Class: 9th

Subject: Physics

Chapter 5: Work, Energy And Power

A Exercise MCQs

5.1. Work done is maximum when the angle between the force F and the displacement d is:

(a) 0° ✅

(b) 30°

(c) 60°

(d) 90°

5.2. A joule can also be written as:

(a) kg m s^{-2}

(b) kg m s^{-1}

(c) kg m^2 s^{-3}

(d) kg m^2 s^{-2} ✅

5.3. The SI unit of power is:

(a) joule

(b) newton

(c) watt ✅

(d) second

5.4. The power of a water pump is 2 kW. The amount of water it can raise in one minute to a height of 5 metres is:

(a) 1000 litres

(b) 1200 litres

(c) 2000 litres ✅

(d) 2400 litres

5.5. A bullet of mass 0.05 kg has a speed of 300 m/s. Its kinetic energy will be:

(a) 2250 J

(b) 4500 J

(c) 1500 J

(d) 1125 J ✅

5.6. If a car doubles its speed, its kinetic energy will be:

(a) the same

(b) doubled

(c) increased to three times

(**d**) increased to four times ✅

5.7. The energy possessed by a body by virtue of its position is:

(a) kinetic energy

(**b**) potential energy ✅

(c) chemical energy

(d) solar energy

5.8. The magnitude of momentum of an object is doubled, the kinetic energy of the object will:

(a) double

(**b**) increase to four times ✅

(c) reduce to one-half

(d) remain the same

5.9. Which of the following is not a renewable energy source?

(a) Hydroelectric energy

(b) Fossil fuels ✅

(c) Wind energy

(d) Solar energy

Important MCQs:

1. When is work said to be done?

(a) When there is force only

(b) When there is displacement only

(c) When force and displacement are in the same direction ✅

(d) When body is at rest

2. What is the formula of work when force is applied at an angle θ to the displacement?

(a) $W = F \times S$

(b) $W = F + S$

(c) $W = F \times S \times \cos\theta$ ✅

(d) $W = F / S$

3. If the angle between force and displacement is 90°, what is the work done?

(a) Maximum

(b) Minimum

(c) Zero ✅

(d) Negative

4. What is the work done if force is zero and displacement is 5 m?

(a) 5 J

(b) 0 J ✅

(c) Cannot be calculated

(d) 10 J

5. What is the SI unit of work?

(a) Newton

(b) Watt

(c) Joule ✅

(d) Pascal

6. One joule of work is done when:

(a) 1 N force moves a body through 1 m ✅

(b) 1 N force moves a body through 1 cm

(c) 1 W power is used

(d) 1 kg mass is lifted

7. What is the nature of work as a physical quantity?

(a) Vector

(b) Scalar ✅

(c) Tensor

(d) None of these

8. A man pushes a wall with full force but it does not move. What is the work done?

(a) Maximum

(b) Minimum

(c) Zero ✅

(d) Infinite

9. In a force-distance graph, what does the area under the curve represent?

(a) Speed

(b) Force

(c) Work done ✅

(d) Power

10. A person does 200 J of work in pushing a box 5 meters. What force was applied?

(a) 20 N

(b) 25 N

(c) 40 N ✅

(d) 100 N

(Solution: $W = F \times S \Rightarrow F = W / S = 200 / 5 = 40$ N)

