Sources of Ene

DISCLAIMER: For educational reference only. All questions are from NCERT Exemplar Problems, Class 10 Science, Chapter 14. Attempt questions independently before consulting solutions.

KEY TERMS & GLOSSARY

Term	Definition
Renewable energy	Energy from sources that are replenished naturally (sun, wind, water, biomass)
Non-renewable energy	Energy from sources that cannot be replenished (fossil fuels, nuclear fuels)
Fossil fuels	Coal, petroleum, natural gas -- formed from remains of organisms over millions of years
Thermal power plant	Plant where fossil fuels are burned to heat water into steam to drive turbines
Hydroelectric power	Electricity generated using potential energy of water stored at height
Biogas	Gas (mainly CH4) produced by anaerobic decomposition of organic waste (cattle dung etc.)
Biomass	Plant and animal waste used as fuel (wood, agricultural waste, cattle dung)
Solar cooker	Device using sunlight to cook food; uses black coating + glass sheet + plane mirror
Solar cell	Photovoltaic cell converting sunlight directly into electricity (silicon-based)
OTEC	Ocean Thermal Energy Conversion: uses temperature difference between surface and deep ocean water
Tidal energy	Energy from tidal movement of ocean water; captured using tidal barrages
Wind energy	Kinetic energy of moving air used to rotate windmill blades and generate electricity
Nuclear fission	Splitting of heavy nucleus (U-235) by neutron to release enormous energy + more neutrons
Nuclear fusion	Joining of light nuclei (hydrogen) at very high temperature to release energy (as in sun)
Geothermal energy	Heat energy from inside the Earth (hot springs, steam wells) used to generate electricity
Acid rain	Rain with lower pH due to SO2 and NOx released by burning fossil fuels

CONVENTIONAL vs NON-CONVENTIONAL SOURCES

Conventional Sources	Examples	Non-Conventional Sources	Examples
Fossil fuels	Coal, petroleum, natural gas	Solar energy	Solar cooker, solar cell, solar panel
Hydro power	Large dams	Wind energy	Windmills, wind farms
Thermal power	Coal-fired plants	Tidal energy	Tidal barrages
Nuclear energy	Uranium fission (now classified non-conv.)	Ocean energy (OTEC, waves)	OTEC plants
Biomass (traditional)	Wood, cow dung cakes	Geothermal energy	Hot springs, steam wells
Charcoal	Wood charcoal	Biogas	Biogas plants

CHARACTERISTICS OF A GOOD FUEL

Property	Ideal Characteristic
Calorific value	High -- releases more energy per unit mass

Ignition temperature	Low -- easy to start burning
Burning	Clean -- no smoke or harmful gases
Availability	Abundant and cheap
Storage	Easy to store and transport safely
After burning	No residue or very little ash
Cost	Economical and affordable

SECTION A: MULTIPLE CHOICE QUESTIONS (Q1 to Q15)

Exam Strategy: For 'INCORRECT statement' questions (Q14, Q15), identify which option is factually WRONG. For 'CORRECT statement' (Q12), pick the scientifically accurate one.

Q1. Which of the following is a non-renewable source of energy?

(a) Wood

(b) Sun

(c) Fossil fuels [CORRECT]

(d) Wind

Answer: (c)

FOSSIL FUELS (coal, petroleum, natural gas) are non-renewable -- they took millions of years to form and cannot be replenished at the rate we use them. Wood is biomass (renewable -- trees can be replanted). Sun and wind are inexhaustible renewable sources.

Tip: Non-renewable = took millions of years to form, cannot be quickly replaced. Fossil fuels are the classic example.

Q2. Acid rain happens because

(a) Sun leads to heating of upper atmosphere

(b) Burning of fossil fuels releases oxides of carbon, nitrogen and sulphur in atmosphere [CORRECT]

(c) Electrical charges produced due to friction amongst clouds

(d) Earth atmosphere contains acids

Answer: (b)

Burning fossil fuels releases SO2 (sulphur dioxide) and NOx (oxides of nitrogen) into the atmosphere. These gases dissolve in rainwater to form sulphuric acid and nitric acid, making rain acidic (pH < 5.6). This is acid rain. Option (c) describes lightning, not acid rain.

Tip: Acid rain: SO2 + H2O -> H2SO3; NOx + H2O -> HNO3. Both formed by burning fossil fuels.

Q3. Fuel used in thermal power plants is

(a) Water

(b) Uranium

(c) Biomass

(d) Fossil fuels [CORRECT]

Answer: (d)

THERMAL power plants use FOSSIL FUELS (coal primarily) to heat water to produce steam, which drives turbines to generate electricity. Uranium is used in NUCLEAR power plants. Water is used in HYDRO power plants. Biomass in biogas plants.

