Important Instructions:

1. The test is of 3 hours duration and Test Booklet contains 180 questions. Each question carries 4 marks. For each correct response, the candidate will get 4 marks. For each incorrect response, one mark will be deducted from the total scores. The maximum marks are 720.

2. Use Blue / Black Ball point Pen only for writing particulars on this page/marking responses.

3. Rough work is to be done on the space provided for this purpose in the Test Booklet only.

4. On completion of the test, the candidate must handover the Answer Sheet to the Invigilator before leaving the Room / Hall. The candidates are allowed to take away this Test Booklet with them.

5. The CODE for this Booklet is G2.

6. The candidates should ensure that the Answer Sheet is not folded. Do not make any stray marks on the Answer Sheet. Do not write your Roll No. anywhere else except in the specified space in the Test Booklet/Answer Sheet.

7. Each candidate must show on demand his/her Admission Card to the Invigilator.

8. No candidate, without special permission of the Superintendent or Invigilator, would leave his/her seat.

9. Use of Electronic/Manual Calculator is prohibited.

10. The candidates are governed by all Rules and Regulations of the examination with regard to their conduct in the Examination Hall. All cases of unfair means will be dealt with as per Rules and Regulations of this examination.

11. No part of the Test Booklet and Answer Sheet shall be detached under any circumstances.

12. The candidates will write the Correct Test Booklet Code as given in the Test Booklet / Answer Sheet in the Attendance Sheet.
1. Which of the following refer to correct example(s) of organisms which have evolved due to changes in environment brought about by anthropogenic action?
   (a) Darwin's Finches of Galapagos islands.
   (b) Herbicide resistant weeds.
   (c) Drug resistant eukaryotes.
   (d) Man-created breeds of domesticated animals like dogs.

   (1) (a) and (c)
   (2) (b), (c) and (d)
   (3) only (d)
   (4) only (a)

   Answer (2)

   Sol. The correct option is (2) because:
   • Herbicide resistant weeds, drug resistant eukaryotes and man-created breeds of domesticated animals like dogs are examples of evolution by anthropogenic action.
   • Darwin's Finches of Galapagos islands are example of natural selection, adaptive radiation and founder's effect.

2. Meiotic division of the secondary oocyte is completed
   (1) At the time of copulation
   (2) After zygote formation
   (3) At the time of fusion of a sperm with an ovum
   (4) Prior to ovulation

   Answer (3)

   Sol. Meiotic division of secondary oocyte is completed after the entry of sperm in secondary oocyte which lead to the formation of a large ovum and a tiny II\textsuperscript{nd} polar body.

3. Which of the following is correct about viroids?
   (1) They have free RNA without protein coat
   (2) They have DNA with protein coat
   (3) They have free DNA without protein coat
   (4) They have RNA with protein coat

   Answer (1)

   Sol. Viroids have free RNA without protein coat.

4. The plant parts which consist of two generations - one within the other
   (a) Pollen grains inside the anther
   (b) Germinated pollen grain with two male gametes
   (c) Seed inside the fruit
   (d) Embryo sac inside the ovule

   (1) (a), (b) and (c)
   (2) (c) and (d)
   (3) (a) and (d)
   (4) (a) only

   Answer (3)

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

5. Experimental verification of the chromosomal theory of inheritance was done by
   (1) Sutton
   (2) Boveri
   (3) Morgan
   (4) Mendel

   Answer (3)

   Sol. Experimental verification of the chromosomal theory of inheritance was done by Morgan.

   Note:
   Sutton and Boveri proposed chromosomal theory of inheritance but it was experimentally verified by T.H. Morgan.

6. Which of the following pairs is of unicellular algae?
   (1) Gelidium and Gracilaria
   (2) Anabaena and Volvox
   (3) Chlorella and Spirulina
   (4) Laminaria and Sargassum

   Answer (3)

   Sol. Chlorella and Spirulina are unicellular algae.
   Gelidium, Gracilaria, Laminaria and Sargassum are multicellular. Volvox is colonial.
7. Secondary metabolites such as nicotine, strychnine and caffeine are produced by plants for their
    (1) Growth response
    (2) Defence action
    (3) Effect on reproduction
    (4) Nutritive value
Answer (2)

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

8. By which method was a new breed ‘Hisardale’ of sheep formed by using Bikaneri ewes and Marino rams?
    (1) Mutational breeding
    (2) Cross breeding
    (3) Inbreeding
    (4) Out crossing
Answer (2)

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

9. The infectious stage of *Plasmodium* that enters the human body is
    (1) Sporozoites
    (2) Female gametocytes
    (3) Male gametocytes
    (4) Trophozoites
Answer (1)

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

10. The process responsible for facilitating loss of water in liquid form from the tip of grass blades at night and in early morning is
    (1) Root pressure
    (2) Imbibition
    (3) Plasmolysis
    (4) Transpiration
Answer (1)

Sol. • Root pressure is positive hydrostatic pressure.
    • It develops in tracheary element at night and in early morning.

11. From his experiments, S.L. Miller produced amino acids by mixing the following in a closed flask
    (1) CH$_3$, H$_2$, NH$_4$ and water vapor at 800°C
    (2) CH$_4$, H$_2$, NH$_3$ and water vapor at 600°C
    (3) CH$_3$, H$_2$, NH$_3$ and water vapor at 600°C
    (4) CH$_4$, H$_2$, NH$_3$ and water vapor at 800°C
Answer (4)

Sol. In 1953, S.L. Miller, an American scientist created electric discharge in a closed flask containing CH$_4$, H$_2$, NH$_3$ and water vapor at 800°C.

12. In relation to Gross primary productivity and Net primary productivity of an ecosystem, which one of the following statements is correct?
    (1) Gross primary productivity is always more than net primary productivity
    (2) Gross primary productivity and Net primary productivity are one and same
    (3) There is no relationship between Gross primary productivity and Net primary productivity
    (4) Gross primary productivity is always less than net primary productivity
Answer (1)

Sol. Gross primary productivity of an ecosystem is the rate of production of organic matter during photosynthesis.

Net primary productivity is GPP-respiration

Hence gross primary productivity is always more than NPP

13. The sequence that controls the copy number of the linked DNA in the vector, is termed
    (1) Ori site
    (2) Palindromic sequence
    (3) Recognition site
    (4) Selectable marker
Answer (1)

Sol. The correct option is (1) because Ori sequence is responsible for controlling the copy number of the linked DNA in the vector. Ori i.e. origin of replication is responsible for initiation of replication.
14. Cuboidal epithelium with brush border of microvilli is found in
   (1) Ducts of salivary gland
   (2) Proximal convoluted tubule of nephron
   (3) Eustachian tube
   (4) Lining of intestine

   Answer (2)

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

15. The body of the ovule is fused within the funicle at
   (1) Micropyle
   (2) Nucellus
   (3) Chalaza
   (4) Hilum

   Answer (4)

   Sol. The attachment point of funicle and body of ovule is known as hilum.

16. In light reaction, plastoquinone facilitates the transfer of electrons from
   (1) Cytd\textsubscript{b} complex to PS-I
   (2) PS-I to NADP\textsuperscript{+}
   (3) PS-I to ATP synthase
   (4) PS-II to Cytd\textsubscript{b} complex

   Answer (4)

   Sol. After excitation, e\textsuperscript{−} is passed from PS-II (P\textsubscript{680}) to primary electron acceptor (Pheophytin). From primary e\textsuperscript{−} acceptor, e\textsuperscript{−} is passed to plastoquinone. Plastoquinone (PQ) in turn transfer its e\textsuperscript{−} to Cytd\textsubscript{b} complex. Therefore plastoquinone facilitates the transfer of electrons from PS-II to Cytd\textsubscript{b} complex.

17. Match the following diseases with the causative organism and select the correct option.

   | Column-I | Column-II
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Typhoid</td>
<td>(i) Wuchereria</td>
</tr>
<tr>
<td>(b) Pneumonia</td>
<td>(ii) Plasmodium</td>
</tr>
<tr>
<td>(c) Filariasis</td>
<td>(iii) Salmonella</td>
</tr>
<tr>
<td>(d) Malaria</td>
<td>(iv) Haemophilus</td>
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<tr>
<td>(a) (b) (c) (d)</td>
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<td>(1) (ii) (i) (iv) (iii)</td>
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<td>(2) (i) (ii) (iv) (iii)</td>
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<td>(3) (iv) (iii) (ii) (i)</td>
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<tr>
<td>(4) (iii) (iv) (ii) (i)</td>
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</tr>
</tbody>
</table>

   Answer (1)

   Sol. Typhoid fever in humans is caused by pathogenic bacterium *Salmonella typhi.*

   Pneumonia is caused by *Streptococcus Pneumoniae* and *Haemophilus influenzae.*

   Filariasis or elephantiasis is caused by the filarial worm, *Wuchereria bancrofti* and *Wuchereria malayi.*

   Malaria is caused by different species of *Plasmodium.*

18. Match the following columns and select the correct option.

<table>
<thead>
<tr>
<th>Column-I</th>
<th>Column-II</th>
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<tbody>
<tr>
<td>(a) Clostridium butylicum</td>
<td>(i) Cyclosporin-A</td>
</tr>
<tr>
<td>(b) Trichoderma polysporum</td>
<td>(ii) Butyric Acid</td>
</tr>
<tr>
<td>(c) Monascus purpureus</td>
<td>(iii) Citric Acid</td>
</tr>
<tr>
<td>(d) Aspergillus niger</td>
<td>(iv) Blood cholesterol lowering agent</td>
</tr>
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<td>(1) (ii) (i) (iv) (iii)</td>
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<tr>
<td>(4) (iii) (iv) (ii) (i)</td>
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   Answer (1)

   Sol. Column-I Column-II
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19. Which of the following statements are true for the phylum-Chordata?

   (a) In Urochordata notochord extends from head to tail and it is present throughout their life.
   (b) In Vertebrata notochord is present during the embryonic period only.

   Answer (1)
(c) Central nervous system is dorsal and hollow.
(d) Chordata is divided into 3 subphyla: Hemichordata, Tunicata and Cephalochordata.

(1) (c) and (a)
(2) (a) and (b)
(3) (b) and (c)
(4) (d) and (c)

Answer (3)

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

20. Goblet cells of alimentary canal are modified from
(1) Columnar epithelial cells
(2) Chondrocytes
(3) Compound epithelial cells
(4) Squamous epithelial cells

Answer (1)

Sol. Goblet cells of alimentary canal are modified from columnar epithelial cells which secrete mucus.

21. Which of the following is not an inhibitory substance governing seed dormancy?
(1) Abscisic acid
(2) Phenolic acid
(3) Para-ascorbic acid
(4) Gibberellic acid

Answer (4)

Sol. • Gibberellic acid break seed dormancy.
  • It activate synthesis of α-amylase which breakdown starch into simple sugar.

22. Name the enzyme that facilitates opening of DNA helix during transcription.
(1) DNA helicase
(2) DNA polymerase
(3) RNA polymerase
(4) DNA ligase

Answer (3)

Sol. RNA polymerase facilitates opening of DNA helix during transcription.

23. Match the following
(a) Inhibitor of catalytic activity 
   (i) Ricin
(b) Possess peptide bonds
   (ii) Malonate
(c) Cell wall material in fungi
   (iii) Chitin
(d) Secondary metabolite
   (iv) Collagen

Choose the correct option from the following
(a) (b) (c) (d)
(1) (iii) (i) (iv) (ii)
(2) (iii) (iv) (i) (ii)
(3) (ii) (iii) (i) (iv)
(4) (ii) (iv) (iii) (i)

Answer (4)

Sol. Option (4) is the correct answer because Malonate is the competitive inhibitor of catalytic activity of succinic dehydrogenase, so (a) matches with (ii) in column II.
Collagen is proteinaceous in nature and possesses peptide bonds, so (b) matches with (iv) in column II.
Chitin is a homopolymer present in the cell wall of fungi and exoskeleton of arthropods, so, (c) matches with (iii) in column II.
Abrin and Ricin are toxins, secondary metabolites, so (d) in column I matches with (i) in column II.

