\ y_F = 0\,ft, & t_F = 16\,s \\ a = -g = -32.2\,ft/s^2 \end{cases}$$

(a) Find v_1

$y_F = -\frac{1}{2} g t^2 + v_1 t_F + y_1$ we know t_F, y_F & y_1 so just need to dig out v_1

(b) Find y_{MAX}:

$\boxed{11.36}$



Lands 16 s later

so
$$\begin{cases} y_1 = 89.6\,ft, & t_1 = 0 \\ y_F = 0\,ft, & t_f = 16\,s \\ a = -g = -32.2\,ft/s^2 \end{cases}$$

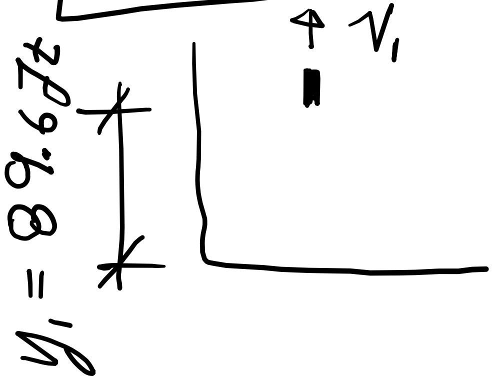
(a) Find v_1

$y_F = -\frac{1}{2}gt^2 + v_1 t_F + y_1$ we know t_F, y_F & y_1

so just need to dig out v_1

(b) Find y_{max} : 2 ways

$\boxed{11.36}$



Lands 16 s later

so
$$\begin{cases} y_1 = 89.6\ \text{ft},\ t_1 = 0 \\ y_F = 0\ \text{ft},\ t_f = 16\,\text{s} \\ a = -g = -32.2\ \text{ft}/\text{s}^2 \end{cases}$$

(a) Find V_1

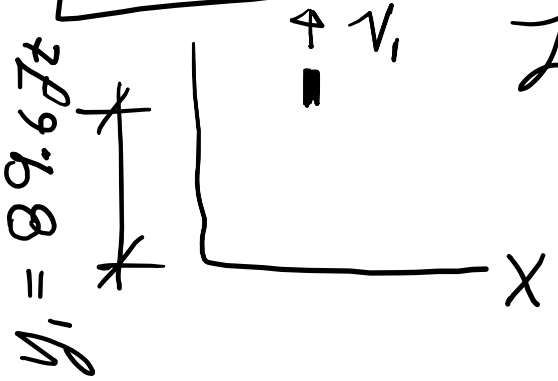
$y_F = -\frac{1}{2} g t^2 + V_1 t_F + y_1$ we know t_F, y_F & y_1

so just need to dig out V_1

(b) Find y_{MAX} : 2 ways: 1 y_{MAX} when $V = 0$

$\Rightarrow$ Find t at $V = 0$ then use t to get y_{MAX}

$\boxed{11.36}$



Lands 16 s later

so
$$\begin{cases} y_1 = 89.6\,\text{ft}, \; t_1 = 0 \\ y_F = 0\,\text{ft}, \; t_f = 16\,\text{s} \\ a = -g = -32.2\,\text{ft/s}^2 \end{cases}$$

(a) Find v_1

$y_F = -\frac{1}{2}gt^2 + v_1 t_F + y_1$ we know t_F, y_F & y_1

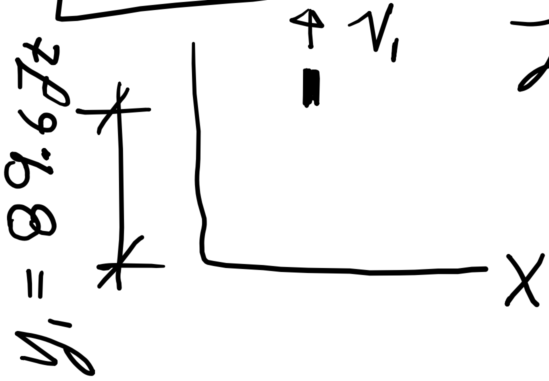
so just need to dig out v_1

(b) Find y_{max}: 2 ways: 1 y_{max} when $v = 0$

$\Rightarrow$ find t at $v = 0$ then use t to get y_{max} or

2 Use $a = v\frac{dv}{dy} \Rightarrow -g = v\frac{dv}{dy}$

11.36



Lands 16 s later

so

$$\begin{cases} y_1 = 89.6\,ft, & t_1 = 0 \\ y_F = 0\,ft, & t_f = 16\,s \\ a = -g = -32.2\,ft/s^2 & \end{cases}$$

