VANCOUVER COMMUNITY COLLEGE

Motion 2:
Tougher Problems

FORMULAS

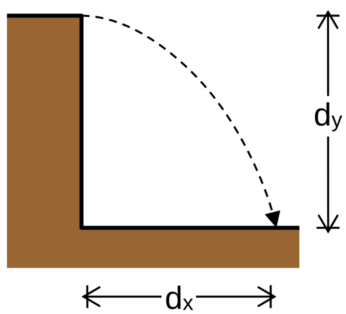
$\bar{v} = \frac{d}{t}$ $\bar{v} = \frac{v_f + v_i}{2}$ $x \text{ km/h} \times \frac{1000 \text{ m}}{3600 \text{ s}} = y \text{ m/s}$ $g = 10 \text{ m/s}^2$ (9.8 m/s^2)

Don't have distance?	$a = \frac{v_f - v_i}{t}$	$v_f = v_i + at$; when $v_i = 0$, $v_f = at$
Don't have final velocity?	$d = v_i \cdot t + ½a \cdot t^2$	when $v_i = 0$, $d = ½at^2$
Don't have time?	$v_f^2 = v_i^2 + 2a \cdot d$	when $v_i = 0$, $v_f^2 = 2ad$

COMMON PHRASES

"comes to a stop" → $v_f = 0$
"starting from rest" → $v_i = 0$
"moving at constant velocity" → $a = 0$

HORIZONTALLY-FIRED PROJECTILES



d_x = the horizontal distance the object travels
d_y = the vertical distance the object falls
v_x = velocity at which the object was fired

Then: $d_x = v_x t$ ← no acceleration!
$d_y = ½at^2 = ½(10 \text{ m/s}^2)t^2$ ← acceleration due to gravity

The time required for the object to reach the ground is the same as if it were dropped from rest. Gravity causes an increase in the vertical velocity, but it doesn't affect the horizontal velocity, which is constant. In general, an acceleration can't affect any motion perpendicular to the direction in which it acts.

EXERCISES (For this worksheet, assume g = 10 m/s². **)**

A. A ball is dropped on a distant alien planet. It attains a velocity of 28.46 m/s in 3.00 s. Determine:
   1) acceleration due to gravity
   2) the distance it fell

B. An automobile is accelerated from 75.0 km/h to 108 km/h in 8.12 s. Determine:
   1) acceleration (m/s²)
   2) distance covered (m)

C. A soccer ball finally falls off the roof of a building 135 m high. Determine:
   1) time needed to hit the ground
   2) its final speed

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D. An object is accelerated at 0.30 m/s^2 for a distance of 50 m, from an initial velocity of 0.50 m/s. Determine:

1) the velocity attained
2) the time required

E. The brakes of an automobile can decelerate it at 3.5 m/s^2. If the brakes are used to slow the car from 115 km/h to 55 km/h, determine:

1) the time required (s)
2) the distance required (m)

F. A race car driver on a straightaway increases his speed from 180 km/h to 230 km/h in exactly 8.00 seconds. During those 8 seconds, what was:

1) the car's average velocity?
2) the distance covered?

G. The speed of light is 3.00×10^8 m/s. If light travels from the moon to the earth in 1.25 seconds, how far away is the moon?

H. The speed of sound is 331.4 m/s. You get a megaphone and yell out your name at a mountain 440 m away, which disturbs a bird on the mountain and returns an echo. How long will it take:

1) until you hear your echo?
2) until you see the bird take off?

I. A person on skis has an acceleration of 1.35 m/s^2.

1) What is her speed at the end of 3.00 seconds, starting from rest?
2) What is her average speed over that time?
3) How far does she travel during the third second (i.e., between t = 2 s and t = 3 s)?

J. Ben runs the 100 m dash in 9.6 s, while Dan runs the same distance in 10 seconds flat. Both runners start in starting blocks and accelerate uniformly all the while they're running. Assuming Ben keeps going, determine:

1) Ben's acceleration
2) how many meters ahead Ben is when Dan finishes

K. While driving down a road at 50 km/h, you notice a skunk in the middle of the road 20.0 meters ahead. Your brakes can decelerate at 4.25 m/s^2.

1) Will you stop in time?
2) How long until you stop or collide with the skunk?

SOLUTIONS

A. (1) 9.49 m/s^2 (2) 42.7 m B. (1) 1.13 m/s^2 (2) 206 m C. (1) 5.20 s (2) 52.0 m/s
D. (1) 5.5 m/s (2) 17 s E. (1) 4.8 s (2) 1.1×10^2 m [112.4] F. (1) 56.9 m/s (2) 456 m
G. 3.75×10^8 m H. (1) 2.66 s (2) 1.33 s [*You were given the speed of light in the previous question, but at such a small distance, it won't affect your calculation.*]
I. (1) 4.05 m/s (2) 2.03 m/s (3) 3.38 m J. (1) 2.2 m/s^2 (2) 8.5 m
K. (1) No, because you will stop in ~23 m. (Imagine the smell…) (2) 2.1 s