

HINTS & SOLUTION

1. (a) Under the leadership of Gandhiji, the Civil Disobedience Movement was launched in AD 1930. It began with the Dandi March. On 12 March 1930, Gandhiji with some of his followers left the Sabarmati Ashram at Ahmedabad and made their way towards Dandi, a village on the west coast of India. Here, Gandhiji protested against the Salt Law (salt was a monopoly of the government and no one was allowed to make salt) by making salt himself and throwing up a challenge to the British government.
2. (b) The Code of Hammurabi is one of the earliest known legal codes, created by King Hammurabi of Babylon (c. 1754 BCE). It laid down strict rules and penalties for various crimes, showcasing early legal systems. The Epic of Gilgamesh, a Sumerian text, is one of the oldest pieces of literature. It includes a flood story similar to that found in the Bible and other ancient texts. The Ziggurat of Ur is associated with Sumer, not Babylon. It was built during the Sumerian period, before Babylon became prominent.
3. (d) The first Rupee (Silver coin) was introduced by Sher Shah and was called "Rupia" which remained in use throughout the Mughal rule.
4. (b) The Saka Era was started by Kanishka, the ruler of the Kushan dynasty, in 78 CE. It marks the beginning of his reign and is used in the Indian national calendar, which is officially recognized by the Government of India. Kanishka is also known for his patronage of Buddhism and the organization of the fourth Buddhist council in Kashmir.
5. (c) The Saka calendar used as the official civil calendar in the country is the National Calendar of India. The Saka calendar, often referred as the Hindu calendar is originally named as Saka Samvat. There are 12 months in Saka Calendar which are named as Vaisakha, Jyestha, Asadha, Sravana, Bhadrapada, Asvina, Kartika, Margasirsa, Pausa, Magh, Phalgura, Chaitra.
6. (d) The Gupta period (c. 320–550 CE) is called the "Golden Age" of Indian culture due to advancements in science, art, literature, and mathematics. Aryabhata, a renowned mathematician, contributed significantly to astronomy and mathematics, while Varahamihira made notable advancements in astrology and natural sciences. Both belonged to this era. The Prashastis were inscriptions or eulogies praising the achievements of Gupta rulers, such

- as Samudragupta's Allahabad Pillar inscription.
7. (b) In District administration each district was administered by 3 officers viz. Pradeshika, Rajuka, & Yukta. Pradeshika was senior and Rajuka was subordinate. Yukta was subordinate to both of them. The district administration was under the charge of Rajukas, whose position and functions are similar to modern collectors. He was assisted by Yuktas or subordinate officials. The rajjuka was responsible for surveying and assessing the land, fixing its rent and record keeping besides judicial functions.
 8. (a) Kalidasa is one of ancient India's greatest Sanskrit playwrights and poets. He is known for three major plays: Malavikagnimitram, Vikramorvashiyam, and Abhigyanashakuntalam.
 9. (b) Pulakesin II (610-642 CE) is the most famous ruler of the Chalukya dynasty. The Aihole inscription describes how the mighty Harsha lost his harsha (joy) when he suffered the ignominy of defeat. Pulakesin entered into a treaty with Harsha, with the Narmada River designated as the border between the Chalukya Empire and that of Harshavardhana.
 10. (c) Emperor Ashoka, of the Maurya Empire, inscribed his edicts on rocks and pillars throughout his empire around the 3rd century BCE. These inscriptions, written in Prakrit, Greek, and Aramaic, promote Dhamma (righteousness) and reflect his commitment to Buddhism after the Kalinga War.
 11. (a) The Theosophical Society was formed by Helena Petrovna Blavatsky, Henry Steel Olcott, William Quan Judge and others in November 1875 in New York. The aim of the society was to promote spiritual principles and search for truth known as Theosophy.
 12. (a) Government of India Act 1909 introduced separate and discriminatory electorates for Muslims. This was for the first time that, electorate for returning to the representatives to the councils was decided on the basis of class & community. For the central council, one more category Muslims was added. This was for the first time that the seats in the legislative bodies were reserved on the basis of religion for Muslims.
 13. (a) On the night of December 16, 1773, Samuel Adams and the Sons of Liberty boarded three ships in the Boston harbour and threw 342 chests of tea overboard. This resulted in the passage of the punitive Coercive Acts in 1774 and pushed the two sides closer to war.
 14. (b) The Sangam refers to assemblies or gatherings of Tamil poets that occurred in ancient Tamil Nadu. These poets

composed literature that forms the basis of early Tamil culture and society. The Sangam age (3rd century BCE–3rd century CE) is renowned for its rich literary works like *Tolkappiyam* and *Silappadikaram*.

