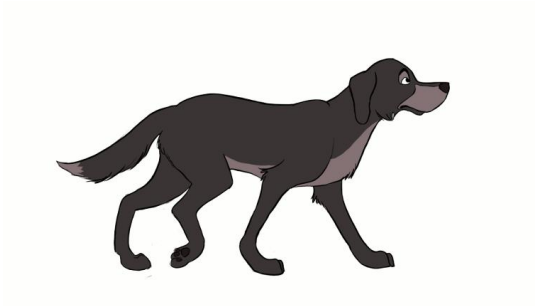
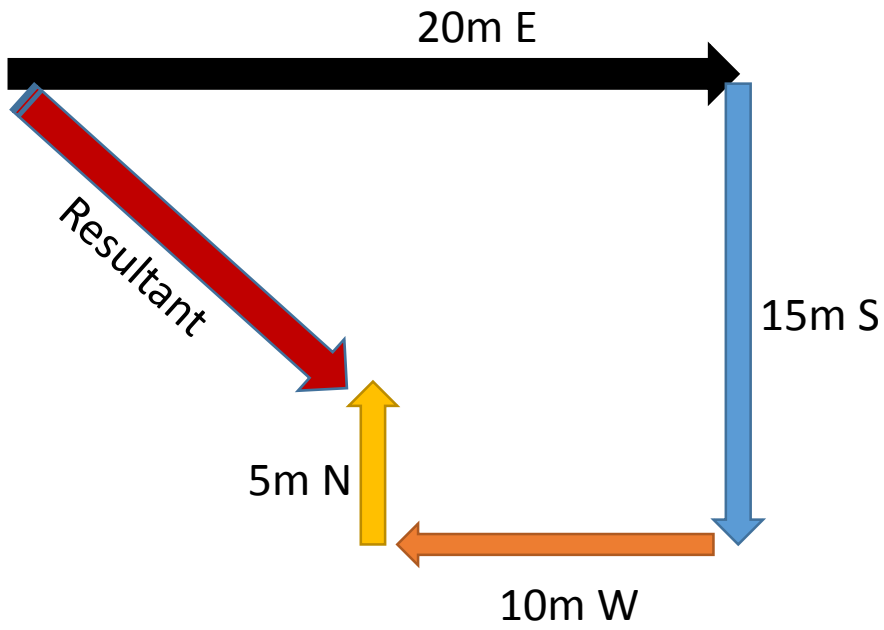
Adding Vectors

- Drawing Vectors
- Pythagorean Thm.
- Vector Components
- Law of Cosines / Law of Sines

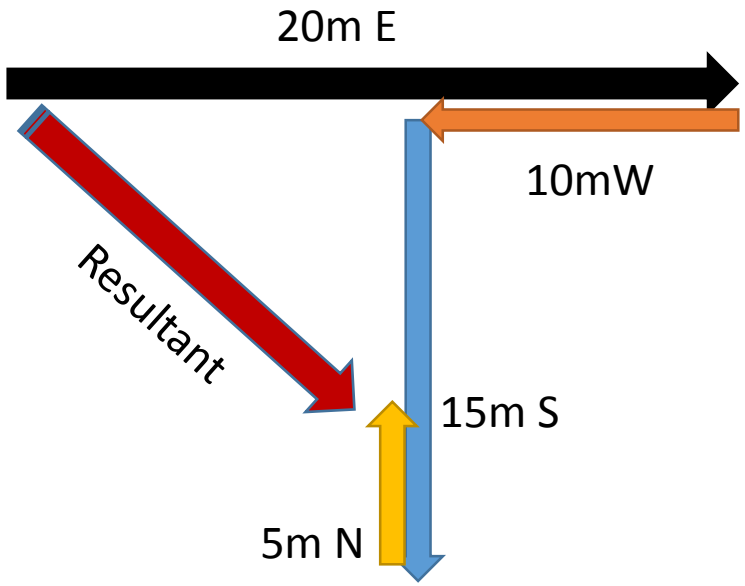
Adding Vectors (drawing vectors)

- Draw Vectors Tip to Tail
- Where one vector ends, the other begins
- Resultant: The vector from the start of the first vector, to the end of the final vector.
- Example: A dog walks due East 20 m, then due South 15m, then due West 10m, Due North 5m.



