

FEDERAL PUBLIC SERVICE COMMISSION
COMPETITIVE EXAMINATION 2022

GENERAL KNOWLEDGE-I (General Science & Ability)

— COMPLETE SOLVED PAPER —

*Every question from Part-II fully answered, explained & formatted
Section A (Science) and Section B (Mental Ability) — all parts solved*

Post: BS-17, Federal Government

Paper: General Knowledge-I — General Science & Ability

Coverage: Section A (Q.2–Q.5) & Section B (Q.6–Q.8) — all parts

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*Note: As per the examination instructions, candidates attempt any FOUR questions (selecting TWO from each section). For complete preparation and revision value, this guide provides fully worked solutions to **every** question in Part-II.*

SECTION - A

General Science — Q.2 to Q.5

Q.2 General Science — Earth Processes, Energy & Climate

(20)

(a) What do you know about Volcanoes? Discuss the causes and effects of volcanic eruptions.

SOLVED ANSWER

A volcano is a rupture in the Earth's crust that allows molten rock (magma), ash, and gases to escape from below the surface. When magma reaches the surface it is called lava. Volcanoes commonly form along tectonic plate boundaries — both at convergent boundaries, where one plate is forced beneath another (subduction), and at divergent boundaries, where plates move apart and magma rises to fill the gap. They also form over isolated “hot spots” in the Earth's mantle.

Causes of Volcanic Eruptions:

- Build-up of pressure from gases trapped in magma chambers.
- Movement and collision of tectonic plates (subduction zones).
- Rising of magma through cracks and weak zones in the crust.
- Mantle plumes / hot spots causing localised melting of rock.

Effects of Volcanic Eruptions:

- Destruction of nearby settlements, infrastructure and agricultural land by lava flow and ash fall.
- Release of toxic gases (SO_2 , CO_2) affecting air quality and climate.
- Pyroclastic flows and lahars (mudflows) posing severe threats to life.
- Long-term formation of fertile volcanic soil and new landforms.
- Global cooling effects when ash and aerosols block sunlight (volcanic winter).

(b) Differentiate between renewable and non-renewable sources of energy. Briefly explain wind energy, solar energy and biofuels.

SOLVED ANSWER

Renewable Energy is derived from natural sources that replenish continuously (sunlight, wind, water, biomass) and does not get depleted with use, whereas **Non-Renewable Energy** comes from finite resources such as coal, petroleum and natural gas, which take millions of years to form and are being consumed faster than they can regenerate. Renewables are generally cleaner and produce little to no greenhouse gas emissions, while non-renewables are major contributors to pollution and climate change.

Wind Energy: Kinetic energy of moving air is captured by wind turbines and converted into electricity via a rotor-generator system; ideal for coastal and open plain areas.

Solar Energy: Sunlight is converted into electricity using photovoltaic (PV) cells, or into heat using solar thermal collectors; abundant, silent and low-maintenance.

Biofuels: Fuels such as ethanol and biodiesel produced from organic matter (crops, plant waste, algae) through fermentation or chemical processing; used mainly as a substitute for petrol/diesel in transport.

(c) What is a Tornado? How is it formed and what are the effects of tornadoes? Explain briefly.

SOLVED ANSWER

A tornado is a violently rotating column of air that extends from a thunderstorm cloud (cumulonimbus) down to the ground, characterised by a funnel-shaped cloud and extremely high wind speeds.

Formation:

- Warm, moist air near the surface meets cool, dry air aloft, creating atmospheric instability.
- Wind shear (change in wind speed/direction with height) causes the air to begin rotating horizontally.
- Strong updrafts inside a thunderstorm tilt this rotating air into a vertical position, forming a mesocyclone.
- The rotating column intensifies and extends downward to touch the ground, becoming a tornado.

Effects:

- Severe destruction of buildings, trees and power lines along its narrow path.
- Loss of life and injuries due to flying debris and structural collapse.
- Disruption of transportation, communication and utility infrastructure.
- Significant economic losses in agriculture and property.

(d) Discuss various factors which affect the variations in the climate of a place.

