11. Work, Energy and Power

Exercise Questions

1. Question

The unit of work is:

A. Newton

B. Joule

C. watt

D. None of these

Answer

The unit of work is joule.

Option A is incorrect because Newton is the unit of force.

Option C is incorrect because Watt is the unit of Power.

2. Question

If there is an angle θ is in between force F and displacement s, then the value of work done will be :

A. Fs sin θ

B. Fs θ

C. Fscos θ

D. Fs tan θ

Answer

If there is an angle θ is in between force F and displacement s, then the value of work done is Fscos θ

3. Question

An object of mass m is moving with velocity v then kinetic energy will be :

A. mv

B. mgv

C. mv^2

D. $\frac{1}{2}mv^2$

Answer

An object of mass m is moving with velocity v then kinetic energy is $\frac{1}{2}mv^2$.

4. Question

An object of mass m is situated at height h from the earth surface then its value of potential energy will be :

A. mgh

B. $\frac{mg}{h}$

C. $\frac{mh}{g}$

D. $\frac{1}{2}mgh^2$

Answer

An object of mass m is situated at height h from the earth surface then its value of potential energy is mgh.

5. Question

Unit of power is :

A. newton

B. Watt

C. joule

D. newton-metre

Answer

Unit of power is watt.

6. Question

A mass of 1 kg is lifted up to height of 4 meters then the work done will be (g = 10 m/s^2) :

A. 1 joule

B. 4 joule

C. 20 joule

D. 40 joule

Answer

Given:mass(m) = 1kg

Displacement (s) = 4m

Work done = F × S = mg × h = mgh

= 1 × 10 × 4 = 40J

7. Question

The value of the energy of the body which is falling freely towards the earth will be :

A. increases

B. decreases

C. remain constant

D. becomes 0

Answer

According to the law of conservation of energy the mechanical energy of a body always remains constant.

8. Question

if the velocity of an object is doubled then what will be kinetic energy :

A. one-fourth

B. half

C. doubled

D. four times

Answer

K is the kinetic energy when the velocity is v.

K' is the kinetic energy when the velocity is 2v.

$$K = \left(\frac{1}{2}\right)mv^2$$

$$K' = \left(\frac{1}{2}\right)m(2v)^2$$

$$K' = 4 \times \left(\frac{1}{2}\right)mv^2$$

$$K' = 4K$$

9. Question

What is commercial unit of electrical energy?

A. joule

B. Watt-second

C. Kilowatt hour

D. Kilowatt per hour

Answer

The commercial unit of electrical energy is Kilowatt hour(kWh).

10. Question

An spring is compressed within its elasticity limit then what will be earned potential energy (spring constant is K)?

A. Kx

B. $\frac{1}{2}kx^2$.

C. Kx^2

D. None of these

Answer

If the potential energy is E_p ,the mass of the bob of the pendulum be m, the displacement of the bob be x, then

If

$$k = \frac{(mg)}{l}$$

Then

$$E_p = \frac{1}{2}kx^2$$

11. Question

Define work. Write its unit.

Answer

Work is done when a force is applied to move any object from rest or change the speed of any moving object. Work is a scalar quantity and it can be positive or negative.

Mathematically, work(W) is the product force and displacement.

$W = F \times S$

The unit of work is joule.

12. Question

What is energy? Write unit of energy.

Answer

The capacity of doing work is known as energy.

Mechanical energy has two types:

1. Kinetic energy

2. Potential energy

The unit of energy is joule.

13. Question

What do you mean by kinetic energy?

Answer

The energy possessed by any moving object by virtue of its motion is called kinetic energy.

14. Question

What is potential energy?

Answer

Potential energy is the energy which is stored in object due to virtue of its shape and position.

15. Question

Describe law of conservation of energy.

Answer

Energy can only be converted from one form to another. It can neither be created nor destroyed. The total energy before and after the transformation remains the same.

16. Question

What are the forms in which dissipation of energy commonly takes place?

Answer

The forms in which dissipation of energy commonly takes placeare :

1. Heat energy

2. Light energy

3. Sound energy

17. Question

Can any device of cent percent efficiency be prepared?

