

EVERYDAY SCIENCE

COMPLETE SOLVED PAPER · 100 MCQs · TOUGH & CHALLENGING

SUBJECT	EVERYDAY SCIENCE	TOTAL QUESTIONS	100 MCQs
PAPER TYPE	FULLY SOLVED	DIFFICULTY	HARD / TOUGH
TOPICS COVERED	10 SECTIONS	ANSWER KEY	HIGHLIGHTED ✓
FORMAT	MULTIPLE CHOICE	EXPLANATIONS	INCLUDED

**ANSWER KEY
LEGEND:**

● **GREEN BOLD = CORRECT ANSWER (Highlighted)** ■ Regular text = Incorrect option

SECTIONS: PHYSICS · CHEMISTRY · BIOLOGY · EARTH SCIENCE & ENVIRONMENT · ASTRONOMY & SPACE
SCIENCE · TECHNOLOGY & EVERYDAY APPLICATIONS · FOOD SCIENCE & NUTRITION · ADVANCED PHYSICS &
CHEMISTRY

SECTION 1: PHYSICS

Q1. Which phenomenon explains why the sky appears blue during the day?

A. (A) Refraction of sunlight through the atmosphere

✓ **B. (B) Rayleigh scattering of short-wavelength light by atmospheric particles**

C. (C) Mie scattering of sunlight by large aerosol particles

D. (D) Absorption of long wavelengths by the ozone layer

■ **Explanation:** Rayleigh scattering causes shorter (blue) wavelengths to scatter far more than longer wavelengths, making the sky appear blue.

Q2. A sound wave travels fastest through which medium?

A. (A) Air at 0 degrees C (approx. 331 m/s)

B. (B) Vacuum (electromagnetic waves only)

✓ **C. (C) Steel (approx. 5100 m/s)**

D. (D) Water at 25 degrees C (approx. 1480 m/s)

■ **Explanation:** Sound travels fastest through solids because tightly packed molecules transfer vibrations more rapidly. Speed in steel is approximately 5100 m/s.

Q3. Convex mirrors are used as rear-view mirrors because they produce images that are:

A. (A) Real, inverted, and magnified

✓ **B. (B) Virtual, erect, and diminished with a wider field of view**

C. (C) Real, upright, and life-size

D. (D) Virtual, inverted, and enlarged

■ **Explanation:** Convex mirrors always form virtual, erect, and diminished images behind the mirror, giving the driver a wider field of view.

Q4. What happens to the boiling point of water at high altitudes where atmospheric pressure is lower?

A. (A) It increases above 100 degrees C

B. (B) It remains exactly 100 degrees C

✓ **C. (C) It decreases below 100 degrees C**

D. (D) It becomes indeterminate

■ **Explanation:** Lower atmospheric pressure means water molecules need less kinetic energy to escape into vapour, so boiling occurs at a lower temperature than 100 degrees C.

Q5. Bernoulli's principle states that for an ideal fluid in steady flow:

A. (A) Pressure increases as velocity increases

✓ **B. (B) The sum of pressure, kinetic, and potential energy per unit volume is constant**

C. (C) Temperature and pressure are directly proportional

D. (D) Viscosity remains constant regardless of flow speed

■ **Explanation:** Bernoulli's equation: $P + \frac{1}{2}\rho v^2 + \rho gh = \text{constant}$. As fluid velocity increases, static pressure decreases.

Q6. Which type of electromagnetic radiation carries the most energy per photon?

A. (A) Ultraviolet radiation

B. (B) X-rays

✓ C. (C) Gamma rays

D. (D) Microwaves

■ **Explanation:** Gamma rays have the highest frequency (above 10^{19} Hz) and thus the highest energy per photon ($E = hf$), far exceeding X-rays or UV.

Q7. A fuse wire must have which combination of electrical properties?

A. (A) High resistance and high melting point

B. (B) Low resistance and high melting point

C. (C) High resistance and low melting point

✓ D. (D) Low resistance and low melting point

■ **Explanation:** Low resistance allows normal current flow without heating; low melting point ensures the fuse melts and breaks the circuit quickly during overload.

Q8. Which principle explains why a spinning gyroscope maintains its orientation in space?

A. (A) Newton's First Law of linear motion

✓ B. (B) Conservation of angular momentum

C. (C) Bernoulli's principle

D. (D) Archimedes' principle of buoyancy

■ **Explanation:** A spinning gyroscope conserves angular momentum ($L = I\omega$). Any external torque is resisted, causing precession rather than immediate reorientation.

Q9. The electric force between two point charges is described by Coulomb's Law. If the distance between charges is doubled, the force:

A. (A) Doubles

B. (B) Halves

✓ C. (C) Reduces to one-quarter

D. (D) Reduces to one-eighth

■ **Explanation:** Coulomb's Law: $F = kq_1q_2/r^2$. Force is inversely proportional to the square of distance. Doubling r reduces F by a factor of 4.

Q10. Which property of a wave determines its loudness (for sound) or brightness (for light)?

A. (A) Frequency

B. (B) Wavelength

✓ C. (C) Amplitude

D. (D) Wave speed

■ **Explanation:** Amplitude determines the energy carried by a wave. Greater amplitude means louder sound or brighter light; frequency determines pitch or colour.

SECTION 2: CHEMISTRY

Q11. When dilute hydrochloric acid reacts with zinc metal, which gas is produced?