11. What is energy?

(a) Ability to rest

(b) Ability to absorb force

(c) Ability to do work ✅

(d) Ability to gain speed

12. Which of the following is a scalar quantity?

(a) Force

(b) Work

(c) Energy ✅

(d) Velocity

13. What is the SI unit of energy?

(a) Newton

(b) Joule ✅

(c) Watt

(d) Meter

14. What kind of energy does a moving object possess?

(a) Potential energy

(b) Nuclear energy

(c) Heat energy

(d) Kinetic energy ✅

15. What is the formula for kinetic energy?

(a) KE = mgh

(b) KE = mv

(c) KE = ½ mv² ✅

(d) KE = m/v²

16. What is potential energy?

(a) Energy due to motion

(b) Energy due to position ✅

(c) Energy due to temperature

(d) Energy due to power

17. Which formula represents gravitational potential energy?

(a) PE = ½ mv²

(b) PE = mgh ✅

(c) PE = Fd

(d) PE = v/t

18. Which of the following is an example of chemical potential energy?

(a) A moving car

(b) A lifted brick

(c) Battery chemicals ✅

(d) Boiling water

19. What does the law of conservation of energy state?

(a) Energy is always lost

(b) Energy can be created

(c) Energy can only be stored

(d) Energy cannot be created or destroyed ✅

20. What happens to the total mechanical energy in the absence of friction?

(a) It decreases

(b) It remains constant ✅

(c) It increases

(d) It turns into mass

21. Which of the following is not a fossil fuel?

(a) Coal

(b) Oil

(c) Natural gas

(d) Uranium ✅

22. In fossil fuel power plants, which energy is used to run the turbines?

(a) Electrical

(b) Chemical

(c) Heat ✅

(d) Nuclear

23. The energy stored in water at a height in a dam is:

(a) Kinetic energy

(b) Electrical energy

(c) Gravitational potential energy ✅

(d) Chemical energy

24. The device which converts sunlight directly into electricity is:

(a) Generator

(b) Solar cell ✅

(c) Battery

(d) Reflector

25. Solar panels are painted black to:

(a) Reflect sunlight

(b) Cool down quickly

(c) Absorb more heat ✅

(d) Reduce cost

26. Which fuel is used in nuclear power stations?

(a) Diesel

(b) Uranium ✅

(c) Methane

(d) Coal

27. Nuclear energy is released during:

(a) Chemical reaction

(b) Evaporation

(c) Nuclear fission ✅

(d) Photosynthesis

28. Geothermal energy is found in the form of:

(a) Oil under rocks

(b) Hot rocks beneath Earth's surface ✅

(c) Wind

(d) Rivers

29. In geothermal power plant, water is pumped:

(a) Over rocks

(b) Into the air

(c) Into hot rocks through a hole ✅

(d) Into turbines directly

30. The energy of wind is used to:

(a) Heat water

(b) Rotate turbines ✅

(c) Absorb sunlight

(d) Split atoms

31. Windmills convert wind energy into:

(a) Sound energy

(b) Light energy

(c) Electrical energy ✅

(d) Nuclear energy

32. Tidal energy is obtained from:

(a) Heat of Sun

(b) Sea waves

(c) Rise and fall of sea water ✅

(d) Chemical reactions

33. Which device moves with sea waves to generate electricity?

(a) Waterwheel

(b) Salter's duck ✅

(c) Solar cell

(d) Geothermal digester

34. Biofuel is produced from:

(a) Plastic

(b) Biomass ✅

(c) Metals

(d) Coal

35. Methane-rich biogas is produced in a:

(a) Furnace

(b) Solar panel

(c) Digester ✅

(d) Generator

36. Which of the following energy sources is renewable?

(a) Coal

(b) Nuclear energy

(c) Solar energy ✅

(d) Fossil fuels

37. Why are fossil fuels considered non-renewable?

(a) They are very cheap

(b) They get depleted and take millions of years to form again ✅

(c) They produce no pollution

(d) They are found everywhere

38. Which of the following is an advantage of hydroelectric power?

(a) It causes pollution

(b) It is economical and pollution free ✅

(c) It requires high initial cost

(d) It produces radioactive waste

39. What is a major disadvantage of nuclear power?

(a) It produces noise pollution

(b) Risk of radioactive leakage and nuclear waste disposal problem ✅

(c) It is very cheap

(d) It depends on weather

40. Power is defined as:

(a) Work done × Time

(b) Work done ÷ Time ✅

(c) Energy × Distance

(d) Force × Velocity

41. Efficiency of a working system is defined as the ratio of:

(a) Total input energy to useful output energy

(b) Useful output energy to total input energy ✅

(c) Total input energy to wasted energy

(d) Useful output energy to wasted energy

42. Why can no machine have 100% efficiency?

(a) Because all energy is converted to useful energy

(b) Because some energy is always lost as heat or friction ✅

(c) Because input energy is always less

(d) Because output energy is always more

43. What is a perpetual energy machine?

(a) A machine that never stops working without energy input ✅

(b) A machine with 100% efficiency

(c) A machine that loses energy as heat

(d) A machine powered by fossil fuels

44. In the given example, a block weighing 120 N is dragged up a 20 m slope with a force of 100 N to a height of 10 m. What is the efficiency of this system?

(a) 40%

(b) 50%

(c) 60% ✅

(d) 80%

45. Which of the following causes energy loss in machines?

(a) Friction between moving parts ✅

(b) Increasing input energy

(c) Increasing useful output energy

(d) None of the above

B Exercise Short Questions

5.1. What is the work done on an object that remains at rest when a force is applied on it?

If an object remains at rest and does not move, the displacement is zero. Therefore, the work done on the object is zero.

5.2. A slow-moving car may have more kinetic energy than a fast-moving motorcycle. How is this

possible?

Kinetic energy depends on both mass and speed. A car has much greater mass than a motorcycle, so even if it moves slower, its kinetic energy can be greater.

5.3. A force F_1 does 5 J of work in 10 s. Another force F_2 does 3 J of work in 5 s. Which force delivers greater power?

- Power = Work done / Time taken
- Power by F_1 = 5 J / 10 s = 0.5 W
- Power by F_2 = 3 J / 5 s = 0.6 W
- Force F_2 delivers greater power.

5.4. A woman runs up a flight of stairs. The gain in her gravitational potential energy is 4500 J. If she runs up the same stairs with twice the speed, what will be her gain in potential energy?

The gain in potential energy depends on the height climbed, not speed. So, the gain remains 4500 J.

5.5. Define work and its SI unit.

Work is done when a force causes displacement of an object in the direction of the force.

SI unit of work is joule (J).

5.6. What is the potential energy of a body of mass m when lifted through a height h?

Potential energy = $m \times g \times h$

(where g = acceleration due to gravity)

5.7. Find an expression for the kinetic energy of a moving body.

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

(where m = mass, v = velocity)

5.8. Define efficiency of a working system. Why can a system not have 100% efficiency?

- Efficiency = (Useful output energy / Total input energy) × 100
- A system cannot have 100% efficiency because some energy is always lost as heat or other forms due to friction and other factors.

5.9. What is power? Define the unit used for it.

- Power is the rate of doing work or energy transfer per unit time.
- SI unit of power is watt (W), where 1 watt = 1 joule/second.

5.10. Differentiate between renewable and non-renewable energy sources.

Renewable Energy Sources:

1. These sources can be naturally replenished after use.

2. They are available in unlimited quantity.

3. They cause little or no pollution.

4. **Examples** include solar energy, wind energy, hydroelectricity, tidal and geothermal energy.

5. They are sustainable and environment-friendly.

Non-Renewable Energy Sources:

1. These sources cannot be replenished once they are used.

2. They are limited in quantity and will eventually run out.

3. They cause pollution and contribute to global warming.

4. Examples include fossil fuels (coal, oil, natural gas) and nuclear fuels.

5. They are not sustainable for long-term use.

Important Short Questions:

1. Define work and write its mathematical formula.

Definition: Work is said to be done when a force is applied on an object and it moves in the direction of the force.

