Ch 1: Entering the World of Secondary Science

1. **Case Study:** In a historical aviation incident, an aircraft failed mid-flight because the ground crew calculated the fuel mass using pounds (lb) instead of kilograms (kg). The flight required 22,300 kg of fuel, but was loaded with only 22,300 lb.

   Answer the following questions:

   (i) Analyse how the lack of adherence to Standard International (SI) units can transform a simple calculation error into a systemic catastrophe in engineering. (2 marks)

   (ii) If the aircraft was 15,000 litres short of fuel, evaluate the role of agreed international standards in ensuring "scientific fairness" and safety in global trade and technology. (2 marks)

2. **Case Study:** To determine if a specific grain supply can sustain a community, scientists often use "rough estimates" rather than exact counts.

   Answer the following questions:

   (i) An average adult requires 2,000–2,500 kcal per day. If 100 g of uncooked rice provides roughly 350 kcal, justify whether a 100 kg bag of rice is a reasonable estimate to feed a family of four for one month. (2 marks)

   (ii) Contrast the cognitive utility of "approximate reasoning" in detecting errors with the necessity of "zero-error" precision in laboratory experiments. (2 marks)

3. The physical constant for the speed of light is defined as exactly 299,792,458 m/s. Discuss the epistemological reason why such constants are defined with absolute precision and how they anchor the formulation of scientific laws. (3 marks)
4. Distinguish between a "Scientific Law" and a "Scientific Theory" by evaluating why Newton's Laws of Motion are categorised differently from the Atomic Theory, despite both being supported by evidence. (3 marks)
5. The *Exploration* text states humans take roughly 18–22 thousand breaths per day. Estimate the total mass (in tonnes) of air inhaled by a city of 1,000,000 residents in one year (365 days). Assume an average breath volume of 0.5 litres and an air density of 1.2 g/L. Justify your choice of values within the given range. (5 marks)
6. Critically analyse the statement: "A scientific theory is never final." Use the textbook's concept of "openness to being corrected by nature" to explain how new evidence can dismantle a long-held model. (3 marks)
7. A viral claim suggests that drinking water becomes "toxic" during a solar eclipse. Formulate three inquiry-based questions using the "What if..." approach to scientifically investigate and disprove this claim based on physical or biological mechanisms. (3 marks)
8. Evaluate the importance of "Scientific Temper" in the digital age. How does the ability to pose questions, as highlighted in the NCF-SE 2023, protect a citizen from misinformation? (2 marks)
9. Explain how the "Airplane fuel miscalculation" case study serves as a critique of human error versus the reliability of the SI system itself. (3 marks)
10. Explore the "Threads of Curiosity" regarding the symbol 'c' for the speed of light. How does understanding the Latin roots (*celeritas*) help students view science as a human-constructed language? (2 marks)
11. Design a controlled experiment to test the prediction: "An increase in wind speed will increase the rate of cooling of a hot liquid." Identify the independent, dependent, and constant variables. (3 marks)

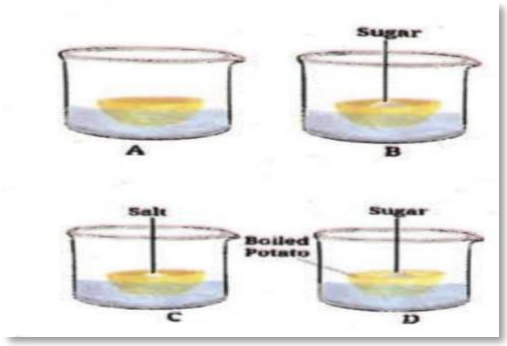
12. Why is mathematics described as the "language" of science rather than just a tool for arithmetic? Provide an example involving the prediction of a planet's position. (2 marks)
13. Describe a situation in secondary science where a "precise" result might still be "inaccurate" due to a systematic error in the measuring instrument. (2 marks)
14. Solving the problem of mask filtration efficiency requires an integrated approach. Explain how concepts from physics (particle motion), biology (viral size), and chemistry (polymer properties) must converge to design a high-efficiency N95 mask. (5 marks)
15. If a student measures a room using a stride length they *estimate* to be 1 metre, but is actually 0.85 metres, evaluate the impact on the "correctness" of the resulting area calculation for ordering a carpet. (3 marks)
16. Using the "Ready to Go Beyond" logic, explain why weather forecasts are inherently reliable for short durations (24–48 hours) but lose predictive power over 10 days. (2 marks)
17. If you are provided with a ruler that is missing the first 3 cm due to wear, propose a methodology to ensure your measurements remain both accurate and repeatable.(2 marks)
18. Explain the "Conservation of Energy" as a broad principle. How does this principle allow a scientist to link two seemingly unrelated events, such as a chemical reaction in a battery and the motion of a toy car? (3 marks)
19. How does "inductive reasoning" (moving from specific observations to a general rule) differ from the "What if..." deductive approach used in the textbook? (2 marks)
20. In the context of the Grade 9 *Exploration* curriculum, justify why "learning how to learn" through experimentation is prioritised over the memorisation of definitions. (3 marks)

Ch 2: Cell: The Building Block of Life

1. **Case Study**

   Four potato cups (A, B, C, D) are prepared. Cup A is empty, B has sugar, C has salt, and D is a boiled potato with sugar. All are placed in a tray of water for two hours.

   Answer the following questions



   (i) Explain why water accumulates in Cups B and C but not in Cup A. (2 marks)

   (ii) Predict the outcome for Cup D and critically evaluate how the process of boiling affects the selective permeability of the plasma membrane. (2 marks)

2. **Case Study:**

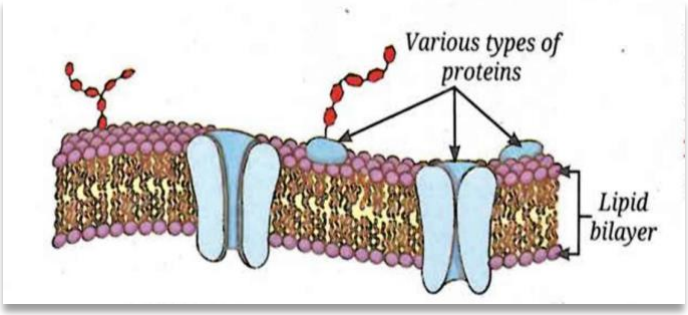
   A researcher observes that leucoplasts in a potato tuber (stored underground) lack pigment, but when the tuber is exposed to sunlight for several days, it turns green.