(a) Find v_1

$y_F = -\frac{1}{2} g t^2 + v_1 t_F + y_1$ we know t_F, y_F & y_1

so just need to dig out v_1

(b) Find y_{MAX}: 2 ways: 1 y_{MAX} when $v = 0$

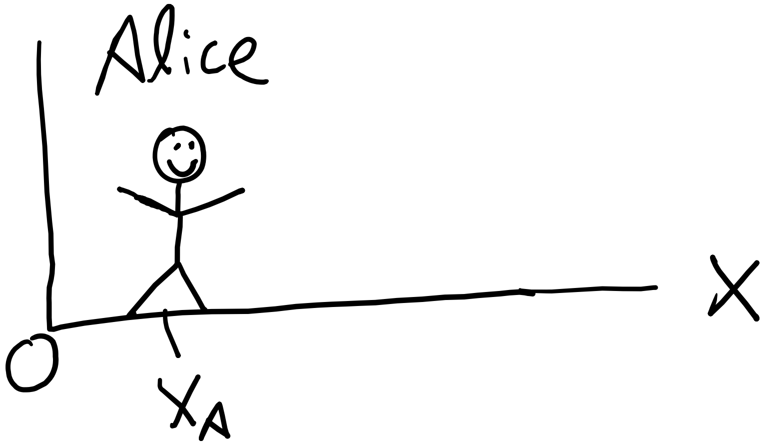
$\Rightarrow$ find t at $v = 0$ then use t to get y_{MAX} or

2 Use $a = v\frac{dv}{dy} \Rightarrow -g = v\frac{dv}{dy} \Rightarrow -g\,dy = v\,dv$

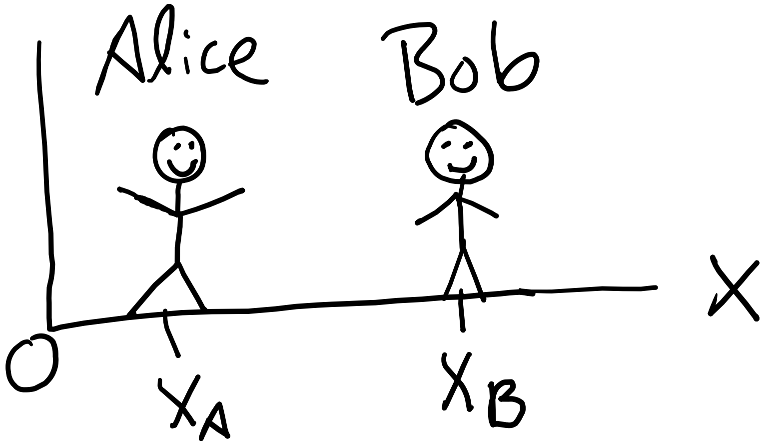
$$\Rightarrow -g\int_{y_1}^{y_{MAX}} dy = \int_{v_1}^{v=0} v\,dv$$