Formula:

- **Formula:**
  $\text{Work (W)} = \text{Force (F)} \times \text{Distance (S)}$
  $W = F \times S$

2. Under what conditions is work said to be zero even when a force is applied? Give an example.

Work is zero when:

- No displacement occurs, even if force is applied.
- The force is applied perpendicular to the direction of motion.

Example:

A man pushing a wall with force, but the wall does not move. Here, force is applied, but displacement is zero, so work done is zero.

3. What is the formula for work done when force makes an angle with the direction of motion?

- When the force makes an angle θ with displacement:
  $W = F \cdot S \cdot \cos\theta$
  Where:
  - F = Magnitude of force
  - S = Displacement
  - θ = Angle between force and displacement

4. Why is no work done when a person carries a bag while walking horizontally?

- The force applied to hold the bag is upward (to balance weight),
- The displacement is horizontal,
- Since the force is perpendicular to displacement,
- Therefore, no work is done in physics.

5. Define joule. How is it related to newton and metre?

Definition: One joule is the work done when a force of one newton moves a body through a distance of one metre in the direction of the force.

- **Relation:**

$$1, \text{Joule} = 1, \text{Newton} \times 1, \text{metre}$$

$$1, J = 1, N \cdot m$$

1. What is energy?

- Energy is the ability of a body to do work.

- A body must have energy to cause motion or bring about a change.
- When work is done on a body, energy is transferred to it.
- Like work, energy is a scalar quantity.
- Its SI unit is joule (J).

6. What are the two basic forms of energy?

- The two basic forms of energy are kinetic energy and potential energy.
- **Kinetic energy** is the energy possessed by a body due to its motion.
- **Potential energy** is the energy due to position or shape of the body.
- The **combination** of these two is called **mechanical energy**.
- Different forms of energy include chemical, heat, light, and nuclear energy.

7. What is potential energy?

Potential energy is the energy a body possesses

due to its position or shape.

For example, water at a height has gravitational potential energy.

- A stretched spring has elastic potential energy.
- It is stored energy that can be used to do work.
- The formula for gravitational potential energy is Ep = mgh.

8. Write the formula for gravitational potential energy.

The **formula** is: Ep = mgh

- Where Ep is **potential energy**, m is mass, g is gravity (9.8 m/s²), and h is height.
- This formula shows how energy increases with mass and height.
- It is used to calculate the stored energy of raised objects.
- For **example**, a lifted block or water in a dam.

9. What is the SI unit of energy?

The SI unit of energy is joule (J).

- One joule is the energy used when one newton force moves a body one metre.
- It is the same unit used for measuring work.
- Energy can also be measured in kilojoules (kJ) or megajoules (MJ).
- 1 kJ = 1000 J, and 1 MJ = 1,000,000 J.

10. State the law of conservation of energy.

Energy can neither be created nor destroyed; it can only be transformed from one form to another.

11. What happens to total energy during a transformation process?

The total energy remains constant during any transformation, even if some is converted into waste energy like heat or sound.

12. What is waste energy?

Waste energy is the part of energy lost as heat due to friction or other factors and cannot be used for useful work.

13. What happens to potential and kinetic energy

when a body falls freely?

Potential energy decreases and is converted into kinetic energy as the body gains speed while falling.

14. What form of energy does a body have just before hitting the ground?

Just before hitting the ground, the body has maximum kinetic energy and zero potential energy.

15. What are fossil fuels?

Fossil fuels are natural resources like coal, oil, and natural gas that release heat energy when burned.

16. What is hydroelectric energy?

It is the energy generated by falling water, which turns turbines to produce electricity.

17. How do solar panels work?

Solar panels absorb sunlight and convert it into heat or electricity using solar cells.

18. What is geothermal energy?

It is energy extracted from hot rocks deep inside the Earth, used to generate electricity.

19. What are biofuels?

Biofuels are fuels made from organic materials like plants, waste food, or dung, and include products like biogas and ethanol.

20. What is a renewable energy source? Give one example.

A renewable energy source is one that can be naturally replenished or replaced after use. It does not run out with continuous use.

Example: Solar energy.

21. Write two examples of non-renewable energy sources.

Answer:

Two examples of non-renewable energy sources are:

1. Fossil fuels (coal, oil, natural gas)
2. Nuclear energy

22. Why is hydroelectric power considered pollution-free?

Hydroelectric power is pollution-free because it generates electricity by using the energy of flowing water without producing harmful gases or smoke.

23. What kind of pollution is caused by burning fossil fuels?

Burning fossil fuels produces smoke and releases carbon dioxide (CO_2) gas, causing air pollution and contributing to global warming.

24. Name two dangers associated with nuclear energy?

Answer:

Two dangers of nuclear energy are:

1. Leakage of harmful radioactive radiation.
2. Difficulty in disposing of nuclear waste safely.

25. Write two methods of energy production that require high initial cost but are environment-friendly.

Answer:

Two environment-friendly methods with high initial

costs are:

1. Solar power
2. Wind power

26. How is power defined?

Answer:

Power is defined as the rate at which work is done or energy is transferred in a unit of time.

27. Write the mathematical formula for power.

Answer:

$$\text{Power (P)} = \frac{\text{Work done (W)}}{\text{Time taken (t)}}$$

28. What is efficiency? Write its formula.

Answer:

Efficiency is the measure of how much input energy is converted into useful output energy.

$$\text{Efficiency} = \frac{\text{Useful output energy}}{\text{Total input energy}} \times 100\%$$

---

29. Why is 100% efficiency not possible in any machine?

100% efficiency is impossible because some energy is always lost as heat or other forms of energy due to friction, air resistance, and other unavoidable factors during energy conversion.