SOLVED ANSWER

- **Latitude:** Areas near the equator receive more direct sunlight and are warmer; higher latitudes are cooler.
- **Altitude:** Temperature decreases with increasing elevation above sea level.
- **Distance from the Sea:** Coastal areas have moderate climates; interior/continental areas show extreme temperature variation.
- **Ocean Currents:** Warm currents (e.g., Gulf Stream) raise coastal temperatures; cold currents lower them.
- **Prevailing Winds:** Winds carry heat and moisture, influencing rainfall and temperature patterns.
- **Relief/Topography:** Mountain ranges block or divert winds, creating rain-shadow (arid) zones.
- **Vegetation Cover:** Forests moderate temperature and increase local humidity through transpiration.
- **Human Activity:** Urbanisation, deforestation and industrial emissions alter local and global climate patterns.

(a) Discuss Vaccination, types of Vaccines, their side-effects and effectiveness.

SOLVED ANSWER

Vaccination is the process of stimulating the body's immune system to develop protection (immunity) against a specific infectious disease by administering a vaccine, without causing the disease itself.

Types of Vaccines:

- **Live-attenuated vaccines** — weakened form of the live germ (e.g., measles, MMR).
- **Inactivated vaccines** — killed version of the germ (e.g., inactivated polio vaccine).
- **Subunit/conjugate vaccines** — use only a specific piece of the germ, e.g. protein or sugar (e.g., Hepatitis B).
- **Toxoid vaccines** — use a toxin made by the germ (e.g., tetanus, diphtheria).
- **mRNA vaccines** — use genetic instructions for cells to produce a harmless viral protein (e.g., COVID-19).

Side Effects: Usually mild and temporary — soreness at injection site, mild fever, fatigue or headache. Serious adverse reactions are rare and closely monitored.

Effectiveness: Vaccines significantly reduce disease incidence and severity, and when a large proportion of a population is vaccinated, “herd immunity” develops, protecting even those who cannot be vaccinated.

(b) What is Polio? Discuss its symptoms, causes of spreading, prevention and vaccine.

SOLVED ANSWER

Polio (Poliomyelitis) is a highly infectious viral disease caused by the poliovirus, which mainly affects children under five and can invade the nervous system, causing paralysis.

Symptoms: Fever, fatigue, headache, vomiting, stiffness of the neck, and pain in the limbs; in severe cases, irreversible paralysis (most often of the legs).

Causes of Spreading: Spreads mainly through the faecal-oral route (contaminated water or food), and occasionally through respiratory droplets, especially in areas with poor sanitation and low vaccination coverage.

Prevention: Maintaining hygiene and safe drinking water, proper sanitation, and achieving universal childhood immunisation coverage.

Vaccine: Oral Polio Vaccine (OPV) and Inactivated Polio Vaccine (IPV) are administered in multiple doses during infancy as part of national immunisation programmes.

(c) What do you understand by the DNA and RNA?

SOLVED ANSWER

DNA (Deoxyribonucleic Acid): A double-stranded, helical molecule found mainly in the nucleus of cells that carries the complete genetic instructions (hereditary information) needed for the growth, development, functioning and reproduction of all known organisms. It is composed of nucleotides containing the bases Adenine, Thymine, Guanine and Cytosine.

RNA (Ribonucleic Acid): A single-stranded molecule that plays a central role in converting the genetic information stored in DNA into proteins. Its main types are messenger RNA (mRNA), transfer RNA (tRNA) and ribosomal RNA (rRNA). RNA uses Uracil in place of Thymine.

Key Difference: DNA is double-stranded and stores genetic information long-term; RNA is single-stranded and acts mainly as a messenger/working copy used in protein synthesis.

(d) What is Solid Waste? Discuss the main issues of Solid Waste Management in our country?

SOLVED ANSWER

Solid waste refers to any discarded or unwanted solid material generated from household, commercial, industrial, agricultural or institutional activities — including food waste, plastics, paper, glass, metals and construction debris.

Main Issues of Solid Waste Management in Pakistan:

- Insufficient collection infrastructure, leaving large amounts of waste uncollected on streets.
- Lack of waste segregation at source (organic, recyclable and hazardous waste are mixed).
- Open dumping and burning of waste, causing air, soil and water pollution.
- Very limited use of scientific landfill sites and modern waste-to-energy technology.
- Weak enforcement of environmental regulations and low public awareness.
- Insufficient funding and trained manpower at the municipal level.
- Rapid urbanisation increasing waste generation faster than management capacity.