   Answer the following questions

(i) Identify the organelle transformation occurring here and explain the functional significance of this change. (2 marks)

(ii) Why is this transition not possible in animal cells, even if they are exposed to sunlight? (2 marks)

3. The human eye has a "limit of resolution" of 0.1 mm. If a mitochondrion is 1 mm in length, calculate the minimum magnification required for it to be perceived as a distinct object by the human eye. (3 marks)
4. Analyse the "Fluid-Mosaic Model". Evaluate why the "fluid" nature of the lipid bilayer is essential for processes like endocytosis and cell growth. (3 marks)

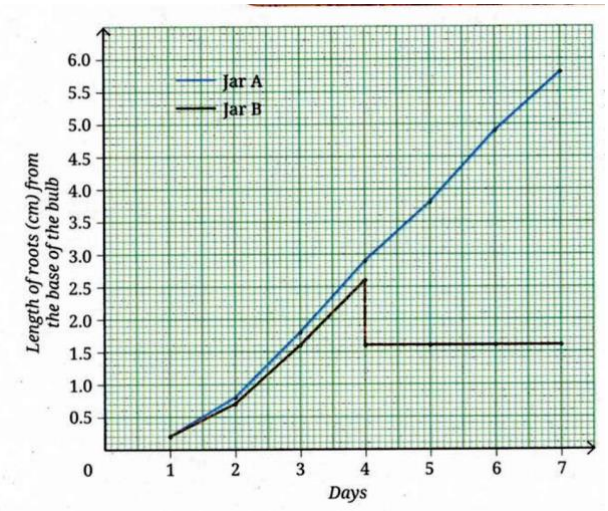


5. In a microscope field of view with a diameter of 4 mm , a student counts 20 cells arranged in a single file. Calculate the average diameter of one cell and estimate how many such cells would fit in a square area of 1 mm^2. (3 marks)
6. Mitochondria and Chloroplasts are described as "semi-autonomous organelles." Compare their structural evidence (DNA/ribosomes) and explain how this supports the theory of their evolutionary history as independent organisms. (5 marks)
7. Why is the nucleus termed the "House of coded instructions"? Distinguish between chromatin, chromosomes, and DNA, explaining their physical state during different phases of the cell cycle. (3 marks)
8. Differentiate between mitosis and meiosis based on their end goals: one for "continuity within an individual" and the other for "continuity of the species." (3 marks)
9. "Omnis cellula-e cellula." Discuss how Rudolf Virchow's addition to the cell theory shifted the scientific understanding of life from "spontaneous generation" to biological continuity. (2 marks)
10. Predict the morphological changes in a plant cell placed in a hypertonic solution. Why does the cell undergo plasmolysis rather than total collapse like an animal cell? (3 marks)
11. Explain the "Threads of Curiosity" regarding mature human Red Blood Cells (RBCs). Evaluate the biological trade-off involved in losing the nucleus to maximise oxygen transport. (3 marks)
12. Lysosomes are often called "suicide bags." Describe a scenario where this "self-destruction" is actually a protective mechanism for the whole organism. (2 marks)
13. If the nuclear pores were obstructed, predict the immediate effect on the cell's ability to respond to external stimuli that require new protein synthesis. (3 marks)
14. Discuss the concept of "Contact Inhibition" mentioned in the text. How does a failure in this regulatory mechanism lead to the formation of malignant tumours? (3 marks)

15. Describe the transition from a single fertilised egg (zygote) into a complex multicellular organism. Elaborate on the roles of mitosis, cell cycle regulation, and cellular differentiation. (5 marks)
16. Compare Prokaryotic and Eukaryotic cells Why is the lack of membrane-bound organelles in prokaryotes not necessarily a disadvantage for their survival? (3 marks)
17. Explain the function of the Golgi apparatus as the "packaging and dispatching unit." What would happen to the cell if the Golgi body stopped functioning? (3 marks)
18. In 2010, scientists inserted a chemically synthesised DNA sequence into a *Mycoplasma mycoides* cell. Discuss the ethical implications and the definition of "life" raised by this experiment. (3 marks)
19. How does the cell wall provide "structural support" to plants in hypotonic environments, and why is this property absent in the Kingdom Animalia? (2 marks)
20. Draw a well-labelled schematic diagram of a plant cell, highlighting three features that distinguish it from an animal cell. (2 marks)

Ch3: Tissues in Action

1. **Case Study :** Two onion bulbs are grown. In Jar B, the root tips are excised on Day 4.Using the data from Table

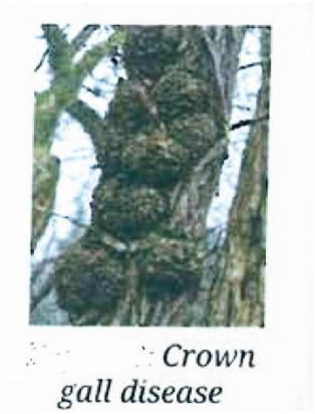


Answer the following questions

i)analyse why the roots in Jar A continue to grow while Jar B shows zero longitudinal growth after the cut. (2 marks)

(ii) If Jar B's roots began to increase in diameter (girth) despite the tip being cut, identify the specific tissue responsible for this secondary growth. (2 marks)

2. **Case Study:** Crown Gall disease (Fig) causes uncontrolled cell division in plants.