Relative motion

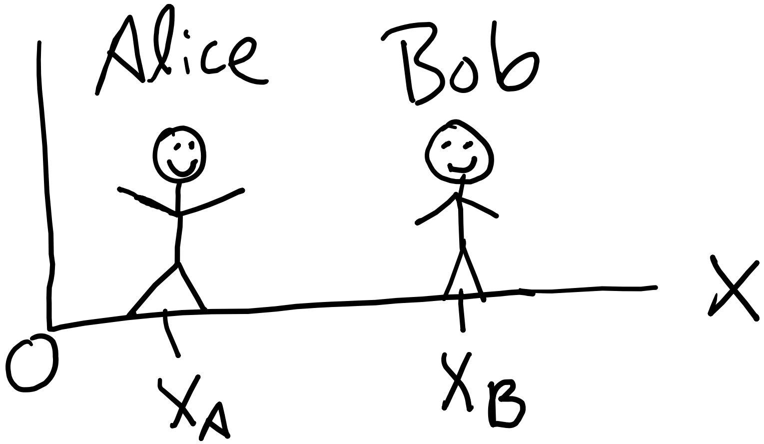
Relative motion



Relative motion



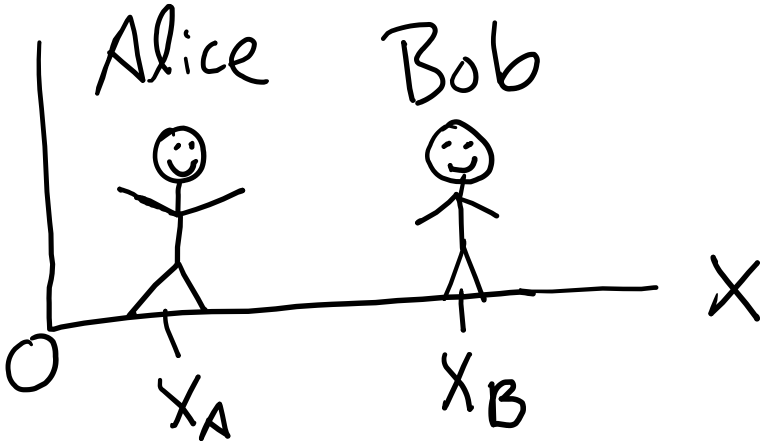
Relative motion



position:

$x_{B/A} \equiv x$ of B relative to A

Relative motion

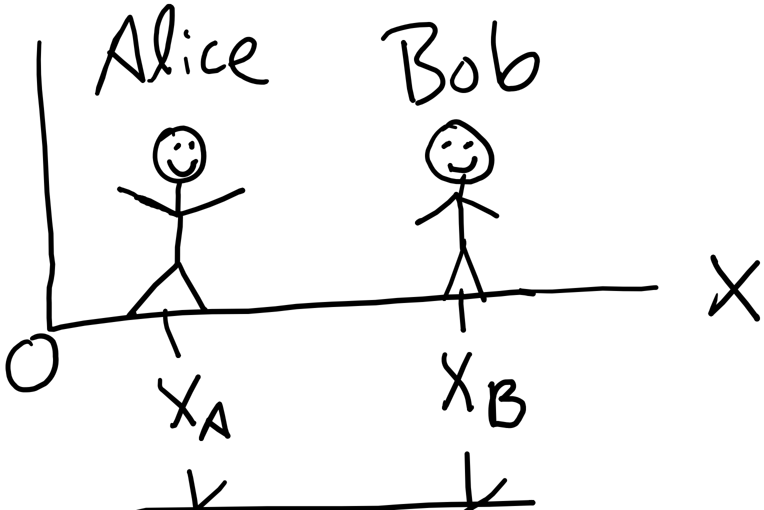


position:

$x_{B/A} \equiv$ x of B relative to A

& $x_{B/A} \equiv x_B - x_A$

Relative motion



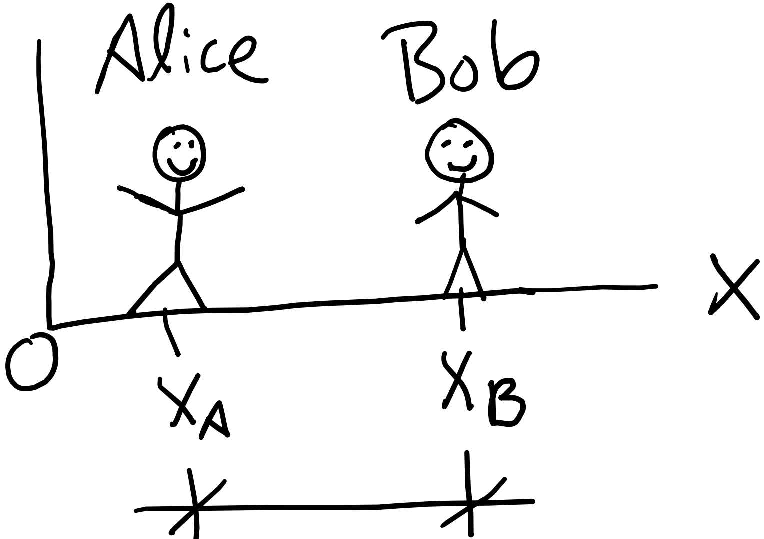
$x_{B/A} = x_B - x_A$

position:

