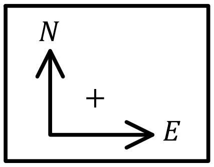
P11 - 2.1 - $v = \frac{d}{t}$ *Notes*

$\boxed{s = \frac{d}{t}}$ $\boxed{v = \frac{\vec{d}}{t}}$ $\boxed{\text{Units!}}$



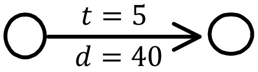
Find the speed travelling 40 m in 5 s?

$s = \frac{d}{t}$

$s = \frac{40}{5}$

$s = 8\frac{m}{s}$

t	d
0	0
1	8
2	16
3	24
4	32
5	40



Find the velocity travelling 40 m in 5 s?

$v = \frac{\vec{d}}{t}$

$v = \frac{40}{5}$

$v = 8\frac{m}{s}$

Obviously!

How far will you drive at $25\frac{m}{s}$ *for* $15\ s$?

$v = \frac{\vec{d}}{t}$

$25 = \frac{\vec{d}}{15}$

$15 \times 25 = \frac{\vec{d}}{15} \times 15$

$d = 375m$

Algebra

$v = \frac{\vec{d}}{t}$

$\vec{d} = vt$

$\vec{d} = 25 \times 15$

$\vec{d} = 375\ m$

Isolate 1st

How long to drive $125\ km$ *travelling* $25\frac{km}{hr}$?

$v = \frac{\vec{d}}{t}$

$25 = \frac{125}{t}$

$t \times 25 = \frac{125}{t} \times t$

$25t = 125$

$\frac{25t}{25} = \frac{125}{25}$

$t = 5\ hr$

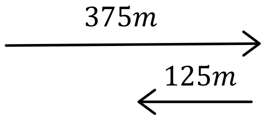
$v = \frac{\vec{d}}{t}$

$t = \frac{d}{v}$

$t = \frac{125}{25}$

$t = 5\ hr$

Walk 375 m E and then 125 m W in 25 s. Find d, $\vec{d}, s, and\ v$.



$d = 375 + 125$

$d = 500m$

$s = \frac{d}{t}$

$s = \frac{500}{25}$

$s = 20\frac{m}{s}$

$\vec{d} = 375 - 125$

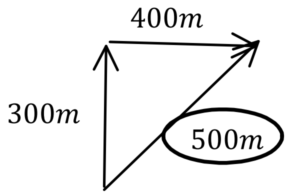
$\vec{d} = 250m$

$v = \frac{\vec{d}}{t}$

$v = \frac{250}{25}$

$v = 10\frac{m}{s}$

Walk 300 m N and then 400 m E in 25 seconds. Find d, $\vec{d}, s, and\ v$.



$d = 400 + 300$

$d = 700m$

$s = \frac{d}{t}$

$s = \frac{700}{25}$

$s = 28\frac{m}{s}$

$c = \sqrt{a^2 + b^2}$

$c = \sqrt{300^2 + 400^2}$

$c = 500$

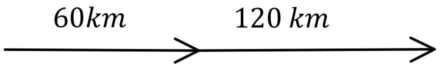
$\vec{d} = 500\ m$

$v = \frac{\vec{d}}{t}$

$v = \frac{500}{25}$

$v = 20\frac{m}{s}$

Drive $2hrs$ @ $30\frac{km}{h} + 3hrs$ @ $40\frac{km}{h}$



$\boxed{v_{av}^{*} = \frac{d_{total}}{t_{total}}}$

$v = \frac{\vec{d}}{t}$

$\vec{d} = vt$

$\vec{d} = 30 \times 2$

$\vec{d} = 60$

$v = \frac{\vec{d}}{t}$

$\vec{d} = vt$

$\vec{d} = 40 \times 3$

$\vec{d} = 120$

$v_{av} = \frac{d_{total}}{t_{total}}$

$v_{av} = \frac{180}{5}$

$v_{av} = 36\frac{km}{h}$

$d_{total} = 60 + 120$

$= 180km$

$t_{total} = 2 + 3$

$= 5\ hrs$

$v_{av}^{*} = \frac{v_f + v_i}{2}$

$v_{av}^{*} = \frac{40 + 30}{2}$

$v_{av}^{*} \neq 35$

Cannot use formula

a ≠ constant

P11 - 2.2 - $a = \frac{v}{t}$ Notes

$\boxed{v_f = v_i + at}$

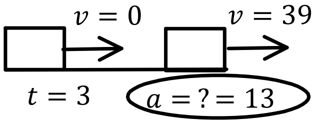
$\boxed{a = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t}}$ $\boxed{\begin{matrix} REST \\ v_i = 0 \end{matrix}}$ $\boxed{\Delta = final - initial}$

Find "a" if a car gets to 39 $\frac{m}{s}$ *in 3 s from rest.*

$$a = \frac{\Delta v}{t}$$
$$a = \frac{39 - 0}{3}$$
$$\boxed{a = 13\frac{m}{s^2}}$$

t	v
0	0
1	13
2	26
$\boxed{3}$	$\boxed{39}$

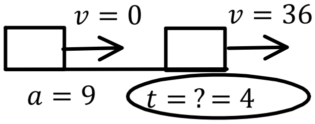
Obviously!



Find "t" if it takes a boat from rest to 36 $\frac{m}{s}$ *accelerating at 9* $\frac{m}{s^2}$*?*

$$a = \frac{\Delta v}{t}$$
$$9 = \frac{36}{t}$$
$$t \times 9 = \frac{36}{t} \times t$$
$$9t = 36$$
$$\frac{9t}{9} = \frac{36}{9}$$
$$\boxed{t = 4s}$$

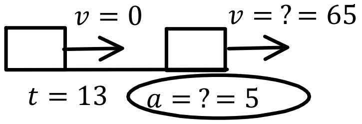
$$a = \frac{\Delta v}{t}$$
$$t = \frac{\Delta v}{a}$$
$$t = \frac{36}{9}$$
$$\boxed{t = 4s}$$



Find "v" if a fish $a = 5\frac{m}{s^2}$ *for 13 seconds from rest?*

$$a = \frac{\Delta v}{t}$$
$$5 = \frac{\Delta v}{13}$$
$$13 \times 5 = \frac{\Delta v}{13} \times 13$$
$$\Delta v = 65\frac{m}{s}$$
$$\boxed{v_f - \overset{0}{\cancel{v_i}} = 65\frac{m}{s}}$$

$$a = \frac{\Delta v}{t}$$
$$\Delta v = at$$
$$\Delta v = 5 \times 13$$
$$\boxed{\Delta v = 65\frac{m}{s}}$$