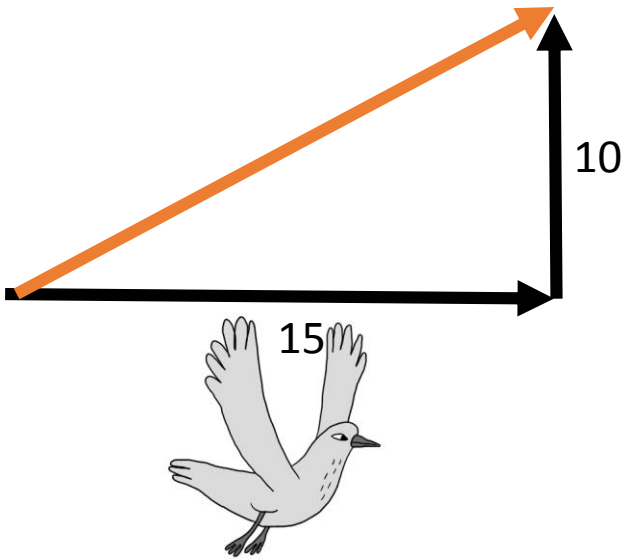


Adding Vectors (determining resultant)



Adding Vectors (determining resultant)

- A bird flies due east at 15 m/s, the wind blows due nort at 10 m/s. What is the resultant velocity of the bird?



MAGNITUDE:

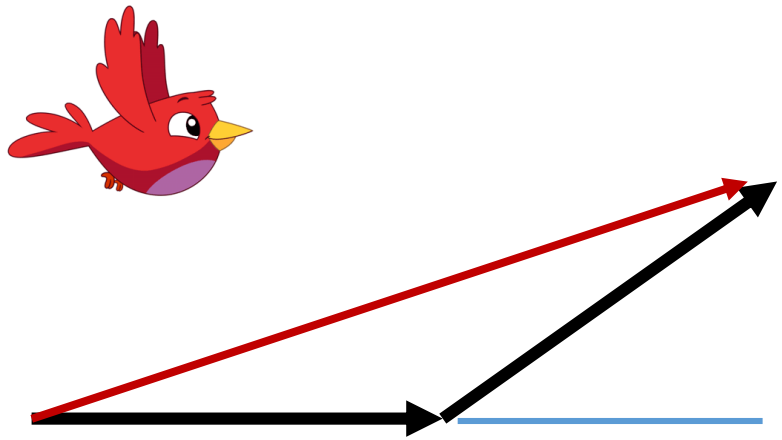
$a^2 + b^2 = c^2$

DIRECTION

$tan^{-1}\left(\frac{y}{x}\right)$

Adding Vectors (determining resultant)

- A bird flies due east at *10 m/s*, the wind blows *37^o North of East* at *15 m/s*. What is the resultant velocity of the bird?



MAGNITUDE:

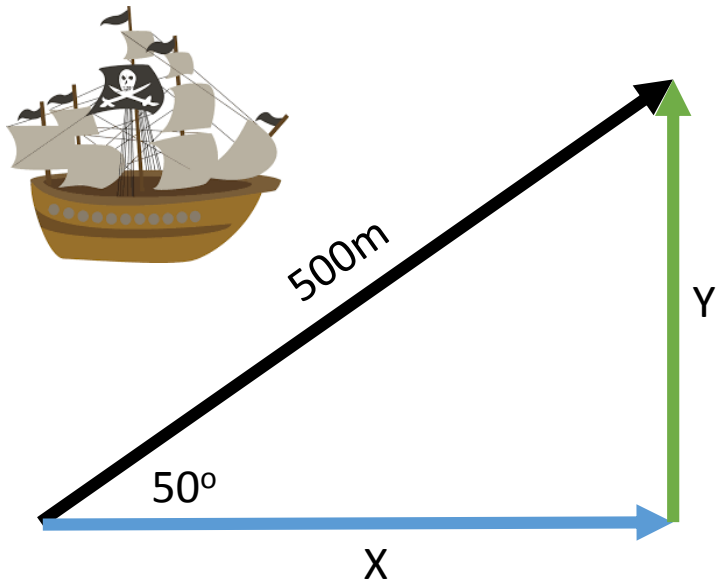
$c^2 = a^2 + b^2 - 2ab\ cos(C)$

DIRECTION

$$\frac{A}{sinA} = \frac{B}{sinB} = \frac{C}{sinC}$$

Adding Vectors (components)

- Vectors at angles can be split into perpendicular components.
- perpendicular components are independent of each other
- EXAMPLE: A ship sails 500m at 50^{o} North of East.

