4. Will Elsie, the cow, make it? Al Einstein is speeding down a country road in Palatine at a constant 32 m/s (73 mph) when he crests a hill and spots a cow (Elsie) standing in the middle of the road just 45 m in front of him. Can he stop in time to avoid hitting the cow?

The facts:

Mr. E's response time is 0.32 seconds

The corvette has a braking acceleration of 20 m/s/s when the brakes are applied.

a. Calculate how far the car will travel while Al moves his foot from the gas pedal to the brake.

$v_i = 32\ m/s$ $\quad a = 0$ $\quad d =$ $\quad t = .32s$

$d = v_i t + \frac{1}{2}at^2$

$d = 32\ m/s(.32s)$ $\quad d = 10.24m$

*Mark this distance on graphic to show far Mr. E is when his foot hits the brake.

b. Calculate how far the car will travel while it is coming to a complete stop (stopping distance).

$v_i = 32\ m/s$

$v_f = 0\ m/s$

$a = -20\ m/s^2$

$t =$ $\quad d =$

$v_f = v_i + at$

$0\ m/s = 32\ m/s + (-20\ m/s^2)t$

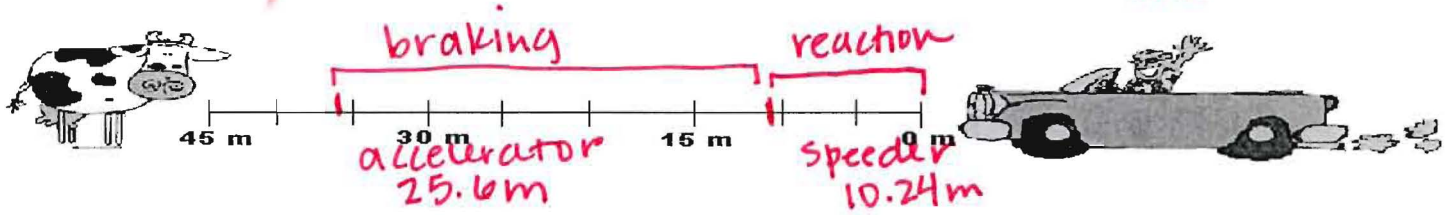
$t = 1.6s$

$d = v_i t + \frac{1}{2}at^2$

$d = (32\ m/s)(1.6)t + \frac{1}{2}(-20\ m/s^2)(1.6)^2$

$d = 25.6\ m$

Below on the same diagram mark how much further the car will travel.

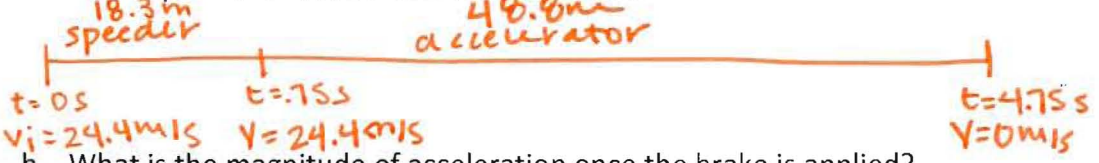


Did Elsie make it?

Yes! ☺

5. In a test, a car was traveling at a speed of 24.4 m/s when the driver received a signal to stop. It took 0.75s before he could apply the brake and then 4 s were required to stop the car.

a. Draw a picture of the scenario and label the speeds at each interval. Also label whether the car was a speeder or accelerator for each motion.



b. What is the magnitude of acceleration once the brake is applied?

$v_f = v_i + at$

$0\ m/s = 24.4\ m/s + a(4s)$

$a = -6.1\ m/s^2$

c. How far does the car travel after the driver received the signal to stop?

Stage 1

$v_i = 24.4\ m/s$

$v_f = 24.4\ m/s$

$a = 0\ m/s^2$

$d =$

$t = .75s$

$d = v_i t + \frac{1}{2}at^2$

$d = (24.4\ m/s)(.75s)$

$d_1 = 18.3m$

Stage 2

$v_i = 24.4\ m/s$

$v_f = 0\ m/s$

$a = -6.1\ m/s^2$

$d =$

$t = 4s$

$d = v_i t + \frac{1}{2}at^2$

$d = (24.4\ m/s)(4s) + \frac{1}{2}(-6.1)(4s)^2$

$d = 48.8m$

6. A jetliner starts from rest and needs to attain a speed of 75.0 m/s to leave the ground. If the jet can accelerate at a rate of 12.5 m/s/s, then...

   a. How much runway is required for the jet to take off?