Answer

No device can be created with cent percent efficiency due to the dissipation of energy.

18. Question

What do you mean by electric energy?

Answer

The energy possessed by charged particles is called electrical energy.

19. Question

Name the three types of power plant.

Answer

The three types of the power plant are:

1. Coal power plant

2. Nuclear power plant

3. Wind power plant

20. Question

What is power? Write a unit of power.

Answer

Power is defined as the rate of doing work or the rate of transfer of energy.

Mathematically, power is given by

$$\text{Power (P)} = \frac{\text{Work done}}{\text{time}}$$

SI unit of power is Watt.

21. Question

Which light would be suitable to reduce power consumption in homes?

Answer

CFLs and LEDs must be used to reduce power consumption in homes.

22. Question

What are the thing to keep in mind when buying new home electrical appliances?

Answer

The thing to keep in mind when buying a new home electrical appliances are :

1. Buying appliances with more star ratings to reduce electric consumption

2. Using CFLs and LEDs instead of bulbs and tube lights to reduce the energy consumption

3. Making the walls of the rooms with heat resistors to reduce the energy consumption of air conditioners

23. Question

If we apply 20-newton force on one object, it displaces 10 meters. Calculate the work done.

Answer

Force applied (F) = 20N

Displacement (s) = 10 m

Work done (W) = F × s

W = 20 × 10 J

W = 200J

Hence, the work done is 200 J.

24. Question

An object of 30 kg mass takes 1 minute to lift up to 2 meters. Calculate the power consumed.

Answer

Mass (m) = 30kg

Distance (s) = 2 m

Time (t) = 1minute = 60 seconds

$$\text{Power (P)} = \frac{W}{t}$$

$$P = \frac{F \times s}{t}$$

$$P = \frac{30 \times 10 \times 2}{60}$$

P = 10 Watt

Hence, the power consumed is 10 watts.

25. Question

If a bulb of 60 watts is lighted 8 hours daily then how much unit will be consumed in 30 days?

Answer

Power (P) = 60 W = $\frac{60}{1000} = 0.06\ \text{kW}$

Unit consumed per day = 0.06 × 8 = 0.48 kWh

Unit consumed in 30 days = 0.48 × 30 = 14.4 kWh = 14.4 units

Hence, unit consumed by the bulb in 30 days is 14.4 units.

26. Question

What do you mean by work? How the work done is calculated if the direction of force is different than the direction of displacement. Explain with example.

Answer

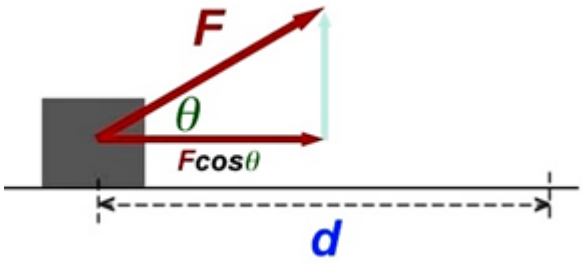
Work is done when a force is applied to move any object from rest or change the speed of any moving object. Work is a scalar quantity and it can be positive or negative.

Mathematically, work(W) is the product force and displacement.

W = F × S

Then,

W = Fcosθ × s



If the block is given force in a direction making an angle of θ with the direction of propagation of the block, then the work done is given by

W = Fcosθ × s

27. Question

On applying force F on a moving object, its velocity increases from u to v. If the distance covered is s then calculate the change in kinetic energy.

Answer

Let, initial velocity = u

Final velocity = v

We know that according to third Law of kinematics:-

$v^2 = u^2 + 2as$

$\therefore a = \frac{v^2-u^2}{2s}$

According to Newton's second law of motion:-

F = ma

(Putting the value of a in the above equation)

$$F = m\left(\frac{v^2 - u^2}{2s}\right)$$

$$\Rightarrow F.S = \frac{1}{2}m(v^2 - u^2)$$

Initial kinetic energy = $\frac{1}{2}mu^2$

Final kinetic energy = $\frac{1}{2}mv^2$

The change in kinetic energy =

Final kinetic energy - Initial kinetic energy

The change in kinetic energy = $\frac{1}{2}m(v^2 - u^2)$

28. Question

What is potential energy? If the spring constant of a standard spring is K and the spring is compressed to x distance. Find the formula to calculate earned potential energy.

