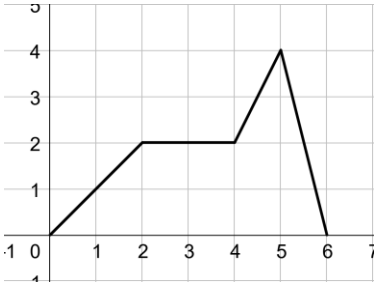
Physics Unit 1: Motion Review

Level 2: 70% on test, Level 3: 80% on test, Level 4: 80% on test and success on Projectile Motion Lab

1. Know about scientific method, units, fundamental units, unit prefixes, precision, accuracy, significant figures, vectors, scalars, projectile motion
2. Know how to find velocity from a position vs. time graph
3. Know how to find displacement and acceleration from a velocity vs. time graph
4. Convert 120 Tm to m
5. In the process of delivering milk, a milkman, walks 100 m due east from his truck. He then turns around and walks 20 m due west. What is the milkman's displacement relative to his truck (magnitude and direction)? What distance did he travel?
6. A pigeon flew 10 km across town with an average speed of 5 m/s. How long, in hours, did it take the pigeon to make this journey?

Use the graph to answer questions 7-9.



7. If this is a position vs. time graph of an object moving in a straight line. Find the velocity of the object at 4.5 s.
8. If this is a velocity vs. time graph of an object moving in a straight line. Find the displacement of the object after 4 seconds.
9. If this is a velocity vs. time graph of an object moving in a straight line. Find the acceleration of the object at 1 second.
10. A deer, starting from rest, accelerates in a straight-line path at a constant rate of 1.5 m/s^2. What will the deer's final velocity be after 3 seconds?
11. A car, starting from rest, accelerates in a straight-line path at a constant rate of 2 m/s^2. How far will the car travel in 10 seconds?
12. The minimum takeoff speed for a certain airplane is 50 m/s. What minimum acceleration is required if the plane must leave a runway of length 2000 m? Assume the plane starts from rest at one end of the runway.
13. Water drips from rest from a leaf that is 2 m above the ground. Neglecting air resistance, what is the speed of each water drop when it hits the ground?
14. Water drips from rest from a leaf that is 2 m above the ground. Neglecting air resistance, how long will it take each water drop to hit the ground?
15. What maximum height will be reached by a stone thrown straight up with an initial speed of 5 m/s?
16. A cheetah is walking at a speed of 0.5 m/s when it observes a gazelle 15 m directly ahead. If the cheetah accelerates at 3 m/s^2, how long does it take the cheetah to reach the gazelle if the gazelle doesn't move?
17. A sailboat leaves a harbor and sails 21 km in the direction 15° north of east, where the captain stops for lunch. A short time later, the boat sails 2 km in the direction 75° south of east. What is the magnitude of the resultant displacement?
18. A swimmer swims with a velocity of 15 m/s south relative to the water. The current of the water is 2 m/s relative to the shore. If the current is moving west, what is the velocity of the swimmer relative to the shore?
19. An eagle is flying due east at 5 m/s carrying a gopher in its talons. The gopher manages to break free at a height of 50 m. What is the magnitude of the gopher's velocity as it reaches the ground?