- A. (A) Oxygen gas
 C. (C) Chlorine gas
 ✓ B. (B) Hydrogen gas
 D. (D) Carbon dioxide gas

■ **Explanation:** $\text{Zn} + 2\text{HCl} \rightarrow \text{ZnCl}_2 + \text{H}_2$ (gas). The hydrogen produced burns with a characteristic 'pop' when a lit splint is applied.

Q12. Stainless steel resists corrosion due to the formation of:

- A. (A) A nickel oxide protective layer
 C. (C) High carbon content blocking oxygen
 ✓ B. (B) A thin, stable chromium oxide (Cr_2O_3) passive layer
 D. (D) A manganese silicate coating

■ **Explanation:** Chromium (10.5%+ by mass) in stainless steel reacts with atmospheric oxygen to form a self-repairing Cr_2O_3 passive layer that prevents iron oxidation.

Q13. What is the pH of a solution with a hydrogen ion concentration of 10^{-9} mol/L?

- A. (A) pH = 3 (acidic)
 B. (B) pH = 5 (weakly acidic)
 C. (C) pH = 7 (neutral)
 ✓ D. (D) pH = 9 (basic/alkaline)

■ **Explanation:** $\text{pH} = -\log[\text{H}^+] = -\log(10^{-9}) = 9$. A pH above 7 indicates an alkaline (basic) solution.

Q14. Fermentation converts glucose into ethanol and carbon dioxide in the absence of:

- A. (A) Water
 B. (B) Yeast
 ✓ C. (C) Oxygen (anaerobic process)
 D. (D) Temperature control

■ **Explanation:** Anaerobic fermentation by yeast: $\text{C}_6\text{H}_{12}\text{O}_6 \rightarrow 2\text{C}_2\text{H}_5\text{OH} + 2\text{CO}_2$. It requires no oxygen, exploited in bread-making and alcohol production.

Q15. Catalytic converters in vehicles use which metals to reduce harmful exhaust emissions?

- A. (A) Iron, copper, and zinc
 C. (C) Nickel, cobalt, and silver
 ✓ B. (B) Platinum, palladium, and rhodium
 D. (D) Aluminium, titanium, and gold

■ **Explanation:** Pt, Pd, and Rh catalyse oxidation of CO and unburned hydrocarbons to $\text{CO}_2/\text{H}_2\text{O}$, and reduction of NO_x to N_2 , significantly cutting toxic emissions.

Q16. The Tyndall effect distinguishes a colloid from a true solution because:

- A. (A) Colloids allow light to pass through unaffected
 C. (C) True solutions scatter light more strongly than colloids
 ✓ B. (B) Colloid particles scatter visible light, making the beam visible
 D. (D) Colloids filter out all wavelengths of light

■ **Explanation:** Colloid particles (1-1000 nm) are large enough to scatter light (Tyndall effect), whereas solute particles in true solutions (below 1 nm) are too small to scatter light.

Q17. In an exothermic chemical reaction, which of the following is true?

A. (A) Energy is absorbed from the surroundings; delta-H is positive

✓ B. (B) Energy is released to the surroundings; delta-H is negative

C. (C) No energy transfer occurs between system and surroundings

D. (D) Bond-breaking releases more energy than bond-forming absorbs

■ **Explanation:** Exothermic reactions release energy (heat or light) because bond formation in products releases more energy than bond breaking in reactants requires. $\Delta H < 0$.

Q18. Dry ice is solid carbon dioxide. Its most distinctive property relevant to everyday use is:

A. (A) It melts to a liquid before evaporating

✓ B. (B) It sublimates directly from solid to gas at -78.5 degrees C

C. (C) It dissolves easily in water to form carbonate ions

D. (D) It reacts with oxygen to release heat

■ **Explanation:** Dry ice sublimates (solid → gas) directly at -78.5 degrees C, producing no liquid water, making it ideal for shipping temperature-sensitive goods.

Q19. Which type of chemical bond involves the complete transfer of electrons from one atom to another?

A. (A) Covalent bond (sharing of electrons)

B. (B) Metallic bond (sea of delocalized electrons)

✓ C. (C) Ionic bond (electrostatic attraction after electron transfer)

D. (D) Hydrogen bond (weak dipole-dipole interaction)

■ **Explanation:** Ionic bonds form when a metal atom transfers one or more electrons to a non-metal atom, creating oppositely charged ions (e.g., Na^+ and Cl^-) that attract each other.

Q20. Osmosis in biological systems is the movement of:

A. (A) Solute molecules from high to low concentration through any membrane

✓ B. (B) Water molecules from low solute concentration to high solute concentration through a semi-permeable membrane

C. (C) Both solute and water through a membrane at equal rates

D. (D) Charged ions against a concentration gradient using energy

■ **Explanation:** Osmosis is passive movement of water across a selectively permeable membrane from dilute (low solute) to concentrated (high solute) solution, equalising concentrations.

SECTION 3: BIOLOGY

Q21. Which organelle is the site of ATP production through cellular respiration?

- A. (A) Nucleus (site of DNA replication) B. (B) Ribosome (site of protein synthesis)
- ✓ C. (C) Mitochondria (powerhouse of the cell) D. (D) Golgi apparatus (protein packaging/export)

■ **Explanation:** Mitochondria house the Krebs cycle (matrix) and electron transport chain (inner membrane), converting glucose and oxygen to ATP, CO₂, and water.

Q22. Which molecule serves as the template for protein synthesis at ribosomes?

- A. (A) DNA (stays in the nucleus) B. (B) tRNA (transfers amino acids to ribosomes)
- ✓ C. (C) mRNA (messenger RNA carries the genetic code from nucleus to ribosome) D. (D) rRNA (forms the ribosome structure)

■ **Explanation:** mRNA is transcribed from DNA in the nucleus, exported to the cytoplasm, and translated by ribosomes. tRNA brings specific amino acids matching the mRNA codons.