Answer

Potential energy is the energy which is stored in an object due to the virtue of its shape and position.

In the spring the potential energy is stored due to the change in the shape of the spring.

If the potential energy is E_p ,the mass of the bob of the pendulum be m, the displacement of the bob be x, then

$$E_p = \frac{\frac{1}{2}(mg)}{l} \times x^2$$

If

$$k = \frac{(mg)}{l}$$

Then

$$E_p = \frac{1}{2}kx^2$$

29. Question

An object is moving with constant speed v. The mass of an object is m then how much work will be done to bring the object in rest position?

Answer

The speed of the object = v

Mass of the object = m

The work done by the object is equal to the change in kinetic energy

Initial kinetic energy = 0

Final kinetic energy = $\frac{1}{2}mv^2$

The work is done = $\frac{1}{2}mv^2$ - 0

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

30. Question

What do you understand by mechanical energy conservation?

Answer

According to the law of conservation of mechanical energy, the mechanical energy of the body remains constant. If the kinetic energy increases then h potential energy will decrease and vice versa.

31. Question

An object is falling freely from a height? Its potential energy decreases. How the process of mechanical energy conservation takes place in the action?

Answer

When a body is at a certain height then its potential energy is the maximum. When the body starts to fall from that height its potential energy decreases while its kinetic energy goes on increasing. Hence, the law of conservation of mechanical energy remains constant.

32. Question

How the energy dissipation takes place?

Answer

Energy is dissipated in three forms of energy. They are:

1. Heat energy: When work is done some amount of energy is wasted due to friction or air resistance in the form of heat.

2. Light energy: In burning some amount of energy is wasted in the form of light

3. Sound energy: In friction and collision some amount of energy is wasted in the form of sound.

33. Question

How the dissipation takes place from the generation of electricity to the home?

Answer

Electricity is transferred from the place of generation to the houses through overhead electric wires. During this transmission some amount of electric energy is dissipated in the form of heat energy.

34. Question

How the work energy and power are related to each other?

Answer

Power is defined as the rate of doing work or the rate of transfer of energy.

Mathematically, power is given by

$$\text{Power (P)} = \frac{\text{Work done}}{\text{time}}$$

SI unit of power is Watt.

35. Question

What do you understand by electrical energy? How the electrical energy is produced by coal power plants?

Answer

The amount of energy possessed by the charged particles is called electric energy.

Electric energy is produced by the coal power plants, where the coal is burned to generate heat energy. This heat energy whichis generated is used to turn heavy water into steam that rotates the turbine which in turn generate electricity.

36. Question

How the electricity generated by the hydro-electric power plant?

Answer

In hydro power plants the potential energy of water is increased by storing it into dams. The energy is converted into kinetic energy of water and this kinetic energy is used to rotate the turbine. The generators connected with the turbine generate electricity.

37. Question

How can we reduce the dissipation of energy?

Answer

The methods to reduce the dissipation of energy:-

1. The home appliances like TV, microwave, washing machine must be kept in standby mode when not in use

2. Buying appliances with more star ratings to reduce electric consumption

3. Using CFLs and LEDs instead of bulbs and tube lights to reduce the energy consumption

4. Making the walls of the rooms with heat resistors to reduce the energy consumption of air conditioners

38. Question

What is electrical power? How the electricity consumed in our houses is calculated? Explain with example.

Answer

The rate of transformation of electric energy in an electric circuit is called electric power.

The electricity consumed in our houses is measured in kilowatt-hour (kWh), also called units.

Example: If a 60 W bulb is used for 10 hrs then the electricity consumed by the bulb is $\frac{60}{1000} \times 10$

= 0.6 kWh = 0.6 units

39. Question

When we light a bulb by pressing the switch, then explain the energy transformation which takes place.

Answer

The battery stores chemical energy, when the switch is closed this chemical energy transforms into electrical energy and flows through the wire which is then converted into light energy as the bulb glows.

40. Question

What is energy? Prove that the work done by any object is equal to the difference of two energies present in the object.

