NEET - 2020 (Solutions)

SECTION : BIOLOGY
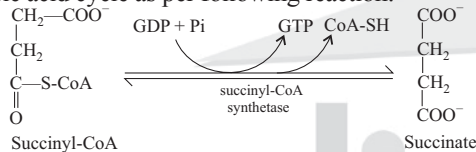
1. (b) Length of DNA = $[0.34 \times 10^{-9}]$ m $\times 6.6 \times 10^9$ bp = 2.2 m
   Distance between 2 base pair in DNA helix = 0.34 nm = 0.34×10^{-9} m
   Total number of base pair = 6.6×10^9 bp

2. (a) Platyhelminthes are bilaterally symmetrical, triploblastic and acoelomate animals with organ level of organisation.

3. (a) *Locusta* is a gregareous pest. In Echinoderms, adults are radially symmetrical but larvae are bilaterally symmetrical. Scorpions respire through book lungs. Bioluminescence is well marked in ctenophores.

4. (b) Golgi bodies are site of formation of glycoproteins and glycolipids in eukaryotic cells.

5. (b) The QRS complex represents the depolarisation of the ventricles, which initiates the ventricular contraction. The contraction starts shortly after Q and marks the beginning of the systole.

6. (c) 11th and 12th pairs of ribs are not connected ventrally and are therefore, called floating ribs. Acromion is a flat expanded process of spine of scapula. The lateral end of clavicle articulates with acromion process. Scapula is a flat triangular bone in the dorsal part of the thorax between 2nd and the 7th rib. Glenoid cavity of scapula articulates with head of the humerus to form the shoulder joint.

7. (c) Experimental verification of the chromosomal theory of inheritance was done by Morgan. Sutton and Boveri proposed chromosomal theory of inheritance but it was experimentally verified by T.H. Morgan.

8. (b) Correct statement: Sapwood is outermost secondary xylem. Outer secondary xylem or sapwood serves in water conduction, while the inner part called heartwood is composed of dead but structurally strong primary xylem.

9. (b) Grave's disease is due to excess secretion of thyroid hormones (T_3 & T_4). Diabetes mellitus is due to hyposecretion of insulin from beta-cells of pancreas. Diabetes insipidus is due to hyposecretion of ADH from posterior pituitary. Addison's disease is due to hyposecretion of hormone from adrenal cortex.

10. (a) *Bacillus thuringiensis* is a source of Cry- proteins. *Thermus aquaticus* is a source of thermostable DNA polymerase (*Taq polymerase*) used in PCR. *Agrobacterium tumefaciens* is a cloning vector. The construction of 1st recombinant DNA molecule was performed using native plasmid of *Salmonella typhimurium*.

11. (c) Inulin is a mixture of linear fructose polymers with different chain length and a glucose molecule at each C2 end. Adjacent fructose units are linked through glycosidic bond. The inulin that is used for medicine is most commonly obtained by soaking chicory roots in hot water.
    Insulin is a protein composed of 51 amino acids and acts as a hormone which is secreted by beta-cells of pancreas. Adjacent amino acids are attached through peptide bond.

12. (c) RNA polymerase facilitates opening of DNA helix during transcription. The two strands have opposite polarity and the DNA-dependent RNA polymerase also catalyse the polymerisation in only one direction, that is, 5'→3', the strand that has the polarity 3'→5' acts as a template, and is also referred to as **template strand**. The other strand which has the polarity (5'→3') and the sequence same as RNA (except thymine at the place of uracil), is displaced during transcription. Strangely, this strand is referred to as **coding strand**.

13. (b) Cockroaches breathe passively through a network of pipes connected to holes called spiracles along the length of their body. They are independent of blood circulation to move oxygen around and their body fluids are at a much lower pressure. The sensory input from the eyes and antennae, along with many other behaviours, are transmitted and handled by their brain such as running and reacting to touch, handled by 'mini brains' called ganglia in each body segment. A decapitated cockroach will eventually starve to death but this can still take few days.

14. (d) Inspiration is initiated by the contraction of diaphragm, which increases the volume of thoracic chamber in the anterio-posterior axis. The contraction of external inter-coastal muscles lifts up the ribs and the sternum causing an increase in the volume of the thoracic chamber in the dorso-ventral axis.

15. (b) Hisardale is a new breed of sheep developed in Punjab by crossing Bikaneri-ewe and Marino rams.
    In cross-breeding, superior male of one breed are mated with superior females of another breed.

16. (a) Collagen is the most abundant protein in animal world. Collagen is the major insoluble fibrous protein found in the extracellular matrix and in connective tissue. RuBisCO is the most abundant protein in the whole of the Biosphere.

17. (b) Mendel selected 14 True breeding plant varieties. True breeding line refers to the plant that has undergone continuous self-pollination and showed stable trait inheritance and expression for several generations. Mendel (father of genetics) selected 14 true-breeding pea plant varieties, as pairs, which were similar except for one character with contrasting traits.
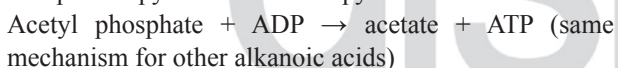
18. (d) The attachment point of funicle and body of ovule is known as hilum. A hilum is a scar or mark left on a seed coat by the former attachment to the ovary wall or to the funiculus (which in turn attaches to the ovary wall). A hilum can also be a nucleus of a starch grain; the point around which layers of starch are deposited.

19. (a) Viroids have free RNA without protein coat. Viroid, an infectious particle smaller than any of the known viruses, an agent of certain plant diseases. The particle consists only of an extremely small circular RNA (ribonucleic acid) molecule, lacking the protein coat of a virus.
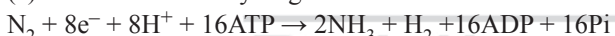
20. (a) One substrate level phosphorylation in one turn of citric acid cycle as per following reaction:

Succinyl-CoA   Succinate

Another example of substrate level phosphorylation are as follows:

1,3-*bis*phosphoglycerate + ADP →
3-phosphoglycerate + ATP

Phosphoenolpyruvate + ADP → pyruvate + ATP

Acetyl phosphate + ADP → acetate + ATP (same mechanism for other alkanoic acids)

21. (c) Ammonia and Hydrogen.

$N_2 + 8e^- + 8H^+ + 16ATP \rightarrow 2NH_3 + H_2 + 16ADP + 16Pi$

The steps involved in the process of nitrogen fixation are as follows:
- Rhizobia multiply and colonise the surroundings of roots and get attached to epidermal and root hair cells.
- The root-hairs curl and the bacteria invade the root-hair.
- An infection thread is produced carrying the bacteria into the cortex of the root, where they initiate the nodule formation in the cortex of the root.
- Then the bacteria are released from the thread into the cells which leads to the differentiation of specialised nitrogen fixing cells.
- The nodule thus formed, establishes a direct vascular connection with the host for exchange of nutrients.
- The nodule contains all the necessary biochemical components, such as the enzyme nitrogenase and leghaemoglobin.
- The enzyme nitrogenase is a Mo-Fe protein and catalyses the conversion of atmospheric nitrogen to ammonia, the first stable product of nitrogen fixation.
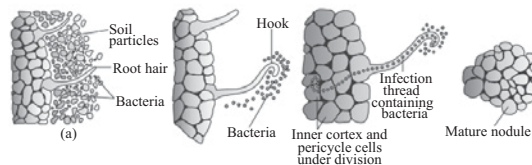
22. (a) Typhoid fever in humans is caused by pathogenic bacterium *Salmonella typhi*. Pneumonia is caused by *Streptococcus Pneumoniae* and *Haemophilus influenzae*. Filariasis or elephantiasis is caused by the filarial worm, *Wuchereria bancrofti* and *Wuchereria malayi*. Malaria is caused by different species of *Plasmodium*.

