Phyz Question and Problem Set
1.02 MOTION AND INERTIA

9/23/09 AM

Section I: Do You Know? Do You Know? Do You Know?
BASIC CONCEPT QUESTIONS

INSTRUCTIONS: The following questions require written responses. Answers may include diagrams and/or references to equations. Respond in complete sentences and include a statement of the question in your response. Leave at least one blank line between your answers.

Speed

1. Speed is the rate at which *what* happens?

2. a. What is the difference between *instantaneous speed* and *average speed?*
b. Does the speedometer of a car read instantaneous speed or average speed?

3. What is meant by saying, "motion is relative"? For everyday motion, what is motion relative to?

4. What is the difference between *speed* and *velocity?*

5. If the speedometer in a car reads a constant speed of 50 mph, you can say that the car has a constant speed but you can't say that it has a constant velocity. Why is this?

6. Which two controls on a car enable a change in *speed?* Name another control that enables a change in *velocity* (without a change in speed).

Acceleration

7. a. Acceleration is the rate at which *what* happens?
b. Rewrite your response to part a without using the word "velocity."

8. What is the difference between *velocity* and *acceleration?* Answer this question carefully; it is one of the most important questions in the unit.

9. a. Can acceleration occur when *speed* is constant?
b. Can acceleration occur when *velocity* is constant?

10. Which has a greater acceleration when moving in a straight line—a car that increases its speed from 50 km/h to 60 km/h, or a bicycle that goes from zero to 10 km/h in the same time? Explain.

Freefall

11. Acceleration due to gravity is 9.8 m/s^2 downward. What is the acceleration of a ball thrown straight upward
a. just after it leaves the thrower's hand?
b. at the top of the flight?
c. just before it is caught by the thrower?

Newton's First Law of Motion

12. What is the difference between *mass* and *inertia?*

13. A book is pushed across a desktop and slows down to a stop. Doesn't this contradict Newton's first law? Explain.

14. If the desktop could be made frictionless, would the pushed book behave differently? Explain.

15. How is an object able to maintain a constant speed when friction acts on it?

16. The speed of a ball increases as it rolls down an incline, and the speed decreases as it rolls up an incline. What happens to the speed on a smooth horizontal surface?

17. Does the law of inertia pertain to moving objects, objects at rest, or both? Support your answer with examples.

18. A cannonball is fired in frictionless space. How much force is needed to keep it going?

19. Give an example of an object acted on by a balanced force and one acted on by an unbalanced force. (**No**—you *can't* use examples from the PhyzGuide!)

20. Give an example of an object acted on by an internal force and one acted on by an external force. (**No**—you *can't* use examples from the PhyzGuide!)

Section II: Smooth Operations

EQUATION MANIPULATION EXERCISES

INSTRUCTIONS: Solve the following exercises by writing out the appropriate equation, rearranging it and/or substituting given values into it as indicated. Diagrams may be helpful but are not required unless otherwise specified. Draw a box around your final answer. You may write solutions "two-across" on your paper (but no more than two across).

Space and Time

21. An ant walks along the edge of a meterstick. At 10:34:23, the ant crosses the 31.9 cm point. At 10:34:37, the ant passes the 73.5 cm point.
a. How far did the ant travel during this interval?
b. What was the duration of this interval?
c. How fast (on average) was the ant moving during this interval?

Speed

22. Rewrite the equation for uniform motion ($v = \Delta x/\Delta t$)
a. solving for Δx b. solving for Δt

23. a. If $\Delta x = 132$ m and $\Delta t = 12$ s, determine v.
b. If $v = 13$ m/s and $\Delta t = 17$ s, determine Δx.
c. If $\Delta x = 144$ m and $v = 18$ m/s, determine Δt.

24. James rolls his bowling ball more for speed than for accuracy.
a. If the ball rolls 19 m in 2.2 s, what was its speed?
b. Multiply by 9/4 to convert the speed from m/s to mph.

25. A determined Galápagos Tortoise at the Darwin Research Station can travel at 0.11 m/s. How long does it take the tortoise to travel the 5.0 m from its favorite cooling pad to its feeding area?

26. The US Space Shuttle (1981-2010) traveled at about 7600 m/s and orbits the Earth once every 90 minutes.
a, How far did the shuttle travel in each orbit?
b. Divide the result by 1600 to convert it from meters to miles.

Introduction to Acceleration

27. Rewrite the equation $a = \Delta v/\Delta t$
a. solving for Δv b. solving for Δt

28. a. If $\Delta v = 64$ m/s and $\Delta t = 12$ s, what is a?
b. If $a = 17$ m/s^2, $\Delta t = 9.0$ s, what is Δv?
c. If $\Delta v = 66$ m/s and $a = 8.8$ m/s^2, what is Δt?