Tip: Thermal = heat from fossil fuels. Hydro = falling water. Nuclear = uranium fission. Know each plant type.

Q4. In a hydro power plant

(a) Potential energy possessed by stored water is converted into electricity [CORRECT]

(b) Kinetic energy possessed by stored water is converted into potential energy

(c) Electricity is extracted from water

(d) Water is converted into steam to produce electricity

Answer: (a)

Water stored at HEIGHT in a dam has POTENTIAL ENERGY (PE = mgh). When released, it falls, converting PE to KINETIC ENERGY of moving water. This kinetic energy spins turbines connected to generators which produce electricity. Chain: PE (water) -> KE (falling) -> Mechanical (turbine) -> Electrical energy.

Tip: Greater height = more PE = more electricity. PE -> KE -> Electrical. Water is NOT converted to steam.

Q5. Which is the ultimate source of energy?

(a) Water

(b) Sun [CORRECT]

(c) Uranium

(d) Fossil fuels

Answer: (b)

The SUN is the ultimate source of energy for almost all energy sources on Earth: Solar energy directly powers solar cells/cookers. Wind is caused by unequal heating of Earth by sun. Water cycle (hydro power) is driven by solar evaporation. Fossil fuels store ancient solar energy from photosynthesis. Biomass photosynthesis uses sunlight. Only nuclear/geothermal/tidal don't come from sun.

Tip: Sun is the ultimate source: wind, water cycle, biomass, fossil fuels all ultimately trace to solar energy.

Q6. Which form of energy leads to LEAST environmental pollution in harnessing and utilisation?

(a) Nuclear energy

(b) Thermal energy

(c) Solar energy [CORRECT]

(d) Geothermal energy

Answer: (c)

SOLAR ENERGY is the cleanest: no combustion, no waste products, no emissions during use. Nuclear energy produces radioactive waste (serious disposal problem). Thermal energy (fossil fuels) produces CO_2, SO_2, NO_x, particulate matter. Geothermal can release H_2S and other gases. Solar panels/cookers produce zero pollution during operation.

Tip: Solar = cleanest operational energy. Nuclear has radioactive waste. Thermal pollutes atmosphere most.

Q7. Ocean thermal energy is due to

(a) Energy stored by waves in the ocean

(b) Temperature difference at different levels in the ocean [CORRECT]

(c) Pressure difference at different levels in the ocean

(d) Tides arising out in the ocean

Answer: (b)

OTEC (Ocean Thermal Energy Conversion) exploits the TEMPERATURE DIFFERENCE between warm surface water (25-30 deg C in tropics) and cold deep water (5-7 deg C at depth ~1km). This temperature gradient can run heat engines to generate electricity. Wave energy (a) and tidal energy (d) are separate ocean energy sources.

Tip: OTEC = temperature difference between ocean surface and depth. Not waves, not tides, not pressure.

Q8. The major problem in harnessing nuclear energy is how to

(a) Split nuclei?

(b) Sustain the reaction?

(c) Dispose off spent fuel safely? [CORRECT]

(d) Convert nuclear energy into electrical energy?

Answer: (c)

Splitting nuclei (fission) is well-understood technology. Sustaining reactions (chain reactions in reactors) is also technically solved. Converting heat to electricity uses standard turbine/generator systems. The MAJOR UNSOLVED problem is safe DISPOSAL OF RADIOACTIVE SPENT FUEL, which remains dangerously radioactive for thousands of years. No completely safe long-term solution exists.

Tip: Nuclear fission is solved. The BIG problem = nuclear waste disposal. Spent fuel is radioactive for thousands of years.

Q9. Which part of the solar cooker is responsible for greenhouse effect?

(a) Coating with black colour inside the box

(b) Mirror

(c) Glass sheet [CORRECT]

(d) Outer cover of the solar cooker

Answer: (c)

The GLASS SHEET on top of the solar cooker acts like the atmosphere in the greenhouse effect. It allows SHORT-WAVELENGTH solar radiation (visible light) to pass IN, but traps LONG-WAVELENGTH infrared radiation (heat) emitted by food/box from escaping. Black coating: absorbs radiation. Mirror: reflects and concentrates sunlight into box.

Tip: Glass sheet = greenhouse effect (traps heat inside). Black coating = absorbs radiation. Mirror = reflects/concentrates sunlight.

Q10. The main constituent of biogas is

(a) Methane [CORRECT]

(b) Carbon dioxide

(c) Hydrogen

(d) Hydrogen sulphide

Answer: (a)

BIOGAS composition (approximately): METHANE (CH_4) = 50-75% (main constituent, responsible for burning). Carbon dioxide = 25-45%. Traces of H_2, H_2S, N_2. Methane is the fuel component that burns cleanly with a blue flame. CO_2 does not burn; H_2S gives foul smell.

