Physics Olympics
Distance and Displacement, Speed and Velocity, and Acceleration

Rules

- Each team needs a name and someone to record answers.
- Every answer will be written on a piece of paper with the team's name at the top.
- You may use your notes to help you answer the questions.
- Every team that answers the question correctly within the time limit will earn points for that question.
- There are some challenges mixed in that are worth more points but require more work.
- The team with the most points at the end wins!

Question 1

What does the slope of a distance-time graph represent?

Answer: Speed

Question 2

How fast is a car moving if its distance-time graph has a straight-line slope that is:

- high or steep?
- low or not steep?
- zero?

Answer:

- **High speed**
- **Lower speed**
- **Not moving**

Question 3

Is it possible to move an object that is initially at rest from one place to another without accelerating it?

Answer: No, because you have to change its speed from zero to something positive. This change will represent an acceleration.

Challenge (5 points)

- Choose two objects of different weight (such as a pencil case and an eraser). These objects must not experience a lot of air resistance when dropped.
- Decide on a place to drop the objects from. You must be able to drop them from the same spot both times. You may want to have someone standing on a chair. Use the meter stick to measure the distance from the drop point to the ground.
- Drop each object three times from the drop point and record in a table how long they take to hit the ground. Your table should have six entries. (3 pts)
- What can you conclude about the speed and acceleration of falling objects based on your table (taking into account small amounts of error that may have occurred)? (2 pts)

Answer: The objects should take approximately the same amount of time to hit the ground. It's ok if the time is a little bit off, but they should realize this fact.

Question 4

In uniform or constant speed, the speed is the same during each time interval. In constant acceleration, what is the same in each time interval?

Answer: The *change* in speed.

Question 5

In a road test, four mini-vans accelerate from rest to a particular speed.
Which van has the greatest average acceleration? What is this acceleration?

Answer:
Accelerations are 8.93, <u>10.56</u>, 9.74, 10.0
The biggest acceleration comes from the Ford Windstar

Question 6

What feature of a speed-time graph communicates:
acceleration?
distance traveled?

Answer:

- **Acceleration given by slope**
- **Distance given by the area under the line**

Challenge (5 points)

- Set up a race track for your team: using a meter stick and a roll of masking tape, mark off 0 m, 5 m, and 10 m.
- Position people with a stopwatch at the 5 m and 10 m marks.

- Have one team member hop on one foot from the start to the finish line. The stopwatches will be stopped as the hopper passes the appropriate each 5 or 10 m mark.
- Record both times on a sheet of paper.
- Repeat steps 3 and 4 with another team member walking briskly instead of hopping.

- Now create a chart for both people, including distance travelled (0 m, 5 m, and 10 m), time it took, and the calculated speed at that point. *(1 pt)*
- Draw a distance-time and speed-time graph for hopping and walking. *(2 pts)*

- What task and at what distance did your team member travel at the fastest speed? *(1 pt)*
- In which task did your team member accelerate faster? *(1 pt)*

Answer: Check overall calculations for correctness etc.

Question 7

Classify the following quantities as scalar or vector quantities:

- Distance
- Mass
- Position
- Displacement
- Time
- Change in position

Answer:
Distance -- scalar
Mass -- scalar
Position -- vector
Displacement -- vector
Time -- scalar
Change in position -- vector

Question 8

Give an example where the distance you traveled was different from your final displacement.

Answers will vary.

Question 9

What are the two rules for drawing vectors in a straight line vector diagram? Draw an example and describe it in words.

Answer:
Align the two vectors so that the head of the first vector is touching the tail of the second vector. Then draw a new vector from the tail of the first vector to the head of the second.

Challenge (5 points)

- Choose one person from your team to be a map reader. They will come to the front of class until your map is ready.
- Mark an X on the ground as your starting point.
- Create a map using vectors only. You will list the vectors needed to guide your map reader from the starting point to a secret end point of your choice. North will be the direction of the front of the classroom (where this screen is). The size of the vectors will be in steps. (3 pts)

- On a different piece of paper, write down the secret end point (where your map is supposed to take you). Give this to the judges.
- Your map reader will try to follow your vector list map to see if he/she can get to the end point. (1 pt or 2 pts, depending how close they get)

Question 10

Draw a vector to represent 20 km in each of the following directions, and label each vector:

- 27° W of N
- 32° E of S
- 40° W of S
- 19° N of E

Answers: Check their labels and see if their vectors make sense

Question 11

What makes velocity different from speed?

Answer: Velocity has a direction since it's a vector quantity, whereas speed is just a scalar.

Question 12

You go for a walk. Your average speed is different from the size of your average velocity. How did this happen?

Answer: You changed directions while walking.

Question 13

If any of the following are zero, does that mean the rest are also zero?

- Displacement
- Velocity
- Acceleration

Answer: No. For example, travelling at a constant, non-zero velocity results in zero acceleration.

Question 14

What information does the slope of a velocity-time graph give us?

Answer: Acceleration (this time as a vector quantity).

Question 15

A car, leaving a city speed zone of 45 km/h [E], accelerates uniformly to the new speed limit of 105 km/h [E] in 7.0 s.
What is the average velocity of the car during this constant acceleration?

Answer:
(105 km/h [E] + 45 km/h [E]) / 2 = 75 km/h [E]

Question 16

You are riding on a bus traveling 90 km/h [N].
When the bus driver sees a dog run onto the road, he slams on the brakes and stops in time to save the dog.
In what direction are you accelerating while braking?

Answer: [S]

Question 17

A dragster slows down from 28 m/s [N] to 13 m/s [N] in a time of 12 s using a parachute and brakes. Calculate the displacement during this acceleration.

Answer:
[(28 m/s[N] + 13 m/s [N]) /2] * 12 s = 246 m [N]