Passage VII

Introduction

Students studying a unit on motion and conservation of energy were given the following information:

- *Kinetic energy* (energy that changes as an object's speed changes) and *gravitational potential energy* (energy that changes as an object's altitude changes) are forms of mechanical energy.
- An object's *total mechanical energy* is the sum of its kinetic energy and its gravitational potential energy.
- If an object's total mechanical energy is constant, its total mechanical energy is said to be *conserved.*
- Friction causes some of an object's total mechanical energy to be lost, in which case its total mechanical energy is *not* conserved.

The students' teacher then described the following experiment:

> Suppose a student placed a block upon a surface and gave the block a single push. As the block moved along the surface, the student measured the block's speed twice in succession and found that the second measured speed was lower than the first.

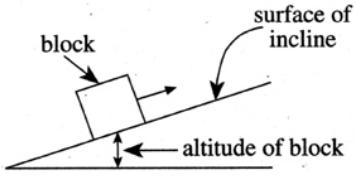
Given no other information, 3 students were asked to explain the results of the 2 measurements and to predict the block's motion after the 2 measurements.

Student 1

The block was moving on a rough, *horizontal* surface (a surface with no incline). There was a constant frictional force between the block and the surface. This force alone caused the block to slow down at a constant rate and would have caused the block eventually to stop. Once stopped, the block would have remained at rest.

Student 2

When the 2 measurements were made, the block was moving up a frictionless, inclined surface as shown in the figure, and was slowing down at a constant rate. No air was present.



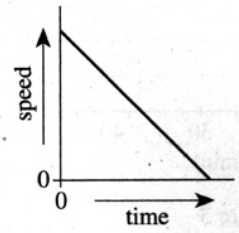
Eventually, the block would have stopped moving up the incline; then gravity alone would have caused the block to accelerate down the incline. At any specified altitude, the block's speed going down the incline would have been the same as its earlier speed going up the incline.

Student 3

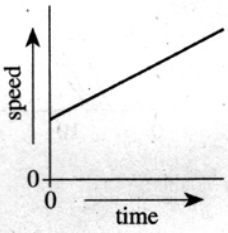
The block moved on a frictionless, horizontal surface. As a result of its motion, the block encountered air resistance. Air resistance alone caused the block to slow down and lose mechanical energy. The rate at which the block slowed down depended upon the amount of air resistance it encountered. As the block's speed decreased, the amount of air resistance decreased.

34. Assume that the block was pushed and then released at time = 0. Student 1's description of the block's speed over time after its release is best illustrated by which of the following graphs?

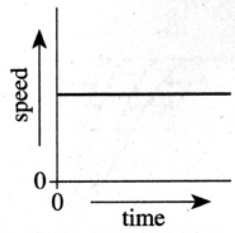
F.



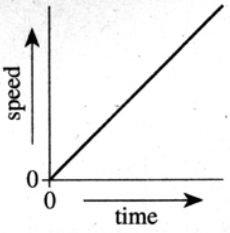
H.



G.



J.



35. The 3 explanations of the block's motion are similar to each other in that all 3 explanations:

- **A.** contradicted the law of conservation of total mechanical energy.
- **B.** were based on 2 measurements.
- **C.** were formulated using the assumption that no friction would exist between the block and the air.
- **D.** were formulated using the assumption that there would be no friction between the block and the surface on which it moved.

36. Based on the explanations of the 3 students, what did the 3 students most likely assume about the block's speed between the times the 2 measurements were made?

- **F.** The speed increased only.
- **G.** The speed decreased only.
- **H.** The speed increased, then decreased.
- **J.** The speed changed, but with no general trend.

37. The teacher posed another question: Suppose, in a second experiment, the student placed the block and the surface in an airless chamber. Then the student repeated the procedure from the first experiment, except that he measured the block's speed throughout the experiment. If the block's speed remained constant throughout this second experiment, the explanation(s) of which student(s) for the results of the first experiment would be best supported?

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

38. Based on Student 2's explanation, the block's gravitational potential energy at the highest point on its path most likely equaled:

F. the block's kinetic energy one-third of the way up the incline.
G. the block's gravitational potential energy two-thirds of the way up the incline.
H. the block's total mechanical energy.
J. zero.

39. According to Student 1, while the block was moving, did the block's speed affect the frictional force on the block?

A. Yes; as the block's speed increased, the frictional force on the block decreased only.
B. Yes; as the block's speed increased, the frictional force on the block increased, then decreased.
C. No; as the block's speed decreased, the frictional force on the block decreased, then increased.
D. No; as the block's speed decreased, the frictional force on the block was unaffected.

40. Assuming that Student 1's explanation is correct, while the block moved, was the total mechanical energy of the block conserved?

F. Yes, because the block's kinetic energy increased and its gravitational potential energy remained constant.
G. Yes, because both the block's kinetic energy and its gravitational potential energy increased.
H. No, because the block's kinetic energy decreased and its gravitational potential energy remained constant.
J. No, because both the block's kinetic energy and its gravitational potential energy decreased.