

## Botany - Section A

1. To form a nucleosome:

1. the negatively charged DNA is wrapped around the positively charged histone octamer
2. the negatively charged DNA is wrapped around the positively charged histone tetramer
3. the positively charged DNA is wrapped around the negatively charged histone octamer
4. the positively charged DNA is wrapped around the negatively charged histone tetramer

2. You start with  $^{15}\text{N}^{15}\text{N}$  (heavy) DNA of *E. coli*. After TWO generations in the  $^{14}\text{N}$  medium, you expect *E. coli* cells will contain:

1. 25%  $^{15}\text{N}^{15}\text{N}$  DNA, 50%  $^{15}\text{N}^{14}\text{N}$  DNA, and 25%  $^{14}\text{N}^{14}\text{N}$  DNA.
2. 50%  $^{15}\text{N}^{15}\text{N}$  DNA and 50%  $^{14}\text{N}^{14}\text{N}$  DNA.
3. 50%  $^{15}\text{N}^{15}\text{N}$  DNA and 50%  $^{15}\text{N}^{14}\text{N}$  DNA.
4. 50%  $^{15}\text{N}^{14}\text{N}$  DNA and 50%  $^{14}\text{N}^{14}\text{N}$  DNA.

3. In the semi-conservative scheme of DNA replication:

- I. The two strands separate and act as a template for the synthesis of new complementary strands.
  - II. After the completion of replication, each DNA molecule would have one parental and one newly synthesised strand.
1. Only I is correct
  2. Only II is correct
  3. Both I and II are correct
  4. Both I and II are incorrect

4. During secondary treatment of sewage water:

- I. vigorous growth of useful aerobic microbes into flocs is allowed
  - II. aerobic microbes consume the major part of the organic matter in the effluent.
  - III. the BOD of the water sample gets significantly increased
1. Only I and II are correct
  2. Only I is correct
  3. Only II and III are correct
  4. I, II and III are correct

5. Abiotic pollination is most commonly brought about by:

1. Wind
2. Water
3. Soil
4. Bees

6. Germ pores are present in:

1. pollen exine where sporopollenin is present
2. pollen exine where sporopollenin is absent
3. pollen intine where hemicellulose is present
4. pollen intine where hemicellulose is absent

7. During Mendel's investigations into inheritance patterns it was for the first time that:

1. experiments were conducted on garden pea
2. artificial pollination experiments were carried out
3. statistical analysis and mathematical logic were applied to problems in biology
4. all characteristics were passed to the next generation through blending inheritance

8. Both autogamy and geitonogamy are prevented in:

1. Castor
2. Papaya
3. Maize
4. Garden pea

9. Which law is based on the fact that the alleles do not show ant blending and that both the characters are recovered as such in the  $F_2$  generation though one of these is not seen at the  $F_1$  stage?

1. Law of dominance
2. Law of segregation
3. Law of independent assortment
4. Law of linkage

10. The sobriquet 'terror of Bengal' is given to water hyacinth because:

1. it reproduces asexually at a phenomenal rate making it an invasive species in water bodies
2. it is very damaging competitor to the jute crop in West Bengal
3. it produces secondary metabolites such as cardiac glycosides causing death of cattle feeding on it
4. it flowers once in a decade and when it does it produces lot of toxins into aquatic bodies

11. Clearing of bottled fruit juices is achieved by treatment with:

1. Lipases and Proteases
2. DNase and RNase
3. Proteases and Pectinases
4. Cellulase and Chitinase

12. Apomixis is:

1. the development of fruit without fertilization
2. production of seeds without fertilization
3. unfertilized eggs developing into males
4. unfertilized eggs developing into females

13. Which of the following is synthesized constitutively in an E.coli cell?

1. Beta galactosidase
2. Permease
3. Transacetylase
4. Repressor of lac Operon

14. *Phoenix dactylifera* is commonly known as:

1. Deadly nightshade
2. Date palm
3. Lupine
4. Methsela

15. All the following can be performed by LAB except:

1. Coagulation and partial digestion of milk proteins
2. Increasing vitamin B12 in curd
3. Checking disease-causing microbes in our stomach
4. Producing large amount of carbon dioxide in fermentation of Swiss cheese

16. Both multiple fission and binary fission are seen in:

1. *Escherichia coli*
2. *Plasmodium falciparum*
3. *Amoeba*
4. *Penicillium*

17. RNA polymerase III is not responsible for transcription of:

1. tRNA
2. 5srRNA
3. snRNAs
4. 5.8srRNA

18. At the four nucleate stage, the number of cells present in a female gametophyte of a typical angiosperm is:

1. 1
2. 2
3. 4
4. 7

19. In eukaryotes if the gene expression is being regulated at the processing level, it means:

1. formation of primary transcript is being regulated
2. splicing of RNA is being regulated
3. transport of mRNA through nuclear pores is being regulated
4. the formation of initiation complex at the ribosome is being regulated

20. What percent of  $F_2$  progeny of a typical Mendelian monohybrid cross are expected to be true-breeding?

1. 25
2. 50
3. 75
4. 100

21. Identify the incorrectly matched pair:

	Bio-control agent	Pest controlled
1.	Lady bird	Aphids
2.	Dragon fly	Mosquito
3.	Trichoderma	Fungi
4.	Baculoviruses	Nematodes

22. If we say that the genetic code is 'degenerate', it essentially means:

1. Some amino acids are coded by more than one codon.
2. The codon is read in mRNA in a contiguous fashion.
3. The code is nearly universal.
4. AUG has dual functions.

23. In an mRNA, untranslated regions are present:

1. only at the 5' end
2. only at the 3' end
3. At both 5' -end (before start codon) and at 3' -end (after stop codon)
4. At both 5' -end (after start codon) and at 3' -end (before stop codon)

24. Identify the incorrect statement:

1. Pollen sacs are developed microsporangia
2. Pollen grains are developed microspores
3. Vegetative cell of the pollen grain is bigger than the generative cell
4. In over 60 percent of angiosperms pollens are shed at 3-celled stage

25. Alcohol percentage is expected to least in which of the following fermented beverages?

1. Wine
2. Whiskey
3. Brandy
4. Rum

26. In Oswald Avery, Colin MacLeod and Maclyn McCarty experiment, transformation was inhibited by the use of:

1. Protease
2. Lipase
3. RNase
4. DNase

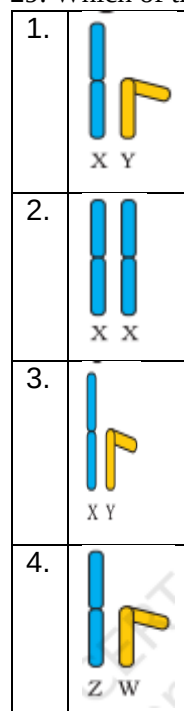
27. In a cross  $AaBb \times aabb$  [assuming independent assortment], what fraction of progeny are expected to be  $AaBb$ ?

1.  $\frac{1}{4}$
2.  $\frac{1}{3}$
3.  $\frac{1}{2}$
4.  $\frac{2}{3}$

28. Thalamus does not contribute to the formation of fruit in:

1. Apple
2. Strawberry
3. Cashew
4. Banana

29. Which of the following describes a male in birds?



30. To form a nucleoside a nitrogenous base is linked to the OH of:

1. 1' C pentose sugar through an O-glycosidic linkage
2. 1' C pentose sugar through an N-glycosidic linkage
3. 5' C pentose sugar through an N-glycosidic linkage
4. 5' C pentose sugar through an O-glycosidic linkage

31. A segment of DNA coding for a polypeptide is a/an:

1. Recon
2. Exon
3. Cistron
4. Intron

32. Select the genotype amongst the given genotypes which will result in lightest skin colour in humans:

1.  $AAbbCC$
2.  $AABBCc$
3.  $aaBBCC$
4.  $AaBbCc$

33. Filiform apparatus is a part of:

1. synergids at the chalazal end of the female gametophyte
2. antipodals at the chalazal end of the female gametophyte
3. synergids at the micropylar end of the female gametophyte
4. antipodals at the micropylar end of the female gametophyte

34. Among the two nucleic acids, the DNA is a better genetic material because:

1. It is able to generate its replica (Replication).
2. It is more stable chemically and structurally.
3. It provides the scope for rapid changes (mutation).
4. It is able to express itself in the form of 'Mendelian Characters'.

40. If the number of chromosomes in a meiocyte of apple is 34, what would be the number of chromosomes in its somatic cells?