(a) Define the term Water Pollution. What indicators are used to measure the quality of water? Write down the drinking water quality standards.

SOLVED ANSWER

Water pollution is the contamination of water bodies (rivers, lakes, groundwater, seas) by harmful substances — chemicals, pathogens, or waste — making water unsafe or unfit for drinking, aquatic life and other uses.

Indicators used to Measure Water Quality:

- pH level (acidity/alkalinity)
- Dissolved Oxygen (DO)
- Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD)
- Total Dissolved Solids (TDS) and turbidity
- Presence of coliform bacteria (E. coli) indicating faecal contamination
- Concentration of heavy metals (arsenic, lead) and nitrates

Drinking Water Quality Standards (typical benchmarks):

- pH: 6.5 – 8.5
- TDS: below 1000 mg/L (ideally under 500 mg/L)
- Turbidity: below 5 NTU
- Arsenic: below 0.01 mg/L (10 ppb)
- E. coli / faecal coliform: nil (zero) per 100 mL

(b) What do you understand by the term Population Planning? Point out the different benefits of Population Planning.

SOLVED ANSWER

Population planning refers to the deliberate regulation of population growth through informed family planning, birth spacing and reproductive health awareness, aimed at achieving a sustainable balance between population size and available resources.

Benefits of Population Planning:

- Improved maternal and child health through adequate birth spacing.
- Better allocation of resources such as food, housing, healthcare and education per capita.
- Reduced pressure on natural resources, infrastructure and the environment.
- Higher household savings and improved standard of living for families.
- Supports faster economic development by reducing the dependency ratio.
- Enables better planning of public services (schools, hospitals, employment).

(c) Discuss the possible negative effects that Pakistan may face due to Global Warming and Climate Change. What steps may be helpful to control the climatic change?

SOLVED ANSWER

Negative Effects on Pakistan:

- Accelerated melting of Himalayan and Karakoram glaciers, threatening long-term water supply.
- Increased frequency and intensity of floods, as witnessed in recent monsoon seasons.
- Prolonged droughts and heatwaves affecting agricultural output and food security.
- Rising sea levels threatening coastal areas of Sindh and Balochistan with erosion and salinity intrusion.
- Loss of biodiversity and disruption of ecosystems.
- Greater incidence of vector-borne diseases due to changing weather patterns.

Steps to Control Climate Change:

- Large-scale afforestation programmes (e.g., Ten Billion Tree Tsunami).
- Transition to renewable energy sources (solar, wind, hydel) to cut carbon emissions.
- Improved water management and construction of small/large dams for storage.
- Enforcement of environmental regulations on industries and vehicles.
- Climate-resilient agricultural practices and drought-resistant crop varieties.
- Public awareness campaigns and international climate cooperation.

(d) What is Radioactivity? Differentiate between natural and artificial radioactivity.

SOLVED ANSWER

Radioactivity is the spontaneous emission of energy in the form of particles (alpha, beta) or electromagnetic radiation (gamma rays) from the unstable nucleus of certain atoms as they decay into more stable forms.

Natural Radioactivity: Occurs spontaneously in naturally occurring unstable isotopes such as Uranium-238, Thorium-232 and Radium, found in rocks, soil and cosmic rays, without any human intervention.

Artificial (Induced) Radioactivity: Produced when a normally stable nucleus is made radioactive by bombarding it with particles (neutrons, protons or alpha particles) in a laboratory or nuclear reactor — used in medical treatment, industry and nuclear power.

Key Difference: Natural radioactivity happens without external interference, while artificial radioactivity is deliberately induced by scientists through nuclear reactions.

(a) What do you understand by the term Remote Sensing? Write its basic principle. Give its important applications.

SOLVED ANSWER

Remote Sensing is the science of acquiring information about objects or areas on the Earth's surface without making physical contact, typically using sensors mounted on satellites or aircraft.

Basic Principle: Remote sensing works on the principle that every object reflects, absorbs or emits electromagnetic radiation in a distinctive pattern depending on its physical properties. Sensors detect and record this reflected/emitted radiation, which is then processed to identify and analyse the object or surface feature.

