Passage VI

A teacher described the procedure of a study to students in a science class:

> A 1 kg sphere, Sphere X, and a 2 kg sphere, Sphere Y, were released from rest, one at a time, from Point P on the right side of a frictionless, U-shaped incline. H_P was the height of Point P above Point L, the lowest point on the incline (see Figure 1).

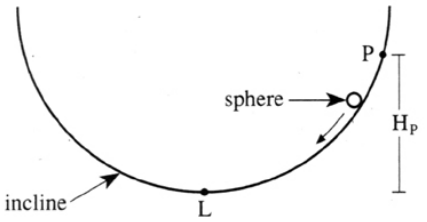

Figure 1

> Each sphere was allowed to slide as far up the left side of the incline as it could go.

Next, the teacher gave the students the following definitions:

1. GPE_P, the gravitational potential energy of a sphere at Point P, equaled mgH_P, where m was the sphere's mass and g was the acceleration of the sphere due to Earth's gravity.
2. KE_L, the kinetic energy of a sphere at Point L, equaled $\frac{1}{2}mV_L^2$, where V_L was the sphere's speed at Point L.
3. MO_L, the amount of momentum of a sphere at Point L, equaled mV_L.

Then the teacher asked 3 students to predict (giving their reasons) which sphere, if either, slid farther up the left side of the incline.

Student 1

As a sphere slid down the incline, its GPE_P was converted to kinetic energy. By the time it reached Point L, all of its GPE_P had been converted. Based on Definition 1, because Sphere Y had a greater m than did Sphere X, but the same g and H_P as Sphere X, Sphere Y had a greater GPE_P than did Sphere X. As a result, Sphere Y had a greater KE_L than did Sphere X. Thus, Sphere Y slid farther up the left side of the incline than did Sphere X.

Student 2

Because the 2 spheres had the same g and H_P, they had the same V_L. Based on Definition 3, because Sphere Y had a greater m than did Sphere X, Sphere Y had a greater MO_L than did Sphere X. Thus, Sphere Y slid farther up the left side of the incline than did Sphere X.

Student 3

Because the 2 spheres had the same g and H_P, they had the same V_L. Thus, they slid the same distance up the left side of the incline.

After hearing the students' predictions, the teacher gave them the results of the study (see Table 1).

Table 1

Sphere	H_P (m)	GPE_P (joules)	V_L (m/sec)	KE_L (joules)	Greatest height attained on left side of incline (m)
X	1.0	9.8	4.4	9.8	1.0
Y	1.0	19.6	4.4	19.6	1.0

28. Which sphere, X or Y, was subjected to the greater amount of force from Earth's gravitational field?

F. Sphere X, because it had the greater mass.
G. Sphere X, because it had the lesser mass.
H. Sphere Y, because it had the greater mass.
J. Sphere Y, because it had the lesser mass.

29. Suppose 2 other spheres, Sphere S and Sphere T, are released from Point P. The m and V_L for each sphere are given in the table below.

Sphere	m (kg)	V_L (m/sec)
S	5.0	4.4
T	3.5	4.4

Based on Definition 3 and Student 2's statements, which sphere will slide farther up the left side of the incline?

A. Sphere S, because it will have a greater MO_L than will Sphere T.
B. Sphere S, because it will have a lesser MO_L than will Sphere T.
C. Sphere T, because it will have a greater MO_L than will Sphere S.
D. Sphere T, because it will have a lesser MO_L than will Sphere S.

30. Suppose that the study were conducted on the Moon instead of on Earth. Based on Definition 1 and Student 1's statements, compared to the KE_L of Sphere X for the study on Earth, the KE_L of Sphere X for the study on the Moon would be:

F. greater, because the acceleration due to gravity on the Moon is greater than the acceleration due to gravity on Earth.
G. greater, because the acceleration due to gravity on the Moon is less than the acceleration due to gravity on Earth.
H. less, because the acceleration due to gravity on the Moon is greater than the acceleration due to gravity on Earth.
J. less, because the acceleration due to gravity on the Moon is less than the acceleration due to gravity on Earth.

31. Consider the statement "The greatest height attained by a sphere sliding up the left side of the incline does not depend on the sphere's mass." This statement is consistent with the prediction(s) of which of the students?

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

32. Based on Student 3's statements, how did the *amount of time* for Sphere Y to slide from Point P to Point L compare to the *amount of time* for Sphere X to slide from Point P to Point L ? The amount of time for Sphere Y to slide from Point P to Point L was:

F. $\frac{1}{4}$ as great.
G. $\frac{1}{2}$ as great.
H. the same.
J. 2 times as great.

33. Suppose that a sphere is released from a new point on the incline, Point Q, that is between Point P and Point L. At Point Q, the sphere's gravitational potential energy is equal to mgH_Q, where H_Q is the height of Point Q relative to Point L. Based on Student 1's statements about the conversion of gravitational potential energy to kinetic energy, would the sphere's KE_L following the release from Point Q be less than or greater than the sphere's KE_L following the release from Point P ?

A. Greater, because GPE_Q would be greater than GPE_P.
B. Greater, because GPE_Q would be less than GPE_P.
C. Less, because GPE_Q would be greater than GPE_P.
D. Less, because GPE_Q would be less than GPE_P.

34. Consider the 3 students' hypotheses concerning which sphere, if either, slid farther up the left side of the incline. Based on the results of the study, which of the students' predictions, if any, was(were) correct?

F. Student 1's only
G. Student 3's only
H. Student 1's and Student 2's only
J. Neither Student 1's, Student 2's, nor Student 3's