Work, Power, Energy

1. If the power of a motor is 100 kW, at what speed can it raise a load of 50,000N? **[2]**

(2017)

Answer:

P = Fυ,

$\therefore$ υ = $\frac{P}{F}$

= $\frac{100000}{50000}$

= 2 ms^{-1}

2. A boy weighing 40 kgf climbs up a stair of 30 steps each 20 cm high in 4 minute and a girl weighing 30 kgf does the same in 3 minutes. Compare:
(i) The work done by them.
(ii) The power developed by them.

(2016)

Answer:
(i) Given: m_1 = 40 kgf, m_2 = 30 kgf,
$h_1 = h_2$,
t_1 = 4 minutes = 4 x 60 sec,
t_2 = 3 minutes = 3 x 60 sec.
Comparing work done by them:

$$\frac{\text{Work done by a boy}}{\text{Work done by a girl}} = \frac{m_1gh_1}{m_2gh_2} = \frac{m_1}{m_2} = \frac{40}{30} = 4:3$$

(ii) Comparing power developed by them :

$$\frac{\text{Power developed by boy}}{\text{Power developed by girl}}$$

$$= \frac{\text{Work done by boy/time taken to climbs up the stairs in seconds}}{\text{Work done by girl/time taken to climbs up the stairs in seconds}}$$

$$= \frac{\frac{2400}{4 \times 60}}{\frac{1800}{3 \times 60}}$$

$$= \frac{2400}{4 \times 60} \times \frac{3 \times 60}{1800} = 1 : 1$$

3. An enemy plane is at a distance of 300 km from a radar. In how much time the radar will be able to detect the plane? Take velocity of radio waves as 3×10^8 m s^{-1}. **[2]**

(2017)

Answer:
Distance between plane and radar, d = 300 km
Distance travelled by radio waves, D = 2d = 2 × 300 = 600 km
= 600×10^3 km
Speed of radio waves = 3×10^8 m/s
Time take to detect the waves = t = $\frac{D}{v}$
t = $\frac{600 \times 10^3}{3 \times 10^8}$ = 2×10^{-3} s

4. State two causes of energy loss in a transformer. **[2]**

(2017)

Answer:
Copper loss and iron loss

5. How is work done by a force measured when the force :
(i) is in the direction of displacement.
(ii) is at an angle to the direction of displacement. **[2]**

(2015)

Answer:

(i) Work done by a force when the force is in the direction of displacement = Force × Displacement of the point of application of the force in the direction of force.
(ii) Work done by a force when the force is at an angle [θ] to the direction of displacement = Force × component of displacement in the direction of force = Force × S cos θ
[S is the displacement of the body at the angle θ to the direction of force]

6. State the energy changes in the following while in use :
(i) Burning of a candle.
(ii) A steam engine. **[2]**

(2015)

Answer:
Energy changes :
(i) Burning of a candle: Chemical energy to light energy.
(ii) Steam engine: Chemical energy of coal first changes to heat energy of steam and then heat energy charges into mechanical energy.

7. 1 kWh = ……….. J.

(2015)

Answer:
1 kWh = 3.6×10^6 J.

8. Rajan exerts a force of 150 N in pulling a cart at a constant speed of 10 m/s. Calculate the power exerted.

(2015)

Answer:
Given : Force = 150 N, Speed = 10 m/s.
Power = Force × Speed
= 150 × 10
= 1500 Watt.

9. Is it possible to have an accelerated motion with a constant speed ? Explain.

(2014)

Answer:
Yes. The velocity of particle in circular motion is variable or the circular motion is accelerated even though the speed of particle is uniform.

10. (i) When does a force do work ?
(ii) What is the work done by the moon when it revolves around the earth ?
(2014)

Answer:
(i) Work is said to be done only when the force applied on a body makes the body moves (i.e., there is displacement of the body).
(ii) The work done by the moon when it revolves around the earth is zero.