Important Applications:

- Weather forecasting and monitoring of natural disasters (floods, cyclones, wildfires).
- Agricultural monitoring — crop health, yield estimation and irrigation planning.
- Mapping of land use, urban planning and deforestation monitoring.
- Military surveillance and reconnaissance.
- Monitoring glaciers, water bodies and environmental change over time.

(b) Explain the Optical Fiber. Explain how Fiber Optic Communication works?

SOLVED ANSWER

An optical fiber is a thin, flexible strand of glass or plastic, thinner than a human hair, designed to transmit data as pulses of light over long distances with minimal loss.

How Fiber Optic Communication Works:

- Electrical signals (data) are converted into light signals by a transmitter (LED or laser diode).
- The light signal travels through the fiber's core, continuously reflecting off the cladding layer through a phenomenon called **total internal reflection**, which keeps the light confined inside the fiber.
- At the receiving end, a photodetector converts the light pulses back into electrical signals.
- This allows extremely fast data transmission over long distances with very low signal loss and immunity to electromagnetic interference — the backbone of modern internet and telecom networks.

(c) Briefly explain the working and structure of a Cell Phone.

SOLVED ANSWER

Structure: A cell phone consists of a microphone, speaker, display screen, processor (CPU), memory, battery, antenna, and a transceiver (which both transmits and receives radio signals) along with a SIM card that identifies the user on the network.

Working: When a user speaks, the microphone converts sound waves into electrical signals, which the processor digitises and compresses. The transceiver converts this data into radio waves and transmits it via the antenna to the nearest cell tower (base station). The signal is routed through the mobile network to the receiving phone, where the process is reversed — radio waves are converted back into electrical signals and then into sound through the speaker. Cell phones operate by continuously connecting to the nearest cellular tower as the user moves, ensuring uninterrupted communication (a process called 'handoff').

(d) Explain Artificial Intelligence. What do you understand by the term Robotics?

SOLVED ANSWER

Artificial Intelligence (AI): AI is a branch of computer science that enables machines to simulate human-like intelligence — such as learning from data, reasoning, problem-solving, understanding language and making decisions. It includes fields such as machine learning, deep learning and natural language processing, and is used in applications ranging from virtual assistants and recommendation systems to self-driving cars.

Robotics: Robotics is the interdisciplinary field concerned with the design, construction, operation and use of robots — programmable machines capable of carrying out physical tasks, often automatically or with minimal human intervention. Robotics combines mechanical engineering, electronics and (increasingly) AI, and is widely used in manufacturing, surgery, space exploration and hazardous environments.

Relationship: AI provides the 'thinking' capability, while robotics provides the physical body and actuation — together they enable intelligent, autonomous machines.

SECTION - B

Mental Ability — Q.6 to Q.8

Q.6 Mental Ability — Direction Sense, Percentages & Intelligence

(20)

(a) For his morning walk Aslam went 110 meters towards east from his house and then turned right to keep walking for 40 meters before turning right again. After continuing to walk for 50 more meters, he turned right again and kept walking for another 120 meters, before he sat down on a bench at the park. How far was the bench located from his house?

SOLVED ANSWER

Taking the house as the origin (0, 0):

Step 1: Walks 110 m East → new position (110, 0)

Step 2: Turns right (now facing South), walks 40 m → position (110, -40)

Step 3: Turns right (now facing West), walks 50 m → position (60, -40)

Step 4: Turns right (now facing North), walks 120 m → position (60, 80)

Straight-line distance from house (0,0) to bench (60, 80):

Distance = $\sqrt{(60^2 + 80^2)} = \sqrt{(3600 + 6400)} = \sqrt{10000} = 100$ meters

Answer: The bench was 100 meters from Aslam's house.

(b) The income of a company decreased by 10% and 15% in two successive years. What is the percentage of decrease in income after two years?

SOLVED ANSWER

Let the original income = 100.

After a 10% decrease in Year 1: Income = $100 \times (1 - 0.10) = 100 \times 0.90 = 90$

After a 15% decrease in Year 2: Income = $90 \times (1 - 0.15) = 90 \times 0.85 = 76.5$

Total decrease = $100 - 76.5 = 23.5$

Answer: The overall percentage decrease in income after two years is 23.5%.

