1. d  We want the slope of the position vs. time graph at t = 1. From t = 0 to t = 4, the position decreases from 30m to -30m. So, the slope is \((30m – 30m)/(4-0)s = -15 m/s\).

2. a  The average velocity over a time interval is \(\Delta x/\Delta t\). So, for the interval t = 5 to t = 12 s we have \((-20m - -30m)/(12-5)s = 10m/7s = 1.43.m/s\)

3. a  For the interval from t = 4 to t = 10 s, the displacement is from negative x to positive x, so it’s moving in the positive direction, and the average velocity is to the right.

4. c  The taxi is stopped when its velocity is zero. This corresponds to areas on the position vs. time graph that have a slope of zero. This occurs from t = 4 to t = 6, and t = 10 to t = 11.

5. f  

1. Find the x and y components of the second displacement.
2. Add the x and y components of both displacements.
3. Use \(\theta = \tan^{-1}(\text{Opposite} / \text{Adjacent})\) to find the angle.

\[
\begin{align*}
\text{Ax} &= 0, \text{Ay} = 3. \\
\text{Bx} &= 7\cos(30) = 6.06, \text{By} = 7\sin(30) = 3.50. \\
\text{Cx} &= 0 + 6.06, \text{Cy} = 3 + 3.50 = 6.50. \\
|\text{C}| &= \sqrt{6.06^2 + 6.5^2} = 8.86 \text{ mi}. \\
\text{So } \theta &= \tan^{-1}(6.5/6.6) = 47 \text{ deg N of W}. \\
\end{align*}
\]

6. b  The graph is a velocity vs. time graph, and the velocity decreases as time increases. Therefore the car is slowing down.

7. a  The velocity is always positive in the graph, which we usually define to mean that it is moving to the right.

8. a  The acceleration is the slope of a velocity vs. time graph. The slope of the graph starts out mostly flat and becomes steeper, showing that the magnitude of the acceleration is increasing.

9. e  The burgler gets ahead by 1.5m/s * 30 s = 45 m. The policeman is going at 2.0 m/s, so he closes the gap with a relative speed of 2.0-1.5 = 0.5 m/s. So the he catches up in 45m/0.5m/s = 90 sec. In that time both are 180 m from the house.

10. c  Gravity will cause the skier to accelerate downwards (the positive direction), so her velocity will increase and the slope of the graph must be positive. Since she flew off the cliff going horizontally, her initial vertical velocity is 0.

11. d  Gravity only accelerates in the vertical dimension, so her horizontal velocity is constant.
12. e The airtime of a projectile is determined by the height it reaches. The steeper the angle, the greater the initial vertical velocity will be, so the projectile will reach a higher height and stay in the air longer.

13. b Putting on the brakes will slow the car down. A car will slow down if the acceleration vector points in the opposite direction as its velocity vector. Since the car is going north, the acceleration must point south.

14. c The man’s initial velocity is 0 m/s, the acceleration of gravity is 9.8 m/s², and the height he falls is 3 m. We want to solve for time. The only kinematic equation that has all of those quantities is \( \Delta x = \frac{1}{2}at^2 + v_0t \). Solving for \( t \) gets us \( t = 0.78 \) s.

15. d The car is slowing down for 100 m at an acceleration of 0.25 m/s² with an initial speed of 8 m/s. If the initial direction of travel is the positive direction, then the acceleration vector will be negative. The equation \( v_f^2 = v_i^2 + 2a\Delta x \) is the easiest one to solve for final velocity. Plugging it in and solving (and taking the positive square root), the answer is 3.74 m/s.

16. Now we want to solve for time. Now that the final velocity is known, the equation \( v = v_0 + at \) is easiest. Solving for \( t \), you get \( t = 17.03 \) s.

17. e If he’s in the air for 3 seconds, he’s going up 1.5 seconds and falling for 1.5 seconds. How far would he fall in 1.5 seconds? \[ \Delta y = v_it + \frac{1}{2}at^2 \] So, take \( y = 0 \) and \( v_i = 0 \) at the top. Falling, \( \Delta y = 0 + -\frac{1}{2}(9.8 \text{ m/s}^2)(1.5\text{s})^2 = - 11.0 \text{ m} \), which is about 33 feet! No human can jump 33 ft, so the claim is impossible.

18. a There is no acceleration in the horizontal dimension, so the horizontal velocity remains constant.

19. b The acceleration of a projectile is a constant 9.8 m/s² down, even if its velocity is 0, like it is as the top of its trajectory.

20. d The velocity addition equation in this case would be \( v_{bs} = v_{bw} + v_{ws} \). The vector diagram turns out to be a right triangle, so you can just use the Pythagorean theorem to solve for the length of the hypotenuse, which comes out to be 8.06 km/h.

\[ \theta \]

21. a The angle east of north is pictured in the diagram above. The opposite (4 km/h) side and the adjacent (7 km/h) are known, so using \( \tan^{-1}(4/7) \) gives us the angle of 29.7°.
22. f The total air time for the jumper is twice the time it takes to get to the maximum height, were the velocity is zero in the y-dimension. The initial velocity in the y-dimension is 12sin(20⁰) and the acceleration of gravity is -9.8 m/s². Using \( v_f = v_i + at \) and solving for \( t \) we get 0.4189 s. So, the total air time is twice that, or 0.838 s.

23. a She is speeding up, so her acceleration is in the same direction velocity (up).

24. e. There is no acceleration in the horizontal direction, so the lemming’s velocity in the horizontal direction is a constant 3 m/s. If the lemming lands 8 m away, we can just use \( \Delta x = vt \) to solve for time of 2.67 s to hit the tree. Since the lemming started horizontally, its initial vertical velocity was 0. The acceleration of gravity is 9.8 m/s², taking down to be positive. Plugging those numbers into the \( \Delta y = v_i t + \frac{1}{2}at^2 \), you can then solve for \( \Delta y \), which is 34.8 m.

25. Both had the same starting and ending points, so the displacement was the same, and so is the average velocity.

26. In trips, speed means (total distance along a path) / time, so you went the farthest, so your average speed was greatest.