23. (d) In 1953, S.L. Miller, an American scientist created electric discharge in a closed flask containing CH_4, H_2, NH_3 and water vapor at 800°C.

24. (d) Based on the observation of Erwin Chargaff that for a double stranded DNA, the ratios between Adenine and Thymine and Guanine and Cytosine are constant and equals one. Adenine pairs with thymine through two H-bonds i.e., A = T and guanine pairs with cytosine with three H-bonds.

25. (a) Zygotene → Synapsis
Pachytene → Crossing over
Diplotene → Chiasmata formation
Diakinesis → Terminalisation

26. (a) Ligases join the two DNA molecules. DNA **ligase** is an enzyme which can connect two strands of DNA together by forming a bond between the phosphate group of one strand and the deoxyribose group on another. It is used in cells to join together the Okazaki fragments which are formed on the lagging strand during DNA replication.

27. (d) Gonorrhoea, Syphilis, Genital herpes are sexually transmitted diseases. Gonorrhoea is caused by a bacterium *Neisseria gonorrhoeae*. Syphilis is caused by a bacterium *Treponema pallidum*. Genital herpes is caused by a virus Type-II-Herpes simplex virus.

28. (d) Embryological support for evolution was disapproved by Karl Ernst von Baer, he noted that embryos never pass through the adult stages of other animals during embryonic development.

29. (d) The roots that originate from the base of the stem are fibrous roots. A **fibrous root** system is the opposite of a taproot system. It is usually formed by thin, moderately branching **roots** growing from the stem. A **fibrous root** system is universal in monocotyledonous plants and ferns. The **fibrous root** systems look like a mat made out of **roots** when the tree has reached full maturity.

30. (a) The separated DNA fragments can be visualised only after staining the DNA with Ethidium bromide followed by exposure to UV radiation.

31. (d) The gonadotropin (LH and FSH) increases gradually during the follicular phase, and stimulates follicular development as well as secretion of estrogens by the growing follicles. Both LH and FSH attain a peak level in the middle of cycle (about 14th day). Rapid secretion of LH leading to its maximum level during the mid-cycle called LH surge induces rupture of Graafian follicle and thereby the release of ovum (ovulation).

32. (a) Goblet cells are found within the lining of the airways and intestines. Goblet cells secrete mucus, which helps to lubricate surfaces and prevent infection. Goblet cells have large numbers of secretory vesicles that transport mucus to the cell surface (exocytosis). They also have an extensive *endoplasmic reticulum' and large* golgi bodies'' needed to synthesise and the proteins found in mucus (e.g. mucin).

33. (a) UV-B radiations damage DNA and mutations may occur. In human eye, cornea absorbs UV-B radiations, and a high dose of UV-B causes inflammation of cornea called snow blindness, cataract, etc.

34. (b) Iron is essential for the formation of chlorophyll. Zinc is needed for synthesis of auxin. Boron plays a role in pollen grain germination. Manganese is involved in the splitting of water to liberate O_2 during photosynthesis.

35. (d) Bt cotton is resistant to cotton bollworm (Insect pest). *cry* I Ac and *cry* II Ab genes have been introduced in cotton to protect it from cotton bollworm. This makes Bt cotton as biopesticide.

36. (d) Ray floret have inferior ovary. Ray floret is condition in flower where any of a number of strap-shaped and typically sterile florets that form the ray e.g., Sunflower Epignous flower are formed in family Asteraceae.

37. (a) Montreal protocol – Signed in 16 Sep, 1987 (Ozone day) came into force – 1 Jan, 1989. It was aimed at stopping the production and import of ODS and reduce their concentration in the atmosphere.
    The main uses of ozone depleting substances include:
    - CFCs and HCFCs in refrigerators and air conditioners,
    - HCFCs and halons in fire extinguishers,
    - CFCs and HCFCs in foam,
    - CFCs and HCFCs as aerosol propellants, and
    - Methyl bromide for fumigation of soil, structures and goods to be imported or exported.

38. (c) Restriction endonucleases make cuts at specific positions within the DNA. They function by inspecting the length of a DNA sequence. Restriction endonuclease binds to the DNA and cut the two strands of double helix at specific points in their sugar-phosphate backbones. They are used in genetic engineering to form recombinant molecules of DNA. DNA ligases join the DNA fragments.

39. (a) *Plasmodium* enters the human body as sporozoites (Infectious stage) through the bite of Infected Female *Anopheles* mosquito.

40. (c) Meiotic division of secondary oocyte is completed after the entry of sperm in secondary oocyte which lead to the formation of a large ovum and a tiny 2nd polar body.

41. (a) In photorespiration, O_2 binds to RubisCo. As a result RuBP instead to being converted to 2 molecules of PGA bind with O_2 to form one molecule each of phosphoglycerate (3 carbon compound) and phosphoglycolate (2 carbon compound).

42. (c) In vertebrata, notochord is present during embryonic period only as it is replaced by vertebral column. In chordates, central nervous system is dorsal and hollow.

43. (a) *Clostridium butylicum* (a bacterium) is used for the production of butyric acid. An bioactive molecule, cyclosporin A, that is used as an immunosuppressive agent in organ-transplant patients, is produced by the fungus *Trichoderma polysporum*. Statins produced by the yeast *Monascus purpureus* have been commercialized as blood-cholesterol lowering agents. It acts by competitively inhibiting the enzyme responsible for synthesis of cholesterol. *Aspergillus niger* (a fungus) is used for the commercial production of citric acid.

44. (c) *Chlorella* and *Spirulina* are unicellular algae. *Gelidium, Gracilaria*, *Laminaria* and *Sargassum* are multicellular. *Volvox* is colonial.

45. (d) After excitement, e^- is passed from PS-II (P_{680}) to primary electron acceptor (Pheophytin). From primary e^- acceptor, e^- is passed to plastoquinone. Plastoquinone (PQ) in turn transfer its e^- to Cyt b_6f complex. Therefore plastoquinone facilitates the transfer of electrons from PS-II to Cyt b_6f complex.

46. (b) Presence of Ketone bodies in urine (Ketonuria) and presence of glucose in urine (Glycosuria) are indicative of Diabetes mellitus.

47. (b) A wide variety of chemical substances that we extract from plants on a commercial scale (nicotine, caffeine, quinine, strychnine, opium, etc) are produced by them (plants) as defences against grazers and browsers.

48. (a) Adrenal cortex secretes mineralocorticoids like aldosterone which increase the reabsorption of Na^+ and water from renal tubule that prevent diuresis. Diuresis is a condition in which the kidneys filter too much bodily fluid.

49. (b) Phenylketonuria is an inborn error of metabolism is also inherited as the autosomal recessive trait. Sickle cell anemia is an autosomes linked recessive trait that can be transmitted from parents to the offspring when both the partners are carrier for the gene (or heterozygous). Thalassemia is an inherited blood disorder that causes your body to have less hemoglobin than normal. Hemoglobin enables red blood cells

to carry oxygen. Thalassemia can cause anemia, leaving you fatigued. Haemophilia is a sex linked recessive disease, which shows its transmission from unaffected carrier female to some of the male progeny.

50. (c) Natality refers to the number of births during a given period in the population that are added to the initial density. Mortality is the number of deaths in the population during a given period. Population interaction is the interaction between different populations. It refers to the effects that the organisms in a community have on one another. The sex ratio is the ratio of males to females in a population.

51. (a) Inclusion bodies are nuclear or cytoplasmic aggregates which are stainable substances, usually proteins, and formed due to viral multiplication or genetic disorders in human beings these bodies are either intracellular or extracellular abnormalities and they are specific to certain diseases. These are not involved in ingestion of food particles.