11. Calculate the change in the Kinetic energy of a moving body if its velocity is reduced to 113rd of the initial velocity.
(2014)

Answer:

Given : **Initial velocity** $= v$; **Final velocity** $= \frac{v}{3}$

$$\text{Initial kinetic energy } k_1 = \frac{1}{2} \times m \times v^2$$

$$\text{Final kinetic energy } k_2 = \frac{1}{2} \times m \times \left(\frac{v}{3}\right)^2 = \frac{1}{9} \times \frac{1}{2} mv^2$$

$$\begin{aligned}\text{Change in kinetic energy} &= \frac{1}{2} mv^2 - \frac{1}{9} \times \frac{1}{2} mv^2 \\ &= \frac{1}{2} mv^2 \left(1 - \frac{1}{9}\right) \\ &= \frac{8}{9} \times \frac{1}{2} \times mv^2 \\ &= \frac{8}{9} \times \text{Initial kinetic energy.}\end{aligned}$$

12. State the energy changes in the following devices while in use:
(i) A loud speaker.
(ii) A glowing electric bulb.
(2014)

Answer:
(i) Electrical energy converted to sound energy.

(ii) Electrical energy converted to light and heat energy.

13. (i) What is nuclear energy ?
(ii) Name the process used for producing electricity using nuclear energy.

(2014)

Answer:
(i) In nuclear fission and fusion there is a loss in mass due to loss in mass energy is released. The energy so released is called the nuclear energy.
(ii) Nuclear fission.

14. State one important advantage and disadvantage each, of using nuclear energy for producing electricity.

(2014)

Answer:
Advantage: A very small amount of nuclear fuel can produce a tremendous amount of electricity energy.
Disadvantage: Very harmful nuclear radiations are produced in the process which are highly energetic and penetrating.

15. (i) The conversion of part of the energy into an undesirable form is called ………. .
(ii) For a given height h, ………… the length l of the inclined plane, lesser will be the effort required.

(2014)

Answer:
(i) Dissipation of energy.
(ii) More.

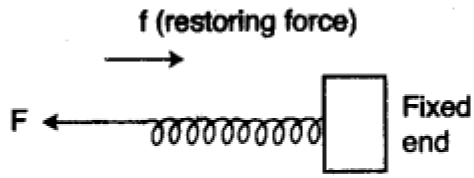
16. One end of a spring is kept fixed while the other end is stretched by a force as shown in the diagram.

(i) Copy the diagram and mark on it the direction of the restoring force.
(ii) Name one instrument which works on the above principle.

(2013)

Answer:

(i)



(ii) Spring Balance.

17. A force is applied on a body of mass 20 kg moving with a velocity of 40 ms^{-1}. The body attains a velocity of 50 ms^{-1} in 2 seconds. Calculate the work done by the body

(2013)

Answer:

$$\text{Force} = m\frac{(v-u)}{t} = m.a.$$

$$\text{Displacement} = \frac{(v^2-u^2)}{2a}$$

$$\text{Work done} = \text{Force} \times \text{Displacement}$$

$$= m.a.\frac{(v^2-u^2)}{2a}$$

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

$$W = \frac{1}{2} \times 20 \times (2500-1600)$$

$$= \frac{1}{2} \times 20 \times 900$$

$$= 9000 \text{ Joule.}$$

18. A girl of mass 35 kg climbs up from the first floor of a building at a height 4m above the ground to the third floor at a height 12m above the ground. What will be the increase in her gravitational potential energy ? (g = 10 ms^{-2}).

(2013)

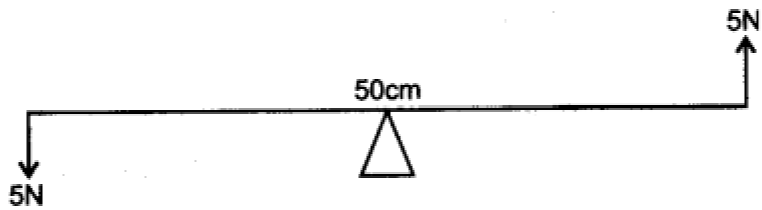
Answer:

Gravitational potential energy at 1st floor = mgh_1

= 35 × 10 × 4 = 1400 J

Potential energy at third floor = mgh_2
= 35 × 10 × 12 = 4200 J
Increase in potential energy = 4200 – 1400 = 2800 joule.