15. (c) The *Arthashastra* by Kautilya (Chanakya) provides a detailed account of Mauryan administration, including governance and economic policies, making Statement 1 correct. Ashoka's inscriptions, issued during his reign, were written in multiple scripts, such as Brahmi in central India and Kharosthi in the northwest, making Statement 3 correct. However, the Mauryan Empire did not introduce the first standardized currency system; this development is attributed to the Gupta Empire, making Statement 2 incorrect.
16. (d) Lord William Bentinck was the first governor General of India.
17. (d) They are written in Aramaic language, Kharoshthi script. Shahbaz Garhi is an historic site located in Mardan District in the North West Frontier Province of Pakistan. Mansehra is located in Mansehra District, Khyber-Pakhtunkhwa province of Pakistan.
18. (b) The responsibility for all finance and management of Jagir and Inam Lands rested with Wazir.
19. (a) Income tax is levied and collected by Union government or the central government and distributed between itself and states.
20. (b) Indirect taxes are the charges that are levied on goods and services. Some of the significant indirect taxes include Value Added Tax, Central Sales Tax, Central Excise Duty, Customs Duty, stamp duties and expenditure tax. Property tax, Corporation tax and Wealth tax are examples of direct taxes.
21. (d) Capital account convertibility means free conversion of cross-border capital flows, implying that anybody can convert domestic currency into hard currency at the market rate and take the hard currency out of the country.
22. (b) Deflation is a decrease in the prices of goods and services. It occurs when the annual inflation rate falls below 0% which is a negative inflation rate. This is different from Disinflation which is a slow-down in the inflation rate. This is a situation when inflation declines to lower levels but prices continue to rise.
23. (d) Darwin's "struggle for existence" in natural history is analogous to the class struggle in "human History". So option (c) stands incorrect. The sketch of dialectical materialism given by Karl Marx explains that Dialectical

- principle is of universal application and all the development is “struggle of opposites” or “conflict of opposites”.
24. (a) The Vice President of India cannot be impeached like the President. Instead, a resolution to remove the Vice President must be initiated in the Rajya Sabha and passed by an absolute majority. It must then be agreed to by the Lok Sabha.
25. (a) Power sharing in a democratic political system is primarily focused on ensuring fair representation, reducing conflict, and fostering inclusivity among various communities. The primary aim is to prevent the dominance of one group over others and to involve all stakeholders in the governance process, which strengthens democracy. However, power sharing often slows down the decision-making process because it requires consultation, negotiation, and compromise among diverse groups. Hence, option (d) is not a valid argument in favour of power sharing.
26. (d) The 86th amendment to the Constitution approved in 2002 providing free and compulsory education to all children age 6 to 14 years has been notified. It included Article 21(a) in the Indian constitution making education a fundamental right.
27. (d) The Parliamentary form of Government is commonly referred to as Cabinet Government, Responsible Government, and the Westminster form of government. This system is characterized by a Council of Ministers (cabinet) that holds executive power and is collectively responsible to the legislature. It operates on the principle of maintaining the confidence of the majority in the legislature to remain in power. The term Westminster model is derived from the British parliamentary system, which India's government closely follows. Hence, all these terms correctly describe the parliamentary system.
28. (a) Article 19 of the Indian Constitution originally guaranteed seven fundamental rights to citizens, including the right to freedom of speech and expression, assembly, association, movement, residence, profession, and the right to acquire, hold, and dispose of property. However, the 44th Amendment Act of 1978 removed the right to property (Article 19(1)(f)) from the list of fundamental rights, leaving six rights under Article 19.
29. (b) The Constitution of India specifically provides that, Parliament may by law establish a common High Court for two or more States or for two or more States and a Union territory.