52. (d) The monocot stem is characterised by conjoint, collateral, and closed vascular bundles, scattered in the ground tissue containing the parenchyma. Each vascular bundle is surrounded by sclerenchymatous bundle-sheath cells. Phloem parenchyma and medullary rays are absent in monocot stems.

53. (a) Gross primary productivity of an ecosystem is the rate of production of organic matter during photosynthesis. Net primary productivity is GPP-respiration. Hence, gross primary productivity is always more than NPP.

54. (d) In majority of aquatic plants, the flowers emerge above the level of water. These may be pollinated by insects or wind *eg.*: Water hyacinth and water lily.

55. (c) The sediment in settlement tank is called activated sludge. A small part of the activated sludge is pumped back into aeration tank. Remaining major part of the sludge is pumped into large tank called anaerobic sludge digesters.

56. (a) Root pressure is positive hydrostatic pressure. It develops in tracheary element at night and in early morning. Root pressure is caused by active distribution of mineral nutrient ions into the root xylem. Without transpiration to carry the ions up the stem, they accumulate in the root xylem and lower the water potential. Water then diffuses from the soil into the root xylem due to osmosis.

57. (b) Cuboidal epithelium with brush border of microvilli is found in proximal convoluted tubule of nephron (PCT).

58. (d) Glucagon is associated with hyperglycemia. Insulin acts on hepatocytes and adipocytes and is associated with hypoglycemia. Glucocorticoid stimulates gluconeogenesis, so increase blood sugar level.

59. (d) Gibberellic acid breaks seed dormancy. It activate synthesis of alpha-amylase which breakdown starch into simple sugar.

60. (c) Robert May estimated global species diversity at about 7 million. Although some extreme estimates range from 20 to 50 million.

61. (d) Grassland ecosystem is a terrestrial ecosystem. It includes various trophic levels. First trophic level (T_1) – Grass Second trophic level (T_2) – Rabbit Third trophic level (T_3) – Crow Fourth trophic level (T_4) – Vulture.

62. (b) The first phase of translation involves activation of amino acid in the presence of ATP and linked to their cognate tRNA - a process commonly called as charging of tRNA or aminoacylation of tRNA.

63. (c) Strobili or cones are found in *Equisetum*. Strobili or **cones** are the dense and compact structure **present** on non flowering plants. They contain sporangia and perform function of protecting spores from wild animals and harsh conditions of environment.

64. (d) Cyclostomes have an elongated body bearing 6-15 pairs of gill slits for respiration. The caudal fin is the tail fin located at the end of the caudal peduncle and is used for propulsion. See body-caudal fin locomotion. **Heterocercal** means the vertebrae extend into the upper lobe of the tail, making it longer (as in sharks). It is the opposite of hypocercal. Air bladder and poison string (for. e.g, *Trygon*) are found in Chondrichthyes as they have to swim constantly to avoid sinking.

65. (d) Some dividing cells exit the cell cycle and enter vegetative inactive stage, called quiescent stage (G_0). This process occurs at the end of M-phase and beginning of G_1 phase.

66. (b) Option (b) is correct as ileum is a highly coiled tube. Serosa is the outermost layer of the alimentary canal, thus, option (a) is an incorrect statement.
A narrow finger-like tubular projection, the vermiform appendix arises from caecum part of large intestine thus; option (c) is incorrect statement. Ileum opens into the large intestine, thus option (d) is also an incorrect statement.

67. (d) Option (d) is the answer because ART in which embryos are transferred, include ZIFT and IUT i.e. Zygote Intrafallopian Transfer and Intra Uterine Transfer respectively, both are embryo transfer (ET) methods.
Option (a), (b) and (c) are incorrect because in GIFT (Gamete Intrafallopian Transfer), gamete is transferred into the fallopian tube of female who cannot produce ova. ICSI is Intra cytoplasmic sperm injection in which sperm is directly injected into the ovum.

68. (c) The plant parts which consist of two generations one within the other are pollen grains inside the anther and embryo sac inside the ovule. Pollen grain is haploid inside the diploid anther. Embryo sac is haploid inside the diploid ovule.

69. (b) Dissolution of the synaptonemal complex occurs during diplotene stage of Prophase-I of Meiosis-I. The beginning of diplotene is recognised by the dissolution of the synaptonemal complex and the tendency of the recombined homologous chromosomes of the bivalents to separate from each other except at the sites of crossovers. These X-shaped structures are called chiasmata.

70. (b) Option (b) is correct because organ of Corti is located on the basilar membrane, thus (a) in column-I matches with (iv) in column-II. Cochlea, so (b) matches with (ii) in. The coiled portion of the labyrinth is called column II.

71. (c) The ovary is half inferior in Plum. A half-inferior ovary is embedded or surrounded by the receptacle. Such flowers are termed perigynous or half-epigynous. In some classifications, half-inferior ovaries are not recognized and are instead grouped with either the superior or inferior ovaries.

72. (b) Option (b) is the correct answer because lysine is a basic amino acid. Valine is a neutral amino acid. Glutamic acid is an acidic amino acid while Tyrosine is an aromatic amino acid.

73. (d) Option (d) is the correct answer because Eosinophils are associated with allergic reactions and release histaminase, Basophils secrete histamine, serotonin, heparin etc. and are involved in inflammatory reactions, Neutrophils are phagocytic cells; Both B and T lymphocytes are responsible for immune responses of the body.

74. (d) Option (d) is the correct answer because malonate is the competitive inhibitor of catalytic activity of succinic dehydrogenase, Collagen is proteinaceous in nature and possesses peptide bonds, Chitin is a homopolymer present in the cell wall of fungi and exoskeleton of arthropods, Abrin and Ricin are toxins, secondary metabolites.

75. (b) During G_1 phase the cell is metabolically active and continuously grows but does not replicate its DNA. DNA synthesis takes place in S phase. Nuclear division occurs during Karyokinesis. Reorganization of all cell components takes place in M-Phase.

76. (a) Spraying sugarcane crop with gibberellins increases the length of the stem, thus increasing the yield by as much as 20 tonnes per acre.

77. (b) ABO blood groups are controlled by the gene I. The gene I has three alleles I^A, I^B and i. The alleles I^A and I^B produce a slightly different form of the sugar while allele i does not produce any sugar because humans are diploid organisms, each person can possess at the most any two of the three I gene alleles.

78. (b) The correct option is (b) because active immunity is slow and takes time to give its full effective response in comparison to passive immunity where pre-formed antibodies are administered.

79. (a) The correct option is (a) because trypsinogen is activated by an enzyme, enterokinase, secreted by the intestinal mucosa into active trypsin. Trypsinogen is a zymogen from pancreas.

80. (d) The correct option is (d) because the specific palindromic sequence which is recognised by *Eco*RI is
5' - GAATTC - 3'
3' - CTTAAG - 5'

81. (d) The correct option is (d) because in Bt cotton the specific Bt toxin gene was isolated from *Bacillus thuringiensis*. The first clinical gene therapy was given in 1990 to a 4-year old girl with adenosine deaminase (ADA) deficiency. RNAi (RNA interference) takes place in all eukaryotic organisms as a method of cellular defense. PCR is now routinely used to detect HIV in suspected AIDS patients.

82. (d) Floridean starch is stored food material in red algae. Its structure is similar to Amylopectin and Glycogen.

83. (b) The correct option is (b) because functional insulin has A and B chains linked together by disulphide bridges.

84. (d) The correct option is (d) because flippers of Penguins and Dolphins are an example of analogous organs. Analogous structures are a result of convergent evolution.

85. (b) The correct option is (b) because herbicide resistant weeds, drug resistant eukaryotes and man-created breeds of domesticated animals like dogs are examples of evolution by anthropogenic action. Darwin's Finches of Galapagos islands are example of natural selection, adaptive radiation and founder's effect.