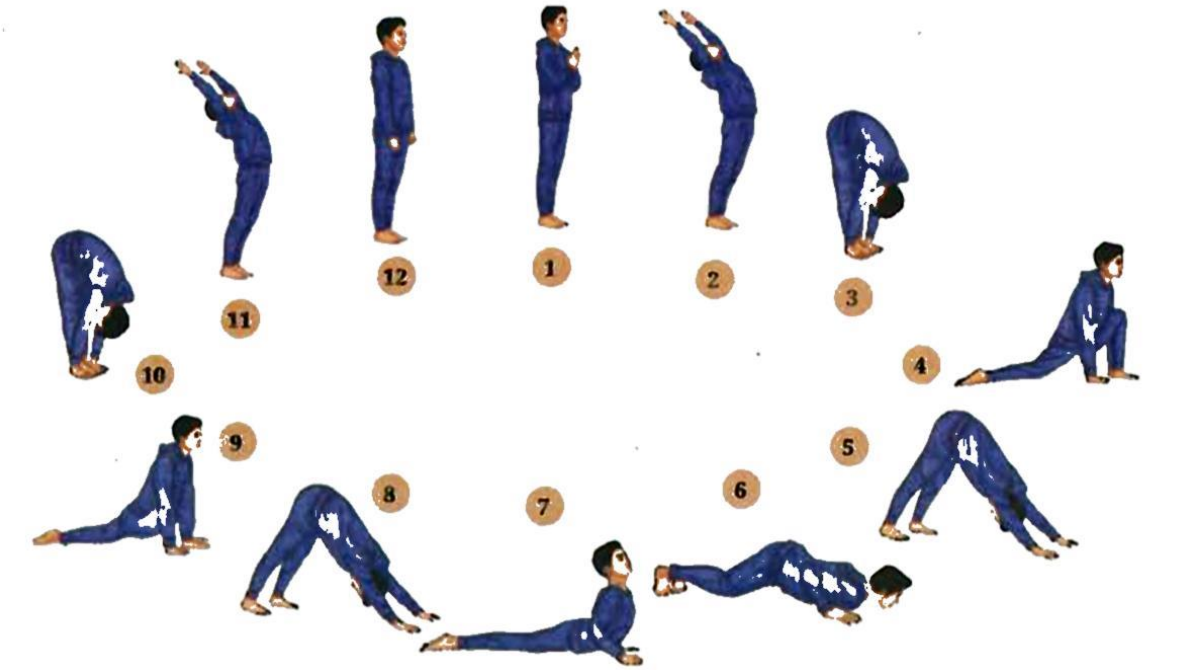
Crown gall disease

Answer the following questions

(i) How does the *Agrobacterium tumefaciens* bacterium manipulate the plant's meristematic potential to its own advantage? (2 marks)

(ii) Explain how this "natural genetic engineering" is repurposed by scientists to create genetically modified (GM) crops. (2 marks)

3. Evaluate the mechanical requirements of a plant. Compare Sclerenchyma and Collenchyma based on the chemical nature of their cell wall thickenings (lignin vs pectin) and their respective roles in providing "rigidity" vs "flexibility." (5 marks)
4. Classify meristematic tissues (Apical, Lateral, Intercalary) based on their location and explain how they contribute to the "indeterminant growth" seen in plants. (3 marks)
5. Why are Xylem and Phloem classified as "Complex Permanent Tissues"? Contrast the conduction of water (unidirectional) with the conduction of food (bidirectional) based on the living/dead state of their components. (3 marks)
6. Analyse the structure of a Neuron (Fig. 3.14). How does the elongation of the axon facilitate the rapid communication required for a "reflex arc"? (3 marks)
7. Describe the "Musculoskeletal System" in action during a Surya Namaskar pose (Fig.). Detail the coordination between antagonistic muscle pairs, tendons, ligaments, and specific types of joints. (5 marks)



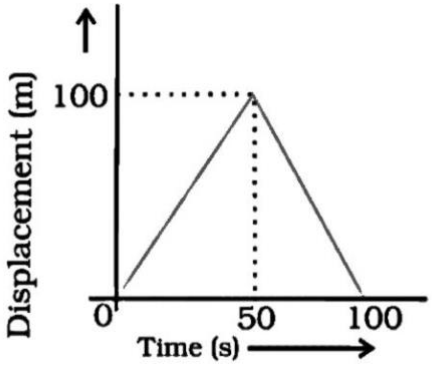
8. Differentiate between Skeletal, Smooth, and Cardiac muscles. Why is the "striated" nature of cardiac muscle essential for its role as a lifelong pump? (3 marks)
9. Identify the types of joints involved in: (a) nodding the head 'no', (b) throwing a cricket ball, and (c) the movement of the knee during a squat. (3 marks)
10. During vigorous exercise, breathing rate and blood flow increase. Explain this as a systemic response of the muscular and vascular tissues to oxygen debt. (3 marks)
11. What is the functional significance of the "matrix" in connective tissues? Compare the matrix of bone with the matrix of blood. (2 marks)
12. Meristematic cells lack large vacuoles and have dense cytoplasm. Justify this structural adaptation in the context of rapid cell division. (2 marks)
13. Compare the Parenchyma found in aquatic plants (Aerenchyma) with that found in desert plants (Chlorenchyma) in terms of their adaptive functions. (3 marks)
14. Explain the role of "Stem Cells" in the bone marrow. How does their "totipotency" allow them to treat disorders like Leukaemia? (2 marks)
15. Describe the location and function of Ciliated Columnar Epithelium. What would be the consequence if these cilia were damaged by environmental pollutants? (3 marks)
16. Explain the "Pause and Ponder" regarding coconut husk (Fig. 3.8c). Why are its fibres hard and brittle, whereas coriander stalks are soft? (2 marks)
17. Evaluate the role of the "Rib Cage" as both a protective shield and a flexible structure required for respiration. (2 marks)
18. Discuss the process of "Differentiation." How does a meristematic cell "decide" to become a specific permanent tissue like Xylem? (3 marks)
19. Ethical Analysis: Discuss the implications of using "Synthetic Tissues" grown in labs to replace damaged human organs. (2 marks)

Ch 4: Describing Motion Around Us

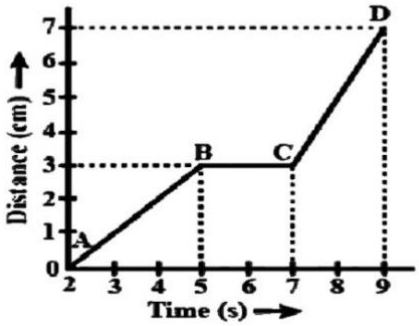
1. **Case Study:** A passenger on a high-speed train looks at a person on the platform. The platform observer sees the train moving at 100 km/h East, while the passenger sees the platform person moving at 100 km/h West.