24. Bilaterally symmetrical and acoelomate animals are exemplified by
(1) Platyhelminthes
(2) Aschelminthes
(3) Annelida
(4) Ctenophora

Answer (1)

Sol. Platyhelminthes are bilaterally symmetrical, triploblastic and acoelomate animals with organ level of organisation.

25. Presence of which of the following conditions in urine are indicative of Diabetes Mellitus?
(1) Uremia and Renal Calculi
(2) Ketonuria and Glycosuria
(3) Renal calculi and Hyperglycaemia
(4) Uremia and Ketonuria

Answer (2)
26. Ray florets have
   (1) Superior ovary  (2) Hypogynous ovary
   (3) Half inferior ovary  (4) Inferior ovary
   
   Answer (4)

27. Identify the substances having glycosidic bond and peptide bond, respectively in their structure
   (1) Glycerol, trypsin  (2) Cellulose, lecithin
   (3) Inulin, insulin  (4) Chitin, cholesterol

   Answer (3)

28. Which of the following statements is not correct?
   (1) The proinsulin has an extra peptide called C-peptide.
   (2) The functional insulin has A and B chains linked together by hydrogen bonds.
   (3) Genetically engineered insulin is produced in E.coli.
   (4) In man insulin is synthesised as a proinsulin

   Answer (2)

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

   Answer (4)

30. Identify the correct statement with regard to $G_1$ phase (Gap 1) of interphase.
   (1) Reorganisation of all cell components takes place.
   (2) Cell is metabolically active, grows but does not replicate its DNA.
   (3) Nuclear Division takes place.
   (4) DNA synthesis or replication takes place.

   Answer (2)

31. The QRS complex in a standard ECG represents
   (1) Depolarisation of auricles
   (2) Depolarisation of ventricles
   (3) Repolarisation of ventricles
   (4) Repolarisation of auricles

   Answer (2)

32. If the distance between two consecutive base pairs is $0.34 \text{ nm}$ and the total number of base pairs of a DNA double helix in a typical mammalian cell is $6.6 \times 10^9 \text{ bp}$, then the length of the DNA is approximately
   (1) 2.5 meters  (2) 2.2 meters  (3) 2.7 meters  (4) 2.0 meters

   Answer (2)

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

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

Sol. QRS complex represents the depolarisation of ventricles.

Sol. Length of DNA = $[0.34 \times 10^{-9}] \text{ m} \times 6.6 \times 10^9 \text{ bp}$

\[ = 2.2 \text{ m} \]

Distance between 2 base pair in DNA helix

\[ = 0.34 \text{ nm} = 0.34 \times 10^{-9} \text{ m} \]

Total number of base pair = $6.6 \times 10^9 \text{ bp}$
33. Which of the following regions of the globe exhibits highest species diversity?
   (1) Madagascar
   (2) Himalayas
   (3) Amazon forests
   (4) Western Ghats of India
Answer (3)
Sol. The largely tropical Amazonian rain forest in South America has the greatest biodiversity on earth.

34. Which of the following is put into Anaerobic sludge digester for further sewage treatment?
   (1) Floating debris
   (2) Effluents of primary treatment
   (3) Activated sludge
   (4) Primary sludge
Answer (3)
Sol. The sediment in settlement tank is called activated sludge.
A small part of the activated sludge is pumped back into aeration tank
Remaining major part of the sludge is pumped into large tank called anaerobic sludge digesters.

35. Dissolution of the synaptonemal complex occurs during
   (1) Zygotene
   (2) Diplotene
   (3) Leptotene
   (4) Pachytene
Answer (2)
Sol. Dissolution of the synaptonemal complex occurs during Diplotene stage of Prophase-I of Meiosis-I.

36. Select the option including all sexually transmitted diseases.
   (1) Gonorrhoea, Malaria, Genital herpes
   (2) AIDS, Malaria, Filaria
   (3) Cancer, AIDS, Syphilis
   (4) Gonorrhoea, Syphilis, Genital herpes
Answer (4)
Sol. Gonorrhoea, Syphilis, Genital herpes are sexually transmitted diseases.
Gonorrhoea is caused by a bacterium Neisseria gonorrhoeae.
Syphilis is caused by a bacterium Treponema pallidum.
Genital herpes is caused by a virus Type-II Herpes simplex virus.

37. Select the correct statement.
   (1) Glucagon is associated with hypoglycemia.
   (2) Insulin acts on pancreatic cells and adipocytes.
   (3) Insulin is associated with hyperglycemia.
   (4) Glucocorticoids stimulate gluconeogenesis.
Answer (4)
Sol. Glucagon is associated with hyperglycemia. Insulin acts on hepatocytes and adipocytes and is associated with hypoglycemia. Glucocorticoids stimulate gluconeogenesis, so increase blood sugar level.

38. The product(s) of reaction catalyzed by nitrogenase in root nodules of leguminous plants is/are
   (1) Nitrate alone
   (2) Ammonia and oxygen
   (3) Ammonia and hydrogen
   (4) Ammonia alone
Answer (3)
Sol. \[ \text{N}_2 + 8e^- + 8H^+ + 16\text{ATP} \xrightarrow{\text{Mg}^{2+}} 2\text{NH}_3 + H_2 + 16\text{ADP} + 16\text{Pi} \]
Ammonia and Hydrogen.

39. In gel electrophoresis, separated DNA fragments can be visualized with the help of
   (1) Ethidium bromide in UV radiation
   (2) Acetocarmine in UV radiation
   (3) Ethidium bromide in infrared radiation
   (4) Acetocarmine in bright blue light
Answer (1)
Sol. The separated DNA fragments can be visualised only after staining the DNA with Ethidium bromide followed by exposure to UV radiation.

40. In which of the following techniques, the embryos are transferred to assist those females who cannot conceive?
   (1) GIFT and ZIFT
   (2) ICSI and ZIFT
   (3) GIFT and ICSI
   (4) ZIFT and IUT
Answer (4)
Sol. Option (4) is the answer because ART in which embryos are transferred, include ZIFT and IUT i.e. Zygote Intrafallopian Transfer and Intra Uterine Transfer respectively, both are embryo transfer (ET) methods.

Option (1), (2) and (3) are incorrect because in GIFT (Gamete Intrafallopian Transfer), gamete is transferred into the fallopian tube of female who cannot produce ova. ICSI is Intra cytoplasmic sperm injection in which sperm is directly injected into the ovum.

41. Select the correct match

(1) Phenylketonuria – Autosomal dominant trait

(2) Sickle cell anaemia – Autosomal recessive trait, chromosome-11

(3) Thalassemia – X linked

(4) Haemophilia – Y linked

Answer (2)
Sol. Phenylketonuria – Autosomal recessive disorder

Thalassemia – Autosomal recessive disorder

Haemophilia – X linked recessive disorder

Sickle cell anaemia – Autosomal recessive trait, caused due to mutation in gene present on chromosome no. 11

43. The oxygenation activity of RuBisCo enzyme in photorespiration leads to the formation of

(1) 1 molecule of 3-C compound

(2) 1 molecule of 6-C compound

(3) 1 molecule of 4-C compound and 1 molecule of 2-C compound

(4) 2 molecules of 3-C compound

Answer (1)
Sol. In photorespiration, O₂ binds to RubisCo. As a result RuBP instead to being converted to 2 molecules of PGA bind with O₂ to form one molecule each of phosphoglycerate (3 carbon compound) and phosphoglycolate (2 carbon compound).

44. Match the following concerning essential elements and their functions in plants

(a) Iron – Essential for the formation of chlorophyll

(b) Zinc – Needed for synthesis of auxin

(c) Boron – Have a role in pollen grain germination

(d) Manganese – Is involved in the splitting of water to liberate O₂ during photosynthesis

Select the correct option

(a) (iv) (iii) (ii) (i)

(b) (iii) (iv) (ii) (i)

(c) (iv) (i) (ii) (iii)

(d) (ii) (i) (iv) (iii)

Answer (2)
Sol. (a) Iron – Essential for the formation of chlorophyll

(b) Zinc – Needed for synthesis of auxin

(c) Boron – Have a role in pollen grain germination

(d) Manganese – Is involved in the splitting of water to liberate O₂ during photosynthesis

45. Which is the important site of formation of glycoproteins and glycolipids in eukaryotic cells?

(1) Peroxisomes

(2) Golgi bodies

(3) Polysomes

(4) Endoplasmic reticulum

Answer (2)
Sol. Golgi bodies are site of formation of glycoproteins and glycolipids in eukaryotic cells.

46. Select the correct events that occur during inspiration.
(a) Contraction of diaphragm
(b) Contraction of external inter-costal muscles
(c) Pulmonary volume decreases
(d) Intra pulmonary pressure increases
(1) (c) and (d)
(2) (a), (b) and (d)
(3) only (d)
(4) (a) and (b)

Answer (4)

Sol. Inspiration is initiated by the contraction of diaphragm, which increases the volume of thoracic chamber in the antero-posterior axis.

The contraction of external intercostal muscles increase the volume of the thoracic chamber in the dorsoventral axis.

47. The roots that originate from the base of the stem are
(1) Primary roots
(2) Prop roots
(3) Lateral roots
(4) Fibrous roots

Answer (4)

Sol. The roots that originate from the base of the stem are fibrous roots.

48. The ovary is half inferior in :
(1) Mustard
(2) Sunflower
(3) Plum
(4) Brinjal

Answer (3)

Sol. The ovary is half inferior in Plum.

49. Match the following columns and select the correct option.

<table>
<thead>
<tr>
<th>Column-I</th>
<th>Column-II</th>
</tr>
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<tbody>
<tr>
<td>(a) Floating Ribs</td>
<td>(i) Located between second and seventh ribs</td>
</tr>
<tr>
<td>(b) Acromion</td>
<td>(ii) Head of the Humerus</td>
</tr>
<tr>
<td>(c) Scapula</td>
<td>(iii) Clavicle</td>
</tr>
<tr>
<td>(d) Glenoid cavity</td>
<td>(iv) Do not connect with the sternum</td>
</tr>
</tbody>
</table>

(a) (b) (c) (d)
(1) (i) (iii) (ii) (iv)
(2) (iii) (ii) (iv) (i)
(3) (iv) (iii) (i) (ii)
(4) (ii) (iv) (i) (iii)

Answer (3)

Sol. (a) 11th and 12th pairs of ribs are not connected ventrally and are therefore, called floating ribs.

(b) Acromion is a flat expanded process of spine of scapula. The lateral end of clavicle articulates with acromion process.

(c) Scapula is a flat triangular bone in the dorsal part of the thorax between 2nd and the 7th rib.

(d) Glenoid cavity of scapula articulates with head of the humerus to form the shoulder joint.

50. If the head of cockroach is removed, it may live for few days because
(1) the cockroach does not have nervous system.
(2) the head holds a small proportion of a nervous system while the rest is situated along the ventral part of its body.
(3) the head holds a 1/3rd of a nervous system while the rest is situated along the dorsal part of its body.
(4) the supra-oesophageal ganglia of the cockroach are situated in ventral part of abdomen.

Answer (2)

Sol. The head holds a small proportion of a nervous system while the rest is situated along the ventral part of its body.