86. (b) The correct option is (b) because higher H+ concentration favours the dissociation of oxygen from oxyhaemoglobin in tissues. In the alveoli, high pO2, low pCO2, lesser H+ concentration and lower temperature favour formation of oxyhaemoglobin.

87. (d) In exponential growth, the initial growth is slow (lag phase) and it increases rapidly thereafter at an exponential rate in log or exponential phase.

88. (c) The largely tropical Amazon rain forest in South America has the greatest biodiversity on earth.

89. (a) The correct option is (a) because *ori* sequence is responsible for controlling the copy number of the linked DNA in the vector. Ori *i.e.* origin of replication is responsible for initiation of replication.

90. (c) The correct option is (c) because placenta secretes human chorionic gonadotropin (hCG). Zona pellucida is a primary egg membrane secreted by the secondary oocyte. The secretions of bulbourethral glands help in lubrication of the penis Leydig cells synthesise and secrete testicular hormones called androgens.
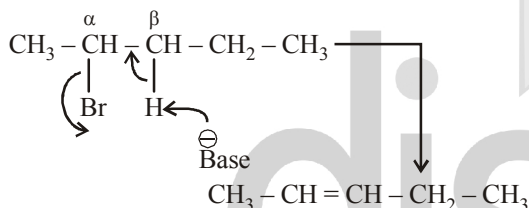
SECTION : CHEMISTRY

91. (b) Sucrose $\xrightarrow{\text{Hydrolysis}}$ α-D-Glucose + β-D-Fructose

α-D-Glucose   β-D-Fructose

92. (d)
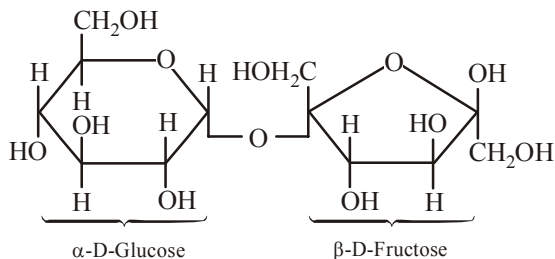
$$\overset{1}{C}H_3 - \overset{2}{C}H - \overset{3}{C}H_2 - \overset{4}{C}H_2 - \overset{5}{C}H_3 \xrightarrow{\text{Elimination}}$$
$$\underset{\substack{|\\Br\\\text{2-Bromo-pentane}}}{}$$

$$CH_3 - CH = CH - CH_2 - CH_3$$

Mechanism :

$$CH_3 - CH = CH - CH_2 - CH_3$$

It is an β elimination reaction as β hydrogen is abstracted and results more substituted alkene, which fallows Zaitsev's rule.

Since 'H' and 'Br' are removed, it is dehydro-halogenation.

93. (d) 1 equivalent of any substance is deposited by 1 F of charge.

20 g calcium contains,

$$\text{Number of equivalents} = \frac{\text{Given mass}}{\text{Equivalent mass}}$$

(Equivalent mass of Ca $= \dfrac{\text{Atomic mass}}{\text{Valency}} = \dfrac{40}{2} = 20$)

$$= \frac{20}{20} = 1$$

So, 1 Faraday of charge is required to deposit 1 equivalent of Ca.

94. (d) For bcc,

$$\sqrt{3}a = 4r \Rightarrow r = \frac{\sqrt{3}a}{4}$$

Given, $a = 288$ pm

$$r = \frac{\sqrt{3}}{4} \times 288 \text{ pm}$$

95. (a) When HCl is passed through the solution Cl⁻ ion concentration increases. Hence ionic product becomes more than solubility product. Only NaCl is crystallised due to less solubility than $MgCl_2$ and $CaCl_2$.

96. (d) $\underset{s}{Ni(OH)_2 \text{ (s)}} \rightleftharpoons \underset{s}{Ni^{2+} \text{ (aq)}} + \underset{2s}{2OH^- \text{ (aq)}}$

$$\underset{0.1}{NaOH\,(aq)} \longrightarrow \underset{0.1}{Na^+\,(aq)} + \underset{0.1}{OH^-\,(aq)}$$
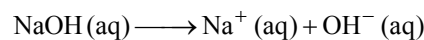
Total $(OH^-) = 2s + 0.1 \approx 0.1$

Ionic product $= (Ni^{2+})(OH^-)^2$

$$\Rightarrow 2 \times 10^{-15} = s(0.1)^2$$

$$\Rightarrow s = 2 \times 10^{-13} \text{ M}$$

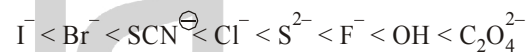**97.** (c) We know that, $Cl_2\,(g) \longrightarrow 2Cl(g)$ is endothermic reaction because it required energy to break bond.

So reverse reaction, $2Cl(g) \longrightarrow Cl_2\,(g)$ will be exothermic, $\Delta_r H < 0$.

Also, two gaseous atom combine together to form 1 gaseous molecule.

So, randomness decreases i.e., $\Delta_r S < 0$.

98. (d) According to spectrochemical series, the order of ligand field strength is

$$I^- < Br^- < SCN^\ominus < Cl^- < S^{2-} < F^- < OH < C_2O_4^{2-}$$
$$< H_2O < NCS^\ominus < EDTA^{4-} < NH_3 < en < \overset{\ominus}{C}N < CO$$
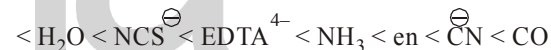
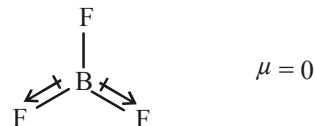So, correct order is $SCN^- < F^- < C_2O_4^{2-} < CN^-$

99. (a) Electronic configuration of $Cr^{2+} - [Ar]\,3d^4$

 $n = 4$

$$\mu_n = \sqrt{n(n+2)}$$

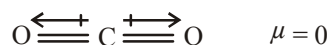$$\therefore \mu_n = \sqrt{4(4+2)} = \sqrt{24} \text{ BM} = 4.9 \text{ BM}$$

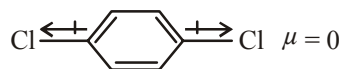**100.** (c) BF_3, BeF_2, CO_2 and 1, 4-dichlorobenzene all are symmetrical molecules.
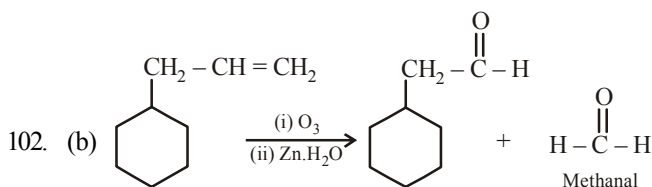
    $\mu = 0$
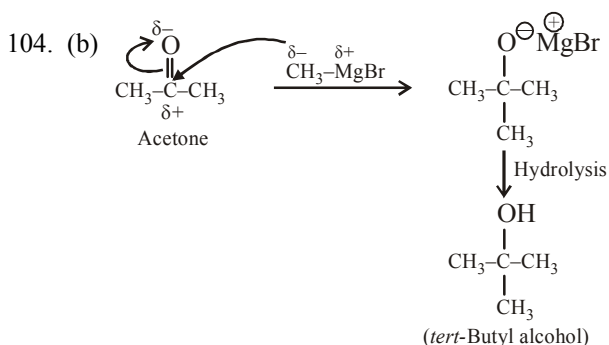
    $\mu = 0$

    $\mu = 0$

 $\mu = 0$

101. (c) Potassium (K) activates many enzymes to participate in oxidation of glucose to produce ATP and helps in the transmission of nerve signal along with Na.