Q23. Insulin secreted by pancreatic beta cells functions to:

- A. (A) Raise blood glucose by stimulating glycogen breakdown ✓ B. (B) Lower blood glucose by promoting its uptake into cells and glycogen synthesis
- C. (C) Stimulate the liver to release glucose into the bloodstream D. (D) Inhibit the digestion of carbohydrates in the small intestine

■ **Explanation:** Insulin allows cells to take up glucose (especially in muscle and adipose tissue) and signals the liver to store glucose as glycogen, thereby lowering blood glucose levels.

Q24. How many chromosomes are found in a normal human somatic (body) cell?

- A. (A) 23 chromosomes (haploid - gametes only) B. (B) 44 chromosomes (autosomes only)
- ✓ C. (C) 46 chromosomes (23 pairs - diploid) D. (D) 48 chromosomes (found in great apes)

■ **Explanation:** Human somatic cells are diploid ($2n = 46$), containing 22 pairs of autosomes and 1 pair of sex chromosomes (XX or XY). Gametes are haploid ($n = 23$).

Q25. Transpiration in plants refers to:

- A. (A) Absorption of water through root hair cells via osmosis ✓ B. (B) Loss of water vapour from leaves primarily through stomata
- C. (C) Transport of organic nutrients through phloem tissue D. (D) Production of oxygen as a by-product of photosynthesis

■ **Explanation:** Transpiration drives the upward movement of water (transpiration pull) through the xylem from roots to leaves, where it evaporates through stomata into the atmosphere.

Q26. The human liver produces bile, which is stored in the gallbladder and functions to:

A. (A) Produce digestive enzymes that break down proteins

✓ B. (B) Emulsify (break up) large fat globules into smaller droplets

C. (C) Secrete insulin directly into the bloodstream

D. (D) Absorb glucose from digested food in the small intestine

■ **Explanation:** Bile salts emulsify fats, increasing surface area for pancreatic lipase enzymes to digest triglycerides into fatty acids and glycerol, enabling fat absorption.

Q27. Which part of the human brain controls balance, posture, and fine motor coordination?

A. (A) Cerebrum (higher cognitive functions)

B. (B) Hypothalamus (homeostasis and hormonal regulation)

C. (C) Medulla oblongata (autonomic functions: breathing, heart rate)

✓ D. (D) Cerebellum (balance, coordination, and fine movement)

■ **Explanation:** The cerebellum receives sensory inputs from vestibular system, eyes, and proprioceptors, and coordinates muscle activity to produce smooth, precise movements and maintain balance.

Q28. Which blood type is considered the universal donor for red blood cell transfusions?

A. (A) A positive (A+)

✓ B. (B) O negative (O-) - lacks A, B, and Rh antigens

C. (C) AB positive (AB+) - the universal recipient

D. (D) B negative (B-)

■ **Explanation:** O- red blood cells lack ABO and Rh antigens, so they cannot trigger immune reactions in any recipient. AB+ individuals are universal recipients (accept all types).

Q29. Melanin in human skin primarily provides protection by:

A. (A) Killing surface bacteria through enzymatic action

✓ B. (B) Absorbing and dissipating UV radiation to prevent DNA damage

C. (C) Reflecting infrared heat radiation away from skin

D. (D) Providing a physical barrier against viral infections

■ **Explanation:** Melanocytes produce melanin, which absorbs UV photons and dissipates their energy as heat, preventing UV from damaging the DNA in skin cells and causing mutations.

Q30. Haemoglobin carries oxygen through the blood. Which metal ion at the core of each haem group binds O₂?

A. (A) Copper (Cu²⁺) - found in haemocyanin of some invertebrates

B. (B) Zinc (Zn²⁺) - found in carbonic anhydrase

✓ C. (C) Iron (Fe²⁺) - four haem groups bind four O₂ molecules per Hb

D. (D) Magnesium (Mg²⁺) - found in chlorophyll

■ **Explanation:** Each haemoglobin tetramer contains four haem groups, each with Fe²⁺ that reversibly binds one O₂ in the lungs and releases it in tissues with lower O₂ pressure.

SECTION 4: EARTH SCIENCE & ENVIRONMENT

Q31. The ozone layer, which shields Earth from harmful UV radiation, is located in the:

- A. (A) Troposphere (0-12 km, where weather occurs) ✓ **B. (B) Stratosphere (12-50 km, ozone layer at 15-35 km)**
- C. (C) Mesosphere (50-85 km, where meteors burn up) D. (D) Thermosphere (85-600 km, where auroras occur)

■ **Explanation:** The stratospheric ozone layer (15-35 km altitude) absorbs 97-99% of the Sun's medium-frequency UV radiation, protecting life from harmful UVB and UVC.

Q32. Acid rain is primarily caused by the atmospheric reaction of which gases with water?

- A. (A) Carbon dioxide (CO₂) forming carbonic acid (weak, natural) ✓ **B. (B) Sulfur dioxide (SO₂) and nitrogen oxides (NO_x) forming sulfuric and nitric acids**
- C. (C) Chlorofluorocarbons (CFCs) dissolving in rainwater D. (D) Methane (CH₄) reacting with atmospheric oxygen

■ **Explanation:** SO₂ from coal combustion and NO_x from vehicle exhausts react with atmospheric moisture to form H₂SO₄ and HNO₃, producing rainfall with pH as low as 4.