Find "a" of a rabit that accelerates from 8 $\frac{m}{s}$ *to 24* $\frac{m}{s}$ *in 4 seconds.*

$$a = \frac{\Delta v}{\Delta t}$$
$$a = \frac{24 - 8}{4 - 0}$$
$$a = \frac{16}{4}$$
$$\boxed{a = 4\frac{m}{s^2}}$$

Find "v" of a fish get if it accelerates from rest at 5 $\frac{m}{s^2}$ *for 13 seconds?*

$$a = \frac{v}{t}$$
$$5 = \frac{v}{13}$$
$$\boxed{v = 65\frac{m}{s}}$$

OR

$$v_f = v_i + at$$
$$v_f = 0 + 5(13)$$
$$\boxed{v_f = 65\frac{m}{s}}$$

$$a = \frac{v_f - v_i}{t}$$
$$at = v_f - v_i$$
$$\boxed{v_f = v_i + at}$$

How long to accelerate to 10 $\frac{m}{s}$ *from rest at 2* $\frac{m}{s^2}$*?*

$$a = \frac{v}{t}$$
$$t \times 2 = \frac{10}{t} \times t$$
$$2t = 10$$
$$\boxed{t = 5\ s}$$

$$a = \frac{v}{t}$$
$$t = \frac{v}{a}$$
$$t = \frac{10}{2}$$
$$\boxed{t = 5\ s}$$

OR

$$v_f = v_i + at$$
$$10 = 0 + 2t$$
$$\boxed{t = 5\ s}$$

How long to accelerate from 6 $\frac{m}{s}$ *to 18* $\frac{m}{s}$ *at 2* $\frac{m}{s^2}$*?*

$$v_f = v_i + at$$
$$18 = 6 + 2t$$
$$12 = 2t$$
$$\boxed{t = 6\ s}$$

$$v_f = v_i + at$$
$$t = \frac{v_f - v_i}{a}$$
$$t = \frac{18 - 6}{2}$$
$$\boxed{t = 6s}$$

How fast does a car get accelerating at 3 $\frac{m}{s^2}$ *from 10* $\frac{m}{s}$ *for 6 seconds?*

$$v_f = v_i + at$$
$$v_f = 10 + (3)(6)$$
$$\boxed{v_f = 28\frac{m}{s}}$$

Find the initial velocity of a truck that reaches 25 $\frac{m}{s}$ *acclelerating at 5* $\frac{m}{s^2}$ *in 2 seconds?*

$$v_f = v_i + at$$
$$25 = v_i + 5(2)$$
$$25 = v_i + 10$$
$$\boxed{v_i = 15\frac{m}{s}}$$

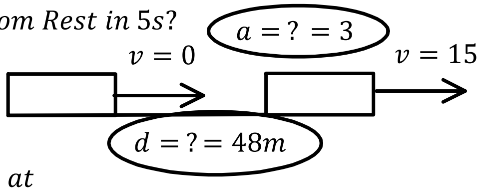
$$v_f = v_i + at$$
$$v_i = v_f - at$$
$$v_i = 25 - 5(2)$$
$$\boxed{v_i = 15\ m/s}$$

$\boxed{v_f = v_i + at}$ $\boxed{v_f^2 = v_i^2 + 2ad}$

P11 - 2.2 - $v_f = v_i + at,\ v_f^2 = v_i^2 + 2ad$ Notes

Find the Acceleration of a Bear reaching a Velocity of $15\frac{m}{s}$ *from Rest in* $5s$?

How Far did the Bear get in that time?



t	v
0	0
1	3
2	6
3	9
4	12
5	15

Obviously!

$$v_f = v_i + at$$
$$v_f = at$$
$$a = \frac{v_f}{t}$$
$$a = \frac{15}{5}$$
$$\boxed{a = 3\frac{m}{s^2}}$$

$$v_f^2 = v_i^2 + 2ad$$
$$15^2 = 0^2 + 2(3)d$$
$$324 = 0 + 6d$$
$$324 = 6d$$
$$\boxed{d = 37.5m}$$

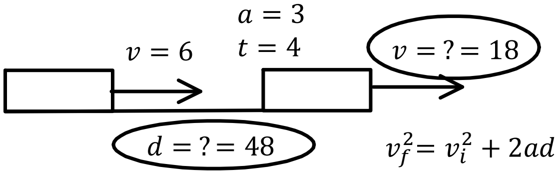
Algebra

$$v_f^2 = v_i^2 + 2ad$$
$$d = \frac{v_f^2}{2a}$$
$$d = \frac{15^2}{2(3)}$$
$$\boxed{d = 37.5\ m}$$

Isolate 1st

How far does a cheetah get running at $6\frac{m}{s}$ *accelerates at* $3\frac{m}{s^2}$ *for* $4\ s$. *What is her* v_f?

How Far did the Cheetah get in that time?

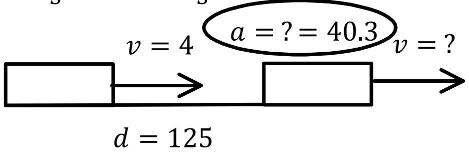


$$v_f = v_i + at$$
$$v_f = 6 + 3(4)$$
$$\boxed{v_f = 18\frac{m}{s}}$$

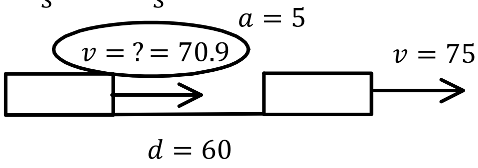
$$v_f^2 = v_i^2 + 2ad$$
$$18^2 = 6^2 + 2(3)d$$
$$324 = 36 + 6d$$
$$288 = 6d$$
$$\boxed{d = 48m}$$

$$v_f^2 = v_i^2 + 2ad$$
$$d = \frac{v_f^2 - v_i^2}{2a}$$
$$d = \frac{18^2 - 6^2}{2(3)}$$
$$\boxed{d = 48\ m}$$

Find the v_f *of a boat if it accelerates at* $4\frac{m}{s^2}$ *from* $25\frac{m}{s}$ *in* $125\ m$?



Find v_i *of a whale if it accelerates at* $5\frac{m}{s^2}$ *to* $75\frac{m}{s}$ *in* $60\ m$?



