Reference Guide For The Pharmacy College Admission Test - PCAT

Second Edition 2010-2011

By Manan H. Shroff

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Second Edition 2010-2011

Dedicated To
My beloved
grandfather

PREFACE:

I am very pleased to introduce a review guide for the PCAT (Pharmacy College Admission Test). So far, I have written pharmacy licensing review books related to the NAPLEX, FPGEE and PTCE.

This review guide covers verbal ability, biology, chemistry and mathematics in order to prepare you for your exam. The detailed explanations in each of these sections will help make you familiar with the exam content and hopefully help you to ultimately succeed in earning an excellent score.

Each answer is explained thoroughly to refresh your memory on specific topics. Please do not go through only the questions and answers. Try to understand and learn the reason for each specific answer, and grasp the explanation in order to improve your comprehension skills for other questions. It is the most productive and efficient way to get the most out of this review guide.

I hope my efforts will help you to pass your key exam. As always, any questions or comments are welcome.

Good Luck,

MANAN H. SHROFF

TABLE OF CONTENTS

Biology

1. Which of the following organelles helps green plants synthesize organic compounds like starch in the presence of sunlight?

a. Mitochondria
b. Chloroplast
c. Ribosomes
d. Golgi body

2. Which of the following is described as the "power house of the cell?"

a. Endoplasmic reticulum
b. Ribosomes
c. Mitochondria
d. Vacuoles

3. Production of ATP is defined as a(n):

a. Exothermic reaction
b. Endothermic reaction
c. Uniforming reaction
d. Interacting-absorbing reaction

4. Which of the following is described as a physical basis of life?

a. Protoplasm
b. Chloroplast
c. Ribosomes
d. Nucleus

5. Virus should be classified as:

a. Akaryotic
b. Eukaryotic
c. Prokaryotic
d. Nokaryotic

6. Which of the following is NOT present in prokaryotic organisms but is present in eukaryotic organisms?

a. Cell wall
b. Plasma membrane
c. Ribosome
d. Nucleolus

7. Endoplasmic reticulum is visible in the cytoplasm of all the Eukaryotic cells EXCEPT:

a. Amoeba
b. Yeast
c. Mushroom
d. Sperm

8. Which of the following is the major source of digestive enzymes?

a. Golgi body
b. Mitochondria
c. Lysosome
d. Chloroplast

9. The oxidation of one glucose molecule will generate how many molecules of ATP during one Kreb's cycle?

a. 16
b. 22
c. 38
d. 2

10. Which of the following molecules play an important role in the process of photosynthesis?

a. Grana
b. Thylakoids
c. Lamellae
d. Chlorophyll

11. Which of the following is an essential organelle for survival of a cell?

a. Mitochondria
b. Nucleus
c. Lysosome
d. Nucleolemma

12. Which of the following differentiates the nucleus from the cytoplasm?

a. Ribosomes
b. Nucleus
c. Vacuoles
d. Nucleolemma

13. A plant cell wall is normally formed of:

a. Chlorophyll
b. Cellulose
c. Chitin
d. Periactin

14. A small saclike structure filled with liquid and appearing like small dots in the cytoplasm is known as:

a. Chromosomes
b. Nucleus
c. Vacuoles
d. Nucleolus

15. In the process of Mitosis, if the number of chromosomes in the mother cell is designated as 2n, how many chromosomes will be present in each daughter cell?

a. 2n
b. n
c. 4n
d. 8n

16. In which stage of the cell cycle is the cell synthesizing its structural proteins and enzymes to perform its functions?

a. S phase
b. G_1 phase
c. G_2 phase
d. G_3 phase

17. How many chromosomes will be present in red blood cells of humans?

a. 46
b. 23
c. 92
d. 0

18. In the prophase of mitosis, the protoplasm forms ray-like structures surrounding each centrosome known as:

a. Chromatid
b. Centromere
c. Asters
d. Karyokinesis

19. How many number of chromosomes are found in sex cells of humans?

a. 92
b. 46
c. 23
d. 0

20. Which of the following is the basic unit of classification?

a. Genus
b. Species
c. Family
d. Class

21. Blue green algae should be classified under which of the following living kingdoms?

a. Monera
b. Protista
c. Metaphyta
d. Metazoa

22. All of the following are TRUE about the Monera kingdom EXCEPT:

a. Monera are so small in size that they can be only seen with the help of a microscope.

b. Organisms found in this kingdom have cell walls surrounding the cell.

c. Mitochondria, endoplasmic reticulums, and Golgi bodies are present in the cytoplasm of Monera organisms.

d. A Monera organism contains primitive nucleis in their cytoplasm.

23. Which of the following portions of the bacteriophage play an important role in transferring genetic information?

a. Capsid
b. Core
c. Tail
d. Tail fibers

24. There are very minute hair-like processes that are present on the cell wall of E.coli. These processes are known as:

a. Pili
b. Flagella
c. Cilia
d. Plasmids

24A. Microorganisms that convert complex organic compounds into simple inorganic compounds are known as:

a. Transformers
b. Dictators
c. Decomposers
d. Protectors

25. Nitrogen fixing bacteria on root nodules of Leguminous plants are known as:

a. Azobacteria
b. Nanobacteria
c. Rhizobium bacteria
d. Mycobacteria

26. Red is the dominant color for flowers, and white is the recessive color. What percentage of the second generation offspring is expected to be white heterozygous if the homozygous red flower is crossed with a homozygous white flower?

a. 50%
b. 75%
c. 25%
d. 100%

27. Which of the following cells of humans contain multiple alleles?

a. RBC
b. WBC
c. Thrombocytes
d. Eosinophils

28. Which of the following characteristics in a human is due to a condition known as polygenetic inheritance?

a. Skin color
b. Strength of the bone
c. Nail of middle finger
d. Free earlobes

29. Due to a sex-linked trait, which of the following disorders is more frequently seen in men compared to women?

a. Hypertension
b. Colorblindness
c. Hemophilia
d. Both B and C

30. Which of the following is the building block of nucleic acids?

a. Protein
b. Amino acids
c. Starch
d. Nucleotides

31. If one of the chains of the DNA has the sequence of nitrogen bases AAGCC, what would be the sequence of nitrogen bases on the other chain?

a. CCAGG
b. GCATT
c. TTCGG
d. GGATT

32. Which of the following nitrogen bases is present in RNA but absent in DNA?

a. Cytosine
b. Uracil
c. Guanine
d. Adenine

33. Which of the following types of RNA is used to synthesize ribosomes?

a. r RNA
b. t RNA
c. m RNA
d. u RNA

34. Hydrolysis of a molecule of maltose yields:

a. glucose + glucose
b. glucose + galactose
c. glucose + fructose
d. fructose + lactose

35. Which of the following components of a starch is insoluble in water?

a. Amylose
b. Amylodextrin
c. Amylopectin
d. Amylase

36. Which of the following polysaccharides is largely stored in the liver and muscles?

a. Cellulose
b. Starch
c. Glycogen
d. Inulin

37. Which of the following alcohol is a principal constituent of a lipid?

a. Ethanol
b. Methanol
c. Glycerol
d. Butanol

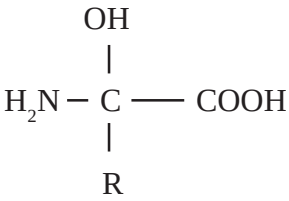
38. Which of the following steroids contains hydroxyl (-OH) groups but does not contain any carboxyl (-COOH) or keto (> C = O) groups?

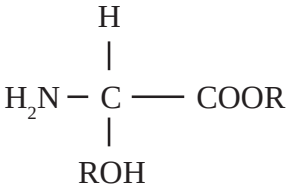
a. Cholesterol
b. Progesterone
c. Cortisone
d. Cortisol

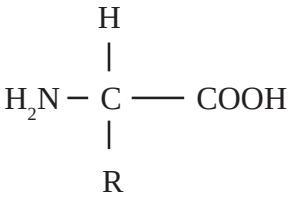
39. Upon oxidation one gram of fat provides:

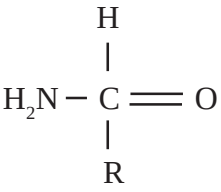
a. 4 calories
b. 9 calories
c. 7 calories
d. 5 calories

40. Which of the following is the general formula for amino acid?

a. 

b. 

c. 

d. 

41. In a protein, two amino acids are linked together by:

a. Hydrogen bond
b. Peptide bond
c. London forces
d. Van Der Walls force

42. Which of the following proteins is found in the hair and nails of humans?

a. Casein
b. Actin
c. Melanin
d. Keratin

43. What is a nonprotein moiety of chlorophyll?

a. Iron
b. Carbohydrate
c. Magnesium
d. Lipid

44. Some enzymes become active only in the presence of certain substances. These substances are known as:

a. Proenzymes
b. Coenzymes
c. Prenzymes
d. Retroenzymes

45. The final product of anaerobic respiration is:

a. Carbon dioxide
b. Water
c. Glucose
d. Lactic acid

46. How many molecules of ATP are formed in the process of glycolysis from one molecule of glucose?

a. 2
b. 4
c. 6
d. 8

47. For the complete oxidation of one molecule of glucose, how many Krebs cycles are required?

a. 2
b. 4
c. 6
d. 8

48. In animals, polygonal cells with straight margins are present in all of the following EXCEPT:

a. Peritoneum
b. Wall of blood vessels
c. Epidermis
d. Wall of Bowman's capsules

49. The inner lining of the alveoli of lungs consists of which of the following tissues?

a. Squamous epithelium
b. Cuboidal epithelium
c. Ciliated epithelium
d. Columnar epithelium

50. The cells from the inner lining of hepatic ducts, bile ducts and ureters are classified as:

a. Squamous epithelium
b. Cuboidal epithelium
c. Ciliated epithelium
d. Columnar epithelium

51. Blood should be classified as:

a. Stratified epithelial tissue
b. Connective tissue proper
c. Liquid connective tissue
d. Skeletal tissue

52. What is the structural and functional unit of a striated muscle fiber?

a. Myofibrils
b. Sarcolemma
c. Krause's membrane
d. Sacromere

53. Cyton is the principal component of the:

a. Neuron
b. Liver
c. Heart
d. Kidney

54. A cell process that carries impulses away from the cyton is known as:

a. Myelin sheath
b. Nissl's granules
c. Axon
d. Dendron

55. A constriction in the myelin sheath, occurring at varying intervals along the length of a nerve fiber, is called:

a. Neuraxon
b. Schwann's cell
c. Myelin sheath
d. Node of Ranvier

56. Which of the following enzymes is required for the synthesis of m-RNA?

a. DNA ligase
b. RNA polymerase
c. DNA polymerase
d. RNA isomerase

56A. The type of chromosome in which the centromere is in the center and all four chromatids are of equal length is known as:

a. Metacentric
b. Submetacentric
c. Acrocentric
d. Telocentric

57. Turner Syndrome is a genetic disorder normally seen in females, the 23rd pair of chromosomes of will be:

a. XX
b. XY
c. X
d. YX

58. Which of the following muscles are controlled by the somatic nervous system?

a. Skeletal muscles
b. Cardiac muscles
c. Visceral muscles
d. None of the above

59. The hardness of bone structure is due to the presence of:

a. Water
b. Organic solids
c. Inorganic acids
d. Salts of calcium

60. The substance that is found in between the bone plates of the spongy substance and in the bone canal is known as:

a. Sacrum
b. Carpels
c. Fibula
d. Bone marrow

61. Which of the following provides the necessary freedom for bones as well as protect joints from external injury and bones from dislocation?

a. Cartilage
b. Ligaments
c. Tendons
d. Muscles

62. A disease of the bone usually found in adults due to vitamin D and calcium deficiency is called:

a. Osteomalacia
b. Osteoporosis
c. Osteomyelitis
d. Myeloma

63. Which of the following serves as a lubricant between two movable joints?

a. Ligaments
b. Synovial fluid
c. Tissues
d. Cartilage

64. A chronic inflammatory disease mostly infecting small joints, characterized by stiffness and pain in joints is defined as:

a. Osteoarthritis
b. R. arthritis
c. Bursitis
d. Gout

65. Which of the following lipids in a cell membrane acts as a selective barrier for controlling the exit and entry of substances into and out of the cell?

a. Cholesterol
b. Glycolipids
c. Phospholipids
d. Lipoproteins

66. A process by which materials move across cell membranes without the use of cellular energy is defined as:

a. Active transport
b. Passive transport
c. Facilitated diffusion
d. None of the above

67. Oxygen is carried by the pigment hemoglobin of the RBC in the loosely combined form called:

a. Carboxyhemoglobin
b. Oxyhemoglobin
c. Paradoxyhemoglobin
d. Hydroxyhemoglobin

68. A normal RBC count in an adult male will be:

a. 2.5 millions/cmm
b. 5 millions/cmm
c. 7.5 millions/cmm
d. 10 millions/cmm

69. Which of the following is the principal PROTEIN component of a RBC?

a. Iron
b. Phospholipid
c. Globin
d. Potassium phosphate

70. An average life span of an RBC is:

a. 30 days
b. 60 days
c. 90 days
d. 120 days

71. The most important property of hemoglobin is its ability to bind and carry oxygen. Generally, one gram of hemoglobin can take up:

a. 2 cc of oxygen
b. 0.05 cc of oxygen
c. 1.34 cc of oxygen
d. 0.001 cc of oxygen

72. Which of the following gases can replace oxygen and form a more stable complex with hemoglobin?

a. CO_2
b. NO
c. CO
d. H_2S

73. Iron deficiency anemia is known as:

a. Hypochromic anemia
b. Hyperchromic anemia
c. Hereditary anemia
d. None of the above

74. Which of the following provides the first line of defense against microorganisms?

a. Erythrocytes
b. Thrombocytes
c. Leukocytes
d. None of the above

75. What happens when an Rh -ve mother bears an Rh +ve fetus?

a. Normal delivery
b. Caesarean delivery
c. Miscarriage
d. None of the above

76. Which of the following cells plays an important role in the clotting process of the blood?

a. RBC
b. WBC
c. Platelets
d. None of the above

49. (d) The cells of columnar epithelium are much longer than broad and may look like pillars. The upper end of the cell is broad while the lower end, which is connected with basement membrane, is very narrow. They form the inner lining of the alimentary canal, alveoli of lungs and ducts of salivary glands.

50. (b) The cells from the inner lining of hepatic ducts, bile ducts and ureters are classified as cuboidal epithelium. They are more or less equal in height, width and length, and thus appear cuboidal in shapes.

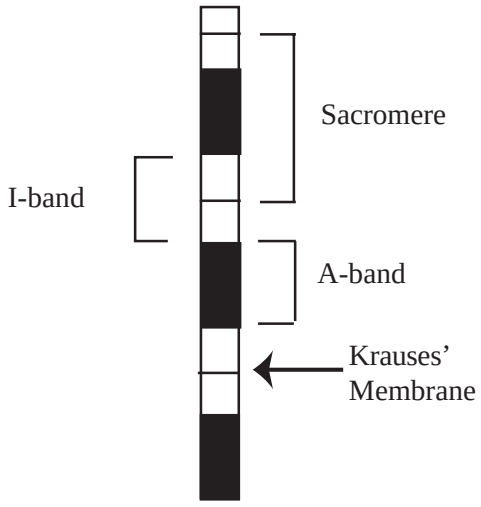
51. (c) Blood should be classified as liquid connective tissue. The connective tissue consists of fewer cells but a larger amount of intercellular substance (matrix) with fibers therein, which is secreted from the cells within. Connective tissue can be subdivided into three major categories:

1. Connective tissue proper: This type of connecting tissue normally performs the function of connecting different organs and tissues. It also serves as a packing material. Areolar tissue is the perfect example of it. This tissue (Areolar) is found as packing material between the skin and muscles, in peritoneum, mesentery and around the blood vessels and nerve fibers entering various organs.

2. Skeletal tissue: This type of tissue forms the skeletal system of vertebrates. They are hard and rigid. Hyaline cartilage is a perfect example of skeletal tissue. This type of tissue is normally found on the head of long bones. It is normally smooth, semitransparent and possesses a surface like glass. The outer surface of hyaline cartilage is formed of a hard fibrous layer known as perichondrium. Chondrin is an intercellular substance secreted from chondroblasts. This type of tissue protects the bone against friction and jerks by acting as a mechanical buffer.

3. Liquid connective tissue: Blood and lymph are examples of liquid connective tissues. They contain much less than 50% cellular components and more than 50% liquid matrix or plasma. Such tissues perform the function of supporting, connecting and protecting different organs and systems.

52. (d) Striated muscular tissue is also known as skeletal muscular tissue. They are classified as voluntary muscles since their contraction is under voluntary control. Each myofibril is cylindrical and has alternately arranged light and dark bands. Therefore, they appear to be striated. The dark bands are known as A-bands (anisotropic) while the light bands are known as I-bands (Isotropic). A thin membrane known as Krauser's membrane (Z-band) runs horizontally and passes through the middle of all I-bands along the width of the muscle fiber. The portion between every two consecutive Krauser's membrane (Z-bands) is known as sacromere, which is the structural and functional unit of a striated muscle fiber.



Myofibril

53. (a) Nervous tissues are formed of nerve cells known as neurons having nerve fibers and neuroglia. The neuron is the structural and functional unit of nervous tissue. It consists of two parts: (1) Cyton (2) Cell processes. Cyton is the principal component of a neuron and contains cytoplasm and the nucleus. The cytoplasm contains Nissl's granules which are thought to be nutritive and are composed of nucleoproteins.