30. (d) Sarkaria Commission was set up by the central government of India in June 1983 to examine the relationship and balance of power between state and central governments in the country and suggest changes within the framework of Constitution of India.
31. (b) The Dyarchy system was introduced for the first time in India under the Government of India Act, 1919. This system divided the subjects of provincial administration into two categories: Reserved subjects and Transferred subjects. The Reserved subjects, such as law and order and finance, were administered by the Governor and his Executive Council, who were not accountable to the legislature. On the other hand, Transferred subjects, such as education and public health, were administered by ministers who were responsible to the legislative councils.
32. (d) Department of Official language (Raj Bhasha Vibhag) comes under Ministry of Home affairs.
33. (a) Lord Ripon's plan for local Self government in India is as follows: The sub-division, not the district, should be the maximum area served by one committee or local board with primary boards under it serving very small areas, so that each member of it might possess knowledge of and interest in its affairs.; The local boards should consist of a large majority of elected non-official members, and they should be presided over by a non-official member.
34. (d) The 102nd Constitutional Amendment Act (2018), not the 104th, provided constitutional status to the National Commission for Backward Classes (NCBC). All other are correct.
35. (a) The Three-tier Panchayati Raj System is established as per the 73rd Constitutional Amendment Act of 1992 and is defined under Part IX of the Indian Constitution. It includes the following levels. Village Panchayat (Gram Panchayat): The lowest level operating at the village level. Intermediate Panchayat (Block or Taluka level): It operates between the village and district levels in states where the population exceeds 20 lakhs. District Panchayat (Zila Parishad): The apex body operating at the district level.
36. (c) Article 105 of the Constitution provides immunity to Members of Parliament for anything said or any vote cast in Parliament. This immunity is an exception to equality under Article 14, as it ensures freedom of speech within legislative proceedings.
37. (a) Kesavananda Bharati vs State of Kerala (1973) is a landmark decision of the Supreme Court of India that outlined the Basic Structure doctrine of the Constitution. In the case, the

Supreme Court ruled that all provisions of the constitution, including Fundamental Rights can be amended. However, the Parliament cannot alter the basic structure of the constitution like secularism, democracy, federalism, separation of powers.

38. (a) The Balwant Rai Mehta Committee was appointed by the Government of India in January 1957 to examine the working of the Community Development Programme(1952).It recommended a 3-tier Panchayati Raj system-Gram Panchayat at the village level, Panchayat Samiti at the block level, and Zila Parishad at the district level.

39. (a) The Regulating Act of 1773 established the Supreme Court at Calcutta as the first British court in India with original and appellate jurisdiction. It replaced the judicial functions of the Mayor's Court in Calcutta.

40. (a) The 52nd Constitutional Amendment Act of 1985 added the Tenth Schedule to the Constitution, which deals with provisions related to the disqualification of Members of Parliament and State Legislatures on the grounds of defection (anti-defection law). The 86th Constitutional Amendment Act of 2002, however, introduced Article 21A, making education a fundamental

right for children aged 6–14 years and did not specifically provide special provisions for backward classes in educational institutions.

41. (b) The statement 2 is incorrect. While the Act did allow the governance of India to continue under the Government of India Act, 1935, it also permitted necessary modifications and adaptations until a new constitution was framed. Thus, governance was not strictly under the 1935 Act.

42. (c) Article 26 of the Indian Constitution states freedom to manage religious affairs subject to public order, morality and health, every religious denomination or any section thereof shall have the right (a) to establish and maintain institutions for religious and charitable purposes; (b) to manage its own affairs in matters of religion; (c) to own and acquire movable and immovable property; and (d) to administer such property in accordance with law.

43. (b) The Special Officer for Linguistic Minorities was added by the 7th Amendment Act, 1956, the National Commission for Backward Classes by the 102nd Amendment Act, 2018, and the GST Council by the 101st Amendment Act, 2016. In contrast, NITI Aayog is an executive body created in 2015, and the Central Information Commission is a statutory body established under the RTI Act,

- 2005, not through constitutional amendments.
44. (c) The Morley-Minto Reforms (Indian Councils Act of 1909) introduced indirect elections for the legislative councils, where elected members were chosen by an electoral college of local bodies like district boards and municipalities. While the reforms provided separate electorates for Muslims, fulfilling a key demand of the Muslim League, they did not precede its formation, as the Muslim League was established in 1906. The Act did not introduce bicameralism (added in 1919) or ordinance-making power for the Viceroy (introduced in 1935). Therefore, the only correct provision is (c) regarding the system of indirect elections.
45. (c) Free and fair elections in India are a cornerstone of the democratic process, allowing citizens to directly participate in choosing their representatives who then make laws and policies on their behalf. This enhances citizen involvement in governance.
46. (c) The structural part of constitution is based on Government of India Act 1935, whereas philosophical part comprised of Fundamental Right and Directive Principles of state policy are derived from Constitution of USA & Ireland respectively.
47. (a) Statement 3 is incorrect. In a joint sitting of both Houses, as provided under Article 108, the session is presided over by the Speaker of the Lok Sabha. However, if the position of the Speaker is vacant, the Deputy Speaker of the Lok Sabha or another member chosen by the members will preside.
48. (c) 7th Schedule gives allocation of powers and functions between Union & States. It contains 3 lists: Union List (97 Subjects); States List (66 subjects); Concurrent List(52 subjects).
49. (a) The Bombay High Court has benches in Nagpur, Aurangabad and Panaji.
50. (c) The 44th Amendment Act, 1978, abolished the fundamental right to property under Article 19(1)(f) and instead made it a legal right under Article 300A. It did not restore property as a fundamental right. Therefore statement 2 is incorrect.
51. (d) Janjatiya Gaurav Divas is celebrated every year on November 15 to honor tribal communities' contributions, especially in India's freedom struggle. The day marks the birth anniversary of Bhagwan Birsa Munda, a revered tribal leader and freedom fighter. Since 2021, this day highlights the sacrifices of tribal freedom fighters like the Santhals,