102. (b)

103. (b) First order rate equation is $k = \dfrac{2.303}{t}\log\dfrac{[A_0]}{[A]}$

$$\Rightarrow 4.606 \times 10^{-3} = \dfrac{2.303}{t}\log\dfrac{2}{0.2}$$

$$\Rightarrow t = \dfrac{2.303}{4.606 \times 10^{-3}} \times \log 10 = \dfrac{10^3}{2} = 500 \text{ sec}$$

104. (b)

(*tert*-Butyl alcohol)

105. (d) *cis*-1,4-Polyisoprene is a nautral polymer.

106. (c)
(i) Dry ice, $CO_2(s)$, is used as refrigerant.
(ii) C_{60} contains 20 six membered rings, 12 five membered rings.
(iii) Ethanol, methanol and larger alcohols can be converted at 300-400° C in the presence of a zeolite catalyst (ZSM-5).

107. (d) Free expansion of ideal gas
$P_{ex} = 0$
$\therefore w = -P_{ex}\Delta V = 0$
$\because$ Adiabatic process $\Rightarrow q = 0$
$\Delta E = q + w$ (first law of thermodynamics)
$\therefore \Delta E = 0$
$\Delta E = nC_v dT \Rightarrow \Delta E = 0$
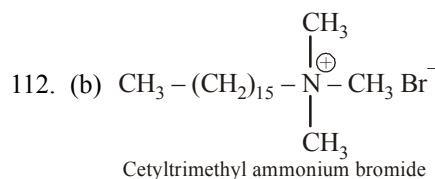So, $q = 0$, $\Delta T = 0$, $w = 0$.

108. (b)

Peroxodisulphuric acid

109. (b)
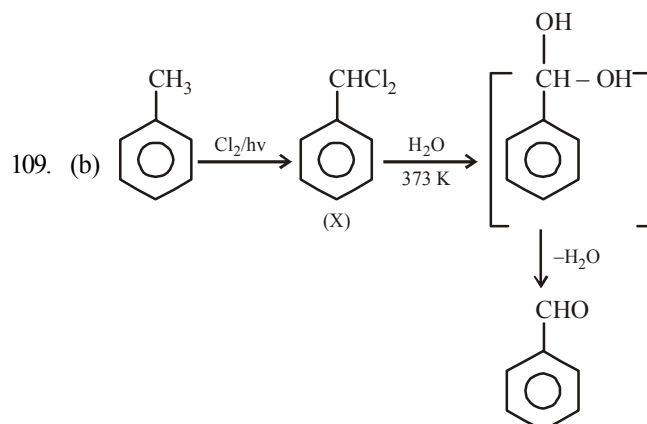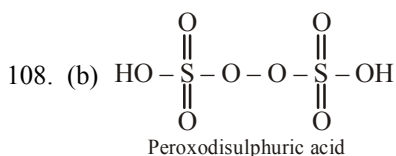
110. (d) $^{175}_{71}\text{Lu}$

No. of protons = No. of electrons = 71
No. of neutrons = Mass no. – No. of protons
$= 175 - 71 = 104$

111. (c) Oxidation state of Cr in CrO_4^{2-} and $Cr_2O_7^{2-}$ is + 6
i.e. oxidation states are same.

112. (b)

Cetyltrimethyl ammonium bromide

113. (b) $\Delta T_f = k_f m = 5.12 \times 0.078 = 0.399\,K = 0.40\,K$

114. (c) Unununium (Z = 111), it is Roentgenium (Rg) not Darmstadtium.

115. (d) Hydron bond of ethanol gets weakened by addition of acetone. Thus the mixture of ethanol and acetone show positive deviation from Roult's law.

116. (a) CO : Neutral oxide
BaO : Basic oxide
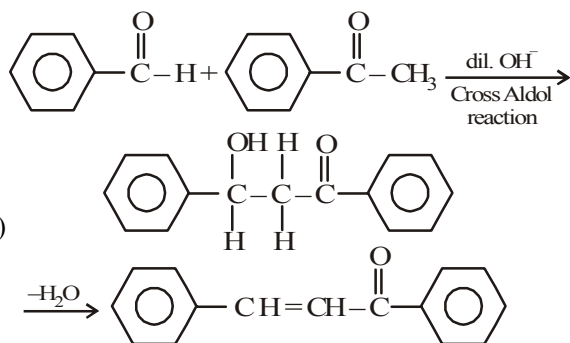Al_2O_3 : Amphoteric oxide
Cl_2O_7 : Acidic oxide

117. (c) Number of atoms $= \dfrac{W}{\text{Molar mass}} \times N_A \times$ atomicity

(a) Number of Mg atoms $= \dfrac{1}{24} \times N_A \times 1$

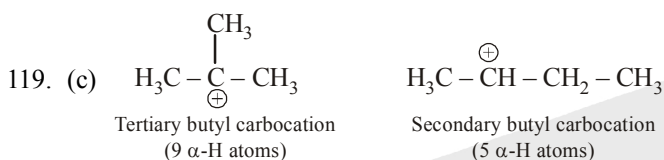(b) Number of O atoms $= \dfrac{1}{32} \times N_A \times 2$

(c) Number of Li atoms $= \dfrac{1}{7} \times N_A \times 1$

(d) Number of Ag atoms $= \dfrac{1}{108} \times N_A \times 1$

118. (c)

In the presence of dil. NaOH, C_6H_5CHO and $C_6H_5COCH_3$ will react to undergo cross-aldol condensation.

119. (c)

Tertiary butyl carbocation (9 α-H atoms)

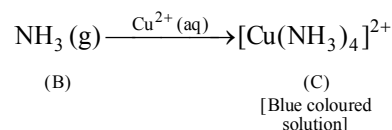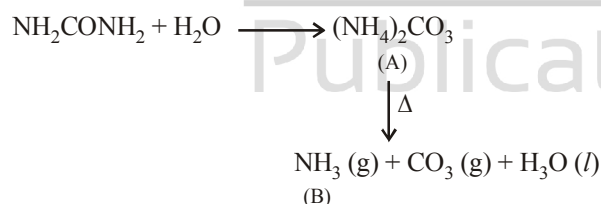Secondary butyl carbocation (5 α-H atoms)

t-Butyl carbocation is more stable due to hyper-conjugation.

120. (b) The carboxyhaemoglobin (haemoglobin bound to CO), is about 300 times more stable than oxygaemoglobin.

121. (c)

$$H_2N - (CH_2)_4 - \underset{\underset{NH_3}{\overset{+}{|}}}{CH} - COO^-$$

Lysine
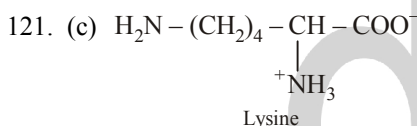
Since it contains more number of –NH$_2$ groups as compared to –COOH groups, hence it is basic amino acid.

122. (a)

$$NH_2CONH_2 + H_2O \longrightarrow \underset{(A)}{(NH_4)_2CO_3}$$

$$\downarrow \Delta$$

$$\underset{(B)}{NH_3 \, (g) + CO_3 \, (g) + H_3O \, (l)}$$

$$\underset{(B)}{NH_3 \, (g)} \xrightarrow{Cu^{2+} \, (aq)} \underset{\underset{[Blue \, coloured \, solution]}{(C)}}{[Cu(NH_3)_4]^{2+}}$$

123. (b) $n_{N_2} = \dfrac{7}{28} = \dfrac{1}{4} = 0.25$

$n_{Ar} = \dfrac{8}{40} = \dfrac{1}{5} = 0.20$

Now, applying Dalton's law of partial pressure,

$p_{N_2} = (\text{mole fraction})N_2 \cdot P_{Total}$

$\dfrac{0.25}{0.45} \times 27 = \dfrac{5}{9} \times 27 = 15$ bar

124. (c) The iron obtained from blast furnace contains about 4% carbon and smaller amount of impurities like S, P, Si, Mn. This form of iron is known as pig iron. It can be moulded into variety of shapes.

