4 Study Guide

In your textbook, read about addition of vectors using components. The diagram shows the displacement of a hiker. The data table shows the magnitudes of the vertical and horizontal components of each displacement.

Table 1

<table>
<thead>
<tr>
<th>Component</th>
<th>Magnitude (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A_x</td>
<td>1.4</td>
</tr>
<tr>
<td>A_y</td>
<td>3.8</td>
</tr>
<tr>
<td>B_x</td>
<td>4.0</td>
</tr>
<tr>
<td>B_y</td>
<td>6.9</td>
</tr>
<tr>
<td>C_x</td>
<td>1.5</td>
</tr>
<tr>
<td>C_y</td>
<td>1.3</td>
</tr>
</tbody>
</table>

Circle the letter of the choice that is the best response.

11. What is the value of \( R_x \), which represents the sum of the horizontal components of the displacements?
   a. \( R_x = 1.4 \text{ km} + 4.0 \text{ km} + 1.5 \text{ km} = 6.9 \text{ km} \)
   b. \( R_x = (-1.4 \text{ km}) + (-4.0 \text{ km}) + (-1.5 \text{ km}) = -6.9 \text{ km} \)
   c. \( R_x = (-1.4 \text{ km}) + 4.0 \text{ km} + 1.5 \text{ km} = 4.1 \text{ km} \)
   d. \( R_x = 1.4 \text{ km} + (-4.0 \text{ km}) + (-1.5 \text{ km}) = -4.1 \text{ km} \)

12. What is the value of \( R_y \), which represents the sum of the vertical components of the displacements?
   a. \( R_y = 3.8 \text{ km} + 6.9 \text{ km} + 1.3 \text{ km} = 12.0 \text{ km} \)
   b. \( R_y = (-3.8 \text{ km}) + (-6.9 \text{ km}) + (-1.3 \text{ km}) = -12.0 \text{ km} \)
   c. \( R_y = (-3.8 \text{ km}) + 6.9 \text{ km} + (-1.3 \text{ km}) = 1.8 \text{ km} \)
   d. \( R_y = 3.8 \text{ km} + (-6.9 \text{ km}) + (-1.3 \text{ km}) = -4.4 \text{ km} \)

13. What is the magnitude of the resultant \( R \)?
   a. \( R < 0 \text{ km} \)
   b. \( R = 0 \text{ km} \)
   c. \( R > 0 \text{ km} \)

14. What is the magnitude and direction of the displacement vector \( Y \) that will return the hiker to the starting point?
   a. \( Y = 0 \text{ km} \)
   b. \( Y = R \)
   c. \( Y = -R \)
   d. \( Y = -2R \)

A Mathematical Model of Motion

Vocabulary Review

Write the term that correctly completes each statement. Use each term once.

- acceleration due to gravity
- instantaneous velocity
- position-time graph
- slope
- constant acceleration
- uniform motion
- rise
- velocity-time graph
- run

1. \( \text{position-time graph} \)  A graph that shows how position depends on time is \( a(n) \) _____.

2. \( \text{rise} \)  The vertical separation of any two points on a curve is the _____.

3. \( \text{instantaneous velocity} \)  On a position-time graph, the slope of a tangent to the curve at a specific time is the _____.

4. \( \text{uniform motion} \)  In _____ equal displacements occur during successive equal time intervals.

5. \( \text{constant velocity} \)  An object that has the same average velocity for all time intervals is moving at _____.

6. \( \text{acceleration due to gravity} \)  The constant acceleration that acts on falling bodies is the _____.

7. \( \text{slope} \)  The ratio of the rise to run is the _____ of a curve.

8. \( \text{velocity-time graph} \)  A graph that shows how velocity depends on time is \( a(n) \) _____.

9. \( \text{constant acceleration} \)  Motion that can be described by a constant slope on a velocity-time graph is _____.

10. \( \text{run} \)  The horizontal separation of any two points on a curve is the _____.

11. \( \text{instantaneous acceleration} \)  On a velocity-time graph, the slope of a tangent to the curve at a specific time is the _____.
Section 5.1: Graphing Motion in One Dimension

In your textbook, read about position-time graphs.
Answer the following questions, using complete sentences.

1. How are the position and time of a moving object related on a position-time graph?
   Each position on the graph is associated with a particular time.

2. If you decide that the duration of an instant on a position-time graph is a finite period of time, where is the object during that period?
   The object is in the position indicated on the graph.