51. Identify the incorrect statement.
(1) Sapwood is involved in conduction of water and minerals from root to leaf
(2) Sapwood is the innermost secondary xylem and is lighter in colour
(3) Due to deposition of tannins, resins, oils etc., heart wood is dark in colour
(4) Heart wood does not conduct water but gives mechanical support

Answer (2)
Sol. Incorrect statement: Sapwood is the innermost secondary xylem and is lighter in colour.
Correct statement: Sapwood is outermost secondary xylem.

52. Bt cotton variety that was developed by the introduction of toxin gene of *Bacillus thuringiensis* (Bt) is resistant to
   (1) Fungal diseases (2) Plant nematodes
   (3) Insect predators (4) Insect pests
Answer (4)
Sol. Bt cotton is resistant to cotton bollworm (Insect pest).
*cry I Ac* and *cry II Ab* genes have been introduced in cotton to protect it from cotton bollworm. This makes Bt cotton as biopesticide.

53. The number of substrate level phosphorylations in one turn of citric acid cycle is
   (1) One (2) Two
   (3) Three (4) Zero
Answer (1)
Sol. One substrate level phosphorylation in one turn of citric acid cycle as per following reaction:

\[
\text{Succinyl Co-A} \xrightarrow{\text{Thiokinase}} \text{Succinate}
\]

\[
\begin{array}{c}
\text{GDP} \\
\text{GTP} \\
\text{ATP} \\
\text{ADP}
\end{array}
\]

54. Identify the wrong statement with regard to Restriction Enzymes.
   (1) They cut the strand of DNA at palindromic sites.
   (2) They are useful in genetic engineering.
   (3) Sticky ends can be joined by using DNA ligases.
   (4) Each restriction enzyme functions by inspecting the length of a DNA sequence.
Answer (3)
Sol. Restriction endonucleases make cuts at specific positions within the DNA. They function by inspecting the length of a DNA sequence.
Restriction endonuclease bind to the DNA and cut the two strands of double helix at specific points in their sugar-phosphate backbones. They are used in genetic engineering to form recombinant molecules of DNA.
DNA ligases join the DNA fragments.

55. Flippers of Penguins and Dolphins are examples of
   (1) Convergent evolution
   (2) Industrial melanism
   (3) Natural selection
   (4) Adaptive radiation
Answer (1)
Sol. The correct option is (1) because flippers of Penguins and Dolphins are an example of analogous organs. Analogous structures are a result of convergent evolution.

56. Identify the wrong statement with reference to transport of oxygen
   (1) Partial pressure of CO\(_2\) can interfere with O\(_2\) binding with haemoglobin
   (2) Higher H\(^+\) conc. in alveoli favours the formation of oxyhaemoglobin
   (3) Low pCO\(_2\) in alveoli favours the formation of oxyhaemoglobin
   (4) Binding of oxygen with haemoglobin is mainly related to partial pressure of O\(_2\)
Answer (2)
Sol. The correct option is (2) because higher H\(^+\) concentration favours the dissociation of oxygen from oxyhaemoglobin in tissues.
In the alveoli, high pO\(_2\), low pCO\(_2\), lesser H\(^+\) concentration and lower temperature favours the formation of oxyhaemoglobin.

57. Identify the wrong statement with reference to the gene ‘I’ that controls ABO blood groups.
   (1) A person will have only two of the three alleles.
   (2) When I\(^A\) and I\(^B\) are present together, they express same type of sugar.
   (3) Allele ‘i’ does not produce any sugar.
   (4) The gene (I) has three alleles.
Answer (3)
58. Identify the basic amino acid from the following.
(1) Glutamic Acid   (2) Lysine   (3) Valine   (4) Tyrosine

Answer (2)
Sol. Option (2) is the correct answer because lysine is a basic amino acid.
Valine is a neutral amino acid.
Glutamic acid is an acidic amino acid while Tyrosine is an aromatic amino acid.

59. Name the plant growth regulator which upon spraying on sugarcane crop, increases the length of stem, thus increasing the yield of sugarcane crop.
(1) Gibberellin   (2) Ethylene   (3) Abscisic acid   (4) Cytokinin

Answer (1)
Sol. Gibberellin

60. Which of the following statements is correct?
(1) Adenine pairs with thymine through one H-bond
(2) Adenine pairs with thymine through three H-bonds
(3) Adenine does not pair with thymine
(4) Adenine pairs with thymine through two H-bonds

Answer (4)
Sol. Adenine pairs with thymine through two H-bonds i.e., A = = T

61. Which of the following statements is correct?
(1) Adenine pairs with thymine through one H-bond
(2) Adenine pairs with thymine through three H-bonds
(3) Adenine does not pair with thymine
(4) Adenine pairs with thymine through two H-bonds

Answer (4)
Sol. Adenine pairs with thymine through two H-bonds i.e., A = = T

62. Match the following columns and select the correct option.
Column-I          Column-II
(a) Gregarious           (i) Asterias     polypagous pest
(b) Adult with radial symmetry and larva with bilateral symmetry
(c) Book lungs           (iii) Ctenoplan
(d) Bioluminescence      (iv) Locusta

Answer (1)
Sol. (a) Bacillus thuringiensis is a source of Cry-proteins.
(b) Thermus aquaticus is a source of thermostable DNA polymerase (Taq polymerase) used in PCR.
(c) Agrobacterium tumefaciens is a cloning vector.
(d) The construction of 1st recombinant DNA molecule was performed using native plasmid of Salmonella typhimurium.
Sol. (a) *Locusta* is a gregarious pest.
(b) In Echinoderms, adults are radially symmetrical but larvae are bilaterally symmetrical.
(c) Scorpions respire through book lungs.
(d) Bioluminescence is well marked in ctenophores.

63. Which of the following would help in prevention of diuresis?

(1) Reabsorption of Na$^+$ and water from renal tubules due to aldosterone
(2) Atrial natriuretic factor causes vasoconstriction
(3) Decrease in secretion of renin by JG cells
(4) More water reabsorption due to undersecretion of ADH

Answer (1)

Sol. Adrenal cortex secretes mineralocorticoids like aldosterone which increase the reabsorption of Na$^+$ and water from renal tubule that prevent diuresis.

64. Choose the correct pair from the following

(1) Polymerases - Break the DNA into fragments
(2) Nucleases - Separate the two strands of DNA
(3) Exonucleases - Make cuts at specific positions within DNA
(4) Ligases - Join the two DNA molecules

Answer (4)

Sol. Ligases join the two DNA molecules.

65. Identify the correct statement with reference to human digestive system.

(1) Serosa is the innermost layer of the alimentary canal
(2) Ileum is a highly coiled part
(3) Vermiform appendix arises from duodenum
(4) Ileum opens into small intestine

Answer (2)

Sol. Option (2) is correct as ileum is a highly coiled tube. Serosa is the outermost layer of the alimentary canal, thus, option (1) is an incorrect statement.

66. Embryological support for evolution was disapproved by

(1) Alfred Wallace
(2) Charles Darwin
(3) Oparin
(4) Karl Ernst von Baer

Answer (4)

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

67. Which of the following hormone levels will cause release of ovum (ovulation) from the graffian follicle?

(1) High concentration of Progesterone
(2) Low concentration of LH
(3) Low concentration of FSH
(4) High concentration of Estrogen

Answer (4)

Sol. High level of estrogen will send positive feedback to anterior pituitary for release of LH.

- FSH, LH and estrogen are at peak level during mid of menstrual cycle (28 day cycle).
- LH surge leads to ovulation.

68. The specific palindromic sequence which is recognized by EcoRI is

(1) 5’ - GGAACC - 3’
   3’ - CCTTGG - 5’
(2) 5’ - CTTAAG - 3’
   3’ - GAATTC - 5’
(3) 5’ - GGATCC - 3’
   3’ - CCTAGG - 5’
(4) 5’ - GAATTC - 3’
   3’ - CTTAAG - 5’

Answer (4)
Sol. The correct option is (4) because the specific palindromic sequence which is recognised by EcoRI is
- 5' - GAATTC - 3'
- 3' - CTTAAG - 5'

69. The first phase of translation is
(1) Recognition of DNA molecule
(2) Aminoacylation of tRNA
(3) Recognition of an anti-codon
(4) Binding of mRNA to ribosome

Answer (2)
Sol. The first phase of translation involves activation of amino acid in the presence of ATP and linked to their cognate tRNA - a process commonly called as charging of tRNA or aminoacylation of tRNA.

70. Floridean starch has structure similar to
(1) Amylopectin and glycogen
(2) Mannitol and algin
(3) Laminarin and cellulose
(4) Starch and cellulose

Answer (1)
Sol. Floridean starch is stored food material in red algae. It's structure is similar to Amylopectin and Glycogen.

71. Strobili or cones are found in
(1) Pteris
(2) Marchantia
(3) Equisetum
(4) Salvinia

Answer (3)
Sol. Strobili or cones are found in Equisetum.

72. How many true breeding pea plant varieties did Mendel select as pairs, which were similar except in one character with contrasting traits?
(1) 2
(2) 14
(3) 8
(4) 4

Answer (2)
Sol. Mendel selected 14 True breeding plant varieties.

73. Snow-blindness in Antarctic region is due to
(1) Inflammation of cornea due to high dose of UV-B radiation
(2) High reflection of light from snow
(3) Damage to retina caused by infra-red rays
(4) Freezing of fluids in the eye by low temperature

Answer (1)
Sol. UV-B radiations damage DNA and mutations may occur.

In human eye, cornea absorbs UV-B radiations, and a high dose of UV-B causes inflammation of cornea called snow blindness, cataract, etc.

74. The enzyme enterokinase helps in conversion of
(1) trypsinogen into trypsin
(2) caseinogen into casein
(3) pepsinogen into pepsin
(4) protein into polypeptides

Answer (1)
Sol. The correct option is (1) because trypsinogen is activated by an enzyme, enterokinase, secreted by the intestinal mucosa into active trypsin. Trypsinogen is a zymogen from pancreas.

75. Match the following with respect to meiosis
(a) Zygotene (i) Terminalization
(b) Pachytene (ii) Chiasmata
(c) Diplotene (iii) Cross over
(d) Diakinesis (iv) Synapsis

Select the correct option from the following
(1) (iv) (iii) (ii) (i)
(2) (i) (ii) (iv) (iii)
(3) (ii) (i) (iv) (iii)
(4) (iii) (iv) (i) (ii)

Answer (1)
Sol. Zygotene → Synapsis
Pachytene → Cross over
Diplotene → Chiasmata formation
Diakinesis → Terminalisation
76. Which of the following statements about inclusion bodies is incorrect?

(1) These are involved in ingestion of food particles
(2) They lie free in the cytoplasm
(3) These represent reserve material in cytoplasm
(4) They are not bound by any membrane

Answer (1)
Sol. These are not involved in ingestion of food particles.

77. Match the following columns and select the correct option.

<table>
<thead>
<tr>
<th>Column - I</th>
<th>Column - II</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Eosinophils</td>
<td>(i) Immune response</td>
</tr>
<tr>
<td>(b) Basophils</td>
<td>(ii) Phagocytosis</td>
</tr>
<tr>
<td>(c) Neutrophils</td>
<td>(iii) Release histaminase, destructive enzymes</td>
</tr>
<tr>
<td>(d) Lymphocytes</td>
<td>(iv) Release granules containing histamine</td>
</tr>
</tbody>
</table>

(a) (i) (ii) (iii) (iv)
(1) (iv) (i) (ii) (iii)
(2) (i) (ii) (iv) (iii)
(3) (ii) (i) (iv) (iii)
(4) (iii) (iv) (i) (ii)

Answer (4)
Sol. Option (4) is the correct answer because Eosinophils are associated with allergic reactions and release histaminase, destructive enzymes, so (a) in column I matches with (iii) in column II.

