Phys 131 F2025

Lecture 6

Fri: HW by 5pm

Ex: 59, 61, 63, 64, 69, 73, 74, 76

↳ requires some estimation

Thurs: Seminar WS 160

Mon: Warm Up 3 D2L

Free fall motion

An object falling near to Earth's surface is said to be in free-fall if the only influence on the object's motion is Earth's gravity. This category of motion includes both upwards and downwards vertical motion.

Experiments show that:

1) the acceleration is non-zero
2) the acceleration is independent of the object's mass or its state of motion.

Quiz1 95% - 100% { 90% - 100%

Quiz2 70% - 100% { 70% - ~~90~~ 95%

3) near to Earth's surface, the acceleration is constant and

$$\boxed{a = -g \quad \text{where} \quad \underbrace{g = 9.80\,m/s^2}_{\text{always positive}}}$$

makes acceleration negative

Since acceleration is constant, the kinematic equations apply:

$$v_f = v_i + a\Delta t$$

$$y_f = y_i + v_i\Delta t + \frac{1}{2}a(\Delta t)^2$$

$$v_f^2 = v_i^2 + 2a(y_f - y_i)$$

$$a = -9.8\,m/s^2 = -g$$

Fundamental Mechanics: Group Exercise 2

27 August 2025

Names: ____________________ ____________________ ____________________

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1 Rock launch speed

A person, lying on their back, throws a rock vertically from the ground. The rock reaches a maximum height of 3.6 m above the ground (about 12 ft). We aim to determine the launch speed and the time of flight of the rock.

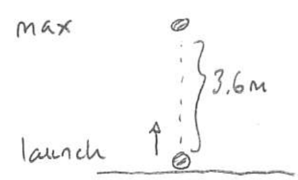
a) First consider the launch speed. Sketch the situation, illustrating the rock at two key instants. List all relevant variables at these instants.

b) Determine the launch speed of the rock.

c) Now consider the time of flight. Again sketch the situation, illustrating the rock at two key instants. List all relevant variables at these instants. Find teh time of flight.

Answer

a)



$t_i = 0s \quad t_f = ?$

$y_i = 0m \quad y_f = 3.6m$

$v_i = ? \quad v_f = 0m/s$

$a = -9.8m/s^2$

b) $v_f^2 = v_i^2 + 2a(y_f - y_i)$

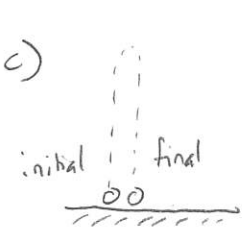
$\Rightarrow (0m/s)^2 = v_i^2 + 2(-9.8m/s^2)(3.6m)$

$\Rightarrow -v_i^2 = -70.6m^2/s^2$

$\Rightarrow v_i^2 = 70.6m^2/s^2$

$\Rightarrow v_i = \sqrt{70.6m^2/s^2} = 8.4m/s$

c)



$t_i = 0s \quad t_f = ?$

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

$v_i = 8.4m/s \quad v_f = ?$

$a = -9.8m/s^2$

$\cancel{y_f} = \cancel{y_i} + v_i \Delta t + \frac{1}{2} a \Delta t^2$

$\Rightarrow 0 = v_i \Delta t + \frac{1}{2} a \Delta t^2$

$\Rightarrow 0 = (v_i + \frac{1}{2} a \Delta t) \Delta t$

$\Rightarrow \Delta t = 0$ (launch) or $v_i + \frac{1}{2} a \Delta t = 0$

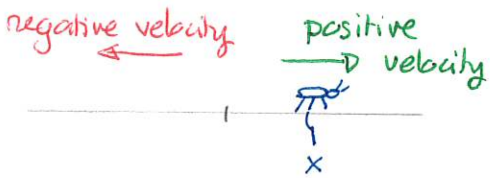
$\Rightarrow \Delta t = -\frac{2v_i}{a}$

$\Rightarrow \Delta t = \frac{-2 \cdot 8.4m/s}{-9.8m/s^2} \Rightarrow \Delta t = 1.7s$

Motion in Two Dimensions

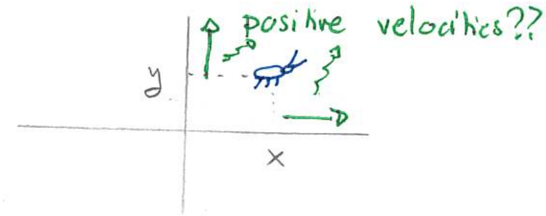
We would like to generalize the kinematics of motion to cover motion in two or three dimensions. We can see some complications

Motion in one dimension



* only need one variable to describe location
* direction can be described completely with sign of velocity

Motion in two dimensions



* we need two variables to describe location
* it is not sufficient to use positive or negative velocity to describe directions. We need more than two different words

It will be convenient to describe two dimensional kinematics using <u>vector</u> quantities:

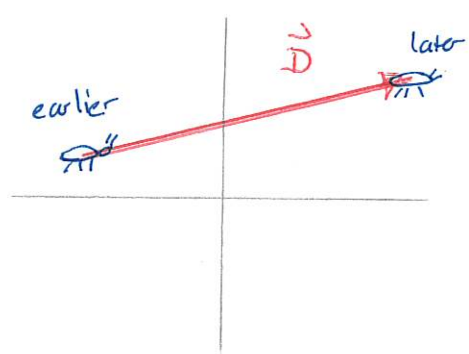
* position
* displacement
* velocity
* acceleration

We develop the concepts of vectors by considering displacement. The idea is

Displacement is a change in position

We can represent this by

A <u>displacement vector</u> is an arrow:
* whose tail is at earlier position
* whose head is at later position

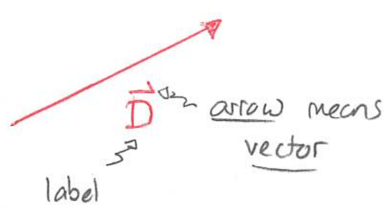


The arrow contains two pieces of information:

1) magnitude ~ straight line distance from earlier to later points
2) direction

Thus the displacement vector cannot be described by a single number and we need a new type of symbol.

<u>Vector</u>



<u>Mathematical notation</u>

* Vector $\vec{D}$ arrow
* Magnitude of vector = (positive) length of vector D no arrow
  (never negative)
* Direction ~ some description of the way it points e.g.