Answer

The capacity of doing work is known as energy.

Mechanical energy has two types:

1. Kinetic energy- The energy possessed by any moving object by virtue of its motion is called kinetic energy

2. Potential energy- The energy possessed by a body by virtue of its shape and position.

The unit of energy is joule.

The work done (W) by a body is given by

$W = F \times s$

$W = ma \times s$

Now, if the body of mass m has initial velocity and final velocity as u and v respectively, then

$$v^2 - u^2 = 2as$$

$$as = \frac{1}{2}(v^2 - u^2)$$

So,

$$W = m \times \frac{1}{2}(v^2 - u^2)$$

$$W = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$$

W = Final Kinetic energy-initial kinetic energy

W = Change in kinetic energy

41. Question

What is electrical energy? How electrical energy is generated in the following power plant? Explain

(a) Hydro electric power plant (b) Wind energy power plant (c) Solar energy power plant.

Answer

The energy possessed by charged particles is called electrical energy.

Electrical energy is generated in the power plants in the following way:

(a) Hydro electric power plant: In hydro power plants the potential energy of water is increased by storing it into dams. The energy is converted into kinetic energy of water and this kinetic energy is used to rotate the turbine. The generators connected with the turbine generate electricity.

(b) Wind energy power plant: In windmills, the kinetic energy of the winds is used to rotate the turbine and generate electricity by the turbines.

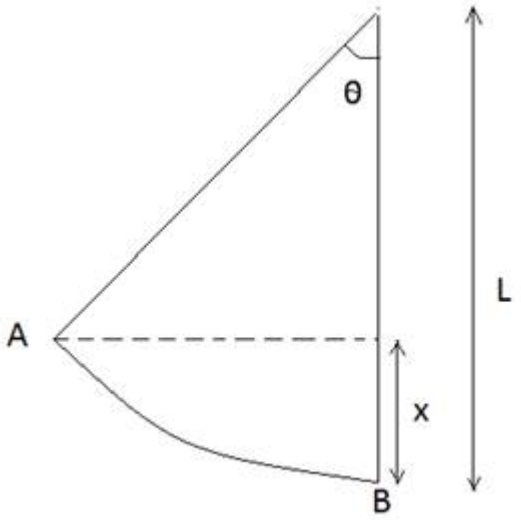
(c) Solar energy power plant: In solar panels, the energy is produced by the solar cells; they convert solar energy into electrical energy.

When the rays fall on solar panel these cells accept photons and activate electrons. These charged particles flow in the form of electric current in the circuit.

42. Question

The total energy in an ideal simple pendulum is conserved. Calculated the energy in the different states of the pendulum and justify this statement.

Answer



In the position A, the total energy (E) of the pendulum is potential energy (U) and at point B the total energy of the pendulum is kinetic energy (K).

From the figure, x = l-lcosθ

A:

The total energy at A is given by,

E = U = mgx

E = mgl(1-cosθ)

B:

The total energy at B is given by,

$$E = K = \frac{1}{2}mv^2$$

The velocity of the bob of the pendulum at B is

$$v^2 - u^2 = 2as$$

$$v^2 - 0 = 2gx$$

$$v^2 = 2gl(1 - \cos\theta)$$

So, the kinetic energy is

$$K = \frac{1}{2}m \times 2gl(1 - \cos\theta)$$

$$K = mgl(1 - \cos\theta)$$

Hence, the total energy at A and B are same and we can say that the total energy of a pendulum remains constant.

43. Question

Explain different types of energy dissipation in energy transformation. How can these dissipation reduced ?