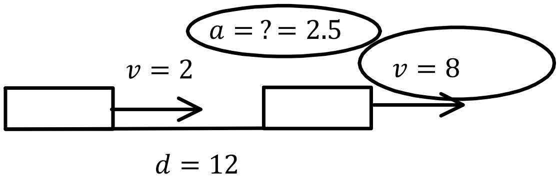
$$v_f^2 = v_i^2 + 2ad$$
$$v_f^2 = 25^2 + 2(4)(125)$$
$$v_f^2 = 1625$$
$$\sqrt{v_f^2} = \sqrt{1625}$$
$$\boxed{v_f = 40.3\ m/s}$$

$$v_f^2 = v_i^2 + 2ad$$
$$v_f = \sqrt{v_i^2 + 2ad}$$
$$v_f = \sqrt{25^2 + 2(4)(125)}$$
$$\boxed{v_f = 40.3\ m/s}$$

$$v_f^2 = v_i^2 + 2ad$$
$$75^2 = v_i^2 + 2(5)(60)$$
$$5625 = v_i^2 + 600$$
$$\sqrt{5025} = \sqrt{v_i^2}$$
$$\boxed{v_i = 70.9\frac{m}{s}}$$

$$v_f^2 = v_i^2 + 2ad$$
$$v_i = \sqrt{v_f^2 - 2ad}$$
$$v_i = \sqrt{75^2 - 2(5)(60)}$$
$$\boxed{v_i = 70.9\frac{m}{s}}$$

What is the accleration of an object which accelerates from $2\frac{m}{s}$ *to* $8\frac{m}{s}$ *in* $12\ m$?

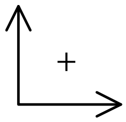


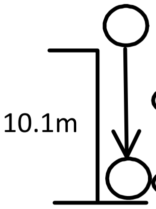
$$v_f^2 = v_i^2 + 2ad$$
$$8^2 = 2^2 + 2(a)(12)$$
$$64 = 4 + 24a$$
$$60 = 24a$$
$$\boxed{a = 2.5\frac{m}{s^2}}$$

$$v_f^2 = v_i^2 + 2ad$$
$$a = \frac{v_f^2 - v_i^2}{2d}$$
$$a = \frac{8^2 - 2^2}{2(12)}$$
$$\boxed{a = 2.5\frac{m}{s^2}}$$

P11 - 2.3 - Ball Drop Notes

$\boxed{\Delta d = v_i t + \frac{1}{2}at^2}$ $\boxed{\begin{array}{l} v_f^2 = v_i^2 + 2ad \\ v_f = v_i + at \end{array}}$





$v_i = 0$

$t = ? = 1.44$

$v_f = ? = -14.1$

$\boxed{a = g = -9.8\frac{m}{s^2}}$

$$\Delta d = v_i t + \frac{1}{2}at^2$$
$$-10.1 = \cancel{0 \times t} + \frac{1}{2}(-9.8)t^2$$
$$-10.1 = \frac{1}{2}(-9.8)t^2$$
$$-10.1 = -4.9t^2$$
$$2.06 = t^2$$
$$t = 1.44s$$

$\boxed{\begin{array}{l} \Delta d = d_f - d_i \\ \Delta d = 0 - 10.1 \\ \Delta d = -10.1m \end{array}}$

Down

$Time\ to\ Fall = 1.44s$

$$\Delta d = v_i t + \frac{1}{2}at^2$$
$$\Delta d = \frac{1}{2}at^2$$
$$t = \sqrt{\frac{2d}{a}}$$
$$t = \sqrt{\frac{2(-10.1)}{-9.8}}$$
$$t = 1.44s$$

Velocity before impact $\boxed{v_f = v_{before\ impact}}$

$$v_f^2 = v_i^2 + 2ad$$
$$v_f^2 = (0)^2 + 2(-9.8)(-10.1)$$
$$v_f^2 = 197.96$$
$$v_f = -14.1\frac{m}{s}$$

$$v_f^2 = v_i^2 + 2ad$$
$$v_f^2 = 2ad$$
$$v_f = \sqrt{2ad}$$
$$v_f = \sqrt{2(-9.8)(-10.1)}$$
$$v_b = -14.1\frac{m}{s}$$

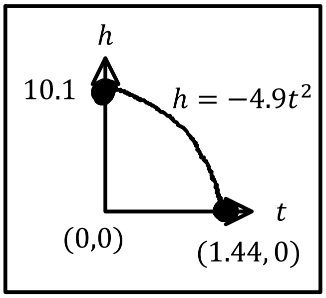
OR

$$v_f = v_i + at$$
$$v_f = at$$
$$v_f = (-9.8)(1.44)$$
$$v_f = -14.1\frac{m}{s}$$

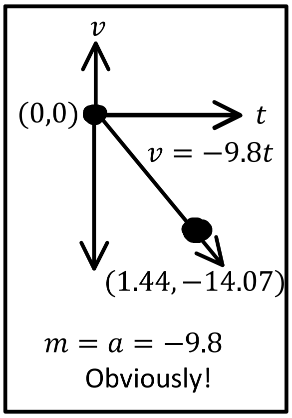
Rounding!

$Velocity\ Before\ Impact = -14.07\frac{m}{s}$ $\boxed{-ve\,; Down!}$

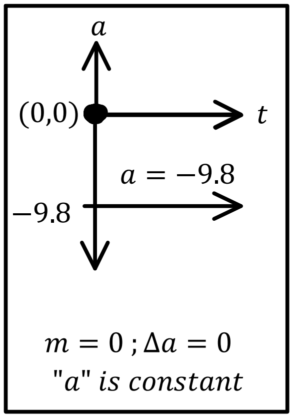
$h\ vs\ t$



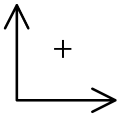
$v\ vs\ t$

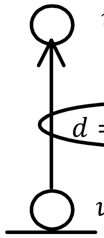


$a\ vs\ t$



P11 - 2.4 - Ball Throw Up from Ground Notes





$v_f = 0$; Max Height

$d = ? = 5.1$

$v_i = 10\frac{m}{s}$

$\boxed{a = g = -9.8\frac{m}{s^2}}$

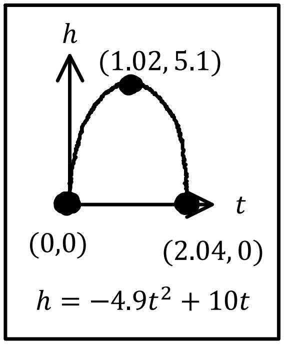
$v_f^2 = v_i^2 + 2ad$
$0^2 = 10^2 + 2(-9.8)d$
$0 = 100 - 19.6d$
$19.6d = 100$
$d = 5.1m$

Up

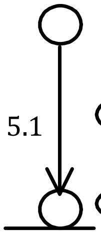
$Max\ Height = 5.1m$

$v_f^2 = v_i^2 + 2ad$
$0 = v_i^2 + 2ad$
$d = \frac{-v_i^2}{2a}$
$d = \frac{-10^2}{2(-9.8)}$
$d = 5.1m$

h vs t



To find time, Drop it from Max Height, $v_i = 0$



$v_i = 0$

$t = ? = 1.02$

$v_f = ? = -10$

$\Delta d = v_i t + \frac{1}{2}at^2$
$-5.1 = \cancel{0 \times t} + \frac{1}{2}(-9.8)t^2$
$-5.1 = -4.9t^2$
$1.04 = t^2$
$t = 1.02s$

