Important Questions for Class 9

Science

Chapter 10 – Work and Energy

Very Short Answer Questions **1 Mark**

1. What is the power of a lamp which consumes 1000 J of electrical energy in 10 s?

Ans: Power = Work/Time = 1000Joules/10seconds = 100 Watts

2. Can an object displace without applying force?

Ans: No

3. What is the SI unit of power?

(a) J/s

(b) J/s

(c) s/J

(d) J/s^2

Ans: (a) J/s

4. What will be the change in kinetic energy of a body if it starts from the rest?

(a) Positive

(b) Negative

(c) Zero

(d) It can be positive or negative, depending on the body mass.

Ans: (a) Positive.

5. Which of the following sets of quantities have similar units?

(a) Power and Energy

(b) Work and Power

(c) Energy and Work

(d) None of the above

Ans: (c) Energy and work

6. A body is present at a height 'h'. Which type of energy will it possess?

(a) Kinetic energy

(b) Potential energy

(c) Both kinetic and potential energy

(d) None

Ans: (b) Potential energy

7. What will be the work done, if a body moves in the opposite direction of the direction in which force is applied?

(a) Positive

(b) Negative

(c) Zero

(d) Cannot predicted

Ans: (b) Negative

8. What will be the work done, if the force is applied at an angle θ?

(a) $W = FSCos\theta$ Where F = Force

(b) $W = SCos\theta$ Where S = Distance

(c) $W = FSSin\theta$ Where W = work

(d) None of the above

Ans: (a) $W = FSCos\theta$ where F = Force

9. A body having mass of 5 kg is lifted vertically upto the distance of 9 meters. What will be the work done?

(a) 450 J

(b) -450 J

(c) 45 J

(d) 540 J

Ans: (a) 450J

10. What is the relation between joules (J) and ergs (erg)?

(a) $1J = 10^7 erg$

(b) 1 erg $= 10^7 J$

(c) $1J = 10^{-7} erg$

(d) None of the above

Ans: (a) $1J = 10^7$ **erg**

Short Answer Questions **2 Marks**

1. When the work is said to be done?

Ans: When a force acts on an object and moves it in the same direction that of force then work is said to be done.

2. What will be the expression for the work done when a force acts on an object in the direction of its motion?

Ans: Work done = Force × Displacement

If W is the work done, F is the force applied on object and d is the displacement, then the expression of work done will be

W = F × d

3. Explain 1 joule of work done.

Ans: When a force of 1 N (Newton) is applied on an object and that object displaces upto a distance of 1 m (meter) in the same direction of its displacement, then 1 joule (J) of work is done on the object.

4. How much work is done in ploughing a 15 m long field when a pair of bullocks applies a force of 140 N on the plough?

Ans: Since Work done (W) = Force (F) × Displacement (d)

Hence, Work done in ploughing (W) = 140 N × 15 m = 2100 J

5. The force acting on the object is 7 N, and the displacement of the object occurs in the direction of the force is 8 m. Suppose that force acts on the object through displacement, then how much work was done in this case?

Ans: As we know, Work done (W) = Force (F) × Displacement (d)

Thus, Work done in the given case (W) = 7 N × 8 m = 56 J

6. Define kinetic energy of an object.

Ans: The kinetic energy of an object is a kind of mechanical energy that exists in the object due to its state of motion (movement).

7. Write down the kinetic energy expression of an object.

Ans: If m is the mass of an moving object and v is its velocity, then the expression of its kinetic energy (KE) will be

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

8. Define power.

Ans: The rate by which work is done refers to power. It is expressed by P.

Power = Work done/Time

$$\text{P} = \text{W} / \text{t}$$

9. What is 1 watt of power?

Ans: When an object is doing work at the rate of 1 J/s, then the power of that body or object is 1 watt (where watt is the unit of power).

10. An object is thrown at an angle to the ground, moves along a curve and falls back to the ground. The start and end points of the object path are on the same horizontal line. How much work is done by the gravity on that object?

Ans: There must be a displacement to calculate the work, but since the vertical displacement in this case is zero (because the start and end points are on the same horizontal line), the work done by gravity is zero.

11. How does the state of energy get changed when a battery lights up a bulb?

Ans: The chemical energy of the battery is converted into heat and light energy of the bulb in the given case.

12. Calculate the work done by the force that changes the velocity of a moving body from $5\ ms^{-1}$ to $2\ ms^{-1}$. The body has a mass of 20 kg.