19. (i) A man having a box on his head, climbs up a slope and another man having an identical box walks the same distance on a levelled road. Who does more work against the force of gravity and why ?
(ii) Two forces each of 5N act vertically upwards and downwards respectively on the two ends of a uniform metre rule which is placed at its mid-point as shown in the diagram. Determine the magnitude of the resultant moment of these forces about the midpoint.



(2014)

Answer:
(i) Man climbs up a slope does more work because the work done by the man walking on a levelled road is zero.
(ii)

Given : $F_1 = F_2 = 5N, d_1 = d_2 = 0{\cdot}5m$

Torque $\tau = F \times d$

$\tau_1 = F_1 \times d_1 = 5N \times 0{\cdot}5\ m$
$= 2{\cdot}5\ Nm$ (Anti-clockwise)

$\tau_2 = F_2 \times d_2 = 5N \times 0{\cdot}5\ m$
$= 2{\cdot}5\ Nm$ (Anti-clockwise)

The resultant moment of force = $\tau_1 + \tau_2$
$= 2{\cdot}5 + 2{\cdot}5 = 5Nm$ in Anti clockwise direction.

20. A body is thrown vertically upwards. Its velocity keeps on decreasing. What happens to its kinetic energy as its velocity becomes zero ?

(2014)

Answer:

When a body thrown vertically upward its velocity continuously decreases, kinetic energy also decreases and potential energy increases due to increase in height.

21. (i) With reference to their direction of action, how does a centripetal force differ from a centrifugal force ?
(ii) State the Principle of conservation of energy.
(iii) Name the form of energy which a body may possess even when it is not in motion. **[3]**

(2013)

Answer:
(i) Centripetal force directed towards the centre of circle while centrifugal force is opposite to centripetal force.
(ii) Principle of Conservation of Energy : Energy can neither be created nor destroyed. It convert from one form to other form.
(iii) Potential energy.

22. A coolie is pushing a box weighing 1500 N up an inclined plane 7.5m long on to a platform, 2.5m above the ground.
(i) Calculate the mechanical advantage of the inclined plane.
(ii) Calculate the effort applied by the coolie.
(iii) In actual practice, the coolie needs to apply more effort than what is calculated. Give one reason why you think the coolie needs to apply more effort.

(2013)

Answer:
(i) Given: l = 7.5 m, h = 2.5 m.

$$\text{M.A.} = \frac{l}{h} = \frac{7 \cdot 5}{2 \cdot 5} = 3$$

(ii)

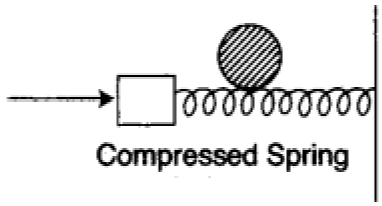
$$\text{M.A.} = \frac{\text{Load}}{\text{Effort}}$$

$$\text{Effort} = \frac{\text{Load}}{\text{M.A.}} = \frac{1500}{3}$$

$$\text{Effort} = 500 \text{ N.}$$

(iii) In actual practice, due to some friction between the plane and the bottom face of the body which is pulled over it, the effort needed is certainly more than L sin θ, so the mechanical advantage is always less than l/h, hence, efficiency is less than 1.

23. A ball is placed on a compressed spring. When the spring is released, the ball is observed to fly away.



(i) What form of energy does the compressed spring possess ?
(ii) Why does the ball fly away ?

(2012)

Answer:
(i) Potential Energy
(ii) Since P.E. is converted into K.E which transferred to the ball and makes the ball flyaway.

24. (i) State the energy conversion taking place in a solar cell.
(ii) Give one disadvantage of using a solar cell.