125. (d) $\Delta G = \Delta G^o + RT \ln Q$

At equilibrium $\Delta G = 0$, $Q = K_{eq}$

So, $\Delta_r G^o = -RT \ln K_{eq}$

$\Delta_r G^o = -8.314 \text{ J mol}^{-1} \text{ K}^{-1} \times 300 \text{ K} \times \ln(2 \times 10^{13})$

126. (d) For He$_2$ molecule, Electronic configuration is $\sigma 1s^2$, $\sigma *1s^2$

Bond order $= \dfrac{1}{2}(N_b - N_a) = \dfrac{1}{2}(2-2) = 0$

Since, bond order of He$_2$ is zero, so it does not exist.

127. (c) The number of collisions per second per unit volume of the reaction mixture is known as collision frequency (Z) collision frequency $\propto$ no. of reacting molecules or atoms. Higher the concentration of reactant molecules higher is the probability of collision and so the collision frequency.

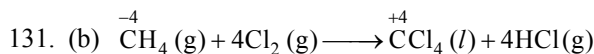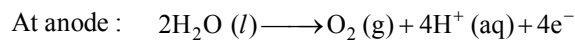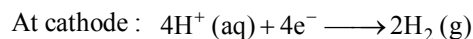**128. (b)** Wurtz reaction is used to prepare symmetrical alkanes like R$_1$ – R$_1$, as

$$R_1 - X + 2Na + X - R_1 \xrightarrow{\text{Dry ether}} R_1 - R_1 + 2NaX$$
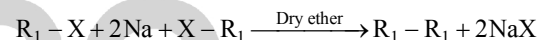
If R$_1$ and R$_2$ are different, then mixture of alkanes may be obtained as

$$R_1 - X + 2Na + R_2 - X \xrightarrow{\text{Dry ether}}$$
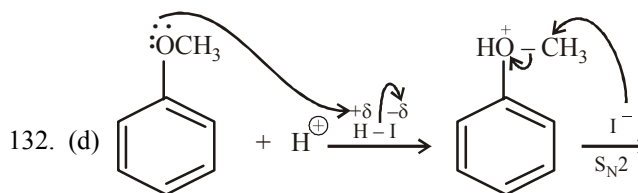
$$R_1 - R_1 + R_1 - R_2 + R_2 - R_2 + 2NaX$$
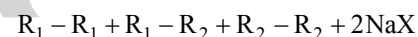
Hence, n-heptane cannot be made in good yield using Wurtz reaction, since it is unsymmetrical alkene.
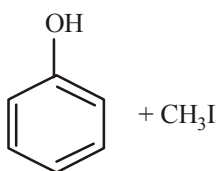
129. (d) Aliphatic and aromatic primary amines give carbylamine reaction. Since aniline is primary aromatic amine it gives carbylamine test.

130. (a) During the electrolysis of dil. sulphuric acid using Pt electrodes following reaction occurs.

At cathode : $4H^+ \, (aq) + 4e^- \longrightarrow 2H_2 \, (g)$

At anode : $2H_2O \, (l) \longrightarrow O_2 \, (g) + 4H^+ \, (aq) + 4e^-$

131. (b) $\overset{-4}{C}H_4 \, (g) + 4Cl_2 \, (g) \longrightarrow \overset{+4}{C}Cl_4 \, (l) + 4HCl(g)$

Change in oxidation state of carbon is –4 to +4.

132. (d)

(structure of phenol)

OH

(benzene ring) $+ CH_3I$

133. (b) In colloidal solution, the potential difference between the fixed layer and the diffused layer of opposite charge is known as Zeta potential.

Greater the Zeta potential more will be the stability of colloidal particle.

134. (a) Paper chromatography is a type of partition chromatography.

135. (d) (A) Water gas is a mixture of combustible gases (CO and H_2).

(B) Temporary hardness of water is due to bicarbonates of calcium and magnesium. It can be removed by boiling of water.

(C) Diborane (B_2H_6) is an electron deficient hydride.

(D) Hydrogen peroxide (H_2O_2) is a non-planar molecule with (twisted symmetry). It is non-planar, non-linear molecule with a open book structure.

SECTION : PHYSICS

136. (b) When L is removed,
Phase difference

$$\tan\phi = \frac{|X_C|}{R} = \tan\frac{\pi}{3} = \frac{X_C}{R} \qquad ...(1)$$

When C is removed,
Phase difference

$$\tan\phi = \frac{|X_L|}{R} = \tan\frac{\pi}{3} = \frac{X_L}{R} \qquad ...(2)$$

From eqs. (1) and (2), $X_L = X_C$

Since, $X_L = X_C$, the circuit is in resonance.
In this case, $Z = R$

∴ Power factor, $\cos\phi = \frac{R}{Z} = 1$.

137. (c) Stress $= \dfrac{\text{force}}{\text{cross-section area}} = \dfrac{Mg}{A}$

Strain $= \dfrac{\text{change in length}}{\text{original length}} = \dfrac{\Delta L}{L} = \dfrac{L_1 - L}{L}$

Young's modulus, $Y = \dfrac{\text{stress}}{\text{strain}} = \dfrac{MgL}{A(L_1 - L)}$

138. (d) Magnetic field at the centre of solenoid,

$$B_{\text{solenoid}} = \mu_0 nl$$

Given : No. of turns / length,

$$n = \frac{N}{L} = \frac{100}{50 \times 10^{-2}} = 200 \text{ turns/ m}$$
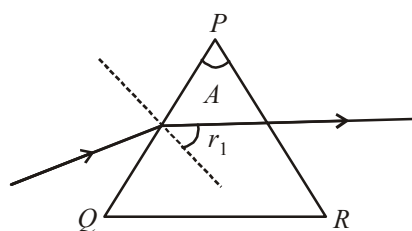
Current, $I = 2.5$ A

$$\therefore B_{\text{solenoid}} = \mu_0 nI = 4\pi \times 10^{-7} \times 200 \times 2.5$$

$$= 6.28 \times 10^{-4} \text{ T}$$

139. (b) Light ray emerges normally from another surface, hence, e (angle of emergence) $= 0$

$$\therefore r_2 = 0$$

$$r_1 + r_2 = A \Rightarrow r_1 = A$$

$$\mu_1 \cdot \sin i = \mu_2 \cdot \sin r$$

Applying Snell's law on first surface PQ

$$\Rightarrow 1 \cdot \sin i = \mu \cdot \sin r_1 \Rightarrow \sin i = \mu \sin A$$

For small angles $(\sin\theta \approx \theta)$

$$\therefore \quad i = \mu A$$

140. (d) Since, electric potential is constant throughout the volume, hence electric field, $E = -\dfrac{dV}{dr} = 0$.

141. (c) Bohr model is only valid for single electron species i.e., Hydrogen or hydrogen like atom – He^+, deuteron, etc. Singly ionised neon atom has more than one electron in orbit. Hence, Bohr model is not valid.

142. (b) Using intensity, $I = \dfrac{E}{At}$

$$\Rightarrow E = IAt = \frac{20}{10^{-4}} \times 20 \times 10^{-4} \times 60 = 24 \times 10^3 \text{ J}$$

143. (c) Using, $\lambda = \dfrac{12.27}{\sqrt{V}}\text{Å}$

$$\Rightarrow \sqrt{V} = \frac{12.27 \times 10^{-10}}{1.227 \times 10^{-11}} = 10^2$$

[Given, $\lambda = 1.227 \times 10^{-11}$ m]

$$\therefore V = 10^4 \text{ volt}$$

144. (a) Weight of a body on the surface of the earth,
$$W_S = mg = 72 \text{ N}$$
Acceleration due to gravity, g varies with height,

$$h = \frac{R}{2} \text{ (given)}$$

$$W_h = \frac{mgs}{\left(1+\dfrac{h}{R}\right)^2} = \frac{72}{\left(1+\dfrac{R/2}{R}\right)^2} = \frac{72}{(3/2)^2}$$

$$= \frac{4}{9} \times 72 = 32 \text{ N}$$

145. (b) For metals like copper, at temperature much lower than 0°C, graph deviates considerably from a straight line.