1. 17
2. 34
3. 51
4. 68

35. When the two genes in a dihybrid cross are situated on the same chromosome,

1. the proportion of parental gene combinations are much lower than the non-parental type
2. the proportion of parental gene combinations are much higher than the non-parental type
3. the proportion of parental gene combinations and the non-parental type is equal
4. the two genes will always assort independently

41. Identify the incorrect statement:

1. In human eye, cornea absorbs UV-B.
2. Good ozone is found in stratosphere.
3. Thickness of ozone is measured in Dobson Units.
4. Ozone hole is particularly marked over equatorial regions.

42. Plants generated through micropropagation are:

1. Somatic hybrids
2. Embryoids
3. Somaclones
4. Explants

## Botany - Section B

36. Smooth-leaved and nectar-less cotton does not attract:

1. Jassids
2. Bollworms
3. Stem sawfly
4. Stem borers

43. What improved variety of cauliflower is resistant to black rot?

1. *Pusa Shubhra*
2. *Pusa Sadabahar*
3. *Pusa Gaurav*
4. *Pusa Sawani*

37. The Indian Agricultural Research Institute is located at:

1. New Delhi
2. Patna
3. Lucknow
4. Pune

44. Intangible benefits like aesthetic pleasures of walking through thick woods is a strong argument for the need to conserve biodiversity. This type of argument is called as:

1. Narrowly utilitarian
2. Ethical
3. Broadly utilitarian
4. Sustainable

38. In grass embryos, a flap-like structure present opposite to the scutellum is called as:

1. coleoptile
2. coleorrhiza
3. epiblast
4. hypoblast

45. According to the ISFR [India State of Forest Report] 2021, what percent of total geographic area of India is the forest cover?

1. 21.7
2. 33.33
3. 50
4. 66.66

39. CNG is better than diesel as a fuel for automobiles. This would be most strongly supported by which of the following statements?

1. CNG burns more efficiently.
2. CNG is cheaper.
3. It cannot be adulterated.
4. It cannot be siphoned off by thieves.

46. What category is given to species known only by living members kept in captivity by the International Union for Conservation of Nature?

1. Critically endangered
2. Extinct in the wild
3. Endangered
4. Vulnerable

47. Name the scientist who conducted long-term ecosystem experiments to understand correlation between species richness with ecosystem stability:

1. Paul Ehlich
2. David Tilman
3. Robert May
4. MacArthur

48. COP 26 was held at:

1. Glasgow, Scotland
2. Paris, France
3. Bonn, Germany
4. Katowice, Poland

49. Consider the following facts regarding nutrient cycling:

I.	Carbon cycle	Atmosphere only contains 10 % of total global carbon.
II.	Phosphorus cycle	Respiratory release of phosphorus into atmosphere is absent.
III.	Nitrogen cycle	Only prokaryotes are capable of carrying out biological nitrogen fixation.

1. Only I and II are correct
2. Only I and III are correct
3. Only II and III are correct
4. I, II and III are correct

50. India's share of world's land area and global species diversity respectively is:

1. 2.4 % and 8.1 %
2. 1.7 % and 12 %
3. 2.1 % and 9.5 %
4. 3.4 % and 16 %

## Zoology - Section A

51. Identify the incorrectly matched pair:

1.	<i>Wuchereria</i>	Filariasis
2.	<i>Streptococcus</i>	Pneumonia
3.	Rhinovirus	Common cold
4.	<i>Trichoderma</i>	Ringworm

52. A monovalent antibody molecule can be represented as:

1.  $H_5N_1$
2.  $H_1L_1$
3.  $H_2L_2$
4.  $H_1N_1$

53. Regarding MOET [Multiple Ovulation and Embryo Transfer] program for herd improvement, the incorrect statement is:

1. FSH analogue is used to induce super ovulation
2. Cow is either mated with an elite bull or artificially inseminated
3. The fertilized eggs are removed surgically
4. At 8-32 cell stages, the pro-embryos are transferred to surrogate mothers

54. The main challenge for production of insulin using rDNA techniques was:

1. getting insulin assembled into a mature form.
2. isolating DNA in pure form from human cell
3. selecting the vector for cloning the gene
4. purification of the human insulin

55. Mood swings, increased aggressiveness and reduced fertility in males can be the result of long term abuse of:

1. Narcotic analgesics
2. Anabolic steroids
3. Diuretics
4. Cannabinoids

56. Identify the incorrect statement:

1. Cleavage divisions in early embryonic stages are mitotic divisions
2. Embryo with 4-8 cells is called as morula
3. Implantation occurs at the stage of blastocyst
4. Placenta acts as an endocrine tissue and produces some hormones.

57. To generate a 3-D image of the internals of an object, computed tomography uses:

1. Gamma rays
2. X rays
3. Non-ionizing radiations
4. Sound waves

58. Which of the following is not an example of commensalism?

1. An orchid growing as an epiphyte on a mango branch
2. Barnacles growing on the back of a whale
3. Cuckoo laying eggs in the nests of crow
4. Clown fish living among the tentacles of sea anemone

59. What controls the copy number of linked DNA in a transformed bacterial cell?

1. Ori
2. Cloning sites
3. Selectable marker
4. Reporter gene

60. To overcome short duration stressful conditions, organism may escape the stressful conditions in time. All the following will be example for this strategy except:

1. Hibernation
2. Aestivation
3. Migration
4. Diapause

61. Out-cross is very important in animal breeding programs because:

I. It is the best method for animals that are below average in productivity in milk production, growth rate of beef cattle etc.

II. A single outcross often helps to overcome inbreeding depression.

1. Only I is correct
2. Only II is correct
3. Both I and II are correct
4. Both I and II are incorrect

62. The fragments created by cutting DNA with restriction endonucleases can be separated by gel electrophoresis. What is incorrect regarding this procedure?

1. The fragments move towards anode.
2. Agar gel is used for sieving effect.
3. DNA fragments can be visualized moving in the medium if stained with ethidium bromide followed by exposure to UV radiation.
4. The larger fragments move farther in the medium.

63. Which cell of the sperm lineage undergoes the reduction division during spermatogenesis?

1. Spermatogonium
2. Primary spermatocyte
3. Secondary spermatocyte
4. Spermatid

64. The discipline of biotechnology was founded on the breakthrough work of:

1. Bolivar and Rodriquez
2. Cohen and Boyer
3. Nathans and Daniels
4. Redi and Spallanzani

65. You want to set up a dairy farm. Which of the following is the most important step?

1. Selection of good breeds
2. Cleanliness and hygiene
3. Processes should be mechanised
4. Employing a veterinary doctor

66. Identify the incorrect statement regarding HIV/AIDS:

1. HIV is a retrovirus
2. HIV can be transmitted from infected mother to her child through placenta
3. The time lag between infection and appearance of AIDS symptoms is 7-10 days
4. HIV destroys helper T lymphocytes

67. Identify the incorrect statement:

1. PCR is now routinely used to detect HIV in suspected AIDS patients.
2. PCR is being used to detect mutations in genes in suspected cancer patients.
3. ELISA is based on the principle of antigen-antibody interaction.
4. ELISA does not detect antibodies and can detect only antigens.

68. Which of the following reproductive organs in human males is unpaired?

1. Testis
2. Seminal vesicle
3. Prostate
4. Bulbo-urethral gland

69. The first transgenic cow produced:

1. enzyme to treat emphysema
2. human protein enriched milk
3. enzyme to treat phenylketonuria
4. organs for xenotransplantation

70. Match each item in Column I with one in Column II and select the correct match from the codes given:

	COLUMN I		COLUMN II
A	Apiculture	P	Maintenance of hives of honeybees
B	Sericulture	Q	Cultivation of silkworms to produce silk
C	Aquaculture	R	Breeding, raising, and harvesting fish, shellfish and aquatic plants.
D	Floriculture	S	Cultivation of flowering and ornamental plants for gardens and for floristry

Codes:

	A	B	C	D
1.	P	Q	R	S
2.	Q	P	S	R
3.	R	S	Q	P
4.	S	R	P	Q

71. Identify the correct statement:

1. *Agrobacterium tumefaciens* is able to transform large number of monocot plants.
2. Micro-injection is the only way to transform animal cells.
3. Competence in bacterial cells can be induced by trivalent anions like phosphates.
4. Biolistics or gene gun is a suitable method to transform plant cells.

