I. Divya is walking along a straight path in the positive direction, moving at 0.8 m/s. At a clock reading of 0 s, she passes the visitor’s center. Scott is 150 m further along the path, heading back toward the visitor center. He is jogging at 1.4 m/s.

a) Draw a picture with a coordinate system for the situation described.

b) Write an equation \( x(t) \) for each person which describes his/her position as a function of time.

c) When and where will they meet? Explain how you determined your answer.
II. Characterizing aspects of motion:

A. On its website, Porsche characterizes a particular model by “21 mph per second“.
   
i) Use everyday language to explain what the number 21 tells about the Porsche. Be as specific as you can. In particular, discuss the meaning of the word “per” in this situation. What would be different about the car if the number was 20 instead of 21?

   ii) Make a sketch that explains your answer to part i).

B. When the acceleration of an object changes abruptly it can be uncomfortable to humans and results in jerkiness (think about turbulence on an airplane or a particularly jerky roller coaster ride)

Below are some descriptions of the most abrupt motion changes that occur for several roller coasters.

   i) Invent a jerkiness index that will characterize the roller coasters and allow customers to pick and choose which coasters they prefer to ride. Remember, the bigger the index, the jerkier the ride.

<table>
<thead>
<tr>
<th>Roller Coaster name</th>
<th>Change in motion</th>
<th>Jerkiness Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>INSTANT DEATH</td>
<td>from +0 m/s² to -10 m/s² in 0.36 seconds.</td>
<td></td>
</tr>
<tr>
<td>YOUR NITEMARE</td>
<td>from +9 m/s² to -10 m/s² in 0.75 seconds.</td>
<td></td>
</tr>
<tr>
<td>BALLISTIC</td>
<td>from +1 m/s² to +12 m/s² in 0.32 seconds.</td>
<td></td>
</tr>
<tr>
<td>JAGGED LIGHTNING</td>
<td>from +4 m/s² to -4 m/s² in 0.25 seconds.</td>
<td></td>
</tr>
</tbody>
</table>

   ii) What does the numeric value of the jerkiness index tell you about each roller coaster?
3. A ball rolls with a constant speed towards a wall, bounces and returns at the same constant speed to its starting point. Which of the following could represent the pair of graphs for \( x(t) \) and \( v(t) \) of the ball? Assume the collision with the wall is instantaneous.

<table>
<thead>
<tr>
<th>( x(t) )</th>
<th>( v(t) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) 2</td>
<td>1</td>
</tr>
<tr>
<td>b) 1</td>
<td>4</td>
</tr>
<tr>
<td>c) 1</td>
<td>3</td>
</tr>
<tr>
<td>d) 2</td>
<td>3</td>
</tr>
<tr>
<td>e) 4</td>
<td>1</td>
</tr>
</tbody>
</table>

4. A particle initially traveling at 30 m/s slows to a stop in 2.0 s at a constant acceleration. How far does the particle travel?

a) 17 m  
b) 30 m  
c) 45 m  
d) 80 m  
e) 38 m

5. The motion diagram below describes a motion. Which of the following could NOT be true about this motion?

a) A ball rolls to the right and slows down.  
b) A cart experiences a net force that points to the left.  
c) A skater is moving to the left and speeding up.  
d) A bicyclist is moving to the right and speeding up.  
e) This object accelerates to the left.
6. The graph shows a position vs time graph for an object. During what time interval(s) is the object slowing down?
   a) During \( t=0 \) to \( t=12 \text{s} \).
   b) During \( t=12 \text{s} \) to \( t=20 \text{s} \).
   c) During \( t=20 \text{s} \) to \( t=28 \text{s} \).
   d) During \( t=28 \text{s} \) to \( t=40 \text{s} \).
   e) Both a) and d) are correct.

7. A 20 kg bike moves with a velocity that is described by

   \[ \mathbf{v}(t) = (2\mathbf{i} + 0.8t^2\mathbf{j}) \frac{m}{s} \]

   where \( \mathbf{j} \) is to the north and \( \mathbf{i} \) is to the east. The net force acting on the bike at the time \( t=5 \text{s} \) is
   a) 20 N to the north
   b) 440 N to the northeast
   c) 200 N to the northeast
   d) 80 N to the north
   e) 160 N to the north

8. A traffic light weighs 80 Newtons and is suspended by two cables as shown. Is the tension in cable A
   a) greater than 40 N?
   b) less than 40 N?
   c) equal to 40 N?
   d) equal and opposite to the tension in cable B?
   e) not able to say because there is not enough information.