Answer

Energy is dissipated in three forms of energy. They are:

1. Heat energy: When work is done some amount of energy is wasted due to friction or air resistance in the form of heat.

2. Light energy: In burning some amount of energy is wasted in the form the form of light

3. Sound energy: In friction and collision some amount of energy is wasted in the form of sound.

The methods to reduce the dissipation of energy:-

1. The home appliances like TV, microwave, washing machine must be kept in standby mode when not in use

2. Buying appliances with more star ratings to reduce electric consumption

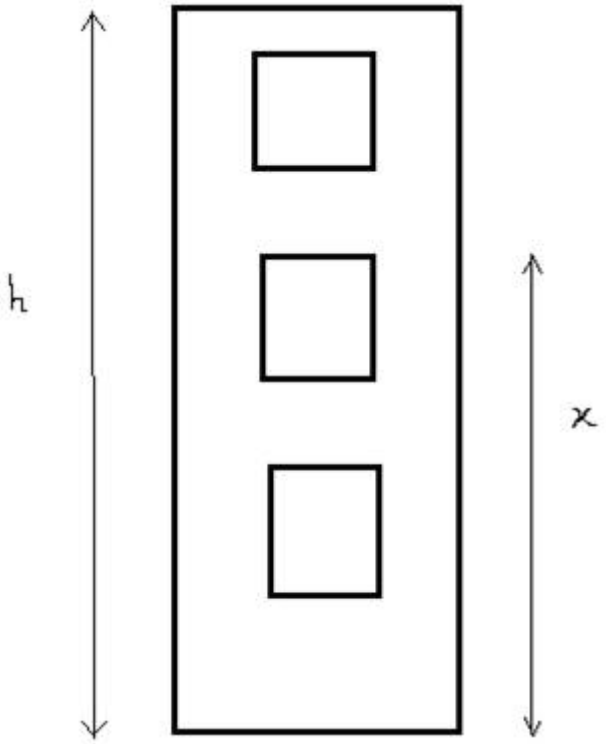
3. Using CFLs and LEDs instead of bulbs and tubelights to reduce the energy consumption

4. Making the walls of the rooms with heat resistors to reduce the energy consumption of air conditioners

44. Question

Prove that the mechanical energy of a freely falling object in the gravitational field remains constant at every point.

Answer



In the figure, the height of the building is h and let the object be at a height x above the ground level.

1: The total energy(E) of the object when it was at the top of the building was potential energy(U)

E = U = mgh

2: The total energy of the object when at a height of x above the ground level is partly kinetic energy (K) and potential energy.

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

The velocity v of the object is gien by,

$$v^2 - u^2 = 2as$$

As the initial energy is 0,

$$v^2 = 2g(h - x)$$

So,

$$K = \frac{1}{2}m \times 2g(h - x)$$

$$K = mg(h - x)$$

Now the potential energy is

U = mgx

Hence, the total energy of the object is

E = K + U = mg(h-x) + mgx

E = mgh

Hence, it is proved that the mechanical energy of freely falling on object in gravitational the eld remain constant remains point as x is any arbitrary distance.

45. Question

An electron is moving with the velocity of 1.2 x 10^6m/s. If the mass of an electron is 9.1 x 10 $^-$31 kg, then find its kinetic energy.

Answer

velocity of electron = 1.2 × 10^6 m/s

mass of electron = 9.1 × 10^{-31} Kg

Kinetic energy is given by,

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

$$K = \frac{1}{2} \times 9.1X10^{-31} \times (1.2 \times 10^6)^2$$

$$K = \frac{\frac{1}{2} \times 9.1 \times 1.44}{10^{19}}$$

$$K = 6.552 \times 10^{-19}J$$

Hence, the kinetic energy of the electron is $6.552 \times 10^{-19}J$

46. Question

A machine lifts an object of 40 kg mass up to the height of 10 m, then calculate the work done. (g = 9.8 m/s_2).

Answer

Mass of object (m) = 40 Kg

Height (h) = 10 m

Work done(W) = F × s

W = 40 × 9.8 × 10

W = 3920 J

Hence, the work is 3920 J.

47. Question

An object of mass 6 kg falls from the height of 5 m. Calculate the change in potential energy of the object .

Answer

Mass of object (m) = 6Kg

Height (h) = 5m

Change in potential energy is given by,

$= mg(h_2 - h_1)$

$= 6 \times 9.8 \times (5-0)$

$= 6 \times 9.8 \times 5$

= 294 J

(Height of ground level is 0m)

Hence, the change in potential energy is 294 J.

48. Question

A spring constant is 4×10^3 N/m. How much work will be done to compress the spring to 0.04 m?