Ans: Since work done by force = Change in the kinetic energy of the moving body

Therefore, Work done by force $= \frac{1}{2} \times m\left(v_1^2 - v_2^2\right)$

$= \frac{1}{2} \times 20 \times \left(5^2 - 2^2\right)$

$= 10 \times (25 - 4) = 10 \times 21$

$= 210\,J$

13. An object having 10 kg weight is moved from point A to point B on the table. If the distance between A and B is horizontal, what work does gravity do to the object? Give the reason for the answer.

Ans: Since the work done by gravity on the object depends on the change in the vertical height of the object, the vertical height of the object will not change. Because the connection level of A and B is at the same height, the work done is zero.

14. The potential energy of an object decreases gradually in a free fall. How does this violate the law of conservation of energy?

Ans: This does not violate the law of conservation of energy, because the potential energy of an object in free fall gradually decreases with gradual changes until the kinetic energy of the object maintains the state of free fall, that is, the total energy of the object remains conserved.

15. What energy conversion occurs when riding a bicycle?

Ans: Our muscle energy is converted into mechanical energy while riding a bicycle.

16. Does energy transfer occur when you push a huge rock with all your strength without moving it? Where did the energy you applied go?

Ans: As long as you push a big rock with all your strength and do not move it, energy transfer will not occur, because cell energy is only used for muscle contraction and relaxation, and also for releasing heat (sweating).

17. A household uses 250 units of energy in a month. How much energy is used by that house in joules?

Ans: Energy consumption by a house $= 250\text{kWh}$

Since, $1\text{kWh} = 3.6\times10^{6}\text{ J}$

Hence, $250\text{kWh} = 250\times3.6\times10^{6} = 9\times10^{8}\text{ J}$

18. The output power of the electric heater is 1500 watts. How much energy does it consume in 10 hours?

Ans: Power of electric heater $(p) = 1500\,\text{W} = 1.5\,\text{kW}$

$$\text{Energy} = \text{Power} \times \text{Time} = 1.5\,\text{kW}\times10\text{ hours} = 15\text{kWh}$$

19. An object of mass m moves at a constant speed v. How much work does the subject need to do to make it stable?

Ans: For an object to be stationary, the work done must be equal to the kinetic energy of the moving object.

The kinetic energy of any object is equal to

$\text{KE} = \frac{1}{2}mv^2$, where m is the mass of the body and v is its velocity.

20. Sony said that even if different forces act on the object, the acceleration of the object can be zero. Do you agree with her, if yes, why?

Ans: Yes, we agree with Soni, because the displacement of an object becomes zero when many balancing forces act on that object.

21. Calculate the energy (in kilowatt hours) consumed by four 500 W devices in 10 hours.

Ans: Since, Energy = Power × Time

Hence, Energy consumed by four 500 W devices in 10 hours = 4 × 500 × 10 = 20000 Wh = 20 kWh.

22. Free-falling objects will eventually stop when they hit the ground. What will happen to their kinetic energy?

Ans: The object will eventually stop after it hits the ground in free fall, because its kinetic energy will be transferred to the ground when it hits the ground.

23. A large force acting on an object, and the displacement of that object is zero, what will be the work done?

Ans: The work done on the body is defined as the force exerted on the body that causes a net displacement of the body.

Work done = Force x Displacement

If the force does not cause any displacement, the work done to the object is zero.

24. Write some differences between kinetic and potential energy.

Ans: Differences between kinetic and potential energy are:

	Potential Energy		Kinetic Energy
1.	Energy possessed by an object when it is at rest.	1.	Energy possessed by an object when it is moving and having some velocity.
2.	Potential energy =Mgh Where, M= Mass g= Acceleration due to gravity h= Height	2.	Kinetic energy $KE = \frac{1}{2}mv^2$ m= Mass v= velocity
3.	Water stored in the tank has potential energy.	3.	A moving car has kinetic energy.

25. Describe the law of conservation of energy.

Ans: The law of conservation of energy says that:

1. Energy cannot be produced or destroyed. It can only be transformed from one form to another.
2. The energy of the universe is constant.

26. A person weighing 50 kg climbs the stairs with a height difference of 5 meters, within 4 seconds.

a. What kind of work is done by that person?