72. Oral contraceptive combination pills:

- I. Inhibit ovulation
  - II. May prevent implantation
  - III. Retard passage of sperms through the cervix
1. Only I and II are correct
  2. Only I and III are correct
  3. Only II and III are correct
  4. I, II and III are correct

73. Temperature is the most important environmental factor for organisms because:

1. it affects enzyme kinetics
2. its availability is closely linked to availability of light
3. it causes more water to be available in oceans
4. vast majority of organisms are eurythermals

74. In accordance with their life styles, parasites evolved special adaptations that do not include:

1. the loss of unnecessary sense organs
2. presence of adhesive organs or suckers to cling on to the host
3. loss of digestive system
4. low reproductive capacity.

75. Cattle and goats are not seen browsing on *Calotropis* growing in abandoned fields because:

1. the plant has large number of thorns
2. the plant produces toxic cardiac glycosides
3. the plant leaves secrete lot of distasteful mucilage
4. the plant produces secondary metabolite strychnine

76. Most birds and mammals:

1. breed many times during their lifetime and produce a small number of large-sized offspring.
2. breed only once during their lifetime and produce a small number of large-sized offspring.
3. breed many times during their lifetime and produce a large number of small-sized offspring.
4. breed only once during their lifetime and produce a large number of small-sized offspring.

77. Identify the incorrectly matched pair:

1.	Bone marrow	Primary lymphoid organ
2.	Thymus	Increases in size after puberty
3.	Payer's patches	Present in small intestine and appendix
4.	Spleen	Has a large reservoir of RBCs

78. Antibiotics are used to treat all the following diseases except:

1. Plague
2. Whooping cough
3. Diphtheria
4. Common cold

79. Which of the following drugs has a potent stimulating action on CNS, producing a sense of euphoria and increased energy?

1. Cocaine
2. Morphine
3. Barbiturates
4. Benzodiazepines



80. That embryos never pass through the adult stages of other animals was proposed by:

1. Karl Ernst von Baer
2. Hugo de Vries
3. Eldredge and Gould
4. Ernst Haeckel

81. Modern Homo sapiens arose:

1. 75000-10000 years ago
2. 100000-40000 years ago
3. 1.5 mya
4. 3-4 mya

82. Which of the following will not be an example of passive immunity?

1. Foetus receiving antibodies from their mother, through placenta.
2. Immunity conferred by IgA antibodies present in colostrums.
3. Giving antivenom [containing antibodies against venom] after snake bite
4. A person developing immunity after natural infection by a pathogen

83. What is true regarding Downstream Processing?

- I. This stage is after the biosynthetic stage.
  - II. The processes include separation and purification.
1. Only I
  2. Only II
  3. Both I and II
  4. Neither I nor II

84. Darwin finches and Australian marsupials are excellent examples of:

1. Saltation
2. Catastrophism
3. Adaptive radiation
4. Anthropogenic artificial selection

85. For which of the following animals will thermoregulation be the most energetically expensive?

1. Elephant
2. Humming bird
3. Rabbit
4. Horse

## Zoology - Section B

86. Alec Jeffreys pioneered the technique for:

1. DNA profiling
2. Amplification of DNA
3. Separation of DNA fragments in gel electrophoresis
4. Artificial synthesis of gene

87. A plasmid contains two genes for resistance to separate antibiotics. One of the two is insertionally inactivated due to insertion of alien DNA.

I. The gene that was not inactivated helps in selecting the transformants.

II. The gene that was insertionally inactivated helps in selection of recombinants.

1. Only I is correct
2. Only II is correct
3. Both I and II are correct
4. I, II and III are correct

88. In a continuous culture system:

I. The used medium is drained out from one side while fresh medium is added from the other.

II. The cells are maintained in their physiologically most active log/exponential phase.

III. A larger biomass is produced leading to higher yields of desired proteins.

1. Only I and II are correct
2. Only I and III are correct
3. Only II and III are correct
4. I, II and III are correct

89. In 1970, Hamilton O. Smith, Thomas Kelly and Kent Wilcox isolated and characterized the first type II restriction enzyme that was:

1. EcoR I
2. Hind II
3. Bam HI
4. Sma I

90. In a population of 500 people, the frequency of recessive allele is 0.2 [only two alleles are present for the gene with one completely dominant]. What is the number of heterozygous persons in this population?

1. 200
2. 320
3. 160
4. 240



91. Which of the following animals can trace their ancestry from therapsids?

1. Mammals only
2. Mammals and Birds
3. Dinosaurs, Crocodiles and Birds
4. Turtles, Lizards, Snakes and Tuataras

92. Sugical methods, tubectomy and vasectomy:

- I. are sterilization procedures
  - II. are highly effective
  - III. have very good reversibility
1. Only I and II are correct
  2. Only I and III are correct
  3. Only II and III are correct
  4. I, II and III are correct

93. Which of the following can cause disturbance in genetic equilibrium or Hardy-Weinberg equilibrium?

1. Large population
2. No mutations are taking place
3. Assortative [non-random] mating
4. No gen flow

94. The peak secretion of which of the following hormones does not coincide with the day, in the menstrual cycle, of the peak secretion of other three hormones?

1. Oestrogen
2. Progesterone
3. LH
4. FSH

95. At present, the legal age for marriage in India:

1. has been raised to 21 years for females
2. has been reduced to 18 years for males
3. is 18 years for females and 21 years for males
4. is 18 years for males and 21 years for females

96. Which of the following is not aneuploidy?

1. Down's syndrome
2. Klinefelter's syndrome
3. Turner's syndrome
4. Phenylketonuria

97. Nicotine:

1. is a CNS depressant and can cause respiratory depression
2. commonly leads to development of cirrhosis of liver
3. stimulates adrenal gland to release adrenaline and nor-adrenaline
4. is very effective analgesic and sedative

98. The 'chain termination method' for genome sequencing was developed by:

1. Hargobind Khorana
2. Fred Sanger
3. Marshall Nirenberg
4. Severo Ochoa

99. Match each item in Column I with one in Column II and select the correct match from the codes given:

Extinct animal	Country/continent
A Stellar's sea cow	P Australia
B Thylacine	Q Russia
C Quagga	R Mauritius
D Dodo	S Africa

- A B C D
1. P Q R S
  2. Q P S R
  3. R S P Q
  4. S R Q P

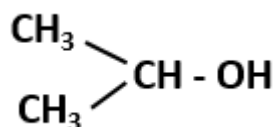
100. What was the main point of difference between Darwin and Hugo de Vries regarding evolution?

1. Darwin did not believe in inheritance of acquired traits while Hugo de Vries did.
2. Evolution for Darwin was gradual while Hugo de Vries believed mutation caused speciation.
3. Evolution for Darwin was stochastic process and for Hugo de Vries was a determinist process.
4. Fitness for Darwin was reproductive fitness and for Hugo de Vries was physical fitness.

## Chemistry - Section A

101. Primary alcohol, amongst the following, is

1.  $\text{CH}_3 - \text{OH}$
2.  $\text{CH}_3 - \text{CH}_2 - \text{OH}$



- 3.
4. Both (1) and (2)

102. From which of the following reactions, aniline can't be formed?

1. Schmidt Reaction
2. Hoffmann's Bromamide reaction
3. Mendius reaction
4. None of the above

103. The hybridised state of Xe and shape of  $XeOF_4$ , respectively, will be

1.  $sp^3d$  and square pyramidal
2.  $sp^3d^2$  and octahedral
3.  $sp^3d^2$  and square pyramidal
4.  $sp^3d$  and trigonal bipyramidal

104. When 2-bromobutane is reacted with potassium tertiary butoxide, then the major product and reaction mechanism involved, respectively, are

1. But-1-ene, E1
2. But-2-ene, E2
3. But-1-ene, E2
4. But-1-ene, E1

105. In Luca's test of alcohols, the intermediate formed is

1. Carbocation
2. Carbanion
3. Free Radical
4. No intermediate

106. We have two compartments A and B and both are separated by a semipermeable membrane. In compartment A, 0.01 M  $Na_2SO_4$  solution is present and in compartment B, 0.02 M  $BaCl_2$  solution is present. The precipitate of  $BaSO_4$  will be formed in

1. Compartment A
2. Compartment B
3. No precipitate is formed in any compartment
4. Both Compartment A & B

107. When sodium chloride crystal is heated in sodium metal vapors then it gives the appearance of yellow color. It is due to

