TNPSC Group II / IIA — General Science

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A. Quick Revision Notes

Physics — mechanics, heat, light, electricity

Newton's laws: inertia; force = mass times acceleration (F = ma); action equals reaction. SI base units: metre, kilogram, second, ampere, kelvin. Work = force times distance; power = work/time (watt); energy in joules — kinetic energy = 1/2 times m times v squared, potential energy = mgh. Acceleration due to gravity g = 9.8 m/s squared. Heat transfers by conduction, convection and radiation; 0 degrees C = 273 K. Light shows reflection and refraction (Snell's law); the visible spectrum is VIBGYOR; light speed is about 3 times 10^8 m/s. Electricity: Ohm's law V = IR; power = VI; energy is billed in kilowatt-hours.

Chemistry — elements, acids & bases, metals

Matter exists as solid, liquid or gas. An atom has protons, neutrons and electrons; the atomic number equals the number of protons. The modern periodic table (Moseley) arranges elements by atomic number into groups and periods; Mendeleev's earlier table used atomic mass. Acids have pH below 7, taste sour and turn blue litmus red (HCl, H2SO4); bases have pH above 7, feel soapy and turn red litmus blue (NaOH); pH 7 is neutral; acid plus base gives salt and water (neutralisation). Metals are lustrous, malleable conductors; alloys include brass (copper + zinc) and steel (iron + carbon).

Biology — cell, human body, plants

The cell is the basic unit of life; Robert Hooke first observed cells in cork (1665). Cells are prokaryotic or eukaryotic. Organelles: nucleus (control centre), mitochondria (the 'powerhouse', makes ATP), chloroplast (photosynthesis, in plants), ribosomes (protein synthesis). Human systems include digestive, respiratory (lungs), circulatory (a four-chambered heart; blood groups A, B, AB, O and Rh), nervous (brain and neurons) and excretory (kidneys). In plants, photosynthesis converts carbon dioxide and water into glucose and oxygen using chlorophyll and sunlight; transpiration is water loss through leaves.

Nutrition, health & diseases

Balanced nutrition needs carbohydrates, proteins, fats, vitamins, minerals and water. Vitamin deficiencies: A causes night blindness, B1 beriberi, C scurvy, D rickets, and B12 anaemia. Diseases are communicable — bacterial (tuberculosis, cholera, typhoid), viral (polio, measles, dengue spread by Aedes mosquito) and protozoan (malaria by the female Anopheles mosquito) — or non-communicable (diabetes, hypertension, heart disease). Immunisation uses vaccines; Edward Jenner developed the smallpox vaccine. Iodised salt prevents goitre. Proteins build and repair tissue; carbohydrates and fats provide energy.

Environment & biodiversity

An ecosystem has biotic and abiotic parts connected through food chains and webs. Biodiversity is the variety of life; India is a megadiverse country with hotspots in the Western Ghats, the Eastern Himalaya, Indo-Burma and Sundaland. Conservation is in-situ — national parks, wildlife sanctuaries, biosphere reserves, Project Tiger (1973) and Project Elephant — and ex-situ, such as zoos and seed banks. The IUCN Red List grades species as endangered, vulnerable and so on. The Wildlife Protection Act 1972 safeguards species. Nutrients recycle through the carbon and nitrogen cycles.

Science & technology developments

ISRO was formed in 1969; Vikram Sarabhai is called the father of India's space programme, and Aryabhata was the first Indian satellite (1975). Homi Bhabha is the father of India's nuclear programme; the first reactor was Apsara and nuclear tests were held at Pokhran in 1974 (Smiling Buddha) and 1998. DRDO develops missiles such as Agni and Prithvi; A.P.J. Abdul Kalam is known as the 'Missile Man'. National research bodies include CSIR, ICAR (agriculture), ICMR (medicine) and C-DAC (PARAM supercomputers). The Green Revolution and IT revolution transformed the economy.