54. (c) Cell processes are of two types:

(1) Dendrons or dendrites
(2) Axons

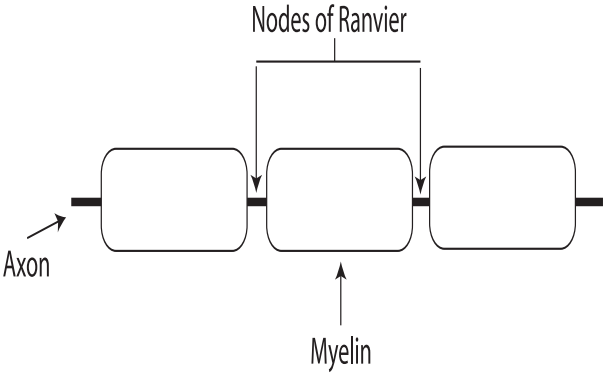
Dendrons are afferent in nature and normally send impulses to the cyton, whereas axons are efferent in nature and carry impulses away from the cyton. According to the number of cell processes, neurons are classified into three types:

1. Unipolar neuron: This type of nerve cell has only one process which is very short and immediately divides into a dendron and an axon.

2. Bipolar neuron: This type of nerve cell (neuron) has two processes. A dendrite and an axon are situated at opposite ends of the cyton.

3. Multipolar neuron: This type of neuron has several processes - an axon and several dendrons. This type of neuron is widely distributed in the motor centers of the brain and spinal cord. Interconnected neurons are so arranged that the nerve endings of the axon of one neuron and the nerve endings of the dendron of the other neuron are not directly and physically connected with each other, but keep a small gap that physically separates neurons. This small gap is defined as a synapse. Axon terminals of a neuron sending a message (the presynaptic neuron) release neurotransmitters into the synapse. The neurotransmitters diffuse to the other side (the postsynaptic side), where they bind to receptors on the postsynaptic neurons, thereby relaying the message.

55. (d) The axon as well as dendrons are usually surrounded by an insulating coat in order to prevent diffusion of impulses in the neighboring processes. Both these processes (axons and dendrons) are enclosed in a series of cylindrical-shaped cells known as Schwann's cell. The outermost layer of Schwann's cell is called neurilemma, which is continuous throughout neighboring Schwann's cells. Beneath the neurilemma, neuroplasm and a nucleus of the nerve cell are present. The neuroplasm of the Schwann's cell is also continuous throughout the neighboring cells. Between the cytoplasm and axon or dendron, there is a presence of a large number of compactly packed layers of lipoproteins which together form an insulating medullary sheath known as the myelin sheath. This sheath is not continuous throughout the nerve fiber, therefore one can see a constriction between two adjacent cells of Schwann's which is called the node of Ranvier.



56. (b) The m-RNA is synthesized from the DNA with the help of an enzyme called RNA polymerase. The definite region of DNA at which this enzyme synthesizes is known as the promoter. After the DNA double-helix unwinds and gets separated, the RNA polymerase binds to the specific promoter of 3'⟶5'strand of DNA and the synthesis of m-RNA begins at that region. The U, G, C, and A of m-RNA are arranged opposite and sequentially with A, C, G,

and T of DNA. The DNA strands which synthesizes the m-RNA in this way are known as DNA template , and this process of synthesis is known as Transcription. The synthesis of m-RNA occurs on 3'→5' strands of DNA in a 5'→3' direction only.

56A. (a) The type of chromosome in which the centromere is in the centre and all the four chromatids are of equal length is known as metacentric.

Submetacentric: In this type of chromosome, the centromere is a little away from the center and therefore chromatid of one side are slightly longer than the other side.

Acrocentric: In this type of chromosome, the centromere is located closer to one end of the chromatid and therefore the chromatids on the opposite side are very long. Also, one can see a small round structure attached by a very thin thread on the shorter side of the chromatids, known as a satellite.

Telocentric: In this type of chromosome, the centromere is placed at one end of the chromatids and hence it has only one arm.

57. (c) Turner Syndrome occurs due to abnormality in the 23rd pair of chromosomes in females. In such females, instead of XX, only a single X chromosome has been found. The reproductive organs in such females are poorly developed. In several cases ovaries may be absent or poorly developed. In such females, characteristics such as a shield-shaped chest, poorly developed breasts, small uterus, short stature and short neck are observed.

58. (a) Skeletal muscles are controlled by the somatic nervous system while cardiac and visceral muscles are controlled by the autonomic nervous system.

Skeletal muscles: They are usually attached to bones. They are under control of will and therefore they are known as voluntary muscle fibers. Fibers are long and cylindrical shaped and show distinct striation, hence they are called striated fibers. Each fiber is surrounded by a small membrane called the sacrolemma. Fibers are unbranched and consist of a number of nuclei.

Cardiac muscles: This type of muscular tissue is found in the heart, hence it is known as cardiac muscle. They are not under the control of will hence they are involuntary in nature. They are controlled by the autonomic nervous system. Fibers are long and cylindrical, however they are branched. Branches join with other fibers and form a three-dimensional network.

Visceral muscles: This type of muscular tissue is found in visceral muscles. They are also involuntary in nature. They are also controlled by the autonomic nervous system. They are unbranched, long and spindle-shaped.

59. (d) A bone is a structurally complex organ. It consists of 25% water, 35% organic solids and 45% inorganic salts of calcium. The hardness of bone is due to the presence of calcium salts.

60. (d) The substance that is found in between the bone plates of the spongy substance and in the bone canal is known as bone marrow. There are two types of bone marrow: red and yellow. The yellow bone marrow cell consists of fat cells, whereas red bone marrow produces red blood cells (RBC).

Functions of bone marrow:

1. It forms hemoglobin and RBCs.
2. It is rich in reticuloendothelial cells which help in carrying out various functions, especially protecting the body against microbial infections and foreign bodies.
3. It helps in development of final thrombocytes from megakaryocytes.
4. It forms granulocyte types of white blood cells.
5. It destroys old red blood cells with the help of reticuloendothelial cells.

61. (b) Ligaments are strong flexible white fibrous bands. They bind the articular surfaces of bones together. They connect bones to other bones in joints. They do not connect muscles to bones; that is the function of tendons. They provide necessary freedom for the bones as well as protect joints from external injury and bones from dislocation. They are inelastic. Tendons are white bands which join muscles with bones.

62. (a) A disease of the bone usually found in adults due to vitamin D and calcium deficiency is called osteomalacia. It is somewhat similar to infant rickets.

Osteoporosis: It is an absolute decrease in bone tissue mass where the bone becomes progressively porus and decalcified. However, the remaining part of the bone appears morphologically normal.

Osteomyelitis: It is an infection of the bone or bone marrow.

Myeloma: A rare fatal disease characterized by multiple tumors in bones or bone marrow.

63. (b) Synovial fluid serves as a lubricant between two movable joints. This type of joint is known as a synovial joint. In this type of joint, the body surfaces of opposite bones are covered with an articular cartilage, however cartilages do not touch each other. The space between two opposite cartilages is known as the synovial cavity, which is surrounded by ligaments or capsules. The synovial cavity is filled with a fluid called synovial fluid which lubricates the joint.

64. (b) Rheumatoid arthritis is a chronic inflammatory disease mostly infecting small joints, characterized by stiffness and pain in joints resulting from progressive destruction of articular and periarticular structures.

Osteoarthritis is a degenerative condition generally of large joints, involving articular cartilages and weight-bearing surfaces of the swollen joints. Muscle stiffness with pain in joints, muscle wasting, and limited and unsteady movements are principal characteristics of osteoarthritis.

Gout is a recurrent acute arthritis of peripheral joints which results from deposition of crystals of monosodium urates in the joints and tendons.

Bursitis is an acute or chronic inflammation of a bursa. A bursa is a sac filled with synovial greasy fluid.

65. (c) The primary type of lipids found in the cell membrane are phospholipids, cholesterol and glycolipids. Out of these, phospholipids play an important role in controlling the movement

of substances into and out of the cell. In general, lipid soluble substances are allowed to move into the cell whereas water soluble molecules are restricted or not allowed to pass through the cell membrane.

66. (b) A process by which materials move across cell membranes without the use of cellular energy is defined as passive transport. It is always nonselective, unsaturable, and energy independent. It is also known as non-mediated transport. Diffusion and osmosis are examples of passive transport.

A process by which materials move across cell membranes with the help of a carrier that passively but specially transports the substances is defined as facilitated diffusion. It is saturable and energy independent. Substances such as glucose, some amino acids and vitamins are transported faster by facilitated diffusion compared to simple diffusion.

A process by which materials move across cell membranes with the help of specific carriers against concentration, electrical or pressure gradient is defined as an active transport. It is selective, saturable and energy dependent. Like facilitated diffusion it is saturable, however, unlike facilitated diffusion it requires energy which is supplied by ATP. Sodium potassium ATPase enzyme is the specific active transport carrier for Na^+ and K^+ across the cell membrane.

67. (b) Blood carries oxygen from the lungs to cells and carbon dioxide from cells to the lungs. Oxygen is carried by the pigment called hemoglobin of the RBC in a loosely combined form called oxyhemoglobin. Carbon dioxide is carried mainly in a dissolved form in the plasma as a carbamino compound by the RBC.

68. (b) The normal RBC count in an adult male is 5 millions/cmm and 4.5 millions/cmm in an adult female. In infants it is 6 to 7 millions/cmm and in fetuses it is 8 millions/cmm.

69. (c) RBCs are composed of 60 to 70% water and 30 to 40% solids, which are formed mostly of hemoglobin, the protein-globin conjugated with iron containing heme, phospholipids and potassium phosphate.

70. (d) An average life span of an RBC is 120 days.

71. (c) The most important property of hemoglobin is its ability to bind and carry oxygen and then dissociates it. One gram of hemoglobin can take up 1.34 cc of oxygen. If 15 gm of hemoglobin (Hb) are present in 100 cc of blood, it can take upto 20.1 cc of oxygen. The maximum volume of oxygen which blood can take up under favorable circumstances is known as the oxygen carrying capacity of blood.

72. (c) Oxygen of the oxyhemoglobin can readily be replaced by other gases such as carbon monoxide (CO), carbon dioxide (CO_2), hydrogen sulfide (H_2S) and nitric oxide (NO). Out of these, carbon monoxide forms a very strong complex with hemoglobin by replacing oxygen, and therefore it can stop oxygen transport and may cause life-threatening situations.

73. (a) Iron deficiency anemia is known as hypochromic anemia. It is due to a reduced amount of Hb in the RBCs. RBCs are generally of smaller size, therefore it is also known as microcytic anemia. A person suffering from this type of anemia should eat plenty of leafy vegetables, green leaves, fruits, and meat.

Hyperchromic anemia occurs due to defective RBC formation. The Hb % is generally normal however the RBC count is less. RBC are

larger in size and cells are megaloblast, therefore this type of anemia is also known as megaloblastic anemia. A deficiency of vitamin B_{12} is responsible for this type of anemia, hence it is also known as pernicious anemia. Vitamin B_{12} is the only vitamin that requires specific career for its absorption. This specific career is known as the intrinsic factor. Therefore when treating vitamin B_{12} deficiency anemia, the supplement must be combined with intrinsic factor.

Hereditary anemia usually results from specific genes which direct the synthesis of abnormal forms of hemoglobin. There are two principal types of hereditary anemias:

1. Sickle cell anemia
2. Thalassemia

Sickle cell anemia: It is a hemolytic condition which is fatal before the age of 30 years. When oxygen level is low, the sickle cell hemoglobin molecules may aggravate and cause red blood cells to change from biconcave discs to crescent shapes. This may impair oxygen transport, clog capillaries and enlarge the spleen.

Thalassemia: It is also a hemolytic anemia which occurs due to defective synthesis of Hb. In this type of anemia, erythrocytes are extremely thin and fragile.

74. (c) White blood cells (leukocytes) provide the first line of defense against microorganisms. Unlike RBCs, they have a nucleus but no hemoglobin. There are 8000 leukocytes (4000 to 11,000) per cmm of blood.

75. (c) In the case of an Rh -ve mother bearing an Rh +ve fetus, there is a high probability of miscarriage or abortion. In such cases, the Rh +ve antigen travels from the fetus to the mother's blood and produces Rh +ve antibodies in mother's blood. The same antibodies (Rh +ve) travel back from the mother's blood to fetus and cause antigen- antibody reactions. This may result in miscarriage or an abortion, or if the baby is born alive, it suffers from severe anemia.

76. (c) Platelets look like round or oval plates with biconvex surfaces. Since they play an important role in the process of thrombus (clot) formation in the blood, they are also known as thrombocytes. There are about 250,000 to 500,000 platelets per cmm in the blood.

77. (a) Clotting of blood normally involves three basic steps:

1. The first step involved in the blood clotting mechanism is the activation of prothrombin.

2. Prothrombin then converts into thrombin in the presence of calcium and other factors.

3. Thrombin finally converts fibrinogen into fibrin. This fibrin forms the meshwork of threads. RBCs and WBCs get trapped in this mesh network.

78. (d) Vitamin K raises the prothrombin level in the blood and accelerates the blood clotting process. It is also used as an antidote for the well known anticoagulant Warfarin.

79. (c) Lymph fluid is a thin, slightly yellowish, translucent fluid originating in many organs and tissues of the body. Its composition is varied depending on the area of the body but generally contains about 95% water, a few red blood cells, and a number of white blood cells (1000 to 20000 per cmm); it contains less protein than blood plasma. It circulates in the lymphatic system. Platelets (thrombocytes) are absent in the lymph fluid.

Vitamin	Sources	Deficiency Syndrome
Vitamin A (Carotene)	Carrots, milk, butter, fish, eggs, cheese, liver oil	Night blindness, xerophthalmia, dry and rough skin
Vitamin B_1 (Thiamine)	Rice, wheat, yeast, germinated cereals	Beri-beri and polyneuritis
Vitamin B_2 (Riboflavin)	Milk, yeast, eggs, meat, liver, green vegetables	Cheilitis, red tongue
Nicotinic acid (Niacin)	Nuts and pulses, wheat germ	Pellagra
Vitamin B_{12} (Cyanocobalamine)	Liver, milk, meat	Pernicious anemia,
Folic acid	Green vegetables, curd, pulses, liver	Macrocytic anemia
Vitamin B_6 (Pyridoxine)	Liver, meat, green vegetables	Peripheral neuropathy
Vitamin C (Ascorbic acid)	Citrus fruits, lemon, tomatoes	Scurvy
Vitamin D (Calciferol)	Cod and shark liver oil, eggs, milk, butter	Rickets, osteomalacia
Vitamin E (Tocopherol)	Leafy vegetables, wheat, germ oil, milk	Degeneration of heart, nerves, muscles
Vitamin K (Phytonadione)	Autosynthesis in intestine, vegetables, tomato, soyabean, liver	Thrombocytopenia and bleeding

(Vitamins and their deficiency syndromes)

80. (c) Lymph nodes are small bean-sized organs of the immune system, distributed widely throughout the body. They are found both superficially and deep. Lymph fluid is filtered through the lymph nodes in which all types of lymphocytes take up temporary residence. They filter the germs, their toxins and foreign bodies. They provide the first line of defense for respective areas throughout the body.

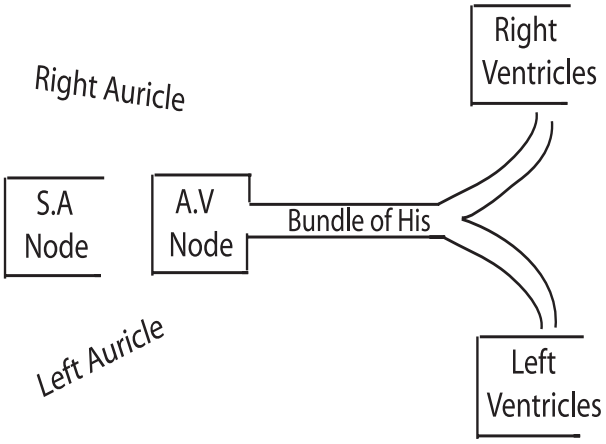
81. (d) The spleen is a ductless, vertebrate gland that is not necessary for life but is closely associated with the circulatory system, where it functions in the destruction of old red blood cells and removal of other debris from the bloodstream, and also in holding a reservoir of blood. Blood is poured out from the spleen at the time of stress, anoxia, hemorrhage, or carbon monoxide poisoning. It is also considered as one of the centers for reticuloendothelium activity.

82. (a) Blood circulates all over the body through blood vessels. There are mainly two types of vessels: 1. Arteries 2. Veins.

Arteries: They normally carry blood from the heart and supply it to different organs. They usually carry oxygenated blood, except for the pulmonary artery which carries deoxygenated blood or carbon dioxide containing blood. The arteries divide and redivide to form small arteries called arterioles. These arterioles finally end in very thin and small capillaries.

Veins: They usually bring the blood from various organs to the heart. They normally carry deoxygenated blood except for the pulmonary vein which carries oxygenated blood. They are formed from venules and venous capillaries.

83. (c) A small area of specialized heart tissue located in the right atrium that conducts impulses through the right and left atria, signaling these chambers to contract and pump blood into the ventricles is known as the SA node. Normally, the SA node initiate the impulses and therefore it is also known as the pacemaker of the heart. The AV node receives the impulse from the SA node and conducts it to the ventricles through bundle of His. During heart failure when SA node fails to initiate impulses, a new rhythm is generated from the AV node. The Bundle of His just starts from AV node. It gives two bundle branches. The right bundle branch passes to the right ventricle and the left one to the left ventricle. They merge into purkinje fibers.