3. What does your conclusion in problem 2 indicate about the motion of the object during that period?
   The object is at rest.

4. If the object is moving, what can you conclude about the duration of an instant?
   An instant is not a finite period of time.

5. What is the duration of an instant?
   An instant lasts 0 s.

In your textbook, read about using graphs to determine position and time.
The position-time graph below shows the position of a teacher at various times as she walks across the front of the room.
The position 0.0 m represents the left side of the room and movement to the right is positive.
Circle the letter of the choice that best completes each statement.

6. Each position on the graph is associated with a particular time.
   a. 1.0–2.0 s  b. 6.0–7.0 s  c. 10.0–12.0 s  d. 7.0–12.0 s

7. The object is in the position indicated on the graph.
   a. –3.0 m  b. 0.0 m  c. +1.0 m  d. +3.0 m

8. The object is at rest.
   a. –1.0 m/s  b. +1.0 m/s  c. +2.0 m/s  d. +3.0 m/s

9. The object is standing still during the time interval.
   a. 1.0–2.0 s  b. 6.0–7.0 s  c. 10.0–12.0 s  d. 12.0–15.0 s

10. The object is not at rest during the time interval.
    a. +1.0 m/s  b. +0.5 m/s  c. 0.0 m/s  d. –0.5 m/s

11. The object is moving during the time interval.
    a. –2.0 m/s  b. 0.0 m/s  c. +0.067 m/s  d. +0.75 m/s

Sketch a motion diagram for each time interval, using the teacher's position-time graph on page 26.

Time Interval

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6. The teacher was walking to the right during the time interval ______
   a. 1.0–2.0 s  b. 6.0–7.0 s  c. 10.0–12.0 s  d. 7.0–12.0 s

7. The teacher's displacement for the time interval 0.0–3.0 s is ______
   a. –3.0 m  b. 0.0 m  c. +1.0 m  d. +3.0 m

8. The teacher's average velocity for the time interval 1.0–3.0 s is ______
   a. –1.0 m/s  b. +1.0 m/s  c. +2.0 m/s  d. +3.0 m/s

9. The teacher is standing still during the time interval ______
   a. 1.0–2.0 s  b. 6.0–7.0 s  c. 10.0–12.0 s  d. 12.0–15.0 s

10. The teacher's average velocity for the time interval 0.0–15.0 s is ______
    a. –2.0 m/s  b. 0.0 m/s  c. +0.067 m/s  d. +0.75 m/s

Sketch a motion diagram for each time interval, using the teacher's position-time graph on page 26.

Motion Diagram

12. 0.0–5.0 s

13. 5.0–7.0 s

14. 7.0–15.0 s

In your textbook, read about using graphs to determine position and time.
Refer to the equation $d = d_0 + vt$. For each of the statements below, write true or rewrite the italicized part to make the statement true.

15. Four ______ The equation contains three quantities.

16. This equation ______ The equation cannot be used if the velocity is changing.

17. ______ The quantity $d_0$ represents the position at any time.

18. ______ The quantity in the equation that represents the slope of a position-time graph for this motion is $v$.

19. ______ The displacement of the object is $vt$. 
### Section 5.2: Graphing Velocity in One Dimension

In your textbook, read about velocity-time graphs and displacement. Refer to the velocity-time graph of a jogger to complete the two tables.

#### Table 1

<table>
<thead>
<tr>
<th>Segment</th>
<th>$v$ (km/min)</th>
<th>$\Delta t$ (min)</th>
<th>$\Delta d$ (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.25</td>
<td>10.0</td>
<td>2.5</td>
</tr>
<tr>
<td>B</td>
<td>0.0</td>
<td>7.5</td>
<td>0.0</td>
</tr>
<tr>
<td>C</td>
<td>0.40</td>
<td>13.0</td>
<td>5.2</td>
</tr>
</tbody>
</table>

#### Table 2

<table>
<thead>
<tr>
<th>$\Delta t$ (min)</th>
<th>Distance Ran (km)</th>
<th>Displacement (km)</th>
<th>Average Velocity (km/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0–30.0</td>
<td>7.7</td>
<td>7.7</td>
<td>0.26</td>
</tr>
</tbody>
</table>

### Section 5.3: Acceleration

In your textbook, read about equations of motion for uniform acceleration. Complete each table with the values of the variables and initial conditions. Write a question mark for the unknown variable. If a variable or an initial condition is not needed to answer the problem, write an X. Then write the equation that you would use to solve the problem. It is not necessary to calculate the answer.