Basophils secrete histamine, serotonin, heparin etc. and are involved in inflammatory reactions, so (b) matches with (iv).

Neutrophils are phagocytic cells; so (c) matches with (ii). Both B and T lymphocytes are responsible for immune responses of the body, so, (d) in column I matches with (i) in column II.

78. The transverse section of a plant shows following anatomical features:

(a) Large number of scattered vascular bundles surrounded by bundle sheath
(b) Large conspicuous parenchymatous ground tissue
(c) Vascular bundles conjoint and closed
(d) Phloem parenchyma absent

Identify the category of plant and its part:

(1) Monocotyledonous root
(2) Dicotyledonous stem
(3) Dicotyledonous root
(4) Monocotyledonous stem

Answer (4)
Sol. All features are related to monocotyledonous stems.

79. Match the following columns and select the correct option.

<table>
<thead>
<tr>
<th>Column-I</th>
<th>Column-II</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Pituitary gland</td>
<td>(i) Grave's disease</td>
</tr>
<tr>
<td>(b) Thyroid gland</td>
<td>(ii) Diabetes mellitus</td>
</tr>
<tr>
<td>(c) Adrenal gland</td>
<td>(iii) Diabetes insipidus</td>
</tr>
<tr>
<td>(d) Pancreas</td>
<td>(iv) Addison’s disease</td>
</tr>
</tbody>
</table>

(a) (b) (c) (d)
(1) (iii) (ii) (i) (iv)
(2) (iii) (i) (iv) (ii)
(3) (ii) (i) (iv) (iii)
(4) (iv) (iii) (i) (ii)

Answer (2)
Sol. Graves' disease is due to excess secretion of thyroid hormones (T₃ & T₄).

Diabetes mellitus is due to hyposecretion of insulin from β-cells of pancreas.

Diabetes insipidus is due to hyporelease of ADH from posterior pituitary.

Addison's disease is due to hyposecretion of hormone from adrenal cortex.

80. Match the following columns and select the correct option.

<table>
<thead>
<tr>
<th>Column-I</th>
<th>Column-II</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Placenta</td>
<td>(i) Androgens</td>
</tr>
<tr>
<td>(b) Zona pellucida</td>
<td>(ii) Human Chorionic Gonadotropin (hCG)</td>
</tr>
<tr>
<td>(c) Bulbo-urethral glands</td>
<td>(iii) Layer of the ovum</td>
</tr>
<tr>
<td>(d) Leydig cells</td>
<td>(iv) Lubrication of the Penis</td>
</tr>
</tbody>
</table>
(a) (b) (c) (d)
(1) (i) (iv) (ii) (iii)
(2) (iii) (ii) (iv) (i)
(3) (ii) (iii) (iv) (i)
(4) (iv) (iii) (i) (ii)

Answer (3)
Sol. The correct option is (3) because
(a) Placenta secretes human chorionic gonadotropin (hCG)
(b) Zona pellucida is a primary egg membrane secreted by the secondary oocyte
(c) The secretions of bulbourethral glands help in lubrication of the penis
(d) Leydig cells synthesise and secrete testicular hormones called androgens

81. In water hyacinth and water lily, pollination takes place by:
(1) Water currents only
(2) Wind and water
(3) Insects and water
(4) Insects or wind

Answer (4)
Sol. In majority of aquatic plants, the flowers emerge above the level of water. These may be pollinated by insects or wind eg.: Water hyacinth and water lily

82. According to Robert May, the global species diversity is about
(1) 20 million
(2) 50 million
(3) 7 million
(4) 1.5 million

Answer (3)
Sol. Robert May estimated global species diversity at about 7 million.
• Although some extreme estimates range from 20 to 50 million.

83. Match the following columns and select the correct option.

<table>
<thead>
<tr>
<th>Column-I</th>
<th>Column-II</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) 6-15 pairs of gill slits</td>
<td>(i) Trygon</td>
</tr>
<tr>
<td>(b) Heterocercal caudal fin</td>
<td>(ii) Cyclostomes</td>
</tr>
<tr>
<td>(c) Air Bladder</td>
<td>(iii) Chondrichthyes</td>
</tr>
<tr>
<td>(d) Poison sting</td>
<td>(iv) Osteichthyes</td>
</tr>
</tbody>
</table>

Answer (4)

84. The process of growth is maximum during
(1) Lag phase
(2) Senescence
(3) Dormancy
(4) Log phase

Answer (4)
Sol. In exponential growth, the initial growth is slow (lag phase) and it increases rapidly thereafter at an exponential rate in log or exponential phase.

85. Match the following columns and select the correct option.

<table>
<thead>
<tr>
<th>Column-I</th>
<th>Column-II</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Bt cotton</td>
<td>(i) Gene therapy</td>
</tr>
<tr>
<td>(b) Adenosine deaminase deficiency</td>
<td>(ii) Cellular defence</td>
</tr>
<tr>
<td>(c) RNAi</td>
<td>(iii) Detection of HIV infection</td>
</tr>
<tr>
<td>(d) PCR</td>
<td>(iv) Bacillus thuringiensis</td>
</tr>
</tbody>
</table>

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

86. Match the following columns and select the correct option.

<table>
<thead>
<tr>
<th>Column-I</th>
<th>Column-II</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Organ of Corti</td>
<td>(i) Connects middle ear and pharynx</td>
</tr>
<tr>
<td>(b) Cochlea</td>
<td>(ii) Coiled part of the labyrinth</td>
</tr>
<tr>
<td>(c) Eustachian tube</td>
<td>(iii) Attached to the oval window</td>
</tr>
<tr>
<td>(d) Stapes</td>
<td>(iv) Located on the basilar membrane</td>
</tr>
</tbody>
</table>

(a) (b) (c) (d)
(1) (iii) (i) (iv) (ii)
(2) (iv) (ii) (i) (iii)
(3) (i) (ii) (iv) (iii)
(4) (ii) (iii) (i) (iv)

Answer (2)

Sol. Option (2) is correct because organ of Corti is located on the Basilar membrane, thus (a) in column-I matches with (iv) in column-II.

87. Which one of the following is the most abundant protein in the animals?
(1) Collagen  (2) Lectin
(3) Insulin  (4) Haemoglobin

Answer (1)

Sol. Collagen is the most abundant protein in animal world and RuBisCO is the most abundant protein in the whole of the Biosphere.

88. Identify the wrong statement with reference to immunity.
(1) When ready-made antibodies are directly given, it is called “Passive immunity”.
(2) Active immunity is quick and gives full response.
(3) Foetus receives some antibodies from mother, it is an example for passive immunity.
(4) When exposed to antigen (living or dead) antibodies are produced in the host’s body. It is called “Active immunity”.

Answer (2)

Sol. The correct option is (2) because active immunity is slow and takes time to give its full effective response in comparison to passive immunity where pre-formed antibodies are administered.

89. Montreal protocol was signed in 1987 for control of
(1) Emission of ozone depleting substances
(2) Release of Green House gases
(3) Disposal of e-wastes
(4) Transport of Genetically modified organisms from one country to another

Answer (1)

Sol. Montreal protocol – Signed in 16 Sep, 1987 (Ozone day)

Come into force – 1 Jan, 1989.

It was aimed at stopping the production and import of ODS and reduce their concentration in the atmosphere.

90. Match the trophic levels with their correct species examples in grassland ecosystem.
(a) Fourth trophic level (i) Crow
(b) Second trophic level (ii) Vulture
(c) First trophic level (iii) Rabbit
(d) Third trophic level (iv) Grass

Select the correct option

<table>
<thead>
<tr>
<th>(a)</th>
<th>(b)</th>
<th>(c)</th>
<th>(d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) (iii)</td>
<td>(i)</td>
<td>(ii)</td>
<td>(iv)</td>
</tr>
<tr>
<td>(2) (iv)</td>
<td>(iii)</td>
<td>(i)</td>
<td>(ii)</td>
</tr>
<tr>
<td>(3) (i)</td>
<td>(ii)</td>
<td>(iii)</td>
<td>(iv)</td>
</tr>
<tr>
<td>(4) (ii)</td>
<td>(iii)</td>
<td>(iv)</td>
<td>(i)</td>
</tr>
</tbody>
</table>

Answer (4)

Sol. Grassland ecosystem is a terrestrial ecosystem. It includes various trophic levels

First trophic level ($T_1$) – Grass
Second trophic level ($T_2$) – Rabbit
Third trophic level ($T_3$) – Crow
Fourth trophic level ($T_4$) – Vulture
91. A screw gauge has least count of 0.01 mm and there are 50 divisions in its circular scale. The pitch of the screw gauge is:

(1) 0.25 mm    (2) 0.5 mm
(3) 1.0 mm    (4) 0.01 mm

*Answer (2)*

*Sol.* Least count

\[
\text{Pitch} = \frac{\text{Number of divisions on circular scale}}{50}
\]

\[
0.01 \text{ mm} = \frac{\text{Pitch}}{50}
\]

\[
\text{Pitch} = 0.5 \text{ mm}
\]

92. The mean free path for a gas, with molecular diameter \( d \) and number density \( n \) can be expressed as:

(1) \( \frac{1}{\sqrt{2\pi d^2}} \)
(2) \( \frac{1}{\sqrt{2n^2\pi d^2}} \)
(3) \( \frac{1}{\sqrt{2n^2\pi^2 d^2}} \)
(4) \( \frac{1}{\sqrt{2n\pi d}} \)

*Answer (1)*

*Sol.* According to the formula

\[
\lambda = \frac{1}{\sqrt{2\pi d^2}}
\]

93. Light of frequency 1.5 times the threshold frequency is incident on a photosensitive material. What will be the photoelectric current if the frequency is halved and intensity is doubled?

(1) four times    (2) one-fourth
(3) zero    (4) doubled

*Answer (3)*

*Sol.*

\[
v = \frac{3}{2} v_0
\]

\[
v' = \frac{v}{2} = \frac{3}{4} v_0
\]

\[
\therefore v' < v_0
\]

\[
\therefore \text{No photoelectric emission will take place.}
\]

94. In a certain region of space with volume 0.2 m³, the electric potential is found to be 5 V throughout. The magnitude of electric field in this region is:

(1) 0.5 N/C    (2) 1 N/C
(3) 5 N/C    (4) zero

*Answer (4)*

*Sol.* Since, electric potential is found throughout constant, hence electric field, \( E = -\frac{dV}{dr} = 0 \)

95. Which of the following graph represents the variation of resistivity (\( \rho \)) with temperature (\( T \)) for copper?

(1) \[
\rho
\]
(2) \[
\rho
\]
(3) \[
\rho
\]
(4) \[
\rho
\]

*Answer (2)*

*Sol.* At temperature much lower than 0°C, graph deviates considerably from a straight line. Option (2) is correct.