84. (a) In the mouth, food is normally moistened by saliva. It is usually neutral or slightly acidic (pH 6 to 7). There are three pairs of major salivary glands (Parotid, Submaxillary, Sublingual) which secrete saliva into the mouth. The saliva contains an enzyme called amylase (ptyalin) which digests starch molecules into maltose. Saliva also contains inorganic salts, sodium chloride, potassium chloride and phosphatase.

85. (d) During digestion, stomach muscles contract and churn the bolus of food with gastric juices to form a soupy liquid called chyme. Chief cells also called gastric glands secrete pepsinogen. In the presence of hydrochloric acid, pepsinogen is converted into pepsin. The pepsin then digests large protein into smaller proteins called peptides.

86. (d) Pancreatic juice is secreted from the pancreas, a large gland in the abdominal cavity that secretes digestive enzymes into the small intestine and also secretes the hormones insulin and glucagon into the blood, where they regulate blood glucose levels. It secretes a number of enzymes including amylase (for starch), sucrase (for sucrose), maltase (for maltose), lactase (for lactose) and lipase (for fat). In addition to these enzymes, it also secretes trypsin and chymotrypsin for digesting large protein molecules into peptides. Peptidases secreted by the pancreas reduce these small peptide molecules into amino acids, whereas nucleases (also secreted by pancreas) digest nucleic acid molecules into nucleotides in the small intestine.

87. (d) The soupy mixture called chyme from the stomach passes through a sphincter into the small intestine. An adult's small intestine is about 23 feet long and is divided into three sections. The first 10 to 12 inches of the intestine forms the duodenum. Most chemical digestion takes place in the duodenum of the small intestine. The next 10 feet form the jejunum and the final 12 feet form the ileum. The inner surface of the small intestine contains numerous fingerlike projections called villi. Each villus has a projection of cells called microvilli. They increase the surface area of the intestine to improve absorption of digested nutrients.

87A. (c) Bile (or gall) is a bitter, greenish-yellow alkaline fluid secreted by the liver of most vertebrates. In many species, it is stored in the gall bladder between meals, and upon eating is discharged into the duodenum where it aids the process of digestion. Bile salts (glycine and taurine) act to some extent as a detergent, helping to emulsify fats, and thus aid in their absorption. Besides its digestive function, bile serves as the route of excretion for hemoglobin breakdown products (bilirubin) which give bile its color. Bile also contains cholesterol, which occasionally accelerates into lumps in the gall bladder, forming gallstones.

The human liver produces about a quart (or roughly a litre) of bile per day. Since bile increases the absorption of fats, it can help the body to absorb fat-soluble vitamins: A, D, E, and K.

88. (b) Most absorption of food and other nutrients occurs in the jejunum of the small intestine; most chemical digestion of food takes place in the duodenum.

89. (b) Generally, diffusion plays an important role in transferring other nutrients from the small intestine to blood, however the molecules of glucose and amino acids are transferred through the process of an active transport from the small intestine to blood.

90. (b) The excessive glucose in the blood is stored as a reservoir in the liver in the form of glycogen.

91. (a) The movement of the molecules from a higher concentration to a lower concentration is known as diffusion. Osmosis is a special case of diffusion in which water molecules diffuse across a selectively permeable membrane which allows only water molecules to pass.

92. (a) In humans, an exchange of oxygen and carbon dioxide take place through the process of diffusion.

93. (b) The tiny microscopic areas of the lung where the actual exchange of oxygen and carbon dioxide into and out of the blood occurs is known as the alveoli.

94. (b) The main part of the large intestine, responsible for absorbing water and salts from the digested products of the small intestine and passing the digested products into the rectum for removal from the body is called the colon. It is divided into ascending, transverse, and descending portions. The intestinal matter

remaining after water has been removed is called feces. Feces consists of nondigested food, harmless bacteria, bile pigments and other material. The rectum gets filled up with fecal material from the colon and then excreted via the process of defecation through the anus.

95. (c) The pancreas is a long, irregularly shaped gland, which lies behind the stomach and secretes pancreatic juice into the lower end of the stomach that aids in the digestion of proteins, carbohydrates and fats. It consists of two parts: (1) Endocrine and (2) Exocrine. The exocrine part of the pancreas is made up of lobules which consist of numerous secretory cells which secrete pancreatic juice. The endocrine part mainly consists of islets of Langerhans which consist of α and β cells. These cells secrete glucagon and insulin respectively. Both these hormones play an important role in regulating normal glucose levels in the blood.

96. (c) The gall bladder is a sac like structure which serves as the reservoir of bile. It also concentrates the bile. About 10 cc of liver bile is concentrated to 1 cc of gall bladder bile.

97. (a) Bile (or gall) is a bitter, greenish-yellow alkaline fluid secreted by the liver of most vertebrates. It helps in the complete digestion of fats by reducing surface tension. It also activates the enzyme lipase. It serves as a good solvent for fats and fat-splitting enzymes. Bile also helps in absorption of carbohydrates, fats, fat soluble vitamins and proteins.

98. (a) Specialized chemical messengers (e.g. acetylcholine, dopamine, norepinephrine, serotonin) that send a message from one nerve cell to another are classified as neurotransmitters. Acetylcholine is the chemical mediator at most of the synapses and also between the nerves and skeletal muscles. Once the impulse has been received, another chemical cholinesterase metabolizes the acetylcholine into acetic acid and choline so that the impulse does not continue indefinitely. The dissociated acetic acid and choline then move back to the axon vesicles where they are reunited by choline acetylase and stored for future use. Norepinephrine, acetylcholine, epinephrine, histamine, dopamine and serotonin are examples of neurotransmitters.

99. (b) A watery, colorless, clear fluid that bathes and protects the brain and spinal cord is known as CSF or cerebro spinal fluid. It contains glucose, traces of proteins, other nitrogenous substances and electrolytes such as sodium, potassium, calcium, chloride, bicarbonates, etc. The principal functions of CSF are:

1. Bathing of the brain and spinal cord.

2. It protects brain and spinal cord from injury by acting as a shock absorber or buffer.

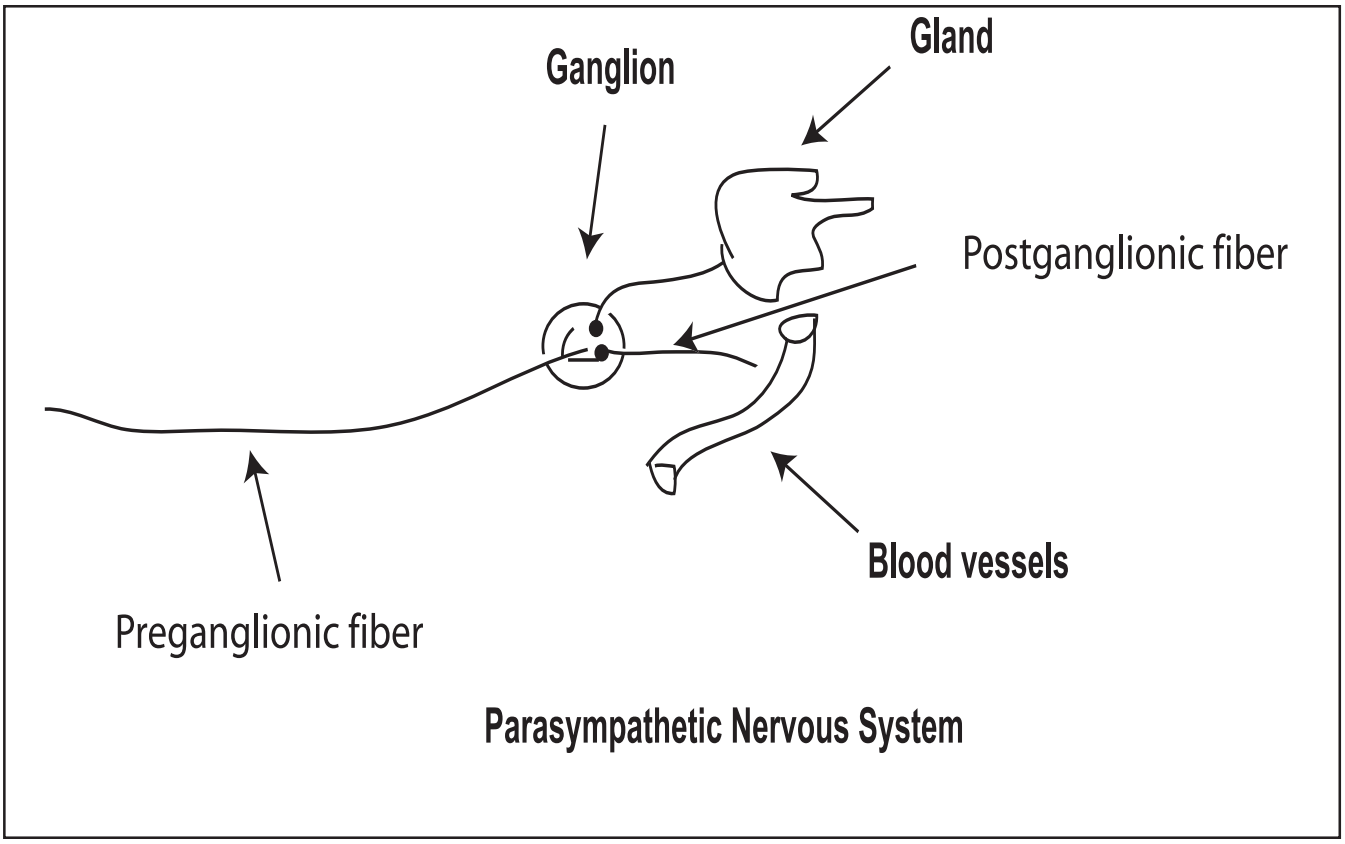
3. It supplies nutrition to and takes away the waste products from the brain and spinal cord.

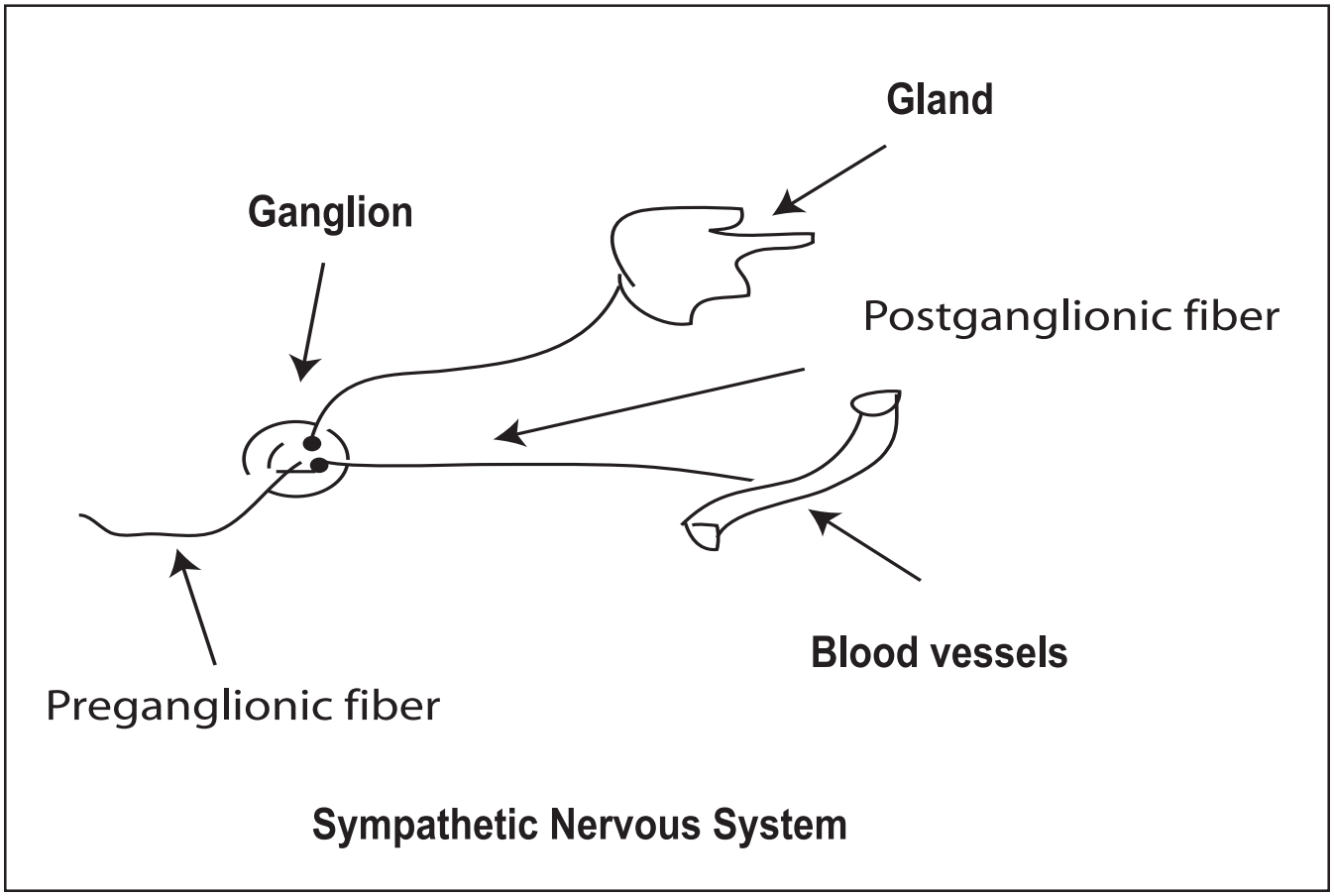
100. (c) The autonomic nervous system (ANS) governs the activity of the body's visceral organs. It is involuntary in nature. It regulates blood pressure, secretion of glands and activity of the cardiac and smooth muscles. It is supplied to all organs except the skeletal muscles. Thus it does not regulate the activity of skeletal muscle.

101. (c) The autonomic nervous system can be subdivided into two main divisions:

1. Parasympathetic nervous system
2. Sympathetic nervous system

1. The parasympathetic system is also known as the craniosacral system since it is formed by oculomotor, facial, glossopharyngeal and vagus cranial nerves and the third to fifth


Gland
Ganglion
Postganglionic fiber
Blood vessels
Preganglionic fiber
Parasympathetic Nervous System


Gland
Ganglion
Postganglionic fiber
Blood vessels
Preganglionic fiber
Sympathetic Nervous System

spinal nerves. A ganglia of a parasympathetic system lies near to or within the organ, therefore the preganglionic nerve fiber of a parasympathetic system is longer than the preganglionic fiber of a sympathetic system.

2. The sympathetic system is also known as the thoracic-lumbar system since it is formed from all twelve thoracic nerves and the first three lumbar nerves. A ganglia of a sympathetic nervous system lies close to the spinal cord or away from the organ, hence its preganglionic fiber is shorter compared to preganglionic fiber of a parasympathetic system.

102. (b) The chemical transmitter of the preganglionic fiber is acetylcholine for all the autonomic nerves, that is both sympathetic and parasympathetic. The chemical transmitter in post ganglionic fibers is noradrenaline in the sympathetic system and acetylcholine in the parasympathetic system. Therefore, the sympathetic nervous system is known as an adrenergic system whereas a parasympathetic system is called a cholinergic system.

103. (a) Normally, the retina is composed of nerve cells, rods and cones arranged in various layers. Rods and cones are photoreceptor cells of the retina. Each retina contains approximately 6 million cones and 120 million rods. The rods are primarily responsible for peripheral vision and vision in dim light or night whereas cones are responsible for color vision and seeing fine detail. Rods contains the light sensitive pigment called rhodopsin whereas cones contain the photochemical called photopsin or iodopsin. Rhodopsin is formed when a protein called opsin is chemically linked to a specialized form of Vitamin A. Rhodopsin resides almost exclusively in the outer segments of rod photoreceptor cells and can only be formed in the dark. When light strikes, the rhodopsin molecule changes shape, generating the initial signal in the visual process. Ultimately, the vitamin A splits off from the opsin protein but can be re-attached in the dark. This series of reactions in light and dark is called the visual cycle. Photopsins or iodopsins are the photoreceptor pigments found in the cone cells of the retina that are the basis of color vision. Photopsins are very close analogs of the visual purple rhodopsin that is used in dark vision. Photopsins consist of a protein called opsin and a bound chromophore, the retinal. Different opsins differ in a few amino acids and absorb light at different wavelengths as retinal-bound pigments.

104. (c) The lachrymal gland secretes a saline-like fluid which keeps the eye clean and moist. During emotions it overflows in the form of tears.

105. (a) Myopia is classified as a disorder of the eye. Myopic people are short-sighted. They can see the near object perfectly but find it difficult to see far objects. In this type of disorder, the parallel rays are not focused on the retina but fall short in front of the retina. It can be corrected by wearing biconcave lenses (negative lenses) which focus parallel rays on the retina.

Hypermetropic people are long-sighted. They can see the distant object well but find it difficult to see near objects. In this case, the divergent rays are focused behind the retina. This can be corrected by wearing convex lenses (positive lenses) which focused the divergent rays onto the retina.

106. (d) Glaucoma is characterized by elevated intraocular pressure, which causes optic nerve damage and subsequent peripheral vision loss. Most people have no initial symptoms of chronic (open-angle) glaucoma, but they can develop peripheral vision loss, headaches, blurred vision, difficulty adapting to darkness and halos around lights. Other forms of glaucoma (e.g. closed-angle glaucoma) may

have additional symptoms such as eye pain, a pupil that doesn't respond to light, redness, nausea and a bulging eye.

107. (c) Night blindness is defined as an inability to see in the dim light due to reduced power of dark adaptation. It may occur due to retinitis pigmentosa, vitamin A deficiency or hereditary. There is a specific relationship between vitamin A and rhodopsin formation. The deficiency of vitamin A may affect the rhodopsin formation and lead to night blindness.

