Lecture 11

Fri: HW by 5pm

Mon: Warm Up 5 (D2L)

Tues: Review Exam 1

~~Wed~~ Thurs: Exam 1 - will cover all classes through 11 (and maybe 12)

Projectile motion

Projectile motion is that where an object only moves under the influence of Earths gravity. Then the acceleration is

$$a_x = 0 \qquad a_y = -9.8 m/s^2$$

and the kinematics equations apply:

$$v_{fx} = v_{ix} + a_x \Delta t \qquad v_{fy} = v_{iy} + a_y \Delta t$$

$$x_f = x_i + v_{ix} \Delta t + \frac{1}{2} a_x \Delta t^2 \qquad y_f = y_i + v_{iy} \Delta t + \frac{1}{2} a_y \Delta t^2$$

$$v_{fx}^2 = v_{ix}^2 + 2a_x (x_f - x_i) \qquad v_{fy}^2 = v_{iy}^2 + 2a_y (y_f - y_i)$$

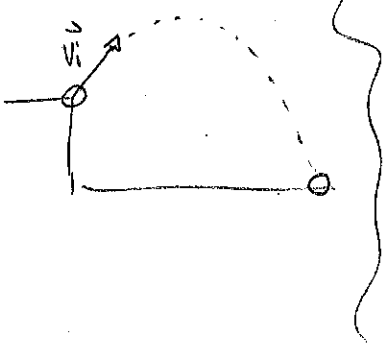
123 Diver splashdown

A diver launches off a platform at an angle of 55° above the horizontal and with speed 8.0 m/s. The platform is 3.0 m above the surface of a pool. *(131Sp2025)*

a) Determine the diver's speed just before hitting the water.

b) Determine the time taken by the diver to hit the water.

Answer a) ① Sketch



② Variables:

$t_i = 0s$ $\quad t_f = ?$

$x_i = 0m$ $\quad x_f =$

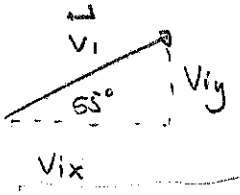
$y_i = 3.0m$ $\quad y_f = 0m$

$v_{ix} = 4.6m/s$ $\quad v_{fx} =$

$v_{iy} = 6.6m/s$ $\quad v_{fy} =$

$a_x = 0\ m/s^2$ $\quad a_y = -9.8m/s^2$

③ Components of $\vec{v}_i$



$v_{ix} = v_i \cos 55^\circ = 8.0m/s \cos 55^\circ = 4.6m/s$

$v_{iy} = v_i \sin 55^\circ = 8.0m/s \sin 55^\circ = 6.6m/s$

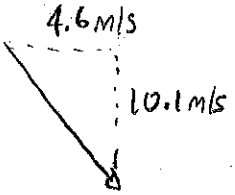
④ want $v_f = \sqrt{v_{fx}^2 + v_{fy}^2}$ and this requires v_{fx}, v_{fy}

$v_{fx} = v_{ix} + a_x \Delta t \Rightarrow v_{fx} = v_{ix} = 4.6m/s$ $\quad \boxed{v_{fx} = 4.6\ m/s}$

$v_{fy}^2 = v_{iy}^2 + 2a_y(y_f - y_i) \Rightarrow v_f^2 = (6.6m/s)^2 + 2(-9.8m/s^2)(0m - 3m) = 102.36\ m^2/s^2$

$\Rightarrow \boxed{v_{fy} = -10.1m/s}$

$\Rightarrow v_f = \sqrt{(-10.1m/s)^2 + (4.6m/s)^2} = 11.1m/s$



b) $v_{fy} = v_{iy} + a_y \Delta t \Rightarrow \frac{v_{fy} - v_{iy}}{a_y} = \Delta t$

$\Rightarrow \frac{-10.1m/s + 6.6m/s}{-9.8m/s^2} = \Delta t$

$\Rightarrow \Delta t = 1.7s$

Circular motion

There are many situations where an object moves along a circular path

1) object swinging on the end of a string
2) planets and moons orbiting

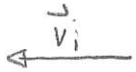
DEMO: TheSky 3D – show planets

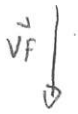
The same basic rules for determining velocities and accelerations apply.

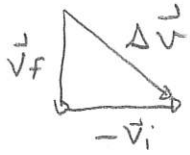
Quiz 1 40%

Exercise: Have class do in steps

① $\vec{a}_{avg} = \dfrac{\vec{v}_f - \vec{v}_i}{\Delta t}$

② sketch $\vec{v}_i$ 

③ sketch $\vec{v}_f$ 

④ form $\Delta\vec{v} = \vec{v}_f - \vec{v}_i$ 

→ gives $\vec{a}_{avg}$ ↘

Quiz 2

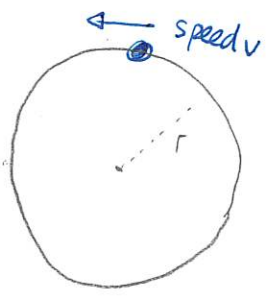
These provide the rules for the direction of acceleration for uniform circular motion (object moves in a circle at constant speed)

For uniform circular motion the acceleration, called centripetal acceleration

1) points radially inward
2) has magnitude

$$a_c = v^2/r$$

where r = radius of orbit
v = speed of object



130 Merry-go-round

A merry-go-round is a large flat disk that spins around a vertical axis through its center. A child is at the edge of a merry-go-round with radius 3.0 m. The merry-go-round spins so that the child's acceleration is $1.5g$. Determine the period and frequency of orbit for this to occur. *(131F2024)*

Strategy: From known acceleration → get v

↓

from v get time for one orbit (period)

↳ frequency = 1/period.

$$a = \frac{v^2}{r} \Rightarrow v^2 = ar$$

$$\Rightarrow v = \sqrt{ar} = \sqrt{1.5 \times 9.8\,m/s^2 \times 3.0\,m}$$

$$\Rightarrow v = 6.6\,m/s$$

Then $v = \frac{\text{distance one orbit}}{\text{period}} \Rightarrow v = \frac{2\pi r}{T} \Rightarrow T = \frac{2\pi r}{v}$

$$\Rightarrow T = \frac{2 \times \pi \times 3.0\,m}{6.6\,m/s} \Rightarrow T = 2.8\,s$$

The frequency is

$$f = 1/T = 1/2.8\,s = 0.35\ rev/s.$$