(c) What do you understand by Mental Ability Scales? Differentiate between Aptitude and Intelligence?

SOLVED ANSWER

Mental Ability Scales: These are standardised psychological tools/tests used to measure a person's cognitive capabilities — such as reasoning, memory, comprehension, numerical and verbal ability — and to express the results in a quantifiable score (e.g., IQ score) that can be compared against norms for a given age group.

Aptitude refers to a person's natural or acquired capacity/potential to learn and perform well in a specific skill or activity (e.g., mechanical aptitude, numerical aptitude) — it predicts future performance in a particular domain.

Intelligence is a broader, general mental capability involving reasoning, problem-solving, abstract thinking, learning from experience and adapting to new situations across many domains, not limited to one specific skill.

Key Difference: Intelligence is general and overall cognitive ability, while aptitude is specific potential/talent for a particular kind of task.

(d) Discuss the factors affecting Intelligence.

SOLVED ANSWER

- **Heredity/Genetics:** Intelligence has a significant genetic component inherited from parents.
- **Environment:** Quality of upbringing, stimulation, and exposure to learning opportunities in early childhood.
- **Nutrition:** Adequate nutrition, especially during infancy and childhood, is critical for healthy brain development.
- **Education:** Access to quality education and continuous learning enhances cognitive ability.
- **Socio-economic Status:** Family income and resources affect access to books, schooling and stimulating environments.
- **Health:** Physical and mental health, including freedom from disease and injury, affects cognitive functioning.
- **Emotional and Social Environment:** Family relationships, emotional security and social interaction shape cognitive and emotional development.
- **Culture:** Cultural values and practices influence the type of skills that are developed and valued.

(a) The sum of three consecutive odd numbers is 273. What are the three odd numbers?

SOLVED ANSWER

Let the three consecutive odd numbers be: x , $(x+2)$, $(x+4)$

Sum: $x + (x+2) + (x+4) = 273$

$3x + 6 = 273 \rightarrow 3x = 267 \rightarrow x = 89$

Answer: The three consecutive odd numbers are 89, 91 and 93. (Check: $89+91+93 = 273$ ✓)

(b) Find the missing number in the given series: (i) 4, 16, 36, 64, ?, 144 (ii) 30, 29, 27, ?, 20, 15 (iii) 1, 7, 15, 25, ?, 51 (iv) 0, 2, 6, 12, 20, 30, ? (v) 48, 24, 72, 36, 108, ?

SOLVED ANSWER

(i) 4, 16, 36, 64, ?, 144

These are squares of even numbers: $2^2=4$, $4^2=16$, $6^2=36$, $8^2=64$, $10^2=100$, $12^2=144$.

Missing number = 100

(ii) 30, 29, 27, ?, 20, 15

Differences subtracted are increasing by 1 each time: -1 , -2 , -3 , -4 , -5 .

$30-1=29$, $29-2=27$, $27-3=24$, $24-4=20$, $20-5=15$.

Missing number = 24

(iii) 1, 7, 15, 25, ?, 51

Differences increase by 2 each time: $+6$, $+8$, $+10$, $+12$, $+14$.

$1+6=7$, $7+8=15$, $15+10=25$, $25+12=37$, $37+14=51$.

Missing number = 37

(iv) 0, 2, 6, 12, 20, 30, ?

Each term = $n \times (n-1)$: $0=0 \times 1$, $2=1 \times 2$, $6=2 \times 3$, $12=3 \times 4$, $20=4 \times 5$, $30=5 \times 6$, next = 6×7 .

Missing number = 42

(v) 48, 24, 72, 36, 108, ?

Pattern alternates $\div 2$ then $\times 3$: $48 \div 2 = 24$, $24 \times 3 = 72$, $72 \div 2 = 36$, $36 \times 3 = 108$, $108 \div 2 = 54$.