1. F - center defect
2. Anion deficiency defect
3. Metal excess defect
4. All of the above

108. The complex that does not follow EAN (Effective atomic number) rule is

1.  $K_4[Fe(CN)_6]$
2.  $[Ni(CO)_4]$
3.  $[NiCl_4]^{2-}$
4.  $[Fe(CO)_5]$

109. When salicylic acid is reacted with  $CH_3OH$  in presence of concentrated  $H_2SO_4$  then the drug formed is

1. Methyl Salicylate
2. Oil of wintergreen
3. Both 1 and 2
4. Salol

110. In which of the following complexes, central atom has  $sp^3$  hybridisation?

1.  $[PtCl_4]^{2-}$
2.  $[Ni(CN)_4]^{2-}$
3.  $[Cu(NH_3)_4]^{2+}$
4. None of these

111. Which, of the following, acid derivatives is reduced by  $NaBH_4$ ?

1.  $CH_3COCl$
2.  $(CH_3CO)_2O$
3.  $CH_3COOC_2H_5$
4. None of the above

112. When  $AgBr$  is reacted with  $Na_2S_2O_3$  (hypo), a soluble complex is formed. This soluble complex is

1.  $[Ag(S_2O_3)]^-$
2.  $[Ag(S_2O_3)_2]^{3-}$
3.  $[Ag(S_2O_3)_3]^{5-}$
4. None of the above

113. In Ellingham diagram, which conversion has a negative slope when a graph is plotted in between  $\Delta G$  and T?

1.  $C \rightarrow CO_2$
2.  $Mg \rightarrow MgO$
3.  $C \rightarrow CO$
4.  $Al \rightarrow Al_2O_3$

114. The most acidic compound, amongst the following, is

1. p-nitrophenol
2. o-nitrophenol
3. o-cresol
4. m-nitrophenol

115. Assertion (A):  $Eu^{2+}$  behaves as a reducing agent  
Reason (R): +3 oxidation state of lanthanoids are more common  
1. Both assertion and reason are true and the reason is the correct explanation of the assertion  
2. Both assertion and reason are true but the reason is not the correct explanation of the assertion  
3. Assertion is true but reason is false  
4. Both assertion and reason are false

116. Which of the following is not a neutral oxide?

1. NO
2.  $NO_2$
3.  $N_2O$
4. CO

117. When  $HCHO$  and  $C_6H_5CHO$  are reacted in presence of 50%  $NaOH$ , then the products formed are

1.  $HCOONa$  and  $C_6H_5COONa$
2.  $CH_3OH$  and  $C_6H_5CH_2OH$
3.  $HCOONa$  and  $C_6H_5CH_2OH$
4.  $CH_3OH$  and  $C_6H_5COONa$

118. How many crystal systems have only primitive unit cell?

1. 1
2. 2
3. 3
4. 4

119. When nitrobenzene is reduced in the presence of  $As_2O_3/NaOH$ , then the product formed is

1. Phenyl hydroxyl amine
2. Azoxybenzene
3. Azobenzene
4. Hydrazobenzene

120. The number of Faradays required for the deposition of 127 gram copper in copper sulphate solution is (Atomic weight of copper = 63.5)

1. 1 F
2. 2 F
3. 3 F
4. 4 F

121. In a reaction, when the concentration of a reactant increases two times then the half-life period of reactant decreases two times. The order of the reaction will be

1. 0
2. 1
3. 2
4. 3

122. Bredig's Arc method is used for the preparation of metallic sol. It is

1. Dispersion method
2. Condensation method
3. Dispersion as well as condensation method
4. Neither dispersion nor condensation method

123. Which amine gives liquid compound with diethyl oxalate?

1.  $CH_3 - CH_2 - NH_2$
2.  $(CH_3)_2NH$
3.  $(CH_3)_3N$
4.  $CH_3 - NH_2$

124.  $[Pt(en)_2Cl_2]$  can show optical as well as geometrical isomerism. The total number of isomers of  $[Pt(en)_2Cl_2]$  will be

1. 2
2. 3
3. 4
4. 5

125. For an exothermic reaction, the value of  $\Delta H$  will be

1. More than  $E_a$
2. Less than  $E_a$
3. Equal to  $E_a$
4. All of the above

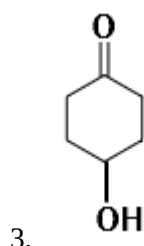
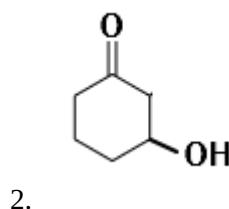
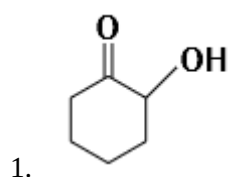
126. A mixture of ethanol and water shows a positive deviation from Raoult's law. This mixture also forms an azeotropic mixture. The boiling point of this azeotropic mixture will be

1. Less than the boiling point of water but more than the boiling point of ethanol
2. More than the boiling point of water but less than the boiling point of ethanol
3. More than the boiling point of ethanol as well as water
4. Less than the boiling point of ethanol as well as water

127. The slag formed in the metallurgy of copper is

1.  $CuSiO_3$
2.  $CaSiO_3$
3.  $FeSiO_3$
4.  $MgSiO_3$

128. Which, of the following compounds, is readily dehydrated on heating?



4. All, of the above, are equally dehydrated

129. When alkyl halide is reacted with AgCN, then alkyl isocyanide is formed as a major product. The reason for this reaction is

1. AgCN is an electrovalent compound
2. AgCN is a covalent compound
3. In cyanide ion, nitrogen is more nucleophilic
4. Alkyl isocyanide is more stable than alkyl cyanide

130. When glucose is reduced with red phosphorous and HI, then n-hexane is formed. This reaction shows that glucose has

1. a ring structure
2. a linear chain of six carbon atoms
3. five -OH groups
4. -CHO group

131. When  $K_2Cr_2O_7$  is reacted with  $SnCl_2$  in presence of  $HCl$ , then the reduced product of  $K_2Cr_2O_7$  and oxidized product of  $SnCl_2$ , respectively, are

1.  $[CrCl_4]^-$  and  $Cl_2$
2.  $CrCl_3$  and  $Cl_2$
3.  $CrCl_3$  and  $SnCl_4$
4.  $CrCl_6$  and  $SnCl_4$

132. Aspirin is used as an

1. Analgesic
2. Antipyretic
3. Analgesic as well as Antipyretic
4. Antiseptic

133. When  $NH_3$  is reacted with excess of  $Cl_2$ , then a compound of nitrogen is formed. The compound formed is

1.  $NCl_3$  (explosive solid)
2.  $NCl_3$  (explosive liquid)
3.  $NH_4Cl$  (solid)
4.  $NH_4Cl$  (liquid)

134. The feasible reaction, amongst the following, is

1.  $2KCl + Br_2 \rightarrow 2KBr + Cl_2$
2.  $2KF + I_2 \rightarrow 2KI + F_2$
3.  $2KClO_3 + I_2 \rightarrow 2KIO_3 + Cl_2$
4.  $2KIO_3 + Cl_2 \rightarrow 2KClO_3 + I_2$

135. Low density polythene (LDPE) is formed at

1. Low pressure
2. Moderate pressure
3. High pressure
4. Pressure has no role

## Chemistry - Section B

136. Which of the following polymer is formed by Cationic polymerisation?

1. Polythene
2. PVC
3. Teflon
4. Polypropylene

137. When  $KMnO_4$  is reacted with oxalic acid in presence of dilute  $H_2SO_4$  then decolourisation of  $KMnO_4$  takes place. In this reaction, the autocatalyst is

1.  $Mn^{2+}$
2.  $SO_4^{2-}$
3.  $CO_2$
4.  $K^+$

138. The number of  $Na^+$  ions and  $Cl^-$  ions (part or full) required to form one unit cell of  $NaCl$ , respectively, are

1. 4 and 4
2. 13 and 14
3. 14 and 13
4. 6 and 6

139.  $NO_2$  is the anhydride of

1.  $HNO_3$
2.  $HNO_2$
3.  $HNO_3 + HNO_2$
4.  $HNO_5$

140. Which, of the following, is not a sulphide ore?

1. Chalcopyrite
2. Argentite
3. Calamine
4. Iron Pyrite

141. Ether cannot be dry up to dryness due to fear of explosion. It is due to the formation of

1. Superoxide
2. Peroxide
3. Oxide
4. Alcohols

142. The non reducing sugar, amongst the following, is

1. Glucose
2. Fructose
3. Sucrose
4. Mannose

143. Aqueous  $\text{NaCl}$  solution is electrolysed using platinum electrodes. The incorrect statement regarding this electrolysis is

1. pH of solution increases
2.  $\text{Cl}_2$  gas is evolved at the anode
3.  $\text{H}_2$  gas is evolved at the cathode
4. pH of solution remains unchanged

144. The intermediate formed in Hoffmann's Bromamide reaction is

1. Carbene
2. Nitrene
3. Benzyne
4. Carbocation

145. When the mixture of calcium formate and calcium acetate is dry distillate then the carbonyl compound formed is

1. Formaldehyde
2. Acetaldehyde
3. Acetone
4. All of these

146. Which, of the following, solutions has the highest freezing point?

1. 1 M Urea solution
2. 1 M  $\text{KCl}$  solution
3. 1 M  $\text{MgCl}_2$  solution
4. All have the same freezing point

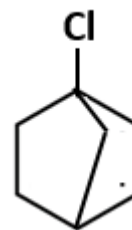
147. The heterobidentate ligand, amongst the following, is

1. en(ethylenediammine)
2. ox(oxalato)
3. gly(glycinato)
4. All of the above

148. The temperature coefficient of a reaction is 2.5. How many times the rate of reaction increases when temperature increases from  $10^\circ\text{C}$  to  $40^\circ\text{C}$ ?