(2012)

Answer:
(i) Solar energy to Electrical energy.
(ii) Solar cell is not a constant source of energy.

25. A body of mass 0.2 kg falls from a height of 10m to a height of 6m above the ground. Find the loss in potential energy taking place in the body, [g = 10 ms^{-2}]

(2012)

Answer:

Given : $m = 0.2$ kg, $g = 10\ ms^{-2}$, $h_1 = 10m$, $h_2 = 6m$.

$$\text{Loss in P.E.} = mg(h_1 - h_2)$$
$$= 0{\cdot}2 \times 10 \times (10 - 6)$$
$$= 0.2 \times 10 \times 4 = 8\ J.$$

26. (i) A moving body weighing 400 N possesses 500 J of kinetic energy. Calculate the velocity with which the body is moving. ($g = 10\ ms^{-2}$)
(ii) Under what condition will a set of gears produce :
1. a gain in speed.
2. a gain in torque.

(2012)

Answer:
(i)

Let $W = mg$

$$m = \frac{400}{10} = 40 \text{ kg.}$$

We know that $K.E. = \frac{1}{2}mv^2$

$$500 = \frac{1}{2} \times 40 \times v^2$$

$$v^2 = 25$$

$\therefore$ $v = 5 \text{ ms}^{-1}$.

(ii) (1) **For gain in speed:** No. of teeth in driving wheel is greater than no. of teeth in driven wheel.
(2) **For gain in torque:** No. of teeth in driven wheel is greater than no. of teeth in driving wheel.

27. A ball of mass 200 g falls from a height of 5 m. What will be its kinetic energy when it just reaches the ground ? ($g = 9.8\ ms^{-2}$).

(2011)

Answer:

K.E. at the lowest point = P.E. at the highest point

P.E. at the heightest point = mgh

$$= \frac{200}{1000} \times 9{\cdot}8 \times 5$$

$$= 9{\cdot}8 \text{ J}$$

$\because$ K.E. when it just reaches the ground = 9·8 J.

28. (i) What is meant by an ideal machine ?
(ii) Write a relationship between the mechanical advantage (M.A.) and velocity ratio (V.R.) of an ideal machine.
(iii) A coolie carrying a load on his head and moving on a frictionless horizontal platform does no work. Explain the reason why. **[3]**

(2011)

Answer:
(i) A machine with 100% efficiency is called an ideal machine.
(ii) For an ideal machine, M.A. = V.R.
(iii) Because the angle between the force applied (vertically upwards) and displacement of load (along the horizontal) is 90°.

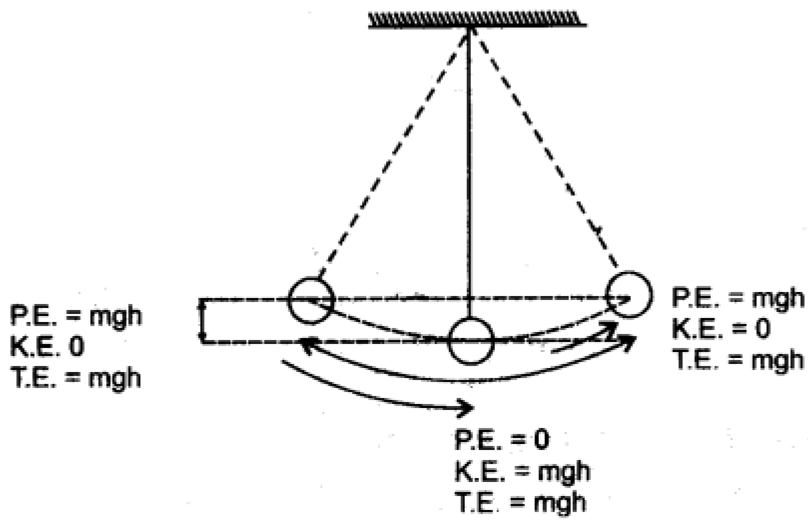
$\because$ W = Fd cos θ

$\therefore$ W = Fd cos 90° = 0

29. Draw a diagram to show the energy changes in an oscillating simple pendulum. Indicate in your diagram how the total mechanical energy in it remains constant during the oscillation. **[3]**