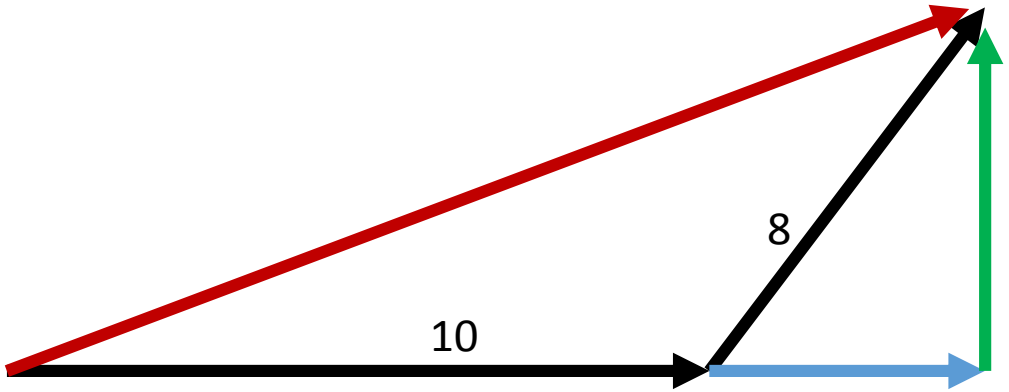


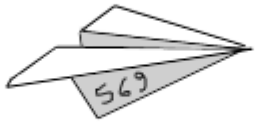
X =500cos(50)

Y =500sin(50)

Adding Vectors (determining resultant w/ Components)

- A paper plane flies due East with an airspeed of 10m/s. The wind blows at 8 m/s, 60^{o} North of West. What is the resultant Velocity?

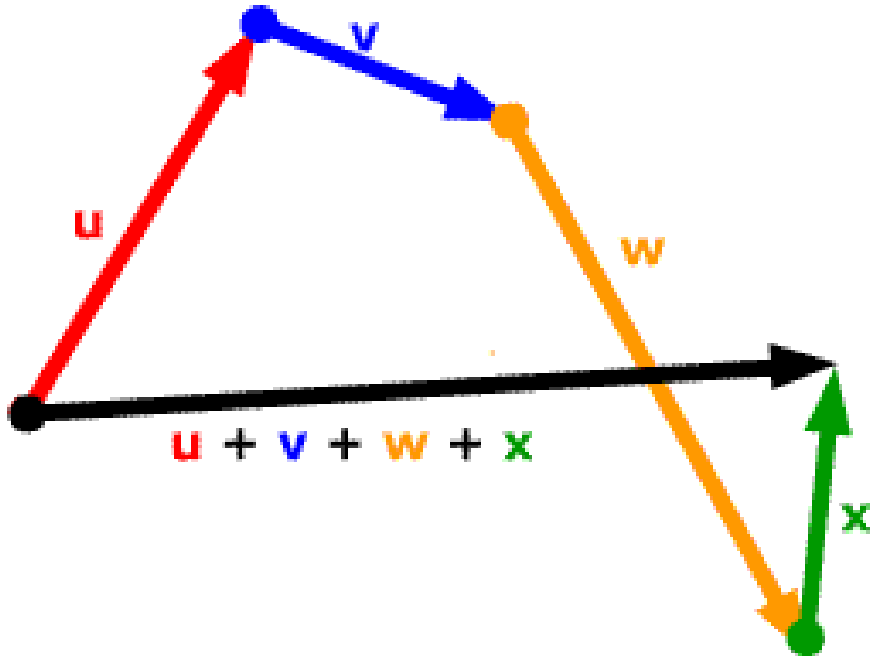




X	Y

Adding Vectors

- Draw Diagram
- Make Triangle if appropriate
- Determine Strategy
  - Pythagorean Thm.
  - Law of Cosine / Law of Sines
  - Vector Components