108. (d) There are mainly two types of glands in a human body: (1) Exocrine gland (2) Endocrine gland. Exocrine glands possess ducts through which secretions are secreted. Gastric glands, salivary glands and lachrymal glands are examples of exocrine glands.

109. (d) The synthesis and release of various hormones in the body is controlled by feedback mechanism. Normally there are two types of feedback mechanisms through which the body controls the synthesis and release of particular hormones in the blood.

Any fall in any particular hormone in the blood stimulates the hypothalamus to secrete the respective releasing factor (e.g. growth hormone releasing factor). This releasing factor then stimulates the pituitary gland to secrete the trophic hormone which finally stimulates the gland to release a desired hormone. This type of feedback mechanism is known as positive feedback mechanism.

The process will be reversed when there is a high level of a particular hormone found in the blood. The process of inhibition of a particular endocrine gland in response to elevated hormone levels in the blood is defined as negative feedback mechanism.

110. (d) The pituitary is a small oval endocrine gland attached to the base of the vertebrate brain and consisting of an anterior and a posterior lobe, the secretions of which control the other endocrine glands and influence growth, metabolism, and maturation. It is also known as Hypophysis-cerebri gland. The anterior pituitary lobe secretes the following hormones:

1. Growth Hormone (GH)
2. Prolactin
3. Thyroid Stimulating Hormone (TSH)
4. Follicle Stimulating Hormone (FSH)
5. Luteinizing Hormone (LH)
6. Adrenal-cortex Stimulating Hormone (ACTH)

The posterior pituitary lobe secretes only two hormones:

1. Vasopressin or Antidiuretic Hormone (ADH)

2. Oxytocin

111. (b) The cells of thyroid follicles have a remarkable ability to extract iodide from the blood. This trapped iodide is converted into iodine in the thyroid follicles which is finally combined with the amino acid tyrosine to form thyroid hormone. The deficiency of iodine may produce a thyroid gland disorder known as goiter.

112. (d) The parathyroid gland is four small kidney-shaped glands that lie in pairs near or within the posterior surface of the thyroid gland and secrete parathormone (parathyroid hormone). Its principal function is to control the calcium ion concentration in the blood. It mobilizes calcium ions from the bones to the blood by stimulating bone resorption and promotes the reabsorption of calcium ions from the tubules back into the blood.

113. (d) Vitamin D, calcitonin and parathormone are chief regulators for maintaining normal calcium ion concentration in the blood. Calcitonin and vitamin D work simultaneously to increase the deposition of calcium in the bone and reduce the calcium level in the blood. Parathormone has an opposite effect; it mobilizes calcium ions from bones to the blood and elevates serum concentration in the blood.

114. (b) Vasopressin is a polypeptide hormone released from the posterior pituitary. Its principal functions are:

1. To constrict blood vessels and capillaries in order to raise the blood pressure.

2. Retention of Na^+ ions in order to increase plasma volume.

115. (d) The adrenal medulla is a small gland that produces steroid hormones, adrenaline and noradrenaline, which help control heart rate, blood pressure, and other important body functions. There are two adrenal glands, one located on top of each kidney. It is also called the suprarenal gland. The adrenal gland is divided into two parts: (1) Adrenal cortex (2) Adrenal medulla.

The adrenal cortex secretes aldosterone, cortisone, corticosterone and sex hormones such as progesterone, estrogen and androgens, whereas the adrenal medulla secretes adrenaline.

116. (d) It is a soft, flattened, pinkish-gray organ located in the upper chest under the breastbone. It is relatively large in the newborn infant (about the size of a baby's fist), and continues to grow throughout childhood up to the age of puberty when it weighs about 1.2 oz (35 grams). Then it gradually decreases in size until it blends in with the surrounding tissue. It is the site of the production of T-lymphocytes. The thymus reaches its maximum development at about puberty and then undergoes a gradual process of involution resulting in a slow decline of immune function throughout adulthood.

117. (b) Glucagon is a polypeptide hormone secreted by (α) cells of islets of Langerhans. The fall in the blood glucose level stimulates the secretion of glucagon through the pancreas. It elevates the serum glucose level by promoting glycogenolysis (breakdown of glycogen into glucose) and by stimulating gluconeogenesis (formation of glucose from non-carbohydrate source). A rise in the blood glucose level inhibits the secretion of glucagon and stimulates insulin secretion.

118. (c) Decreased insulin secretion may result in a condition called diabetes mellitus. It occurs when the body is not able to use blood glucose (sugar). Blood sugar levels are controlled by insulin, a hormone in the body that helps move glucose (sugar) from the blood to muscles and other tissues. Diabetes occurs when the pancreas does not make enough insulin or the body does not respond to the insulin that is made. There are two main types of diabetes mellitus: type I diabetes and type II diabetes. The more common form, diabetes mellitus type II (Maturity onset or non-insulin dependent diabetes mellitus), is characterized by insulin resistance in peripheral tissues and a defect in insulin secretion by beta cells of islets of Langerhans. Type I diabetes also known as Juvenile onset or insulin dependent diabetes, usually occurs at a young age. In this type of diabetes, a patient has to depend on exogenous insulin.

119. (a) Hyperglycemia (increase in blood glucose level), glucosuria (increase in excretion of glucose via urine), polyuria (excessive urination), polyphagia (over eating) and polydipsia (increased thirst) are common symptoms of diabetes mellitus. Hypoglycemia (decrease in blood glucose) is not a symptom of diabetes mellitus.

120. (b) The Sertoli cell is the "nurse" cell of the testes. Its main function is nurturing the developing sperm cells during the process of spermatogenesis. These cells are rich in glycogen. Sertoli cells secrete anti-Müllerian hormone (AMH) during the early stages of fetal life. After puberty, they secrete the hormone inhibin. Sertoli cells control the entry and exit of nutrients, hormones and other chemicals into the tubules of the testes. These cells are unable to proliferate.

121. (d) Sperm cells or spermatozoa are the male gametes produced by meiosis from cells within the walls of seminiferous tubules of the testes.

122. (c) The mature sperm cell (spermatozoa) is 0.05 milliliters long. It consists of a head, body and tail. The head is covered by the ac cap and contains a nucleus of dense genetic material from the 23 chromosomes. It is attached from the neck to the body containing mitochondria that supply the energy for the sperm's activity. The tail is made of protein fibers that contract on alternative sides, giving a characteristic wavelike movement that drives the sperm through the seminal fluid, which also supplies additional energy. All normal cells have 46 chromosomes but sperm have half that number (23). If and when the sperm joins ups with the female's egg (ovum), which also has 23 chromosomes, together they add up to 46 chromosomes.

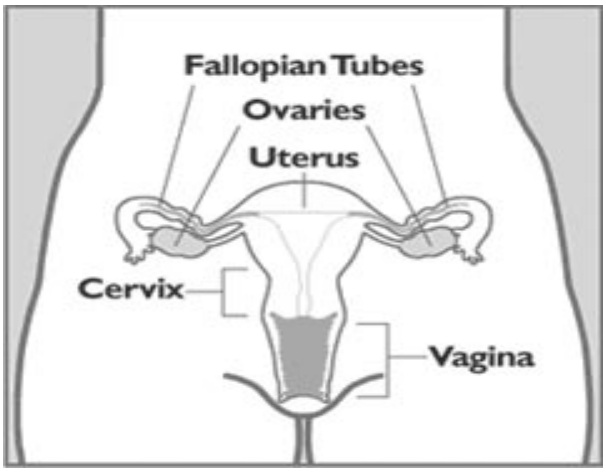
123. (d) The vas deferens is a long, muscular tube that travels from the epididymis into the pelvic cavity, to just behind the urinary bladder. The vas deferens transports mature sperm to the urethra in preparation for ejaculation. These tubes are severed during a vasectomy (performed for birth control).

124. (d) The seminal vesicles are a pair of glands on the posterior surface of the urinary bladder of males. They secrete a significant proportion of the fluid that ultimately becomes semen. About 60% of the seminal fluid in humans originates from the seminal vesicles. Semen is a fluid that activates and protects the sperm after it has left the penis during ejaculation. It also provides fructose to sperm which serves as an energy source for sperm.

125. (b) Hyaluronidase is an enzyme made by traumatized cartilage (to soften and regenerate itself when injured), sperm cells (to dissolve the protective layer around an ovum), the spleen (to speed up hemolysis) and produced by some bacteria so they can dissolve connective tissue and get deep into the body. Hyaluronic acid is the main target.

126. (a) Testosterone is an androgen hormone derived mainly from the testes and adrenal cortex. It is the male hormone that is essential for sperm production and the development of male characteristics, including muscle mass and strength, fat distribution, bone mass and sex drive. Muscular development is found more in males than females because of the presence of the testosterone. Blood volume and RBCs are found more in males than females because of the anabolic function of the testosterone.

127. (d) Fallopian tubes or oviducts are two very fine tubes leading from the ovaries of the female into the uterus. They are named after their discoverer, the 16th century Italian anatomist, Gabriele Falloppio. There are two Fallopian tubes, one on each side of the top of the uterus. They are hollow from inside. The outer end of the tube widens into infundibulum and ends in multiple fimbriae. Once an ovum is released by an ovary, with the help of the fimbriae and tubular epithelia it travels through fallopian tubes and reaches to the uterus.



128. (b) Menstruation is defined as a periodical cycle in women wherein once a month an egg is released from the ovary, and the uterine wall is thickened to prepare for the fertilized egg to settle in it. If fertilization does not occur, then within the next 3 to 6 days the uterine lining sheds with the discharge of blood. It is generally divided into four major phases:

1. Menstrual phase: In this phase, the endometrium sheds blood and mucus which pass out from the uterus. It usually lasts for 3 to 5 days. If this period extends beyond 5 days, it may be considered abnormal. Hormones such as estrogen, progesterone, follicle stimulating hormone (FSH) and luteinizing hormone (LH) are found in minimum quantity.

2. Proliferative, Estrous or Follicular phase: During this phase, the estrogen level rises and reaches its peak. It is estrogen that is responsible for the proliferation of endometrium, hence this phase is also known as the estrous phase. FSH and LH levels are also increased during this phase which help the development and maturation of Graafian follicles. Therefore this phase is also known as the follicular phase. This phase lasts for about 10 to 14 days, i.e. from the 5^{th} to the 15^{th} or 20^{th} day.

3. Ovulation: The monthly release of a mature egg from an ovary into one of the Fallopian tubes is defined as ovulation. A woman is most fertile in the days just before and on the day of ovulation. It usually occurs regularly, around day 14 of a 28-day menstrual cycle. The body temperature rises by 1^{o} F on the day of ovulation.

4. Secretive or progesterous phase: After ovulation, the endometrium becomes more secretive under the influence of progesterone. Therefore this phase is also known as the secretive phase or progesterous phase. Both estrogen and progesterone levels are maintained high and orpus luteum is formed from ruptured graafian follicles. (Graafian follicles are fluid-filled capsules that surround and protect the developing egg cell inside the ovary during the menstrual cycle. After the egg cell has been released, the follicle remains and is known as a corpus luteum.)

This phase last for 14 days. If the ovum does not get fertilized by the sperm, the corpus luteum will degenerate and pass through the uterus during menstruation.

129. (c) Ovarian hormones are produced during different phases of menstruation. They are:

1. Estrogen
2. Progesterone
3. Relaxin
4. Androgen

The estrogen and progesterone are important. Estrogen is secreted by the graafian follicles whereas progesterone is secreted by corpora lutea, which develops from the wall of the graafian follicle after its rupture and liberation of ovum.

A **Functions of estrogen:**

1. Estrogen is responsible for puberty changes or secondary sex characteristics in females such as the appearance of pubic and axillary hair, development of breasts, etc.

2. It is also responsible for the development and growth of the vagina, uterus, fallopian tubes and ovaries.

3. It stimulates the protein and fat metabolism.

4. Skeletal growth is stimulated by estrogen.

B. **Functions of progesterone:**

1. Pregnancy is sustained by progesterone secretion.

2. Menstruation is prevented during pregnancy by progesterone secretions.

3. Birth develop under progesterone stimulation.

4. Birth passage is relaxed by progesterone and widens to facilitate birth.

5. Protein metabolism is slow down with progesterone.

130. (c) Spermatogenesis starts at puberty under the influence of gonadotropic hormone. Germinal epithelial cells of seminiferous tubules undergo first meiotic division and produce primary spermatocyte. The total number of diploid chromosomes in the primary spermatocyte are (44XY i.e. 46). The primary spermatocyte undergoes first meiotic division to form secondary spermatocytes. The diploid numbers are reduced to half (22X or 22Y i.e. 23) by meiotic division. Therefore secondary spermatocytes contain only 23 chromosomes. The secondary spermatocytes then undergo second meiotic division, however this time the chromosomes remain the same, hence the resultant spermatids contain again 23 chromosomes.
There are four spermatids that form after the second meiotic division, which are then converted into spermatozoa (sperm) after maturation.

131. (a) Oogenesis is defined as the formation and maturation of the ovum. The germinal epithelial cell is differentiated into a primary oocyte. When this primary oocyte goes under first meiotic division, it will form one secondary oocyte and one polar body. The diploid number of chromosomes in a primary oocyte (44XX) are reduced to half in the first secondary oocyte (22X) and the first polar body (22X).

The secondary oocyte and first polar body enter into second meiotic division, in which they form a mature oocyte or ovum (22X) and two additional polar bodies (22X).

Thus, the male gamete contains either 22X or 22Y, whereas the female gamete contains only 22X. When spermatozoa containing X chromosomes unites with the ovum, the sex chromosomes in the offspring will be X and X and therefore the resulting sex of the offspring will be female. But if a spermatozoa containing Y chromosomes unites with the ovum, the chromosomes in the offspring will be X and Y, and therefore the sex of the offspring will be a male.

132. (d) The nephron is a structural and functional unit of the kidney. Each kidney contains approximately one million nephrons. Each nephron consists of Bowman's capsules, glomerulus, a proximal convoluted tube, loop of Henle, a distal convoluted tubule and a collecting tubule.

$$X_{water} = \frac{30}{50} = 0.6$$

$$P_{water} = X_{water}\, P^{o}_{water}$$

$$P_{water} = 0.6 \times 525 = 315 \text{ mm Hg}$$

$$\triangle P_{water} = P_{water} - P^{o}_{water}$$
$$= 315 - 525$$
$$= -210$$

Thus, the dissolved solute (sucrose) reduces the vapor pressure by 210 mm Hg.

117. (a) First Order Reaction: When the rate of reaction is proportional to the first power of concentration of the reactant.

$$\text{Log } C_o/C = kt / 2.303 \text{ where}$$

Co = concentration of reactant at time t = 0
C = concentration of reactant at time t
k = rate constant
t = time

* The rearrangement of this equation can be expressed as follows:

$$k = \frac{2.303}{t} \log \frac{Co}{C}$$

$$k = \frac{2.303}{t} \times \log (a)/(a-x)$$

where, a = initial concentration at time (t) = 0
x = the amount of reactant reacted in time (t)
a-x = the amount of reactant left after time (t)

* The half-life of a drug in first order kinetic can be calculated as follows:

$$k = \frac{2.303}{t_{1/2}} \times \log Co / Co/2$$

$$k = \frac{2.303}{t_{1/2}} \times \log 2$$

$$t_{1/2} = 0.693/k$$

118. (b) Catalyst is defined as a substance that increases the rate of a chemical reaction, but is not itself consumed. A catalyst lowers the activation energy by adding new lower energy pathways to a reaction mechanism. The catalyst is not consumed since one of the added steps to the mechanism regenerates the catalyst.

If a catalyst is present in the same phase as the reacting substance, it is called a homogeneous catalyst. For example, I_2 (catalyst) and cis-2 butene are in the same gas phase, therefore I_2 should be called a homogeneous catalyst for this particular reaction.

Many reactions occurring in a solution are catalyzed by solid catalysts. When a catalyst and reacting substances are present in different phases during reaction, a catalyst should be called a heterogeneous catalyst. An example would be the presence of MnO (solid) as a catalyst for the H_2O_2 (solution) decomposition.

119. (d) The sting of ants is due to the presence of weak acid called formic acid. Citric acid and ascorbic acid are usually found in citrus fruits such as lemon and oranges.

120. (b) The degree to which an acid ionizes can be predicted by calculating K_a (acid ionization constant). The larger the K_a value, the stronger an acid will be. The Pk_a of an acid is the negative log of the K_a value. The smaller the pK_a value, the stronger an acid should be. From tabular data, formic acid has the lowest pK_a value among the given choices, therefore it is the strongest acid. As the strongest, it produces the greatest H_3O^+ ion concentration among the given choices.