Q33. The greenhouse effect that naturally warms Earth is primarily maintained by which gas by volume of effect?

- A. (A) Carbon dioxide - largest anthropogenic contributor but not the largest overall ✓ **B. (B) Water vapour - responsible for 50-70% of the natural greenhouse effect**
- C. (C) Methane - 80x more potent but much lower in concentration D. (D) Ozone - primarily important in stratosphere for UV protection

■ **Explanation:** Water vapour accounts for the majority of Earth's natural greenhouse effect. CO₂ is the primary driver of human-caused warming despite lower absolute warming contribution.

Q34. Earthquakes are measured on the Richter scale, which is logarithmic. Each whole number increase represents:

- A. (A) A 2x increase in ground motion amplitude ✓ **B. (B) A 10x increase in amplitude and about 31.6x more energy released**
- C. (C) A 100x increase in both amplitude and energy D. (D) A fixed additive amount of energy regardless of scale

■ **Explanation:** The Richter scale is base-10 logarithmic. Each unit increase = 10x greater amplitude of seismic waves and approximately 31.6 times more energy released.

Q35. Eutrophication of lakes and rivers is primarily triggered by excess:

- A. (A) Carbon dioxide dissolved from the atmosphere B. (B) Heavy metals from industrial discharge
 ✓ C. (C) Nitrogen and phosphorus from agricultural runoff and sewage D. (D) Suspended fine sediment from erosion

■ **Explanation:** Excess N and P (from fertilisers and sewage) cause explosive algal blooms. When algae die and decompose, bacterial respiration depletes dissolved oxygen, creating hypoxic 'dead zones'.

Q36. What percentage of Earth's total water supply is readily accessible freshwater?

- A. (A) Approximately 30% B. (B) Approximately 10%
 C. (C) Approximately 3% ✓ D. (D) Less than 1% (as liquid in lakes, rivers, groundwater)

■ **Explanation:** About 97.5% of Earth's water is saline. Of the 2.5% freshwater, ~68.7% is in glaciers/ice caps, ~30% is groundwater; accessible surface water is under 1% of total.

Q37. The Coriolis effect causes freely moving objects (air, ocean currents) to be deflected because of:

- A. (A) The Moon's gravitational field acting on moving fluids ✓ B. (B) Earth's rotation, which causes deflection right in the Northern Hemisphere
 C. (C) Temperature gradients between equatorial and polar regions D. (D) Differences in air pressure across continental land masses

■ **Explanation:** Earth's rotation means points near the equator move faster than points nearer the poles. Moving air/water is deflected right (NH) or left (SH), creating cyclones and ocean gyres.

Q38. Nitrogen fixation in the nitrogen cycle converts atmospheric nitrogen (N₂) into:

- A. (A) Nitrates directly available to plants without bacterial action ✓ B. (B) Ammonium compounds (NH₄⁺) usable by plants and microbes
 C. (C) Molecular oxygen released back into the atmosphere D. (D) Nitrous oxide (N₂O), a greenhouse gas

■ **Explanation:** Nitrogen-fixing bacteria (*Rhizobium* in legume root nodules, *Azotobacter* in soil) reduce N₂ to NH₄⁺ using the nitrogenase enzyme, entering the nitrogen cycle.

Q39. Which type of rock is formed by cooling and solidification of magma or lava?

- A. (A) Sedimentary rock (formed by compaction of sediments) B. (B) Metamorphic rock (formed by heat and pressure transformation)
 ✓ C. (C) Igneous rock (formed from cooled molten rock - magma or lava) D. (D) Composite rock (formed by mixing of all three types)

■ **Explanation:** Igneous rocks: intrusive (plutonic) forms from slowly cooled magma underground (e.g., granite); extrusive (volcanic) forms from rapidly cooled lava at surface (e.g., basalt).

Q40. The primary cause of Earth's ocean tides is:

A. (A) Earth's rotation creating centrifugal force on ocean water

✓ **B. (B) Gravitational attraction of the Moon (and to a lesser extent the Sun)**

C. (C) Atmospheric pressure differences over ocean surfaces

D. (D) Thermal expansion of seawater due to solar heating

■ **Explanation:** The Moon's gravitational gradient across Earth creates two tidal bulges: one facing the Moon (direct pull) and one on the opposite side (inertia). The Sun creates spring and neap tides.

SECTION 5: ASTRONOMY & SPACE SCIENCE

Q41. Light from the Sun takes approximately how long to reach Earth?

A. (A) 1.3 seconds (Moon-to-Earth distance)

✓ **B. (B) 8 minutes 20 seconds (approx. 150 million km at speed of light)**

C. (C) 24 hours (one complete Earth day)

D. (D) 1 year (distance used for stellar parallax)

■ **Explanation:** At $c = 3 \times 10^8$ m/s, crossing 1.496×10^{11} m (1 AU) takes 499 seconds, or approximately 8 minutes 19 seconds.

Q42. A black hole is defined as a region of spacetime where:

A. (A) No matter exists and the region is a vacuum

✓ **B. (B) Gravity is so extreme that the escape velocity exceeds the speed of light**

C. (C) A neutron star still emits radiation beyond the event horizon

D. (D) Only dark matter accumulates due to absence of electromagnetic force

■ **Explanation:** Beyond the event horizon, escape velocity $> c$. Since nothing can exceed c , not even photons can escape. The boundary is called the Schwarzschild radius.