Tip: Biogas = mainly METHANE (CH4). Burns with blue flame, no smoke, no ash. Excellent clean fuel for cooking.

Q11. The power generated in a windmill

(a) Is more in rainy season since damp air means more air mass hitting blades

(b) Depends on the height of the tower

(c) Depends on wind velocity [CORRECT]

(d) Can be increased by planting tall trees close to the tower

Answer: (c)

Power generated by windmill = (1/2) x rho x A x v^3, where v = wind VELOCITY. Power is proportional to CUBE of wind speed (v^3) -- so doubling wind speed increases power 8x. Option (a): damp air is DENSER not just more mass, and moisture actually reduces efficiency. Option (b): tower height affects access to stronger winds but is not the direct determinant. Option (d): trees BLOCK wind, reducing power -- opposite of what's needed.

Tip: Power in windmill proportional to v^3 (cube of wind velocity). Trees near windmill REDUCE power by blocking wind.

Q12. Choose the CORRECT statement

(a) Sun can be taken as an inexhaustible source of energy [CORRECT]

(b) There is infinite storage of fossil fuel inside the earth

(c) Hydro and wind energy plants are non-polluting sources of energy

(d) Waste from a nuclear power plant can be easily disposed off

Answer: (a)

Option (a) is CORRECT: The sun will continue to radiate energy for ~5 billion more years, effectively inexhaustible on human timescales. Option (b) WRONG: Fossil fuels are finite and will be exhausted. Option (c) WRONG: Hydro dams cause ecological damage (flooding, displacement); wind needs large land area. Option (d) WRONG: Nuclear waste disposal is the MAJOR unsolved problem.

Tip: Sun = inexhaustible for practical purposes. Fossil fuels ARE finite. Hydro dams DO cause environmental damage.

Q13. In a hydroelectric power plant more electrical power can be generated if water falls from a greater height because

(a) Its temperature increases

(b) Larger amount of potential energy is converted into kinetic energy [CORRECT]

(c) The electricity content of water increases with height

(d) More water molecules dissociate into ions

Answer: (b)

PE = mgh. Greater height h -> greater potential energy (for same mass m). When water falls from greater height, MORE PE converts to KE -> faster spinning turbines -> more electrical power generated. Options (a), (c), (d) are scientifically incorrect -- water has no 'electricity content' and does not dissociate due to height.

Tip: PE = mgh. More height = more PE = more KE when falling = more power. Energy conversion, not chemistry.

Q14. Choose the INCORRECT statement regarding wind power

(a) It is expected to harness wind power to minimum in open space [CORRECT]

(b) The potential energy content of wind blowing at high altitudes is source of wind power

(c) Wind hitting blades of windmill causes them to rotate; rotation can be utilised further

(d) One method of utilising rotational energy of windmill blades is to run turbine of electric generator

Answer: (a)

Option (a) is INCORRECT: Wind power is harnessed to MAXIMUM (not minimum) in open spaces like coastal areas, open plains, hills -- wherever wind is fastest and least obstructed. Option (b) WRONG concept too: wind energy is KINETIC energy (not potential energy) but not the 'incorrect' one being asked. Options (c) and (d) are correct descriptions of windmill operation.

Tip: Wind power is harnessed to MAXIMUM in open spaces, NOT minimum. Open/elevated areas have strongest, most consistent winds.

Q15. Choose the INCORRECT statement

(a) We are encouraged to plant more trees to ensure clean environment and provide bio-mass fuel

(b) Gobar-gas is produced when crops, vegetable wastes etc., decompose in absence of oxygen

(c) Main ingredient of bio-gas is ETHANE and it gives lot of smoke and residual ash [CORRECT]

(d) Bio-mass is a renewable source of energy

Answer: (c)

Option (c) is INCORRECT on TWO counts: (1) Main ingredient of biogas is METHANE (CH_4), NOT ethane (C_2H_6). (2) Biogas burns CLEANLY -- it produces NO smoke and leaves NO ash. This is its major advantage over traditional fuels. Options (a), (b), (d) are all correct statements.

Tip: Biogas = mainly METHANE, burns clean (no smoke, no ash). Ethane is a different gas. Classic exam trap.

MCQ ANSWER KEY

1	**(c)**	2	**(b)**	3	**(d)**
4	**(a)**	5	**(b)**	6	**(c)**
7	**(b)**	8	**(c)**	9	**(c)**
10	**(a)**	11	**(c)**	12	**(a)**
13	**(b)**	14	**(a)**	15	**(c)**

SECTION B: SHORT ANSWER QUESTIONS (Q16 to Q22)

Q16. Why is there a need to harness non-conventional sources of energy? Give two main reasons.