Space & defence technology

ISRO's launch vehicles include the reliable PSLV (the 'workhorse'), the GSLV and the heavy-lift LVM3/GSLV Mk-III. Missions: Chandrayaan-1 (2008) detected water on the Moon; the Mars Orbiter Mission/Mangalyaan (2013) made India the first country to reach Mars orbit on its first attempt; Chandrayaan-3 (2023) soft-landed near the lunar south pole, a world first. Satellite series include INSAT (communication), IRS (remote sensing) and NavIC (regional navigation). Defence systems: DRDO's Agni, Prithvi and BrahMos missiles and the Tejas light combat aircraft.

Everyday applications of science

A pressure cooker cooks faster because higher pressure raises water's boiling point. A thermos flask uses a vacuum to block conduction and convection. LPG cooking gas is mainly butane and propane. A refrigerator cools by evaporation of a refrigerant. Optical fibres carry signals by total internal reflection. Soaps and detergents clean by emulsifying oil and grease. A fuse wire melts to protect circuits from overload. Iodised salt prevents goitre. Baking soda is sodium bicarbonate. Ripening of fruit is hastened by the gas ethylene. A lightning conductor safely earths lightning.

B. Practice MCQs (25)

1. ISRO's mission 'Chandrayaan-3' achieved what milestone in August 2023?

(A) First Indian satellite launched to Mars
(B) First soft landing near the lunar south pole
(C) First crewed mission to the Moon
(D) First Indian space station module launch

2. What is nuclear fission?

(A) Combining two light nuclei to form a heavier nucleus
(B) Splitting a heavy nucleus into two lighter nuclei, releasing large amounts of energy
(C) The decay of a radioactive nucleus by emitting alpha particles
(D) The conversion of mass into energy in stars

3. The 'greenhouse effect' is primarily caused by which gases trapping heat in the atmosphere?

(A) Nitrogen and Oxygen
(B) Carbon dioxide, methane, nitrous oxide, and water vapour
(C) Ozone and helium
(D) Argon and neon

4. Biotechnology's CRISPR-Cas9 tool is primarily used for:

(A) Cloning entire organisms
(B) Precise editing of DNA sequences at targeted locations in a genome
(C) Sequencing DNA to read the genetic code
(D) Producing insulin through fermentation

5. Which layer of the Earth's atmosphere is responsible for absorbing cosmic rays and creating the ionosphere?

(A) Troposphere
(B) Stratosphere
(C) Mesosphere
(D) Thermosphere

6. Biodiversity hotspots in India include which of the following regions?

(A) Thar Desert and Gangetic Plain
(B) Western Ghats and Eastern Himalayas
(C) Deccan Plateau and Vindhya Range
(D) Andaman Islands only

7. What is the principle behind a nuclear reactor that makes it different from a nuclear bomb?

(A) A reactor uses fusion; a bomb uses fission
(B) A reactor uses a controlled, sustained chain reaction; a bomb uses an uncontrolled explosive chain reaction
(C) A reactor uses uranium; a bomb uses plutonium
(D) A reactor produces electricity; a bomb destroys infrastructure

8. Which of the following is a correct description of 'eutrophication'?

(A) Increase in soil salinity due to excessive irrigation
(B) Excessive nutrient enrichment of water bodies leading to algal blooms and oxygen depletion
(C) Acidification of ocean water due to dissolved CO■
(D) Loss of topsoil due to wind and water erosion

9. The Doppler Effect is used in which of the following applications?

(A) Measuring the speed of stars and weather radar
(B) Nuclear energy generation
(C) Fibre optic communication
(D) GPS satellite navigation

10. DNA is made up of nucleotides. Each nucleotide consists of:

(A) A sugar (ribose), a phosphate group, and a nitrogenous base
(B) A sugar (deoxyribose), a phosphate group, and a nitrogenous base
(C) An amino acid, a phosphate group, and a fatty acid
(D) A sugar, a sulfate group, and a purine only

11. Which space agency launched the James Webb Space Telescope (JWST) in December 2021?

(A) ISRO
(B) ESA alone
(C) NASA (with ESA and CSA partnership)
(D) Roscosmos

12. What does 'biodiversity' encompass? (Most complete answer)

(A) Only the number of species in an ecosystem
(B) Genetic diversity, species diversity, and ecosystem diversity
(C) Only the diversity of plants and animals
(D) The total biomass of living organisms in a habitat