121. (c) The chemical equation of formic acid in water can be described as follows:

$$HCOOH + H_2O \rightleftharpoons HCOO^- + H_3O^+$$

0.1 M	1×10^{-3}	1×10^{-3}
$0.1 - 10^{-3}$		

Initially, the concentration of formic acid is 0.1 M. After time "t," H_3O^+ and $HCOO^-$ concentration is 1×10^{-3} ($pH = -\log [H_3O^+]$). Therefore, after time "t," the formic acid concentration should be $0.1 - 1 \times 10^{-3}$.

$$Ka = \frac{[HCOO^-] \times [H_3O^+]}{HCOOH}$$

$$Ka = \frac{1 \times 10^{-3} \times 1 \times 10^{-3}}{0.1 - 1 \times 10^{-3}}$$

$$Ka = \frac{1 \times 10^{-6}}{0.099}$$

$$Ka = 0.010 \times 10^{-3}$$

122. (a) The K_w (water ionization constant) value at 25°c is 1.00×10^{-14}. The equation that describes the relationship between K_w, K_a and K_b is as follows:

$$K_w = K_a \times K_b$$

$$1 \times 10^{-14} = 4.2 \times 10^{-7} \times Kb$$

$$Kb = \frac{1 \times 10^{-14}}{4.2 \times 10^{-7}} = 0.238 \times 10^{-7}$$

$$Kb = 2.38 \times 10^{-8}$$

123. (b) The relation between pH and pOH can be expressed by the following equation:

$$pH + pOH = 14$$
$$2 + pOH = 14$$
$$pOH = 12$$

124. (b) Sodium bicarbonate ($NaHCO_3$) is a salt of sodium hydroxide (NaOH) and bicarbonic acid (H_2CO_3). NaOH is a strong base, whereas H_2CO_3 is a weak acid. Therefore, the resultant solution should be basic.

125. (d) A substance that resists a change in pH with the addition of a strong acid or base is known as a buffer.

126. (b) The pH of the buffer solution can be calculated by using the Henderson-Hasselbalch equation.

$$pH = pKa + \log \frac{salt}{acid}$$

When a ratio of salt/acid is equal to 1, log 1 value should be zero, and therefore the pH of the solution is the same as the pKa value of the buffer solution.

$$pH = 5.2 + \log (1)$$

$$pH = 5.2$$

127. (a) The relationship between silver acetate and silver and acetate ions can be expressed by the following equation:

$$\underset{\text{Silver acetate}}{CH_3COOAg} \rightleftarrows \underset{\text{Silver ion}}{Ag^+} + \underset{\text{Acetate ion}}{CH_3COO^-}$$

The addition of silver nitrate will increase the Ag^+ ion concentration in the solution. According to the Le Chatelier principle, if a dynamic equilibrium is disturbed by changing the conditions, the position of equilibrium moves to counteract the change. In this case, the increase in the Ag^+ ion concentration can only be reduced if the equilibrium of the reaction shift to the left side- that is more formation of silver acetate. Therefore, an addition of silver nitrate may result into precipitation of silver acetate.

128. (c) To solve this problem, first we have to find out the moles of nitrogen and fluorine.

$$\text{Moles of } N_2 = \frac{\text{weight in gm}}{\text{molecular weight}}$$

$$\text{Moles of } N_2 = \frac{21}{28} = 0.75 \text{ moles of } N_2$$

$$\text{Moles of } F_2 = \frac{\text{weight in gm}}{\text{molecular weight}}$$

$$\text{Moles of } F_2 = \frac{114}{38} = 3 \text{ moles}$$

Thus, the rate limiting step is nitrogen. Therefore, we can say that:

1 mole of N_2 reacts with 3 moles of F_2 generates 265 kj
0.75 mole of N_2 reacts with 3 moles of F_2 ?

$= 0.75 \times 265 = 198.75$ kj

129. (b) In voltaic cells, the anode is the electrode where oxidation occurs, whereas cathode is the electrode where reduction occurs. A minus sign is assigned to the anode whereas the cathode is marked with a plus sign. The chemical oxidation occurs at the anode which produces free electrons. Electric current in voltaic cells moves from the negative to the positive electrode, that is, from anode to cathode.

In a salt bridge, cations move from anode to cathode, and anions move from cathode to anode.

130. (c) When white light passes through a prism, one can see the following colors:

	Colors	**Wavelengths (nm)**
1.	Red	622 to 780
2.	Orange	597 to 622
3.	Yellow	577 to 597
4.	Green	492 to 577
5.	Blue	455 to 492
6.	Violet	390 to 455

131. (d) The molecular weight of N_2O_3 is 76 gm/mole. Out of which 28 gm of nitrogen is present, therefore the % atomic mass of N_2 is:

$$= \frac{28 \times 100}{76} = 36.84\ \%$$

132. (b) The relative weight can be calculated by dividing the weight % by the atomic weights:

$$\text{nitrogen} = \frac{63.65}{14.00} = 4.54$$

$$\text{oxygen} = \frac{36.84}{16} = 2.30$$

So, the ratio of nitrogen to oxygen in relative atomic weight is:

$$\frac{\text{nitrogen}}{\text{oxygen}} = \frac{4.54}{2.30} = 1.97 \cong 2$$

Therefore, the molecular formula should be N_2O.

133. (b) 28 gm

$$\underset{(4 \times 14) + (3 \times 32)}{4N + 3O_2} \longrightarrow 2N_2O_3$$

Therefore, we can say:

96 gm oxygen requires 56 gm nitrogen
48 gm oxygen requires ?

$$= \frac{48 \times 56}{96} = 28 \text{ gm}$$

134. (d) Fluorine (F). The electronic configuration of fluorine is:

F: $1s^2\ 2s^2\ 2p^5$

Thus, by accepting one more electron, fluorine can finish its octet. Therefore, fluorine always possesses an ionic charge of -1.

135. (b) The condensed structural formula for butane is: CH_3-CH_2-CH_2-CH_3.

136. (c) Amines are a derivative of ammonia (NH_3). If we replace one of the hydrogen of ammonia with methyl group, it will give us methylamine.

1. NH_3 (Ammonia)

2. CH_3NH_2 (Methyl amine)

If we replace two hydrogen atoms with methyl groups, it should give us dimethylamine.

3. CH_3NHCH_3 (Dimethyl amine)

The replacement of all three hydrogen atoms with methyl groups would result in the compound trimethyl amine.

4. $(CH_3)_3N$ (Trimethyl amine)

137. (c) A substance that slows down or stops a reaction, even when present in a small amount, is called an inhibitor. The chlorination of methane is an example of a chain reaction.

1. $Cl_2 \xrightarrow{Heat} 2Cl\cdot$

2. $Cl\cdot + CH_4 \longrightarrow HCl + CH_3\cdot$

3. $CH_3\cdot + Cl_2 \longrightarrow CH_3Cl + Cl\cdot$

This chain reaction continues until an oxygen is added to the reaction. The oxygen in this case is known as an inhibitor. Oxygen reacts with free methyl radical (liberated during step 2) and forms:

$$CH_3\cdot + O_2 \longrightarrow CH3\text{-}O\text{-}O$$

The $CH_3OO\cdot$ radical is less reactive than the $CH_3\cdot$ radical. Thus, by combining with one methyl radical, one oxygen molecule breaks a chain, and prevents the formation of thousands of molecules of methyl chloride.

138. (c) This can be solved by using the following equation:

Formula	**Group**	**Example**
C_nH_{2n+2}	Alkane	C_2H_6
C_nH_{2n}	Alkene	C_2H_4
C_nH_{2n-2}	Alkyne	C_2H_2

By using these formulas, we can say that the given compound ($C_{22}H_{42}$) is alkyne.

139. (a) 4.184 joules. It was named in honor of the British physicist James P. Joule, who proved in 1843 that a specific amount of work was converted into a specific amount of heat. A joule is now a unit for all forms of energy. One joule of work is done when the force of one Newton is exerted on an object moving in the direction of the force, a distance of one meter. It takes about one joule to lift an apple over your head. One joule is equal to 0.239 calories, whereas 1 calorie is equal to 4.184 joules.

140. (b) Below is the chart that summarize various processes and related associated energy terms.

Change of State	Associated Energy Term	Types of Reaction
Solid to liquid	Heat of fusion	Endothermic
Liquid to solid	Heat of crystallization	Exothermic
Liquid to gas	Heat of Vaporization	Endothermic
Gas to liquid	Heat of condensation	Exothermic

141. (d) K_{SP} or solubility constant is defined as the equilibrium constant for a reaction in which a solid ionic compound dissolves to give its constituent ions in a solution. As K_{sp} increases, the solubility of ionic compounds also increases. Therefore, from the given choices, we have to find out which one has the highest K_{sp} value.

1. $MgCO_3$: $K_{sp} = 4 \times 10^{-5}$
2. $CaSO_4$: $K_{sp} = 1.7 \times 10^{-5}$
3. CuCl: $K_{sp} = 1.1 \times 10^{-6} = 0.11 \times 10^{-5}$
4. $Mg(OH)_2$: $K_{sp} = 1.5 \times 10^{-4} = 15 \times 10^{-5}$

From the given choices, $Mg(OH)_2$ is the most soluble in water.

142. (a) The pH of the solution can be calculated by using the following formula:

$$pH = - \log (H_3O^+)$$
$$pH = - \log (1 \times 10^{-4})$$
$$pH = 4$$

To find out pOH, we can use the following equation:

$$pH + pOH = 14$$
$$4 + pOH = 14$$
$$pOH = 10$$

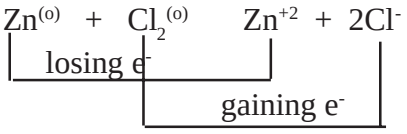
143. (d) Phosphoric acid (H_3PO_4) should be classified as a weak acid. Below is the list of strong and weak acids.

Strong acids	Weak acids
HCl	H_2SO_3
$HClO_3$	H_3PO_4
H_2SO_4	CH_3COOH
HNO_3	H_2CO_3

144. (b) Moles of HCl = 0.365/36.5 = 0.01 moles into 1000 cc of solution. As per the definition of molarity, the H_3O^+ ion concentration should be 0.01M.

$$pH = - \log (H_3O^+)$$
$$pH = - \log (1 \times 10^{-2})$$
$$pH = 2$$

145. (a) This type of reaction is known as a Redox reaction.



In the above reaction, Zn is oxidized by losing 2 electrons whereas chlorine is reduced by gaining 2 electrons. Therefore, chlorine should be considered an oxidizing agent whereas zinc should be defined as a reducing agent.

146. (a) For any electronic cell, the total voltage of the cell is the sum of oxidation and reduction reaction voltages. It can be calculated by using the following formula:

$$EMF_{(Cell)} = EMF_{Oxidation} + EMF_{Reduction}$$

From the given equation, we can say that aluminum is oxidized while zinc is reduced.

Therefore, the EMF of the cell can be:

$EMF_{(Cell)} = 1.66 - 0.76$
$EMF_{(Cell)} = + 0.90$

(If you notice, we have used -0.76 volts instead of + 0.76, volts. The reason behind this is that the value of Zinc is given as an oxidation voltage. As zinc is reduced in the reaction, we should use an opposite value of voltage, which is -0.76.)

147. (b) Based on the principle of Le Chatelier's, if a dynamic equilibrium is disturbed by changing the conditions, the position of equilibrium moves to counteract the change. In this reaction, we have increased the concentration of C_2H_4, to counteract this change, more C_2H_4 will react with H_2, and therefore the concentration or molarity of C_2H_6 will increase.

148. (b) In order to determine whether the reaction is an exothermic or an endothermic one, we shall first calculate the enthalpy of the reaction.

$$\Delta H = H_{Products} - H_{Reactants}$$

$$\Delta H = [(MgO + 2(HCl)] - [(MgCl_2 + H_2O)]$$

$$\Delta H = [-143.8 + 2 (-22.1)] - [(-153.4) + (-68.3)]$$

$$\Delta H = + 33.7 \text{ kcal/mole}$$

The enthalpy of the reaction is positive, therefore the reaction should be considered endothermic. When the enthalpy of the reaction is negative, the reaction should be considered an exothermic reaction.

149. (c) From the reaction, we can say that when 2 moles of H_2S react with 3 moles of O_2, it generates 269 kcal.

$$\text{Moles of } H_2S = \frac{\text{weight of } H_2S \text{ in gm}}{\text{Molecular weight}}$$

$$\text{Moles of } H_2S = \frac{34 \text{ gms}}{34 \text{ gms/mole}} = 1 \text{ mole}$$

$$\text{Moles of } O_2 = \frac{\text{weight of } O_2 \text{ in gm}}{\text{Molecular weight}}$$

$$\text{Moles of } O_2 = \frac{96 \text{ gm}}{32 \text{ gm/mole}} = 3 \text{ moles}$$

There is 1 mole of H_2S and 3 moles of O_2, therefore the rate limiting reactant is H_2S.

2 moles of H_2S yields $\longrightarrow$ 269 kcal
1 mole of H_2S yields $\longrightarrow$?

$$= \frac{269 \times 1}{2} = 134.5 \text{ kcal}$$

150. (b) CH_3CH_2Cl (Ethyl chloride) is classified as an alkyl halide. Alkyl halides have the general formula RX, in which R is an alkyl or substituted alkyl group and X is any halogen atom, e.g. I, Br, Cl, F, etc.

151. (b) This problem can be solved by finding the moles of oxygen and carbon dioxide. As per the ideal gas equation, at STP, 1 mole of any gas is equal to 22.4 liters. Therefore,

Oxygen	Oxygen
22.4 liters	1 mole
10 liters	?

$$= \frac{10 \times 1}{22.4} = 0.446 \text{ moles}$$

From the equation, we can say that 2 moles of oxygen are required to produce 1 mole of carbon dioxide. Therefore, 0.446 moles of oxygen will yield:

$$= \frac{0.446 \times 1}{2} = 0.223 \text{ moles of } CO_2$$

Carbon dioxide		Carbon dioxide
1 mole	⟶	22.4 liters
0.223 moles	⟶	?

$$= 0.223 \times 22.4 = 4.995 \text{ liters} \cong 5 \text{ L}$$

152. (d) As per an ideal gas equation, at STP, 1 mole of gas occupies 22.4 liters. Therefore,

$$\text{Number of moles} = \frac{10 \text{ L}}{22.4 \text{L/mole}} = 0.446 \text{ moles}$$

$$\text{MW of unknown gas} = \frac{\text{weight in gram}}{\text{number of moles}}$$

$$\text{MW of gas} = \frac{50 \text{ gms}}{0.446 \text{ gm/mole}} = 112.10 \text{ gm/mole}$$

153. (a) In this question, the limiting reactant is Al. Therefore, we can say:

Al		Al_2O_3
4 moles yield	⟶	2 moles
8 moles yield	⟶	?

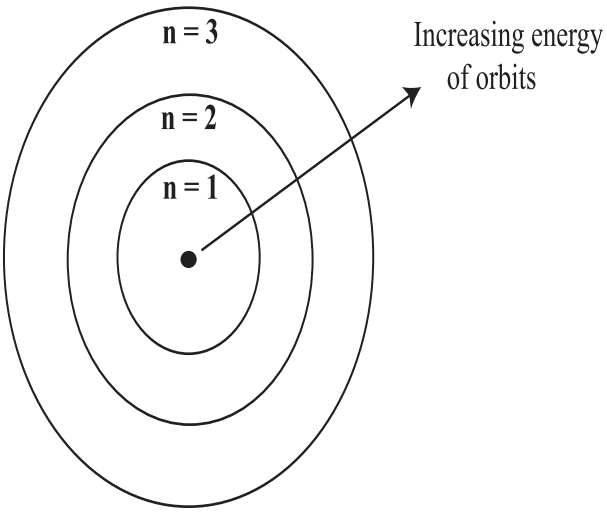
$$= \frac{8 \times 2}{4} = 4 \text{ moles of } Al_2O_3$$

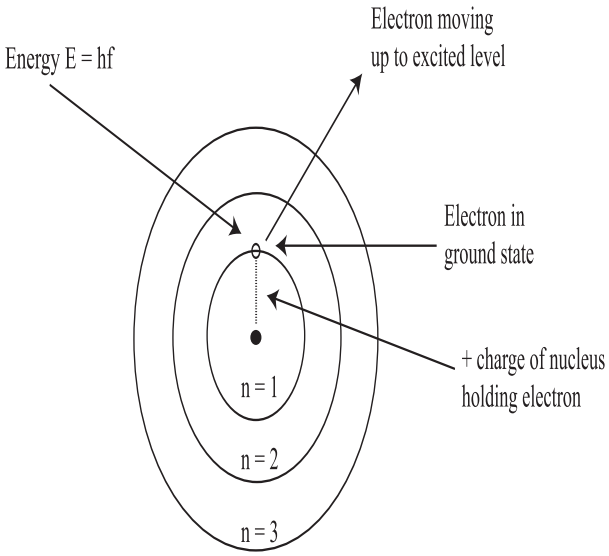
154. (c) A substance that contains unpaired electrons is attracted to a magnetic field. This substance is said to be paramagnetic. Among the given choices, only N has three unpaired electrons in the 2p orbital, therefore it should be called paramagnetic.

155. (d) A substance repelled by both poles of a magnet, or a substance in which the electrons are all paired, is said to be diamagnetic. Since in the above example, Hg does not have any unpaired electron, it is going to be diamagnetic.

156. (a) Ferromagnetism is a phenomenon by which a material can exhibit a spontaneous magnetization, and is one of the strongest forms of magnetism. It is responsible for most of the magnetic behavior encountered in everyday life and, along with ferrimagnetism, is the basis for all permanent magnets (as well as the metals that are noticeably attracted to them). A few materials, e.g. iron, cobalt, nickel, and alloys of these metals, have strong attraction to magnetic fields and are known as ferromagnetic metals.

157. (c) Niels Bohr, a Danish physicist, provided the first connection between the spectra of excited atoms and the quantum ideas of Planck and Einstein. According to his theory, an electron in the n = 1 orbit is close to the nucleus and thus held strongly by the positive charge of nucleus. To excite and move this electron up to the n > 1 level requires more energy compared to an electron present in n = 5 orbit (which is far away from the nucleus and therefore less strongly held by the positive charge of the nucleus.) We can get a better idea by understanding the following figures:





158. (b) According to the Bohr model, an electron is moved up to the higher orbit (n > 1) upon receiving energy. Thus, moving an electron from a state of low n to one of higher n requires it to absorb energy. An excited electron cannot remain for a longer period of time in higher orbits, as it tends to come back to lower orbits by releasing absorbed energy in the form of photon. Thus, the return of an electron from a higher n to one of lower n releases energy in the form of photons. Therefore, the correct choice should be "b".