Ans: Mass of the man = 50 Kg

Distance moved by that man = 5 meter

Time taken to cover the given distance = 4s

Work Done = Force × Acceleration

In this case, the increase in Potential energy = Work done =Mgh
=50×10×5

$= 2500\,J$

b. What is the average power of that person?

Ans: Power $= \frac{\text{work Done}}{\text{Time Taken}} = \frac{2500}{4} = 625\text{Watts}$

27. Write differences between power and energy.

Ans: Differences between power and energy are given below:

	Power		**Energy**
1.	Work done per unit time or the rate of work done is power.	1.	Energy is the ability of a body to do work.
2.	SI unit of power is Joule/second.	2.	SI unit of energy is Joule.

28. Write down the expressions for

a. Potential energy of an object

Ans: The expression for Potential energy of an object = P.E = mgh

Where, m = Mass of Body

g = Acceleration due to gravity

h = Height

b. Kinetic energy of an object

Ans: The expression for Kinetic energy of an object $=\frac{1}{2}mv^2$

Where, m = Mass of body

v = Velocity of body

29. If a force of 12.5 N is applied to complete a work of 100 J, what is the distance covered by the force?

Ans: W = Work = 100 J

$F =$ Force $= 12.5\,\text{N}$

And S is the distance moved or displacemet

$W = FS$

$100 = 12.5 \times \text{S}$

$\frac{100 \times 10}{12.5} = S$

$\frac{1000}{125} = S$

$8m = S$ (Displacement)

30. A car weighing 1800 kg is moving at a speed of 30 m/s when braking. If the average braking force is 6000 N, it is determined that the vehicle has traveled to a standstill distance. What is the distance at which it becomes stable?

Ans: $M =$ Mass of the car $= 1800\text{Kg}$

$V =$ Velocity of the car $= 30\,\text{m/s}$

F = Force applied while braking $= 6000$

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

$\text{KE} = \frac{1}{2} \times 1800 \times 900$

$KE = 810000\,\text{J}$

KE of car = Work done by the car = Force $\times$ Displacement

$810000 = 6000 \times$ Displacement

$\frac{810000}{6000} =$ Displacement

$135m =$ Displacement

Short Answer Questions **3 Marks**

1. The kinetic energy of an object with mass m moving at a speed of 5 m per second is 25 J. If its speed doubles, what is its kinetic energy? What is its kinetic energy when its speed triples?

Ans: As from the question,

$\text{K.E. of the object } = \frac{1}{2} \times m \times (5)^2$

$25 = \frac{1}{2} \times m \times 25$

$m = (25 \times y2) / 25 = 2\,\text{kg}$

If velocity is doubled,

$K.E. = \frac{1}{2} \times 2 \times 10^2 = 200/2 = 100\,\text{J}$ i.e. K.E. will become four times If velocity is increased three times

$K.E = \frac{1}{2} \times 2 \times 15^2 = 225J$ i.e. K.E. will become nine times.

2. What do you understand about average power?

Ans: The agent may not always be able to complete the same amount of work in a given time period. In other words, the power of this work will change over time. Therefore, in this case, we can take the average power of the work done by the body per unit time (that is, the total energy consumed divided by the total time).

3. Take a look at the steps below. Based on your understanding of the word "work", prove whether the work will proceed.

- **Suma swims in the pond.**
- **The donkey carries a heavy load.**
- **The windmill draws water from the well.**
- **Green plants perform photosynthesis.**
- **The trains are pulled by engines.**
- **Drying food grains in the sun.**
- **Sailing boats are powered by wind.**

Ans: The work is said to be done when a force acts on an object and moves in the direction of the force. According to this explanation, the following activities were taken in which work will be proceeded:

- Suma swims in the pond.
- The donkey carries a heavy load.
- The windmill draws water from the well.
- The trains are pulled by engines.
- Sailing boats are powered by wind.

4. An object weighing 40 kg rises to a height of 5 m above the ground. What is its potential energy? If you let an object fall, find the kinetic energy when it is in the middle.

Ans: Potential energy of the object $= P.E = mgh = 40 \times 10 \times 5 = 2000$ Joules

Height at which object is present when it is in the middle $= 2.5\text{m}$

As the object is thrown from the rest, hence, its initial velocity $= 0$

Since $v^2 = u^2 + 2gh$

$v^2 = 0 + 2 \times 10 \times 2.5$

$v^2 = 50$

$\text{Kinetic energy } = \frac{1}{2} \times m \times v^2$

$KE = \frac{1}{2} \times 40 \times 50 = 1000\,\text{J}$

5. A satellite is moving around the earth. What will be the work done by the force of gravity on that satellite? Give justification.

