Answer to Essential Question 2.3: Some examples of constant velocity (or at least almost-constant velocity) motion include (among many others):

- A car traveling at constant speed without changing direction.
- A hockey puck sliding across ice.
- A space probe that is drifting through interstellar space.

2-4 Constant-Velocity Motion

Let's summarize what we know about constant-velocity motion. We will also explore a special case of constant-velocity motion - that of an object at rest.

EXPLORATION 2.4 – Positive, negative, and zero velocities

Three cars are on a straight road. A blue car is traveling west at a constant speed of 20 m/s; a green car remains at rest as its driver waits for a chance to turn; and a red car has a constant velocity of 10 m/s east. At the time $t = 0$, the blue and green cars are side-by-side at a position 20 m east of the red car. Take east to be positive.

Step 1 – ***Picture the scene: sketch a diagram showing this situation.*** In addition to showing the initial position of the cars, the sketch at the middle left of Figure 2.13 shows the origin and positive direction. The origin was chosen to be the initial position of the red car.

Step 2 - ***Sketch a set of motion diagrams for this situation***. The motion diagrams are shown at the top of Figure 2.13, from the perspective of someone in a stationary helicopter looking down on the road from above. Because the blue car's speed is twice as large as the red car's speed, successive images of the blue car are twice as far apart as those of the red car. The cars' positions are shown at 1-second intervals for four seconds.

Step 3 - ***Write an equation of motion (an equation giving position as a function of time) for each car.*** Writing equations of motion means substituting appropriate values for the initial position $\vec{x}_i$ and the constant velocity $\vec{v}$ into Equation 2.5, $\vec{x} = \vec{x}_i + \vec{v}\,t$. The equations are shown above the graphs in Figure 2.13, using the values from Table 2.1.

	Blue car	**Green car**	**Red car**
Initial position, $\vec{x}_i$	+20 m	+20 m	0
Velocity, $\vec{v}$	-20 m/s	0	+10 m/s

Table 2.1: Organizing the data for the three cars.

Step 4 - ***For each car sketch a graph of its position as a function of time and its velocity as a function of time for 4.0 seconds.*** The graphs are shown at the bottom of Figure 2.13. Note that the position-versus-time graph for the green car, which is at rest, is a horizontal line because the car maintains a constant position. An object at rest is a special case of constant-velocity motion: the velocity is both constant and equal to zero.

Key ideas: The at-rest situation is a special case of constant-velocity motion. In addition, all we have learned about constant-velocity motion applies whether the constant velocity is positive, negative, or zero. This includes the fact that an object's displacement is given by $\vec{x} = \vec{x}_i + \vec{v}\,t$; the displacement is the area under the velocity-versus-time graph; and the velocity is the slope of the position-versus-time graph. **Related End-of-Chapter Exercise: 43**

(a) Description of the motion in words: Three cars are on a straight road. A blue car has a constant velocity of 20 m/s west; a green car remains at rest; and a red car has a constant velocity of 10 m/s east. At $t = 0$ the blue and green cars are side-by-side, 20 m east of the red car.

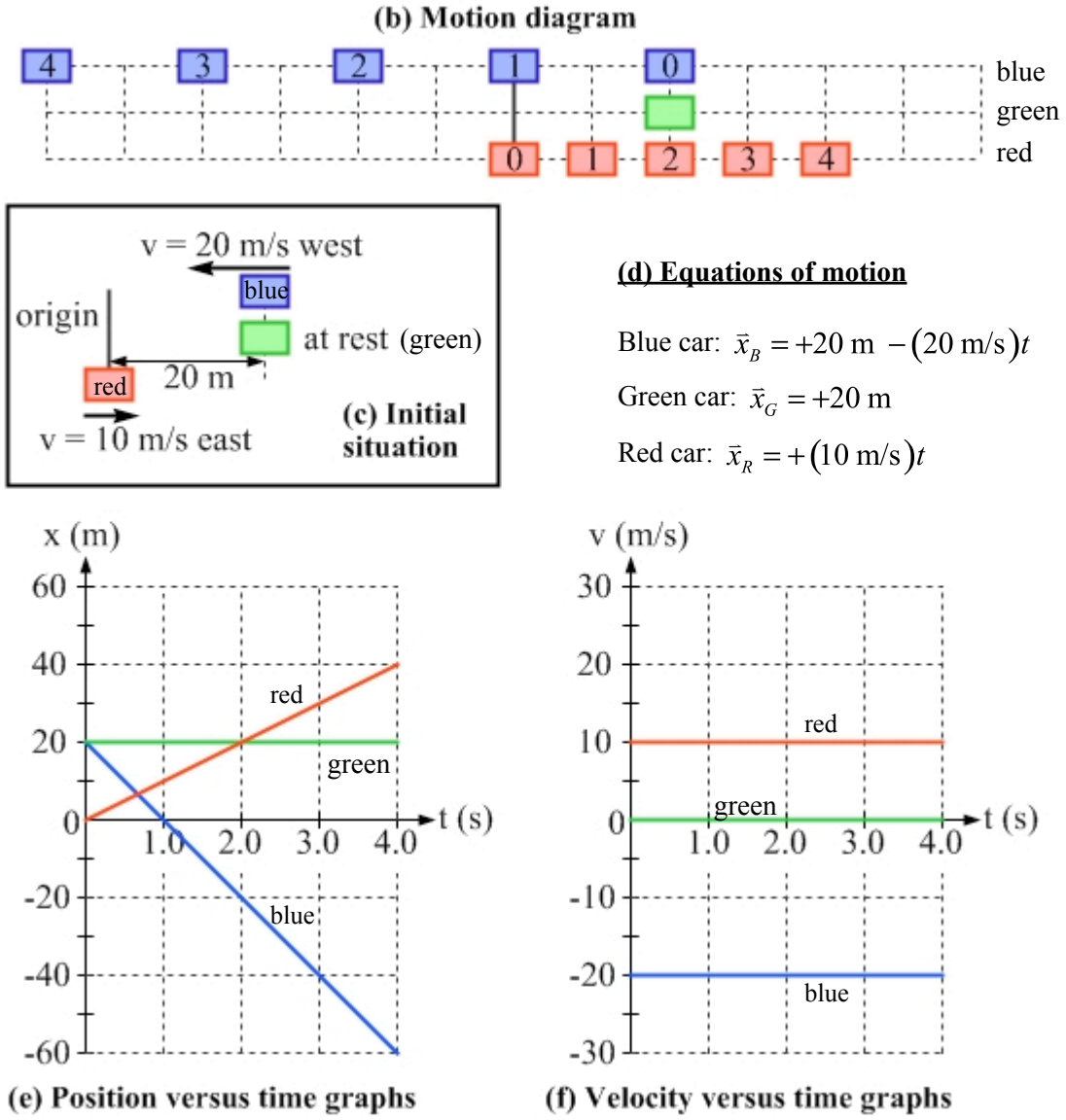

Figure 2.13: Multiple representations of the constant-velocity motions of three cars. These include (a) a description of the motion in words; (b) a motion diagram; (c) a diagram of the initial situation, at $t = 0$ (this is shown in a box); (d) equations of motion for each car; (e) graphs of the position of each car as a function of time; and (f) graphs of the velocity of each car as a function of time. Each representation gives us a different perspective on the motion.

Essential Question 2.4: Consider the graph of position-versus-time that is part of Figure 2.13. What is the significance of the points where the different lines cross? *(The answer is at the top of the next page.)*