13. The 'ozone hole' is most severe over which region?

(A) Arctic region
(B) Equatorial belt
(C) Antarctic region
(D) South Asia

14. What is the primary function of the Large Hadron Collider (LHC) at CERN?

(A) Generating nuclear energy for Europe
(B) Accelerating and colliding particles at high energy to study fundamental particles and forces
(C) Tracking satellites and measuring cosmic radiation
(D) Producing medical isotopes for cancer treatment

15. Which of the following diseases is caused by a prion (misfolded protein)?

(A) AIDS
(B) Tuberculosis
(C) Creutzfeldt-Jakob Disease (CJD) / 'Mad Cow Disease'
(D) Dengue fever

16. India's first nuclear power plant was established at:

(A) Kudankulam, Tamil Nadu
(B) Tarapur, Maharashtra
(C) Rawatbhata, Rajasthan
(D) Kaiga, Karnataka

17. Antibiotics are effective against:

(A) Viral infections like influenza and COVID-19
(B) Bacterial infections like tuberculosis and strep throat
(C) Fungal infections like ringworm
(D) Parasitic infections like malaria

18. The Paris Agreement (2015) set a target of limiting global temperature rise to how many degrees Celsius above pre-industrial levels?

(A) 1°C
(B) 1.5–2°C
(C) 2.5°C
(D) 3°C

19. What is the significance of the PARAM series of supercomputers in India?

(A) They are India's first commercially sold computers
(B) They represent India's indigenously developed high-performance computing capability under C-DAC
(C) They were developed for nuclear weapon simulations exclusively
(D) They are used only for weather forecasting

20. The term 'endemic species' means:

(A) A species that has gone extinct in the wild
(B) A species found naturally only in a specific geographical area and nowhere else in the world
(C) A species introduced to an area from another region
(D) A species common across multiple continents

21. India's Chandrayaan-3 mission achieved which historic milestone in August 2023?

(A) Discovery of water ice in permanently shadowed craters
(B) First Indian astronaut landing on the Moon
(C) First lunar orbit insertion by an Indian spacecraft
(D) Soft landing near the Moon's south pole — making India the first country to do so

22. What is CRISPR-Cas9 technology primarily used for?

(A) Measuring cosmic radiation in deep space
(B) Precise editing of DNA sequences in living organisms
(C) Manufacturing semiconductor chips at nanoscale
(D) Developing quantum computing algorithms

23. India's three-stage nuclear power programme, conceived by Homi Bhabha, is designed to ultimately use which fuel?

(A) Plutonium imported from Russia
(B) Uranium-235 imported from the USA
(C) Thorium-232, which India has in large reserves
(D) Hydrogen fusion from ocean water

24. The 'Paris Agreement' (2015) on climate change set a global temperature goal of:

(A) Limiting warming to well below 2°C, pursuing efforts to limit to 1.5°C
(B) Stabilising temperatures at current 2015 levels
(C) Limiting warming to 1°C above pre-industrial levels
(D) Reducing warming by 2°C from current levels by 2100

25. Which Indian Space Research Organisation mission successfully performed a Gravity Assist manoeuvre around Mars in 2014?

(A) GSAT-30
(B) Aditya-L1
(C) Chandrayaan-2
(D) Mars Orbiter Mission (Mangalyaan)

C. Answer Key & Explanations

1. (B) Chandrayaan-3's Vikram lander achieved a successful soft landing near the lunar south pole on 23 August 2023, making India the first country to land near the lunar south pole.

2. (B) Nuclear fission is the splitting of a heavy atomic nucleus (like Uranium-235 or Plutonium-239) into two smaller nuclei when struck by a neutron, releasing a large amount of energy and additional neutrons that can cause a chain reaction.

3. (B) Greenhouse gases (CO■, CH■, N■O, H■O vapour, and fluorinated gases) allow shortwave solar radiation in but absorb and re-radiate longwave infrared radiation (heat), warming the Earth's surface.