   Answer the following questions

   (i) Define the "Frame of Reference" and explain why both observations are scientifically correct. (2 marks)
   (ii) If a second train moves side-by-side at 100 km/h East, why do the passengers in both trains perceive each other as stationary? (2 marks)
2. **Case Study:** A delivery drone travels 8 km North, then 6 km East, and finally returns to the starting point in a straight line.
   (i) Calculate the total distance and the net displacement for the entire journey. (2 marks)
   (ii) Justify why displacement is a vector quantity while distance is scalar in this context. (2 marks)
3. A vehicle starts from rest and accelerates at 3 m/s^2 for 8 seconds. It then maintains this velocity for 15 seconds before the driver applies brakes to stop the car in 4 seconds. Construct a velocity-time graph and calculate the total distance travelled. (5 marks)
4. Graphically derive the second equation of motion and explain the physical significance of the "area under the curve" in a v-t graph. (5 marks)
5. Compare "Average Speed" and "Average Velocity." Under what specific condition of motion will their magnitudes be identical? (3 marks)
6. Analyse the motion of a ball thrown vertically upwards. Evaluate its velocity and acceleration at the peak of its trajectory. (3 marks)
7. Explain why "Uniform Circular Motion" is considered an accelerated motion even if the speed is constant. Provide an example from planetary motion. (3 marks)
8. **HOTS:** A vehicle travels exactly one lap around a circular track of radius 70 m. Evaluate the "stories" told by the vehicle's Odometer versus a Displacement-Time graph to explain why one shows 440 m while the other shows 0 m. (3 marks)
9. Describe a real-world scenario where an object has a non-zero velocity but zero acceleration. (2 marks)
10. How does the slope of a distance-time graph help in identifying whether an object is in uniform or non-uniform motion? (2 marks)
11. An athlete completes half a round of a circular track of radius R in 40 seconds. Calculate the magnitude of displacement and the distance covered. (3 marks)
12. Evaluate the statement: "The magnitude of displacement can never be greater than the distance travelled." Justify with an example. (3 marks)
13. A girl walks along a straight path to drop a letter in the letterbox and comes back to her initial position. Her displacement–time graph is shown in below figure. Plot a velocity–time graph for the same



14. The graph given alongside shows the positions of a body at different times. Calculate the speed of the body as it moves from:



(i) A to B.
(ii) B to C. and
(iii) C to D (3 marks)

15. A stone is dropped from a cliff 45 m high. Calculate the time taken to reach the ground and the final velocity before impact (g = 10 m/s²). (3 marks)
16. Differentiate between "Instantaneous Speed" and "Average Speed" using the example of a car in city traffic. (2 marks)
17. Explain why the equations of motion cannot be used to calculate the path of a butterfly flying in a garden. (2 marks)
18. If a sprinter reduces their speed from 12 m/s to 0 m/s in 2 seconds, calculate the retardation and describe the force required. (2 marks)
19. Discuss the "Threads of Curiosity": Why do we not "feel" the Earth's rotation (1600 km/h at the equator) in our daily frame of reference? (2 marks)
20. Using a ticker-tape diagram, explain how to distinguish between uniform acceleration and uniform velocity. (3 marks)

Ch 5: Exploring Mixtures and their Separation

1. **Case Study:** An industrial plant accidentally mixes large quantities of iron filings, ammonium chloride, and common salt.
   Answer the following

   (i) Propose a sequence of three separation techniques to recover all three components in their pure state at an industrial scale. (3 marks)
   (ii) (ii) Justify the scientific principle behind the order of your chosen sequence. (1 mark)
2. **Case Study:** A sample of turbid river water contains suspended clay, dissolved minerals, and bacterial contaminants.
   Answer the following
   (i) Explain the role of "loading" with alum in the sedimentation process. (2 marks)
   (ii) Evaluate why simple filtration is insufficient to produce "potable" (drinking) water and suggest a final purification step. (2 marks)
3. Differentiate between "Pure Substances" and "Mixtures" based on their behaviour during a phase change (melting/boiling). (3 marks)
4. Explain the principle of "Centrifugation." How is it applied in medical diagnostics to separate blood plasma from cells? (3 marks)
5. Analyse "Fractional Distillation." Why is a fractionating column necessary when the boiling point difference between two liquids is less than 25 K? (3 marks)
6. Compare "Homogeneous" and "Heterogeneous" mixtures using the example of an alloy (like brass) versus a suspension. (3 marks)
7. How does "Paper Chromatography" allow for the separation of pigments in a single drop of ink? Discuss the role of the mobile and stationary phases. (3 marks)
8. Describe "Crystallisation." Why is it preferred over "Evaporation" for obtaining high-purity solids like copper sulphate? (3 marks)
9. Define "Solubility." Evaluate how the solubility of Oxygen in water changes with increasing temperature and its impact on aquatic life. (3 marks)
10. What is a "Supersaturated Solution"? Explain how it can be prepared from a saturated solution. (2 marks)
11. Explain the "Tyndall Effect." Why does a beam of light become visible in a dark, dusty room but not in clean air? (3 marks)
12. Categorise the following based on their chemical purity: Distilled water, 24k Gold, Air, Carbon dioxide, and Milk. Justify your classification for Milk. (3 marks)
13. Why is "Distilled Water" required for car batteries and lab experiments instead of tap water? (2 marks)
14. Describe the use of a "Separating Funnel." Which physical property of liquids is exploited in this technique? (2 marks)
15. Discuss "Sublimation" as a purification technique. Why can it not be used to separate a mixture of Camphor and Naphthalene? (3 marks)
16. To prepare a saturated solution of potassium chloride, 36 g of the salt is dissolved in 100 g of water at 20°C. Calculate the concentration of the solution as a mass percentage. (3 marks)