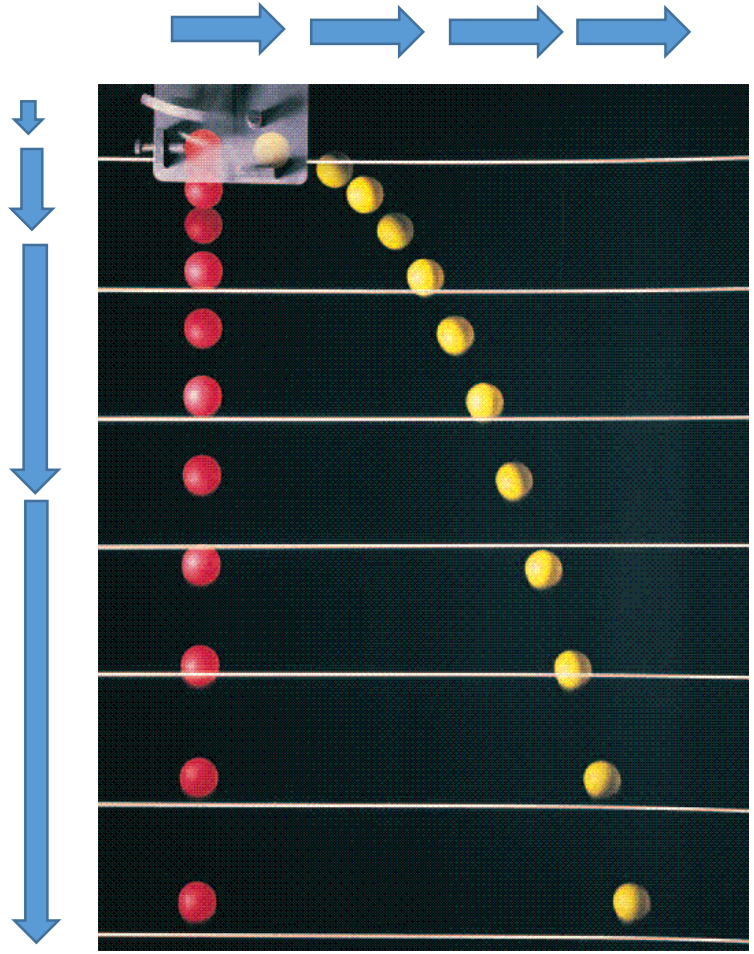
Horizontal Projectiles

- Perpendicular Components of Motion are independent of each other

V_x remains constant

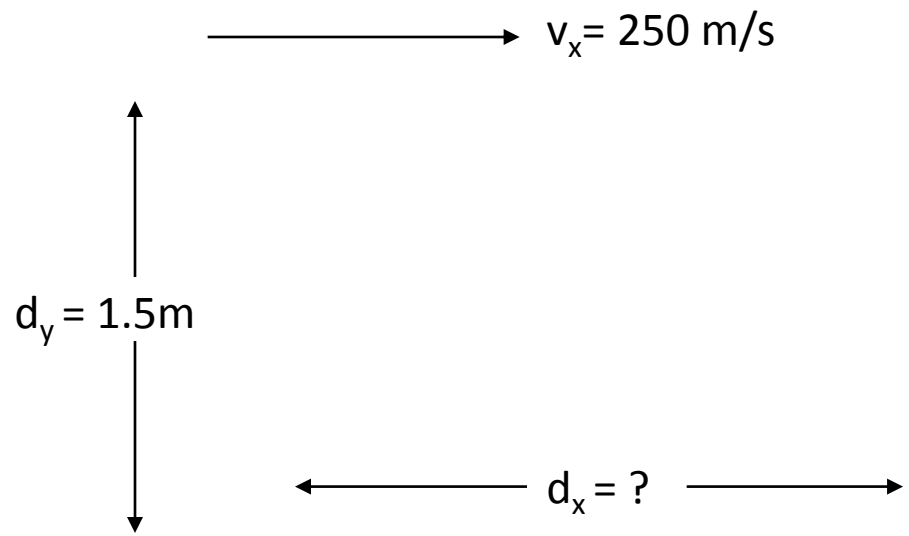
V_y accelerates due to gravity

Bullet Dropped vs. Bullet Fired



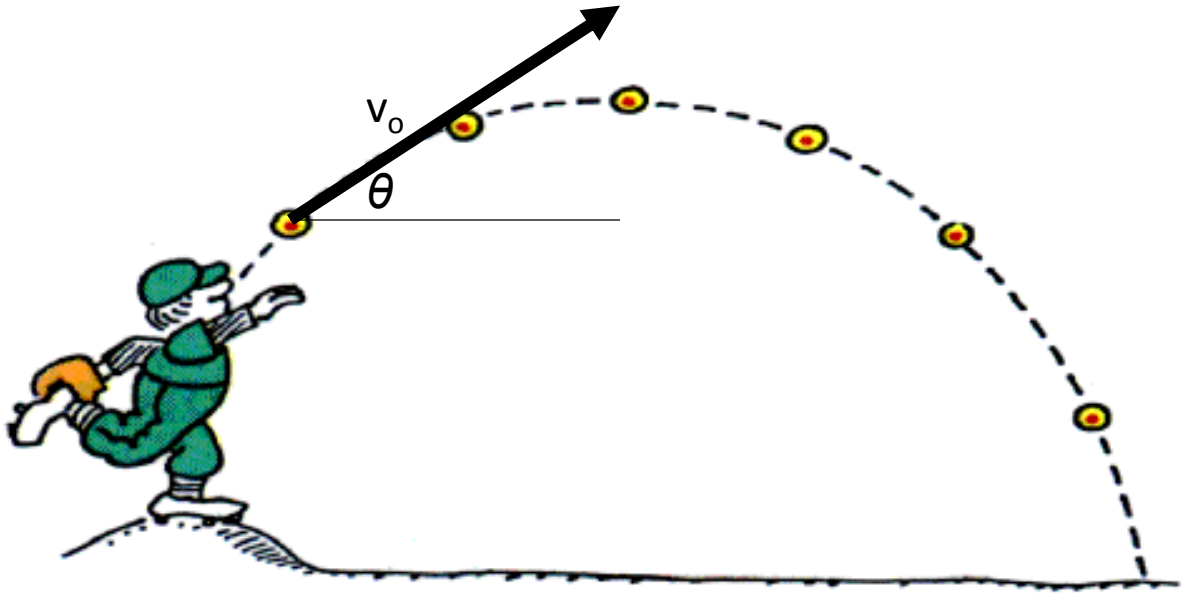
Horizontal Projectiles

- Vertical component Determines time in the air
- $d_y = \frac{1}{2} a t^2$ $(v_y=0)$