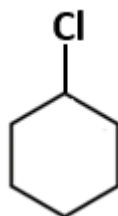
1. 6.25 times
2. 7.5 times
3. 15.625 times
4. 39.0625 times

149.

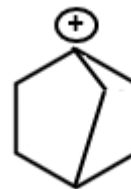


Assertion (A):

is more reactive than

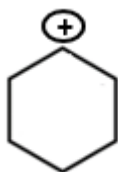


towards nucleophilic substitution reaction.



Reason (R):

is more stable than



1. Both assertion and reason are true and the reason is the correct explanation of the assertion
2. Both assertion and reason are true but the reason is not the correct explanation of the assertion
3. Assertion is true but reason is false
4. Both assertion and reason are false

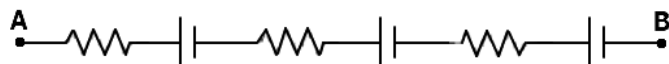
150. The incorrect statement regarding chemical adsorption is

1. It is unilayered
2. On increasing the pressure, chemical adsorption increases
3. On increasing the temperature, chemical adsorption decreases
4. Heat of adsorption is high i.e. 40 - 400 kJ /Mole

## Physics - Section A

151. All the cells, shown in the figure below, are of 2 V, and all the resistances are  $1\ \Omega$ . When a potential difference  $V$  is applied between A and B, the current through the circuit doubles compared to the situation when the potential difference is made zero.

Then,

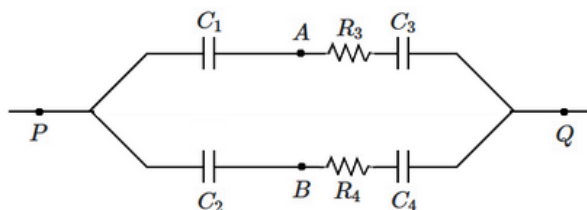


1.  $V = 2$  volt, positive at A.
2.  $V = 2$  volt, negative at A.
3.  $V = 6$  volt, positive at A.
4.  $V = 6$  volt, negative at A.

152. Four uncharged capacitors and resistances are connected as shown and a potential difference is applied between P and Q.

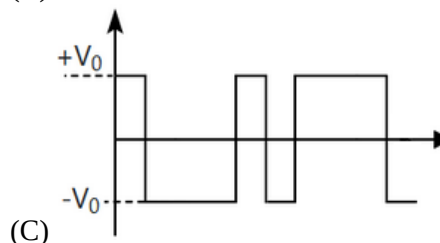
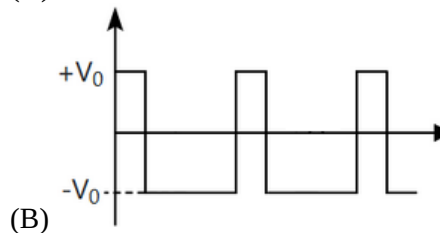
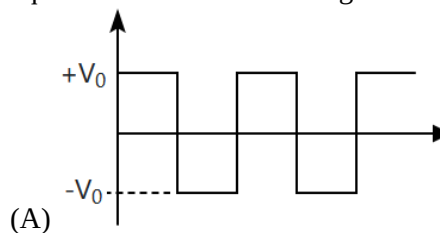
It is observed that  $V_A = V_B$  after a sufficiently long time.

Then:



1.  $\frac{C_1}{C_2} = \frac{C_3}{C_4}$
2.  $\frac{C_1}{C_2} = \frac{R_3 C_3}{R_4 C_4}$
3.  $\frac{C_1}{C_2} = \frac{R_4}{R_3}$
4.  $\frac{C_1}{C_2} = \frac{R_4 C_3}{R_3 C_4}$

153. In which of the following cases is the rms voltage equal to the maximum voltage in magnitude?



1. A
2. A, B
3. A, B, C
4. None of the above

154. A plane electromagnetic wave is given by its electric

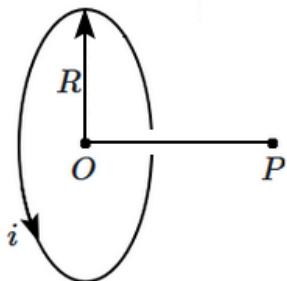
$$\vec{E} = E_0 \cos \frac{\omega}{c}(ct - \beta x)$$

where  $\omega$  and  $\beta$  are constants,  $t$  is the time and  $x$  represents the x-coordinate.  $c$  is the speed of the light in vacuum.

The value of  $\beta$

1. cannot be less than 1.
2. equals 1, always.
3. cannot be greater than 1.
4. can be any non-zero value.

155. The magnetic field at a point ( $P$ ) on the axis of a circular current carrying wire is  $\frac{1}{8}$  of the field at its centre. The radius of the circular curve is  $R$ . The distance between  $P$  and the center of the circle is ( $OP$ ).



Then,

1.  $OP = R$
2.  $OP = \frac{R}{2}$
3.  $OP = \sqrt{3}R$
4.  $OP = 8R$

156. In stimulated emission, an incoming photon interacts with an excited atom (e.g.  $H^*$ ) and brings the atom to its ground state, while an extra photon is emitted - as it happens in a laser. When a photon stimulates the emission of another photon, the two photons have:

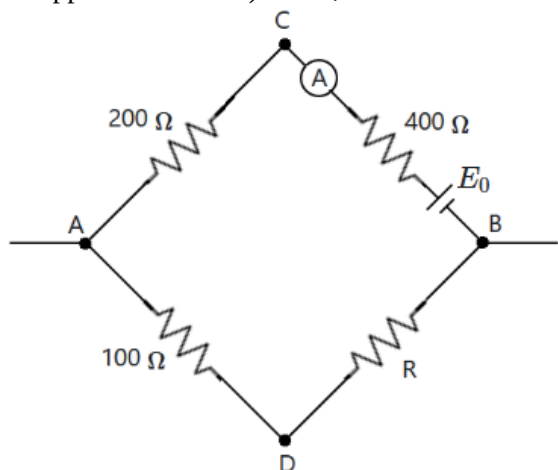
1. the same phase.
2. the same energy.
3. the same direction.
4. the same phase, energy, and direction.

157. Which of the following represents a circuit that gives an output (i.e. true) when both its inputs are equal?

- 1.
- 2.
- 3.
- 4.



158. A cell is connected between A and B and it is observed that  $V_C = V_D$  while the corresponding ammeter current is also noted. When the cell (between A and B) is disconnected, and ends B and C are connected: the current through ammeter A is found to have the same magnitude (but in opposite direction). Then, the resistance  $R$

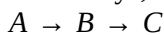


1. equals  $400\ \Omega$ .
2. equals  $200\ \Omega$ .
3. can have any value less than  $400\ \Omega$ .
4. cannot be determined from the given information.

159. A parallel plate air capacitor having a plate separation  $d$  is charged, and the energy stored is  $U$ . The force between the plates is

1.  $\frac{U}{d}$
2.  $\frac{2U}{d}$
3.  $\frac{U}{2d}$
4.  $\frac{\sqrt{2}U}{d}$

160. A radioactive nucleus undergoes a cascade decay (i.e. two decays, one followed by another):



If each of the decays can be either  $\alpha$  or  $\beta^-$ , then which of the following values of  $Z_C$  is possible?

( $Z_C$  &  $Z_A$  are the atomic numbers of C & A.)

