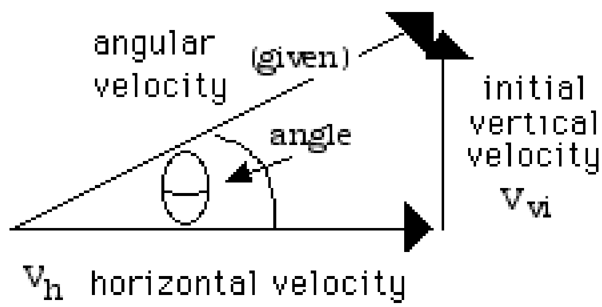
In the earlier projectile problems, we just rolled horizontally off cliffs and tables, but never launched upward at angles, so we had no initial vertical velocity.   Guess what?

When we <u>DO</u> launch upward, we are really launching at 2 different directions... both up and to the side. To calculate this, we break our original velocity (with angle) up into v_h and initial V_{vi} using sine and cosine.



The horizontal portion (v_h) we get by:
(cos of angle) x (angular velocity)

the vertical portion (V_{vi}) we get by:
(sin of angle) x (angular velocity)

This should make sense if you learned the stuff last unit! (Oh, THAT's why...)

The initial vertical velocity (V_{vi}) can be used to determine distance up, time up, et cetera, by using it as v_i in any acceleration equation. (gravity will be the acceleration)

EX: We hit a baseball with a 42.7 m/s velocity at a 62.5º angle.
A) how high does it get at its highest point?
B) how long is it in the air?
C) how far does it go?
<u>Answer</u>:
First break velocity into v_h and v_{vi}: v_h =(cos 62.5)(42.7) =____________m/s
and v_{vi} =(sin 62.5)(42.7)=___________________m/s.
Next, since at highest point $v_{vf} = 0$, we can use $d_v = (v_f^2 - v_{v_i}^2)/2g$,
to find height up = $(0^2 - 37.9^2)/2/(-9.81)$ = ________________m up (answer A)

(Note that we use 37.9 m/s, NOT 42.7 m/s since in a vertical equation, we only use the velocity straight up!)
We then find the $\text{time}_{up} = (v_f - v_{vi}) / g = (0 - 37.9)/-9.81$ = __________ s
time up x 2 = total time in air so: (answer B) = ______________s.

Now that we know the time, we find that $d_h = v_h t$ so

19.7 m/s x 7.72 s = ____________________m (answer C)

(Note: the v_h came from step one)

Many times in dealing with projectiles, we really care only about how far it went horizontally, so there is a shortcut formula to get answer C.

(This <u>only</u> works if you land at the same height you take off from)

$$\text{(range) or } d_h = \sin(2\,ø)\, v^2/{}^{+}g$$

double the angle (like 62.5) <u>before</u> you "sin" it; v is the <u>angular</u> (given) velocity (like 42.7 m/s) 9.81 must be positive here, though it is negative in all the other equations. For those who care, I can show you later why this formula works... for now, just use it. You can algebra it for the velocity or the angle if necessary, but it only works when it lands approximately where it took off from... no cliffs!

Let's do part "C" answer above! $d_h = \sin(2\,ø)\, v^2/{}^{+}g$ so...

$\text{Sin}(2*62.5)(42.7)^2 / 9.81 = 152$ m! it works!