- Time and Horizontal Component Determine Range
- $d_x = v_x t$

Projectiles at an Angle



Perpendicular Components are independent of eachother.

$v_y = v_o \sin\theta$

- Accelerates due to gravity

$v_x = v_o \cos\theta$

- Remains Constant

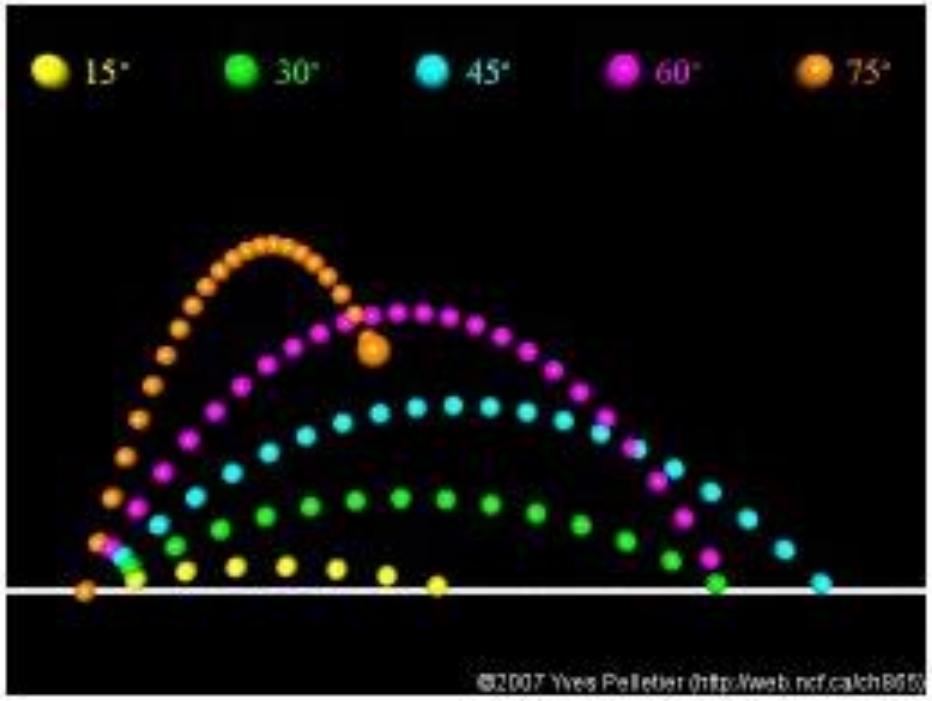
Projectiles at an Angle

- Vertical Component of Velocity determines:
- Max Height
- Air Time

  ($v_y=v_o \sin\vartheta$)