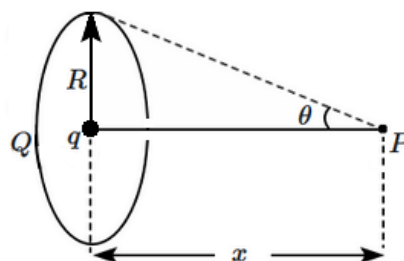
1.  $Z_A + 2$
2.  $Z_A - 1$
3.  $Z_A - 4$
4. Any of the above

161. A graph of the frequency of  $K_\alpha$  ( $\nu$ ) radiation emitted from an X-ray target and the atomic number ( $Z$ ) of the target's element is plotted.

The graph is

1. a straight line with positive slope.
2. a straight line with negative slope.
3. a parabola, curved upward.
4. a parabola, curved downward.

162. A uniformly charged circular ring (of radius  $R$ ) has a total charge  $Q$ ; a second point charge  $q$  is placed at the center of the ring. Consider a point  $P$  on the axis of the ring, at a distance  $x$  from its center. The radius of the ring subtends an angle  $\theta$  at the point  $P$ .



If the net electric field at  $P$  is zero, then,

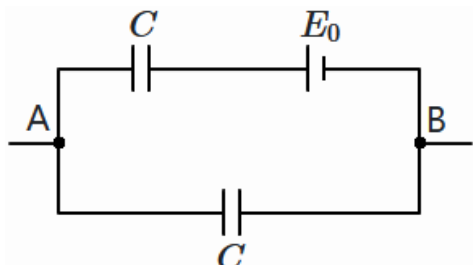
1.  $\cos\theta = \left| \frac{q}{Q} \right|$
2.  $\cos^2\theta = \left| \frac{q}{Q} \right|$
3.  $\cos^3\theta = \left| \frac{q}{Q} \right|$
4.  $\cos^{\frac{1}{2}}\theta = \left| \frac{q}{Q} \right|$

163. Which of the following has the same orbital radius as the Bohr radius?

1.  $n = 2$  state of  $\text{He}^+$  ( $Z = 2$ ) ion
2.  $n = 4$  state of  $\text{He}^+$  ( $Z = 2$ ) ion
3.  $n = 2$  state of  $\text{Be}^{3+}$  ( $Z = 4$ ) ion
4.  $n = 3$  state of  $\text{Li}^{2+}$  ( $Z = 3$ ) ion

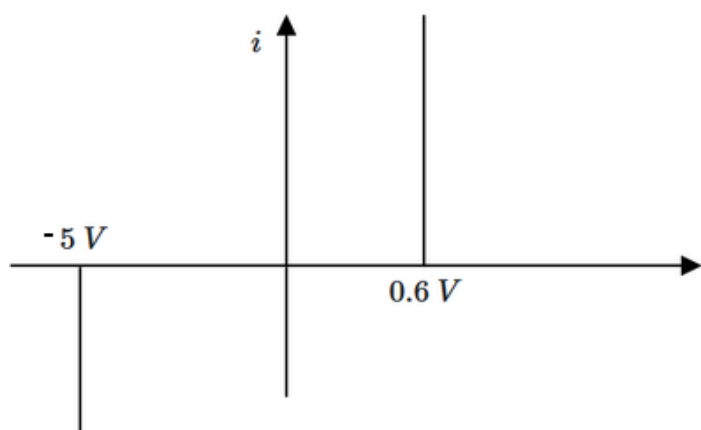
164. The arrangement shown in the figure is set up with capacitors initially uncharged, and the circuit is completed. A potential difference is imposed across AB so that the charge on the upper capacitor is doubled without changing its sign. Then,

$$V_A - V_B =$$



1.  $E_0$
2.  $2E_0$
3.  $-E_0$
4. zero

165. The current-voltage characteristic of an ideal p-n junction diode is given by the graph as shown in the following figure:



This diode is connected with a resistance of  $5\ \Omega$  in series with it as shown below:



Which, of the following shows the dependence of the voltage  $V_{AB}$  and the current  $i$ , when the diode is forward biased? ( $V_{AB}$  in volt,  $i$  in ampere)

1.  $V_{AB} = i \cdot 5 + 0.6$
2.  $V_{AB} = i \cdot 5 - 0.6$
3.  $V_{AB} = i \cdot 5 + (0.6 - 5)$
4.  $V_{AB} = i \cdot 5 + (0.6 + 5)$

166. A dipole is placed at the center of a uniformly charged circular ring, with the axis of the dipole along the axis of the ring.

The dipole experiences:

1. no force and no torque.
2. a force but no torque.
3. a torque but no force.
4. a force and a torque.

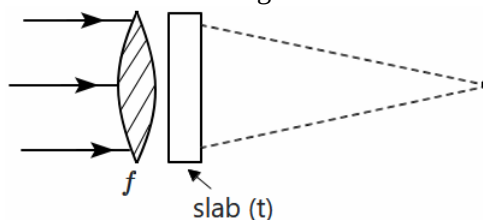
167. Whenever a photon is emitted by a hydrogen atom in the Paschen series, it is followed by further emissions of photons, in the Balmer series or the Lyman series. These photons can have

1. 2 possible energy values.
2. 3 possible energy values.
3. 4 possible energy values.
4. 5 possible energy values.

168. The band gap between the valence band and the conduction band in a certain material is 3 eV. What is the longest wavelength of light that can create an electron-hole pair in the material, with the electron in the conduction band and the hole in the valence band? (Take  $hc = 1240\text{ eV}\cdot\text{nm}$ .)

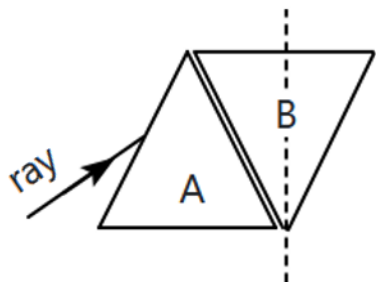
1. 414 nm
2. 300 nm
3. 830 nm
4. 207 nm

169. A thin plane parallel slab (thickness  $t$ , refractive index  $\mu$ ) is placed just behind a converging lens of focal length  $f$ . If a parallel beam of light is incident on the combination it will converge at a distance of



1.  $f$  from the end of the slab.
2.  $f - \frac{t}{\mu}$  from the end of the slab.
3.  $f + \frac{t}{\mu}$  from the end of the slab.
4.  $f + t\left(1 - \frac{1}{\mu}\right)$  from the end of the slab.

170. Two identical equilateral triangular prisms, each of which gives a minimum deviation of  $60^\circ$  are taken: call these prisms A, B. These are placed as shown in the figure, and a ray of light is incident on prism A at minimum deviation. Now prism B is cut in half, along the dotted line, and the right half is removed. The deviation of the emerging ray is



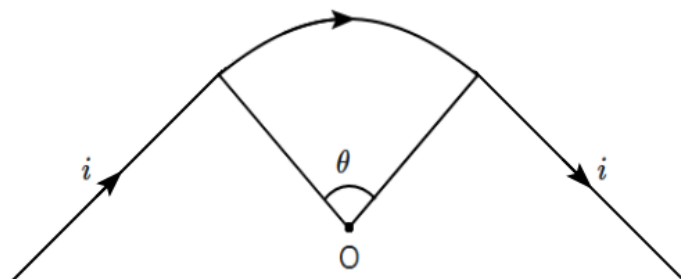
1.  $90^\circ$
2.  $45^\circ$
3.  $60^\circ$
4.  $30^\circ$

171. A radioactive element X decays into another, Y, by  $\beta$ -emission, and the resulting daughter nucleus (Y) is in an excited state and decays further, emitting  $\gamma$ -rays. The half-life of  $\gamma$ -emission  $T_{\frac{1}{2}}(\gamma) \ll T_{\frac{1}{2}}(\beta)$ , that for  $\beta$ -decay.

A sample of X shows a  $\gamma$ -activity of  $R$ ; after what time will the  $\gamma$ -activity become  $\frac{R}{2}$ ?