Down

$\Delta d = v_i t + \frac{1}{2}at^2$
$\Delta d = \frac{1}{2}at^2$
$t = \sqrt{\frac{2d}{a}}$
$t = \sqrt{\frac{2(-5.1)}{-9.8}}$
$t = 1.02s$

$\boxed{\begin{aligned} \Delta d &= d_f - d_i \\ \Delta d &= 0 - 5.1 \\ \Delta d &= -5.1m \end{aligned}}$

Double Time

$t_{total} = 1.02 \times 2$
$t_T = 2.04s$

Symmetry

$\boxed{\begin{aligned} v_f &= v_i \\ v_f &= 10\frac{m}{s} \end{aligned}}$

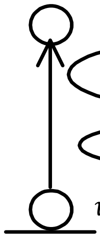
$Time\ to\ Max\ Height = 1.02s$

$Velocity\ Before\ Impact = -10\frac{m}{s}$

$Total\ Time = 2.04s$

OR

Double Time
Up/Down



$v_f = 0$; Max Height

$t = ? = 1.02$

$d = ? = 5.1$

$v_i = 10\frac{m}{s}$

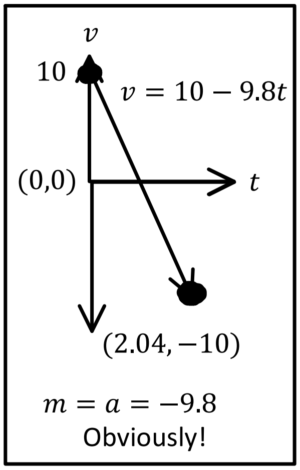
$\boxed{a = g = -9.8\frac{m}{s^2}}$

$v_f = v_i + at$
$0 = 10 + (-9.8)t$
$t = 1.02s$

$Time\ to\ Max\ Height = 1.02s$

$v_f = v_i + at$
$0 = v_i + at$
$t = \frac{-v_i}{a}$
$t = \frac{-10}{-9.8}$
$t = 1.02s$

v vs t



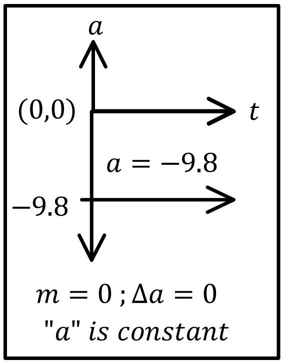
$\Delta d = v_i t + \frac{1}{2}at^2$

Up

$d = 10(1.02) + \frac{1}{2}(-9.8)(1.02)^2$
$d = 5.1m$

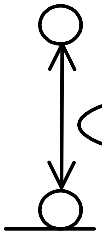
$Max\ Height = 5.1m$

a vs t



$\Delta d = v_i t + \frac{1}{2}at^2$
$0 = 10t + \frac{1}{2}(-9.8)t^2$
$0 = -10t - 4.9t^2$
$0 = -4.9t(t - 2.04)$

$\boxed{\Delta d = 0 \quad \text{Up/Down}}$



$t = ? = 2.04$

$v_i = 10$

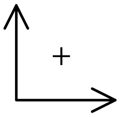
$-4.9t = 0$
$t = 0s$

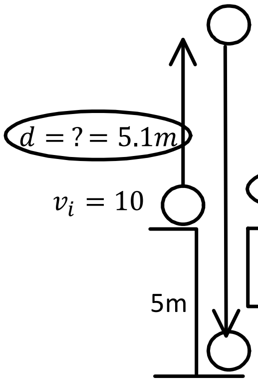
$t - 2.04 = 0$
$t = 2.04s$

$\boxed{\text{Or Quadform}}$

$Total\ Time = 2.04s$

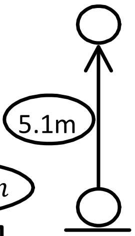
P11 - 2.5 - Ball Throw Up from Building Notes





$d = ? = 10.1m$

$$\boxed{g = -9.8\frac{m}{s^2}}$$



$$v_f^2 = v_i^2 + 2ad$$
$$0^2 = 10^2 + 2(-9.8)d$$
$$0 = 100 - 19.6d$$
$$19.6d = 100$$
$$d = 5.1m$$

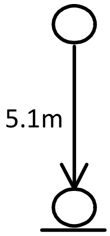
Up

$$v_f^2 = v_i^2 + 2ad$$
$$0 = v_i^2 + 2ad$$
$$d = \frac{-v_i^2}{2d}$$
$$d = \frac{-10_i^2}{2d}$$
$$d = 5.1m$$

Add original height to rise

$$d = 5 + 5.1$$
$$d = 10.1m$$

$Max\ Height = 10.1m$



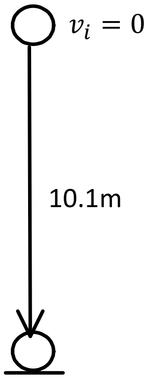
$$\Delta d = v_i t + \frac{1}{2}at^2$$
$$-5.1 = \cancel{0 \times t} + \frac{1}{2}(-9.8)t^2$$
$$-5.1 = -4.9t^2$$
$$1.04 = t^2$$
$$t = 1.02s$$

$$\boxed{\begin{aligned}\Delta d &= d_f - d_i\\ \Delta d &= 0 - 5.1\\ \Delta d &= -5.1m\end{aligned}}$$

$$\Delta d = v_i t + \frac{1}{2}at^2$$
$$t = \sqrt{\frac{2d}{a}}$$
$$t = \sqrt{\frac{2(5.1)}{-9.8}}$$
$$t = 1.02s$$

$Time\ to\ Max\ Height = 1.02s$

Down



$$\Delta d = v_i t + \frac{1}{2}at^2$$
$$-10.1 = \cancel{0 \times t} + \frac{1}{2}(-9.8)t^2$$
$$-10.1 = -4.9t^2$$
$$2.06 = t^2$$
$$t = 1.44s$$

$$\boxed{\begin{aligned}\Delta d &= d_f - d_i\\ \Delta d &= 0 - 10.1\\ \Delta d &= -10.1m\end{aligned}}$$

$$\Delta d = v_i t + \frac{1}{2}at^2$$
$$t = \sqrt{\frac{2d}{a}}$$
$$t = \sqrt{\frac{2(10.1)}{-9.8}}$$
$$t = 1.44s$$