Tamars, Kols, Bhils, Khasis, and Mizos. In 2024, a special event in Jashpur, Chhattisgarh, marked Birsa Munda's 150th birth anniversary, led by Dr. Mansukh Mandaviya and joined by state leaders. The event included a 'Maati Ke Veer' Padayatra to celebrate tribal heritage and contributions to India's progress.

52. (c) India and Bangladesh were strong allies during the Bangladesh Liberation War in 1971. The historic Ganges Water Sharing Treaty was concluded in 1996. Indian External Affairs Minister Sushma Swaraj visited Bangladesh in her first official overseas trip in June, 2014. On May 7 of 2015 the Indian Parliament, in the presence of Bangladeshi diplomats, unanimously passed the Land Boundary Agreement (LBA) as its 100th Constitutional amendment, thereby resolving all 68-year old border disputes since the end of the British Raj..
53. (c) Each eligible farmer receives Rs. 6,000 per year in three equal instalments of Rs. 2,000 each. PM-KISAN is a central sector scheme, which means that it is fully funded by the Government of India.
54. (d) The Indian government launched the NAMASTE programme to support sewer and septic tank workers (SSWs) and mechanize sewer cleaning. Over 38,000 workers have been profiled, with 68.9% from Scheduled Castes, 14.7% from Other Backward Classes, and 8.3% from Scheduled Tribes. The programme aims to prevent deaths caused by hazardous manual cleaning, with 377 deaths recorded between 2019 and 2023. Profiling has been completed in 12 states and Union Territories, with approximately 100,000 SSWs across India. Rs 2.26 crore in capital subsidies has been disbursed to 191 beneficiaries for self-employment projects.
55. (b) The Montreal Protocol, adopted in 1987, is an international treaty designed to phase out the production and consumption of ozone-depleting substances (ODS), such as CFCs and halons. It is legally binding for all participating nations and does not directly target greenhouse gases like carbon dioxide.
56. (b) Samantha Harvey won the 2024 Booker Prize for her novel *Orbital*, set aboard the International Space Station. The Booker Prize is a prestigious literary award for the best English novel of the year, founded in 1969 in the UK. The award is open to any English-language novel published in the UK or Ireland, regardless of the author's nationality. The winner receives £50,000, with shortlisted authors earning £2,500.
57. (b) RudraM-II is an indigenously-developed solid-propelled air-

- launched missile system meant for Air-to-Surface role to neutralise many types of enemy assets. A number of state-of-the-art indigenous technologies developed by various DRDO laboratories.
58. (a) Indian Men's Hockey Team captain Harmanpreet Singh and former goalkeeper PR Sreejesh won the FIH Player of the Year and Goalkeeper of the Year titles for 2024. Awards were presented at the 49th FIH Statutory Congress in Oman.
59. (c) Exercise Agni Warrior is a bilateral military exercise between the Indian Army and the Singapore Armed Forces, focusing on joint artillery operations and enhancing defence cooperation.
60. (b) Pankaj Advani won the IBSF World Billiards Championship for the 28th time.
61. (a) The Kyoto Protocol was adopted in 1997 to set binding emission reduction targets for developed countries. The UNFCCC was established in 1992 during the Rio Earth Summit as the foundation for global climate action. The Paris Agreement was adopted in 2015, focusing on limiting global temperature rise to below 2°C. The Vienna Convention was adopted in 1985 as a framework for international cooperation to protect the ozone layer.
62. (c) Rodri has been named the winner of the Ballon d'Or 2024 award at the ceremony held at the Théâtre du Châtelet in Paris.
63. (d) Kakrapar Atomic Power Station is a nuclear power station, which lies in the proximity of Mandvi, Surat and Tapi river in the state of Gujarat.
64. (d) Myanmar is the largest country in mainland Southeast Asia. It shares borders with Thailand, Laos, China, India and Bangladesh, and has a coastline on the Andaman Sea and the Bay of Bengal. It is ruled by a military government. The National League for Democracy decided not to take part in the election (in 2010). Myanmar is associated with ASEAN.
65. (a) The International Atomic Energy Agency (IAEA) seeks to promote the peaceful use of energy. It was established as an autonomous organization on 29 July 1957. The IAEA has its headquarters in Vienna, Austria. The IAEA as an autonomous organization is not under direct control of the UN, but the IAEA does report to both the UN General Assembly and Security Council.
66. (a) The reduction in import duties on capital goods is indeed an important policy instrument of economic liberalization. It allows local entrepreneurs to access advanced machinery and technology at a lower

cost, enabling them to upgrade their operations and become competitive in global markets. Hence, both the assertion and the reason are true, and the reason correctly explains the assertion.

