Motion in Straight Line

Discussion on Problems Based on Distance, Displacement, Speed, and Velocity

1. Distance and Displacement

- **Distance:** The total path length covered by an object. It is a scalar quantity and is always positive.
- **Displacement:** The shortest straight-line distance from the initial to the final position of an object, considering direction. It is a vector quantity and can be positive, negative, or zero.

Example Problem 1:
A person walks 3 km north, then 4 km east. Calculate the distance and displacement.

- **Distance:** $3\ \text{km} + 4\ \text{km} = 7\ \text{km}$
- **Displacement:** Use Pythagorean theorem: $\sqrt{(3^2 + 4^2)} = \sqrt{9 + 16} = \sqrt{25} = 5\ \text{km}$ northeast.

2. Average Speed and Instantaneous Speed

- **Average Speed:** Total distance traveled divided by the total time taken. It is a scalar quantity.
- **Instantaneous Speed:** The speed of an object at a particular moment in time.

Example Problem 2:
A car travels 150 km in 3 hours. Calculate the average speed.

- **Average Speed:** $\frac{150\ \text{km}}{3\ \text{h}} = 50\ \text{km/h}$

Example Problem 3:
A speedometer reads 60 km/h at a particular instant. This is the instantaneous speed of the car.

3. Average Velocity and Instantaneous Velocity

- **Average Velocity:** Total displacement divided by the total time taken. It is a vector quantity.
- **Instantaneous Velocity:** The velocity of an object at a specific instant. It includes both magnitude and direction.

Example Problem 4:
A runner completes a 400 m track in 50 seconds. Calculate the average velocity if the runner returns to the starting point.

- **Displacement:** 0 m (since the runner returns to the start)
- **Average Velocity:** $\frac{0\ \text{m}}{50\ \text{s}} = 0\ \text{m/s}$

Example Problem 5:
A car moves with a velocity of 20 m/s east at a particular instant. This is its instantaneous velocity.

Multiple Choice Questions (MCQs)

1. **What is the total distance covered by a person who walks 2 km east, then 2 km west?**
    - a) 0 km
    - b) 2 km
    - c) 4 km
    - d) 1 km
2. **What is the displacement of a person who walks 2 km east, then 2 km west?**
    - a) 0 km
    - b) 2 km
    - c) 4 km
    - d) 1 km
3. **If a car travels 100 km north in 2 hours, what is its average speed?**
    - a) 50 km/h
    - b) 100 km/h
    - c) 200 km/h
    - d) 25 km/h
4. **If a car travels 100 km north in 2 hours, what is its average velocity?**
    - a) 50 km/h
    - b) 100 km/h
    - c) 200 km/h
    - d) 25 km/h north
5. **What is the instantaneous speed of a car if the speedometer reads 70 km/h?**
    - a) 50 km/h
    - b) 70 km/h
    - c) 100 km/h
    - d) 0 km/h
6. **Which of the following is a scalar quantity?**
    - a) Velocity
    - b) Displacement
    - c) Speed
    - d) Acceleration
7. **Which of the following is a vector quantity?**
    - a) Speed
    - b) Distance
    - c) Displacement
    - d) Time
8. **A runner completes a 400 m track in 50 seconds and returns to the starting point. What is the average velocity?**
    - a) 8 m/s
    - b) 4 m/s
    - c) 0 m/s
    - d) 2 m/s
9. **A cyclist travels 30 km west in 2 hours. What is the cyclist's average velocity?**
    - a) 15 km/h
    - b) 30 km/h
    - c) 15 km/h west
    - d) 30 km/h west
10. **If an object moves with a constant velocity, what is its acceleration?**
    - a) Positive
    - b) Negative
    - c) Zero

    - d) Cannot be determined
11. **What is the displacement of an object that moves 3 km north and then 4 km south?**
    - a) 7 km north
    - b) 1 km south
    - c) 7 km south
    - d) 1 km north
12. **A car accelerates from rest to 60 km/h in 5 seconds. What is its average speed during this period?**
    - a) 12 km/h
    - b) 30 km/h
    - c) 60 km/h
    - d) 6 km/h
13. **Which quantity can be zero for a moving object?**
    - a) Speed
    - b) Distance
    - c) Displacement
    - d) Time
14. **What does the slope of a distance-time graph represent?**
    - a) Speed
    - b) Velocity
    - c) Acceleration
    - d) Displacement
15. **If a car's velocity changes from 20 m/s to 10 m/s in 2 seconds, what is its acceleration?**
    - a) 5 m/s^2
    - b) -5 m/s^2
    - c) 10 m/s^2
    - d) -10 m/s^2

Answer Key

1. c) 4 km
2. a) 0 km
3. a) 50 km/h
4. d) 25 km/h north
5. b) 70 km/h
6. c) Speed
7. c) Displacement
8. c) 0 m/s
9. c) 15 km/h west
10. c) Zero
11. b) 1 km south
12. b) 30 km/h
13. c) Displacement
14. a) Speed
15. b) -5 m/s^2