Ans: The displacement made by the object is perpendicular to the force direction as it is moving on a round path.

$\theta = 90^\circ$

$W = F \times s \operatorname{Cos} \theta \quad W = F \times 0 = 0$

$W = F \times s \operatorname{Cos} 90^\circ$

Therefore, work done is zero.

6. A person will feel tired if he puts a bundle of hay on his head for 30 minutes. What will be the work done by the person? Prove your answer.

Ans: When a person lifts a bundle of hay above their head for 30 minutes and feels tired, they exert an upward force, and the bundle of hay moves forward perpendicular to the direction of the applied force, so the displacement is zero.

$W = F \times s \operatorname{Cos} \theta$

$W = F \times s \operatorname{Cos} 90^\circ$

$W = F \times 0 = 0$

Hence, no work done.

7. The law of conservation of energy is explained by discussing the energy changes that occur when we move the pendulum laterally and swing it. Why

does the pendulum eventually stop? What happens to the energy and does it violate energy conservation law?

Ans: Bob will eventually stop due to the friction created by the air and the rigid support that holds the thread in place. This does not violate the law of conservation of energy, because mechanical energy can be converted into another unusable form of energy for some useful work. This energy loss is called energy dissipation.

8. How much work is done to stop a car of weight 1500 kg moving with a velocity 60 km/h?

Ans: Given that, initial velocity of a car

$= 60\,\text{km/h} = (60\times1000)/60\times60 = 50/3\,\text{ms}^{-1}$

The object is stopped, thus, its final velocity $=0$

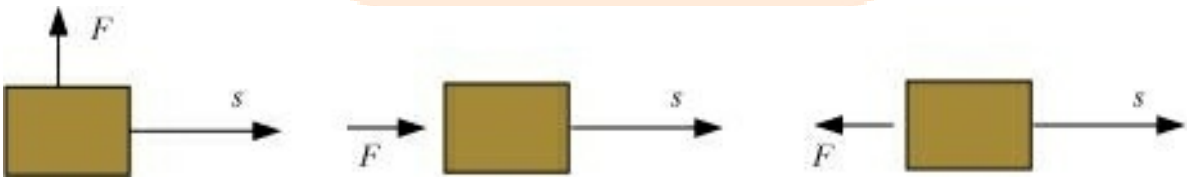
Initial kinetic energy $=\frac{1}{2}\times m\times v^2$

$KE=\frac{1}{2}\times1500\times(50/3)^2=208333.30J$

Final kinetic energy $=\frac{1}{2}\times1500\times0=0$

Therefore, work done = change in kinetic energy $=208333.30-0=208333.30J$

9. In each of the following cases, the force F acts on an object of mass m. The direction of the object's movement is from west to east and is indicated by the longest arrow. Check the given diagram carefully to see if the work done by the force is negative, positive, or zero.



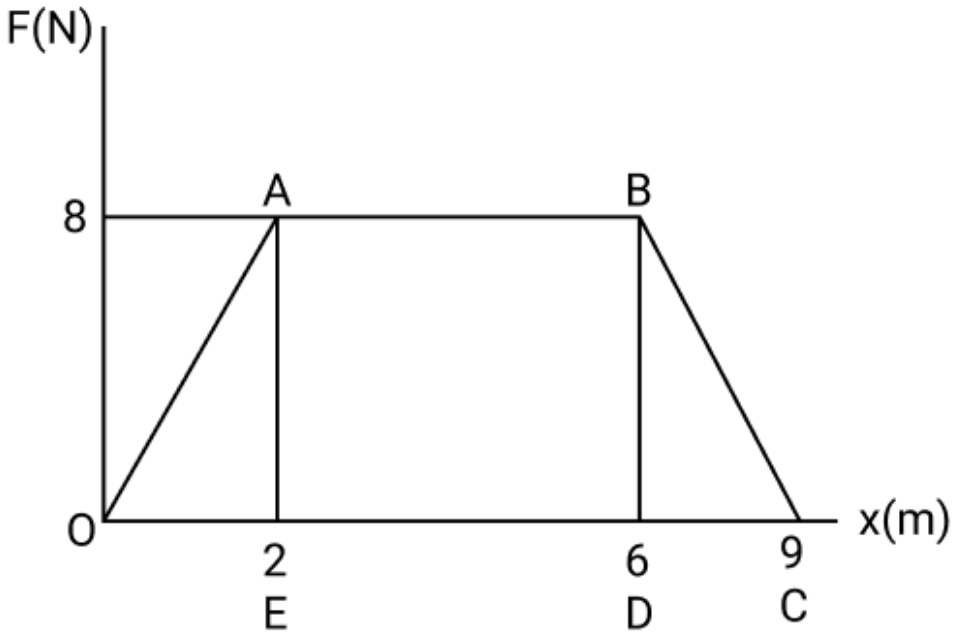
Ans: So as per the figure, following are the observations:

