Question:

Which of the following is *not* a unit of Energy?

a. *kiloWatt•hour*
b. *Joule*
c. *Newton•meter*
d. $\frac{kilogram \bullet meter^2}{second^2}$
e. $\frac{kilogram^2 \bullet meter}{second}$

Answer:

The correct answer is *e*. A *Joule* is the SI unit for energy, typically calculated using the definition of Work-Energy:

$$Work = Force \bullet displacement$$

$$[Joule] = [N][m]$$

The *kiloWatt•hour* is *Power•time*, which can be seen to represent energy:

$$P = \frac{Work}{time} = \frac{Energy}{time} \Rightarrow Energy = Power \bullet time$$

All of the answers except for *e* can be reduced to the fundamental units that represent Energy.

$$Energy = Force \times displacement$$

$$Energy = [N][m] = \frac{[kg][m][m]}{[s]^2} = \frac{[kg][m]^2}{[s]^2}$$

Question:

Which of the following is *not* a unit of energy?

a. $\frac{kg \bullet m^2}{s^2}$

b. kJ

c. $\frac{N \bullet m^2}{s}$

d. $W \bullet s$

e. $N \bullet m$

Answer:

The correct answer is *c*. Energy can be determined in any number of ways, including using the concept of *Work*, calculating *kinetic* or *potential* energies, and considering energy as a function of *Power*.

Using $Work = Force \bullet displacement$, we can see that the units of Work (and thus, Energy), are the $Newton \bullet meter$, or $N \bullet m$. The derived unit for energy is the Joule, *J*.

Given that the Newton is a $\frac{kg \bullet m}{s^2}$, we can see that another possible unit for Energy is

$\frac{[kg][m]}{[s]^2} \bullet [m] = \frac{[kg][m]^2}{[s]^2}$.

Or considering that $Power = \frac{Work}{time}$, we can see that $W = P \bullet t$. Therefore, another unit of energy is $Watt \bullet seconds$, or $W \bullet s$.

The only answer that is not possibly an energy unit is *c*.

Question:

Which of the following includes forms of mechanical energy only?

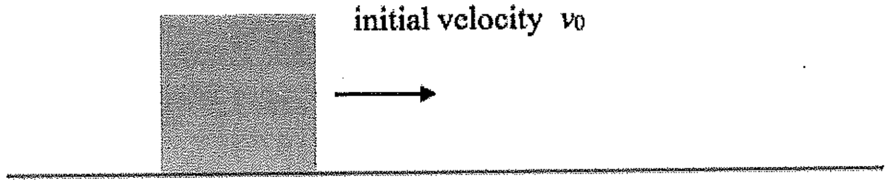
a. nuclear, gravitational potential, electric
b. magnetic, kinetic, elastic potential
c. kinetic, gravitational potential, chemical
d. thermal, kinetic, elastic potential
e. None of the above

Answer:

e. The three forms of mechanical energy include:

Kinetic – Gravitational Potential – Elastic Potential

Question:



A box on the floor is briefly pushed to give it an initial velocity v_0 to the right, as shown. There is friction between the box and the floor. Which of the following statements is *false* ?

a. The box is accelerating to the left.
b. The velocity of the box will decrease as it slides.
c. The kinetic energy of the box will decrease as it slides.
d. There is no net force acting on the box as it slides.
e. Mechanical energy is being converted to thermal energy via heat as the box slides.

Answer:
The correct answer is *d*. There *is* a net force acting on the box as it slides: the force of frcition, which acts to the left in the opposite direction of the box's motion.

The other statements are all true. In *a*, although the box is moving to the right, its direction of acceleration is opposite that motion, which is why it is slowing down. (In the same way, an object thrown up in the air is moving upwards, but slowing down due to the downwards accleration due to gravity). Choices *b* and *c* are both true because the box is slowing down. Choice *e* is true because of the Work being done by friction. In this process, kinetic energy is converted via heat to ***thermal energy***, sometimes called ***internal energy***: the random motion of the atoms and molecules in the box and the floor.

Question:

A 10-meter long, vertical cannon is used to accelerate a 1.0-kg ball straight up into the air. A constant force of 13.2-Newtons is used to accelerate the bowling ball up the length of the cannon. What is the ball's approximate velocity as it leaves the cannon (assuming no energy loss to friction)?

a. 29 m/s
b. 16 m/s
c. 14 m/s
d. 9 m/s
e. 8 m/s

Answer:

The correct answer is *e*. This is a conservation of energy problem, with Work done on the ball contributing to increased potential and kinetic energies.