1. A car accelerates from 10 m/s to 15 m/s in 3.0 s. How far does the car travel in this time?

   - **Table 1**
     - **Variables**: $t$, $d$, $v$, $a$, $d_0$, $v_0$
     - **Initial Conditions**: 3.0 s, ?, 15 m/s, X, 0 m, 10 m/s
     - **Equation**: $d = d_0 + \frac{1}{2}(v_0 + v)t$

2. A racing car accelerates at 4.5 m/s² from rest. What is the car's velocity after it has traveled 35.0 m?

   - **Table 2**
     - **Variables**: $t$, $d$, $v$, $a$, $d_0$, $v_0$
     - **Initial Conditions**: X, 35.0 m, ?, 4.5 m/s², 0 m, 0 m/s
     - **Equation**: $v^2 = v_0^2 + 2a(d - d_0)$

3. A car initially traveling at 15 m/s accelerates at a constant 4.5 m/s² through a distance of 45 m. How long does it take the car to cover this distance?

   - **Table 3**
     - **Variables**: $t$, $d$, $v$, $a$, $d_0$, $v_0$
     - **Initial Conditions**: ?, 45 m, X, 4.5 m/s², 0 m, 15 m/s
     - **Equation**: $d = d_0 + v_0t + \frac{1}{2}at^2$

4. A ball rolls past a mark on an incline at 0.40 m/s. If the ball has a constant acceleration of 0.20 m/s², what is its velocity 3.0 s after it passes the mark?

   - **Table 4**
     - **Variables**: $t$, $d$, $v$, $a$, $d_0$, $v_0$
     - **Initial Conditions**: 3.0 s, X, ?, 0.20 m/s², X, 0.40 m/s
     - **Equation**: $v = v_0 + at$
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Section 5.4: Free-Fall

In your textbook, read about free-fall. Refer to the diagram on the right showing the positions of a ball that was thrown upward at time t₀. Complete the tables by indicating if the direction of the velocity and the direction of the acceleration at each time is + or −, or if the value of the velocity or acceleration equals 0.

1. Downward direction is positive.
   - Rank the magnitudes of the velocities v₀, v₁, v₂, v₃, and v₄, in decreasing order. v₀, v₂, v₃, v₁, and v₄

2. Upward direction is positive.
   - Rank the magnitudes of the velocities v₀, v₁, v₂, v₃, and v₄, in decreasing order. v₀, v₂, v₃, v₁, and v₄

Refer to the velocity-time graph of the vertical velocity of a ball from the time it is thrown upward from the top of a building until it reaches the ground. Answer the following questions.

3. Use a red pencil to shade the area under the curve that represents the total upward displacement of the ball.
4. Use a blue pencil to shade the area under the curve that represents the total downward displacement of the ball.

Refer to the diagram on the right showing the positions of a ball that was thrown upward at time t₀. Calculate the red and blue areas. Subtract the value of the red area from the value of the blue area.

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Forces

Vocabulary Review

Write the term that correctly completes each statement. Use each term once.

1. mechanical resonance
   - In ____, the amplitude of motion is increased by the repeated application of a force when the time between applications is equal to the period of oscillation.
2. net force
   - The vector sum of two or more forces acting on an object is the ____. The net force on an object in ____ is zero.
3. equilibrium
   - The net force on an object in ____ is zero.
4. Newton's second law
   - The acceleration of a body is directly proportional to the net force on it and inversely proportional to its mass; this is a statement of ____.
5. apparent weight
   - The force exerted by a scale on an object is the ____. A force that acts on an object by touching it is a(n) ____.
6. contact force
   - A force exerted by a scale on an object is the ____. The force that acts on an object by touching it is a(n) ____.
7. Newton's third law
   - The two forces in an interactive pair act on different objects and are equal in magnitude and opposite in direction; this is a statement of ____.
8. environment
   - The world outside a system is the ____. An attractive force that exists between all objects is the ____.
9. force of gravity
   - An object that is at rest will remain at rest or an object that is moving will continue to move in a straight line with constant speed, if and only if the net force acting on the object is zero; this is a statement of ____.
10. Newton's first law
    - An object at rest will remain at rest or an object in motion will move in a straight line with constant speed, if and only if the net force acting on the object is zero; this is a statement of ____.
11. kinetic friction force
    - The horizontal force exerted on one surface by another when surfaces are in relative motion is the ____. A defined object or group of objects is a(n) ____.