(i) Since the displacement in the first figure is perpendicular to the direction of the force, the work done is zero.

(ii) Since the displacement in the second figure is in the direction of the force, the work done is positive.

(iii) Since the displacement in the third diagram is opposite to the applied force, the work done is negative.

10. In the given force-displacement plot, calculate the work done in the time interval of



a. 0 < x < 2 m

Ans: The area of force-displacement plot gives the work done, therefore,

For time interval of $0 < x < 2\,\text{m}$

Work Done = Area of triangle OAE

$W = \frac{1}{2} \times \text{Base} \times \text{Height}$

$W = \frac{1}{2} \times OE \times AE$

$W = \frac{1}{2} \times 2 \times 8$

$W = 8\text{J}$

b. 2 < x < 6 m

Ans: For time interval of $2 < x < 6\text{m}$

Work Done = Area of rectangle ABED

$W =$ Length $\times$ Breadth

$W = AB \times BD$

$W = 4 \times 8$

$W = 32J$

c. 0 < x < 9 m

Ans: For time interval of $0 < x < 9\text{m}$

Work Done = Area of triangle DBC

$\text{W} = \frac{1}{2} \times \text{B} \times$ Height

$W = \frac{1}{2} \times DCBD$

$W = \frac{1}{2} \times 3 \times 8$

$W = 12J$

11. Derive the expression of the kinetic energy of an object. Calculate the kinetic energy of a 5 kg object moving at a speed of 2.5 ms^{-1}.

Ans: The kinetic energy of the body is defined as energy with the dignity of body movement.

An object with mass m is at rest. The force F N acting on it will cause acceleration ms^{-2}, assuming the velocity is v ms^{-1} and covering the distance s m.

Now from the third equation of motion

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

$v^2 = 0 + 2as$

$0 = \frac{v^2}{2s}$

$(u = 0 \because$ body starts from rest $)$

From Newton's second law,

$F = ma$

$F = \frac{m \times v^2}{2s} = \frac{mv^2}{2s}$

Work Done on the moving Body = Kinetic energy

$W =$ Force $\times$ Distance

$W = \frac{mv^2}{2s} \times s = \frac{1}{2}mv^2$

Mass of the body $= 5\text{Kg}$

Velocity of the body $= 2.5\text{m/s}$

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

$KE = \frac{1}{2} \times 5 \times (2.5)^2$

$KE = \frac{3125}{2 \times 100}$

$KE = \frac{1562.5}{100}$

12. A stone is thrown with a velocity of 40 m/s in upward direction.

a. The potential and kinetic energy of that stone will be equal at what height?

Ans: Given that, the initial velocity of stone $= u = 0$

And its final velocity $= v = 40\,\text{m/s}$

Let the mass of the body $= M$

Kinetic energy of the body $= \frac{1}{2}mv^2$

And its potential energy $= \text{Mgh}$

Now, $KE = PE$

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

$$\frac{1}{2}m \times (40)^2 m \times g \times h$$

$$\frac{1600}{2} = gh$$

$$800 = gh$$

$$\frac{800}{10} = h$$

$$80m = h$$

b. If the stone's mass is 10 kg, what will be its potential energy?

Ans: $PE = mgh$

$$PE = 10 \times 10 \times 80 = 8000\,\text{J}$$

13. A body having mass 5 kg and constant velocity 12 m/s is lifted upwards. Calculate:

a. Force applied in lifting the body

Ans: Given that, mass of the body $= m = 5Kg$

And height upto which it lifted upwards $= h = 12\,\text{m}$.

g = Acceleration due to gravity $= 10\,\text{m/s}^2$

$\text{PE} = \text{mgh}$

$PE = 5 \times 12 \times 10 \quad PE = 600\,\text{J}$

b. Work done in lifting the body

Ans: Force =?