$$W = U + K$$

$$Fd = mgh + \frac{1}{2}mv^2$$

$$v = \sqrt{\frac{2(Fd - mgh)}{m}}$$

$$v = \sqrt{\frac{2(13.2 \cdot 10 - 1 \cdot 10 \cdot 10)}{1}}$$

$$v = \sqrt{\frac{2(32)}{1}} = 8m/s$$

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Question:
From the top of a tall cliff of height *y*, a soccer ball is kicked horizontally so that it leaves the cliff with a velocity *v*. Assuming air friction is negligible, the speed of the ball just before it hits the ground is:

a. $2gy$
b. $\sqrt{2gy}$
c. v^2+2gy
d. $\sqrt{v^2+2gy}$
e. $\sqrt{v^2-2gy}$

Answer:
The correct answer is *d*. The speed of the ball just before it hits the ground is based on the combined effects of its horizontal and vertical velocities. This problem can be solved by using kinematics to determine velocities in both the *x* direction and the *y* direction, and then combining those using the Pythagorean theorem.

It's also relatively easy to solve using an energy analysis, where the initial kinetic and gravitational potential energies of the ball are converted to a final kinetic energy, where the potential energy of the ball has decreased to 0 at ground level.

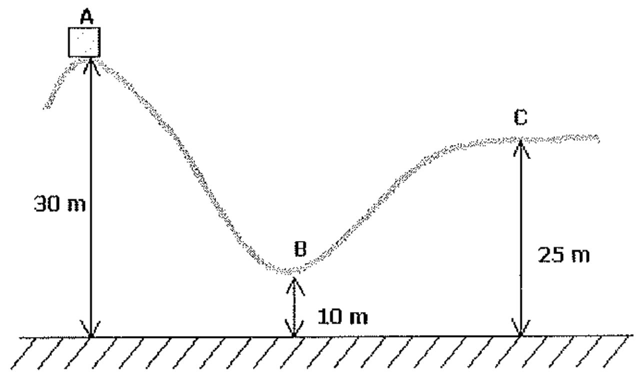
$$K_i+U_i=K_f+U_f$$

$$\frac{1}{2}mv_i^2+mgy=\frac{1}{2}mv_f^2+mg(0)$$

Rearranging and solving:

$$v_f=\sqrt{v^2+2gy}$$

Question:



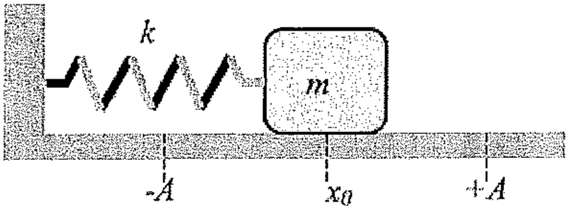
Two children are riding on a roller coaster as shown above. The children and coaster car have a combined mass of 280 kg. Calculate the change in the gravitational potential energy of the children and car as they move from Point A to Point C?

Answer:

$$\Delta E_g = E_{gC} - E_{gA}$$
$$= mgh_C - mgh_A$$
$$= mg(h_C - h_A)$$
$$\Delta E_g = -14\text{ kJ}$$

The ΔE_g is equal to the difference between the gravitational potential energies at point A and point C. Since the gravitational potential energy at Point C is less than the gravitational potential energy at Point A, the change is negative.

Question:



A spring with negligible mass and spring constant *k* is attached on one end to a block of mass *m*, and fastened at the other end to a wall. The block is pulled back a distance *A* from its equilibrium position and released so that it oscillates on the frictionless, horizontal surface. What is the velocity *v* of the mass as it passes the equilibrium position x_0?

a. $\sqrt{\frac{2kA}{m}}$

b. $\frac{k}{m}x^2$

c. $\frac{k}{m}A^2$

d. $A\sqrt{\frac{k}{m}}$

e. $A\sqrt{\frac{2k}{m}}$

Answer:
The correct answer is *d*. This is a conservation of energy problem, with the mass-spring's elastic potential energy at the endpoints, $U_{spring} = \frac{1}{2}kx^2$, converting completely to kinetic energy at the midpoint, $K = \frac{1}{2}mv^2$.

$$U_s = K_0$$

$$\frac{1}{2}kA^2 = \frac{1}{2}mv^2$$

$$v = \sqrt{\frac{kA^2}{m}} = A\sqrt{\frac{k}{m}}$$

Question:

Which of the following statements concerning energy conservation is correct?

I. **For Case II situations in which non-conservative forces act, total mechanical energy of the system remains constant but total energy decreases.**
II. **For Case I situations in which no non-conservative forces act, both total energy and total mechanical energy decrease.**
III. **In any system that undergoes energy transformation, the total work done is never zero and is always equal the change in total energy.**

- **a.** I only
- **b.** II only
- **c.** III only
- **d.** II and III
- **e.** I, II and III

Answer:

c.

Question:

Which statement concerning energy principles is correct?