Reason 1 -- Fossil fuels are limited (non-renewable):

Conventional sources like coal, petroleum and natural gas are FINITE resources that took millions of years to form. At current rates of consumption, they will be exhausted in the near future (coal ~200 years, petroleum ~50 years at current rates). We need alternatives before they run out completely.

Reason 2 -- Environmental damage from fossil fuels:

Burning fossil fuels produces: CO2 (greenhouse gas causing global warming), SO2 and NOx (causing acid rain), particulate matter (causing air pollution and health problems), and contributes to climate change. Non-conventional sources like solar, wind, biogas are much cleaner and cause minimal environmental damage.

Tip: Two reasons: (1) Fossil fuels are finite/non-renewable. (2) Burning fossil fuels causes severe environmental pollution.

Q17. Write two different ways of harnessing energy from ocean.

Method 1 -- Ocean Thermal Energy (OTEC):

The ocean surface (warm, ~25 deg C in tropics) and deep ocean (cold, ~5 deg C at ~1 km depth) have a temperature difference. OTEC plants use this temperature gradient to run heat engines and turbines to generate electricity. Volatile liquids like ammonia are vaporised by warm water and condensed by cold water to drive turbines.

Method 2 -- Tidal Energy:

Tides are caused by gravitational pull of moon and sun, creating rise and fall of sea levels. Tidal barrages (dams built across tidal estuaries) trap high-tide water and release it through turbines during low tide to generate electricity. Also: WAVE ENERGY -- kinetic energy of ocean waves can be used to drive turbines directly.

Tip: Ocean energy: OTEC (temperature difference), Tidal energy (high/low tides), Wave energy (kinetic). Know at least two clearly.

Q18. What steps would you suggest to minimise environmental pollution caused by burning of fossil fuels?

Step 1 -- Use cleaner technologies:

Use improved combustion techniques to ensure more complete burning (reducing CO, soot). Fit catalytic converters in vehicles to convert CO and NOx to less harmful CO2 and N2. Use electrostatic precipitators in chimneys to trap particulate matter.

Step 2 -- Switch to cleaner fuels:

Replace coal with natural gas (burns cleaner, less SO2). Use CNG (Compressed Natural Gas) in vehicles instead of petrol/diesel. Gradually switch to solar, wind, hydro, biogas.

Step 3 -- Improve efficiency and reduce use:

Increase fuel efficiency of engines and appliances to burn less fuel for same output. Use public transport instead of private vehicles. Insulate buildings to reduce heating/cooling needs.

Step 4 -- Afforestation:

Plant more trees to absorb CO2 from atmosphere. Reduce deforestation. Trees also provide biomass fuel (sustainable if managed properly).

Tip: Key steps: better combustion tech, switch to cleaner fuels, improve efficiency, afforestation, use renewable energy.

Q19. What is the role of a plane mirror and a glass sheet in a solar cooker?

Role of Plane Mirror (reflector):

The PLANE MIRROR (or concave mirror in advanced models) is placed at an angle outside the cooker box. It REFLECTS additional sunlight INTO the box, increasing the amount of solar radiation entering the cooker. This raises the internal temperature more quickly and to a higher level (up to ~100-140 deg C). Without mirror, only direct sunlight falls on the box.

Role of Glass Sheet:

The GLASS SHEET placed on top of the box creates a GREENHOUSE EFFECT inside the cooker. It allows SHORT-WAVELENGTH solar radiation (visible light) to PASS THROUGH into the box. But it does NOT allow LONG-WAVELENGTH infrared radiation (heat emitted by the food/box) to escape. This traps heat inside the cooker, raising the temperature. Without glass sheet, heat would escape quickly and temperature would remain low.

Tip: Mirror = reflects MORE sunlight into box (increases input). Glass sheet = traps heat inside (greenhouse effect, reduces loss).

Q20. Mention three advantages of a solar cell.

Advantages of solar cells:

1. NO MOVING PARTS: Solar cells have no moving mechanical parts, so they require very little maintenance and have a long operational life. 2. NO POLLUTION: They generate electricity with ZERO emissions or pollution during operation. No CO2, no smoke, no noise. Very environmentally friendly. 3. REMOTE AREA USE: Can be set up in remote, inaccessible areas (mountains, deserts, islands) where conventional electricity grids cannot reach. Small panels can power individual homes, schools, hospitals in remote areas. Also: (4) Uses inexhaustible solar energy as input; (5) Can be made in small or large sizes; (6) Long lifespan (20-25 years).

Tip: Three key advantages: no moving parts (low maintenance), no pollution, works in remote areas. These are standard exam answers.

Q21. What is biomass? What can be done to obtain bio-energy using biomass?