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Answers

4. $\frac{120\ Tm}{\square}\left(\frac{10^{12}\ m}{1\ Tm}\right) = \mathbf{1.2 \times 10^{14}\ m}$
5. Displacement: $100\ m - 20\ m = \mathbf{80\ m}$;
   Distance: $100\ m + 20\ m = \mathbf{120\ m}$
6. $\overline{v} = 5\frac{m}{s}, \Delta d = 10\ km$
   Convert: $\frac{10\ km}{\square}\left(\frac{10^3\ m}{1\ km}\right) = 10000\ m$
   $\overline{v} = \frac{\Delta d}{\Delta t}$
   $5\frac{m}{s} = \frac{10000\ m}{t}$
   $t = \frac{10000\ m}{5\frac{m}{s}} = \mathbf{2000\ s}$
   Convert: $\frac{2000\ s}{\square}\left(\frac{1\ h}{3600\ s}\right) = 0.56\ h$
7. Find the slope at 4.5 s.
   $v = \frac{y_2 - y_1}{x_2 - x_1} = \frac{4-2}{5-4} = \frac{2}{1} = \mathbf{2}$
8. Find the area between the graph and the *x*-axis between $t = 0$ and $t = 4$.
   $d = \left(\frac{1}{2}bh\right) + (bh)$
   $d = \left(\frac{1}{2}(2)(2)\right) + (2)(2) = \mathbf{6}$
9. Find the slope of the graph at 1 s.
   $a = \frac{y_2 - y_1}{x_2 - x_1} = \frac{2-0}{2-0} = \mathbf{1}$
10. $v_0 = 0\frac{m}{s}, a = 1.5\frac{m}{s^2}, v = ?, t = 3s$
    $a = \frac{v - v_0}{t - t_0}$
    $1.5\frac{m}{s^2} = \frac{v - 0\frac{m}{s}}{3\ s - 0\ s}$
    $\mathbf{4.5\frac{m}{s}} = v$
11. $a = 2\frac{m}{s^2}, t = 10\ s, v_0 = 0\frac{m}{s}, d = ?$
    $d = d_0 + v_0 t + \frac{1}{2}at^2$
    $d = 0\ m + \left(0\frac{m}{s}\right)(10\ s) + \frac{1}{2}\left(2\frac{m}{s^2}\right)(10\ s)^2$
    $d = \mathbf{100\ m}$
12. $v = 50\frac{m}{s}, d = 2000\ m, v_0 = 0\frac{m}{s}, a = ?$
    $v^2 = v_0^2 + 2a(d - d_0)$
    $\left(50\frac{m}{s}\right)^2 = \left(0\frac{m}{s}\right)^2 + 2a(2000\ m - 0\ m)$
    $2500\frac{m^2}{s^2} = (4000\ m)a$
    $a = \mathbf{0.625\ m/s^2}$
13. $y_0 = 2\ m, v_0 = 0\frac{m}{s}, a = -9.8\frac{m}{s^2}, v = ?$
    $v^2 = v_0^2 + 2a(y - y_0)$
    $v^2 = \left(0\frac{m}{s}\right)^2 + 2\left(-9.8\frac{m}{s^2}\right)(0\ m - 2\ m)$
    $v^2 = 39.2\frac{m^2}{s^2}$
    $v = \mathbf{6.26\frac{m}{s}}$
14. $y_0 = 2\ m, v_0 = 0\frac{m}{s}, a = -9.8\frac{m}{s^2}, t = ?$
    $y = y_0 + v_0 t + \frac{1}{2}at^2$
    $0\ m = 2\ m + \left(0\frac{m}{s}\right)t + \frac{1}{2}\left(-9.8\frac{m}{s^2}\right)t^2$
    $-2\ m = \left(-4.9\frac{m}{s^2}\right)t^2$
    $0.408\ s^2 = t^2 \rightarrow \mathbf{0.639\ s} = t$
15. $v_0 = 5\frac{m}{s}, v = 0\frac{m}{s}, a = -9.8\frac{m}{s^2}, y = ?$
    $v^2 = v_0^2 + 2a(y - y_0)$
    $\left(0\frac{m}{s}\right)^2 = \left(5\frac{m}{s}\right)^2 + 2\left(-9.8\frac{m}{s^2}\right)(y - 0\ m)$
    $-25\frac{m^2}{s^2} = \left(-19.6\frac{m}{s^2}\right)y$
    $y = \mathbf{1.28\ m}$
16. $v_0 = 0.5\frac{m}{s}, d = 15\ m, a = 3\frac{m}{s^2}, t = ?$
    $d = d_0 + v_0 t + \frac{1}{2}at^2$
    $15\ m = 0\ m + \left(0.5\frac{m}{s}\right)t + \frac{1}{2}\left(3\frac{m}{s^2}\right)t^2$
    $0 = \left(\frac{3}{2}\frac{m}{s^2}\right)t^2 + \left(0.5\frac{m}{s}\right)t - 15\ m$
    $t = \frac{-0.5 \pm \sqrt{(0.5)^2 - 4\left(\frac{3}{2}\right)(-15)}}{2\left(\frac{3}{2}\right)} = \mathbf{3\ s}, \sout{-3.33\ s}$
17.

	x	y
21 km @ 15° N of E	20.28	5.44
2 km @ 75° S of E	0.52	−1.93
	20.80	3.51

    $r = \sqrt{20.80^2 + 3.51^2} = 21.1\ km$
    $\theta = tan^{-1}\frac{3.51}{20.80} = 9.67°\ N\ of\ E$
18.

	x	y
15 m/s S	0	-15
2 m/s W	-2	0
	-2	-15

    $v_{SG} = \sqrt{(-2)^2 + (-15)^2} = 15.1\ m/s$
    $\theta = tan^{-1} - \frac{15}{-2} = 82.4°$
    $v_{SG} = \mathbf{15.1\frac{m}{s}\ at\ 82.4°\ S\ of\ W}$
19. $x: v_{0x} = 5\frac{m}{s}, y: v_{0y} = 0\frac{m}{s}, y_0 = 50\ m, a_y = -9.8\frac{m}{s^2}, y = 0\ m, v_y = ?$
    $v_y^2 = v_{0y}^2 + 2a_y(y - y_0)$
    $v_y^2 = \left(0\frac{m}{s}\right)^2 + 2\left(-9.8\frac{m}{s^2}\right)(0\ m - 50\ m)$
    $v_y^2 = 980\frac{m}{s}$
    $v_y = 31.30\frac{m}{s}$
    combine: $v = \sqrt{v_x^2 + v_y^2}$
    $v = \sqrt{\left(5\frac{m}{s}\right)^2 + \left(31.30\frac{m}{s}\right)^2} = \mathbf{31.7\ m/s}$