Q43. The cosmic microwave background (CMB) radiation is direct evidence for:

A. (A) The existence of dark matter halos around galaxies

✓ **B. (B) The Big Bang theory - thermal radiation from the early universe**

C. (C) Ongoing nucleosynthesis of elements in stellar interiors

D. (D) The existence of black holes at galactic centres

■ **Explanation:** CMB is residual thermal radiation from approximately 380,000 years after the Big Bang, when the universe cooled enough for atoms to form. First detected by Penzias and Wilson in 1965.

Q44. The Milky Way galaxy is classified as what type of galaxy?

A. (A) Elliptical galaxy - common among massive, old galaxies

B. (B) Irregular galaxy - lacking defined structure

✓ C. (C) Barred spiral galaxy - with a central bar of stars and spiral arms

D. (D) Lenticular galaxy - disc-shaped but without prominent spiral arms

■ **Explanation:** The Milky Way is a barred spiral galaxy (SBbc type) with a central bar-shaped bulge, four major spiral arms, and a diameter of approximately 100,000 light-years.

Q45. Perihelion is the point in Earth's elliptical orbit when Earth is:

A. (A) Farthest from the Sun (this is called aphelion)

B. (B) Directly above the equator (this is an equinox)

✓ C. (C) Closest to the Sun (around January 3-4 each year)

D. (D) At the same orbital speed as the Moon

■ **Explanation:** Earth's perihelion (~147 million km) occurs in early January; aphelion (~152 million km) in early July. Counter-intuitively, Earth is closest to the Sun during Northern Hemisphere winter.

Q46. What causes the Doppler redshift observed in light from distant galaxies?

A. (A) Galaxies absorbing blue light and re-emitting red light

✓ B. (B) Space itself expanding, stretching the wavelength of photons as they travel

C. (C) Gravitational lensing altering the photon path

D. (D) Dust absorption of higher-energy blue photons in intergalactic space

■ **Explanation:** Cosmological redshift is caused by the expansion of spacetime itself. As the universe expands, the wavelength of photons travelling through it is stretched proportionally.

Q47. An astronomical unit (AU) is defined as:A. (A) The distance light travels in one year ($\sim 9.46 \times 10^{15}$ m)✓ B. (B) The mean Earth-Sun distance ($\sim 1.496 \times 10^{11}$ m)C. (C) The radius of the observable universe divided by 10^{13} D. (D) The mean Earth-Moon distance ($\sim 3.84 \times 10^8$ m)

■ **Explanation:** $1 \text{ AU} = 1.496 \times 10^{11} \text{ m} = 149.6 \text{ million km}$, the mean Earth-Sun distance. $1 \text{ light-year} = 63,241 \text{ AU}$. The parsec = $3.26 \text{ light-years} = 206,265 \text{ AU}$.

Q48. Solar flares primarily affect Earth's technology by:

A. (A) Causing earthquakes through gravitational disruption

✓ B. (B) Disrupting radio/satellite communications and inducing currents in power grids

C. (C) Significantly raising ocean temperatures globally

D. (D) Increasing volcanic activity through atmospheric ionisation

■ **Explanation:** Solar flares release X-rays and charged particles. X-rays cause immediate radio blackouts; coronal mass ejections (CMEs) reach Earth in 1-3 days, disrupting GPS, satellites, and power infrastructure.

Q49. Neutron stars are among the densest objects in the universe. A teaspoon of neutron star material would weigh approximately:

A. (A) Around 100 kilograms

B. (B) Around 1 metric tonne

✓ C. (C) Around 1 billion tonnes (10^9 kg)

D. (D) Around 100 billion tonnes (10^{11} kg)

■ **Explanation:** Neutron star density is approximately 10^{17} kg/m³. A 5 mL teaspoon would contain roughly 5×10^{11} kg (500 million tonnes), close to option C.

Q50. Which planet has a day longer than its year?

A. (A) Mercury (rotates slowly but orbits quickly - still shorter year)

✓ B. (B) Venus (rotation period 243 Earth days; orbital period 225 Earth days)

C. (C) Mars (day = 24.6 hours; year = 687 Earth days)

D. (D) Jupiter (day = 10 hours; year = 12 Earth years)

■ **Explanation:** Venus rotates retrograde in 243 Earth days (sidereal day) but orbits the Sun in only 225 Earth days, making its solar day even stranger: approximately 117 Earth days.

SECTION 6: TECHNOLOGY & EVERYDAY APPLICATIONS

Q51. How does a microwave oven heat food?

A. (A) Infrared radiation heats the outer surface, which conducts heat inward

✓ B. (B) Microwaves (2.45 GHz) cause water molecules to rotate, generating heat throughout

C. (C) Convection currents of hot air circulate inside the oven cavity

D. (D) Electrical conduction through metallic ions in food generates resistance heat

■ **Explanation:** Microwaves at 2.45 GHz are absorbed by water, fat, and sugar molecules, causing dipole rotation that generates frictional heat throughout the food volume simultaneously.

Q52. Why does ice float on liquid water, which is unusual for a solid?

A. (A) Ice contains dissolved air that reduces its overall mass

✓ B. (B) Water's hydrogen bonds form a hexagonal crystal lattice in ice, making it less dense than liquid water

C. (C) Surface tension of water supports the weight of floating ice

D. (D) Ice has more molecules per unit volume creating upward buoyancy

■ **Explanation:** Ice density ~ 917 kg/m³ vs liquid water ~ 1000 kg/m³. The open hexagonal lattice of hydrogen bonds in ice takes up more space than the disordered liquid structure, so ice floats.