$x_{B/A} \equiv$ x of B relative to A

& $x_{B/A} \equiv x_B - x_A$

Relative motion



$x_{B/A} = x_B - x_A$

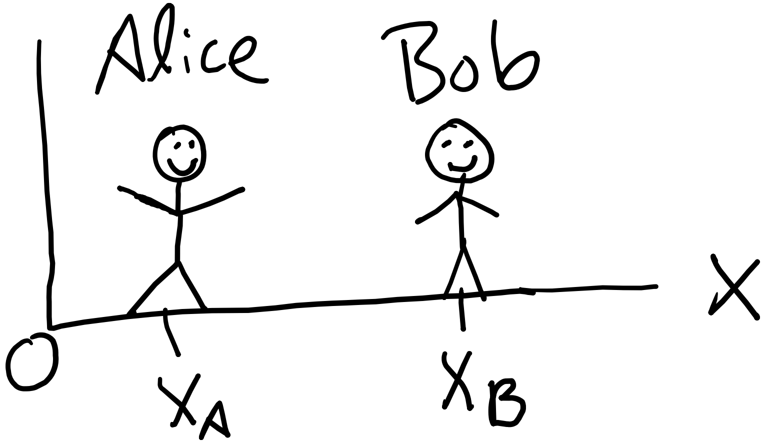
position:

$x_{B/A} \equiv x$ of B relative to A

& $x_{B/A} \equiv x_B - x_A$

Velocity:

Relative motion



$$x_{B/A} = x_B - x_A$$

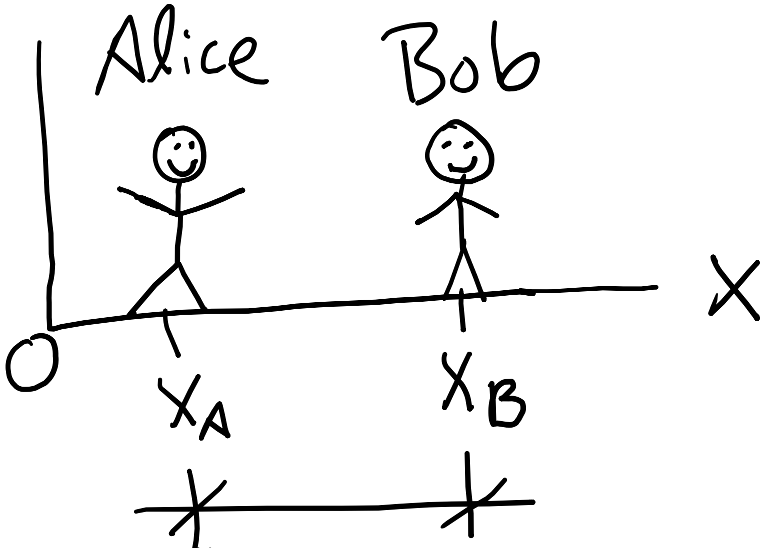
position:

$x_{B/A} \equiv x$ of B relative to A

& $x_{B/A} \equiv x_B - x_A$

Velocity: $v_{B/A} = v_B - v_A$

Relative motion



$x_{B/A} = x_B - x_A$

position:

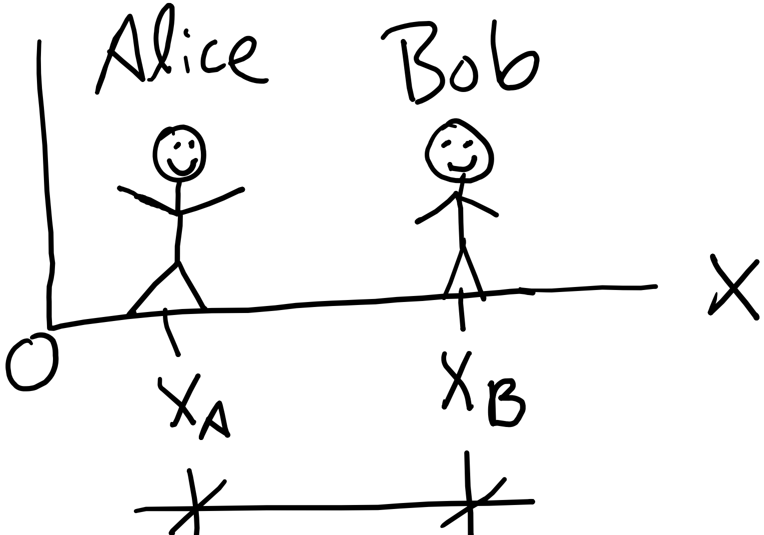
$x_{B/A} \equiv$ x of B relative to A

& $x_{B/A} \equiv x_B - x_A$

Velocity: $v_{B/A} = v_B - v_A$

acceleration:

Relative motion



$x_{B/A} = x_B - x_A$

position:

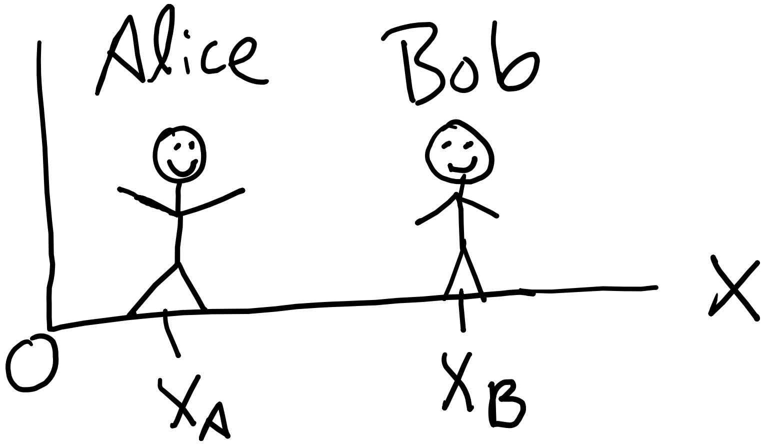
$x_{B/A} \equiv x$ of B relative to A

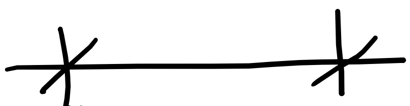
& $x_{B/A} \equiv x_B - x_A$

Velocity: $v_{B/A} = v_B - v_A$

acceleration: $a_{B/A} = a_B - a_A$

Relative motion





$x_{B/A} = x_B - x_A$

position:

$x_{B/A} \equiv x$ of B relative to A

& $x_{B/A} \equiv x_B - x_A$

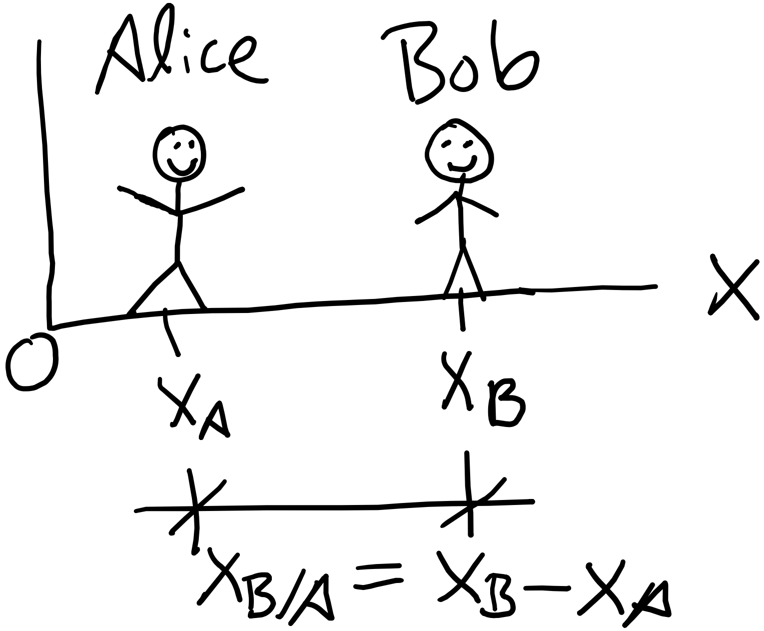
Velocity: $v_{B/A} = v_B - v_A$

acceleration: $a_{B/A} = a_B - a_A$

Note: $v_{B/A} = \dfrac{dx_{B/A}}{dt}$

ASU

Relative motion



position:

$x_{B/A} \equiv$ x of B relative to A

& $x_{B/A} \equiv x_B - x_A$

Velocity: $v_{B/A} = v_B - v_A$

acceleration: $a_{B/A} = a_B - a_A$

Note: $v_{B/A} = \dfrac{dx_{B/A}}{dt}$ & $a_{B/A} = \dfrac{dv_{B/A}}{dt}$

Notes on problem 11.44:

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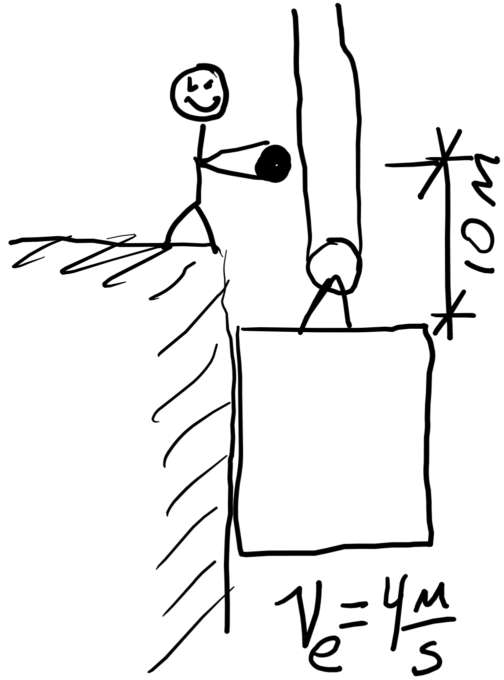
Man throws ball up with initial velocity of $v_{bI} = 3\frac{m}{s}$



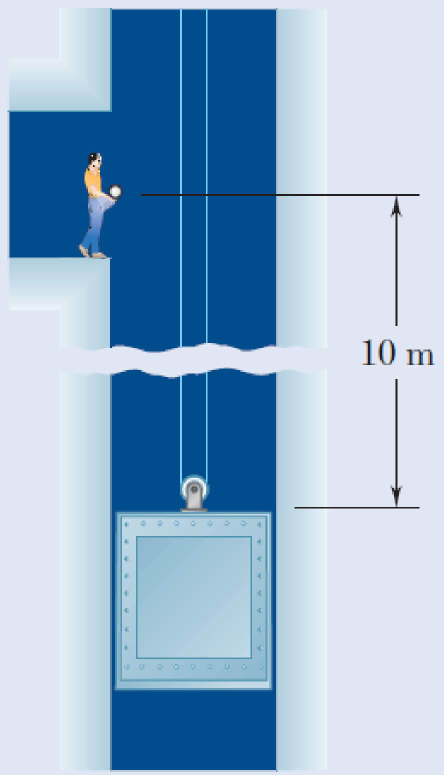


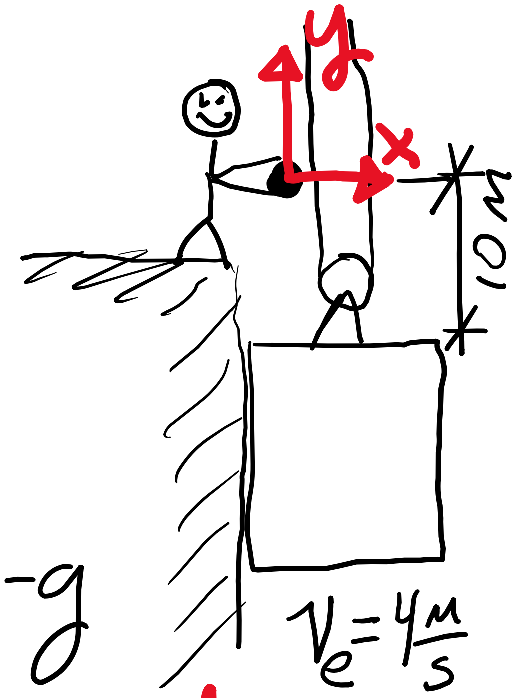
Fig. P11.44

11.44 An elevator is moving upward at a constant speed of 4 m/s. A man standing 10 m above the top of the elevator throws a ball upward with a speed of 3 m/s. Determine (*a*) when the ball will hit the elevator, (*b*) where the ball will hit the elevator with respect to the location of the man.