Important Long Questions:

Q1: Define work in physics and explain the conditions under which work is said to be done.

Definition of Work:

In physics, work is defined as the product of the magnitude of the force applied on an object and the

displacement of the object in the direction of that force.

Mathematically,

$$\text{Work (W)} = \text{Force (F)} \times \text{Displacement (S)} \times \cos\theta$$

- F is the magnitude of the force applied,
- S is the displacement of the object,
- θ is the angle between the direction of force and the direction of displacement.

If the force and displacement are in the **same direction**, then

$$\cos\theta = \cos 0^\circ = 1 \Rightarrow W = F \times S$$

Conditions for Work to be Done:

Work is said to be done only when the following two conditions are met:

1. A force must be applied on the object.

2. The object must be displaced in the direction of the force (or at an angle to it).

If either of these two conditions is not satisfied,

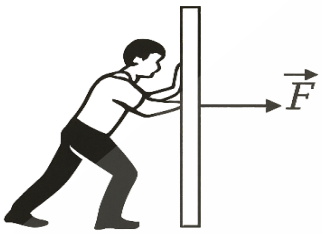
then no work is done.

Diagram:

1. Define work in physics and explain the conditions under which work is said to be done.

Answer Outline:

- Definition of work as the product of force and displacement in the direction of force
- Explain the necessity of both force and displacement for work to be done



Work formula:

$$W = F.d$$

- Work is zero if no displacement or if force is zero.
- Use example of pushing a wall (force but no displacement, so no work).

Examples to Explain the Conditions:

Example 1: Pushing a Wall (No Work Done)

Suppose a man is pushing a wall with a lot of force, but the wall does not move (i.e., displacement = 0).

Here, although a force is applied, there is no displacement, so:

$W = F \times 0 = 0$

Therefore, no work is done.

Example 2: Carrying a Bag (No Work Done)

If a person carries a bag while walking forward, the force applied is upward (to hold the bag), and the displacement is horizontal.

Since the force is perpendicular to the direction of motion:

$$\theta = 90^\circ \Rightarrow \cos 90^\circ = 0$$

W = F \times S \times \cos 90^\circ = 0]

So again, no work is done in the direction of motion.

Q2: Define Energy. Explain how energy is related to work.

Definition: Energy is defined as the ability of a body to do work.

Explanation: Energy is needed to perform any kind of work. Whether it is moving a body, heating a substance, or generating electricity—energy is

always required. When a body does work, it uses its energy. Similarly, when work is done on a body, energy is transferred to that body.

Relation with Work:

- Work is done when energy is transferred from one body to another.
- For example, when you push a swing, chemical energy from your body is transferred to the swing, making it move.
- If 1 joule of work is done on a body, then the body has gained 1 joule of energy.
- **Unit of Energy:** The SI unit of energy is joule (J).

Q3: Describe different forms of energy.

Explanation: There are many forms of energy that we observe in daily life. These include:

1. **Kinetic Energy**: Energy due to motion.
2. **Potential Energy**: Energy due to position or shape.
3. **Chemical Energy:** Stored in substances like food, batteries, or fuel.

4. **Electrical Energy:** Produced by electric currents.

5. **Heat Energy**: Energy due to temperature difference.

6. **Light Energy:** Carried by light waves.

7. **Nuclear Energy:** Energy stored in atomic nuclei, released during nuclear fission or fusion.

Note: All these energies can be converted into one another.

Q4: Define Kinetic Energy. Derive the formula for Kinetic Energy.

Definition: Kinetic energy is the energy possessed by a body due to its motion.

Derivation: Let a body of mass m be moving with velocity v. To stop it, an opposite force F is applied over a distance S.

We know that:

Work done = Force × distance = F × S

Using Newton's laws and equations of motion:

- Final velocity = 0 (since the body stops)
- Initial velocity = v
- From $v^2 = 2aS$, we get $a = \frac{-v^2}{2S}$

Using $F = ma$,
$F = m \cdot \left(\frac{-v^2}{2S}\right)$

Now work done by this force:
$W = F \cdot S = m \cdot \left(\frac{-v^2}{2S}\right) \cdot S = \frac{1}{2}mv^2$

So,

- Kinetic Energy (E_k) = ½ mv²
- SI Unit: joule (J)

Q5: Define Potential Energy. Derive the formula for Potential Energy.

- **Definition**: Potential energy is the energy possessed by a body due to its position or configuration.
- **Example**: Lifting a stone up increases its potential energy.

- **Derivation**: Let a body of mass m be lifted vertically to a height h.
- The force needed = weight of the body = mg
- Distance moved = h
- Work done = Force × Distance = mg × h
- This work is stored in the body as potential energy.

So,

- Potential Energy (E_p) = mgh
- SI Unit: joule (J)

Q6: What is fossil fuel energy? Explain with the help of a diagram how electricity is generated using fossil fuels.

Fossil fuel energy is the energy obtained by burning natural fuels like coal, oil, and natural gas. These fuels were formed millions of years ago from dead plants and animals buried under the earth.