What is Biomass:

BIOMASS refers to any organic material derived from recently living organisms that can be used as fuel. It includes: Plant matter -- wood, agricultural waste (crop residues, straw), sawdust, leaves. Animal waste -- cattle dung (cow dung, gobar), poultry waste. Municipal solid waste -- food scraps, garden waste. All biomass stores chemical energy from photosynthesis (ultimately solar energy).

Obtaining bio-energy from biomass:

Method 1 - DIRECT BURNING: Dry biomass (wood, agricultural waste) can be burned directly as fuel for cooking and heating. However this is inefficient and produces smoke. Method 2 - BIOGAS PRODUCTION: Wet biomass (cattle dung) is allowed to decompose ANAEROBICALLY (without oxygen) in a biogas plant to produce BIOGAS (mainly methane). Biogas burns cleanly, no smoke, no ash. Very efficient use of biomass. Method 3 - CHARCOAL: Wood burned in limited oxygen produces charcoal (higher calorific value). Method 4 - ETHANOL: Sugar/starch crops fermented to produce bioethanol as fuel.

Tip: Biomass = organic material from living organisms. Bio-energy: direct burning, biogas plant (best method), charcoal, bioethanol.

Q22. What are the limitations in obtaining energy from wind?

Limitations of wind energy:

1. MINIMUM WIND SPEED: Wind speed must be at least 15 km/h to maintain rotation and generate electricity. In many areas, wind is too slow or intermittent. Cannot be relied upon for continuous 24/7 power supply. 2. LARGE LAND AREA: Wind farms require vast areas of land -- many hectares per MW of capacity. This land cannot be used for intensive agriculture or other purposes. 3. INITIAL COST: High capital cost of turbines, towers, transmission lines and energy storage systems. 4. NOISE AND VISUAL POLLUTION: Windmills produce noise and are considered visually unappealing. May harm local bird populations (blade strikes). 5. LOCATION DEPENDENT: Can only be placed in specific locations with consistently strong winds (coastal areas, hills, open plains). Not suitable everywhere. 6. INTERMITTENT: Cannot generate electricity on calm days; need backup power or large storage.

Tip: Wind limitations: minimum speed needed, large area required, high cost, noise, location-specific, intermittent supply.

SECTION C: LONG ANSWER QUESTIONS (Q23 to Q29)

Q23. Which is the process used to harness nuclear energy these days? Explain it briefly.

Process: Nuclear Fission

Today, NUCLEAR FISSION is the process used in nuclear power plants to harness nuclear energy. DEFINITION: Nuclear fission is the process by which the nucleus of a HEAVY ELEMENT (usually Uranium-235 or Plutonium-239) is SPLIT into two smaller nuclei when bombarded by a slow-moving NEUTRON, releasing an enormous amount of energy.

Chain Reaction:

The key feature is the CHAIN REACTION: 1. One slow neutron strikes a U-235 nucleus. 2. The nucleus splits into two daughter nuclei (e.g., Ba-141 + Kr-92) + 3 NEW neutrons + ENERGY. 3. Each of the 3 new neutrons can split 3 more U-235 nuclei, releasing 9 neutrons. 4. This cascades geometrically, releasing enormous energy in a very short time. In a nuclear reactor, the chain reaction is CONTROLLED using control rods (graphite or boron) that absorb excess neutrons, keeping the reaction steady.

Conversion to electricity:

The heat generated by fission is used to boil water into steam, which spins turbines connected to generators to produce electricity -- same as thermal power plants but using nuclear heat instead of burning coal.

Problem -- Nuclear waste:

Spent nuclear fuel is highly RADIOACTIVE and remains dangerous for thousands of years. Safe disposal is the major unsolved problem. Currently stored in deep geological repositories.

Tip: Nuclear fission: heavy nucleus (U-235) + neutron -> 2 daughter nuclei + 3 neutrons + ENERGY. Chain reaction in controlled reactor -> electricity.

Q24. How can solar energy be harnessed? Mention two limitations. How are these limitations overcome?

Methods of harnessing solar energy:

1. SOLAR COOKER: Uses black-coated insulated box with glass sheet (greenhouse effect) and mirror reflector to concentrate sunlight for cooking. Reaches 100-140 deg C. 2. SOLAR WATER HEATER: Black-coated pipes in glass-covered insulated box heat water flowing through them using solar radiation. Used in homes and hospitals. 3. SOLAR CELL (Photovoltaic): Silicon-based cells directly convert sunlight to DC electricity. Arrays of cells form solar panels/modules for homes, satellites, remote areas. 4. SOLAR CONCENTRATORS: Large concave reflectors focus sunlight on a small area to achieve very high temperatures for industrial heating or electricity generation.

