## Answer Key to Kinematics Practice Items

**1. C**

**2. C**
The concepts for solving this problem are encapsulated in the kinematics formula:

$$v = v_0 + at$$

What this tells you is how the velocity changes over time due to a constant acceleration. In this case, you know that at maximum height, the velocity will be zero, and you know that the acceleration is **g** (-10 m/s$^2$), the acceleration due to gravity.

**3. B**
This is the only true statement. Speed, being the magnitude of the velocity vector, can only be positive. What you might imagine to be negative speed is only travelling with positive speed in the opposite direction.

**4. B**
The motion in this problem should be divided into two portions. In the first ten seconds, the automobile travels with acceleration of zero. The next ten seconds, the automobile travels accelerating uniformly between two velocities which you are given. Because you know the initial and final velocities for each section of the motion are given, the problem can be solved by finding the average velocity for each segment, which is the simple arithmetic mean of initial and final velocities, and multiplying by each respective time duration for each segment. This simple process is represented in the formula:

$$x - x_0 = \tfrac{1}{2}(v + v_0)t$$

**5. D**
You don't know here that the dragster is accelerating uniformly. It might have reached 120 m/s at 12 seconds or at 20 seconds. There is no way to tell from the given information.

**6. C**
At ten seconds the velocity has increased from the initial 0 cm/s to 1 cm/s. The average acceleration is given by the formula:

$$\bar{a} = \frac{v_f - v_i}{\Delta t}$$

All this formula says is that the average acceleration equals the change in velocity per change in time. Convert centimeters to meters and you have your answer.

**7. A**
Notice in this problem you are not given the time duration. The formula to use here is probably the most difficult to remember of the four kinematics equations for constant acceleration:

$$v^2 = v_0^{\,2} + 2a(x - x_0)$$

**8. C**
A tangent line at the peak of the curve is horizontal. At that point the displament is not changing in time. The object is at rest. The downward sloping section which follows represents negative velocity as the particle heads back to point zero.

**9. C**
Use the kinematics formula that tells you that a velocity changes as the simple product of a constant rate of change and time:

$$v = v_0 + at$$

In free fall the acceleration is **g** ( or -10 m/s$^2$). Don't just "plug numbers into the formula"! An amount of change equals a rate of change times the duration. That is just common sense!

**10. B**
If you remember your calculus, the problem will be self-evident. If not, think about the shaded area as a rectangle a certain velocity high and time wide. Multiplying length by width (seconds time meters per second) gives a distance.

11. A
The formula to use here is

$$x - x_0 = \tfrac{1}{2}(v + v_0)t$$

We were given a distance, and an ititial and final velocity (which in conditions of uniform acceleration means that you also know average velocity). If you know average velocity and distance travelled, you also know duration. Don't just take my word for it. Think about it. (Also, there is another trick here, knowing that because 9 X 10$^3$ is so much smaller than 6 X 10$^6$, you can just ignore it in summing them and call their sum 6 X 10$^6$.)

**12. C**

This is a complicated looking problem which in is actually pretty easy. The authors of the multiple choice physics questions tend to be fond of making the simple look difficult, so don't let complicated expressions scare you. Here, you are given the velocity as a function of time. Simply plug in the time values to get the velocity at one second and four seconds respectively. Then find the average rate of change of velocity (average acceleration).

$$\bar{a} = \frac{v_f - v_i}{\Delta t}$$

**13. B**

The question gives the angle of trajectory and with the initial speed have enough to resolve the velocity into horizontal and vertical components. With the acceleration due to gravity, one can then compute the time to reach the peak, which is the key to these problems.

**14. D**

All of the statements are true.