Notes on problem 11.44:

Man throws ball up with initial velocity of $v_{bI} = 3\frac{m}{s}$

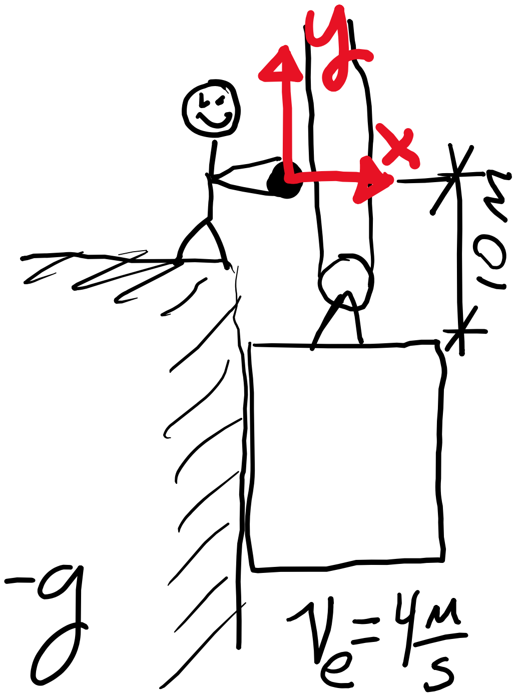
so $\begin{cases} v_e = 4 m/s, & y_{eo} = -10 m \\ v_{bo} = 3\frac{m}{s}, & y_{bo} = 0 m \end{cases}$ & $a_b = -g$



Note: Setting coordinate system at initial position of ball

Notes on problem 11.44:

Man throws ball up with initial velocity of $v_{bI} = 3\frac{m}{s}$

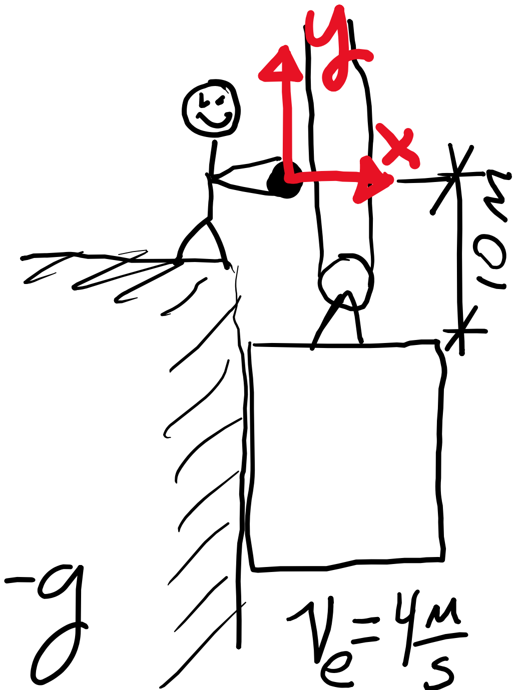


so $\begin{cases} v_e = 4\,m/s, & y_{eo} = -10\,m \\ v_{bo} = 3\frac{m}{s}, & y_{bo} = 0\,m \end{cases}$ & $a_b = -g$

Can write $y_b = -\frac{1}{2}gt^2 + v_{bo}t + y_{bo}$

Notes on problem 11.44:

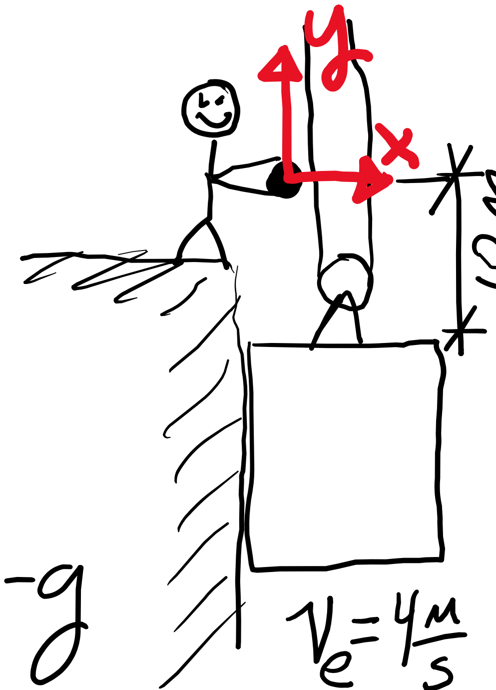
Man throws ball up with initial velocity of $v_{bI} = 3\frac{m}{s}$



so $\begin{cases} V_e = 4\,m/s, & y_{eo} = -10\,m \\ V_{bo} = 3\frac{m}{s}, & y_{bo} = 0\,m \end{cases}$ & $a_b = -g$

