POTENTIAL ENERGY

Review Questions

Name:

26. Which term identifies a scalar quantity?
(1) force
(2) energy
(3) displacement
(4) velocity

27. Energy is measured in the same units as
(1) force (2) momentum (3) power (4) work

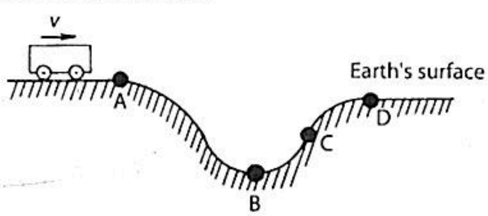
28. Which quantity and unit are correctly paired?
(1) velocity; m/s^2
(2) momentum; $kg \cdot m/s^2$
(3) energy; $kg \cdot m^2/s^2$
(4) work; kg/m

29. A unit for gravitational potential energy is the
(1) watt
(2) joule
(3) newton
(4) kilogram · meter/second

30. Which mass has the greatest gravitational potential energy with respect to the floor?
(1) a 50.-kg mass resting on the floor
(2) a 2.0-kg mass 10. m above the floor
(3) a 10.-kg mass 2.0 m above the floor
(4) a 6.0-kg mass 5.0 m above the floor

31. As an object slides across a rough horizontal surface, what happens to the object's gravitational potential energy with respect to the surface and speed?
(1) Both gravitational potential energy and speed decrease.
(2) Gravitational potential energy decreases and speed remains the same.
(3) Gravitational potential energy remains the same and speed decreases.
(4) Both gravitational potential energy and speed remain the same.

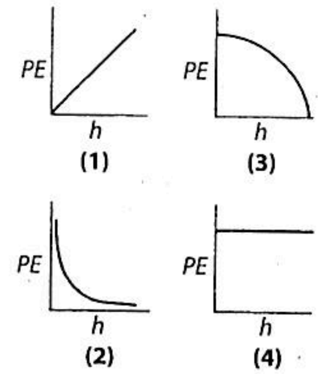
32. The diagram below represents a cart traveling with initial speed *v* from left to right along a frictionless surface.



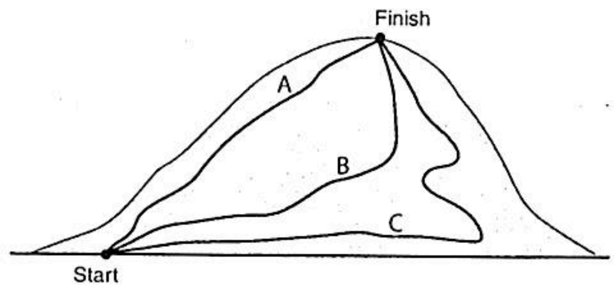
At which point is the gravitational potential energy of the cart least?
(1) A (2) B (3) C (4) D

33. Calculate the gravitational potential energy with respect to Earth's surface gained by a 5.00-kilogram mass as a result of being raised 2.00 meters from Earth's surface.

34. Which graph best represents the relationship between the gravitational potential energy *PE* with respect to the ground and height above the ground *h* for a freely falling object released from rest?



35. Three people of equal mass climb a mountain using paths A, B, and C shown in the diagram below.



Along which path(s) does a person gain the greatest amount of gravitational potential energy from start to finish?
(1) A only
(2) B only
(3) C only
(4) The gain is the same along all paths.

36. A ball is thrown upward from Earth's surface. As the ball rises, what happens to its speed and gravitational potential energy with respect to Earth's surface?
(1) Both speed and gravitational potential energy decrease.
(2) Speed decreases and gravitational potential energy increases.
(3) Speed increases and gravitational potential energy decreases.
(4) Both speed and gravitational potential energy increase.

37. At the top of a frictionless inclined plane, a 0.50-kilogram block of ice possesses 6.0 joules of gravitational potential energy with respect to the bottom of the incline. After sliding halfway down the plane, the block's gravitational potential energy is

(1) 0.0 J (2) 6.0 J (3) 3.0 J (4) 12 J

38. When a 5-kilogram mass is lifted from the ground to a height of 10 meters, the gravitational potential energy of the mass is increased by approximately

(1) 0.5 J (3) 50 J
(2) 2 J (4) 500 J

Elastic Potential Energy

The energy stored in a spring, when work is done in compressing or stretching it, is called **elastic potential energy.** The **compression** or **elongation** of a spring is the change in spring length from its equilibrium position when a force is applied to it. Provided the elastic limit of the spring is not exceeded, the compression or elongation of a spring is directly proportional to the applied force. This relationship, called Hooke's law, is given by the formula:

$$F_s = kx$$

In the equation, k is the **spring constant,** the constant of proportionality between the applied force F_s and the compression or elongation x of the spring. If F_s is in newtons and x is in meters, then k is in newtons per meter. The SI unit for the spring constant is the newton/meter, N/m.

A common laboratory activity is to vary the force applied to a spring and measure the resulting elongation or compression. Force is the independent variable and change in spring length is the dependent variable. However, force is often indicated on the vertical axis and change in spring length on the horizontal axis when the data from the experiment is graphed. If a graph of F_s versus x is plotted for the data collected for a given spring, the slope of the line of best fit is equal to the spring constant for that spring. For an ideal spring, the line is straight and passes through the origin. A stiff spring has a larger value of k than a weak spring.

If F_s versus x data for two different springs is plotted on the same grid and best-fit lines are drawn, the line for the stiffer spring has the greater slope. On the other hand, if change in spring length from its equilibrium position x is indicated on the vertical axis and the force applied to the spring F_s on the horizontal axis, the slope of the line of best fit is equal to $1/k$, the reciprocal of the spring constant. In this case the line for the stiffer spring has the lesser slope.

Potential Energy of a Spring

When no force is applied to a spring, there is no change in spring length from the equilibrium position. That is, when $F_s = 0$ N, $x = 0$ m. According to Hooke's law, as F_s increases, x increases. Because F_s increases uniformly from 0 to kx, the *average* applied force equals $\frac{1}{2}kx$. The work done in stretching the spring is equal to the product of the *average* force $\overline{F}_s$ and the elongation x.