17. Evaluate the mechanism of "Reverse Osmosis" (RO). How does it overcome the natural process of osmosis to desalinate water? (3 marks)
18. Why is "Air" considered a mixture even though its composition is relatively constant in the lower atmosphere? (2 marks)
19. How can you prove that "Colloids" are heterogeneous mixtures using the criteria of stability and the Tyndall effect? (2 marks)
20. **What if...:** If two miscible liquids have identical boiling points, could they be separated by any form of distillation? Propose an alternative property that could be used. (3 marks)

Ch 6: How Forces Affect Motion

1. **Case Study:** A passenger in a bus falls forward when the bus brakes suddenly.
   Answer the following questions

   (i) Evaluate why a seatbelt is more effective in preventing injury than a passenger attempting to "brace" their arms against the dashboard. (2 marks)
   (ii) Link this scenario to the concept of "Inertia of Motion" and Newton's First Law. (2 marks)
2. **Case Study:** A goalkeeper in a football match pulls their hands backward while catching a high-speed ball.
   Answer the following questions

   (i) Explain the physics of this action using the concept of "Change in Momentum." (2 marks)
   (ii) How does increasing the "Time of Impact" mathematically reduce the force felt by the hands? (2 marks)
3. Critically analyse "Weightlessness" in an orbiting space station. Is it the absence of gravity or the state of "continuous free fall"? Justify based on the text. (3 marks)
4. Derive the "Law of Conservation of Momentum" from Newton's Second and Third Laws for a collision between two objects. (5 marks)
5. Why is "Friction" described as a "necessary evil"? Discuss one industrial application where friction is intentionally increased. (3 marks)
6. A bullet of mass 0.02 kg is fired from a rifle of mass 4 kg with an initial velocity of 100 m/s. Calculate the recoil velocity of the rifle and the total momentum of the system after firing. (3 marks)
7. Differentiate between "Balanced" and "Unbalanced" forces. Explain why only an unbalanced force can change the *velocity* of an object. (3 marks)
8. Explain the relationship between "Mass" and "Inertia." Why is it harder to deflect a moving shot-put ball than a tennis ball at the same speed? (3 marks)
9. "Action and Reaction forces always act on different bodies." Explain why this prevents them from cancelling each other out. (3 marks)
10. How does a rocket move in the vacuum of space? Relate this to Newton's Third Law and the conservation of momentum. (2 marks)
11. Discuss the role of "Lubrication" and "Ball Bearings" in reducing friction. How do they transform sliding friction into rolling friction? (3 marks)
12. Why do athletes land on sandpits in long jump events? Relate this to the Second Law of Motion. (2 marks)

13. A 5-tonne truck starts from rest and travels 200 m in 10 s under constant acceleration. Calculate the acceleration and the net force acting on it. (3 marks)
14. Evaluate the safety benefit of "Crumple Zones" in modern cars using the principle of impulse. (2 marks)
15. Explain how a karate player can break a pile of tiles with a single, swift blow. (2 marks)
16. How does the "Curvature of the Earth" enable a satellite to stay in orbit without falling into the planet? (3 marks)
17. Compare "Contact Forces" (Friction) and "Field Forces" (Gravitation). Give an example of how a field force can act across a vacuum. (3 marks)
18. Why is it easier to pull a heavy suitcase with wheels than to drag it? (3 marks)
19. Discuss the "Threads of Curiosity": How did Newton's observation of a falling apple lead to a "Universal" law? (2 marks)
20. Define "Impulse." Explain its relationship to the "Force-Time" graph area. (2 marks)