$v_i = 0\ m/s$
$v_f = 75\ m/s$
$a = 12.5\ m/s^2$
$d =$

$v_f^2 = v_i^2 + 2ad$
$(75\ m/s)^2 = (0\ m/s)^2 + 2(12.5\ m/s^2)d$
$d = 225\ m$

   b. How much time elapses from the time the jet begins to accelerate until it takes off?

$v_i = 0\ m/s$
$v_f = 75\ m/s$
$a = 12.5\ m/s^2$
$t =$

$v_f = v_i + at$
$75\ m/s = 0\ m/s + (12.5\ m/s^2)t$
$t = 6\ s$

7. A person standing on top of a building that is 50.0 m tall throws a stone vertically downward with a velocity of 15.0 m/s

   a. What is the velocity of the stone right before it strikes the ground?

$v_i = 15\ m/s$
$d = -50\ m$
$a = -9.8\ m/s^2$
$v_f =$

$v_f^2 = (-15\ m/s)^2 + 2(-9.8\ m/s^2)(-50\ m)$
$v_f^2 = 1205$
$v_f = -34.7\ m/s$

   b. How long does it take for the stone to reach the ground?

$v_f = -34.7\ m/s$
$v_i = -15\ m/s$
$a = -9.8\ m/s^2$
$t =$

$v_f = v_i + at$
$-34.7\ m/s = -15\ m/s + (-9.8\ m/s^2)t$
$t = 2\ s$

8. A balloon is rising at 29.4 m/s and a stone falls from it. If the stone takes 20.0 s to reach the ground, how high is the balloon when the stone is dropped?

$v_i = 29.4\ m/s$
$a = -9.8\ m/s^2$
$t = 20\ s$

$d = v_i t + \frac{1}{2}at^2$
$d = (29.4\ m/s)(20\ s) + \frac{1}{2}(-9.8\ m/s^2)(20\ s)^2$
$d = -1372\ m$

9. A pebble is dropped down a well and hits the water 1.5 seconds later.

   a. Determine how fast the pebble was moving when it hit the water.

$v_i = 0\ m/s$
$v_f = ?$
$a = -9.8\ m/s^2$
$t = 1.5\ s$

$v_f = v_i + at$
$v_f = 0\ m/s + (-9.8\ m/s^2)(1.5\ s)$
$v_f = -14.7\ m/s$

   b. Determine how far the pebble fell.

$d = v_i t + \frac{1}{2}at^2$
$d = 0\ m/s(1.5\ s) + \frac{1}{2}(-9.8\ m/s^2)(1.5)^2$ $d = -11.025\ m$

10. Now a pebble is thrown downward with a speed of 5 m/s from the top of a building. It takes the pebble 3 seconds to hit the ground.

   c. How tall is the building?

$v_i = -5\ m/s$
v_f
$a = -9.8\ m/s^2$
d
$t = 3\ s$

$d = v_i t + \frac{1}{2}at^2$
$d = (-5\ m/s)(3\ s) + \frac{1}{2}(-9.8\ m/s^2)(3\ s)^2$
$d = -59.1\ m$

   d. How fast was the pebble moving when it hit the ground?

$v_f = v_i + at$
$v_f = -5\ m/s + (-9.8\ m/s^2)(3\ s)$
$v_f = -34.4\ m/s$

11. An automobile with an initial speed of 4.3 m/s accelerates uniformly at a rate of 3 m/s^2.

e. Find the final speed of the car after 5 seconds.

$v_i = 4.3 m/s$ $t = 5s$ $v_f = v_i + at$

$v_f = ?$

$a = 3 m/s^2$ $v_f = 4.3 m/s + (3 m/s^2)(5s)$

$v_f = 19.3 m/s$

f. What is the displacement of the car over the course of the first 5 seconds?

$v_i = 4.3 m/s$ $d = v_i t + 1/2 a t^2$

$a = 3 m/s^2$ $d = 4.3 m/s (5s) + 1/2 (3 m/s^2)(5s)^2$

$t = 5s$ $d = 59m$

g. How about the second five seconds (seconds 5-10)?