$Time\ to\ Fall = 1.44s$

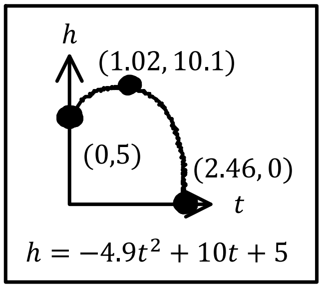
Add Times

$$t = 1.02 + 1.44$$
$$t = 2.46s$$

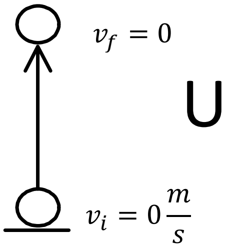
$Total\ Time = 2.46s$

Up/Down

$h\ vs\ t$



OR



Up

$$v_f = v_i + at$$
$$0 = 10 + (-9.8)t$$
$$t = 1.02s$$

$$v_f = v_i + at$$
$$t = \frac{-v_i}{a}$$
$$t = \frac{-10}{-9.8}$$
$$t = 1.02s$$

$Time\ to\ Max\ Height = 1.02s$

$$\Delta d = v_i t + \frac{1}{2}at^2$$
$$\Delta d = (10)(1.02) + \frac{1}{2}(-9.8)(1.02)^2$$
$$\Delta d = 5.1m$$

…

$$\Delta d = v_i t + \frac{1}{2}at^2$$
$$-5 = 10t + \frac{1}{2}(-9.8)t^2$$
$$0 = -4.9t^2 + 10t + 5.0$$

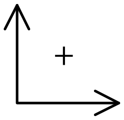
$$\boxed{\begin{aligned}\Delta d &= d_f - d_i\\ \Delta d &= 0 - 5.1\\ \Delta d &= -5.1m\end{aligned}}$$

$\cancel{t = -ve}$ $t = 2.46s$

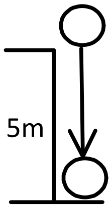
$Total\ Time = 2.46s$

Up/Down

Quadform



P11 - 2.6 - Ball Thrown Down from Building Notes



$v_i = -10\frac{m}{s}$

$\boxed{t = ? = 0.42}$

$\boxed{v_f = ? = -14.1}$

$g = -9.8\frac{m}{s^2}$

$$v_f^2 = v_i^2 + 2ad$$
$$v_f^2 = (-10)^2 + 2(-9.8)(-5)$$
$$v_f^2 = 198$$
$$\boxed{v_f = -14.1\frac{m}{s}}$$

$$\boxed{\begin{aligned}\Delta d &= d_f - d_i\\ \Delta d &= 0 - 5\\ \Delta d &= -5m\end{aligned}}$$

$Velocity\ Before\ Impact = -14.1\frac{m}{s}$

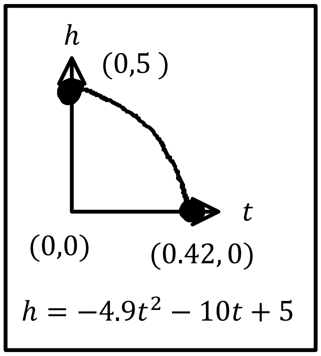
Down

$$v_f = v_i + at$$
$$-14.1 = -10 + (-9.8)t$$

$Time\ in\ drop = 0.42s$ $\boxed{t = 0.42s}$

OR

$h\ vs\ t$



$h = -4.9t^2 - 10t + 5$

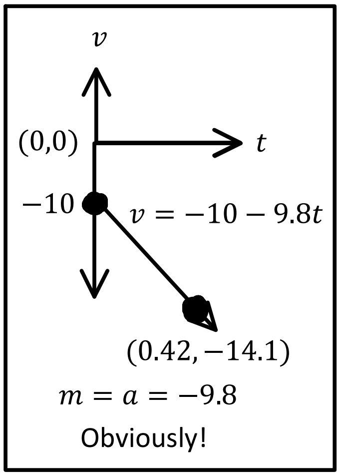
$$\Delta d = v_i t + \frac{1}{2}at^2$$
$$-5 = (-10) \times t + \frac{1}{2}(-9.8)t^2$$
$$-5 = -10t - 4.9t^2$$
$$0 = -4.9t^2 - 10t + 5$$

$\cancel{t = -ve}$ $\boxed{t = 0.42s}$

$Time\ to\ Fall = 0.42s$

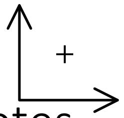
$\boxed{\text{Quadform}}$

$$v_f = v_i + at$$
$$v_f = (-10) + (-9.8)(0.42)$$
$$\boxed{v_f = -14.1\frac{m}{s}}$$

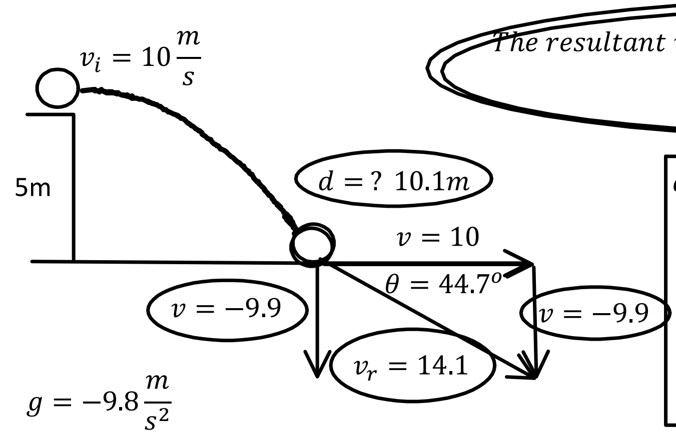


$m = a = -9.8$

Obviously!