96. A wire of length \( L \), area of cross section \( A \) is hanging from a fixed support. The length of the wire changes to \( L_1 \) when mass \( M \) is suspended from its free end. The expression for Young’s modulus is:

(1) \( \frac{Mg(L_1 - L)}{AL} \)
(2) \( \frac{MgL}{AL_1} \)
(3) \( \frac{MgL}{A(L_1 - L)} \)
(4) \( \frac{MgL_1}{AL} \)

*Answer (3)*
Sol. Stress = \( \frac{Mg}{A} \)
Strain = \( \frac{\Delta L}{L} = \frac{L_1 - L}{L} \)
Young's modulus = \( \frac{\text{Stress}}{\text{Strain}} = \frac{MgL}{A(L_1 - L)} \)

97. In a guitar, two strings A and B made of same material are slightly out of tune and produce beats of frequency 6 Hz. When tension in B is slightly decreased, the beat frequency increases to 7 Hz. If the frequency of A is 530 Hz, the original frequency of B will be:
(1) 524 Hz  (2) 536 Hz  (3) 537 Hz  (4) 523 Hz

Answer (1)

Sol. Difference of \( f_A \) and \( f_B \) is 6 Hz
If tension decreases, \( f_B \) decreases and becomes \( f'_B \).
Now, difference of \( f_A \) and \( f'_B \) = 7 Hz (increases)
So, \( f_A > f'_B \)
\( f_A = 530 \) Hz
\( f_B = 524 \) Hz (original)

98. A 40 \( \mu \)F capacitor is connected to a 200 V, 50 Hz ac supply. The rms value of the current in the circuit is, nearly:
(1) 2.05 A  (2) 2.5 A  (3) 25.1 A  (4) 1.7 A

Answer (2)

Sol. \( i_{\text{rms}} = c\omega \varepsilon_{\text{rms}} \)
\( c = 40 \times 10^{-6} \) F
\( \omega = 2\pi f = 100\pi \)
\( \varepsilon_{\text{rms}} = 200 \) V
\( \therefore i_{\text{rms}} = 200 \times 40 \times 10^{-6} \times 2\pi \times 50 \)
\( = 2.5 \) A

99. A ball is thrown vertically downward with a velocity of 20 m/s from the top of a tower. It hits the ground after some time with a velocity of 80 m/s. The height of the tower is: \( (g = 10 \text{ m/s}^2) \)
(1) 340 m  (2) 320 m  (3) 300 m  (4) 360 m

Answer (3)

Sol.
\[ \begin{align*}
&\text{\( v^2 = u^2 + 2gh \)} \\
&\text{\( v = 80 \text{ m/s} \)} \\
&\text{\( u = 20 \text{ m/s} \)} \\
&\text{\( h = \frac{v^2 - u^2}{2g} = \frac{6400 - 400}{20} = 300 \) m} \\
\end{align*} \]
102. A short electric dipole has a dipole moment of $16 \times 10^{-9}$ C m. The electric potential due to the dipole at a point at a distance of 0.6 m from the centre of the dipole, situated on a line making an angle of $60^\circ$ with the dipole axis is:

$$\left(\frac{1}{4\pi \varepsilon_0}\right) = 9 \times 10^9 \text{ N m}^2/\text{C}^2$$

(1) $200 \text{ V}$
(2) $400 \text{ V}$
(3) zero
(4) $50 \text{ V}$

**Answer (1)**

Sol. $V = \frac{kpcos\theta}{r^2}$

$$V = \frac{9 \times 10^9 \times 16 \times 10^{-9} \times \cos 60}{0.36}$$

$V = 200 \text{ V}$

103. An iron rod of susceptibility 599 is subjected to a magnetising field of 1200 A m$^{-1}$. The permeability of the material of the rod is:

($\mu_0 = 4\pi \times 10^{-7}$ T m A$^{-1}$)

(1) $8.0 \times 10^{-5}$ T m A$^{-1}$
(2) $2.4\pi \times 10^{-5}$ T m A$^{-1}$
(3) $2.4\pi \times 10^{-7}$ T m A$^{-1}$
(4) $2.4\pi \times 10^{-4}$ T m A$^{-1}$

**Answer (4)**

Sol. $\chi_m = 599$

$\mu_r = 1 + \chi_m = 600$

$\mu = \mu_r \mu_0$

$\mu = 600 \times 4\pi \times 10^{-7}$

$\mu = 2400\pi \times 10^{-7}$

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

104. The increase in the width of the depletion region in a p-n junction diode is due to:

(1) reverse bias only
(2) both forward bias and reverse bias
(3) increase in forward current
(4) forward bias only

**Answer (1)**

Sol. Due to reverse biasing, the width of the depletion region increases.

105. A capillary tube of radius $r$ is immersed in water and water rises in it to a height $h$. The mass of the water in the capillary is 5 g. Another capillary tube of radius $2r$ is immersed in water. The mass of water that will rise in this tube is:

(1) 5.0 g
(2) 10.0 g
(3) 20.0 g
(4) 2.5 g

**Answer (2)**

Sol. Force of surface tension balances the weight of water in capillary tube.

$$F_s = 2\pi r T \cos \theta = mg$$

Here, $T$ and $\theta$ are constant

So, $m \propto r$

Hence, $m_2 = \frac{2r}{r} \times 5.0 \Rightarrow m_2 = 10.0 \text{ g}$

106. The energy equivalent of 0.5 g of a substance is:

(1) $4.5 \times 10^{13}$ J
(2) $1.5 \times 10^{13}$ J
(3) $0.5 \times 10^{13}$ J
(4) $4.5 \times 10^{16}$ J

**Answer (1)**

Sol. From mass-energy equivalence.

$$E = mc^2$$

$$= 0.5 \times 10^{-3} \times (3 \times 10^8)^2$$

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

107. The solids which have the negative temperature coefficient of resistance are:

(1) insulators only
(2) semiconductors only
(3) insulators and semiconductors
(4) metals

**Answer (3)**
Sol. For metals temperature coefficient of resistance is positive while for insulators and semiconductors, temperature coefficient of resistance is negative.

108. A ray is incident at an angle of incidence \( i \) on one surface of a small angle prism (with angle of prism \( A \)) and emerges normally from the opposite surface. If the refractive index of the material of the prism is \( \mu \), then the angle of incidence is nearly equal to:

(1) \( \frac{2A}{\mu} \)
(2) \( \mu A \)
(3) \( \frac{\mu A}{2} \)
(4) \( \frac{A}{2\mu} \)

Answer (2)

Sol. Light ray emerges normally from another surface, hence \( e(\text{angle of emergence}) = 0 \)

\[
2 = 0
\]

\[
r_1 + r_2 = A
\]

\[
\Rightarrow r_1 = A
\]

Applying Snell’s law on first surface

\[
\sin i = \mu \sin r_1
\]

\[
\Rightarrow \sin i = \mu \sin A
\]

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

\[
\therefore i = \mu A
\]

109. For which one of the following, Bohr model is not valid?

(1) Singly ionised helium atom \( (\text{He}^+) \)
(2) Deuteron atom
(3) Singly ionised neon atom \( (\text{Ne}^+) \)
(4) Hydrogen atom

Answer (3)

Sol. Bohr model is only valid for single electron species.

Singly ionised neon atom has more than one electron in orbit. Hence, Bohr model is not valid.

110. Assume that light of wavelength 600 nm is coming from a star. The limit of resolution of telescope whose objective has a diameter of 2 m is:

(1) \( 1.83 \times 10^{-7} \) rad
(2) \( 7.32 \times 10^{-7} \) rad
(3) \( 6.00 \times 10^{-7} \) rad
(4) \( 3.66 \times 10^{-7} \) rad

Answer (4)

Sol. \( \theta = \frac{1.22 \lambda}{d} \); \( \lambda = 600 \times 10^{-9} \) m \( d = 2 \) m

\[
\theta = \frac{1.22 \times 600 \times 10^{-9}}{2}
\]

\[
\theta = 3.66 \times 10^{-7} \text{ rad}
\]

111. A body weighs 72 N on the surface of the earth. What is the gravitational force on it, at a height equal to half the radius of the earth?

(1) 32 N
(2) 30 N
(3) 24 N
(4) 48 N

Answer (1)

Sol. \( mg_h = \frac{mg_0}{(1 + \frac{h}{R})^2} \)

\[
W = \frac{72}{(1 + \frac{R/2}{R})^2}
\]

\[
W = \frac{72}{(3/2)^2} = \frac{4}{9} \times 72 = 32 \text{ N}
\]

112. A charged particle having drift velocity of \( 7.5 \times 10^{-4} \) m s\(^{-1}\) in an electric field of \( 3 \times 10^{-10} \) Vm\(^{-1}\), has a mobility in m\(^2\) V\(^{-1}\) s\(^{-1}\) of:

(1) \( 2.5 \times 10^6 \)
(2) \( 2.5 \times 10^{-6} \)
(3) \( 2.25 \times 10^{-15} \)
(4) \( 2.25 \times 10^{15} \)

Answer (1)

Sol. Mobility, \( \mu = \frac{\nu_d}{E} \)

\[
\mu = \frac{7.5 \times 10^{-4}}{3 \times 10^{-10}}
\]

\[
\mu = 2.5 \times 10^6 \text{ m}^2\text{V}^{-1}\text{s}^{-1}
\]

113. For transistor action, which of the following statements is correct?

(1) Base, emitter and collector regions should have same size.
(2) Both emitter junction as well as the collector junction are forward biased.
(3) The base region must be very thin and lightly doped.
(4) Base, emitter and collector regions should have same doping concentrations.

Answer (3)
For Bi-polar junction transistor
Length Profile is \( L_C > L_E > L_B \)
and doping profile is \( E > C > B \)
For transistor action Base-emitter junction is forward biased and Base-collector junction is reversed biased.

114. The capacitance of a parallel plate capacitor with air as medium is \( 6 \mu\text{F} \). With the introduction of a dielectric medium, the capacitance becomes \( 30 \mu\text{F} \). The permittivity of the medium is:

\[
\varepsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}
\]

Answer (2)

Sol. \( C = KC_0 \)

\[
K = \frac{C}{C_0} = \frac{30}{6} = 5
\]

\[
\varepsilon = Ke_0
\]

\[
= 5 \times 8.85 \times 10^{-12}
\]

\[
= 0.44 \times 10^{-10} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}
\]

115. Taking into account of the significant figures, what is the value of \( 9.99 \text{ m} - 0.0099 \text{ m} \)?

(1) 9.98 m

(2) 9.980 m

(3) 9.9 m

(4) 9.9801 m

Answer (1)

Sol. \( \frac{0.0099}{9.9801 \text{ m}} \)

In subtraction, answer should be reported to least number of decimal places, so answer should be 9.98 m.
In an electromagnetic wave, half of the intensity is provided by the electric field and half by the magnetic field. Hence, the required ratio should be 1:1.