$v_i = 19.3 m/s$ $d = v_i t + 1/2 a t^2$

$a = 3 m/s^2$ $d = 19.3 m/s (5) + 1/2 (3 m/s^2)(5s)^2$

$t = 5s$ $d = 134$

h. Why are these numbers the same or different?

different → they have a different v_i

12. A penny is dropped from the roof of Fremd High School. The building is approximately 45 ft tall. (Remember 1 foot = 0.3048 meters) $d = (45ft)(.3048 m/ft) = 13.716m$

i. How long does it take to read the ground?

$d = v_i t + 1/2 a t^2$

$-13.716m = 1/2 (-9.8 m/s^2) t^2$ $t = 1.67s$

j. How fast is it moving when it hits the ground?

$v_f = v_i + at$ $v_f = 0 m/s + (-9.8 m/s^2)(1.67s)$ $v_f = -16.396 m/s$

13. A ball is thrown vertically upward.

a. What happens to the ball's velocity while the ball is in the air?

slows down

b. What is its velocity when it reaches maximum altitude?

0 m/s

c. What is its acceleration when it reaches maximum altitude?

$-9.8 m/s^2$

d. Does the acceleration increase, decrease or remain constant?

remain constant

14. A juggler throws a bowling pin in the air with an initial velocity v_i. Another juggler drops a pin at the same instant. Compare their accelerations while they are in the air.

same acceleration $-9.8 m/s^2$

15. A worker drops a wrench from the top of a tower 80.0 m tall. What is the velocity when the wrench strikes the ground?

$v_i = 0 m/s$ $v_f^2 = v_i^2 + 2ad$

$v_f =$ $v_f^2 = 2(-9.8 m/s^2)(80m)$

$a = -9.8 m/s$ $v_f = 39.59 m/s$

$d = -80m$

16. A falcon dives at a pigeon. The falcon starts downward from rest with free-fall acceleration. If the pigeon is 76.0 m below the initial position of the falcon, how long does the falcon take to reach the pigeon? Assume the pigeon stays at rest.

$v_i = 0\ m/s$
$a = -9.8\ m/s$
$d = -76\ m$
$t = ?$

$d = v_i t + \frac{1}{2} a t^2$
$-76\ m = \frac{1}{2}(-9.8\ m/s^2) t^2$
$t = 3.93\ s$

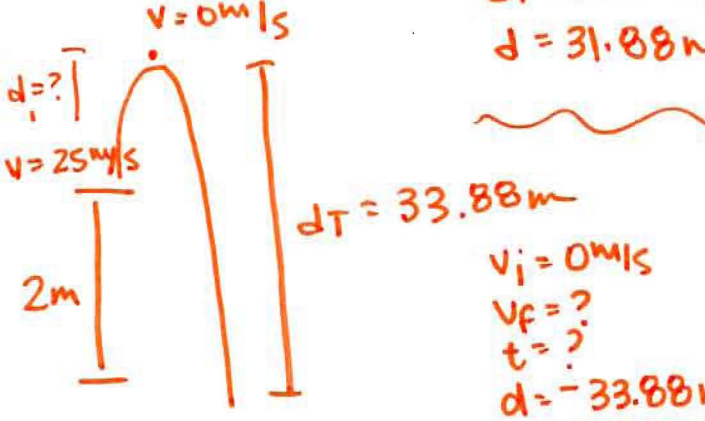
17. A ball is thrown vertically upward with a speed of 25.0 m/s from a height of 2.0 m.

a. How long does it take to reach its highest point?

$v_i = 25\ m/s$
$v_f = 0\ m/s$
$a = -9.8\ m/s^2$

$v_f = v_i + at$
$0\ m/s = 25\ m/s + (-9.8\ m/s^2) t$
$t = 2.55\ s$

b. How long does it take for the ball to hit the ground after it reaches its highest point?



$d_1 = ?$

$d_1 = v_i t + \frac{1}{2} a t^2$
$d_1 = (25\ m/s)(2.55\ s) + \frac{1}{2}(-9.8\ m/s^2)(2.55\ s)^2$
$d = 31.88\ m$

$v_i = 0\ m/s$
$v_f = ?$
$t = ?$
$d = -33.88\ m$
$a = -9.8\ m/s^2$

$d = v_i t + \frac{1}{2} a t^2$
$-33.88\ m = \frac{1}{2}(-9.8\ m/s^2) t^2$
$t = 2.629\ m$

Answers can be found online at mrsgiegler.weebly.com on the Physics 432 page. Make sure to go to the 1-D Motion unit. Email or see Mrs. Giegler with any questions.