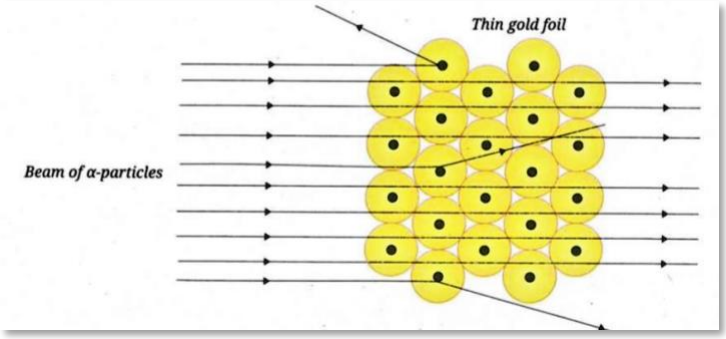
Ch 7: Work, Energy, and Simple Machines

1. A roller coaster car of mass m starts from a height H. (i) Describe the energy transformations at the highest point, the lowest point, and a midway point. (2 marks) (ii) If the car reaches a height less than H on the next peak, account for the "lost" energy in terms of work done against friction. (2 marks)
2. A gardener uses a wheelbarrow to move a heavy load. (i) Identify the type of "Simple Machine" the wheelbarrow represents and its mechanical advantage. (2 marks)
(ii) Does using the wheelbarrow reduce the *total work* done or the *force* required? Justify. (2 marks)
3. A pump lifts 500 kg of water from a well 20 m deep in 10 seconds. Calculate the work done and the power of the pump in kilowatts. ($g = 10\ m/s^2$). (5 marks)
4. State the "Law of Conservation of Energy." Illustrate it using the motion of an oscillating simple pendulum, including air resistance. (3 marks)
5. Calculate the total mechanical energy of a 5 kg object: (a) at a height of 20 m, (b) after falling for 1 second, and (c) just before impact. ($g = 10\ m/s^2$). (5 marks)
6. Define "Work" scientifically. Why is the work done zero when a satellite orbits the Earth in a perfectly circular path? (3 marks)
7. Derive the expression for Kinetic Energy ($Ek = 1/2\}mv^2$) using the third equation of motion and the definition of work. (5 marks)
8. Explain how a "Pulley System" provides a mechanical advantage. How does it trade "distance" for "effort"? (3 marks)
9. Explain "Power" as the rate of doing work. Why are electric bills calculated in "Units" (kWh) instead of Joules? (2 marks)
10. Calculate the number of Joules in 5 kWh. (2 marks)
11. Evaluate the efficiency of a real-world machine. Why can it never reach 100%? (3 marks)
12. A car engine provides a force of 500 N to maintain a constant speed of 72 km/h. Calculate the power developed by the engine. (3 marks)
13. Describe how "Levers" are classified into three types based on the positions of the fulcrum, effort, and load. (3 marks)
14. Explain "Potential Energy" in a compressed spring. What happens to this energy when the spring is released? (2 marks)

15. How does "Friction" lead to the "dissipation" of energy? Give a real-world example of how this heat is managed in machinery. (2 marks)
16. Compare the "Work-Energy Theorem" to the general law of conservation of energy. (3 marks)
17. Why is it easier to lift a heavy stone using a crowbar? (3 marks)
18. Discuss the "Threads of Curiosity": How did the invention of the wheel reduce the "Work" required for transport? (2 marks)
19. An electric heater of 2000 W is used for 2 hours daily. Calculate the cost of energy for 30 days if one unit costs ₹5. (2 marks)
20. Identify the dominant energy form in: (a) a flowing river, (b) a wound-up watch spring, (c) a flashlight battery. (2 marks)

Ch 8: Journey Inside the Atom

1. In the alpha-particle scattering experiment, Rutherford observed that 1 in 12,000 particles rebounded.



Answer the following questions

(i) What did this "rebound" reveal about the volume and mass distribution of the nucleus? (2 marks)
(ii) (Contrast Rutherford's "Nuclear Model" with Thomson's "Plum Pudding Model." (2 marks)

2. **Case Study:** Bohr's model introduced "Discrete Orbits." (i) How did this concept solve the problem of atomic instability inherent in Rutherford's model? (2 marks) (ii) Explain the "Quantum Jump" of an electron when it absorbs energy. (2 marks)
3. Differentiate between "Cathode Rays" and "Canal Rays" (Anode rays) based on their constituent particles and origin. (3 marks)
4. Explain J.J. Thomson's contribution to the discovery of the electron. Why was the "charge-to-mass ratio" significant? (3 marks)
5. Analyse why the "Neutron" was discovered much later (1932) than the proton and electron. (3 marks)
6. **What if...:**If electrons were stationary within the atom, evaluate the impact on the stability of matter and the formation of chemical bonds. (3 marks)
7. Describe the properties of alpha particles that made them suitable for Rutherford's experiment. (3 marks)
8. Define "Subatomic Particles." Provide a table comparing the relative mass and absolute charge of the three main particles. (3 marks)

9. How does the Bohr-Bury scheme determine the maximum number of electrons in the N-shell? (2 marks)
10. Evaluate the significance of the nucleus as the "House of coded instructions" (DNA) in biology versus its physical role in an atom. (3 marks)
11. Discuss the "Threads of Curiosity": The concept of "Anu" and "Parmanu" in ancient Indian philosophy (Maharishi Kanad). (2 marks)
12. Why did Rutherford use a thin Gold Foil instead of other metals? (2 marks)
13. Explain "Valency." Why do Helium and Neon have a valency of zero? (3 marks)
14. Draw the atomic structure of Magnesium (At. No. 12) and Oxygen (At. No. 8). (2 marks)
15. Explain the $2n^2$ rule. Calculate the electron capacity of the M-shell. (2 marks)
16. Compare the "Discovery of the Electron" (discharge tube) with the "Discovery of the Nucleus" (scattering). (3 marks)
17. What are "Canal Rays"? How did their discovery prove the existence of the proton? (2 marks)
18. Why is the mass of an atom concentrated in its centre? (2 marks)
19. Discuss the "Quest Continues": What are "Quarks" and how do they relate to the structure of protons? (2 marks)
20. Define "Atomic Orbitals" vs "Orbits" based on the "Ready to Go Beyond" section. (2 marks)

Ch 9: Atomic Foundations of Matter

1. Carbon-12 and Carbon-14 are isotopes. Carbon-14 is used in "Radiocarbon Dating" for archaeological fossils. (i) Differentiate between these two isotopes in terms of their neutron count and atomic mass. (2 marks)
2. (ii) Justify why both isotopes exhibit identical chemical reactions with oxygen. (2 marks)
3. Iodine-131 is used to treat goitre, and Cobalt-60 is used in cancer therapy. (i) Define an "Isotope" in terms of Atomic Number and Mass Number. (1 mark)
4. (ii) Evaluate the "Ready to Go Beyond" section: Why are radioactive isotopes preferred for medical "tracing" or treatment? (3 marks)
5. Chlorine exists in nature as two isotopes with masses 35 u and 37 u in the ratio of 3:1. Calculate the average atomic mass of Chlorine. (3 marks)
6. Define "Atomic Number" (Z) and "Mass Number" (A). If an ion X^{3-} has 18 electrons and 16 neutrons, find its Z, A, and chemical symbol. (3 marks)
7. Explain "Valence Electrons." How do they determine whether an element is a metal, non-metal, or noble gas? (3 marks)
8. Compare "Isotopes" and "Isobars." Provide one example where isobars are used in the medical field. (3 marks)
9. Analyse the "Octet Rule." Why do atoms form ions to achieve this state? (3 marks)
10. Calculate the valency of: (a) Aluminium (At. No. 13) and (b) Sulphur (At. No. 16). (3 marks)
11. Describe the use of Uranium-235 in nuclear reactors. (2 marks)
12. If an element M has an atomic number of 11, write the electronic configuration of its ion M^{+}. (3 marks)
13. Explain the "Law of Constant Proportions" using the mass ratio of Hydrogen and Oxygen in water. (2 marks)
14. Discuss the evolution of chemical symbols from Dalton's pictographs to Berzelius's alphabetic system. (2 marks)
15. Define "Polyatomic Ions." Provide the formula and charge for the Phosphate and Ammonium ions. (2 marks)