P11 - 2.7 - Ball Thrown Straight Out from Building Notes



$g = -9.8\frac{m}{s^2}$

The resultant velocity is $14.1\frac{m}{s}$ 44.7^o *below horizontal*

Last

$a^2 + b^2 = c^2$

$c = \sqrt{a^2 + b^2}$

$c = \sqrt{9.9^2 + 10^2}$

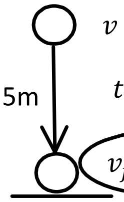
$c = 14.1\frac{m}{s}$

$tan\theta = \frac{o}{a}$

$\theta = \tan^{-1}\left(\frac{9.9}{10}\right)$

$\theta = 44.7^o$

OR $\boxed{h = \frac{a}{cos\theta}}$



Down

Time to Fall $= 1.01s$

$\Delta d = v_i t + \frac{1}{2}at^2$

$\Delta d = \frac{1}{2}at^2$

$t = \sqrt{\frac{2d}{a}}$

$t = \sqrt{\frac{2(-5)}{-9.8}}$

$t = 1.01s$

$v = v_i + at$

$v = at$

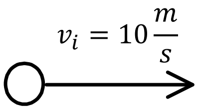
$v = (-9.8)(1.01)$

$v = -9.9\ \frac{m}{s}$

$\Delta d = d_f - d_i$

$\Delta d = 0 - 5$

$\Delta d = -5m$



$d = ? = 10.1m$

Over

$v = \frac{d}{t}$

$d = vt$

$d = 10(1.01)$

$d = 10.1m$

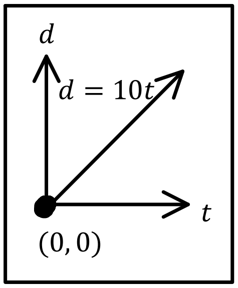
$\Delta d = v_i t + \frac{1}{2}at^2$

$\Delta d = v_i t$

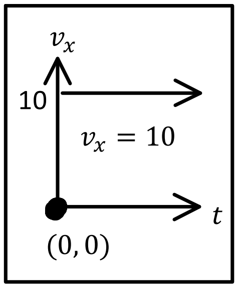
$;\ a = 0$

Over

d vs t

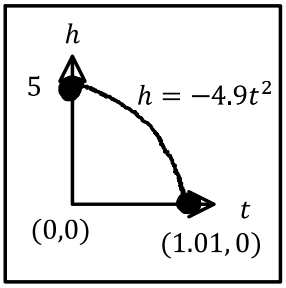


v_x *vs t*

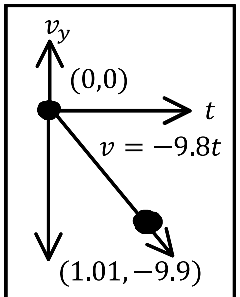


Time is the Link Between x and y, Galileo

h vs t



v_y *vs t*



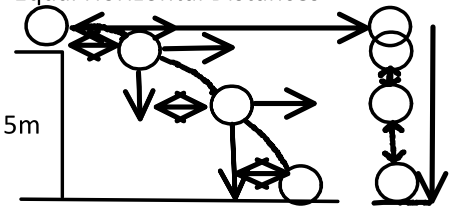
$m = a = -9.8$

Obviously!

Logic

$a_x = 0$

Equal Horizontal Distances

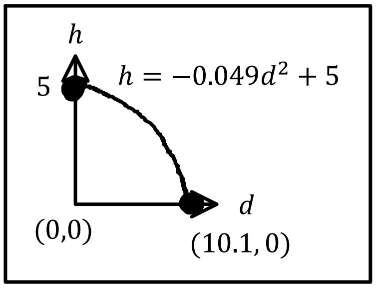


$a_y = -9.8\frac{m}{s^2}$

Greater
Vertical
Distances

Pre Calc 12

h vs d



$h(t) = -4.9t^2 + 5$

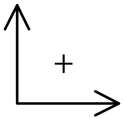
$h(d) = -4.9\left(\frac{d}{10}\right)^2 + 5$

$h(d) = -0.049d^2 + 5$

$t = \frac{d}{v}$

$t = \frac{d}{10}$

P12 - 2.8 - Ball shot Down Angle Notes



$v = h\cos\theta$

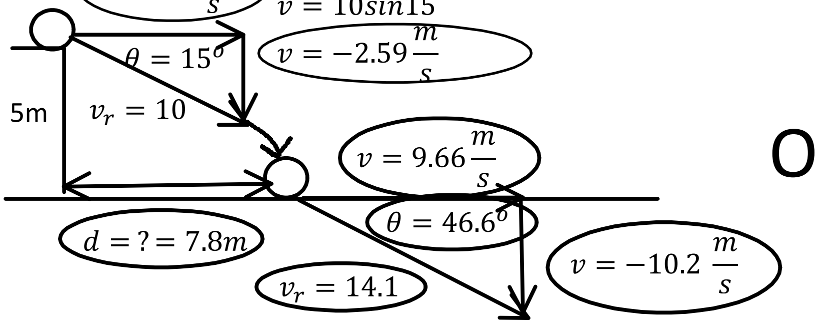
$v = 10\cos 15$

$v = 9.66\frac{m}{s}$

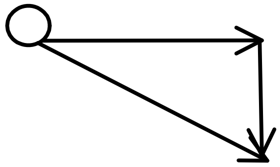
$v = h\sin\theta$

$v = 10\sin 15$

$v = -2.59\frac{m}{s}$



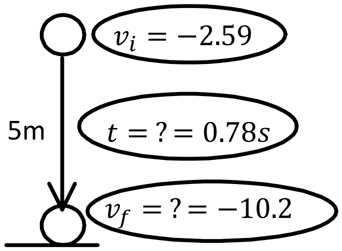
Big Diagrams!



Or off to side

$$The\ final\ resultant\ velocity\ is\ 14.1\frac{m}{s}\ 46.6^o\ below\ horizontal$$

Down



$$\Delta d = v_{iy}t + \frac{1}{2}at^2$$

$$-5 = -2.59t + \frac{1}{2}(-9.8)t^2$$

$$0 = -2.59t + \frac{1}{2}(-9.8)t^2 + 5$$

$$0 = -4.9t^2 - 2.59t + 5$$

$t = 0.78s$ $\boxed{Quadform}$

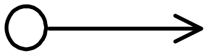
$v_f = v_i + at$

$v_f = -2.59 + (-9.8)(0.78)$

$v_f = -2.59 - 7.6$

$v_f = -10.2\frac{m}{s}$

$v_i = 9.66\frac{m}{s}$



Over

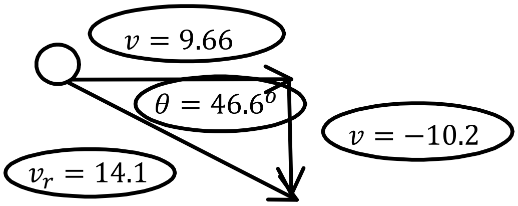
$d = ? = 7.8m$

$v = \frac{d}{t}$

$d = vt$

$d = 10t$

$d = 7.8m$



$tan\theta = \frac{o}{a}$

$\theta = \tan^{-1}\left(\frac{+10.2}{9.66}\right)$

$\theta = 46.6^o$

Always Inverse Positive

$a^2 + b^2 = c^2$

$c = \sqrt{a^2 + b^2}$

$c = \sqrt{(9.66)^2 + (-10.2)^2}$

$c = 14.1\frac{m}{s}$

$sin\theta = \frac{O}{H}$

$H = \frac{0}{sin\theta}$

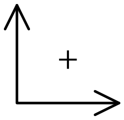
$H = \frac{\pm 10.2}{sin46.66}$

$H = 14.02$

Rounding!

SOH CAH TOA is
fairy land and we
teach you properly
in Trig 12
$\theta = -46.66^o$!!!