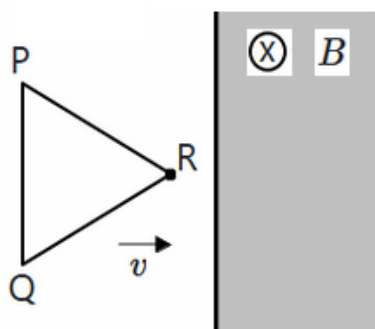
1.  $T_{\frac{1}{2}}(\beta)$
2.  $T_{\frac{1}{2}}(\gamma)$
3.  $2T_{\frac{1}{2}}(\beta)$
4.  $2T_{\frac{1}{2}}(\gamma)$

172. A wire carrying a current  $i$  is bent into the form of an arc of a circle with center  $O$ , joined smoothly to two long, straight wires at its ends. The magnetic field at the center  $O$  is twice that due to the straight portions. The angle subtended at the centre  $O$  by the arc is



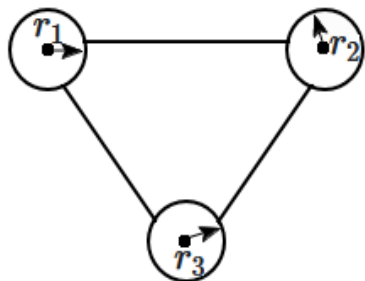
1.  $\theta = \frac{\pi}{3}$
2.  $\theta = \frac{\pi}{2}$
3.  $\theta = 1 \text{ rad}$
4.  $\theta = 2 \text{ rad}$

173. A triangular wire frame, in the form of an equilateral triangle PQR moves with a uniform velocity into a region where there is a uniform magnetic field  $B$ . The edge PQ is parallel to the boundary of the region and the velocity  $v$  is perpendicular to it. The emf( $E$ ) induced within the frame is plotted as a function of time  $t$ , starting from when the frame enters the magnetic field.  $E$  is given by



1.  $Bv^2t$
2.  $2Bv^2t$
3.  $\frac{\sqrt{3}}{2}Bv^2t$
4.  $\frac{2}{\sqrt{3}}Bv^2t$

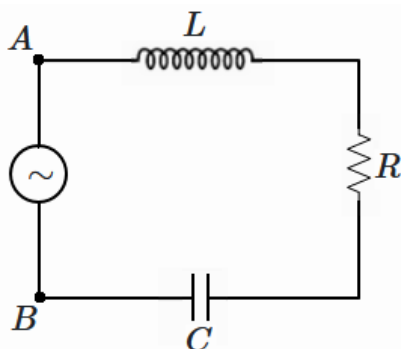
174. Three metallic spheres of radii  $r_1, r_2, r_3$  are connected by very long conducting wires to form an equilateral triangle. The capacitance of the system is



1.  $4\pi\epsilon_0(r_1 + r_2 + r_3)$
2.  $4\pi\epsilon_0 \frac{r_1^2 + r_2^2 + r_3^2}{r_1 + r_2 + r_3}$
3.  $4\pi\epsilon_0 \left( \frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} \right)^{-1}$
4.  $4\pi\epsilon_0 \sqrt{r_1^2 + r_2^2 + r_3^2}$

175. In this LCR circuit, it is observed that the current and the voltage are in phase with each other. When the capacitor is replaced by a short circuit, the phase difference becomes  $60^\circ$ .

Then:



1.  $\frac{L}{C} = R^2$
2.  $\frac{L}{C} = 2R^2$
3.  $\frac{L}{C} = 3R^2$
4.  $\frac{L}{C} = \frac{1}{3}R^2$

176. A p-n junction has an electric field of  $6 \times 10^5$  V/m in the junction and the junction width is 500 nm. The height of the potential barrier is

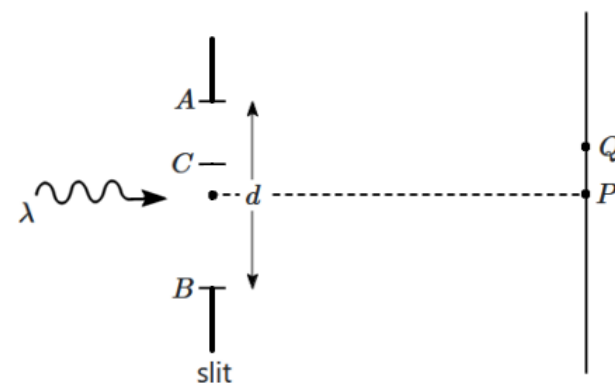
1. 0.6 V
2. 0.3 V
3. 0.5 V
4. 0.25 V

177. The  $\alpha$  and  $\beta$  of a transistor satisfy the relation:

1.  $\alpha + \beta = 1$
2.  $\alpha(1 - \beta) = \frac{1}{\beta}$
3.  $(1 - \alpha)\beta = \alpha$
4.  $(1 - \alpha)(1 - \beta) = 1$

178. Light of wavelength  $\lambda$  falls perpendicularly onto a single slit of width  $d$ . A diffraction maximum is formed at  $P$  on a faraway screen placed parallel to plane of the slit. The first diffraction minimum is formed at  $Q$ , as shown on the screen. Let  $C$  be a 'point' so that it divides the slit  $AB$  in the ratio  $\frac{AC}{CB} = \frac{1}{2}$ , i.e.  $AC$  represents the upper  $\frac{1}{3}$  of the slit. The total amplitude of the oscillation arriving from  $AC$  at  $Q$  is  $A_1$  and from  $CB$  at  $Q$  is  $A_2$ .

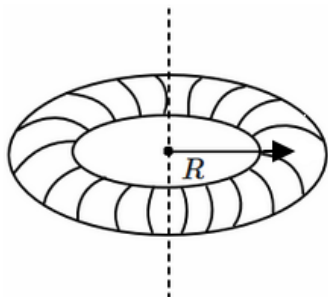
Then,



1.  $2A_1 = A_2$
2.  $A_1 = 2A_2$
3.  $\sqrt{2}A_1 = A_2$
4.  $A_1 = A_2$

179. A toroid has  $N$  turns of wire carrying current  $i$ . The radius of the toroid is  $R$ , while the radius of a turn (i.e. the cross-sectional radius) is  $r$ , where  $r \ll R$ .

The flux through a cross-section of the toroid is proportional to



1.  $\frac{Nr^2i}{R}$
2.  $\frac{NR^2i}{r}$
3.  $Nri$
4.  $NRi$

180. A small solenoid is kept inside a much larger solenoid, with their axes parallel to each other. The small solenoid has a cross-sectional radius  $r_1$ , length  $l_1$  and the total number of turns  $N_1$ . The corresponding quantities for the larger solenoid are:  $r_2$ ,  $l_2$ ,  $N_2$  respectively.

Their mutual inductance is (nearly) given by:

1.  $\frac{\mu_0 \pi r_1^2 N_1 N_2}{l_2}$
2.  $\frac{\mu_0 \pi r_1^2 N_1 N_2}{\sqrt{l_1 l_2}}$
3.  $\frac{\mu_0 \pi r_1^2 N_1 N_2}{l_1}$
4.  $\frac{\mu_0 \pi r_1 r_2 N_1 N_2}{\sqrt{l_1}}$

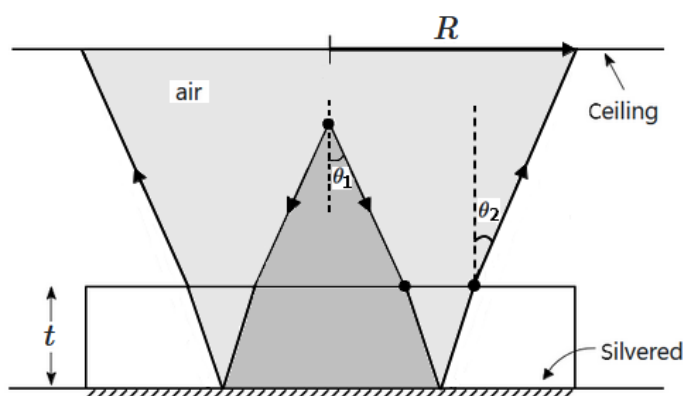
181. A small solenoid is kept inside a much larger solenoid, with their axes parallel to each other. The small solenoid has a cross-sectional radius  $r_1$ , length  $l_1$  and the total number of turns  $N_1$ . The corresponding quantities for the larger solenoid are:  $r_2$ ,  $l_2$ ,  $N_2$  respectively.

The smaller solenoid, which had a mutual inductance  $M_0$  with the larger one, is now rotated so that it makes an angle  $\theta$ , with the larger one: the angle being measured between their axes. The mutual inductance is (nearly)

1.  $M_0$
2.  $M_0 \cos \theta$
3.  $M_0 \sin \theta$
4.  $M_0 \cos^2 \theta$

182. A conical beam of light is incident on a thick parallel slab of glass, the other end of which is silvered. The incoming beam has a divergence of  $\theta_1$ , while the outgoing beam, has a divergence of  $\theta_2$ .

The outgoing beam forms a circular 'patch of light' of radius  $R$ , on the ceiling.