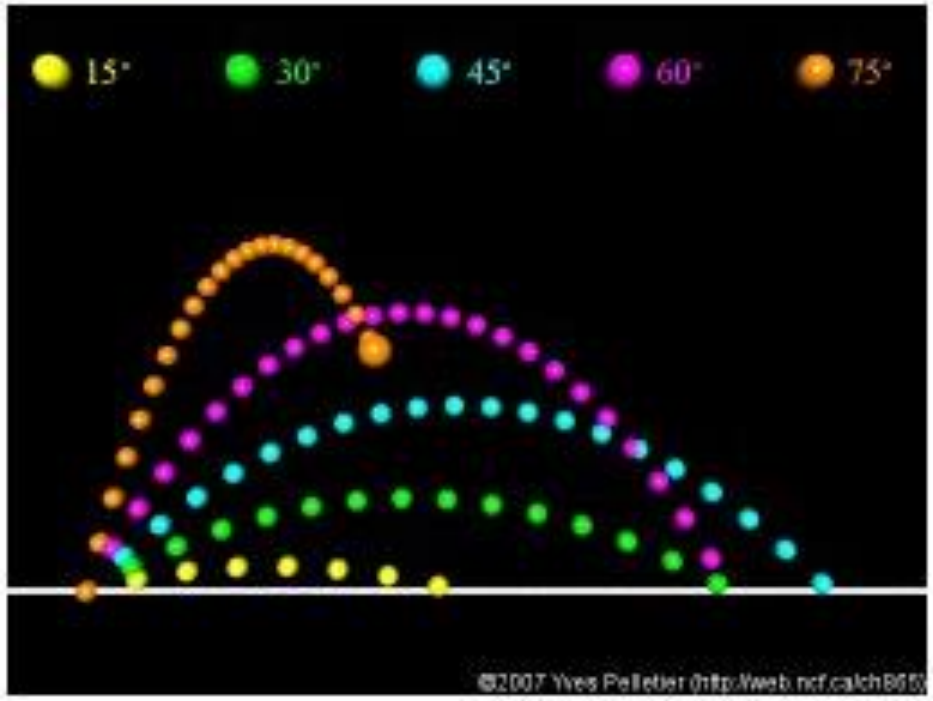
  ($a=g=9.8\ m/s^2$ down)

  - $d_y= \frac{1}{2}\, at^2+v_y t+d_{yi}$
  - $v_f^2=2ad_y+v_{yi}^2$
  - $v_f=at+v_i$



Projectiles at an Angle

- Horizontal Component of Velocity determines Range
  - $d_x=v_xt$
    - $V_x=v_o\cos\theta$



Example

- A small bird with no wings is fired from a sling shot at an angle of 40^{o} with a speed of 20 m/s

How long is the bird in the air ?

Example

- A small bird with no wings is fired from a sling shot at an angle of 40^{o} with a speed of 20 m/s

How far does the bird land from the launch site?

Example

- A small bird with no wings is fired from a sling shot at an angle of 40^{o} with a speed of 20 m/s

How high does the bird go?

Example 2:
A dirt biker jumps off a ramp 4 meters high with a velocity of 15 m/s at an angle of 30^{o}.

How long is he in the air?

Example 2:
A dirt biker jumps off a ramp 4 meters high with a velocity of 15 m/s at an angle of 30^{o}.

How far does he go?