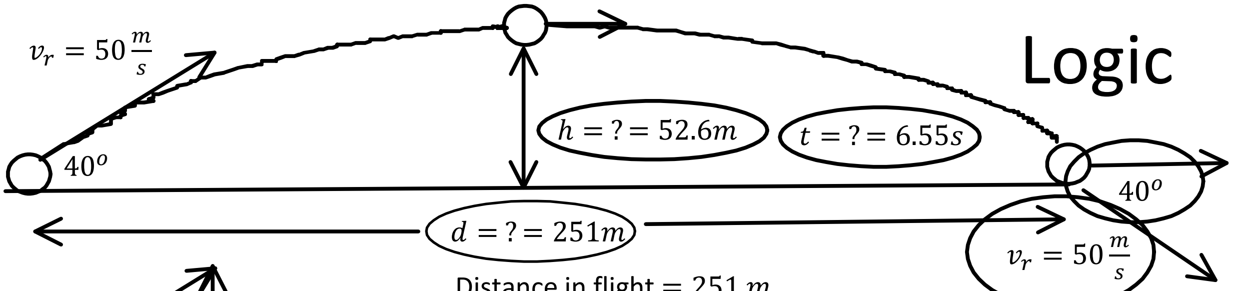
Or Below



P12 - 2.9 - Projectile Motion Ground Angle Notes

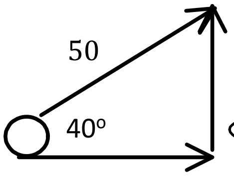
A ball is shot at $50\frac{m}{s}$ at an angle of 40° above the horizontal. What is its max "h"? What is its "t" in flight? What is the "d" the ball travels? Find v_r.

Logic



Distance in flight $= 251\ m$

Up/Over



$v = h\sin\theta$
$v = 50\sin 40$
$v = 32.1$

$v = hcos\theta$
$v = 50\cos 40$
$v = 38.3$

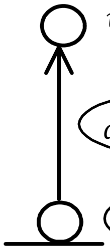
Final Check

$$R^* = \frac{v^2 sin2\theta}{g}$$
$$R^* = \frac{(50)^2 sin2(40)}{9.8}$$
$$R^* = 251m$$

Over

$$R^* = \frac{v^2 sin2\theta}{g}$$
$; \Delta h = 0$

Up



$v_f = 0$

$d = ? = 52.6m$

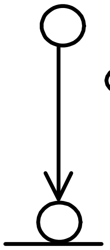
$v_i = 32.1$

$$v_f{}^2 = v_i{}^2 + 2ad$$
$$d = \frac{-v_i^2}{2a}$$
$$d = \frac{-(32.1)^2}{2(-9.8)}$$
$$d = 52.6m$$

Max height $= 52.6m$

$$v_f = v_i + at$$
$$t = \frac{-v_i}{a}$$
$$t = \frac{-32.1}{-9.8}$$
$$t = 3.28s$$

Down



$v_i = 0$

$t = ? = 3.28s$

$d = 52.6m$

$v_f = ? =$

$$\Delta d = v_i t + \frac{1}{2}at^2$$
$$t = \sqrt{\frac{2d}{a}}$$
$$t = \sqrt{\frac{2(-52.6)}{(-9.8)}}$$
$$t = 3.28s$$

$\Delta d = d_f - d_i$
$\Delta d = 0 - 52.6$
$\Delta d = -52.6m$

Or

Total time in flight:

$t = 3.28 \times 2$

$t = 6.55s$

Double Time

Over

$v_i = 38.3\frac{m}{s}$

$d = ? = 251m$

Distance in flight $= 251\ m$

$$v = \frac{d}{t}$$
$$d = vt$$
$$d = (38.3)(6.55)$$
$$d = 251m$$

Or

Up/Down

$$\Delta d = v_i t + \frac{1}{2}at^2$$
$$0 = 32.1t + \frac{1}{2}(-9.8)t^2$$
$$0 = -32.1t - 4.9t^2$$
$$0 = -4.9t(t - 6.55)$$

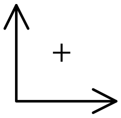
$-4.9t = 0$ $\quad$ $t - 6.55 = 0$

$t = 0s$ $\quad$ $t = 6.55s$

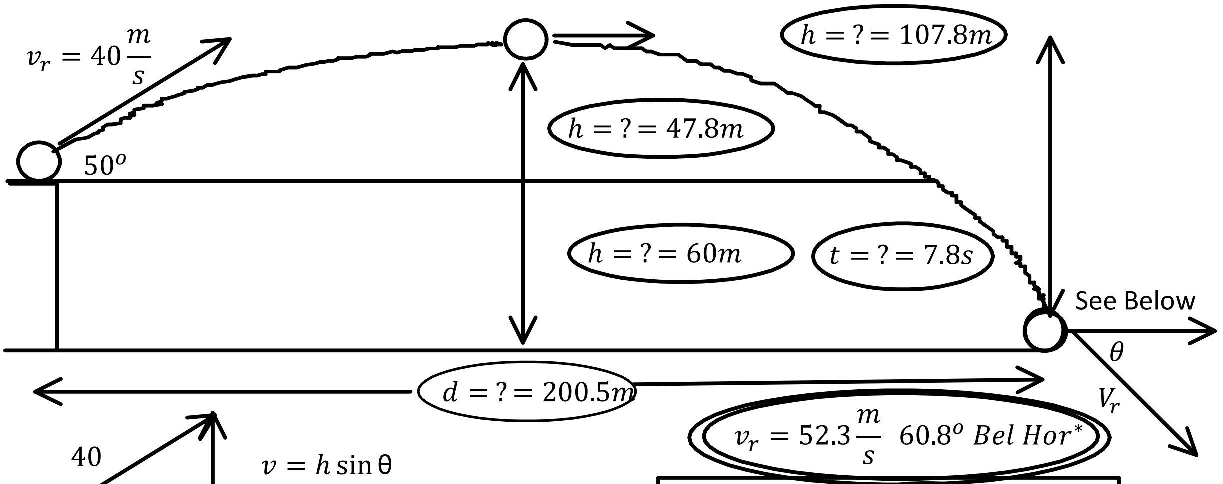
$Total\ Time = 6.55s$

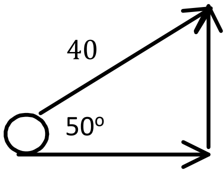
Or Quadform/Square Root Method

P12 - 2.10 - Projectile Motion Cliff Angle Notes



A ball is shot off a $60m$ cliff at $40\frac{m}{s}$ at an angle of 50° from the horizontal. What is its max height? What is its time time in flight? What is the horizontal distance the ball travels? What is the velocity and angle at impact?