When fossil fuels are burned:

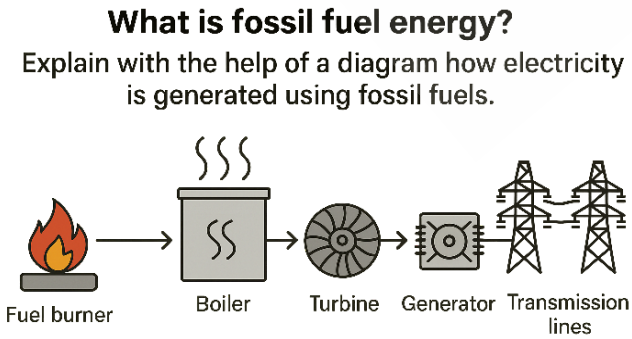
- Heat is produced.

- This heat is used to convert water into steam.
- The steam rotates turbines.
- The turbines drive generators to produce electricity.

Steps for electricity generation:

1. Coal/oil/natural gas is burned in a boiler.
2. The heat converts water into steam.
3. Steam spins the turbine.
4. Turbine turns the generator.
5. Generator produces electricity.
6. Transformer increases the voltage for long-distance transmission.

Diagram :



> **Note**: Fossil fuel energy is non-renewable and causes environmental pollution due to carbon emissions.

Q7: What is hydroelectric power generation? Describe the working of a hydroelectric power plant.

Answer:

Hydroelectric power is the electricity generated from the energy of falling or flowing water.

Working principle:

1. Water is stored in a reservoir at a height.
2. It has gravitational potential energy.
3. Water flows down through tunnels or pipes called penstocks.
4. As it falls, potential energy converts into kinetic energy.
5. Running water spins the turbine.
6. Turbine drives a generator.
7. Generator converts mechanical energy into

electricity.

8. Electricity is transferred via transmission lines.

Advantages:

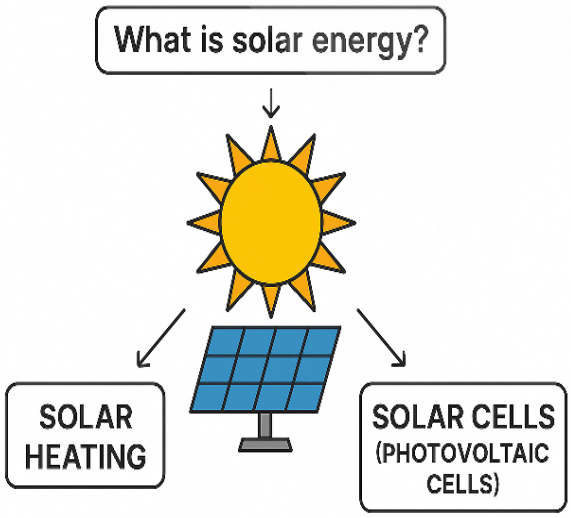
- Renewable
- No pollution
- Low operational cost

Q8: What is solar energy? Explain two methods by which solar energy can be used.

Answer:

Solar energy is the energy obtained from sunlight. The Sun is the biggest natural source of energy.

Two methods of using solar energy:



1. Solar heating system:

- Solar panels with black metal plates absorb sunlight.
- Heat is used to warm houses, heat water, or even boil water.
- Boiled water can produce steam to rotate turbines and generate electricity.

2. Solar cells (Photovoltaic cells):

- Solar cells directly convert sunlight into electricity.
- A single solar cell produces a small voltage.
- Solar panels are made by connecting multiple cells in series.
- Used in calculators, satellites, and solar cars.

> Solar energy is clean, renewable, and freely available.

Q9: What is nuclear energy? How is it used to produce electricity?

Answer:

Nuclear energy is the energy released when the nucleus of an atom splits. This process is called nuclear fission.

Main fuels used:

- Uranium
- Plutonium

Electricity generation process:

1. Nuclear fuel is placed in a reactor.
2. Fission reaction releases huge heat energy.
3. Heat is used to boil water and produce steam.
4. Steam rotates turbines.
5. Turbines drive a generator to produce electricity.

Examples in Pakistan:

Nuclear power stations are located at Karachi and Chashma.

Advantages:

- Large amount of energy from small fuel.
- No greenhouse gases.

Disadvantages:

- Radioactive waste.
- Risk of nuclear accidents.

Q10: What is geothermal energy? How is it used to generate electricity?

Answer:

Geothermal energy is the heat energy from hot rocks beneath the Earth's surface. These rocks are heated by the decay of radioactive elements.

Electricity generation:

1. Two holes are drilled.
2. Cold water is pumped down through one hole.
3. Hot rocks heat the water to produce steam.
4. Steam comes out from the second hole.
5. Steam rotates a turbine, which runs a generator.
6. Generator produces electricity.

Used in countries like:

- Iceland, Japan, Italy, USA, etc.

Advantage:

- Eco-friendly and renewable.
- Low operating cost.

Q11: Describe how tidal and wave energy are used to generate electricity.

Answer:

Tidal Energy:

- Caused by the gravitational pull of the Moon.
- High tides fill a basin behind a dam.
- Water is released at low tide, rotating turbines.
- Turbines run generators to produce electricity.

Wave Energy:

- Waves on the sea surface carry energy.
- Devices like Salter's Duck float on the waves.
- As the duck floats move up and down, they rotate a generator to produce electricity.
- Advantage: Both are renewable and environment-friendly.

Q12: What is biofuel energy? Explain how it is used to generate electricity.

Answer:

Biofuel energy is produced from biomass like:

- Animal dung
- Waste food
- Sewage
- Plant material

Methods of energy production:

1. Direct combustion:

- Solid waste is burned.
- Produces steam to run turbines and generate electricity.

2. Biogas production:

- Biomass is placed in a digester (closed tank).
- Microorganisms break it down in absence of oxygen.
- Methane-rich biogas is produced.