Answer

Spring constant (k) = 4×10^3 N/m

Compression of the spring (x) = 0.04m

Work done by the spring is equal to the potential energy produced,

$$W = \frac{1}{2}kx^2$$

$$W = \frac{1}{2} \times 4 \times 10^3 \times (0.04)^2$$

$$W = 2 \times 16 \times \left(\frac{10^3}{10^4}\right)$$

$$W = \frac{32}{10}$$

W = 3.2 J

Hence, the work done by the spring is 3.2 J.

49. Question

To stretch a spring 0.02 m, work done is 0.4 J. Calculate spring constant.

Answer

Compression (x) = 0.02 m

Work done (w) = 0.4 J

Work done by the spring is equal to the potential energy produced,

$$W = \frac{1}{2}kx^2$$

$$k = \frac{2W}{x^2}$$

$$k = \frac{2 \times 0.4}{0.02^2}$$

$$k = \frac{0.8}{0.004}$$

$$k = 2000\text{Nm}^{-1}$$

Hence, the spring constant is 2000Nm^{-1}.

50. Question

Calculate the power consumed by an engine to lift a mass of 200 kg up to 50 m is 10 seconds.(g = 10 m/s^2).

Answer

Mass of object (m) = 200Kg

Height (h) = 50m

Time (t) = 10 s

Power is given by,

$$P = \frac{W}{t}$$

$$P = \frac{200 \times 10 \times 50}{10}$$

$$P = 10000\,W$$

Hence, power of the engine 10000 W.

51. Question

5 appliances are used 10 hours per day in a house. Out of which 2 appliances are of 200 w and three are of 400 W. Then calculate the amount electric energy consumed in units.

Answer

Power of the appliances = 200W , 400W

= 0.2kW, 0.4kW

Power consumed by the 200W appliances = 2 x 10 x 0.2 = 4 kWh = 4 units

Power consumed by the 400W appliances = 3 x 10 x 0.4 = 12 kWh = 12 units

Total power consumed by the 5 appliances = 4 + 12 = 16 units

52. Question

A force is applied on a body moving with speed of 2 m/s and its mass is 40 kg after appling the force its velocity increases to 5 m/s. Calculate the work done by the force.

Answer

Mass of body (m) = 40 Kg

Initial speed (u) = 2 m/s

Final speed (v) = 5 m/s

The work done by the body is equal to the change in kinetic energy.

$$W = K.E. = \frac{M(v^2 - u^2)}{2}$$

$$\mathrm{W} = \frac{1}{2}\mathrm{m}(\mathrm{v}^2 - \mathrm{u}^2)$$

$$\mathrm{W} = \frac{1}{2} \times 40 \times (5^2 - 2^2)$$

W = 420 J

Hence, the work done by the body is 420 J.

53. Question

An object of 50 kg mass is lifted from the earth surface to the height of 3 meters. Calculate its potential energy If this object is allowed to fall free then calculate its kinetic energy when it is at accurate half of the path.

Answer

Mass of the object (m) = 50 Kg

Height (h) = 3 m

Total potential energy = mgh

= 50 × 9.8 × 3

= 1470 J

According to the conservation of energy, the amount of potential energy lost is equal to the amount of kinetic energy gained.

So, the required kinetic energy is half the potential energy.

Hence, kinetic energy is

$$K = \frac{\text{Potential energy}}{2}$$

$$K = \frac{1470}{2}$$

$$k = 735\ J$$

54. Question

A block of 8 kg is moving with speed of 4 m/s on a frictionless surface. The block into the rest position by compressing the spring. The spring constant is 2×10^2 N/m. How much will the spring compressed?

Answer

Mass of the block (m) = 8 Kg

Velocity of the block (v) = 4m/s

Spring constant (k) = 2×10^2 N/m

The kinetic energy of the block will be converted into the potential energy of the spring.

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

$$x = \sqrt{\frac{mv^2}{k}}$$

$$x = \sqrt{\frac{8 \times 4^2}{2 \times 10^2}}$$

$$x = \sqrt{\frac{64}{100}}$$

$x = \sqrt{0.64}$

$x = 0.8$ m

Hence, the compression of the spring is 0.8 m.