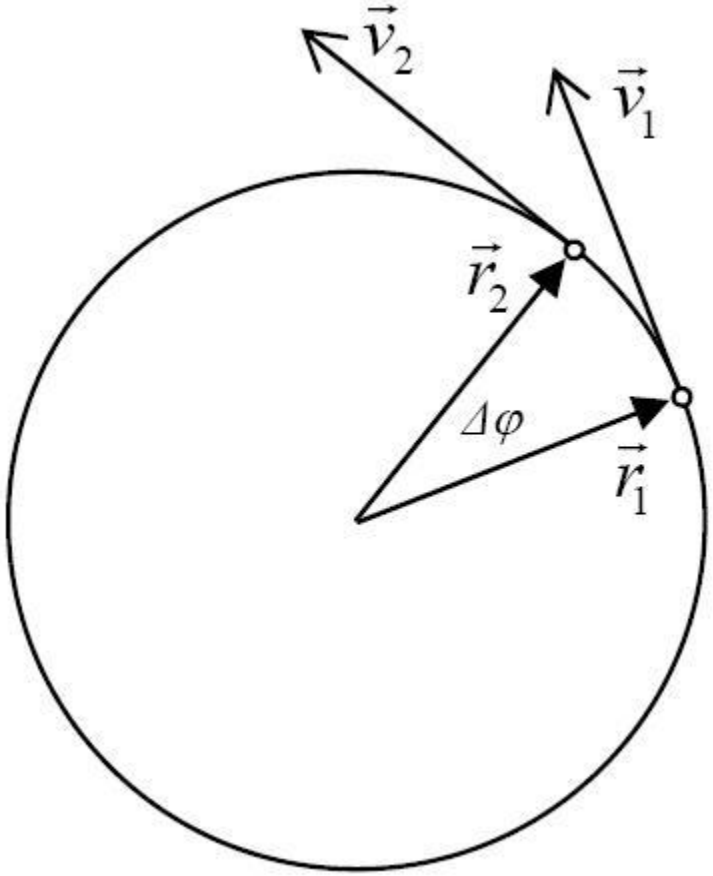
Example 2:
A dirt biker jumps off a ramp 4 meters high with a velocity of 15 m/s at an angle of 30^{o}.

How fast is he going when he lands?

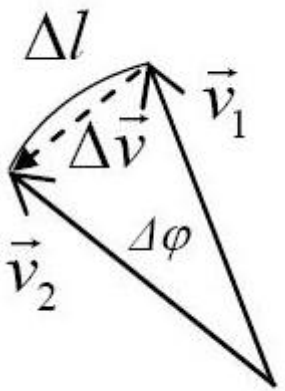
Uniform Circular Motion

motion in a circle of constant radius & constant speed

Instantaneous Velocity always tangent to path



Change in direction = change in velocity = acceleration



Acceleration is towards center of circle along the radius

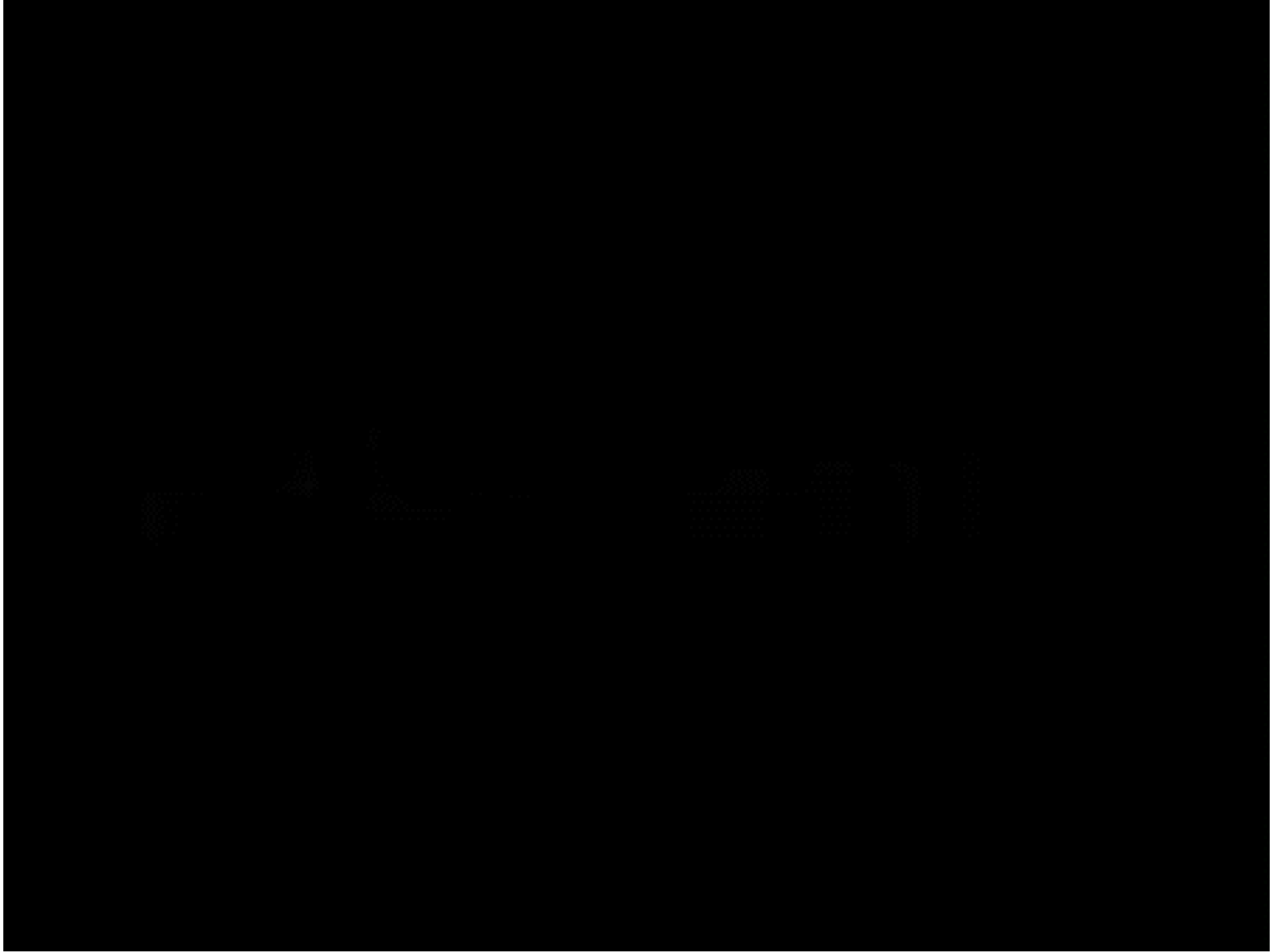
- Centripetal Acceleration
- Radial Acceleration