67. (b) Capital gains arise from the sale of a capital asset, such as property or collectibles, when the selling price exceeds the purchase price. Increased sales of a product (statement 1) result in business revenue, not capital gains, making it incorrect. However, a natural increase in the value of owned property (statement 2) or an increase in the value of a painting due to its popularity (statement 3) can lead to capital gains if these assets are sold.
68. (b) The DEA or the Department of Economic Affairs is also responsible for preparation and presentation to the Parliament of Central Budget and the Budgets for the State Governments under President's Rule and Union Territory Administration.
69. (c) When interest rates decrease then investment expenditure by businesses on capital goods like factories and equipment increase in an economy.
70. (a) The term bear denotes an investor who believes that a particular security or market is headed downward. Bears attempt to profit from a decline in prices. Bears are generally pessimistic about the state of a given market.
- Bearish sentiment can be applied to all types of markets including commodity markets, stock markets and the bond market.
71. (a) Economic liberalization in India started with industrial de-licensing.
72. (b) A company organized for commercial purposes is called an enterprise. Classification of an enterprise into public or private sector is based on ownership of assets of the enterprise.
73. (a) Hashish, also known as "hash," is a concentrated product obtained from the Cannabis plant. It is produced by collecting and compressing the resinous exudate (or trichomes) found mainly on the leaves and female inflorescences (flowering tops) of the plant. This resin contains high concentrations of psychoactive compounds such as THC (Tetrahydrocannabinol).
74. (c) The stomach's inner lining secretes a mucoid alkaline substance, which forms a protective layer over the mucosa. This layer: Neutralizes gastric acid near the stomach lining, preventing damage to the stomach walls. Prevents pepsin (a proteolytic enzyme) from digesting the stomach's own proteins in the mucosa, thereby protecting it from self-digestion.

75. (a) Copper sulphate is commonly used as a fungicide to control the growth of fungi in water tanks. Its antifungal properties effectively inhibit fungal growth and help maintain the cleanliness of water storage systems. Other options like magnesium sulphate, zinc sulphate, and nitric acid are not typically used for this purpose.
76. (a) Xerophthalmia is caused by a deficiency of Vitamin A, which is essential for maintaining healthy vision. This condition primarily affects the eyes, leading to dryness of the conjunctiva and cornea and, in severe cases, blindness. Vitamin A is crucial for the production of rhodopsin, a pigment necessary for low-light and night vision. Deficiency can result from poor dietary intake of Vitamin A-rich foods such as carrots, spinach, and liver.
77. (a) Plant cells have chloroplasts, which are specialized organelles for photosynthesis. These chloroplasts contain chlorophyll, enabling plants to produce energy from sunlight. In contrast, animal cells lack chloroplasts because they do not perform photosynthesis.
78. (a) Flat-footed camels can walk easily in sandy deserts because their wide, flat feet increase the area in contact with the sand. This increased surface area reduces the pressure exerted on the sand (as pressure is inversely proportional to the area, preventing them from sinking into it. This adaptation allows camels to move efficiently in desert conditions).
79. (c) The plasma membrane in eukaryotic cells is primarily composed of a phospholipid bilayer with proteins embedded within it. This structure is often referred to as a phospholipid protein membrane because it contains both phospholipids (lipid molecules with phosphate groups) and proteins. The proteins in the membrane can be integral or peripheral and are involved in functions such as transport, signalling, and structural support.
80. (b) The ability of the eye to see in the dark is due to a pigment called rhodopsin. It is found in the rod cells of the retina, which are responsible for vision in low-light conditions (scotopic vision). Rhodopsin is a light-sensitive pigment that absorbs light and undergoes a chemical change, which helps send signals to the brain, allowing us to see in dim light.
81. (c) In coriander, the leaves are commonly used as a fresh herb in cooking, adding flavour to various dishes, especially in salads, curries, and salsas. The dried fruits (seeds) of coriander are used as a spice in cooking, either whole or ground into powder, contributing a warm, citrusy flavour to dishes.