Two limitations of solar energy:

LIMITATION 1: Solar energy is INTERMITTENT -- only available during DAYLIGHT hours and on SUNNY DAYS. Not available at night or on cloudy/rainy days. LIMITATION 2: DIFFUSE NATURE -- solar energy is spread over large areas at relatively low intensity. Requires large collection areas and sophisticated equipment to concentrate it to usable levels. Efficiency of solar cells is still relatively low (15-20% for commercial panels).

Overcoming limitations:

Limitation 1 (intermittency): Use energy STORAGE SYSTEMS -- large batteries or pumped hydro storage to store excess daytime energy for use at night. Also develop better battery technology. Combine with other renewable sources (wind + solar + storage). Limitation 2 (diffuse/low density): Use large-area solar panels, efficient concentrating mirrors, and improved high-efficiency solar cells (research reaching 40%+ in lab conditions). Install in high-solar-radiation locations (deserts, rooftops).

Tip: Solar methods: cooker, water heater, photovoltaic cells, concentrators. Limitations: intermittent + diffuse. Solutions: storage + efficient collectors.

Q25. Make a list of conventional and non-conventional sources. Give brief description of harnessing one non-conventional source.

Conventional Sources of Energy:

1. Coal (thermal power plants) 2. Petroleum (transport, industry) 3. Natural gas (cooking, power) 4. Firewood/wood (cooking, heating) 5. Hydro power (dams) -- being reclassified as 'conventional large-scale' 6. Nuclear energy (uranium) -- sometimes listed as conventional in Indian curriculum

Non-Conventional (Renewable) Sources:

1. Solar energy (solar cells, solar cookers, solar thermal) 2. Wind energy (windmills, wind farms) 3. Biogas (biogas plants from cattle dung) 4. Ocean thermal energy/OTEC 5. Tidal and wave energy 6. Geothermal energy 7. Hydrogen fuel (future -- using electrolysis powered by renewables)

Harnessing Biogas (Non-conventional) -- Detailed description:

BIOGAS PLANT: A underground cylindrical digester tank is built. Cattle dung (gobar) mixed with water in 1:1 ratio is fed through the inlet pipe. The slurry undergoes ANAEROBIC DECOMPOSITION (without oxygen) by microorganisms for 50-60 days. GASES PRODUCED: Methane (CH_4) 50-75%, CO_2, traces H_2, H_2S collect in the floating gas holder. Gas is piped to kitchen for clean cooking fuel or to generators for electricity. SPENT SLURRY from the outlet is an excellent manure for crops. ADVANTAGES: Clean burning (no smoke/ash), uses waste material, provides fertiliser, reduces disease.

Tip: Know both lists by heart. Biogas plant: inlet -> anaerobic digestion -> gas holder -> cooking/electricity + slurry -> manure.

Q26. Why is there a need for harnessing non-conventional sources? How can energy be harnessed from sea?

Need for non-conventional sources:

1. DEPLETION: Fossil fuels are non-renewable and will be exhausted -- coal in ~200 years, oil in ~50 years at current consumption rates. We need alternatives before crisis hits. 2. POLLUTION: Burning fossil fuels = air pollution (CO_2, SO_2, NO_x), acid rain, smog, particulate matter, global warming/climate change. Non-conventional sources are cleaner. 3. GROWING DEMAND: World population growing; developing nations industrialising -- energy demand increasing rapidly. Non-conventional sources are needed to meet this demand sustainably. 4. ENERGY SECURITY: Fossil fuel reserves are concentrated in few countries. Non-conventional sources (sun, wind, ocean) are available everywhere.

Harnessing energy from the sea:

METHOD 1 -- TIDAL ENERGY: Moon's gravity causes periodic rise (high tide) and fall (low tide) of sea level. A TIDAL BARRAGE (dam) is built across a tidal estuary. Water flows through turbines in the barrage during both high and low tides, generating electricity. Limited suitable locations globally.

METHOD 2 -- WAVE ENERGY: Wind blowing over ocean surface creates waves with kinetic energy. Wave energy converters (various designs -- oscillating water columns, floating devices) capture this motion to drive electrical generators. Potential is enormous but technology is still developing.

METHOD 3 -- OTEC (Ocean Thermal Energy Conversion): Uses temperature DIFFERENCE between warm ocean surface (~25 deg C) and cold deep water (~5 deg C at 1km depth). A volatile working fluid (like ammonia) is evaporated by warm water, drives a turbine, then condensed by cold water. Works continuously (not intermittent). Requires temperature difference of at least 20 deg C -- available in tropical oceans.

Tip: Sea energy: tidal (moon gravity), wave (wind energy), OTEC (temperature difference). Each requires specific conditions.

Q27. Environmental consequences of using fossil fuels. Steps to minimise pollution.