119. A long solenoid of 50 cm length having 100 turns carries a current of 2.5 A. The magnetic field at the centre of the solenoid is:

\( (\mu_0 = 4\pi \times 10^{-7} \text{ T m A}^{-1}) \)

\( (1) 3.14 \times 10^{-4} \text{ T} \)
\( (2) 6.28 \times 10^{-5} \text{ T} \)
\( (3) 3.14 \times 10^{-5} \text{ T} \)
\( (4) 6.28 \times 10^{-4} \text{ T} \)

**Answer (4)**

The magnetic field at the centre of a solenoid is given by:

\[ B = \mu_0 n I \]

where:
- \( n = \frac{N}{L} = \frac{100}{50 \times 10^{-2}} = 200 \text{ turns/m} \)
- \( I = 2.5 \text{ A} \)

On putting the values:

\[ B = 4\pi \times 10^{-7} \times 200 \times 2.5 = 6.28 \times 10^{-4} \text{ T} \]

120. In Young’s double slit experiment, if the separation between coherent sources is halved and the distance of the screen from the coherent sources is doubled, then the fringe width becomes:

(1) half
(2) four times
(3) one-fourth
(4) double

**Answer (2)**

The fringe width is given by:

\[ \beta = \frac{\lambda D}{d} \]

Now, \( d' = \frac{d}{2} \) and \( D' = 2D \)

So, \( \beta' = \frac{\lambda (2D)}{d/2} = \frac{4\lambda D}{d} \)

\[ \beta' = 4\beta \]

121. A resistance wire connected in the left gap of a metre bridge balances a 10 Ω resistance in the right gap at a point which divides the bridge wire in the ratio 3 : 2. If the length of the resistance wire is 1.5 m, then the length of 1 Ω of the resistance wire is:

(1) \( 1.0 \times 10^{-1} \text{ m} \)
(2) \( 1.5 \times 10^{-1} \text{ m} \)
(3) \( 1.5 \times 10^{-2} \text{ m} \)
(4) \( 1.0 \times 10^{-2} \text{ m} \)

**Answer (1)**

The resistance of the wire is given by:

\[ R = \rho \frac{l}{A} \]

\[ \frac{1}{R_1} = \frac{3}{10} \]
\[ \frac{1}{R_2} = \frac{2}{10} \]

So, \( \frac{10}{2} = 15 \Omega \)

122. The energy required to break one bond in DNA is \( 10^{-20} \text{ J} \). This value in eV is nearly:

(1) 0.6
(2) 0.06
(3) 0.006
(4) 6

**Answer (2)**

1 eV = \( 1.6 \times 10^{-19} \text{ J} \)

\[ 1 \text{ J} = \frac{1}{1.6 \times 10^{-19}} \text{ eV} \]

\[ 10^{-20} \text{ J} = \frac{10^{-20}}{1.6 \times 10^{-19}} \text{ eV} \]

\[ = 0.06 \text{ eV} \]

123. When a uranium isotope \(^{235}_{92}\text{U}\) is bombarded with a neutron, it generates \(^{89}_{36}\text{Kr}\), three neutrons and:

(1) \(^{91}_{40}\text{Zr}\)
(2) \(^{101}_{36}\text{Kr}\)
(3) \(^{103}_{36}\text{Kr}\)
(4) \(^{144}_{56}\text{Ba}\)

**Answer (4)**

\[ ^{235}_{92}\text{U} + _1^0\text{n} \rightarrow ^{89}_{36}\text{Kr} + 3n_0 + X^A_2 \]

\( 92 + 0 = 36 + Z \)
\( \Rightarrow Z = 56 \)
\( 235 + 1 = 89 + 3 + A \)
\( \Rightarrow A = 144 \)

So, \(^{144}_{56}\text{Ba}\) is generated.
124. Two cylinders A and B of equal capacity are connected to each other via a stop cock. A contains an ideal gas at standard temperature and pressure. B is completely evacuated. The entire system is thermally insulated. The stop cock is suddenly opened. The process is:
(1) adiabatic (2) isochoric (3) isobaric (4) isothermal
Answer (1)
Sol. Entire system is thermally insulated. So, no heat exchange will take place. Hence, process will be adiabatic.

125. Light with an average flux of 20 W/cm\(^2\) falls on a non-reflecting surface at normal incidence having surface area 20 cm\(^2\). The energy received by the surface during time span of 1 minute is:
(1) 12 \times 10^3 J
(2) 24 \times 10^3 J
(3) 48 \times 10^3 J
(4) 10 \times 10^3 J
Answer (2)
Sol. Energy received = Intensity \times Area \times Time
= 20 \times 20 \times 60
= 24 \times 10^3 J

126. The quantities of heat required to raise the temperature of two solid copper spheres of radii \(r_1\) and \(r_2\) (\(r_1 = 1.5\ r_2\)) through 1 K in the ratio:
(1) \(\frac{9}{4}\)
(2) \(\frac{3}{2}\)
(3) \(\frac{5}{3}\)
(4) \(\frac{27}{8}\)
Answer (4)
Sol. \(\Delta Q = ms\Delta T\)
\[\Delta Q = \frac{4}{3} \pi r^3 \rho s \Delta T\]
\[
\frac{\Delta Q_1}{\Delta Q_2} = \left(\frac{r_1}{r_2}\right)^3 = (1.5)^3 = \frac{27}{8}
\]

127. The average thermal energy for a mono-atomic gas is: (\(k_B\) is Boltzmann constant and \(T\), absolute temperature)
(1) \(\frac{3}{2} k_B T\)
(2) \(\frac{5}{2} k_B T\)
(3) \(\frac{7}{2} k_B T\)
(4) \(\frac{1}{2} k_B T\)
Answer (1)
Sol. For monoatomic gases, degree of freedom is 3.
Hence average thermal energy per molecule is
\[KE_{avg} = \frac{3}{2} k_B T\]

128. A series LCR circuit is connected to an ac voltage source. When L is removed from the circuit, the phase difference between current and voltage is \(\pi\). If instead C is removed from the circuit, the phase difference is again \(\frac{\pi}{3}\) between current and voltage. The power factor of the circuit is:
(1) 0.5
(2) 1.0
(3) –1.0
(4) zero
Answer (2)
Sol. When L is removed,
\[\tan \phi = \frac{|X_C|}{R} \Rightarrow \tan \frac{\pi}{3} = \frac{X_C}{R} \quad \text{...(i)}\]
When C is removed,
\[\tan \phi = \frac{|X_L|}{R} \Rightarrow \tan \frac{\pi}{3} = \frac{X_L}{R} \quad \text{...(ii)}\]
From (i) and (ii), \(X_L = X_C\)
Since, \(X_L = X_C\), the circuit is in resonance. \(Z = R\)
Power factor = \(\cos \phi = \frac{R}{Z} = 1\)

129. Two particles of mass 5 kg and 10 kg respectively are attached to the two ends of a rigid rod of length 1 m with negligible mass.

The centre of mass of the system from the 5 kg particle is nearly at a distance of:
(1) 50 cm
(2) 67 cm
(3) 80 cm
(4) 33 cm
Answer (2)
130. The phase difference between displacement and acceleration of a particle in a simple harmonic motion is:

(1) \(\frac{3\pi}{2}\) rad  
(2) \(\frac{\pi}{2}\) rad  
(3) zero  
(4) \(\pi\) rad

Answer (4)

Sol. If \(y = A \sin \omega t\)
then \(\frac{dy}{dt} = A \omega \cos \omega t\)
\(v = A \omega \cos \omega t\)
\(\frac{dv}{dt} = -A \omega^2 \sin(\omega t)\)
\(a = -A \omega^2 \sin(\omega t + \pi)\)
So phase difference between displacement and acceleration is \(\pi\).

131. The Brewster's angle \(i_b\) for an interface should be:

(1) \(30^\circ < i_b < 45^\circ\)  
(2) \(45^\circ < i_b < 90^\circ\)  
(3) \(i_b = 90^\circ\)  
(4) \(0^\circ < i_b < 30^\circ\)

Answer (2)

Sol. \(\mu = \tan i_b\)
\(1 < \mu < \infty\)
\(1 < \tan i_b < \infty\)
\(\tan^{-1}(1) < i_b < \tan^{-1}(\infty)\)
\(45^\circ < i_b < 90^\circ\)

132. Dimensions of stress are:

(1) \([ML^2T^{-2}]\)  
(2) \([ML^0T^{-2}]\)  
(3) \([ML^{-1}T^{-2}]\)  
(4) \([MLT^{-2}]\)

Answer (3)

Sol. Stress = \(\frac{\text{Force}}{\text{Area}}\)
\([ML^{-1}T^{-2}]\)

133. The color code of a resistance is given below:

Yellow Violet Brown Gold

The values of resistance and tolerance, respectively, are:

(1) 47 k\(\Omega\), 10%  
(2) 4.7 k\(\Omega\), 5%  
(3) 470 \(\Omega\), 5%  
(4) 470 k\(\Omega\), 5%

Answer (3)

Sol. According to colour coding

Yellow Violet Brown Gold

4 7 1 5%

So, \(R = 47 \times 10^4 \pm 5\%\)

134. A spherical conductor of radius 10 cm has a charge of \(3.2 \times 10^{-7}\) C distributed uniformly. What is the magnitude of electric field at a point 15 cm from the centre of the sphere?

\(\left(\frac{1}{4\pi \varepsilon_0}\right) = \frac{9 \times 10^9 \text{Nm}^2/\text{C}^2}{225 \times 10^{-4}}\)

(1) \(1.28 \times 10^5\) N/C  
(2) \(1.28 \times 10^6\) N/C  
(3) \(1.28 \times 10^7\) N/C  
(4) \(1.28 \times 10^4\) N/C

Answer (1)

Sol. Electric field outside a conducting sphere
\(E = \frac{1}{4\pi \varepsilon_0} \frac{Q}{r^2}\)
\(= \frac{9 \times 10^9 \times 3.2 \times 10^{-7}}{225 \times 10^{-4}}\)
\(= 0.128 \times 10^6\)
\(= 1.28 \times 10^5\) N/C

135. Find the torque about the origin when a force of 3\(\hat{j}\) N acts on a particle whose position vector is 2\(\hat{k}\) m.

(1) 6\(\hat{j}\) Nm  
(2) -6\(\hat{i}\) Nm  
(3) 6\(\hat{k}\) Nm  
(4) 6\(\hat{i}\) Nm

Answer (2)

Sol. \(\vec{\tau} = \vec{r} \times \vec{F}\)
\(\vec{\tau} = 2\hat{k} \times 3\hat{j}\)
\(\vec{\tau} = -6\hat{i}\) Nm
136. The mixture which shows positive deviation from Raoult's law is
(1) Benzene + Toluene
(2) Acetone + Chloroform
(3) Chloroethane + Bromoethane
(4) Ethanol + Acetone

Answer (4)

Sol. Pure ethanol molecules are hydrogen bonded. On adding acetone, its molecules get in between the ethanol molecules and break some of the hydrogen bonds between them. This weakens the intermolecular attractive interactions and the solution shows positive deviation from Raoult's law.

137. Which of the following is not correct about carbon monoxide?
(1) It reduces oxygen carrying ability of blood.
(2) The carboxyhaemoglobin (haemoglobin bound to CO) is less stable than oxyhaemoglobin.
(3) It is produced due to incomplete combustion.
(4) It forms carboxyhaemoglobin

Answer (2)

Sol. The carboxyhaemoglobin is about 300 times more stable than oxyhaemoglobin.

138. The number of Faradays (F) required to produce 20 g of calcium from molten CaCl₂ (Atomic mass of Ca = 40 g mol⁻¹) is
(1) 2
(2) 3
(3) 4
(4) 1

Answer (4)

Sol. 1 equivalent of any substance is deposited by 1 F of charge.

We have, 20 g calcium

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

\[ = \frac{20}{20} = 1 \]

Equivalent mass of Ca = \( \frac{40}{2} = 20 \)

So, 1 faraday of charge is required.

139. Hydrolysis of sucrose is given by the following reaction.

\[ \text{Sucrose} + \text{H}_2\text{O} \rightleftharpoons \text{Glucose} + \text{Fructose} \]

If the equilibrium constant \( K_c \) is \( 2 \times 10^{13} \) at 300 K, the value of \( \Delta G^\circ \) at the same temperature will be:
(1) \( 8.314 \text{ J mol}^{-1} \text{K}^{-1} \times 300 \text{ K} \times \ln(2 \times 10^{13}) \)
(2) \( 8.314 \text{ J mol}^{-1} \text{K}^{-1} \times 300 \text{ K} \times \ln(3 \times 10^{13}) \)
(3) \( -8.314 \text{ J mol}^{-1} \text{K}^{-1} \times 300 \text{ K} \times \ln(4 \times 10^{13}) \)
(4) \( -8.314 \text{ J mol}^{-1} \text{K}^{-1} \times 300 \text{ K} \times \ln(2 \times 10^{13}) \)

Answer (4)

Sol. \[ \Delta G = \Delta G^\circ + RT \ln Q \]

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

So \[ \Delta G^\circ = -RT \ln K_{eq} \]

\[ \Delta G^\circ = -8.314 \text{ J mol}^{-1} \text{K}^{-1} \times 300 \text{ K} \times \ln(2 \times 10^{13}) \]

140. For the reaction, \( 2\text{Cl}(g) \rightleftharpoons \text{Cl}_2(g) \), the correct option is:
(1) \( \Delta H > 0 \) and \( \Delta S < 0 \)
(2) \( \Delta H < 0 \) and \( \Delta S > 0 \)
(3) \( \Delta H < 0 \) and \( \Delta S < 0 \)
(4) \( \Delta H > 0 \) and \( \Delta S > 0 \)

Answer (3)

Sol. Given reaction, \( 2\text{Cl}(g) \rightleftharpoons \text{Cl}_2(g) \)

We know that, \( \text{Cl}_2(g) \rightleftharpoons 2\text{Cl}(g) \) is endothermic reaction because it requires energy to break bond.