Work done = Potential energy of the Body

Force x Distance Moved $= 600$

$F \times 12 = 60 \quad F = 50\,\text{N}$

c. What will happen to the work done?

Ans: The work done is stored as the potential energy while lifting the body.

14. Get the expression of the potential energy of an object. Calculate PE for a body of 10 kg which is resting at a height of 10 m.

Ans: The potential energy of an object with mass $= \text{mkg}$, at height above the ground $= h\ \text{m}$

Gravitational force of attraction on that body $= \text{mgN}$

To lift that body to B height at h m above the ground.

Force applied to lift this body with a constant velocity $= \text{mgN}$

Distance moved by the body after applying force = hm

Work done in lifting the body from a to B distance = Force $\times$ Distance

$\text{W} = mg \times h = mgh$

Energy cannot be destroyed, hence, this energy is stored as potential energy in the stone.

$m = 10\text{Kg}$

$g = 10\,\text{m}/\text{s}^2$

$h = 10\,\text{m}$

$\text{P}E = \text{mgh}$

$\text{PE} = mgh = 10 \times 10 \times 10 = 1000\text{Joules}$

15. Prove that the total energy of a ball, having mass m, remains conserved when it is thrown downwards from a height of h.

Ans: According to the law of energy conservation, energy can neither be created nor destroyed, it can only be transformed from one form to another.

Consider a ball with a mass of m stationary at point A at an elevation h from the ground.

Total energy of ball at position A will be:

Potential energy of the ball = mgh

The body is at rest, hence, its KE = 0

Total energy of ball at position $A = KE + PE = 0 + mgh = mgh$

Total energy of the ball at ground (position B) will be:

When the body strikes to the ground, its elevation is equal to zero, hence, its potential energy with respect to ground $= 0$

Velocity of ball when it strikes to the ground (position $\text{B}) =$?

Its acceleration $= 0 - \text{gm}/\text{s}^2 = -\text{gm}/\text{s}2$

Total energy of the body on ground $= KE + PE = mgh + 0 = mgh$

Total energy of ball at point C will be:

Say that, the ball falls through x and be at C during its fall.

Elevation of the body at $C = h - x$

Potential energy at $C = mg(h - x)$

Let the velocity at position C will be v

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

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

$KE = \frac{1}{2}mv^2 = \frac{1}{2} \times m \times 2gx = mgx$

Total energy at $C = mg(h - x) + mgx = mgh$

It means that the total energy at all points of the fall is always the same.

16. Define power. Prove that the power = force x speed. Can you calculate the power of a 10 kg object accelerating at a speed of 10 m/s^2 and reaching a velocity of 5 m/s?

Ans: Power is the rate of work done.

$\text{Power} = \frac{\text{Work Done}}{\text{Time taken}}$ Unit of Power is watt (w)

$P = \text{Power} = \frac{\text{Work Done } (v)}{\text{ime taken } (t)}$

$P = \frac{\text{Force } (F) \times \text{ Displacement } (S)}{\text{Time taken } (t)}$

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

$\frac{S}{t} = v = \text{ Velocity}$

Mass of the object $(M) = 10\text{Kg}$

Acceleration of the object $(a) = 10\,\text{m/s}^2$

And its velocity $(v) = 5\,\text{m/s}$

$P = F \times v$

$P = Fv$

$P = M \times a \times v$

$P = 10 \times 10 \times 5$

$P = 500W$

17. What does the unit of electrical energy mean? When the meter displays 400 energy units, how much energy is consumed in joules?

Ans: The unit of electrical energy is defined as the energy consumed (or consumed) by an electrical device with an output power of 1kW in one hour.

400 units $= 144 \times 10^7 J$ or 1 unit $= 1kwh$

Now, $1kwh = 1000w \times 3600s = 3.6 \times 10^6 ws$

$1w = \dfrac{1 \text{ Joule } (J)}{1\text{second}(S)}$

$1 \text{ unit mm } Kwh = \dfrac{3.6 \times 10^6 J \times S}{S} = 3.6 \times 10^6 J$

So, if 400 units of electrical energy is consumed then,

$1 \text{ Unit } = 3.6 \times 10^6 J$

$400 \text{ Units } = 3.6 \times 10^6 \times 400 J$

$400 \text{ units } = 144 \times 10^7 J$