Environmental consequences of fossil fuels:

1. AIR POLLUTION: CO2, CO, SO2, NOx, particulate matter, hydrocarbons released. Causes respiratory diseases, smog, reduced visibility. 2. ACID RAIN: SO2 + H2O -> H2SO3; NOx + H2O -> HNO3. Damages forests, aquatic life, buildings. 3. GLOBAL WARMING: Excess CO2 (greenhouse gas) traps heat -> rising temperatures, sea level rise, extreme weather events, melting ice caps. 4. WATER POLLUTION: Oil spills contaminate oceans and rivers, killing marine life. 5. SMOG: Photochemical smog from vehicle exhaust (NOx + hydrocarbons + sunlight -> ozone + smog). 6. LAND DAMAGE: Coal mining (open-cast) destroys land, causes subsidence.

Steps to minimise pollution -- Fossil fuel sources:

Install FLUE GAS DESULPHURISATION (FGD) in power plants to remove SO2. Use CATALYTIC CONVERTERS in vehicles. Use ELECTROSTATIC PRECIPITATORS for particles. Switch to NATURAL GAS instead of coal (much less SO2). Improve FUEL EFFICIENCY to burn less for same output. Use PUBLIC TRANSPORT.

Steps to minimise pollution -- Non-conventional sources:

SOLAR: No operational pollution; manage panel manufacturing waste properly. NUCLEAR: Safely store radioactive waste in deep geological repositories; improve reactor safety. HYDRO: Minimise large dam construction; prefer run-of-river plants; address ecosystem disruption. WIND: Plan wind farms away from bird migration routes; consider visual/noise impacts. BIOGAS: Ensure proper sealing of biogas plants to prevent methane leaks (methane is potent greenhouse gas). BIOMASS: Use sustainable harvesting; avoid deforestation.

Tip: Environmental impacts: air pollution, acid rain, global warming, water pollution, smog, land damage. Each needs specific mitigation.

Q28. Energy from various sources is considered to have been derived from the sun. Agree? Justify.

Yes -- Sun is the ultimate source of most energy. Justification:

1. SOLAR ENERGY (direct): Sunlight is directly used in solar cookers, solar cells, solar water heaters. Obviously from the sun.

2. WIND ENERGY:

Wind is caused by UNEQUAL HEATING of different parts of Earth's surface by sunlight. Hot regions cause air to rise; cool air rushes in creating wind. Wind energy = transformed solar energy.

3. HYDROELECTRIC ENERGY:

The SUN evaporates water from oceans and seas (hydrological cycle). Water vapour rises, condenses as rain/snow, falls on mountains filling rivers and reservoirs. The potential energy of water in dams comes from solar-driven evaporation and the water cycle. Hydro energy = indirect solar energy.

4. FOSSIL FUELS:

Coal, petroleum, natural gas formed from remains of ancient PLANTS AND ANIMALS. Plants captured solar energy through PHOTOSYNTHESIS millions of years ago, storing it as organic matter. When fossil fuels burn, they release this ancient solar energy. Fossil fuels = stored ancient solar energy.

5. BIOMASS / BIOGAS:

Plants grow using PHOTOSYNTHESIS (requires sunlight). Biogas comes from anaerobic decomposition of plant/animal matter (originally grew using sunlight). Biomass energy = recently captured solar energy.

Note -- NOT from sun:

Nuclear energy (from uranium formed in stellar explosions), Geothermal energy (Earth's internal radioactive heat), and Tidal energy (from moon's gravitational pull) do NOT originate from the sun.

Tip: Wind = unequal solar heating. Hydro = solar drives water cycle. Fossil fuels = ancient photosynthesis. Biomass = photosynthesis. Direct or indirect solar.

Q29. What is biomass? Explain the principle and working of a biogas plant with a labelled diagram.

Biomass:

BIOMASS is any organic material derived from recently living organisms used as a fuel or raw material for energy production. It includes: agricultural waste, wood, crop residues, cattle dung, poultry droppings, municipal organic waste, aquatic plants. All biomass stores chemical energy from photosynthesis (solar energy). It is a RENEWABLE source -- plants grow back and animals continuously produce waste.

Principle of Biogas Plant:

Biogas is produced by ANAEROBIC DIGESTION -- the process where microorganisms (methanogenic bacteria like Methanobacterium) break down complex organic matter in the ABSENCE OF OXYGEN, producing METHANE (CH4), CO2, H2S and traces of other gases. The organic matter (usually cattle dung mixed with water) provides the substrate for bacteria. The process occurs optimally at 30-40 deg C temperature.