159. (b) The limiting reagent in a chemical reaction is the one that is consumed completely.

160. (c) The quantity of heat evolved when one mole of a hydrocarbon is burned to carbon dioxide and water is called heat of combustion.

161. (c) Methane reacts with bromine at a high temperature and forms bromomethane. Bromination takes place somewhat less rapidly than chlorination. Methane does not react with iodine at all. With fluorine, it reacts so vigorously that reaction takes place even in the dark and at room temperature. We can, therefore, arrange the halogens in following order of reactivity.

$$F_2 > Cl_2 > Br_2 > I_2$$

162. (b) The correct IUPAC name of the compound is 2-Methylpentane.

163. (b) The warming of the earth is produced by the presence of certain gases in the atmosphere. The effect produced as greenhouse gases (carbon dioxide, CFC, methane, water vapors, nitrous oxide) allow incoming solar radiation to pass through the Earth's atmosphere, but prevent most of the outgoing long-wave infrared radiation from the surface and lower atmosphere from escaping into outer space. The greenhouse effect is a natural phenomenon necessary for life on earth; without it the planet's average temperature would be 0 degrees Fahrenheit, instead of 60 degrees. The concentration of greenhouse gases is rising today because of two factors:

1. The manufacturing of CFC (chlorofluorocarbon)

2. Burning of fossil fuels

If this trend is not reversed, it is predicted there will be a steady rise in the temperature of the earth. This global warming could cause drastic climate changes with devastating results.

164. (d) In Figure IV, the F atom is more negative than the C atom and therefore electrons are displaced more towards the F atom. This will make the molecule more polar.

The F atom has more electronegativity than Cl, H and CH_3, therefore the correct choice would be "d".

In Figure III "C" two "F" atoms stand opposite to each other and nullify each other's effects.

165 (a) The high boiling point of H_2O (100^o) compared to H_2S (-60^o) and H_2Se (-41^o) is attributed the the ability of O to make more H-bonds compared to S and Se. The strength of the most H-bonds ranges from 1 to 7 kcal/mole. Hydrogen bonding is also responsible for the higher solubility of polyhydroxy compounds.

166. (b) Due to electrostatic attraction, the negative pole of one molecule will try to line up with the positive pole of a neighboring molecule.

$$O{=}C <.....NR_3$$

This type of attraction is known as a dipole-dipole attraction and has a strength of 1 to 7 kcal/mole.

Sometimes electrons are concentrated in one region of the atom or molecule, and this displacement of electrons generally causes a nonpolar molecule to become a polar molecule, which results in an instantaneous dipole. Slowly, electrons in a neighboring atom or molecule may be displaced to produce a dipole; this is called the process of induction. A newly formed dipole is known as an induced dipole or debye force. Debye force has a strength of about 1 to 3 kcal/mole.

The attraction between two induced dipole molecules is known as dipole-induced dipole interaction, dispersion force or London force. This bond has a strength of about 0.5 to 1 kcal/mole.

Ion dipole or ion-induced dipole bonds: In a polar substance, when the positive end of one dipole tries to line up with the negative end of another dipole, it is called ion dipole or ion-induced dipole bonds

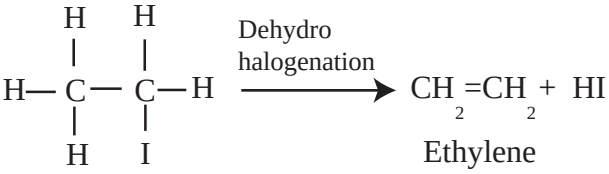
Hydrophobic bond: The association of nonpolar groups in an aqueous solution such as water, due to the tendency of aqueous solvents to exclude nonpolar molecules.

167. (d) A carbon atom to which four different groups are attached is called a chiral center, and that particular carbon is known as a chiral carbon. All the given choices have chiral centers.

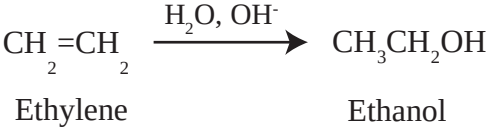
168. (c) A mixture of equal parts of enantiomers is called a racemic modification. The racemic modification is optically inactive. When enantiomers are mixed together, the rotation caused by a molecule of one isomer is exactly cancelled by an equal and opposite rotation caused by a molecule of its enantiomer.

169. (a) The correct structural formula for isopropyl chloride (2-Chloropropane) is:

170. (a) The dehydrohalogenation product of ethyl iodide is as follows::



171. (c) An oxidation of ethene in the presence of H_2O and diborane $(BH_3)_2$ produces ethanol:



172. (c) Dimethylsulfoxide (CH_3SOCH_3) is classified as an aprotic solvent. It is a solvent with moderately high dielectric constant, which does not contain acidic hydrogen.

Solvents like methanol and water are classified as protic solvents. These are solvents containing hydrogen that is attached to oxygen or nitrogen, and hence are acidic enough to form hydrogen bonds.

173. (d) Alkenes are groups of compounds with the general formula C_nH_{2n}.

$CH_3CH=CH_2$ (Propene) is a compound of the alkene family.

174. (c) The dehydration product of propanol in the presence of acid is propylene.

$$\underset{\text{(Propanol)}}{CH_3CH_2CH_2OH} \xrightarrow{\text{Acid}} \underset{\text{(Propylene)}}{CH_3CH=CH_2} + H_2O$$

175. (b) Halogenation of alkene usually yields dihaloderivatives of the compound. In this example, it will yield 1,2-Dibromopropane.

$$\underset{\text{(Propylene)}}{CH_3CH=CH_2} \xrightarrow{Br_2 \text{ in } CCl_4} \underset{\text{1,2-Dibromopropane}}{CH_3CHBrCH_2Br}$$

176. (d) The correct IUPAC name of the product should be 2-Iodopropane or Isopropyl iodide.

177. (c) The reduction or hydrogenation of alkene in the presence of Pt, Pd or Ni would generally yield alkane.

$$-C=C- \xrightarrow{\text{Pt, Pd, or Ni}} -\underset{H}{\overset{|}{C}}-\underset{H}{\overset{|}{C}}-$$

For example,

$$\underset{\substack{\text{(Propene}\\ \text{or}\\ \text{Propylene)}}}{CH_3CH=CH_2} \xrightarrow{\text{Pt, Pd, or Ni}} \underset{\text{(Propane)}}{CH_3CH_2CH_3}$$

Students sometimes find it difficult to recognize or differentiate alkenes from alkynes. The easiest way to differentiate them is by their suffix. Alkenes usually end with the letters ENE, whereas alkynes usually end with the letters YNE (except Acetylene which ends with ENE).

Example,

$\underset{\text{(PropENE or PropylENE)}}{CH_3CH=CH_2}$ $\underset{\text{(1-ButENE)}}{CH_3CH_2CH=CH_2}$

$\underset{\text{(AcetylENE)}}{CH\equiv CH}$ $\underset{\text{(PropYNE)}}{CH_3C\equiv CH}$

$\underset{\text{(1-ButYNE)}}{CH_3CH_2C\equiv CH}$

178. (d) The dehydration of n-butyl alcohol yields two products. The principal or chief product is 2-Butene whereas the minor product is 1-Butene.

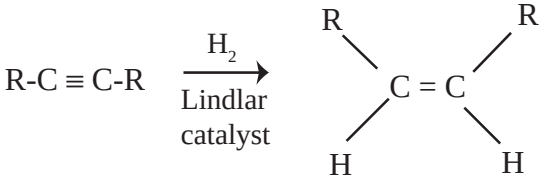
$$\underset{\text{n-Butyl alcohol}}{CH_3CH_2CH_2CH_2OH} \xrightarrow{\text{Acid}} \underset{\text{(2-Butene)}}{CH_3CH=CHCH_3} + \underset{\text{(1-Butene)}}{CH_3CH_2CH=CH_2}$$

179. (a) The reduction of an alkyne can be done two ways:

(1) In the presence of H_2 and a Lindlar catalyst

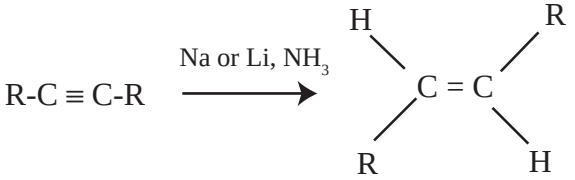
(2) In the presence of Na or Li, NH_3

Both reactions end up with two different geometric isomers of the sameproduct. For example, when reduction of an alkyne takes place in the presence of H_2 and a Lindlar catalyst, the product would be cis-alkene.



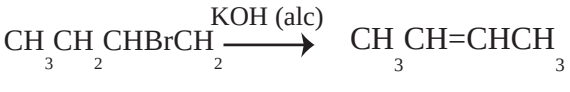
(Cis-alkene)

The reduction of an alkyne in the presence of Na or Li metal with ammonia produces trans-alkene. For example,



(Tras-alkene)

180. (c) The dehydrohalogenation of 2-Bromo butane would generally yield a mixture of isomeric alkenes.



2-Bromo butane (2-Butene 81%)

+

$CH_3CH_2CH=CH_2$

(1-Butene 19%)

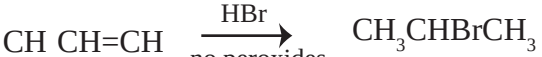
This pattern was first observed by Russian chemist Alexander Saytzeff, who in 1875 formulated a rule which can be stated as: in dehydrohalogenation, the preferred product is the alkene that has the greater number of alkyl groups attached to the doubly bonded carbon atoms. The alkene with the greater number of alkyl groups is the preferred product because it is formed faster than alternative alkenes. Therefore, 2-Butene (2-CH_3 groups) is the preferred product over 1-Butene (1-C_2H_5 group).

Ease of formation of alkenes

$R_2C = CR_2 > R_2C = CHR > R_2C = CH_2$,

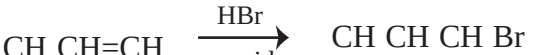
$RCH = CHR > RCH = CH_2$

181. (b) In 1933, M.S. Kharasch and F.R. Mayo at the University of Chicago, discovered that the orientation of the addition of hydrogen bromide (HBr) to the carbon-carbon double bond is determined solely by the presence or absence of peroxides. In the absence of peroxides, the addition of HBr follows the Markovnikov rule, and in the presence of peroxides, it follows the anti-Markovnikov rule. For example:



(Propylene) (Isopropyl bromide)

Markovnikov addition

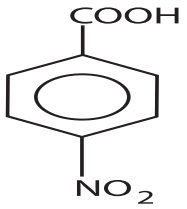


(Propylene) (n-propyl bromide)

Anti-Markovnikov addition

182. (b) To be aromatic, a compound must have a molecule that contains cyclic clouds of delocalized π electrons above and below the plane of the molecule. In addition, the π clouds must contain a total of (4n + 2) π electrons. This rule is known as the Huckel rule.

183. (b) The correct structural formula for p-Nitrobenzoic acid is as follows:



(Para-Nitrobenzoic acid)

184. (b) Decarboxylation. The removal of carboxylic acid groups from the compound is known as decarboxylation.

185. (c) The conductance of solution contains 1 gram of equivalent weight of the solute measured in a cell; when both electrodes are spaced 1 cm apart from each other, it is known as equivalent conductance.

186. (a) 0.0230

Beta max = 0.576 x C
Beta max = Maximum buffer capacity
C = Concentration in mole/lit

Beta max = 0.576 x C
= 0.576 x 0.04 mole/lit
= 0.0230

187. (c) When a reaction in second order contains a high concentration of one of the reactants (OH^- in our case), the rate of reaction generally depends on only one reactant and reaction will be known as pseudo first order.

Definition: Reaction kinetic is the study of rate of chemical degradation in which the rate is influenced by solvent, pressure, temperature and the concentration of products and reactants.

Reaction orders are generally classified into the following categories:

1. Zero order reaction
2. First order reaction
3. Second order reaction
4. Third order reaction
5. Pseudo first order reaction

1. Zero Order Kinetic Reaction: In this type of reaction, the rate of reaction is independent of the concentration of reactants. The rate of reaction is normally expressed by:

$- dc/dt = k$ where,

c = concentration of reactants
k = reaction rate of constant
t = time

$X = kt + constant$

Example: Most of the photochemical degradations are classified as zero order kinetic.

2. First Order Reaction: When the rate of reaction is proportional to the first power of concentration of the reactant.

$Log C_o/C = kt / 2.303$ where

Co = concentration of reactant at time t = 0
C = concentration of reactant at time t
k = rate constant
t = time

* The rearrangement of this equation can be expressed as follows:

$$k = \frac{2.303}{t} \times \log \frac{Co}{C}$$

$$k = \frac{2.303}{t} \times \log (a)/(a-x)$$

where a = initial concentration at time (t) = 0
x = the amount of reactant reacted in time (t)
a-x = the amount of reactant left after time (t)

The half-life of a drug in first order kinetic can be calculated as follows:

$$k = \frac{2.303}{t_{1/2}} \times \log Co / Co/2$$

$$k = \frac{2.303}{t_{1/2}} \times \log 2$$

$$t_{1/2} = 0.693/k$$

3. Second Order Reaction: When the rate of reaction is found to be proportional to the concentration of each of the two reactants or to the second power of the concentration of one reactant; it is defined as a second order kinetic reaction.

It is normally expressed by the following formula:

$dx/dt = k (a-x) (b-x)$ where,

a = concentration of reactant A at time t
b = concentration of reactant B at time t
dx/dt = rate of reaction
k = reaction constant
x = number of moles of reactant A & B at time t

If the concentration of A and B are equal then a = b and therefore,

$$dx/dt = k (a-x) (a-x)$$
$$= k (a-x)^2$$

integration of above equation will yield,

$$K = \frac{1}{t} \cdot \frac{x}{a (a-x)}$$

The half life of the second order kinetic reactions can be calculated by as follows:

When $t = t_{1/2}$, $x = (a-x)$ and therefore,

$k = 1 / t_{1/2}\, a$,

$t_{1/2} = 1 / ka$

When the concentration of reactant A and B are not equal, the second order reaction can be expressed by the following formula:

$$k = \frac{2.303}{t (a-b)} \log \frac{b (a-x)}{a (b-x)}$$

Example: saponification of an ester

$$CH_3COOC_2H_5 + OH^- \longrightarrow CH_3COO^- + C_2H_5OH$$

4. Third Order Reaction: When the rate of reaction is found to be proportional to the concentration of each of three reactants, or proportional to the concentration of one of two reactants and to the second power of concentration of the other reactant, or proportional to the third power of the concentration of the single reactant, it is defined as a third order kinetic reaction.

It can be expressed by the following equation:

$dx/dt = k (a-x) (b-x) (c-x)$

where a, b, and c are concentrations of reactants A, B, and C.

When a = b = c

$dx/dt = k (a-x) (a-x) (a-x)$
$dx/dt = k (a-x)^3$

Upon integration,

$k = 1/2t [1/(a-x)^2 - 1/a^2]$

5. Pseudo First Order Reaction: When the rate of reaction is found to be proportional to two reactant species, it is defined as a second order reaction. However, in a some cases the rate of a second order reaction is proportional to the concentration of only one reactant; a reactant that is present in great excess and this time second order reaction behaves like the first order reaction.

For example, saponification of ester in the presence of an excessive hydroxyl concentration.

$$CH_3COOC_2H_5 + OH^- \text{ (excessive amount)} \longrightarrow$$

$$CH_3COO^- + C_2H_5OH$$

188. (c) A half life equation for zero-order kinetic is $t_{1/2} = a / 2K$:

$t_{1/2}$	=	Half life
K	=	Rate constant
a	=	Initial concentration of drug

189. (b) 2

$$Al_2(SO_4)_3 + 3CaCO_3 + 4CH_3COOH$$

$$= 2Al(CH_3COO)_2 OH + 3CaSO_4 + 3CO_2 + H_2O$$

190. (c) 9 times.

$$\frac{dx}{dt} = k (a-x) (a-x)$$
$$= k (a-x)^2$$
$$= k a^2$$

The concentration of reactant a is triple that of its original concentration, therefore we can say:

$a = 3a$

By putting this value in the above equation:

$$= k (3a)^2$$
$$= k 9 a^2$$
$$= 9 k a^2$$

191. (c) $HClO_4 > H_2CO_3 > NH^{4+} > CH_3OH$

The acidity of a substance is expressed by the ability of a substance to give away the H^+ ions. For example in $HClO_4$, ClO_4^- is a powerful electron withdrawal and this will make its hydrogen ion electronless and more positive. A small amount of energy is required to remove hydrogen ions from the above substance. Hydrogen ions can easily dissociate from the above molecule, and therefore it is a strong acid.

In the example of CH_3OH, it is practically impossible to release the hydrogen ions from OH^- since oxygen is sharing its electron with hydrogen ions to form an octet. Therefore it is less acidic in nature.

192. (c) To answer this refer to the following chart.

Below is the list of compounds that direct ortho and para positions:

-NH_2
-OR
-OH
-OCOR
-R
-X (Halogens)

The list of groups that direct Meta positions include:

-NO_2
-CN
-SO_3H
-CHO
-COR
-COOH
-COOR

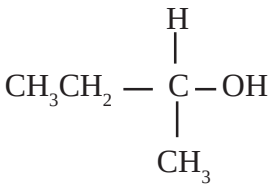
We have to find the chlorination product for nitrobenzene (-NO_2 group), therefore the principal product would be meta-chloronitrobenzen.