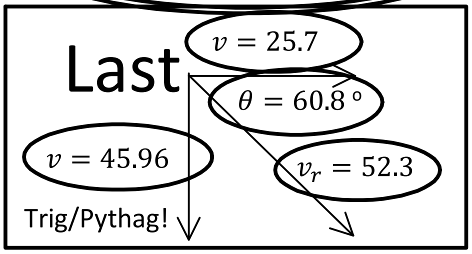




$$v = h\sin\theta$$
$$v = 40\sin 50$$
$$v = 30.6$$

$$v = hcos\theta$$
$$v = 40\cos 50$$
$$v = 25.7$$

Up/Over



$v_f = 0$

$t = ? = 3.1s$

$d = ? = 47.8m$

$v_i = 30.6$

Up

$$v_f{}^2 = v_i{}^2 + 2ad$$
$$d = \frac{-v_i^2}{2a}$$
$$d = \frac{-(30.6)^2}{2(-9.8)}$$
$$d = 47.8m$$

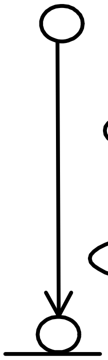
Add Cliff

Max height = ~~47.8 + 60~~

$= 107.8m$

$$v_f = v_i + at$$
$$t = \frac{-v_i}{a}$$
$$t = \frac{-30.6}{-9.8}$$
$$t = 3.1s$$

$Time\ to\ Max\ Height = 3.1s$



$v_i = 0$

$t = ? = 3.28s$

$d = 107.8m$

$v_f = ? = 45.96$

$$\Delta d = v_i t + \frac{1}{2}at^2$$
$$t = \sqrt{\frac{2d}{a}}$$
$$t = \sqrt{\frac{2(-107.8)}{-9.8}}$$
$$t = 4.69s$$

$$v_f{}^2 = (0)^2 + 2a\Delta d$$
$$v_f = \sqrt{2(-9.8)(-107.8)}$$
$$v_f = 45.96\frac{m}{s}$$

Or

$$\Delta d = v_i t + \frac{1}{2}at^2$$
$$-60 = 30.6t + \frac{1}{2}(-9.8)t^2$$
$$0 = -4.9t^2 + 30.6t + 60$$
$$t = 7.8s$$

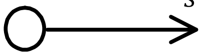
Quadform

Add Times

$$t = 4.69 + 3.1$$
$$t = 7.8s$$

Total time in flight:

Up/Down



$v_i = 25.7\frac{m}{s}$

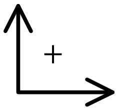
$d = ? = 200.5m$

Over

$$v = \frac{d}{t}$$
$$d = vt$$
$$d = 25.7(7.8)$$
$$d = 200.5m$$

Or Or Or Or Or Or Or Or !!!

P12 - 2.11 - River Boat Current

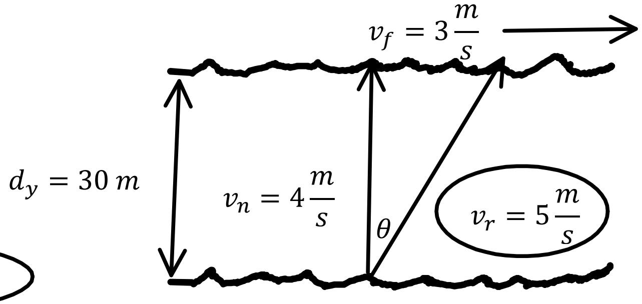


$Nick\ swims\ N\ across\ a\ 30\ m\ river.\ \ Nick\ swims\ at\ 4\frac{m}{s}\ in\ still\ water. The\ river\ flows\ W\ at\ 3\frac{m}{s}.$

$What\ is\ Nick's\ Resultant\ Velocity?$

$$v_{r^2} = v_n^2 + v_f^2$$
$$v_r = \sqrt{4^2 + 3^2}$$
$$v_r = \sqrt{25}$$
$$\boxed{v_r = 5\ \frac{m}{2}}$$

$$tan\theta = \frac{o}{a}$$
$$tan\theta = \frac{3}{4}$$
$$\theta = \tan^{-1}\left(\frac{3}{4}\right)$$
$$\boxed{\theta = 36.9^o\ [EoN]}$$



$How\ long\ does\ it\ take\ to\ cross?$

$$v_y = \frac{d_y}{t}$$
$$t = \frac{d_y}{v_y}$$
$$t = \frac{30}{4}$$
$$\boxed{t = 7.5\ s}$$

$How\ far\ down\ river\ does\ Nick\ land?$

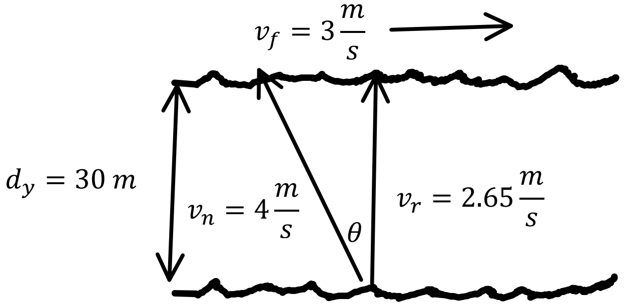
$$v_x = \frac{d_x}{t}$$
$$d_x = v_x t$$
$$d_x = 3(7.5)$$
$$\boxed{d_x = 22.5\ m}$$

$What\ is\ Nick's\ Displacement?$

$$d_r{}^2 = d_x^2 + d_y^2$$
$$d_r = \sqrt{22.5^2 + 30^2}$$
$$\boxed{d_r = 37.5\ m}$$

$At\ what\ heading\ should\ Nick\ head\ to\ arrive\ directly\ across\ the\ river?$

$$sin\theta = \frac{o}{h}$$
$$sin\theta = 3/4$$
$$\theta = \sin^{-1}\left(\frac{3}{4}\right)$$
$$\boxed{\theta = 48.59^o}\qquad \boxed{48.59^o\ [WoN]}$$



$What\ is\ Nick's\ Resultant\ Velocity?$

$$v_{r^2} = v_n^2 + v_f^2$$
$$v_r = \sqrt{4^2 - 3^2}$$
$$v_r = \sqrt{7}$$
$$\boxed{v_r = 2.65\frac{m}{s}}$$

$At\ this\ heading\ how\ long\ will\ it\ take\ to\ cross?$

$$v_y = \frac{d_y}{t}$$
$$t = \frac{d_y}{v_y}$$
$$t = \frac{30}{2.65}$$
$$\boxed{t = 11.32\ s}$$

$What\ is\ Nick's\ Displacement?$

$$\boxed{30\ m!}$$

Less than 3 would be too slow!