$$a_c = \frac{v^2}{r}$$

Texas Motor Speedway

- Radius of Turns = 775ft = 230m
- Record Qualifying Speed = 233mph
- What is the centripetal Acceleration of the driver?

- How many g’s does the driver feel?



G-force Threshold Test

Jet Pilots,
Astronauts,
Daredevils

r = 7.0m

a = 6.1gs

V=?

Record player (rpm)

480 rpm (max)

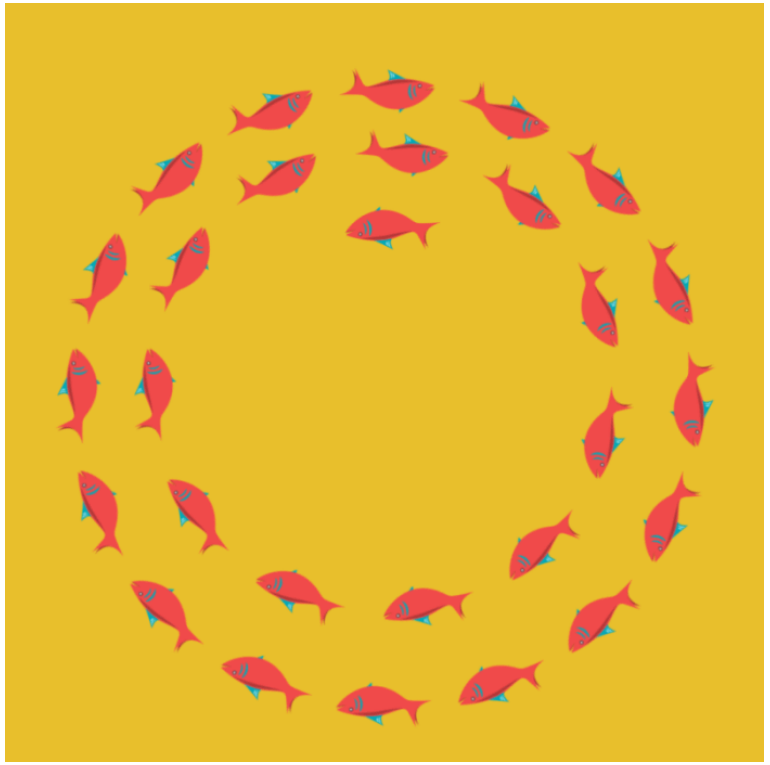
r=0.15m r=0.09m

What is the centripetal acceleration at outer edge?

Rpm ⟶ m/s

Acceleration using Period of Rotation

EXAMPLE



Your inner fish has a rotational rate of 20 rpm.

- What is the period of rotation?
- Using period of rotation and a radius of 3m, Determine the acceleration of the fish.

$$a = \frac{v^2}{r} \qquad v = \frac{d}{t}, \qquad d = 2\pi r$$

$$v = \frac{2\pi r}{T} \rightarrow v^2 = \frac{4\pi^2 r^2}{T^2}$$

$$a = \frac{4\pi^2 r}{T^2}$$