- Used for cooking, heating, or electricity generation.

3. Bioethanol production:

- Made from plant starch by bacteria.
- Used as fuel alternative to petrol.

Q13: Differentiate between renewable and non-renewable sources of energy.

Explain what each type is, provide examples, and discuss why renewable sources are sustainable while non-renewable ones are limited.

Answer:

Energy sources are broadly categorized into renewable and non-renewable based on their ability to be replenished.

🔄 Renewable Sources of Energy:

- These are energy sources that can be naturally replenished in a short period of time.
- They are inexhaustible and will not run out in the near future.

Examples include:

- Solar energy (from sunlight)
- Wind energy
- Hydroelectric energy (from flowing water)
- Tidal and wave energy (from sea movements)
- Geothermal energy (from the Earth's internal heat)
- These sources are environment-friendly, produce little or no pollution, and help reduce global warming.

For instance, sunlight and wind are continuously available, and rainfall and snowfall ensure a regular water supply to reservoirs for hydroelectricity.

❌ **Non-Renewable Sources of Energy:**

- These are sources that cannot be replenished in a short time.
- They are limited and once used, take millions of years to form again.

Examples include:

- Fossil fuels (coal, oil, and natural gas)
- Nuclear fuels (uranium and plutonium)
- Their excessive use leads to pollution, climate change, and global warming.
- As fossil fuels burn, they release harmful gases like carbon dioxide, contributing to environmental damage.

🌍 **Conclusion**:

Renewable energy is sustainable and eco-friendly, making it a better long-term solution. Non-renewable energy is limited and polluting, thus we must shift our focus to renewable sources to ensure a better future.

Q14: Why is it important to promote renewable energy sources in the modern world?

Discuss growing energy demands and the need to reduce reliance on polluting, limited resources.

Answer:

In the modern world, the demand for energy is

increasing rapidly due to population growth, industrialization, and urbanization. Therefore, promoting renewable energy has become very important.

🔋 Reasons to Promote Renewable Energy:

1. Growing Energy Demands:

The world's energy needs are increasing every year.

Fossil fuels are running out and may not be able to meet future energy requirements.

2. Environment Protection:

- Renewable sources such as solar, wind, hydro, and geothermal do not emit harmful gases.
- They help reduce air pollution, acid rain, and global warming.

3. Sustainability:

- Renewable energy is naturally replenished and will never run out.
- This makes it a reliable long-term energy solution.

4. Energy Security:

Countries can produce their own renewable energy and reduce dependence on imported fossil fuels.

5. Job Creation:

Renewable energy industries create millions of jobs in construction, engineering, and maintenance.

6. Public Health Benefits:

Cleaner energy reduces pollution, which leads to fewer diseases and better public health.

✅ **Conclusion**:

Promoting renewable energy is essential for a cleaner, safer, and more sustainable future. It helps us meet rising energy needs without harming the planet.

Q15: Compare the advantages and disadvantages of different energy production methods.

Include hydroelectricity, solar, wind, tidal, wave, fossil fuels, and nuclear energy. Mention cost, pollution, and reliability.

Answer:

Here is a comparison of major energy production methods based on advantages and disadvantages:

- **1. Hydroelectric Power**

Advantages:

- Renewable and eco-friendly
- No air pollution
- Low operating cost once the dam is built

Disadvantages:

- High initial cost
- Depends on water availability
- Can disturb local ecosystems

- **2. Solar Energy**

Advantages:

- Inexhaustible and clean
- No greenhouse gas emissions
- Can be used in remote areas

Disadvantages:

- High initial cost of solar panels
- Not reliable in cloudy or rainy weather
- Requires large area for panels

3. Wind Energy

Advantages:

- Clean and renewable
- No air pollution
- Low operational cost

Disadvantages:

- Wind is not constant
- Noisy and can affect landscape beauty
- Requires a lot of space

4. Tidal and Wave Energy

Advantages:

- Renewable and predictable
- No pollution
- High potential in coastal areas

Disadvantages:

- Limited to coastal regions
- Expensive to build and maintain
- Affects marine life

5. Fossil Fuel Energy (Coal, Oil, Gas)

Advantages:

- Easily available
- High energy output
- Infrastructure already exists

Disadvantages:

- Non-renewable and polluting
- Emits carbon dioxide, causing global warming
- Limited supply, will run out

6. Nuclear Energy

Advantages:

- Produces large amount of energy from small amount of fuel
- No air pollution

Disadvantages:

- Risk of radiation and nuclear accidents
- Expensive and complex waste disposal
- Dangerous for people living near power plants

📄 **Conclusion**:

Each energy method has its pros and cons. However, in today's world, renewable energy sources are more suitable for sustainable development because they are clean, safe, and long-lasting. We must move away from polluting fossil fuels and embrace green energy for a better future.

Q16: Define efficiency. Derive the formula to calculate efficiency. Also express it in percentage form.

Definition of Efficiency:

Efficiency of a system or machine is the ratio of the useful output energy obtained from the system to the total input energy supplied to it. It indicates how effectively a system converts input energy into

useful output energy.

Explanation:

- **Input Energy:** The total energy supplied to the system for it to perform work.
- **Output Energy**: The part of input energy that is converted into the desired or useful form.
- **Wasted Energy:** The part of energy lost during the process, usually as heat, sound, or friction.

Since no machine or system can convert all input energy into useful output energy due to inevitable losses, the efficiency is always less than 100%.