82. (c) Some viruses, known as RNA viruses, contain RNA as their genetic material instead of DNA. In these viruses, the RNA carries the hereditary information and is used to replicate and synthesize proteins necessary for the virus's life cycle. For example, the coronavirus and HIV are RNA viruses. These viruses replicate by converting their RNA into DNA or directly using RNA to make proteins through processes like reverse transcription.
83. (b) Dual Energy X-ray Absorptiometry (DEXA) is used to measure the density or strength of bones.
84. (a) When a stone tied to a string is whirled in a circular motion, the centripetal force is required to keep it moving in the circle. This force is provided by the tension in the string. As the speed of the stone increases, the centripetal force required to maintain the circular motion also increases. The string can sustain a maximum tension (beyond which it will break). When the speed of the stone increases to a point where the required centripetal force exceeds the maximum tension the string can handle, the string breaks.
85. (c) To determine the centripetal force, we use the concept of circular motion. Step 1: Convert the velocity to meters per second (m/s). Step 2: Use the formula for centripetal force.
86. (d) The unit of the coefficient of viscosity is Ns/m^2 because it relates to how "thick" or "resistant to flow" a fluid is.
87. (c) The power radiated by a perfect blackbody is governed by the Stefan-Boltzmann Law. The power radiated depends only on the temperature (T) of the blackbody, not its material, density, or nature of the surface
88. (b) We need to determine the time duration for which angular acceleration is applied to achieve a rotational kinetic energy of 1500 joules. Recall the formula for rotational kinetic energy. $(\text{K.E.}) = \frac{1}{2} (I\omega^2)$. Substituting values, $1500 = \frac{1}{2} \times 1.2 \times \omega^2$. Calculating the above eqn, we get $\omega = \sqrt{2500} = 50\text{rad/sec}$. The angular velocity achieved is related to angular acceleration (α) and time (t) is given by $\omega = \alpha t$. Given, $\alpha = 25 \text{ rad/sec}^2$ and $\omega = 50 \text{ rad/sec}$. Substituting in above eqn, we get $t = 2$ seconds
89. (a) When a gas is heated in a constant volume container, the volume remains fixed. In thermodynamics, a process in which the volume does not change is called an isochoric process (also known as an isovolumetric process).
90. (d) The fringe width is directly proportional to the wavelength of the light. This means that the larger the wavelength, the greater the fringe

width. Blue light has the shortest wavelength, followed by green light, and red light has the longest wavelength. Hence, the correct order is $WR > WG > WB$

91. (d) The potential energy of an electric dipole in a uniform electric field depends on the angle between the dipole axis and the direction of the electric field.

92. (c) A potentiometer is an instrument that can measure both terminal potential difference and electromotive force (emf) of a cell accurately. The potentiometer works on the principle of null deflection, where no current flows through the measuring instrument. It measures emf by comparing it with a standard known voltage and ensures that there is no current drawn from the cell while measuring the emf, which avoids errors. If the circuit has a load (resistance), the potentiometer can also measure the terminal potential difference under those conditions.

93. (a) The force between two parallel current-carrying conductors is directly proportional to the product of the currents flowing through them. If the initial force is F for currents I in both conductors, then $F \propto I_1 \cdot I_2$. Since the force is proportional to the square of the current in this case, doubling the

current in both conductors increases the force by 4 times.

94. (c) A Light Emitting Diode (LED) emits light due to the process of electroluminescence, which occurs when holes and electrons recombine at the junction of a forward-biased LED. Forward Bias: When a p-n junction is forward biased, electrons from the n-region and holes from the p-region move toward the junction. Recombination: When these electrons and holes meet at the junction, the electrons drop to a lower energy state, releasing energy in the form of photons (light). Visible Light: Depending on the energy gap (bandgap) of the semiconductor material used, the emitted photons can fall within the visible spectrum, producing visible light. Special materials and combinations are used to produce white light.

95. (d) The magnetic dipole moment of a current-carrying loop is given by: $[M = N \cdot I \cdot A]$. From this relationship, it is clear that the magnetic dipole moment depends on, Number of turns (N): More turns increase the magnetic dipole moment. Area of the loop (A): A larger loop area increases the moment. Current (I): A higher current enhances the dipole moment. However, the magnetic dipole moment is independent of the external magnetic field in which the loop is lying. The

external field may exert a torque or force on the loop, but it does not affect the intrinsic magnetic dipole moment of the current loop.