Can write $y_b = -\frac{1}{2}gt^2 + V_{bo}t + y_{bo}$ & $y_e = V_e t + y_{eo}$

Notes on problem 11.44:



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Can write $y_b = -\frac{1}{2}gt^2 + v_{bo}t + y_{bo}$ & $y_e = v_e t + y_{eo}$

(a) Find t at hit $\equiv t_h$:

Notes on problem 11.44:

Man throws ball up with initial velocity of $v_{bI} = 3\frac{m}{s}$

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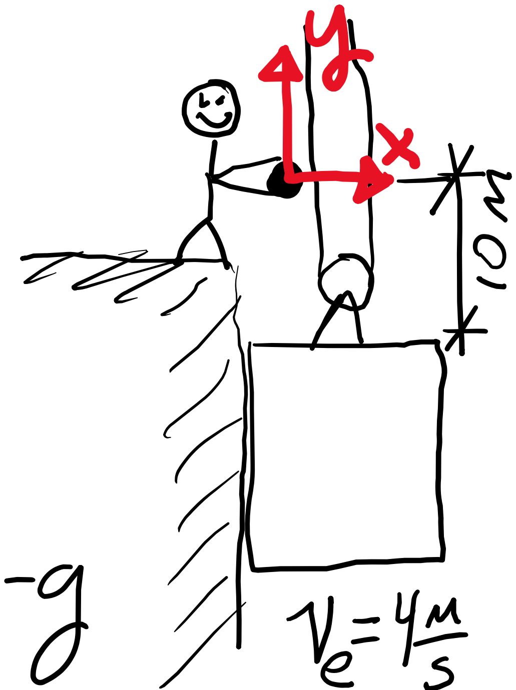
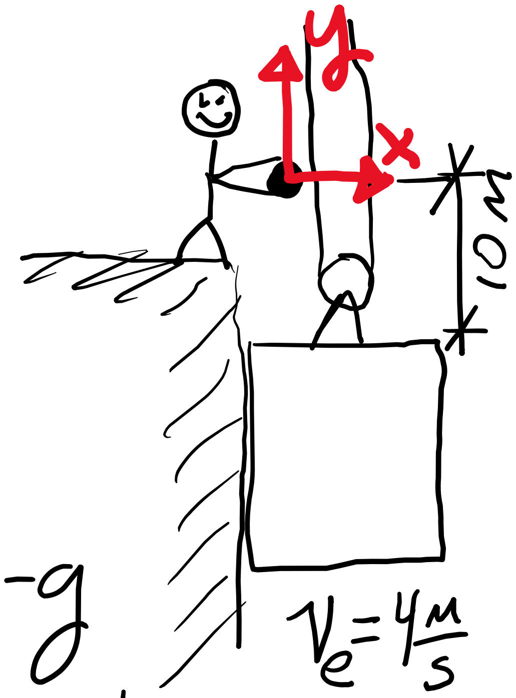


Can write $y_b = -\frac{1}{2}gt^2 + v_{bo}t + y_{bo}$ & $y_e = v_e t + y_{eo}$

(a) Find t at hit $\equiv t_h$: Note: $y_{b/e} = 0$ at t_h so just need to dig out t_h

Notes on problem 11.44:

Man throws ball up with initial velocity of $V_{bI} = 3\frac{m}{s}$



so $\begin{cases} V_e = 4 m/s, \; y_{eo} = -10m \\ V_{bo} = 3\frac{m}{s}, \; y_{bo} = 0m \end{cases}$ & $a_b = -g$

Can write $y_b = -\frac{1}{2}gt^2 + V_{bo}t + y_{bo}$ & $y_e = V_e t + y_{eo}$

(a) Find t at hit $\equiv t_h$: Note: $y_{b/e} = \emptyset$ at t_h so just need to dig out t_h

(b) Find $y_e(t_h)$ or $y_b(t_h)$: Since $y_{b/e} = \emptyset$

$\Rightarrow y_b = y_e$