16. Write the chemical formulas for: (a) Calcium hydroxide, (b) Magnesium nitrate, (c) Sodium carbonate. (3 marks)
17. Calculate the "Molecular Mass" of H_2SO_4 (At. masses: H=1, S=32, O=16). (3 marks)
18. Evaluate the significance of "Isotopes" in archaeology. (2 marks)
19. Why do isotopes have different physical properties like boiling point or density? (2 marks)
20. Discuss the "Threads of Curiosity": How are isotopes used to detect leaks in underground pipelines? (3 marks)
21. Explain why Isobars have different chemical properties despite having the same mass number. (2 marks)
22. Calculate the number of electrons in the valence shell of an N^{3-} ion (At. No. of N = 7). (2 marks)

Ch 10: Sound Waves: Characteristics and Applications

1. A SONAR system on a submarine sends a signal to a wreck on the ocean floor. The signal returns after 2.4 seconds. (i) Calculate the depth of the wreck if the speed of sound in seawater is 1530 m/s. (2 marks)
   (ii) Evaluate how a 10°C increase in water temperature would affect the time taken for the echo to return. (2 marks)
2. Ultrasound (frequencies > 20 kHz) is used in "Ultrasonography" and industrial cleaning. (i) Why is ultrasound better than audible sound for detecting minute cracks in metal blocks? (2 marks)
   (ii) Explain the role of "Echocardiography" in monitoring heart function. (2 marks)
3. A sound wave has a frequency of 500 Hz and a speed of 340 m/s. Calculate its wavelength. How much distance will this wave travel in 2 seconds? (5 marks)
4. Differentiate between "Transverse" and "Longitudinal" waves. Using the example of a "Slinky", explain how sound travels in air. (3 marks)
5. Analyse the relationship between "Pitch" and "Frequency" and "Loudness" and "Amplitude." (3 marks)
6. Describe the conversion of sound waves into electrical impulses in the human ear. Detail the functions of the eardrum, ossicles, and cochlea. (5 marks)
7. What is "Reverberation"? Suggest three structural modifications to reduce it in a cinema hall. (3 marks)
8. Compare "Infrasonic" (e.g., elephants) and "Ultrasonic" (e.g., bats) sounds. How do bats use the latter for "echolocation"? (3 marks)
9. Describe the "Bell Jar Experiment." What does it prove about the nature of sound propagation? (3 marks)
10. Explain the "Reflection of Sound." How is this principle used in a stethoscope and a megaphone? (3 marks)
11. A person stands between two cliffs and fires a gun. He hears the first echo after 1.5 s and the second after 2.5 s. Calculate the distance between the cliffs. (v = 340 m/s). (3 marks)
12. Why does sound travel faster in solids than in gases? Relate this to the "inter-molecular distance." (3 marks)
13. Define "Time Period" (T). How is it related to frequency (f)? (2 marks)
14. What is the "Range of Hearing" for humans? Why does it decrease as one ages? (2 marks)
15. Discuss the "Threads of Curiosity": How do dolphins use sound to "see" underwater? (3 marks)

16. Describe "Sonic Boom." Why is it heard when a jet exceeds the speed of sound? (2 marks)
17. How does a curved ceiling in a concert hall ensure that sound reaches every corner uniformly? (2 marks)
18. Distinguish between a "Tone" and a "Note." (2 marks)
19. Explain how the length of a flute's air column affects the "Pitch" of the sound produced. (2 marks)
20. Evaluate the physiological impact of "Noise Pollution" and suggest two mitigation strategies. (3 marks)

Chapter 11: Reproduction: How Life Continues

1. In 2010, the *Mycoplasma mycoides* experiment involved the creation of a "synthetic cell" by inserting laboratory-made DNA into a host. (i) Discuss the ethical implications of "synthetic biology" as highlighted in "The Quest Continues." (2 marks)
   (ii) Does the resulting cell count as a "new species"? Justify using the textbook's definition of life. (2 marks)
2. Organisms like Amoeba and Hydra reproduce without gametes. (i) Evaluate why Asexual reproduction is advantageous for colonising a stable environment. (2 marks) (ii) Contrast this with Sexual reproduction's role in promoting "genetic diversity." (2 marks)
3. Explain why "Mitosis" is considered "Equational Division," while "Meiosis" is "Reductional Division." (3 marks)
4. Analyse the role of "DNA Copying." Why are the offspring of sexual reproduction never "exact copies" of the parents? (3 marks)
5. What is the evolutionary significance of "Variation"? How does it prevent the extinction of a species during climate change? (3 marks)
6. Describe the developmental journey from a Zygote to an Embryo and finally a Foetus. (3 marks)
7. Why do multicellular organisms require "Specialised Reproductive Cells" (Gametes) with half the number of chromosomes? (3 marks)
8. Compare "Binary Fission" in Amoeba with "Multiple Fission" in Plasmodium. (3 marks)
9. How does the "Cell Cycle" (Fig. 2.17) ensure that the cell does not divide uncontrollably? (3 marks)
10. Explain "Programmed Cell Death" (PCD). How does it help in the development of a human hand from a webbed structure? (3 marks)
11. Discuss the "Threads of Curiosity": How do cancer cells "trick" the body into bypassing the checkpoints of the cell cycle? (3 marks)
12. Evaluate the ethical issues of "Designer Babies" and Gene Editing (CRISPR technology). (2 marks)
13. Why is "DNA Replication" the fundamental basis of reproduction at the cellular level? (2 marks)
14. Describe the role of "Puberty" as a biological transition for reproductive maturity. (2 marks)
15. Contrast "Regeneration" in Planaria with "Fragmentation" in Spirogyra. (3 marks)
16. Discuss the advantages of "Vegetative Propagation" in the production of seedless fruits like bananas. (3 marks)
17. What is "Tissue Culture" (Micropropagation)? Explain the concept of "Totipotency." (3 marks)

