Mon: HW by 5pm

Ex 30, 34, 35, 39, 43, 44, 45, 50

↳ computer activity (works on campus computers)

Weds: Warm Up 3 (D2L)

This class: * analyze complete details of motion with constant acceleration

Motion with Constant Acceleration

Recall that acceleration describes the rate of change of velocity. The average acceleration of an object is $a_{avg} = \frac{\Delta v}{\Delta t}$. When this acceleration is constant the equation works for all time intervals and the acceleration is

$$a = \frac{\Delta v}{\Delta t}$$

Standard algebra then gives, for, example,

$$\underset{\text{later}}{v_f} = \underset{\text{earlier}}{v_i} + a\Delta t$$

This means that we can:

> Use acceleration to determine details about the later motion based on details about the earlier motion.

Applying relevant mathematics allows us to derive a set of equations that relate position and velocity at a later time to those at an earlier time.

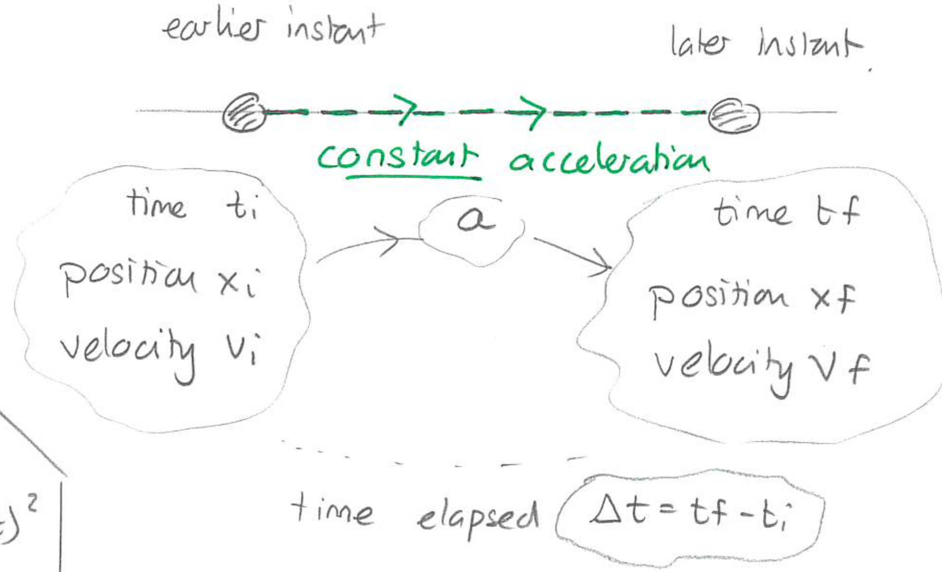
Then:

If the acceleration of an object is <u>constant</u> then

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

$$x_f = x_i + v_i\,\Delta t + \frac{1}{2}a(\Delta t)^2$$

$$v_f^2 = v_i^2 + 2a(x_f - x_i)$$

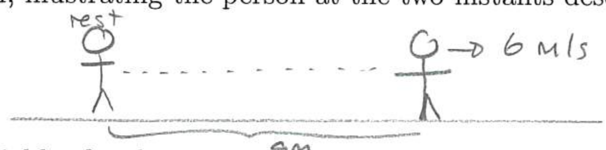


These are the KINEMATIC EQUATIONS that require constant acceleration

40 Person moving with constant acceleration

A person is initially at rest and subsequently moves right with a constant acceleration. The person's reaches speed 6.0 m/s at a point 9.0 m to the right of the starting location. The aim of this exercise will be to determine the time taken to reach this point. A first step will be to determine the acceleration of the person. *(111F2023)*

a) Sketch the situation, illustrating the person at the two instants described above.



List all relevant variables for the two instants:

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

$x_i = 0m$ $\quad$ $x_f = 9m$

$v_i = 0m/s$ $\quad$ $v_f = 6 m/s$

b) Determine the acceleration by selecting one of the kinematic equations, substituting and solving for a.

$$v_f^2 = v_i^2 + 2a(x_f - x_i)$$

$$(6m/s)^2 = (0m/s)^2 + 2\,a\,9.0m$$

$$36m^2/s^2 = 0m^2/s^2 + 18.0m\,a$$

$$36m^2/s^2 = 18.0m\,a$$

$$a = \frac{36m^2/s^2}{18m} = 2.0m/s^2$$

c) Using a different kinematic equation, find the time that it takes the person to reach speed 6.0 m/s.

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

$$6.0m/s = 0m/s + 2.0m/s^2\,\Delta t$$

$$6.0m/s = 2.0m/s^2\,\Delta t$$

$$\Delta t = \frac{6.0m/s}{2.0m/s^2} = 3.0s$$

d) Suppose that you had tried to find the time taken to reach speed 6.0 m/s by using

$$v = \frac{\Delta x}{\Delta t} \Rightarrow 6.0\,\text{m/s} = \frac{9.0\,\text{m}}{\Delta t}.$$

What time does this give? Does it agree with the answer that you obtained to the previous part? Is it correct?

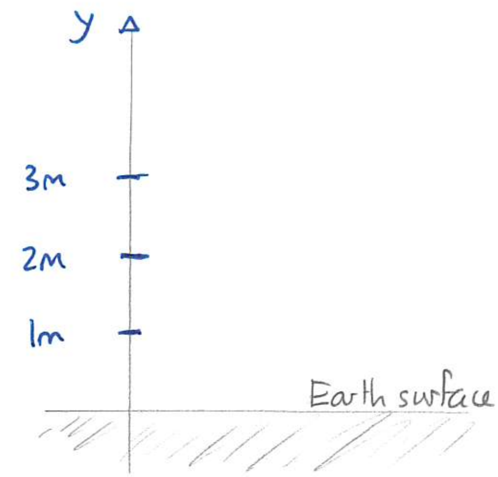
Would give

$$\Delta t = \frac{9.0m}{6.0m/s} = 1.5s$$

NOT SAME, NOT CORRECT

because velocity is not constant

Free fall



The entire system of one dimensional kinematics works for vertical motion. The following modifications occur:

1) position variable = y
2) upward is positive

$v > 0 \Rightarrow$ moves up

$v < 0 \Rightarrow$ " down

An example of such motion is free fall – motion where the object moves (up OR down) only under the influence of Earth's gravity.

Quiz1 (not vertical but similar thinking) 20% – 80%

Quiz2 40% – 80%

Quiz3 25% – 80%

The exact details of the acceleration require experiments. These show:

1) the acceleration of a freely falling object is independent of the objects mass, it's speed or its state of motion,
2) near Earth's surface, the acceleration of a freely falling object is constant with value

$$a = -g$$

where

$$g = 9.80 m/s^2$$ ← g is positive

so $a = -9.80 m/s^2$.

DEMO: Guinea / Feather.