(2011)

Answer:

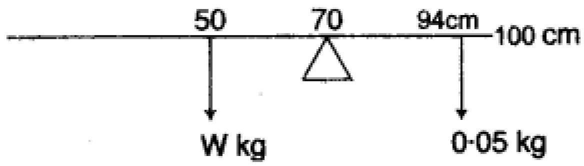


30. A uniform metre scale can be balanced at the 70.0 cm mark when a mass of 0.05 kg is hung from the 94.0 cm mark.
(i) Draw a diagram of the arrangement.
(ii) Find the mass of the metre scale. **[4]**

(2011)

Answer:

(i)



(ii)

Let W be the wt. of the scale,

By principal of moments,

$$W \times (70 - 50) = 0{\cdot}05\,(94 - 70)$$
$$20\,W = 0{\cdot}05 \times 24$$
$$W = \frac{0{\cdot}05 \times 24}{20 \times 100}$$
$$= 0{\cdot}06 \text{ kg.}$$

31. A body of mass 50 kg has a momentum of 3000 kg ms-1. Calculate :
(i) the kinetic energy of the body.
(ii) the velocity of the body.

(2010)

Answer:

Given : $m = 50$ kg, $P = 3000$ kg ms^{-1}.

$$P = m \times v \;\Rightarrow\; v = \frac{P}{m}$$
$$\Rightarrow \quad v = \frac{3000}{50} = 60 \text{ ms}^{-1}$$
$$\text{K.E.} = \frac{1}{2} m v^2$$
$$= \frac{1}{2} \times 50 \times 60 \times 60$$
$$= 90{,}000 \text{ J}$$

32. Two bodies A and B have masses in the ratio 5:1 and their kinetic energies are in the ratio 125:9. Find the ratio of their velocities.

(2019)

Answer:-
Given

$$\frac{m_A}{m_B} = \frac{5}{1} \text{ and } \frac{K_A}{K_B} = \frac{125}{9}$$

Kinetic energy is given by K=$\frac{1}{2}mv^2$

Therefore,

$$\frac{v_A}{v_B} = \sqrt{\frac{K_A m_B}{K_B m_A}} = \sqrt{\frac{125}{9} \times \frac{1}{5}} = \sqrt{\frac{25}{9}} = \frac{5}{3}$$

33. A body of mass 10 kg is kept at a height of 5 m. It is allowed to fall and reach the ground.
(i) What is the total mechanical energy possessed by the body at the height of 2 m assuming it is a frictionless medium?
(ii) What is the kinetic energy possessed by the body just before hitting the ground? Take
g= 10 m s^{-2}.

(2019)

Answer:
(i) The total mechanical energy is the total potential energy it possesses before its fall.
E = mgh = 10 × 10 × 5 = 500 J
(ii)It is equal to the maximum potential energy E = mgh = 10 × 10 × 5 = 500 J.

34. (i) State and define the SI unit of power.
(ii) How is the unit horse power related to the SI unit of power?

(2018)

Answer:
(i) The SI unit of power is watt (W). The power of an agent is said to be one watt if it does one joule of work in one second.
(ii) 1 hp = 746 W

35. State the energy changes in the following cases while in use:
(i) An electric iron.
(ii) A ceiling fan.

(2018)

Answer:-
(i) Electrical into heat energy
(ii) Electrical

36. (i) Why is the motion of a body moving with a constant speed around a circular path said to be accelerated?
(ii) Name the unit of physical quantity obtained by the formula $2K/V_2$ where K: kinetic energy, V: Linear velocity.

(2018)

Answer:
(i) Because at every point of motion the direction of speed changes i.e., the body possesses velocity which changes with time.
(ii) $J\ s^{-2}\ m^{-2}$