193. (a) The nitration of benzaldehyde will result in meta-nitrobenzaldehyde.

194. (c) Alcohol can be classified as primary, secondary or tertiary on the basis of the hydroxy group attached to the carbon. If the C atom has one -OH group, two H atoms and one R group, the alcohol is a primary alcohol (ethanol). If the C atom has one -OH group, one H atom and two R groups, the alcohol is secondary alcohol (2-butanol). If the C atom has one -OH group, no H atoms and three R groups, such as 2-methyl-2 propanol, the alcohol is tertiary alcohol.

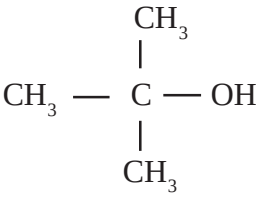
CH_3CH_2OH Primary alcohol

(Ethanol)



Secondary alcohol

(2-butanol)



Tertiary alcohol

(2-Methyl-2-propanol)

195. (b) Acetyl phenyl ketone.

196. (c) We know that a low PKa is interpreted as an acidic compound. We have to find which compound has more acidity. To find out the acidity, we have to find the compound that can easily give away its hydrogen. In the given choices, Aniline is the compound that has an aromatic benzene ring (unsaturated). The nitrogen of the amino group will donate its electron to the unsaturated benzene ring, This will allow the hydrogen ion to leave the benzene ring easily.

The other choices such as Methylamin(CH_3NH_2) and ethylamine ($CH_3CH_2NH_2$) have methyl and ethyl (saturated, not hungry for the electrons) respectively, and will not make hydrogen easily available in the solution.

197. (b) To solve this question, the same rule will apply. Below is the chart of the electron withdrawal groups and electron donor groups.

Electron withdrawal groups:

-NO_2 -COR
-CN -COOH
-SO_3H -COOR
-CHO

Electron donor groups:

$-NH_2$	-OCOR
-OR	-R
-OH	-X (Halogens)

In choice "B," 2,4,6 trinitrophenol has three $-NO_2$ groups (electron hungry groups), that will try to withdraw the electron from the available benzene ring. This will make the benzene ring more unsaturated. To fulfill the unsaturation created by nitrogroups, the benzene ring will pull the electron from the available -OH group, which will make hydrogen more positive and easily available.

198. (b) $CH_2 = CH_2$ is classified as SP^2 hybridization. The electronic configuration of carbon atoms is $1S^2\ 2S^2\ 2P_x^1\ 2P_y^1\ 2P_z^0$. This electron configuration normally changes in excited states, as below:

$1S^2\ 2S^1\ 2P_x^1\ 2P_y^1\ 2P_z^1$

The union of two carbon atoms of this type produces a multiple bond, involving two electron pairs (a double bond). Overlaps of SP^2 orbitals form a sigma bond and P orbital overlap produces a pi bond.

199. (c) C = C bonds require the highest amount of energy to break the bonds. They require 193 kcal/mole to dissociate bond. Cl-Cl bonds require the least amount of energy (about 57.8 kcal/mole) for dissociation.

Bonds	Energy required (Kcal/mole)
H-H	103.2
H-Cl	102.1
O-H	109.4
N-H	92
C-H	98
C-Cl	78

Bonds	Energy required (Kcal/mole)
Cl-Cl	58
C-C	80
C=O	152
C=C	193

200. (c)

$Ka = Kw / Kb$

$= 1 \times 10^{-14} / 1 \times 10^{-4}$

$= 1 \times 10^{-10}$

$[H_3O^+] = \sqrt{Ka \times Ca}$

$= \sqrt{1 \times 10^{-10} \times 9 \times 10^{-2}}$

$= 3 \times 10^{-6}$

Quantitative Ability Answers

Important Mathematical Formulas:

1. $\binom{n}{r} = \frac{n!}{r!(n-r)!}$

2. $nPr = \frac{n!}{(n-r)!}$

3. If $ax^2 + bx + c = 0$, $a \neq 0$, the following equation should be used:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

4. If $ax^2 + bx + c = 0$, $a \neq 0$, and $b^2 - 4ac < 0$, then the following equation should be used:

$$\frac{-b \pm i\sqrt{b^2 - 4ac}}{2a}$$

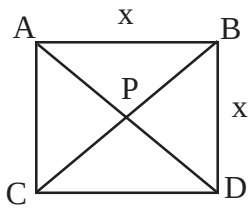
5. $(a^2 - b^2) = (a - b)(a + b)$
6. $(a + b)^2 = a^2 + 2ab + b^2$
7. $(a - b)^2 = a^2 - 2ab + b^2$

8. Distance formula: To find the distance between two points on the line,

$$d(P,Q) = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

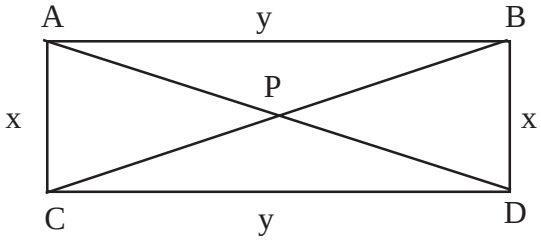
9. Midpoint formula: $M = \left(\frac{x_2 + x_1}{2}, \frac{y_2 + y_1}{2}\right)$

10. Sqaure:



1. Area (A) = x^2, where x = side of square
2. Perimeter(P) = 4x, where x = side of square
3. The diagonal of every square bisect each other, therefore AP = PD and CP = PB
4. The diagonal of every square are congruent, therefore AD = BC

11. Rectangle:

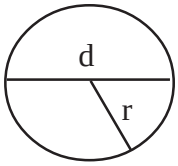


1. Area (A) = xy, where x and y = sides of rectangle
2. Perimeter(P) = 2x + 2y, where x and y = sides of rectangle
3. The diagonal of every rectangular bisect each other, therefore AP = PD and CP = PB
4. The diagonal of every rectangular are congruent, therefore AD = BC

12. Rectangular solid:

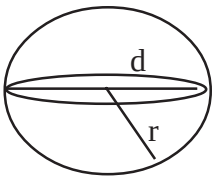
1. Area (A) = 2xy + 2yz + 2zx, where x and y = sides of rectangle and z is the height of the rectangular
2. Volume(V) = xyz, where x and y = sides of rectangle and z is the height of the rectangular

13. Circle:



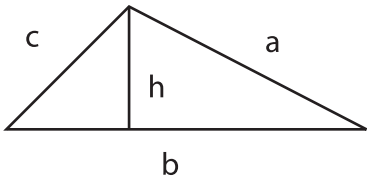
1. Area (A) = πr^2, where r = radius of the circle
2. Circumference (C) = $2\pi r = \pi d$, where r = radius and d = diameter of the circle

14. Sphere:



1. Area (A) = $4\pi r^2$, where r = radius of the circle
2. Volume (V) = $\frac{4}{3}\pi r^3$ where r = radius and d = diameter of the circle

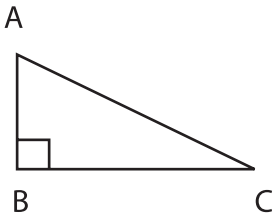
15. Triangle:



1. Area (A) = $\frac{1}{2}bh$ where b = base and h = height of the triangle

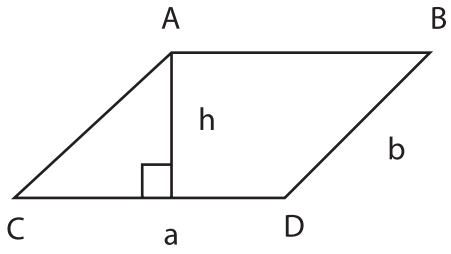
2. Perimeter(P) = a + b + c where a, b and c = sides of triangle

16. Right angle triangle:



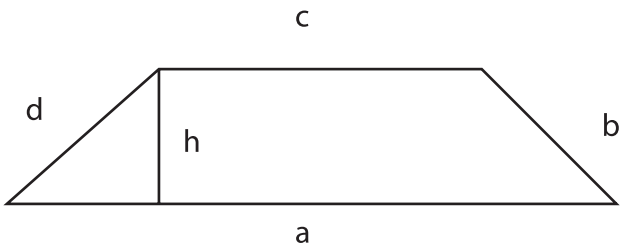
$AC^2 = AB^2 + BC^2$

17. Parrallelogram:



1. Area (A) = ah, where a = base and h = height
2. Perimeter(P) = 2a + 2b, where a and b = sides of parrallelogram
3. In parallelograms, opposite angles are always congruent. e.g. $\angle CAB = \angle CDB$
2. In parallelograms, the sum of the consecutive angles is 180^o. e.g. $\angle CDB + \angle DBA = 180^o$

18. Trapezoid:



1. Area (A) = $\frac{1}{2}$ h (a + c), where a and c = bases and h = height
2. Perimeter(P) = a + b + c + d, where b and d = sides and a and c = bases of trapezoid

19. Cube:

1. Area (A) = $6x^2$, where x = side of the cube
2. Volume (V) = x^3, where x = side of the cube

20. Right circular cylinder:

1. Area (A) = $2\pi rh + 2\pi r^3$ where r = radius and h = height of the cylinder
2. Volume (V) = $\pi r^2 h$, where r = radius and h = height of the cylinder

1. (b) These types of problems can be solved by using the SET THEORY. There are few terminologies and equations you should keep in mind to solve these problems.

1. (U) = It is known as universal set. The universal set depends on the context.

2. $A \subset B$ = When every element of set A also belongs to set B, then set A is said to be the subset of B. For example,

$A = \{1, 2, 3\}$ and $B = \{0, 1, 2, 3, 4\}$

3. When $A \subset B$ and $B \subset A$, then A = B or they are called equal sets.

4. $A \cup B$ = The set consisting of all elements which are in A or in B is called the union of A and B, and is denoted by $A \cup B$. For example,

$A = \{1, 2, 3\}$ and $B = \{0, 1, 2, 3, 4\}$

$A \cup B = \{0, 1, 2, 3, 4\}$

5. $A \cap B$ = The set consisting of all elements which are common in both A and B is called the intersection of A and B, and is denoted by $A \cap B$. For example,

$A = \{1, 2, 3\}$ and $B = \{0, 1, 2, 3, 4\}$

$A \cap B = \{1, 2, 3\}$

6. (A') = The set consisting of all those elements of U which are not in A is called the component of A and is denoted by A'. For example,

$U = \{1, 2, 3, 4, 5\}$ and $A = \{1, 2\}$ then,

$A' = \{3, 4, 5\}$

7. De Morgan's Laws:

1. $(A \cup B)' = A' \cap B'$
2. $(A \cap B)' = A' \cup B'$

Let A be the set of students drinking milk, then n(A) = 400

Let B be the set of students drinking coffee, then n(B) = 300

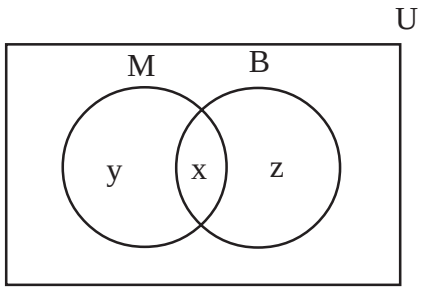
The set of students drinking both milk and coffee is $A \cap B$, therefore $n(A \cap B) = 150$

Finally, let the set of students of the school be U, therefore n(U) = 800

The set of students drinking neither coffee nor milk should be $A' \cap B' = (A \cup B)'$

$$\begin{aligned} n(A \cup B)' &= n(U) - n(A \cup B) \\ &= n(U) - [n(A) + n(B) - n(A \cap B) \\ &= 800 - 400 - 300 + 150 \\ &= 250 \end{aligned}$$

2. (a) 8. This type of problem can also be solved by using a Venn diagram.



Let x = a number of students taking mathematics as well as biology.

Let y = a number of students taking mathematics but not biology.

From a Venn diagram, we can say:

$$x + y = 24$$
$$x + 16 = 24$$
$$x = 8$$

3. (b) This type of problem can be solved by using the Binomial Theorem. Let say a = 2x, b = y and n = 5

$$(a+b)^n = \binom{n}{0} a^n + \binom{n}{1} a^{n-1} b + \binom{n}{2} a^{n-2} b_2 + \ldots\ldots\ldots\ldots \binom{n}{r} a^{n-r}$$

Therefore,

$$(2x+y)^5 = \binom{5}{0}(2x)^5 + \binom{5}{1}(2x)^{5-1}(y) + \binom{5}{2}(2x)^{5-2}(y)^2 + \binom{5}{3}(2x)^{5-3}(y)^3 + \binom{5}{4}(2x)^{5-4}(y)^4 + \binom{5}{5}(y)^5$$

$$= 1\,(32x^5) + \frac{5}{1}(16x^4)\,y + \frac{5*4}{1*2}(8x^3)\,y^2 + \frac{5*4*3}{1*2*3}(4x^2)\,y^3 + \frac{5*4*3*2}{1*2*3*4}(2x)\,y^4 + 1\,(y^5)$$

$$= 32x^5 + 80x^4y + 80x^3y^2 + 40x^2y^3 + 10x\,y^4 + y^5$$

4 (d) $3.\binom{n}{3} = 7.\binom{n}{2}$ therefore,

$$3.\frac{n!}{3!(n-3)!} = 7.\frac{n!}{2!(n-2)!}$$

$$\frac{3.2!}{7.3!} = \frac{(n-3)!}{(n-2)!}$$

$$\frac{1}{7} = \frac{1}{n-2}$$

$$n-2 = 7$$

$$n = 9$$

5. (c) $nPr = 24.\binom{n}{r}$ therefore,

$$\frac{n!}{(n-r)!} = 24\ \frac{n!}{(n-r)!\,r!}$$ therefore,

$$r! = 24$$

$$r! = 1 \times 2 \times 3 \times 4 = 4!$$

$$r = 4$$

6. (b) 3x - 10 = 5x -5 + 2 therefore,

$$3x - 5x = 10 - 5 + 2$$
$$-2x = 7$$
$$x = -\frac{7}{2}$$

7. (d) Subtract 4 from all parts of the inequality, and then divide everything by 3 to find out the value of x.

$$-10 \le 3x + 4 < 20$$
$$-10 - 4 \le 3x + 4 - 4 < 20 - 4$$
$$-14 \le 3x < 16$$
$$-\frac{14}{3} \le x < \frac{16}{3}$$

Therefore, the answer in interval form should be [-14/3, 16/3).

8. (c) [1, ∞) or (-∞, –9/5]

$5x + 2 \ge 7$	or	$5x + 2 \le -7$
$5x \ge 5$	or	$5x \le -9$
$x \ge \frac{5}{5}$	or	$x \le -\frac{9}{5}$
$x \ge 1$	or	$x \le -\frac{9}{5}$

9. (b) In order to solve this problem, first we need to find out the value of (f-g)(x).

$$(f-g)(x) = f(x) - g(x) = x^2 - 5x - 6 - x - 3$$
$$= x^2 - 6x - 9$$

$$(f-g)(-1) = (-1)^2 - 6(-1) - 9$$
$$= 1 + 6 - 9 = -2$$

10. (b) To solve this problem, we have to substitute x for g(x) in f(x).