96. (a) An LC resonant circuit (also called a tank circuit) consists of an inductor (L) and a capacitor (C) connected together. This circuit is used for tuning because it resonates at a specific frequency, depending on the values of the inductor and capacitor. In a television receiver or a radio, the LC circuit helps select the desired frequency (channel) while rejecting other unwanted frequencies. When the circuit resonates at a particular frequency, it allows signals of that frequency to pass while blocking others.
97. (a) When an electric bulb operates on DC (direct current) at 10 volts, it gets a steady and constant power supply. For the bulb to give the same brightness when connected to AC (alternating current), the AC supply must provide an average power equal to what the bulb gets from 10 volts DC. However, AC voltage isn't constant; it rises and falls like a wave. The "effective" value of AC voltage (called RMS voltage) tells us the average power it can deliver. For the same brightness, this effective AC voltage is 10 volts. Now, because the AC voltage is a wave, its peak value (the maximum voltage reached) is higher than its effective value. In simple terms, the AC voltage
- has to "rise up" a bit more to compensate for its fluctuating nature. For a 10-volt effective value, the actual peak value turns out to be about 14.14 volts.
98. (a) The primary structure of DNA refers to the sequence of nucleotides (the building blocks of DNA) in a strand. These nucleotides consist of a sugar, a phosphate group, and a nitrogenous base (adenine, thymine, cytosine, or guanine). The order of these nitrogenous bases along the DNA strand is what carries the genetic information, as this sequence is used to encode instructions for protein synthesis and other cellular processes.
99. (a) Let's assume the charge of the metal ion (Fe) is x . The complex consists of 6 cyanide ions, each contributing a charge of -1 . Therefore, the total charge contributed by the cyanide ions is: $6 \times (-1) = -6$. Now, using the overall charge of the complex, we can set up the equation: $x + (-6) = -4$. Therefore, $x - 6 = -4$. Hence $x = +2$.
100. (a) When a Grignard reagent (RMgX) reacts with an aldehyde, the reaction leads to the formation of an alcohol. The type of alcohol formed depends on the nature of the aldehyde involved. Aldehydes (except formaldehyde) contain one alkyl group attached to the carbonyl carbon, so

when a Grignard reagent attacks, it forms a secondary alcohol.

101. (b) In the given reaction, ethyl magnesium bromide ($\text{CH}_3\text{-CH}_2\text{-Mg-Br}$) reacts with ammonia (NH_3). Here, the Grignard reagent ($\text{CH}_3\text{-CH}_2\text{-Mg-Br}$) is a strong nucleophile and also acts as a strong base. Ammonia acts as a proton donor (acidic H^+ source). The ethyl group ($\text{CH}_3\text{-CH}_2\text{-}$) in the Grignard reagent abstracts a proton (H^+) from ammonia, leading to the formation of ethane ($\text{CH}_3\text{-CH}_3$) as the major product. The leftover part of the Grignard reagent forms magnesium amide (MgBr-NH_2) as a byproduct.

102. (b) Transuranium elements are those elements with atomic numbers greater than uranium (92) on the periodic table. These elements are artificially synthesized and include atomic numbers starting from 93 (Neptunium) up to 103 (Lawrencium) in the actinide series. Uranium (U) has the atomic number 92. The first transuranium element is Neptunium (93), and the series continues up to Lawrencium (103).

103. (b) When SO_2 (sulphur dioxide) is passed through an aqueous solution of I_2 (iodine), a redox reaction occurs. In this reaction: SO_2 acts as a reducing agent and I_2 is reduced to iodide ions (I^-). Here, iodine (I_2), which gives the brown colour in aqueous solution, gets reduced to iodide ions (I^-), which are

colourless. Therefore, the solution becomes colourless.

104. (c) Sugar dissolves in water because both sugar and water molecules can form hydrogen bonds with each other. Sugar molecules contain hydroxyl ($-\text{OH}$) groups, which are polar and capable of hydrogen bonding. Water, being a polar solvent, also has hydrogen-bonding capability. When sugar is added to water, the polar water molecules surround the sugar molecules, breaking the intermolecular forces between sugar molecules and forming new hydrogen bonds, leading to sugar dissolving easily.

105. (b) The correct order of acid strength is fluoroacetic acid $>$ nitrobenzoic acid $>$ methyl benzoic acid $>$ acetic acid because acid strength depends on the presence of electron-withdrawing groups, which stabilize the conjugate base after proton loss. Fluoroacetic acid is the strongest due to the highly electronegative fluorine atom, which strongly withdraws electrons. Nitrobenzoic acid follows, as the nitro group stabilizes the conjugate base through both inductive and resonance effects. Methyl benzoic acid has a weaker electron-donating methyl group, which slightly reduces acidity, and acetic acid is the weakest as it lacks strong electron-withdrawing groups.