18. **What if...:** If human gametes were formed by Mitosis, evaluate the impact on the chromosome number of the next ten generations. (3 marks)
19. Describe the structure and function of the "Placenta" in nourishing the foetus. (2 marks)
20. Justify why reproduction is not essential for the survival of an *individual* but vital for the *species* . (2 marks)

Chapter 12: Patterns in Life: Diversity and Classification

1. A scientist finds an organism that is unicellular, possesses a nucleus, has a cell wall made of cellulose, and performs photosynthesis. (i) Classify this organism using the Hierarchy of Classification. (2 marks)
(ii) Justify whether it belongs to Kingdom Monera, Protista, or Plantae. (2 marks)
2. The "Endosymbiotic Theory" suggests that Mitochondria were once free-living bacteria. (i) Provide two structural pieces of evidence from the textbook to support this. (2 marks)
3. (ii) How does this shared history impact our understanding of the "Diversity of Life"? (2 marks)
4. Explain Whittaker's Five Kingdom Classification. What were the three main criteria (Cell type, Body organisation, Mode of nutrition) used? (3 marks)
5. Differentiate between "Prokaryotes" (Monera) and "Eukaryotes" (Protista, Fungi, etc.) based on internal compartmentalisation. (3 marks)
6. Analyse the transition from "Unicellular" to "Multicellular" complexity. Why did this lead to "Division of Labour" in tissues? (3 marks)
7. Compare "Bryophytes" (Amphibians of the plant kingdom) and "Pteridophytes." (3 marks)
8. Describe the taxonomic hierarchy from Kingdom down to Species. Which level has the maximum common characteristics? (3 marks)
9. What is "Binomial Nomenclature"? Explain the rules for writing a scientific name (e.g., *Homo sapiens*). (3 marks)
10. Evaluate the role of "Classification" in making the study of millions of species manageable. (2 marks)
11. Compare "Aves" and "Mammals" based on their heart structure and thermoregulation. (3 marks)
12. Why are "Fungi" no longer classified as plants? (2 marks)
13. Discuss "Lichens" as a symbiotic relationship. How are they indicators of air pollution? (2 marks)
14. Explain the characteristics of "Arthropoda." Why are they the most diverse group on Earth? (3 marks)
15. Differentiate between "Diploblastic" and "Triploblastic" animals. (2 marks)
16. What is a "Coelom"? Why is it a vital criterion for higher animal classification? (2 marks)
17. Compare "Monocots" and "Dicots" based on venation and root systems. (3 marks)
18. Describe the features of "Amphibians" that allow them to inhabit both land and water. (3 marks)
19. How does "Phylogeny" (Evolutionary History) assist modern taxonomists? (3 marks)
20. **Ready to Go Beyond:** Discuss the impact of "DNA Sequencing" on modern classification. (2 marks)
21. Why are "Viruses" often described as being at the "edge of life"? (2 marks)

Chapter 13: Earth as a System: Energy, Matter, and Life

1. **Case Study:** Human activity has increased atmospheric CO_2 from 280 ppm to over 415 ppm.
   (i) Critical Evaluation: Compare the CO_2 contribution from human respiration with that from industrial fossil fuel combustion. Why does the latter cause a systemic imbalance? (2 marks)
   (ii) How does this imbalance affect the "Albedo Effect" and Earth's energy budget? (2 marks)
2. **Case Study:** Earth is an "Open System" for energy but a "Closed System" for matter.
   (i) Trace the flow of solar energy from a leaf to a top predator. (2 marks)
   (ii) (Why is the "Recycling of Nutrients" mandatory in a closed system for matter? (2 marks)
3. Describe the "Water Cycle" as an intersection of Physics (evaporation/latent heat), Chemistry (solvent properties), and Biology (transpiration). (5 marks)
4. Analyse the "Greenhouse Effect." Distinguish between the "natural" effect and "enhanced" greenhouse effect. (3 marks)
5. Explain the "Carbon Cycle." How do the oceans act as a "Carbon Sink"? (3 marks)
6. What is the "Ozone Layer"? Explain the chemical mechanism of its depletion by CFCs. (3 marks)
7. Evaluate the impact of "Deforestation" on local micro-climates and the Nitrogen cycle. (3 marks)
8. Describe "Nitrogen Fixation." Why is this process critical for the synthesis of proteins in life forms? (3 marks)
9. How does the "differential heating" of Earth's surface drive atmospheric winds and ocean currents? (3 marks)
10. Discuss the "Gaia Hypothesis" – the idea of Earth as a self-regulating system. (2 marks)
11. Why is the "Magnetic Field" of Earth essential for protecting the biosphere? (3 marks)
12. Explain "Biological Magnification." Why are top predators most affected by persistent pesticides like DDT? (3 marks)
13. Describe the "Oxygen Cycle." What are the biological and geological "sinks" for oxygen? (2 marks)
14. How does "Acid Rain" impact soil pH and the survival of aquatic organisms? (3 marks)
15. Discuss how "Renewable Energy" can restore the Earth's energy balance. (2 marks)
16. What is "Eutrophication"? Trace the steps from fertiliser runoff to the formation of "Dead Zones" in water bodies. (3 marks)
17. Explain the "Carbon Footprint" of an individual. How can it be reduced? (3 marks)
18. Why are "Decomposers" the "cleaners" of the Earth system? (2 marks)
19. **What if...:** If the Earth's atmosphere were removed, calculate the impact on the average surface temperature. (3 marks)
20. Describe the "Biosphere" as the interaction zone between the Lithosphere, Hydrosphere, and Atmosphere. (2 marks)