29. A sports car goes from 0 to 26 m/s in 4.6 s. What is its acceleration?

30. A rock falls with acceleration of 10 m/s^2. How fast is it traveling after falling for 3.2 s?

31. A roller-coaster accelerates at 3.5 m/s^2 down the first hill. How long does it take for the roller-coaster to go from 10 m/s to 25 m/s?

Section III: Mysteries of the Universe

GEDANKEN QUESTIONS

INSTRUCTIONS: The following questions require written responses. Answers may include diagrams and/or references to equations. Respond in complete sentences and include a statement of the question in your response. Leave at least one blank line between your answers.

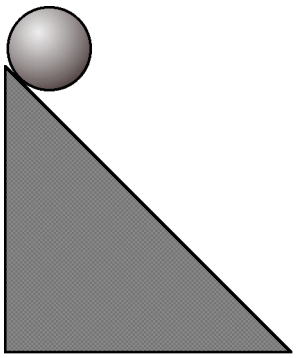
Uniform Motion

32. **Sam.**† Dr. Pisani exercises his dog Sam on a 15-minute walk by throwing a stick that Sam chases and retrieves. When Sam returns the stick, Dr. Pisani throws it again. To keep Sam running for the longest time as Dr. Pisani walks, should he throw the stick in front of him, behind him, to the side of him, or doesn't the direction make any difference? Explain your answer.

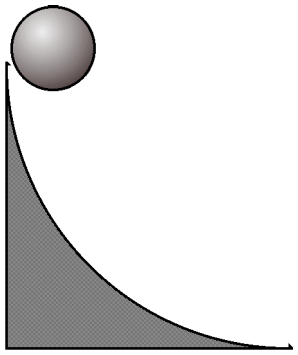
33. **Two Bikes and the Bee.**† Two bicycles are traveling toward each other. Each bicycle has a speed of 15 mph. When the bicycles are 30 miles apart, a bee flies from the front wheel of one bicycle toward the other at a uniform speed of 20 mph. When the bee reaches the front wheel of the other bicycle, it turns around (instantaneously) and flies back toward the first bicycle. This process continues until the bicycles meet and the bee is squashed. Determine the total mileage accumulated by the bee during this time. *(Hint: Finding the answer to this question can be very difficult or very easy, depending on your method.)*

Acceleration

34. **Speed Ain't Acceleration 1.** Characterize the speed and acceleration of the ball as it rolls down the hill shown.
a. What can be said of the *speed* of the ball as it rolls down the hill?
b. What can be said of the *acceleration* of the ball as it rolls down the hill?



35. **Speed Ain't Acceleration 2.†** Characterize the speed and acceleration of the ball as it rolls down the hill shown.
a. What can be said of the *speed* of the ball as it rolls down the hill?
b. What can be said of the *acceleration* of the ball as it rolls down the hill?



Newton's First Law of Motion

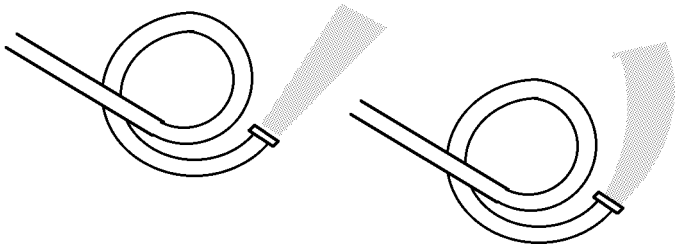
36. **Is Newton Taking You for a Ride?** If Newton's first law is true, why do you have to keep pedaling your bicycle to maintain motion?

37. **RUN!** If you were being chased by an elephant, its mass would be most threatening. Why would it be to your advantage to zigzag?

38. **Whiplash** sometimes results from an automobile accident when the victim's car is struck violently from the rear. Explain why the head of the victim seems to be thrown backward in this situation. Is it really?

39. **Jerk!** Why does a child in a wagon seem to fall backward when you give the wagon a sharp pull? Does the child *really* go backwards?

40. **Kink.†** Water is shooting out of the end of a pipe. The end of the pipe is bent into a loop. Does the water shoot out in a straight line or in a curved arc? Explain. (Neglect gravity.)



41. **Which Is Which?** In a region of space where gravity is zero, there are two identical containers—one filled with lead and the other filled with a few feathers. How could you determine which one had more mass? (**No**—you *can't* look inside!)

42. **Magnet Cart†.** You may have seen cartoons in which a horse or donkey is compelled to move forward by a carrot dangling in front of him. The carrot "attracts" the animal forward. But as the animal moves forward, so does the carrot. This allows sustained forward travel. A modification of this idea is the magnet cart. The rider dangles a magnet in front of a steel cart. The magnetic attraction will pull the car forward, but in doing so, the magnet also moves forward, thus allowing sustained forward travel. Will this work? If so, why? If not, why not?