Passage VI

A science teacher tells students that a ball on a string is in motion, and that the speed of the ball, v, is measured twice in rapid succession and is found to be increasing. The teacher then asks each of 3 students to describe the ball's motion between and after the 2 measurements of v.

While analyzing the students' statements, consider the following information about the ball:

- The *amount of angular momentum* of the ball, *AM*, equals mvr, where m is the ball's mass and r is the distance of the ball from a reference point.
- The ball's *kinetic energy*, *KE*, equals $\frac{1}{2}mv^2$.
- The ball's *total mechanical energy*, *TME*, equals $KE + PE$, where *PE* is potential energy that is available to be converted into the ball's *KE*. If *TME* remains the same during the ball's motion, then *TME* is said to be *conserved*.

Student 1

The ball and string are suspended from a ceiling, forming a pendulum, and the pendulum is swinging without friction (see Figure 1).

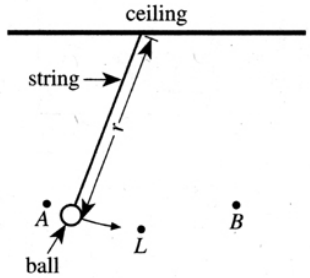

Figure 1

The speed v increases between the 2 measurements because the ball is approaching the lowest point in its path, Point L. At Point L, v has its greatest value; as the ball moves past Point L, v begins to decrease immediately. The decrease in v continues until the ball reaches one of the 2 end points of its path, Point A or Point B. Once the ball reaches an end point, it reverses its direction of motion, and v again begins to increase.

Student 2

One end of the string is threaded through a hole in a horizontal tabletop. While a student pulls down on the string, steadily decreasing r, the ball continuously slides without friction around the hole (see Figure 2).

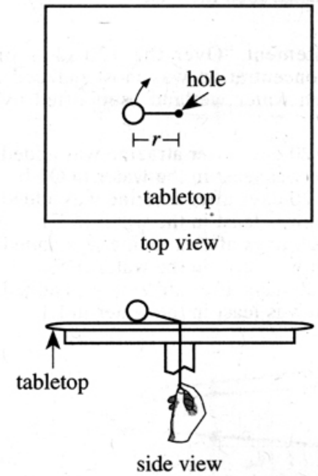

Figure 2

The speed v increases between the 2 measurements because the product vr remains constant; v will continue to increase as r decreases.

Student 3

The ball is on a horizontal tabletop that is against a wall. The string, which is fastened to the wall, is elastic and has been stretched. The ball slides without friction toward the wall (see Figure 3).

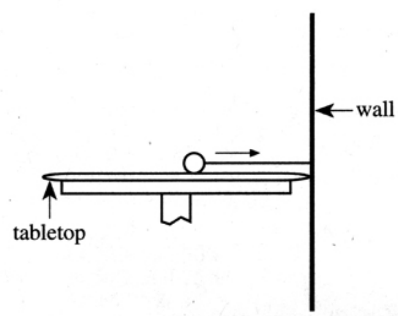

Figure 3

Between the 2 measurements, the string is contracting, so v increases. Once the string is no longer stretched, v remains constant until the ball hits the wall. After the ball bounces off the wall, v remains constant until the string begins to stretch again, at which time v begins to decrease.

29. Based on Student 1's description of the ball's motion, compared to the ball's *KE* at Point A or Point B, the ball's *KE* at Point L is:

A. greater, because v is greater at Point L.
B. greater, because v is less at Point L.
C. less, because v is greater at Point L.
D. less, because v is less at Point L.

30. Based on Student 3's description, when the ball is moving away from the wall and is slowing down, *PE* is accumulating. Where is the accumulating *PE* being stored?

F. In the ball
G. In the wall
H. In the table
J. In the string

31. Throughout the ball's motion as described by Student 1, does the amount of angular momentum of the ball, *AM*, remain constant?

A. Yes, because although v does not remain constant, m and r *do* remain constant.
B. Yes, because although r does not remain constant, m and v *do* remain constant.
C. No, because although m and v remain constant, r *does not* remain constant.
D. No, because although m and r remain constant, v *does not* remain constant.

32. Based on Student 2's description of the motion of the ball, as r decreases, how does the ball's *KE* change?

F. It increases, because v increases.
G. It increases, because v decreases.
H. It decreases, because v decreases.
J. It decreases, because v increases.

33. Speed v is momentarily zero at various times during the motion(s) described by which of the students?

A. Student 2 only
B. Student 3 only
C. Students 1 and 3 only
D. Students 2 and 3 only

34. Suppose that *TME* is conserved throughout the ball's motion. Based on the information given, if *TME* = 100 ergs, *KE* and *PE* can simultaneously have which of the following values?

	KE (ergs)	*PE* (ergs)
F.	10	10
G.	10	90
H.	125	25
J.	1,000	10

35. Suppose that when $r = 5$ cm, $v = 20$ cm/sec. Based on a statement by Student 2, when $r = 15$ cm, v equals a value closest to which of the following?

A. 3 cm/sec
B. 7 cm/sec
C. 15 cm/sec
D. 19 cm/sec