Working of Biogas Plant (with reference to diagram):

CONSTRUCTION: Underground cylindrical brick/concrete tank (digester) with floating mild-steel gas holder (drum) that rises as gas accumulates. STEP 1 -- FEEDING: Fresh cattle dung is mixed with equal volume of water (slurry). Fed daily through INLET PIPE into digester. STEP 2 -- DIGESTION: Slurry decomposes anaerobically over 50-60 days. Bacteria multiply and produce biogas (CH4 + CO2 + traces). STEP 3 -- GAS COLLECTION: Biogas collects in the floating gas holder, pushing it upward. Gas piped to kitchen burners or generator via gas outlet pipe with valve. STEP 4 -- SLURRY REMOVAL: Digested slurry overflows through OUTLET PIPE. Rich in nitrogen and phosphorus -- excellent organic MANURE for crops.

Advantages of Biogas Plant:

1. Burns CLEANLY -- no smoke, no ash (unlike wood). 2. Uses WASTE MATERIAL (cow dung) -- solves waste disposal problem. 3. Spent slurry = rich MANURE -- reduces need for chemical fertilisers. 4. Reduces DEFORESTATION (less need to cut trees for firewood). 5. Improves RURAL SANITATION and HEALTH by proper disposal of waste.

Tip: Biogas plant: cattle dung + water -> anaerobic digestion -> methane + CO2 -> gas for cooking. Slurry outlet -> manure. All stages in sequence.

COMMON MISTAKES TO AVOID

MISTAKE 1: Biogas main ingredient is ethane (WRONG -- it is METHANE)

Biogas = mainly METHANE (CH4), NOT ethane (C2H6). Methane burns with blue flame, no smoke, no ash. This is a classic NCERT MCQ trap (Q15). Biogas composition: CH4 (50-75%), CO2 (25-45%), traces H2, H2S.

MISTAKE 2: Hydro/wind energy are always non-polluting (WRONG)

While wind and solar produce NO air pollution during operation, LARGE HYDRO DAMS cause significant ecological damage: flooding of land/forests, displacement of communities, change in river ecology, loss of biodiversity. Wind farms need large land areas and affect birds. They are 'less polluting' not 'non-polluting'.

MISTAKE 3: Thermal power plants use water as fuel

THERMAL plants burn FOSSIL FUELS (coal) to heat water into steam. Water is the WORKING FLUID, not the fuel. FUEL = coal/fossil fuels. NUCLEAR plants use uranium as fuel. HYDRO plants use falling water (no fuel -- just PE).

MISTAKE 4: Wind power depends on height of tower (NOT the direct answer)

Wind power P = (1/2) x rho x A x v^3 -- directly proportional to CUBE OF WIND VELOCITY. Tower height indirectly gives access to stronger winds, but WIND VELOCITY is the direct determinant. Trees near windmill REDUCE power by blocking wind -- never plant trees close to windmill.

MISTAKE 5: Glass sheet in solar cooker reflects light (WRONG -- mirror does that)

PLANE MIRROR: Reflects sunlight INTO the box (increases radiation input). GLASS SHEET: Traps heat INSIDE the box (greenhouse effect -- allows light in, stops IR going out). They have DIFFERENT and complementary roles. Don't swap them.

MISTAKE 6: Nuclear fusion is used in power plants (WRONG -- it is fission)

Current nuclear power plants use FISSION (splitting heavy nuclei like U-235). FUSION (joining light nuclei like hydrogen) is the process in the SUN and hydrogen bombs. Controlled nuclear fusion for power generation is still experimental (not yet commercial).

QUICK REVISION TABLE

Source	Type	How it works	Environmental Impact
Fossil fuels	Non-renewable	Burn to produce heat -> steam -> turbine	High: CO2, SO2, acid rain, smog
Hydro power	Renewable	PE of stored water -> turbine -> electricity	Medium: dam floods large areas
Solar cooker	Renewable	Black coating absorbs + glass traps heat	Zero pollution in operation
Solar cell	Renewable	Photovoltaic: light -> direct electricity	Zero pollution; panel manufacturing waste
Biogas	Renewable	Anaerobic digestion: dung -> CH4 -> burns	Very low; slurry = good manure
Wind	Renewable	KE of wind -> turbine -> generator	Low; needs large area, kills birds
OTEC	Renewable	Temp difference (surface vs deep) -> turbine	Very low; changes local ocean temps
Tidal	Renewable	Moon's gravity -> tides -> barrage turbine	Low; alters estuarine ecosystems
Nuclear fission	Non-renewable (fuel)	U-235 splitting -> chain reaction -> heat -> turbine	Radioactive waste (very long-lived)
Geothermal	Renewable	Earth's internal heat -> steam -> turbine	Low; some H2S release

Biomass (wood)	Renewable (if managed)	Burned for heat	Smoke, CO_2; deforestation risk