Q53. GPS determines your exact location using signals from satellites. The minimum number of satellites needed is:

- A. (A) 1 satellite (for 1D positioning only) B. (B) 2 satellites (for 2D mapping)
 C. (C) 3 satellites (for latitude and longitude only) ✓ D. (D) 4 satellites (for 3D position including altitude)

■ **Explanation:** At least 4 GPS satellites are needed: 3 for trilateration to calculate latitude, longitude, and altitude, plus a 4th to correct receiver clock errors.

Q54. Optical fibres transmit data as light pulses using which physical phenomenon?

- A. (A) Reflection off metallic inner coating ✓ B. (B) Total internal reflection at the core-cladding boundary
 C. (C) Diffraction of light through a narrow aperture D. (D) Refraction causing light to bend and stay within the fibre

■ **Explanation:** Total internal reflection occurs when light hits the core-cladding interface at an angle greater than the critical angle, keeping light trapped in the core for long-distance transmission.

Q55. LED bulbs are significantly more energy-efficient than incandescent bulbs because:

- A. (A) LEDs generate absolutely no heat during operation ✓ B. (B) LEDs convert up to 90% of electrical energy directly to light via electroluminescence
 C. (C) LEDs use much higher voltages to achieve the same brightness D. (D) LEDs trap photons and re-emit them with higher efficiency

■ **Explanation:** Incandescent bulbs convert approximately 90% of energy to heat (infrared) and only 10% to visible light. LEDs produce light by electron-hole recombination, wasting minimal energy as heat.

Q56. Which phenomenon do noise-cancelling headphones exploit to reduce ambient sound?

- A. (A) Physical soundproofing using dense foam layers only ✓ B. (B) Destructive interference from anti-phase sound waves generated electronically
 C. (C) Amplification of chosen audio to mask background noise D. (D) Magnetic shielding of the ear canal from external vibrations

■ **Explanation:** ANC headphones use microphones to detect ambient noise, then produce an inverted (phase-shifted by 180 degrees) waveform. The two waves interfere destructively, cancelling the noise.

Q57. Wi-Fi transmits data wirelessly using which frequency bands?

- A. (A) AM radio frequencies (540 kHz to 1.6 MHz) ✓ B. (B) 2.4 GHz and 5 GHz microwave frequency bands (IEEE 802.11 standards)
 C. (C) FM radio frequencies (87.5 to 108 MHz) D. (D) Infrared frequencies (300 GHz to 430 THz)

■ **Explanation:** Wi-Fi (802.11 b/g/n/ac/ax/be) operates in 2.4 GHz (longer range, more interference) and 5 GHz (shorter range, faster speeds) ISM bands. Wi-Fi 6E also uses 6 GHz.

Q58. Lithium-ion batteries operate through movement of which particles between electrodes?

- A. (A) Protons (H^+) moving through a solid electrolyte
- ✓ B. (B) Lithium ions (Li^+) migrating between anode and cathode through electrolyte
- C. (C) Electrons moving through the electrolyte directly
- D. (D) Calcium ions (Ca^{2+}) in a wet cell configuration

■ **Explanation:** During charging: Li^+ moves from cathode ($LiCoO_2$) to graphite anode. During discharge: Li^+ moves back, releasing energy. Electrons flow through external circuit, providing current.

Q59. Why does salt (NaCl) sprinkled on icy roads help melt the ice?

- A. (A) Salt generates heat when it dissolves in water
- ✓ B. (B) Dissolved ions disrupt ice crystal formation, lowering the freezing point (freezing point depression)
- C. (C) Salt absorbs heat from the surroundings as it dissolves
- D. (D) Salt increases water density, causing ice to sink and melt

■ **Explanation:** Freezing point depression: dissolved Na^+ and Cl^- ions interfere with hydrogen bond network needed to form ice crystals, requiring a lower temperature to freeze. $\Delta T_f = K_f \times m$.

Q60. What makes carbon monoxide (CO) dangerous even in small concentrations in indoor air?

- A. (A) CO is highly flammable and explosive at room temperature
- ✓ B. (B) CO binds to haemoglobin 200x more strongly than O_2 , preventing oxygen transport
- C. (C) CO reacts with lung moisture to form carbonic acid, damaging tissue
- D. (D) CO displaces nitrogen in the air, causing suffocation

■ **Explanation:** CO binds to haemoglobin (forming carboxyhaemoglobin) with ~240x higher affinity than O_2 . Even low concentrations block O_2 delivery to tissues, causing hypoxia, unconsciousness, and death.

SECTION 7: FOOD SCIENCE & NUTRITION

Q61. Which nutrient provides the highest caloric density at 9 kcal per gram?

- A. (A) Carbohydrates (provide 4 kcal/g)
- B. (B) Proteins (provide 4 kcal/g)
- ✓ C. (C) Fats and oils (provide 9 kcal/g)
- D. (D) Dietary fibre (provides approximately 2 kcal/g after fermentation)

■ **Explanation:** Lipids provide 9 kcal/g because their carbon chains are more reduced (more C-H bonds per carbon) than carbohydrates or proteins, releasing more energy upon oxidation.

Q62. The Maillard reaction, responsible for the flavour and brown colour of baked and seared foods, requires:

A. (A) Caramelisation of pure sugars above 160 degrees C without protein

✓ B. (B) A reaction between amino acids and reducing sugars (above approximately 140 degrees C)

C. (C) Oxidation of unsaturated fatty acids in the food surface

D. (D) Starch gelatinisation in the presence of water and heat

■ **Explanation:** The Maillard reaction (Maillard, 1912) produces hundreds of flavour compounds and brown melanoidin pigments when amino acids react with reducing sugars under heat (above ~140 degrees C).