So reverse reaction is exothermic \( \Delta H < 0 \)

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

So, randomness \( \Delta S < 0 \)

141. Paper chromatography is an example of
(1) Partition chromatography
(2) Thin layer chromatography
(3) Column chromatography
(4) Adsorption chromatography

Answer (1)
Sol. Paper chromatography is a type of partition chromatography in which a special quality paper known as chromatography paper is used.

142. The rate constant for a first order reaction is $4.606 \times 10^{-3} \text{ s}^{-1}$. The time required to reduce 2.0 g of the reactant to 0.2 g is :

(1) 200 s
(2) 500 s
(3) 1000 s
(4) 100 s

Answer (2)

Sol. $k = \frac{2.303 \log A_0}{t}$ (First order rate equation)

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

$t = \frac{2.303}{4.606 \times 10^{-3} \times \log 10}$

$= \frac{10^3}{2} = 500 \text{ s}$

143. Which of the following oxoacid of sulphur has $–O–O–$ linkage?

(1) $\text{H}_2\text{SO}_4$, sulphuric acid
(2) $\text{H}_2\text{S}_2\text{O}_8$, peroxodisulphuric acid
(3) $\text{H}_2\text{S}_2\text{O}_7$, pyrosulphuric acid
(4) $\text{H}_2\text{SO}_3$, sulphurous acid

Answer (2)

Sol. $\text{HO–S–O–O–S–OH}$

Peroxodisulphuric acid

144. Reaction between benzaldehyde and acetophenone in presence of dilute $\text{NaOH}$ is known as

(1) Cannizzaro’s reaction
(2) Cross Cannizzaro’s reaction
(3) Cross Aldol condensation
(4) Aldol condensation

Answer (3)

Sol. In the presence of dil. $\text{OH}^-$, benzaldehyde and acetophenone will react to undergo cross-aldol condensation.

145. An element has a body centered cubic (bcc) structure with a cell edge of 288 pm. The atomic radius is

(1) $\frac{\sqrt{2}}{4} \times 288 \text{ pm}$
(2) $\frac{\sqrt{3}}{4} \times 288 \text{ pm}$
(3) $\frac{\sqrt{4}}{4} \times 288 \text{ pm}$
(4) $\frac{\sqrt{2}}{3} \times 288 \text{ pm}$

Answer (4)

Sol. For BCC,

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

Given, $a = 288 \text{ pm}$

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

146. Which of the following is a cationic detergent?

(1) Sodium stearate
(2) Cetyltrimethyl ammonium bromide
(3) Sodium dodecylbenzene sulphonate
(4) Sodium lauryl sulphate

Answer (2)

Sol. $\text{CH}_3–(\text{CH}_2)_{15}–\text{N}^+–\text{CH}_3 \text{ Br}^-$

Cetyltrimethyl ammonium bromide
147. The calculated spin only magnetic moment of Cr\(^{2+}\) ion is

- (1) 4.90 BM
- (2) 5.92 BM
- (3) 2.84 BM
- (4) 3.87 BM

Answer (1)

Sol. Electronic configuration of Cr – [Ar] 3\(d^5\) 4\(s^1\)

Electronic configuration of Cr\(^{2+}\) – [Ar] 3\(d^4\)

Number of unpaired \(e^-\) = 4

Spin only magnetic moment = \(\sqrt{n(n+2)}\)

\(n = \text{number of unpaired } e^-\)

Spin only magnetic moment = \(\sqrt{4(4+2)}\)

= 24 BM

= 4.9 BM

148. HCl was passed through a solution of CaCl\(_2\), MgCl\(_2\) and NaCl. Which of the following compound(s) crystallise(s)?

- (1) Only NaCl
- (2) Only MgCl\(_2\)
- (3) NaCl, MgCl\(_2\) and CaCl\(_2\)
- (4) Both MgCl\(_2\) and CaCl\(_2\)

Answer (1)

Sol. Since CaCl\(_2\) and MgCl\(_2\) are more soluble than NaCl, on passing HCl(g) through a solution containing CaCl\(_2\), MgCl\(_2\) and NaCl then NaCl crystallizes out.

149. Match the following and identify the correct option.

- (a) CO(g) + H\(_2\)(g)
- (b) Temporary hardness of water
- (c) B\(_2\)H\(_6\)
- (d) H\(_2\)O

- (i) \(\text{Mg(HCO}_3\text{)}_2 + \text{Ca(HCO}_3\text{)}_2\)
- (ii) An electron deficient hydride
- (iii) Synthesis gas
- (iv) Non-planar structure

(a) (b) (c) (d)

(1) (iii) (ii) (i) (iv)
(2) (iii) (iv) (ii) (i)
(3) (i) (iii) (ii) (iv)
(4) (iii) (i) (ii) (iv)

Answer (4)

Sol. • Mixture of CO and H\(_2\) gases is known as water gas or synthesis gas.
- Temporary hardness of water is due to bicarbonates of calcium and magnesium.
- Diborane (B\(_2\)H\(_6\)) is an electron deficient hydride.
- \(\text{H}_2\text{O}_2\) is non-planar molecule having open book like structure.

150. Elimination reaction of 2-Bromo-pentane to form pent-2-ene is

(a) \(\beta\)-Elimination reaction
(b) Follows Zaitsev rule
(c) Dehydrohalogenation reaction
(d) Dehydration reaction

(1) (a), (c), (d) (2) (b), (c), (d)
(3) (a), (b), (d) (4) (a), (b), (c)

Answer (4)

Sol. \(\text{CH}_3\text{CHCH}_2\text{CH}_2\text{CH}_3\) (Reactant)

\(\text{CH}_3\text{CHCHCH}_2\text{CH}_3\) (Elimination)

Mechanism:

Since \(\beta\)-hydrogen is abstracted it is \(\beta\)-elimination.

Since more substituted alkene is formed, it follows Zaitsev’s rule.

Since ‘H’ and ‘Br’ are removed, it is dehydrohalogenation.

151. Which of the following is the correct order of increasing field strength of ligands to form coordination compounds?

- (1) SCN\(^-\) < F\(^-\) < CN\(^-\) < C\(_2\)O\(_4\)\(^2-\)
- (2) F\(^-\) < SCN\(^-\) < C\(_2\)O\(_4\)\(^2-\) < CN\(^-\)
- (3) CN\(^-\) < C\(_2\)O\(_4\)\(^2-\) < SCN\(^-\) < F\(^-\)
- (4) SCN\(^-\) < F\(^-\) < C\(_2\)O\(_4\)\(^2-\) < CN\(^-\)

Answer (4)
Sol. Spectrochemical series (as given in NCERT) :

\[ \text{I}^- < \text{Br}^- < \text{SCN}^- < \text{Cl}^- < S^{2-} < F^- < \text{OH}^- < C_2O_4^{2-} < H_2O < \text{NCS}^- < \text{EDTA}^{4-} < \text{NH}_3 < \text{en} < \text{CN}^- < \text{CO}_3^{2-} \]

152. Identify the correct statement from the following :

(1) Blister copper has blistered appearance due to evolution of \( CO_2 \).
(2) Vapour phase refining is carried out for Nickel by Van Arkel method.
(3) Pig iron can be moulded into a variety of shapes.
(4) Wrought iron is impure iron with 4% carbon.

Answer (3)

Sol. The iron obtained from blast furnace contains about 4% carbon and many impurities like S, P, Si, Mn in smaller amount. This is known as pig iron and cast into variety of shapes.

153. Sucrose on hydrolysis gives

(1) \( \alpha \)-D-Glucose + \( \beta \)-D-Glucose
(2) \( \alpha \)-D-Glucose + \( \beta \)-D-Fructose
(3) \( \alpha \)-D-Fructose +\( \beta \)-D-Fructose
(4) \( \beta \)-D-Glucose + \( \alpha \)-D-Fructose

Answer (2)

Sol. Sucrose \( \xrightarrow{\text{Hydrolysis}} \) \( \alpha \)-D-Glucose + \( \beta \)-D-Fructose

154. What is the change in oxidation number of carbon in the following reaction?

\[ \text{CH}_4(g) + 4\text{Cl}_2(g) \rightarrow \text{CCl}_4(l) + 4\text{HCl}(g) \]

(1) 0 to + 4 \hspace{1cm} (2) - 4 to + 4
(3) 0 to - 4 \hspace{1cm} (4) + 4 to + 4

Answer (2)

Sol. \( CH_4 \rightarrow x + 4 \times 1 = 0 \Rightarrow x = -4 \)

\[ CCl_4 \rightarrow x + 4 \times (-1) = 0 \Rightarrow x = +4 \]

\[ CH_4(g) + 4Cl_2(g) \rightarrow CCl_4(l) + 4HCl(g) \]

Change in oxidation state of carbon is from -4 to +4

155. The following metal ion activates many enzymes, participates in the oxidation of glucose to produce ATP and with Na, is responsible for the transmission of nerve signals.

(1) Copper \hspace{1cm} (2) Calcium
(3) Potassium \hspace{1cm} (4) Iron

Answer (3)

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

156. Which of the following alkane cannot be made in good yield by Wurtz reaction?

(1) 2,3-Dimethylbutane
(2) n-Heptane
(3) n-Butane
(4) n-Hexane

Answer (2)

Sol. Wurtz reaction is used to prepare symmetrical alkanes like \( R_1 - R_1 \), as

\[ R_1 - X + 2\text{Na} + X - R_1 \xrightarrow{\text{Dry ether}} R_1 - R_1 + 2\text{NaX} \]

If \( R_1 \) and \( R_2 \) are different, then mixture of alkanes may be obtained as

\[ R_1 - X + 2\text{Na} + R_2 - X \xrightarrow{\text{Dry ether}} R_1 - R_1 + R_1 - R_2 + R_2 - R_2 + 2\text{NaX} \]

157. Measuring Zeta potential is useful in determining which property of colloidal solution?

(1) Solubility
(2) Stability of the colloidal particles
(3) Size of the colloidal particles
(4) Viscosity

Answer (2)
158. The freezing point depression constant \( K_f \) of benzene is 5.12 K kg mol\(^{-1}\). The freezing point depression for the solution of molality 0.078 m containing a non-electrolyte solute in benzene is (rounded off upto two decimal places):

- (1) 0.80 K
- (2) 0.40 K
- (3) 0.60 K
- (4) 0.20 K

**Answer (2)**

\[
\Delta T_f = K_f m = 5.12 \text{ (K.kg mol}^{-1}\text{)} \times 0.078 \text{ (mol kg}^{-1}\text{)} = 0.399 \text{ K} \\
\approx 0.40 \text{ K}
\]

160. Which of the following set of molecules will have zero dipole moment?

- (1) Boron trifluoride, hydrogen fluoride, carbon dioxide, 1,3-dichlorobenzene
- (2) Nitrogen trifluoride, beryllium difluoride, water, 1,3-dichlorobenzene
- (3) Boron trifluoride, beryllium difluoride, carbon dioxide, 1,4-dichlorobenzene
- (4) Ammonia, beryllium difluoride, water, 1,4-dichlorobenzene

**Answer (3)**
163. On electrolysis of dil. sulphuric acid using Platinum (Pt) electrode, the product obtained at anode will be

(1) Oxygen gas
(2) H₂S gas
(3) SO₂ gas
(4) Hydrogen gas

Answer (1)

Sol. During the electrolysis of dil. sulphuric acid using Pt electrodes following reaction will take place.