146. (c) For photoelectric emission, photoelectric current, incident light frequency should be greater than threshold frequency.

Light of frequency 1.5 times the threshold frequency v_0 incident.

$$v = \frac{3}{2}v_0$$

If frequency is halved,

$$\therefore v' = \frac{v}{2} = \frac{3}{4}v_0 \qquad\qquad (\because v' < v_0)$$

$\therefore$ No photoelectric emission will take place.

147. (b) Given :
Capacitance, $C = 40\ \mu\text{F} = 40 \times 10^{-6}$ F
Frequency, $f = 50$ Hz
$\therefore \omega = 2\pi f = 100\pi$

$\varepsilon_{rms} = 200$ V

$$\therefore I_{rms} = \frac{\varepsilon_{rms}}{X_C} = \frac{\varepsilon_{rms}}{\dfrac{1}{C\omega}}$$

$$= 200 \times 40 \times 10^{-6} \times 2\pi \times 50 = 2.5 \text{ A}.$$
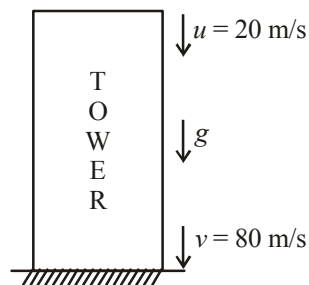
148. (d) Given :

Wavelength, $\lambda = 600$ nm $= 600 \times 10^{-9}$ m

and diameter of objective, $d = 2$ m
Limit of resolution of telescope,

$$\theta = \frac{1.22\lambda}{d} = \frac{1.22 \times 600 \times 10^{-9}}{2} = 3.66 \times 10^{-7} \text{ rad}$$

149. (c)

Using $v^2 = u^2 + 2gh$

Height, $h = \dfrac{v^2 - u^2}{2g} = \dfrac{(80)^2 - (20)^2}{2 \times 10}$

$$= \frac{6400 - 400}{20} = 300 \text{ m}$$

150. (a) Given : Pressure $P = 249\ kPa = 249 \times 10^3$ N/m^2
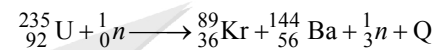Mass of hydrogen, $M = 2g = 2 \times 10^{-3}$ kg
Temperature, $T = 27 + 273 = 300$ K
Using, ideal gas equation, $PV = nRT$

$$PM = \rho RT \Rightarrow \rho = \frac{PM}{RT} \qquad\qquad \left(\because \rho = \frac{M}{V}\right)$$

$$\therefore \rho = \frac{(249 \times 10^3)(2 \times 10^{-3})}{8.3 \times 300} = 0.2 \text{ kg/m}^3.$$

151. (d) It is a nuclear fission reaction.

$$^{235}_{92}\text{U} + {}^{1}_{0}n \longrightarrow {}^{89}_{36}\text{Kr} + {}^{144}_{56}\text{Ba} + {}^{1}_{3}n + \text{Q}$$

152. (a) Due to reverse biasing, the width of the depletion region increases in a *p-n* junction diode.

153. (d) Displacement equation of a SHM

$$y = A\sin(\omega t + \phi)$$

$$\therefore \text{ Velocity, } v = \frac{dy}{dt} = A\omega\cos(\omega t + \phi)$$

$$\text{Acceleration, } a = \frac{dv}{dt}$$

$$\text{or, } a = -A\omega^2\sin(\omega t + \phi)$$

$$\therefore a = A\omega^2\sin(\omega t + \phi + \pi)$$

Hence, phase difference between displacement and acceleration is π.

154. (d) Given : Magnetic susceptibility of iron, $\chi_m = 599$

Using, $\mu_r = 1 + \chi_m = 600$

$\mu = \mu_r\mu_0 = 600 \times 4\pi \times 10^{-7} = 2400\pi \times 10^{-7}$
Hence, permeability of the material of the rod,

$$\mu = 2.4\pi \times 10^{-4} \text{ T m A}^{-1}$$

155. (d) Heat supplied, $\Delta Q = ms\Delta T$

$$\Delta Q = \frac{4}{3}\pi r^3 \rho s\Delta T \qquad\qquad \left[\because \rho = \frac{m}{v}\ \&\ V = \frac{4}{3}\pi r^3\right]$$

or $\Delta Q \propto r^3$

$$\therefore \frac{\Delta Q_1}{\Delta Q_2} = \left(\frac{r_1}{r_2}\right)^3 = (1.5)^3 = \frac{27}{8}$$

156. (b) Given : Mass $m_1 = 4$ kg and $m_2 = 6$ kg.
Acceleration of the system,

$$a = \frac{(m_1 - m_2)g}{(m_1 + m_2)} \text{ where } m_1 > m_2$$

$$\therefore a = \frac{(6-4)g}{6+4} = \frac{g}{5}$$

157. (a) Mean free path for a gas $\lambda_m = \dfrac{1}{\sqrt{2}n\pi d^2}$

Here, d = diameter of a gas molecule and, n = molecular density.

158. (a) Given,

Dipole moment of short electric dipole,

$p = 16 \times 10^{-9}$ C m.

Distance from centre of dipole, $r = 0.6$ m

Electric potential, $V = \dfrac{kp\cos\theta}{r^2}$

$\Rightarrow V = \dfrac{9 \times 10^9 \times 16 \times 10^{-9} \times \cos 60}{0.36} = 200$ V

159. (c) Stress $= \dfrac{\text{Force}}{\text{Area}}$

Dimension of force = $[MLT^{-2}]$
Dimension of area = $[L^2]$

$\therefore$ Stress $= \dfrac{[MLT^{-2}]}{[L^2]} = [ML^{-1}T^{-2}]$

160. (b) One electron volt (1 eV) is the energy gained by electron moving through a potential difference of 1 V.

$\therefore$ 1 eV = 1.6×10^{-19} J

$\Rightarrow 1$ J $= \dfrac{1}{1.6 \times 10^{-19}}$ eV

$\Rightarrow 10^{-20}$ J $= \dfrac{10^{-20}}{1.6 \times 10^{-19}}$ eV $= 0.06$ eV

161. (a) Frequency of string, $f = \dfrac{1}{2l}\sqrt{\dfrac{T}{m}}$

Frequency $\propto \sqrt{\text{Tension}}$

Difference of f_A and f_B is 6 Hz.
If tension decreases, f_B decreases and becomes f'_B.
Now, difference of f_A and f'_B = 7 Hz (increases)

So, $f_A > f_B$

$f_A - f_B = 6$ Hz

$\Rightarrow f_A = 530$ Hz $\Rightarrow f_B = 524$ Hz (original)

162. (c) According to colour coding -

Yellow	Violet	Brown	Gold
4	7	1	5%

First colour gives first digit, second colour gives the second digit and third colour gives the multiplier and fourth colour gives tolerance.

$\therefore$ Resistance, $R = 47 \times 10^1 \pm 5\% = 470 \pm 5\%\Omega$

163. (b) According to Brewster's law, when a beam of unpolarised light is reflected from a transparent medium of refractive index (μ_2), the reflected light is completely polarised at certain angle of incidence called the angle of polarisation (i_b).