Q63. Pasteurisation of milk involves heating to approximately 72 degrees C for 15 seconds in order to:

A. (A) Sterilise the milk completely, killing all microorganisms including spores

✓ B. (B) Kill pathogenic bacteria (e.g., Salmonella, E. coli) while preserving flavour and nutrition

C. (C) Denature lactose into simpler sugars for easier digestion

D. (D) Remove water to concentrate the milk's protein content

■ **Explanation:** Pasteurisation kills pathogenic bacteria but not all heat-resistant spores or spoilage organisms (which UHT treatment achieves at 135-140 degrees C for 2-5 seconds).

Q64. Why does cutting onions cause eyes to tear up?

A. (A) Onion pollen triggers an immediate allergic reaction in the eyes

✓ B. (B) Syn-propanethial-S-oxide gas forms and reacts with eye moisture to create mild sulfuric acid

C. (C) Volatile alkaline compounds from onion sap directly irritate the cornea

D. (D) Onion releases ethylene gas that stimulates lacrimal glands

■ **Explanation:** Cutting onions ruptures cells, mixing enzymes with sulfoxide substrates. Syn-propanethial-S-oxide volatilises, dissolves in tear film, and forms sulfuric acid, triggering protective lacrimation.

Q65. Vitamin C (ascorbic acid) is essential for the synthesis of collagen because it acts as:

A. (A) A direct building block incorporated into collagen triple helix

✓ B. (B) A cofactor for prolyl and lysyl hydroxylase enzymes that stabilise collagen

C. (C) An antioxidant that prevents collagen degradation after synthesis

D. (D) A hormone that signals fibroblasts to produce collagen

■ **Explanation:** Vitamin C is required for hydroxylation of proline and lysine residues in procollagen. Without these hydroxyl groups, collagen cannot form stable triple helices, causing scurvy.

Q66. Which enzyme secreted into the stomach begins digesting dietary proteins?

- A. (A) Salivary amylase (digests starch in the mouth) B. (B) Gastric lipase (digests a small amount of fat in the stomach)
- ✓ C. (C) Pepsin (activated from pepsinogen by HCl; cleaves protein peptide bonds) D. (D) Trypsin (secreted by pancreas into the small intestine)

■ **Explanation:** Chief cells secrete pepsinogen, activated by low stomach pH (1.5-2) to pepsin. Pepsin is an endopeptidase that cleaves peptide bonds, especially adjacent to phenylalanine and leucine residues.

Q67. Iron deficiency anaemia primarily reduces which function of blood?

- A. (A) The ability of white blood cells to engulf pathogens (phagocytosis) B. (B) The ability of platelets to form clots (haemostasis)
- ✓ C. (C) The oxygen-carrying capacity due to reduced haemoglobin synthesis D. (D) The fluid volume of plasma in blood vessels

■ **Explanation:** Iron is essential for haem synthesis in haemoglobin. Without sufficient iron, smaller and fewer red blood cells are produced, reducing O₂ transport capacity and causing fatigue and pallor.

Q68. CO₂ dissolved under high pressure makes beverages fizzy. What happens when the bottle is opened?

- A. (A) CO₂ reacts with water to form more carbonic acid, increasing fizz ✓ B. (B) Pressure drops, reducing CO₂ solubility; dissolved CO₂ comes out of solution as bubbles
- C. (C) Temperature increases when the cap opens, heating the gas D. (D) Oxygen from the air dissolves in, reacting with CO₂ to form bubbles

■ **Explanation:** Henry's Law: gas solubility is proportional to partial pressure above the liquid. Opening drops headspace CO₂ pressure to atmospheric, so dissolved CO₂ rapidly nucleates and escapes as bubbles.

Q69. 'Empty calories' is a nutritional term describing foods that:

- A. (A) Contain exactly zero calories and are completely non-nutritive ✓ B. (B) Provide significant energy from sugar or fat but contain minimal vitamins, minerals, or fibre
- C. (C) Are calorie-dense, nutritious, and beneficial for athletes D. (D) Have a negative net caloric effect because of high fibre content

■ **Explanation:** Foods like sugary drinks, candy, and alcohol provide energy (calories) from sugar or fat but little or no micronutrients, displacing more nutritious foods from the diet.

Q70. Which vitamin is synthesised in human skin when exposed to sunlight?

- A. (A) Vitamin A (retinol) - obtained primarily from diet B. (B) Vitamin B₁₂ (cobalamin) - requires intrinsic factor for absorption
- C. (C) Vitamin C (ascorbic acid) - not synthesised by humans ✓ D. (D) Vitamin D₃ (cholecalciferol) - synthesised from 7-dehydrocholesterol by UVB

■ **Explanation:** UVB radiation (290-315 nm) converts 7-dehydrocholesterol in the epidermis to pre-vitamin D₃, which isomerises to vitamin D₃ (cholecalciferol), later hydroxylated in liver and kidneys to active calcitriol.

SECTION 8: ADVANCED PHYSICS & CHEMISTRY

Q71. What does the 'half-life' of a radioactive isotope represent?

A. (A) The time for the substance to become completely non-radioactive

✓ B. (B) The time required for exactly half the atoms in a sample to undergo decay

C. (C) The time for half the total radiation intensity to be absorbed by shielding

D. (D) The time for half the substance's mass to vaporise into the atmosphere

■ **Explanation:** Half-life ($t_{1/2}$) is constant for a given isotope. After n half-lives, the fraction remaining is $(1/2)^n$. Carbon-14 has a half-life of ~5730 years, used in radiocarbon dating.