At cathode:

\[ 4H^+(aq) + 4e^- \rightarrow 2H_2(g) \]

At anode:

\[ 2H_2O(l) \rightarrow O_2(g) + 4H^+(aq) + 4e^- \]

164. Anisole on cleavage with HI gives

(1) \[ \begin{array}{c} & & \text{I} \\ \text{C} & \text{H} & \text{C} \end{array} \] + CH₃OH

(2) \[ \begin{array}{c} \text{OH} \\ \text{C} & \text{H} \end{array} \] + C₂H₅I

(3) \[ \begin{array}{c} & & \text{I} \\ \text{C} & \text{H} & \text{C} \end{array} \] + C₂H₅OH

(4) \[ \begin{array}{c} \text{OH} \\ \text{C} & \text{H} \end{array} \] + CH₃I

Answer (4)

165. The number of protons, neutrons and electrons in ☐⁷¹Lu, respectively, are

(1) 104, 71 and 71
(2) 71, 104 and 71
(3) 175, 104 and 71
(4) 71, 104 and 71

Answer (4)

Sol. \[ ^{^{175}}_{^{71}}\text{Lu} \]

No. of Protons = 71 = No. of Electrons

No. of Neutrons = Mass no. – No. of Protons

= 175 – 71

= 104

166. Match the following:

<table>
<thead>
<tr>
<th>Oxide</th>
<th>Nature</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) CO</td>
<td>(i) Basic</td>
</tr>
<tr>
<td>(b) BaO</td>
<td>(ii) Neutral</td>
</tr>
<tr>
<td>(c) Al₂O₃</td>
<td>(iii) Acidic</td>
</tr>
<tr>
<td>(d) Cl₂O₇</td>
<td>(iv) Amphoteric</td>
</tr>
</tbody>
</table>

Which of the following is correct option?

(1) (ii) (i) (iv) (iii)
(2) (iii) (iv) (i) (ii)
(3) (iv) (iii) (ii) (i)
(4) (i) (ii) (iii) (iv)

Answer (1)

Sol. CO : Neutral oxide
BaO : Basic oxide
Al₂O₃ : Amphoteric oxide
Cl₂O₇ : Acidic oxide
167. A tertiary butyl carbocation is more stable than a secondary butyl carbocation because of which of the following?

(1) + R effect of – CH₃ groups
(2) – R effect of – CH₃ groups
(3) Hyperconjugation
(4) – I effect of – CH₃ groups

Answer (3)

Sol. Tertiary butyl carbocation

\[H₃C\overset{\ominus}{\text{C}}\text{CH₃} \quad \text{Secondary butyl carbocation} \quad \text{H₃C\overset{\ominus}{\text{C}}\text{CH₂CH₂CH₃}}\]

More the number of α-H atoms, more will be the hyperconjugation effect hence more will be the stability of carbocation.

168. Which one of the followings has maximum number of atoms?

(1) 1 g of Mg(s) [Atomic mass of Mg = 24]
(2) 1 g of O₂(g) [Atomic mass of O = 16]
(3) 1 g of Li(s) [Atomic mass of Li = 7]
(4) 1 g of Ag(s) [Atomic mass of Ag = 108]

Answer (3)

Sol. • Number of Mg atoms = \(\frac{1}{24} \times N_A\)
• Number of O atoms = \(\frac{1}{32} \times 2 \times N_A\)
• Number of Li atoms = \(\frac{1}{7} \times N_A\)
• Number of Ag atoms = \(\frac{1}{108} \times N_A\)

169. Which of the following is a basic amino acid?

(1) Alanine
(2) Tyrosine
(3) Lysine
(4) Serine

Answer (3)

Sol. \(\text{H₂N—CH₂—CH₂—CH₂—CH—COOH} \quad \text{NH₂}\)

(Structure of Lysine)

Lysine is a basic amino acid.

170. The correct option for free expansion of an ideal gas under adiabatic condition is

(1) \(q = 0, \Delta T < 0\) and \(w > 0\)
(2) \(q < 0, \Delta T = 0\) and \(w = 0\)
(3) \(q > 0, \Delta T > 0\) and \(w > 0\)
(4) \(q = 0, \Delta T = 0\) and \(w = 0\)

Answer (4)

Sol. Free expansion \(\Rightarrow P_{\text{ex}} = 0\)

\[\therefore w = -P_{\text{ex}} \Delta V = 0\]

\[\therefore \text{Adiabatic process } \Rightarrow q = 0\]

also, \(\Delta U = q + w\) [first law of thermodynamics]

\[\therefore \Delta U = 0\]

\[\therefore \text{Internal energy of an ideal gas is a function of temperature}\]

\[\therefore \Delta T = 0\]

171. Identify the incorrect match.

Name IUPAC Official Name

(a) Unnilunium (i) Mendelevium
(b) Unniltrium (ii) Lawrencium
(c) Unnilhexium (iii) Seaborgium
(d) Unununnium (iv) Darmstadtium

(1) (b), (ii)
(2) (c), (iii)
(3) (d), (iv)
(4) (a), (i)

Answer (3)

Sol. Unununnium

Atomic number = 111

IUPAC official name : Roentgenium

172. Identify a molecule which does not exist.

(1) Li₂
(2) C₂
(3) O₂
(4) He₂

Answer (4)

Sol. For He₂ molecule

Electronic configuration is \(σ1s^2, σ^*1s^2\)

so bond order = \(\frac{1}{2} (N_b - N_a)\)

\[= \frac{1}{2} [2 - 2]\]

\[= 0\]

Since, bond order is zero, so He₂ molecule does not exist.
173. Identify the correct statements from the following:

(a) \( \text{CO}_2(g) \) is used as refrigerant for ice-cream and frozen food.
(b) The structure of \( C_{60} \) contains twelve six carbon rings and twenty five carbon rings.
(c) ZSM-5, a type of zeolite, is used to convert alcohols into gasoline.
(d) CO is colorless and odourless gas.

(1) (a) and (c) only
(2) (b) and (c) only
(3) (c) and (d) only
(4) (a), (b) and (c) only

Answer (3)

Sol. • Dry ice, \( \text{CO}_2(s) \), is used as refrigerant
• \( C_{60} \) contains 20 six membered rings, 12 five membered rings

174. An alkene on ozonolysis gives methanal as one of the product. Its structure is

(1) \[ \text{CH}_2=\text{CH}_2 \]
(2) \[ \text{CH}_2=\text{CH}=\text{CH}_2 \]
(3) \[ \text{CH}_2=\text{CH}_2=\text{CH}_3 \]
(4) \[ \text{CH}=\text{CH}_2 \]

Answer (2)

Sol. • \[ \text{CH}_2=\text{CH}=\text{CH}_2 \] on ozonolysis gives \[ \text{CH}_2=\text{CH} \] and \[ \text{CH} = \text{CH}_2 \] and methanal

175. Reaction between acetone and methylmagnesium chloride followed by hydrolysis will give:

(1) Sec. butyl alcohol
(2) Tert. butyl alcohol
(3) Isobutyl alcohol
(4) Isopropyl alcohol

Answer (2)

Sol. \[
\begin{align*}
\text{CH}_3\text{C} & \text{CH}_3 \quad \text{CH} & \text{MgBr} \\
\delta^- & \delta^- & \delta+ \\
\text{CH}_3 & \text{CH}_3 \quad \text{CH}_3 \\
\downarrow & & \\
\text{CH}_2\text{C} & \text{CH}_3 \\
\downarrow & \\
\text{CH}_2\text{C} & \text{CH}_3 \\
\downarrow & \\
\text{CH}_3 \\
\end{align*}
\]
(tert-Butyl alcohol)

176. A mixture of \( \text{N}_2 \) and \( \text{Ar} \) gases in a cylinder contains 7 g of \( \text{N}_2 \) and 8 g of \( \text{Ar} \). If the total pressure of the mixture of the gases in the cylinder is 27 bar, the partial pressure of \( \text{N}_2 \) is:

[Use atomic masses (in g mol\(^{-1}\)) : \( \text{N} = 14 \), \( \text{Ar} = 40 \)]

(1) 12 bar
(2) 15 bar
(3) 18 bar
(4) 9 bar

Answer (2)
Sol. \( n_{\text{N}_2} = \frac{7}{28} = \frac{1}{4} = 0.25 \)

\( n_{\text{Ar}} = \frac{8}{40} = \frac{1}{5} = 0.20 \)

Now, Applying Dalton’s law of partial pressure, \( P_{\text{N}_2} = \left(\frac{n_{\text{N}_2}}{N}\right)P_{\text{Total}} \)

\[ \frac{0.25}{0.45} \times 27 \text{ bar} = \frac{5}{9} \times 27 = 15 \text{ bar} \]

177. An increase in the concentration of the reactants of a reaction leads to change in

(1) heat of reaction
(2) threshold energy
(3) collision frequency
(4) activation energy

Answer (1)

Sol. Heat of reaction is an extensive property. Hence, on change of amount/concentration of reactants heat of reaction changes.

178. Find out the solubility of Ni(OH)\(_2\) in 0.1 M NaOH. Given that the ionic product of Ni(OH)\(_2\) is \(2 \times 10^{-15}\)

(1) \(2 \times 10^{-8} \text{ M}\)
(2) \(1 \times 10^{-13} \text{ M}\)
(3) \(1 \times 10^{-8} \text{ M}\)
(4) \(2 \times 10^{-13} \text{ M}\)

Answer (4)

Sol. \(\text{Ni(OH)}_2 \rightleftharpoons \text{Ni}^{2+} + 2\text{OH}^-\)

\[
\begin{align*}
\text{NaOH} \rightarrow & \text{Na}^+ + \text{OH}^- \\
0.1 & \rightarrow 0.1 + 0.1
\end{align*}
\]

Total \(\text{[OH]} = 2s + 0.1 = 0.1\)

Ionic product = \([\text{Ni}^{2+}][\text{OH}]^2\)

\[2 \times 10^{-15} = s(0.1)^2\]

\[s = 2 \times 10^{-13}\]

Solubility of Ni(OH)\(_2\) = \(2 \times 10^{-13}\) M

179. Identify compound X in the following sequence of reactions

Sol. \(\text{CH}_3\text{Cl} \xrightarrow{\text{hv}} \text{X} \xrightarrow{\text{H}_2\text{O}} 373 \text{ K}\)

\(\text{CHCl}_2\)

Answer (2)

Sol. \(\text{CH}_3\text{Cl} \xrightarrow{\text{hv}} \text{X} \xrightarrow{\text{H}_2\text{O}} 373 \text{ K}\)

\(\text{CH}–\text{OH}\)

\(\text{H}_2\text{O}\)

Answer (2)

Sol. \(\text{NH}_2\text{CONH}_2 + \text{H}_2\text{O} \xrightarrow{\Delta} (\text{NH}_4)_2\text{CO}_3\)

\(\text{NH}_3(g) + \text{CO}_2(g) + \text{H}_2\text{O}(l)\)

\(\text{NH}_3(g) \xrightarrow{\text{Cu}^{2+}(aq)} \) [Blue coloured solution]

Answer (1)