- 106.** (c) The sugar component in the nucleotide unit of RNA (Ribonucleic Acid) is D-ribose. D-ribose is a pentose sugar (a 5-carbon sugar) that contains a hydroxyl group (-OH) attached to the 2'-carbon atom. In contrast, DNA (Deoxyribonucleic Acid) contains deoxyribose, which lacks one oxygen atom at the 2'-carbon, making it 2-deoxy-D-ribose.
- 107.** (a) During the electrolysis of molten NaCl (sodium chloride): At the anode (positive electrode): Chlorine gas (Cl₂) is released. Chlorine gas is yellow-green in colour. At the cathode (negative electrode): Sodium metal (Na) is deposited in its molten silvery white form.
- 108.** (d) After World War II, the Oder-Neisse line was established as the new border between Germany and Poland. It follows the Oder River and its tributary, the Neisse River (specifically the Lusatian Neisse). This border was agreed upon during the Potsdam Conference in 1945 by the Allied powers (Soviet Union, United States, and United Kingdom).
- 109.** (c) Bass Strait is a sea strait which separates Tasmania from the Australian mainland.
- 110.** (d) A geostationary satellite is an earth-orbiting satellite. It is placed at an altitude of approximately 35,800 kilometres directly over the equator that revolves in the same direction the earth rotates (west to east).
- 111.** (a) Both statements are true. An anticyclone is a high-pressure system that typically brings calm, clear weather without significant changes in weather conditions, as stated in Statement I. Statement II correctly explains this by noting that the outward movement of wind from the high-pressure center prevents the upward movement of air, limiting the formation of weather disturbances. Therefore, Statement II logically explains why anticyclones do not cause significant weather changes.
- 112.** (d) The Global Positioning System (GPS) is a satellite based system that can be used to locate positions anywhere on the earth. It is associated with longitude and latitude. It is a "constellation" of 24 well-spaced satellites that orbit the Earth and make it possible for people with ground receivers to pinpoint their geographic location. The Russian government has developed a system, similar to GPS, called GLONASS. The US began the GPS project in 1973.
- 113.** (c) Kanha National Park belongs to tropical moist dry deciduous forest. It is a tiger reserve of India and the largest national park of Madhya Pradesh.

- 114.** (d) The performance ratio (PR) of a photovoltaic system measures the efficiency of the system in real-world conditions compared to its theoretical maximum. Factors like cell efficiency (a), installation angle and orientation (b), and electrical losses (c) directly impact the PR because they affect the system's energy output and losses. However, the land area available does not directly influence the performance ratio; it may limit the system's overall capacity but doesn't affect the efficiency of energy conversion or losses within the system itself.
- 115.** (b) In an elliptical orbit, the distance of a planet from the Sun varies: it is closest at perihelion and farthest at aphelion. If the orbit were perfectly circular, the planet would maintain a constant distance from the Sun throughout its revolution. This would mean no variation in distance, and the planet would revolve at a constant speed.
- 116.** (b) The correct sequences of water bodies, from lower to higher salinity concentration, is Baltic sea- Arctic Sea- Gulf of California-Red sea.
- 117.** (c) The Mistral winds are cold, dry winds that blow from the north-west to the south-east, affecting southern France. They are known for causing clear skies and cooler temperatures, not heavy rainfall. While they can benefit agriculture by reducing humidity and controlling certain pests, they do not bring significant rainfall.
- 118.** (d) In the northern plains of India, canal irrigation is primarily practiced due to the presence of perennial rivers (like the Ganges, Yamuna, and Indus) that provide a continuous water supply (Statement 1). Additionally, the flat terrain in this region makes it easy to construct and maintain a network of canals (Statement 3). While the soil is not typically sandy, groundwater can be utilized in some areas, but the flat landscape and availability of river water are the key factors for canal irrigation. Therefore, Statement 2 is not a strong reason for canal irrigation in this region.
- 119.** (a) There are four terrestrial planets in our Solar System: Mercury, Venus, Earth, and Mars. The terrestrial planets in our Solar System are also known as the inner planets because these planets are the four closest to the Sun.
- 120.** (a) The lack of atmosphere around the Moon is primarily due to two factors: Low gravitational attraction: The Moon's gravity is about 1/6th that of Earth's, which means it cannot hold onto lighter molecules like nitrogen and oxygen. Low escape velocity: The escape velocity of the Moon is much lower compared to Earth. This allows air molecules to escape into space more easily. The combination of low

gravity and low escape velocity results in the Moon being unable to retain a substantial atmosphere.