Derivation of the Formula:

Efficiency is defined as:

$$\text{Efficiency} = \frac{\text{Useful output energy}}{\text{Total input energy}}$$

Expressing Efficiency as a Percentage:

To express efficiency as a percentage, multiply the

above ratio by 100:

$$\text{Percentage Efficiency} = \left(\frac{\text{Useful output energy}}{\text{Total input energy}}\right) \times 100\%$$

Why is 100% Efficiency Not Possible?

- In all real systems, some energy is lost as heat due to friction between moving parts.
- Some energy is lost due to air resistance, noise, or other forms of dissipation.
- Because of these unavoidable losses, the useful output energy is always less than the input energy.
- Therefore, achieving 100% efficiency (where no energy is wasted) is impossible according to the laws of thermodynamics.

C Constructed Response Questions

5.1. Can the kinetic energy of a body ever be negative?

Answer:

No, the kinetic energy of a body can never be negative.

Kinetic energy is given by the formula:

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

Since mass m and velocity squared v^2 are always positive, kinetic energy is always a positive quantity or zero (when the body is at rest).

5.2. Which one has the greater kinetic energy; an object travelling with a velocity v or an object twice as heavy travelling with a velocity of 1/2 v?

Answer:

Answer:

Let mass of the first object be m, so its kinetic energy is:

$KE_1 = \frac{1}{2}mv^2$

The second object has mass $2m$ and velocity $\frac{v}{2}$, so:

$KE_2 = \frac{1}{2}(2m)\left(\frac{v}{2}\right)^2 = m \cdot \frac{v^2}{4} = \frac{1}{4}mv^2$

Thus,

$KE_1 = \frac{1}{2}mv^2 > \frac{1}{4}mv^2 = KE_2$

Conclusion: The object with velocity v has greater kinetic energy.

5.3. A car is moving along a curved road at constant speed. Does its kinetic energy change?

Answer:

No, its kinetic energy does not change.

Kinetic energy depends on speed and mass, not on direction. Since speed remains constant, kinetic energy remains the same even though the direction is changing.

5.4. Comment on the statement. "An object has one joule of potential energy."

Answer:

- It means that the object can do 1 joule of work due to its position.
- **For example**, if a body is raised above the ground, it gains **gravitational** potential energy. **One joule** of potential energy means it can do one joule of work when allowed to fall.

5.5. While driving on a motorway, tyre of a vehicle sometimes bursts. What may be its cause?

Answer:

- Due to high-speed driving, friction between tyre and road generates heat.
- This heat increases the air pressure inside the tyre, and if the pressure exceeds the tyre's limit, it can burst.

5.6. While playing cricket on a street, the ball smashes a window pane. Describe the energy changes in this event.

Answer:

- The moving ball has kinetic energy.
- When it hits the glass, this kinetic energy is

transferred to the glass, causing it to break. The energy is converted into sound, heat, and breaking the bonds of the glass.

5.7. A man rowing boat upstream is at rest with respect to the shore. Is he doing work?

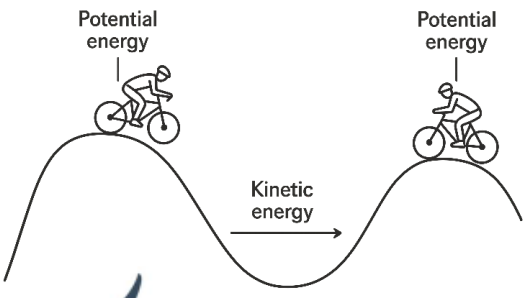
Answer:

Yes, he is doing work.

Even though the boat appears stationary relative to the shore, the man is applying force to row against the current. Work is done relative to the flowing water, even if displacement with respect to land is zero.

5.8. A cyclist goes downhill from the top of a steep hill without pedalling and takes it to the top of the next hill.

(i) **Diagram**:



(ii) Analysis in terms of potential and kinetic energy:

At point A: High potential energy, zero kinetic energy.

At point B: Maximum kinetic energy, minimum potential energy.

At point C: Kinetic energy is converted back into potential energy.

This is an example of interconversion of energy:

Potential energy ⇒ Kinetic energy ’n Potential energy.

5.9. Is timber or wood a renewable source of heat energy? Comment.

Answer:

Yes, wood is a renewable source of energy.

Trees can be replanted, and they grow back over time. However, using wood for fuel must be managed sustainably. Deforestation without replanting can make it non-renewable.

D Comprehensive Questions

5.1. What is meant by kinetic energy? State its unit. Describe how it is determined.

Answer:

- Kinetic energy is the energy possessed by a body due to its motion.
- Any object that has mass and is moving with a certain velocity has kinetic energy.

Mathematically,

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

- m = mass of the object (in kg)
- v = velocity of the object (in m/s)

SI Unit:

- The SI unit of kinetic energy is joule (J).
- 1 joule is the energy possessed by a body of mass 1 kg moving at 1 m/s.

Explanation:

The faster or heavier an object is, the more kinetic energy it has.

5.2. State the law of conservation of energy. Explain it with the help of an example of a body falling from a certain height in terms of its potential energy and kinetic energy.

Answer:

Law of Conservation of Energy:

Energy can neither be created nor destroyed. It can only change from one form to another, but the total amount of energy remains constant.

Example: A body falling from a height:

- **At the top**: It has maximum potential energy (PE) and zero kinetic energy (KE).
- **During fall**: Potential energy decreases and is converted into kinetic energy.
- **Just before hitting the ground**: Kinetic energy becomes maximum and potential energy is almost zero.