$\tan i_b = \dfrac{\mu_2}{\mu_1}$

For air, $\mu_1 = 1$

$\therefore \tan i_b = \mu_2 > 1$

$\Rightarrow \tan i_b > 1 \Rightarrow 90° > i_b > 45°$

164. (b) Capacitance of a parallel plate capacitor with air is

$C = \dfrac{\varepsilon_0 A}{d}$ . . . (i)

Here, A = area of plates of capacitor,
d = distance between the plates

Capacitance of a same parallel plate capacitor with introduction of dielectric medium of dielectric constant K is

$C' = \dfrac{K\varepsilon_0 A}{d}$ . . . (ii)

Dividing (ii) by (i)

$\Rightarrow \dfrac{C'}{C} = K \Rightarrow \dfrac{30}{6} = K \Rightarrow K = 5$

$\Rightarrow K = \dfrac{\varepsilon}{\varepsilon_0}$

$\Rightarrow \varepsilon = K\varepsilon_0 = 5 \times 8.85 \times 10^{-12}$
$= 0.44 \times 10^{-10}$ C^{2}N^{-1}m^{-2}

165. (b) Given :

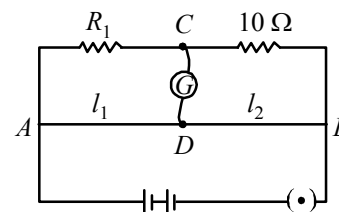Force, $\vec{F} = 3\hat{j}$ N

Position vector, $\vec{r} = 2\hat{k}$ m

Torque, $\vec{\tau} = \vec{r} \times \vec{F} = 2\hat{k} \times 3\hat{j} = 6(\hat{k} \times \hat{j}) = 6(-\hat{i})$

$\Rightarrow \vec{\tau} = -6\hat{i}$ Nm

166. (a) Let R_1 be the resistance of resistance wire.

From the balancing condition of metre bridge,

$\dfrac{R_1}{10} = \dfrac{\ell_1}{\ell_2} = \dfrac{3}{2} \Rightarrow R_1 = \dfrac{30}{2} = 15\Omega$
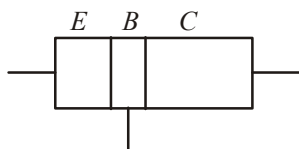
Length of 15Ω resistance wire is 1.5 m.

$\therefore$ Length of 1 Ω resistance wire

$= \dfrac{1.5}{15} = 0.1$ m $= 1.0 \times 10^{-1}$ m

167. (c) In a transistor, emitter is heavily doped, the base region is lightly doped and thin. The size of collector region is larger than other two regions.

Length profile in transistor is $L_C > L_E > L_B$ and doping profile in transistor is $E > C > B$.
For transistor action Base-emitter junction is forward biased and Base-collector junction is reversed biased.

168. (a) The energy in electromagnetic wave is divided equally between the electric and magnetic field.

So, in an electromagnetic wave, half of the intensity is provided by the electric field and half by the magnetic field.

Hence, required ratio should be 1 : 1.

169. (a) Given,

Drift velocity of charged particle, $V_d = 7.5 \times 10^{-4}$ m/s

Electric field, $E = 3 \times 10^{-10}$ Vm^{-1}

Mobility, $\mu = \dfrac{V_d}{E} = \dfrac{7.5 \times 10^{-4}}{3 \times 10^{-10}} = 2.5 \times 10^{6}$ m^{2}V^{-1}s^{-1}

170. (a) If the charge on a spherical conductor of radius R is Q, then electric field at distance r from centre is

$E = 0$ (if $r \angle R$)

$E = \dfrac{1}{4\pi \in_0} \dfrac{Q}{r^2}$ (if $r \geq R$)

Electric field at a distance 15 cm from the centre of sphere will be

$E = \dfrac{9 \times 10^9 \times 3.2 \times 10^{-7}}{225 \times 10^{-4}} = 0.128 \times 10^6 = 1.28 \times 10^5$ N/C

171. (a) In subtraction the number of decimal places in the result should be equal to the number of decimal places of that term in the operation which contain lesser number of decimal places.

$$
\begin{array}{r}
9.99 \\
-0.0099 \\
\hline
9.9801
\end{array}
$$

As the least number of decimal places is 3. So, answer should be 9.98 m.

172. (b) Fringe width $\beta = \dfrac{\lambda D}{d}$

Here, λ = wavelength of light from coherent sources,
     D = distance of screen from the coherent sources,
     d = separation between coherent sources

When, $d' = \dfrac{d}{2}$ and $D' = 2D$

New Fringe width, $\beta' = \dfrac{\lambda(2D)}{d/2} = \dfrac{4\lambda D}{d}$

$\Rightarrow \beta' = 4\beta$

Fringe width becomes 4 times.

173. (a) Entire system is thermally insulated. So, no heat exchange with surrounding will take place. Hence, process will be adiabatic.

174. (a) From the Einstein's mass-energy equivalence, the relation between the mass of a substance m and its energy E is

$E = mc^2$

Here, c = speed of light

$\therefore E = 0.5 \times 10^{-3} \times (3 \times 10^8)^2 = 0.5 \times 10^{-3} \times 9 \times 10^{16}$

$= 4.5 \times 10^{13}$ J.

175. (b) Force of surface tension balances the weight of water in capillary tube.

$F_S = 2\pi rT\cos\theta = mg$

Here, T and θ are constants.

So, $m \propto r$

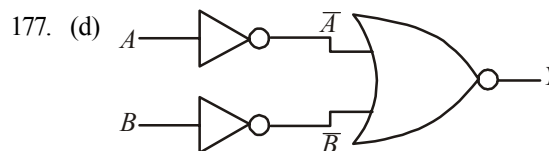Let m_1 and m_2 be the mass of water in two capillary tube.

$\therefore \dfrac{m_2}{m_1} = \dfrac{r_2}{r_1}$

$\Rightarrow \dfrac{m_2}{5.0} = \dfrac{2r}{r}$ $(\because r_2 = 2r)$

$\Rightarrow m_2 = 10.0$ g

176. (b) Least count of screw gauge = 0.01 mm

$\text{Least count} = \dfrac{\text{Pitch}}{\text{No. of divisions on circular scale}}$

$\Rightarrow 0.01$ mm $= \dfrac{\text{Pitch}}{50}$

$\Rightarrow$ Pitch = 0.5 mm

177. (d)

$Y = \overline{\overline{A} + \overline{B}} = \overline{\overline{A} \cdot \overline{B}} = A \cdot B \Rightarrow$ AND Gate

Truth Table is :

A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

178. (a) From the law of equipartition of energy, energy associated with each degree of freedom is $\frac{1}{2}kT$

For monoatomic gases, degree of freedom is 3. Hence average thermal energy for mono-atomic gas is

$$KE_{avg} = 3 \times \frac{1}{2}k_BT = \frac{3}{2}k_BT$$

179. (c) For metals temperature coefficient of resistance is positive while for insulators and semiconductors, temperature coefficient of resistance is negative.

180. (b)
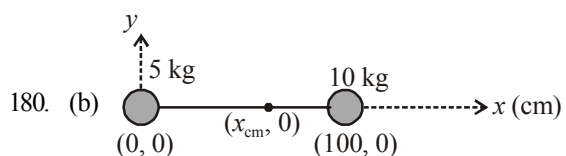
Centre of mass of a system of two particles of masses m_1 and m_2 having position vectors $\vec{x_1}$ and $\vec{x_2}$ is

$$x_{cm} = \frac{m_1x_1 + m_2x_2}{m_1 + m_2}$$

Taking particle of mass 5 kg at origin.

$$\Rightarrow x_{cm} = \frac{5 \times 0 + 100 \times 10}{5 + 10} = \frac{200}{3} = 66.66 \text{ cm}$$

$$\Rightarrow x_{cm} = 67 \text{ cm}$$