- **I. A conservative force property is such that does not return mechanical energy to a system when the path of motion of an object is reversed.**
- **II. Total energy, but not mechanical energy is always conserved for a Case II energy system.**
- **III. Work done by non-conservative forces always transforms mechanical energy into non-mechanical energy forms.**

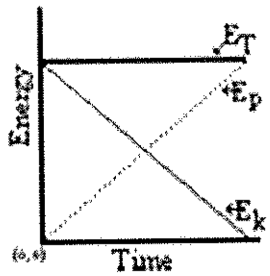
a. I only
b. II only
c. III only
d. I and III only
e. II and III only

Answer:

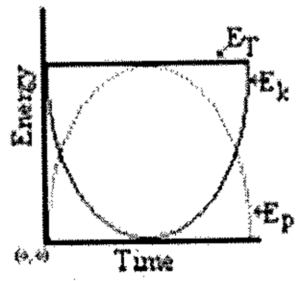
e.

A pendulum is pulled to one side and released. It swings freely to the opposite side and stops. Which of the following might best represent graphs of:

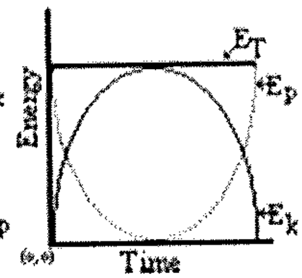
kinetic energy (E_k), potential energy (E_p) and total mechanical energy (E_T)



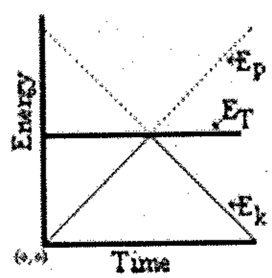
A)



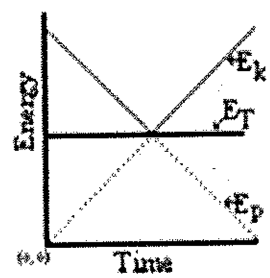
B)



C)



D)



E)

Question:

A rock is dropped from the edge of a cliff, where it has 80 Joules of gravitational potential energy relative to the ground below. 30 meters below its point of release, the rock has 40 Joules of kinetic energy. If energy losses due to air friction are negligible, what is the total height of the cliff?

a. 20m
b. 40m
c. 60m
d. 80m
e. 100m

Answer:

The correct answer is *c*. This is a conservation of energy problem, where gravitational potential energy diminishes as kinetic energy decreases. The rock has lost half of its potential energy at a point 30 meters from the top of the click, so it must be halfway down the cliff at this point. The total cliff height, then, is 60 m.

More quantitatively:

$$U_{g-i} + K_i = U_{g-f} + K_f$$

$$80J + 0 = U_{g-f} + 40J$$

$$U_{g-f} = 40J$$

$$mgh_i = 80J,\ mgh_f = 40J$$

$$h_i = 2h_f = 2(30m) = 60m$$

Question:

Mass *m* is placed at the top of a frictionless ramp of initial height *h* and released. A different mass *M* is placed at the top of a different frictionless ramp of initial height *H* and released. If both masses have the same kinetic energy at the bottom of their respective ramps, the velocity *V* of mass *M* is

a. $\sqrt{\frac{m}{M}}\,v$

b. $\sqrt{\frac{M}{m}}\,v$

c. $\frac{m}{M}\,v$

d. $\frac{M}{m}\,v$

e. $\frac{m}{M}\sqrt{v}$

Answer:

The correct answer is ***a***. The kinetic energy of each mass can be calculated and compared according to $K = \frac{1}{2}mv^2$:

$$K_m = K_M$$

$$\frac{1}{2}mv^2 = \frac{1}{2}MV^2$$

$$V = \sqrt{\frac{m}{M}v^2} = \sqrt{\frac{m}{M}}\,v$$

Question:

A glider moving on a frictionless air track has a mass *m*, velocity *v*, and a total energy $E = \frac{1}{2}mv^2$ just before it hits a bumper at the end of the track. The glider bounces back from the bumper with a velocity $v/4$. The energy converted to heat in the collision with the bumper is

a. $\frac{1}{16}E$

b. $\frac{1}{4}E$

c. $\frac{1}{2}E$

d. $\frac{3}{4}E$

e. $\frac{15}{16}E$

Answer:

The correct answer is *e*. This is a conservation of energy problem that we can analyze as follows:

$$E_{initial} - \Delta E_{internal} = E_{final}$$

$$\frac{1}{2}mv^2 - \Delta E_{internal} = \frac{1}{2}m\left(\frac{-v}{4}\right)^2$$

$$\Delta E_{internal} = \frac{1}{2}mv^2 - \frac{1}{16}\left(\frac{1}{2}mv^2\right)$$

$$\Delta E_{internal} = \frac{15}{16}\left(\frac{1}{2}mv^2\right) = \frac{15}{16}E$$