Missing number = 54

(c) Find out the correct word from the given jumbled spellings: (i) THR SI (ii) GNDREA (iii) SCHAMOT (iv) ONLNDO (v) HIODALY

SOLVED ANSWER

(i) THR SI $\rightarrow$ **SHIRT**

(ii) GNDREA $\rightarrow$ **GARDEN**

(iii) SCHAMOT $\rightarrow$ **STOMACH**

(iv) ONLNDO $\rightarrow$ **LONDON**

(v) HIODALY $\rightarrow$ **HOLIDAY**

(d) Sara's mother is 6 times older than Sara, whereas her brother Ali is twice as old as Sara. In three years' time the sum of their ages will be 72. How old are Sara, Ali and their mother now?

SOLVED ANSWER

Let Sara's current age = x

Then Mother's age = $6x$, and Ali's age = $2x$

In 3 years: $(x+3) + (6x+3) + (2x+3) = 72$

$9x + 9 = 72 \rightarrow 9x = 63 \rightarrow x = 7$

Answer: Sara = 7 years, Ali = 14 years, Mother = 42 years (at present).

(a) What do you understand by Sampling? Discuss Non-Probability Sampling.

SOLVED ANSWER

Sampling is the process of selecting a smaller, representative subset (sample) from a larger population, in order to study and draw conclusions about that population without having to examine every single member of it — saving time, cost and effort.

Non-Probability Sampling: A sampling technique in which samples are selected using the researcher's judgement or convenience rather than random selection, meaning not every member of the population has a known or equal chance of being included. It is quicker and cheaper but carries a higher risk of selection bias and lower generalisability.

Common types of Non-Probability Sampling:

- **Convenience Sampling** — selecting readily available subjects.
- **Judgmental/Purposive Sampling** — selecting based on researcher's expert judgement.
- **Quota Sampling** — selecting a fixed number from specific subgroups.
- **Snowball Sampling** — existing subjects recruit future subjects from among their acquaintances.

(b) Aslam is willing to use stylish ceramic tiles in the lounge of his under-construction house. The shape of the tile is a right triangle, having the lengths of two legs of 12 cm and 4 cm. Each tile costs Rs. 15. How much will it cost to fill the lounge of 8 meters length and 6 meters width with these tiles?

SOLVED ANSWER

Area of one triangular tile = $\frac{1}{2} \times \text{base} \times \text{height} = \frac{1}{2} \times 12 \times 4 = 24 \text{ cm}^2$

Area of the lounge = $8 \text{ m} \times 6 \text{ m} = 800 \text{ cm} \times 600 \text{ cm} = 480,000 \text{ cm}^2$

Number of tiles needed = Lounge area $\div$ Tile area = $480,000 \div 24 = 20,000$ tiles

Total cost = $20,000 \times \text{Rs. } 15 = \text{Rs. } 300,000$

Answer: It will cost Rs. 300,000 to tile the lounge.

(c) During a sale a clerk was putting new price tags on each item. On one sweater, he accidentally raised the price by 20% instead of lowering the price by 20%. As a result the price on the tag was Rs. 80 too high. What was the original price of the sweater?

SOLVED ANSWER

Let the original price = P

Mistaken (raised) price = $P + 20\% \text{ of } P = 1.20P$

Correct (lowered) price = $P - 20\% \text{ of } P = 0.80P$

Difference between the two = $1.20P - 0.80P = 0.40P$

Given: $0.40P = 80 \rightarrow P = 80 \div 0.40 = 200$

Answer: The original price of the sweater was Rs. 200.

(d) If in a certain language, BROTHER is written as QDGSNQA, then in the same language, SISTER would be written as -----?

SOLVED ANSWER

Step 1 — Discover the coding rule using BROTHER → QDGSNQA:

Reverse the word BROTHER: B-R-O-T-H-E-R → R-E-H-T-O-R-B

Now shift every letter one step back in the alphabet:

R→Q, E→D, H→G, T→S, O→N, R→Q, B→A

Result: Q-D-G-S-N-Q-A = QDGSNQA ✓ (matches the given code, confirming the rule)

Rule: Reverse the word, then shift each letter one position back in the alphabet.

Step 2 — Apply the same rule to SISTER:

Reverse SISTER: S-I-S-T-E-R → R-E-T-S-I-S

Shift each letter one step back:

R→Q, E→D, T→S, S→R, I→H, S→R

Result: Q-D-S-R-H-R

Answer: SISTER would be written as QDSRHR

— End of Solved Paper —