Q72. Superconductivity is characterised by which remarkable electrical property?

A. (A) Extremely high resistance that blocks all current below the critical temperature

✓ B. (B) Exactly zero electrical resistance below a critical temperature (T_c)

C. (C) Infinite resistance allowing only quantum tunnelling of electrons

D. (D) Resistance that fluctuates randomly below absolute zero

■ **Explanation:** Superconductors (e.g., niobium below 9.2 K, YBCO below ~90 K) exhibit zero resistance and expel magnetic fields (Meissner effect), enabling lossless current flow and magnetic levitation.

Q73. In beta-minus (beta-) decay, a nucleus emits which particles?

A. (A) A helium-4 nucleus (alpha particle) and gamma ray

✓ B. (B) An electron (beta particle) and an electron antineutrino

C. (C) A positron (anti-electron) and an electron neutrino

D. (D) Two gamma ray photons simultaneously

■ **Explanation:** In beta-minus decay: $n \rightarrow p + e^- + \bar{\nu}_e$. A neutron converts to a proton, emitting an electron and an antineutrino to conserve lepton number and energy.

Q74. Which metal has the highest electrical conductivity at room temperature?

A. (A) Copper (6.00×10^7 S/m) - industry standard

B. (B) Gold (4.10×10^7 S/m) - used for corrosion resistance

C. (C) Aluminium (3.77×10^7 S/m) - used in power lines

✓ D. (D) Silver (6.30×10^7 S/m) - highest conductivity of all metals

■ **Explanation:** Silver has the highest electrical conductivity (6.30×10^7 S/m) of all metals. Copper (6.00×10^7 S/m) is preferred commercially for its lower cost and adequate conductivity.

Q75. Entropy in thermodynamics is a measure of disorder. The Second Law of Thermodynamics states:

- | | |
|---|---|
| A. (A) Energy is conserved in all physical and chemical processes | ✓ B. (B) Total entropy of an isolated system always increases or remains constant |
| C. (C) Heat flows from cold objects to hot objects spontaneously | D. (D) The entropy of a perfect crystal at 0 K is always greater than zero |

■ **Explanation:** The Second Law: $\Delta S(\text{universe}) \geq 0$ for all spontaneous processes. Entropy increases because statistically there are far more disordered microstates than ordered ones.

Q76. The process of sublimation occurs when a substance transitions directly from:

- | | |
|--|---|
| A. (A) Gas to liquid without passing through the solid phase | B. (B) Solid to liquid, bypassing the gaseous state |
| ✓ C. (C) Solid to gas without passing through the liquid phase | D. (D) Liquid to gas at exactly its boiling point |

■ **Explanation:** Sublimation occurs when vapour pressure of a solid exceeds atmospheric pressure before melting occurs. Examples: dry ice (CO_2), iodine crystals, and naphthalene (mothballs).

Q77. $E = mc^2$ in nuclear reactions means that a small mass converts to enormous energy. This explains why nuclear reactions release:

- | | |
|--|--|
| A. (A) Less energy per gram than chemical reactions like combustion | B. (B) Energy approximately equivalent to chemical reactions of similar mass |
| ✓ C. (C) Millions of times more energy per gram than chemical combustion | D. (D) Unlimited energy, as mass and energy are infinitely interchangeable |

■ **Explanation:** Since $c^2 = (3 \times 10^8)^2 = 9 \times 10^{16} \text{ J/kg}$, even tiny mass defects yield enormous energy. Fission of 1 g of U-235 releases $\sim 8 \times 10^{10} \text{ J}$, vs $3.3 \times 10^4 \text{ J}$ from 1 g of TNT combustion.

Q78. Absolute zero (0 Kelvin, -273.15 degrees C) is the temperature at which:

- | | |
|---|---|
| A. (A) All matter becomes a superconductor regardless of material | ✓ B. (B) Particles theoretically have minimum possible thermal motion (zero-point energy) |
| C. (C) Water ice converts to its densest possible solid form | D. (D) All matter converts entirely to energy following $E = mc^2$ |

■ **Explanation:** At 0 K, classical thermal energy is zero. Quantum mechanically, particles still have zero-point energy (from Heisenberg uncertainty principle) but thermodynamic work output falls to zero.

Q79. Why do deserts experience extreme cold at night despite very high daytime temperatures?

A. (A) Desert sand actively absorbs heat and cools the air at night

✓ B. (B) Low humidity means minimal water vapour to retain heat; heat radiates to space rapidly

C. (C) High altitude of deserts allows cold air from the stratosphere to descend

D. (D) Nocturnal winds from polar regions specifically target desert areas

■ **Explanation:** Water vapour is a powerful greenhouse gas that traps outgoing longwave (infrared) radiation. Dry desert air lacks this 'blanket', so surface heat escapes rapidly to space after sunset.

Q80. Which sub-atomic particle primarily determines the chemical properties and reactivity of an element?

A. (A) Neutrons in the nucleus (determine isotope mass)

B. (B) Protons in the nucleus (determine atomic number and identity)

✓ C. (C) Electrons, specifically the valence electrons in the outermost shell

D. (D) Quarks that constitute protons and neutrons

■ **Explanation:** Valence electrons determine bonding capacity, electronegativity, ionisation energy, and reactivity. Elements in the same group share valence electron configurations and similar chemistry (e.g., Group 1 alkali metals all have 1 valence electron).

■ END OF PAPER ■

*All 100 questions cover Physics · Chemistry · Biology · Earth Science · Astronomy · Technology · Food Science ·
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