4. (B) CRISPR-Cas9 is a molecular tool that acts as 'genetic scissors', allowing scientists to add, delete, or modify specific DNA sequences in the genome of any organism with high precision.
5. (D) The thermosphere (80–700 km altitude) is where cosmic rays and solar radiation ionise gas molecules, creating the ionosphere. Temperatures here can exceed 1,500°C despite low air density.
6. (B) India has four global biodiversity hotspots: Western Ghats, Eastern Himalayas, Indo-Burma region, and Sundaland (Nicobar Islands). Western Ghats and Eastern Himalayas are the two most prominent within mainland India.
7. (B) In a nuclear reactor, control rods absorb excess neutrons to maintain a steady, controlled chain reaction. A bomb allows a supercritical, uncontrolled chain reaction to exponentially accelerate.
8. (B) Eutrophication is the process by which excessive nutrients (mainly nitrogen and phosphorus from agricultural runoff and sewage) enter water bodies, causing explosive algal growth that depletes dissolved oxygen, killing aquatic life.
9. (A) The Doppler Effect (change in frequency/wavelength due to relative motion) is used in astronomy (red/blue shift to measure star velocities) and weather radar (detecting rain speed and direction).
10. (B) DNA (deoxyribonucleic acid) nucleotides each contain a deoxyribose sugar (5-carbon), a phosphate group, and one of four nitrogenous bases (adenine, thymine, guanine, cytosine).
11. (C) The James Webb Space Telescope was launched on 25 December 2021 as a collaborative project between NASA, ESA (European Space Agency), and CSA (Canadian Space Agency).
12. (B) Biodiversity refers to the variety of life at three levels: genetic diversity (variation within species), species diversity (variety of species), and ecosystem diversity (variety of habitats and ecological processes).
13. (C) The most severe ozone depletion (the 'ozone hole') occurs over Antarctica during the southern spring (September–October) due to polar stratospheric clouds that catalyse the destruction of ozone by CFCs.
14. (B) The LHC is the world's largest particle accelerator, built in a 27-km circular tunnel; it collides protons and ions at near-light speed to recreate conditions after the Big Bang and study fundamental physics.
15. (C) Prion diseases including CJD in humans and BSE ('Mad Cow Disease') in cattle are caused by abnormally folded prion proteins that induce normal proteins to misfold, progressively destroying brain tissue.
16. (B) The Tarapur Atomic Power Station (TAPS) in Maharashtra, set up with American assistance in 1969, was India's first commercial nuclear power plant.
17. (B) Antibiotics are compounds that kill or inhibit bacteria; they target bacterial cell walls, protein synthesis, or DNA replication. They have no effect on viruses, fungi, or parasites.
18. (B) The Paris Agreement (adopted December 2015, effective November 2016) aims to limit global average temperature increase to well below 2°C above pre-industrial levels, with efforts to limit it to 1.5°C.
19. (B) The PARAM series (beginning with PARAM 8000 in 1991) was developed by C-DAC as India's indigenous supercomputing initiative, establishing high-performance computing capability for scientific research.
20. (B) Endemic species are those found naturally confined to a particular geographic region and not found wild anywhere else. For example, the Nilgiri tahr is endemic to the Nilgiri Hills of Tamil Nadu.
21. (D) Chandrayaan-3's Vikram lander soft-landed on 23 August 2023 near the lunar south pole — a world first. The Pragyan rover then operated on the surface for ~14 days.
22. (B) CRISPR-Cas9 (Clustered Regularly Interspaced Short Palindromic Repeats) is a molecular tool that can precisely cut and edit DNA at specific gene locations.
23. (C) Stage 1: PHWRs using natural uranium. Stage 2: Fast Breeder Reactors using Pu-239 to breed U-233 from Th-232. Stage 3: Advanced reactors using Th-232/U-233 fuel.
24. (A) Article 2 of the Paris Agreement sets the goal of 'holding the increase in global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit it to 1.5°C.'
25. (D) MOM (Mangalyaan), launched November 2013, entered Mars orbit on 24 September 2014 — making India the first country to succeed on its maiden Mars attempt.