Thus,

$$\text{Total Energy} = \text{PE} + \text{KE} = \text{Constant}$$

5.3. Differentiate between renewable and non-renewable sources of energy. Give three examples for each.

Answer:

Renewable Sources of Energy:

1. These are the energy sources that can be naturally replenished in a short period of time.

2. They are sustainable, meaning they do not run out with use.

3. Renewable sources are usually clean and eco-friendly, as they do not release harmful gases into the environment.

4. They can be used again and again without the risk of depletion.

5. Initial setup cost may be high, but running cost is low and they are good for long-term use.

Examples of Renewable Energy Sources:

- Solar energy (energy from the Sun)
- Wind energy (energy generated using wind turbines)
- Hydroelectric energy (energy generated from moving water like dams and rivers)

Non-Renewable Sources of Energy:

1. These are the energy sources that are present in limited amounts and cannot be replenished quickly.

2. They take millions of years to form, such as fossil fuels.

3. Once used, they are gone forever or take a very long time to regenerate.

4. Their usage causes pollution like smoke, carbon dioxide, and other harmful gases.

5. They are cheaper to set up initially, but harmful to the environment and not sustainable.

Examples of Non-Renewable Energy Sources:

- Coal (solid fossil fuel used in power plants)

- Oil or petroleum (used in vehicles and industries)
- Natural gas (used for heating, cooking, and electricity generation)

5.4. Explain what is meant by efficiency of a machine. How is it calculated? Why is there a limit for the efficiency of a machine?

Answer:

Efficiency is the measure of how well a machine converts input energy into useful output energy.

Formula:

$$\text{Efficiency} = \frac{\text{Useful Output Energy}}{\text{Total Input Energy}}$$

Percentage Efficiency:

$$\text{Efficiency}\ (\%) = \left(\frac{\text{Output Energy}}{\text{Input Energy}}\right) \times 100$$

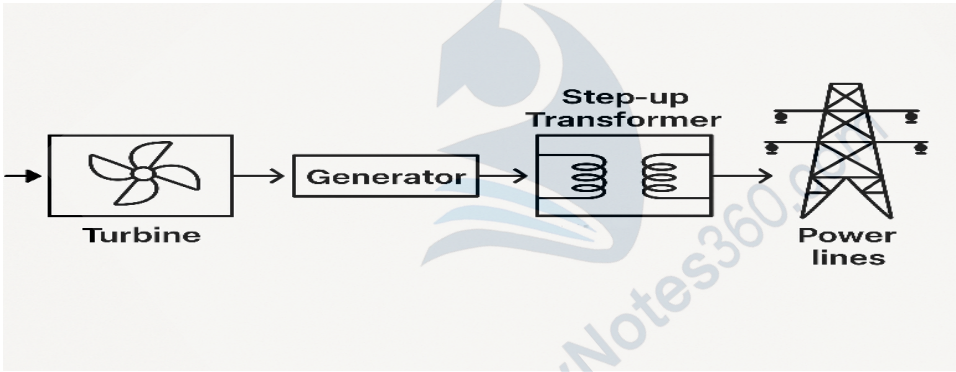
Why 100% Efficiency is Not Possible:

- In every machine, some energy is lost due to

friction, heat, sound, etc.

- Therefore, no machine can convert all input energy into useful output energy.
- That's why a machine cannot have 100% efficiency.

5.5. Describe the process of electricity generation by drawing a block diagram of the process in the following cases.



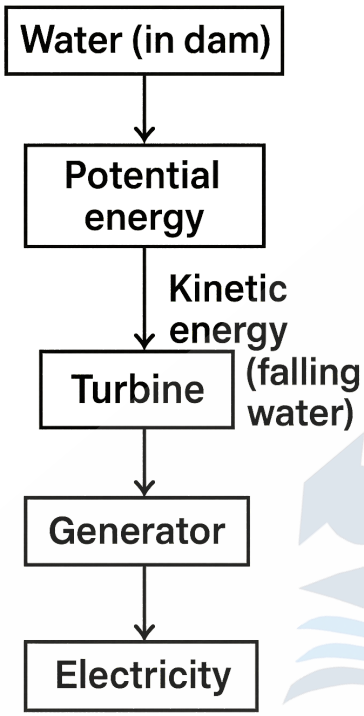
(i) Hydroelectric Power Station:

Process:

- Water stored at height in a dam has potential energy.
- It flows down with high speed, converting potential energy into kinetic energy.
- This fast-moving water turns the turbine.

- Turbine rotates a generator to produce electricity.

Block Diagram:

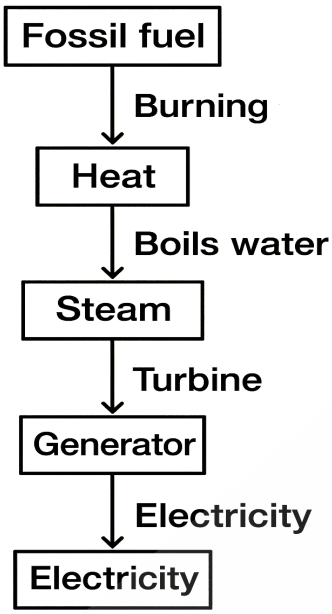


(ii) Fossil Fuels Power Station:

Process:

- Coal, oil, or gas is burned to produce heat.
- Heat boils water to produce steam.
- Steam turns a turbine.
- Turbine runs the generator, which produces electricity.

Block Diagram:



Note:

This chapter is designed to provide a solid foundation of knowledge, with the goal of deepening understanding and encouraging further exploration of the subject. The content has been carefully selected to support effective learning and

inspire students to engage with the topic more deeply.

Author: Muhammad Asghar

Purpose: To contribute to education by offering insightful, valuable content that enhances learning and understanding.

Copyright & Usage Policy