$f(g(x)) = f(x - 1) = (x-1)^2 - 2(x - 1) + 12$

$= x^2 - 2x + 1 - 2x + 2 + 12$
$= x^2 - 4x + 15$

11 (d) To find out the inverse function, we should follow the steps below:

1. Rewrite the function using y instead of f(x).
2. Switch the x and y variables.
3. Find the value of y for new equation.
4. Finally, replace y with $f^{-1}(x)$

Rewriting f(x) = y,

$y = (5x + 6)^{1/2}$, switching x and y variables,

$x = (5y + 6)^{1/2}$
$x^2 = 5y + 6$
$y = \frac{x^2 - 6}{5}$, substituting $y = f^{-1}(x)$

$f^{-1}(x) = \frac{x^2 - 6}{5}$

12. (b) $g(x) = 2x^2 + 3$, therefore
$g(f(x)) = g(3x + 2) = 2(3x + 2)^2 + 3$
$= 2(9x^2 + 12x + 4) + 3$
$= 18x^2 + 24x + 8 + 3$
$= 18x^2 + 24x + 11$

13. (c) $f(x) = x^2 - 2x + 3$ therefore,

$f(f(x)) = f(x^2 - 2x + 3)$

$= (x^2 - 2x + 3)^2 - 2(x^2 - 2x + 3) + 3$
$= (a + 3)^2 - 2(a + 3) + 3 \quad (a = x^2 - 2x)$
$= a^2 + 6a + 9 - 2a - 6 + 3$
$= a^2 + 4a + 6$
$= (x^2 - 2x)^2 + 4(x^2 - 2x) + 6$ (replacing $a = x^2 - 2x$)
$= x^4 - 4x^3 + 4x^2 + 4x^2 - 8x + 6$
$= x^4 - 4x^3 + 8x^2 - 8x + 6$

14. (b) In order to solve this function, first we need to find out the value of g(hx).

g(h(x)) = g(2x), therefore

g(2x) = (2x) - 1 (where g(x) = x - 1)
g(h(x)) = 2x -1

Now, we can find the value of f(g(hx))

$f(x) = x^2 + x = 1$
$f(g(hx)) = f(2x-1)$
$f(2x-1) = (2x - 1)^2 + (2x-1) + 1$
$f(2x-1) = 4x^2 - 4x + 1 + 2x - 1 + 1$
$f(2x-1) = 4x^2 - 2x + 1$
$f(g(hx)) = 4x^2 - 2x + 1$

15. (c) $f(x) = \frac{1 - x}{1 + x}$

$$f(f(x)) = \frac{1 - \frac{1 - x}{1 + x}}{1 + \frac{1 - x}{1 + x}}$$

$$f(f(x)) = \frac{\frac{x + 1 - 1 + x}{x + 1}}{\frac{x + 1 + 1 - x}{x + 1}}$$

$f(f(x)) = \frac{2x}{2} = x$

16. (d) $f(x) = 2x^2 - 5x + 6$ and $g(x) = 2x + 3$,

$(f-g)(x) = 2x^2 - 5x + 6 - 2x - 3$
$(f-g)(x) = 2x^2 - 7x + 3$
$(f-g)(5) = 2(5)^2 - 7(5) + 3$
$(f-g)(5) = 50 - 35 + 3 = 18$

17. (a) $f(x) = 5x^3 + 7x^2 + 2x$, $g(x) = 2x^2 + 4x$

$$\left(\frac{f}{g}\right)(x) = \frac{f(x)}{g(x)} = \frac{5x^3 + 7x^2 + 2x}{2x^2 + 4x}$$

$$= \frac{x(5x^2 + 7x + 2)}{x(2x + 4)} = \frac{5x^2 + 7x + 2}{(2x + 4)} \quad \text{if } x \neq -2$$

18. (a) $f(x) = 2x^3 + 5x + 7$, $g(x) = 5x - 7$

$(f + g)(x) = 2x^3 + 5x + 7 + 5x - 7$
$(f + g)(x) = 2x^3 + 10x$

19. (c) First, we need to find out the value of f(fx).

$$(fx) = 1 - \frac{1}{x} = \frac{x - 1}{x}$$

$$f(f(x)) = \frac{\frac{x - 1}{x} - 1}{\frac{x - 1}{x}} = \frac{\frac{x - 1 - x}{x}}{\frac{x - 1}{x}}$$

$$f(f(x)) = \frac{1}{1 - x}$$ Now, we can find the value of f(f(fx)).

$$f(x) = \frac{x - 1}{x}$$

$$f(f(fx)) = \frac{\frac{1}{1 - x} - 1}{\frac{1}{1 - x}}$$

$$f(f(fx)) = \frac{\frac{1 - 1 + x}{1 - x}}{\frac{1}{1 - x}} = x$$

20. (b) $f(x) = y$,

$y = 3x + 2$
$x = 3y + 2$ (replacing x an y variables)
$x - 2 = 3y$
$y = f^{-1}(x) = \frac{x - 2}{3}$

21. (b) $g(x) = (go)(fof^{-1}(x)) = (gof)(f^{-1}(x))$

$$(gof)(f^{-1}(x)) = (gof)\left(\frac{x - 2}{3}\right) = 6\left(\frac{x - 2}{3}\right) + 7$$

$(gof)(f^{-1}(x)) = g(x) = 2x + 3$

22. (c) To solve this problem, first we need to find out the value of fg(x).

$(fg)(x) = f(x)*g(x) = (x + 2)(x - 2) = x^2 - 4$
$(fg)(x) = y = x^2 - 4$
$x = y^2 - 4$
$y^2 = x + 4$
$y = (fg)^{-1}(x) = (x + 4)^{1/2}$

23. (c) $f(x) = y = ax + b$
$y = ax + b$
$x = ay + b$
$ay = x - b$
$y = f^{-1}(x) = \frac{x - b}{a}$

24. (d) In order function to be an inverse, a function must be one to one. A function is a one-to-one if no two different elements in D have the same element in R. The definition of a one to one function can be written algebraically as follows: A function f(x) is one-to-one if x1 is not equal to x2 (x1 and x2 any elements of D) then f(x1) is not equal to f(x2). For example, if f : Z Z (Z is the set of positive and negative integers include zero) and $f(x) = x^2$, then:

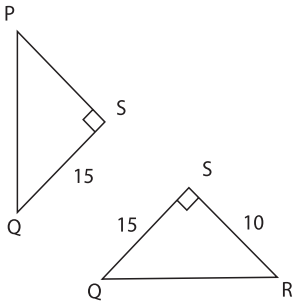
$f(3) = 3^2 = 9$ and $f(-3) = (-3)^2 = 9$

Thus, for two different values of x (3 and -3), we get a common function value f(x) = 9, and therefore according to definition, the function $f(x) = x^2$ is not one-to-one, so its inverse function does not exist.

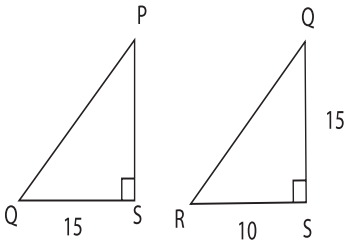
177. (a) Using the same proportional formula:

$$\frac{PS}{PS+SQ}=\frac{ST}{QR}$$
$$\frac{3}{3+9}=\frac{ST}{25}$$
$$ST=25.\left(\frac{3}{12}\right)$$
$$ST=\frac{25}{4}=6.25$$

178. (b) If we carefully observe the figure, we can see the following triangles, one of which is bigger and the other which is smaller.

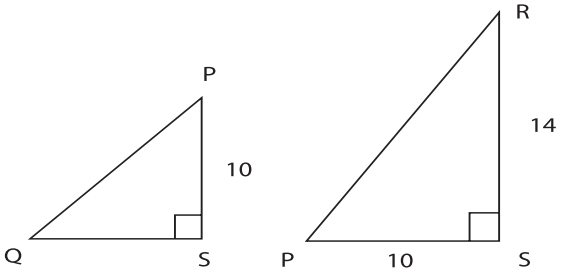


Rearranging both triangles,



$$\frac{PS}{QS}=\frac{QS}{RS}$$
$$\frac{PS}{15}=\frac{15}{10}$$
$$PS=\frac{15x15}{10}=\frac{225}{10}=22.5$$
$$\overline{PR}=\overline{PS}+\overline{SR}$$
$$\overline{PR}=22.5+10$$
$$\overline{PR}=32.5$$

179. (c) We can split the figure into two right angles.

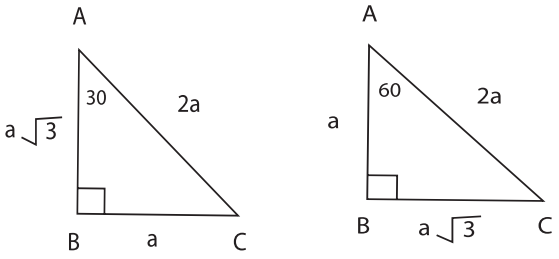


Using the same proportional formula, we can say:

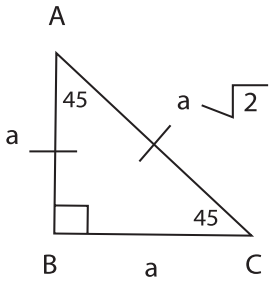
$$\frac{QS}{PS}=\frac{PS}{RS}$$
$$QS=\frac{PS.PS}{RS}$$
$$QS=\frac{10.10}{14}$$
$$QS=7.142$$

180. (b) Before we solve this type of problem, we must remember the following properties of right angle triangles.

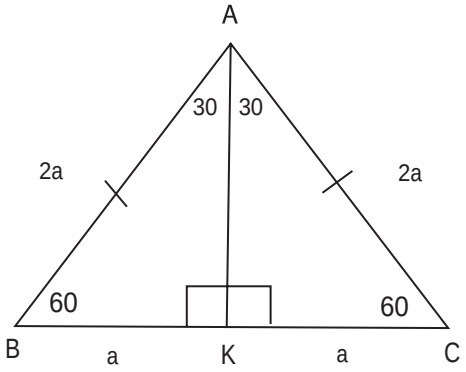
1. In a 30°-60°-90° triangle, the hypotenuse is twice the length of the shorter side, and the longer side length is the product of the shorter side length and the square root of three.



2. In an isosceles right triangle, the length of the hypotenuse is the length of a leg multiplied by the square root of two.



3. The altitude of an equilateral triangle forms two smaller congruent triangles that are 30°-60° - 90° triangles.



In question 180, ∠ A = 30°, ∠B = 90° and ∠ c = 60°. Therefore, BC is the shorter side. As per the rule, in a 30°-60°-90° triangle, the hypotenuse is the twice the length of the shorter side. So the length of AC should be:

$$\overline{AC} = 2\overline{BC}$$
$$\overline{AC} = 2(5)$$
$$\overline{AC} = 10$$

181. (d) Time to clean the whole house:

$$= \frac{7}{\left(\frac{4}{5}\right)}$$
$$= \frac{7x5}{4}$$
$$= \frac{35}{4} = 8\frac{3}{4}$$

182. (c) To solve percentage related problems, we use the following equation:

$175 = 100 percent
$35 = ?

$$= \frac{35x100}{175}$$
$$= 20\%$$

183. (c) 6% of $3\frac{5}{2}$ is:

$$= \frac{\frac{11}{2}x6}{100} \quad \left(3\frac{5}{2} = \frac{11}{2}\right)$$
$$= \frac{11x6}{200}$$
$$= 0.33$$

184. (a) 20% of 500 liters is:

$$= \frac{500x20}{100}$$
$$= \frac{500}{5} = 100 \text{ liters}$$

185. (d) Find 33% of $\frac{7}{3}$ of $\frac{5}{8}$

$$= \frac{33}{100} x \frac{7}{3} x \frac{5}{8}$$
$$= \frac{11x7x5}{100x8}$$
$$= \frac{11x7}{20x8}$$
$$= 0.481$$

186. (c) $= \frac{13}{45} x100$

$= 28.88\%$

187. (d) 22% of $4\frac{1}{2}$ of $\frac{3}{8}$:

$= \frac{9}{2} x \frac{3}{8} x \frac{22}{100}$

$= \frac{27x11}{8x100} = 0.371$

188. (c) 2.5% of $\frac{5}{7} \div \frac{2}{7}$.

$= \frac{2.5}{100} x \frac{5}{7} x \frac{7}{2}$

$= 0.0625$

$= 6.25x10^{-2}$

189. (d) 0.45% of $\frac{2}{6}$ of $\frac{3}{8}$.

$= \frac{0.45}{100} x \frac{2}{6} \text{ x } \frac{3}{8}$

$= 0.056 \text{ x } 10^{-2}$

190. (a) $= \left(\frac{3}{4} \div \frac{5}{6}\right) \text{ x } 100$

$= \frac{3}{4} \text{ x } \frac{6}{5} \text{ x } 100$

$= 90\%$

191. (a) Suppose that the event that a clerk remains absent on any working day is denoted by A. Similarly the event that a peon remains absent is denoted by B. According to the information given in the problem:

P(A) = 0.08, P(B) = 0.05 and P(A∩B) = 0.02

Now A∪B denotes the event that at least one of the two employees remains absent on any working day. Therefore, the probability of this event is:

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

$$P(A \cup B) = 0.08 + 0.05 - 0.02$$

$$P(A \cup B) = 0.11$$

192. (b) There are a total of 14 balls in a box. 3 balls can be drawn at random in $\binom{14}{3}$ = 364ways.

$$\frac{n!}{r!(n-r)!} = \frac{14!}{3!(11)!} = \frac{12x13x14}{1x2x3} = 364$$

Therefore n = 364.

Suppose E denotes the event that three balls drawn all are white. There are 4 white balls in the box and 3 white balls can be drawn in $\binom{4}{3}$ = 4 ways.

$$\frac{n!}{r!(n-r)!} = \frac{4!}{3!(1)!} = \frac{1x2x3x4}{1x2x3} = 4$$

$$P(E) = \frac{4}{364}$$

$$P(E) = \frac{1}{91}$$

$$P(E) = 0.010$$

193. (a) The sum of probability of success and failure is always equal to 1. It is denoted by the following formula:

p + q = 1, where

p = probability of success
q = probability of failure

Therefore:

$0.3 + q = 1$
$q = 0.7$

194. (a)

$p + q = 1$
$p + 0.6 = 1$
$p = 0.4$
$p = 0.4 \times 100$
$p = 40\%$

195. (c) We have a total of 12 balls. One out of 12 balls can be drawn $\binom{12}{1}$.

$$\binom{12}{1} = \frac{12!}{1!(12-1)!}$$

$$= \frac{12!}{1!(11)!}$$

$$= 12$$

Therefore, n = 12.

Let A be the event that the ball drawn is white or red. Since there are 4 white and 5 red balls, the ball drawn must be one of these (4 + 5 = 9) Therefore,

$$\binom{n}{r} = \frac{n!}{r!(n-r)!}$$

$$\binom{9}{1} = \frac{9!}{1!(9-1)!}$$

$$\binom{9}{1} = \frac{9!}{1!(8)!} = 9$$

$$P(A) = \frac{9}{12}$$

$$P(A) = \frac{3}{4}$$

$$P(A) = 0.75$$

196. (a) The number of ways of drawing 2 cards from 52 = $\binom{52}{2} = \frac{52!}{2!(52-2)!}$

$$= \frac{52!}{2!(50)!}$$

$$= \frac{51x52}{2}$$

$$= 26x51 = n$$

Event A = both are heart cards. There are 13 heart cards out of 52 cards. Hence, the number of ways of drawing 2 cards out of 13 is as follows:.

$$\binom{13}{2} = \frac{13!}{2!(13-2)!}$$

$$= \frac{13!}{2!(11)!}$$

$$= \frac{12x13}{2}$$

$$= 78 = r$$

$$P(A) = \frac{r}{n}$$

$$P(A) = \frac{78}{26x51} = \frac{1}{17}$$

197. (c) The number of ways of selecting 3 bulbs from 8 = $\binom{8}{3} = \frac{8!}{3!(8-3)!}$

$= \frac{8!}{3!(5)!}$

$= \frac{6x7x8}{2x3}$

$= 56$

Let A be the event of the room being lit. For A to happen, one, two or all three of the selected bulbs should be good. If we work this way, the calculations would be lengthy. So we take the other route.

Let A' be the event which is the complement of A, i.e. event A' = the room does not get lit

For A' to happen, all three selected bulbs must be defective. Since the number of defective bulbs is 4.

$$A' = \binom{4}{3} = \frac{4!}{3!(4-3)!} = 4 = r$$

$$P(A') = \frac{4}{56} = \frac{1}{14}$$

$$P(A) = 1 - P(A')$$

$$P(A) = 1 - \left(\frac{1}{14}\right) = \frac{13}{14}$$

198. (d) The number of ways of drawing 2 cards from 52 is = $\binom{52}{2} = \frac{52!}{2!(52-2)!}$

$= \frac{52!}{2!(50)!}$

$= \frac{51x52}{2}$

$= 26x51 = n$

Event A = both are face cards. There are 12 face cards out of 52 cards. Hence, the number of ways of drawing 2 cards out of 12 are:

$$\binom{12}{2} = \frac{12!}{2!(12-2)!}$$

$$= \frac{11x12}{2} = 66 = r$$

$$P(A) = \frac{r}{n} = \frac{66}{26x51} = \frac{33}{663} = \frac{11}{221}$$

199. (c) We have total 9 balls. Two out of 9 balls can be drawn in the following manner.

$$\binom{9}{2} = \frac{9!}{2!(9-2)!}$$

$$= \frac{9!}{2!(7)!}$$

$$= \frac{8x9}{2} = 36 = n$$

Let A be the event that both balls drawn are black. Since there are 3 black balls, two balls drawn must be out of 3. Therefore,

$$\binom{3}{2} = \frac{3!}{2!(3-2)!}$$

$$= \frac{3!}{2!(1)!}$$

$$= \frac{2x3}{2} = 3 = r$$

$$P(A) = \frac{r}{n} = \frac{3}{36} = \frac{1}{12}$$

200. (a) We have a total of 400 screws, out of which two screws are randomly picked. Therefore,

$$\binom{400}{2} = \frac{400!}{2!(400-2)!}$$

$$= \frac{400!}{2!(398)!} = \frac{399x400}{2} = 399x200 = n$$

Let A be the event that both screws are defective. Since there are 50 defective screws, two screws drawn must be out of 50. Therefore,

$$\binom{50}{2} = \frac{50!}{2!(50-2)!}$$

$$= \frac{50!}{2!(48)!} = \frac{49x50}{2} = 49x25 = r$$

$$P(A) = \frac{r}{n}$$

$$P(A) = \frac{49x25}{399x200} = \frac{49x25}{79800} = \frac{49}{3192} = \frac{7}{456}$$

Verbal Ability Answers

Analogy Answers

1. C
2. C
3. A
4. B
5. D
6. A
7. D
8. B
9. C
10. C
11. A
12. A
13. D
14. B
15. A
16. C
17. D
18. B
19. A
20. B
21. C
22. D
23. A
24. B
25. B
26. D
27. C
28. D
29. A
30. B

Sentence Completion Answers

1. B
2. A
3. B
4. C
5. D
6. A
7. B
8. D
9. C
10. B
11. A
12. D
13. A
14. C
15. B
16. D
17. B
18. A
19. C
20. D
21. B
22. A
23. C
24. B
25. D

Reading Comprehension

Reading Comprehension Answers

1. A
2. C
3. D
4. A
5. B
6. D
7. C
8. B
9. A
10. C
11. D
12. A
13. B
14. B
15. A
16. D
17. C
18. A
19. B
20. D
21. C
22. D
23. A
24. B
25. B
26. D
27. D
28. A
29. C
30. B
31. B
32. A
33. D
34. D
35. C
36. B
37. A
38. D
39. A
40. C