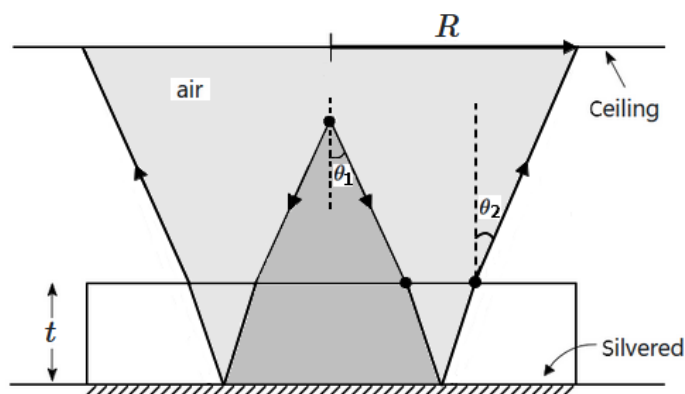


As  $t$  is decreased, keeping everything else fixed,

1.  $\theta_2$  remains constant
2.  $\theta_2$  increases
3.  $\theta_2$  decreases
4.  $\theta_2$  first increases, then decreases

183. A conical beam of light is incident on a thick parallel slab of glass, the other end of which is silvered. The incoming beam has a divergence of  $\theta_1$ , while the outgoing beam, has a divergence of  $\theta_2$ .

The outgoing beam forms a circular 'patch of light' of radius  $R$ , on the ceiling.



As  $t$  is decreased,

1.  $R$  decreases
2.  $R$  increases
3.  $R$  remains constant
4.  $R$  first increases, then decreases

184. A uniform electric field exists in a certain region of space. The potential at the following points are given (all units are in SI):

- $A(1, 0, 0)$   $V_A = 2$  volt
- $B(0, 2, 0)$   $V_B = 4$  volt
- $C(0, 0, 2)$   $V_C = 6$  volt
- $D(1, 1, 0)$   $V_D = -1$  volt

The component of the electric field along the x-axis is

1. 2 V/m
2. 8 V/m
3. 3 V/m
4. -6 V/m

185. A current carrying circular loop of wire is placed in a magnetic field  $B$ , which makes an angle  $\theta$  with the normal to the loop. The radius of the loop is  $r$ , and the loop carries a current  $i$ . The magnetic interaction energy of the current carrying loop is  $E_B$  and the torque on the loop has the magnitude  $\tau_B$ .

Which of the following, is independent of  $\theta$ ?

1.  $E_B \cdot \tau_B$
2.  $\frac{E_B}{\tau_B}$
3.  $E_B^2 + \tau_B^2$
4.  $E_B^2 - \tau_B^2$

## Physics - Section B

186. A simple p-n junction diode follows the law:

$$i(\text{current}) = i_0 e^{qV/kT}, \text{ for large currents in forward bias.}$$

Here,  $T$  = absolute temperature,  $V$  = voltage across the diode,  $k$  = Boltzmann's constant and  $i_0$  = the drift current.

Then, the differential resistance of the diode  $\left(\frac{dV}{di}\right)$  is given by:

1.  $(\text{constant})i$
2.  $(\text{constant})i^2$
3.  $\frac{\text{constant}}{i}$
4.  $(\text{constant})e^{-\beta i}$ ,  $\beta$  - constant

187. The zero of the potential energy is so chosen that the total energy of the hydrogen atom in its 1<sup>st</sup> excited state is zero. Then, the energy of the ground state of the hydrogen atom is

1. -3.4 eV
2. -6.8 eV
3. -10.2 eV
4. -13.6 eV

188. An equiconvex lens of focal length 100 cm is split into two plano-convex lenses and the plane surface of one of these lenses is silvered. This acts as a

1. converging mirror of focal length 200 cm.
2. converging mirror of focal length 100 cm.
3. diverging mirror of focal length 200 cm.
4. diverging mirror of focal length 100 cm.

189. Two short bar-magnets are placed at large distance from each other, with their axes aligned along the same line but in opposition direction to each other. A null point is formed between them at a distance  $r_1$  from the first magnet and  $r_2$  from the second. If the dipole moments of the magnets are  $P_1$  and  $P_2$ , then

1.  $\frac{r_1}{r_2} = \frac{P_1}{P_2}$
2.  $\left(\frac{r_1}{r_2}\right)^2 = \frac{P_1}{P_2}$
3.  $\left(\frac{r_1}{r_2}\right)^3 = \frac{P_1}{P_2}$
4. none of the above is true.

190. Photoelectrons emerging from a photocathode (work function: 2.2 eV) are allowed to fall onto a gas containing hydrogen atoms in the ground state and the first excited state. What is the minimum energy of the photons incident on the photo-cathode that will cause the photoelectrons to transfer energy to the H-atoms?

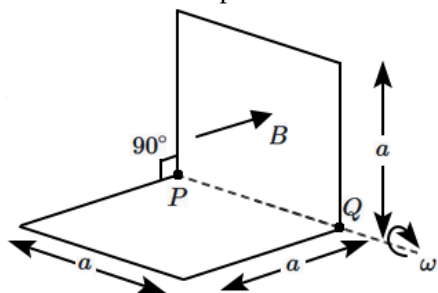
1. 13.6 eV + 2.2 eV
2. (10.2 + 2.2) eV
3. (3.4 + 2.2) eV
4. (1.89 + 2.2) eV

191. Electromagnetic waveform given by the electric field:  $\vec{E} = E_0[\hat{i} + \hat{j}\cos(\omega t - kx)]$  is established in space.

The magnetic field associated with the wave has the amplitude:

1.  $\frac{E_0}{c}$
2.  $\frac{2E_0}{c}$
3.  $\frac{\sqrt{2}E_0}{c}$
4. zero

192. A rectangular conducting wire-frame having dimensions of  $a \times 2a$  is bent symmetrically so that its two halves are at right-angle with respect to each other. A uniform, constant magnetic field  $B$  acts parallel to one of the bent sides, initially. The wire frame begins to rotate with a uniform angular speed  $\omega$  about the bend-line,  $PQ$ . The emf induced in the loop will have the form:

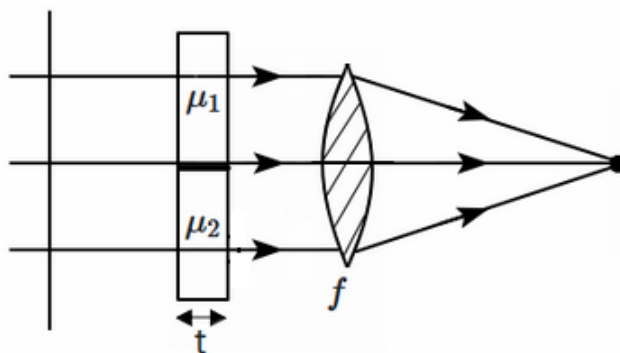


1.  $2\omega Ba^2 \sin\omega t$
2.  $2\omega Ba^2 \cos\omega t$
3.  $\omega Ba^2(\cos\omega t + \sin\omega t)$
4.  $\omega Ba^2(\cos\omega t - \sin\omega t)$

193. A radioactive nucleus can decay through two different ways into different products: the decay constants being  $\lambda$ ,  $2\lambda$  respectively. The two processes release energy amounting to  $E_1$ ,  $E_2$  respectively. The average energy released per nucleon during the decay of a sample over a time  $t$  is

1.  $\frac{E_1 + E_2}{2}$
2.  $\frac{E_1 + 2E_2}{3}$
3.  $\frac{2E_1 + E_2}{3}$
4. dependent on time,  $t$

194. Plane waves of light of wavelength  $\lambda$  are incident onto a convex lens, and the beam is brought to a focus. A plane slab of thickness  $t$  having refractive indices  $\mu_1$ ,  $\mu_2$  in the upper and lower halves is placed parallel to the incoming wavefronts. The phase difference between the wavefronts at the focus, coming from the upper and lower halves of the slab is:

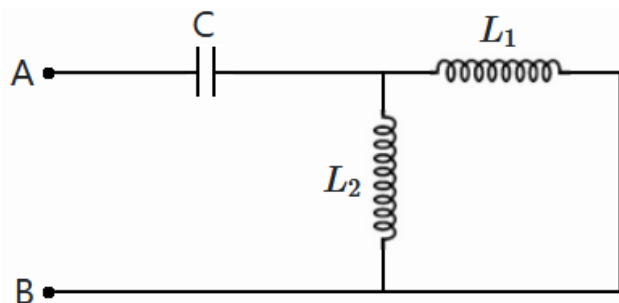


1.  $\frac{2\pi}{\lambda} [(\mu_1 - 1)t + (\mu_2 - 1)t]$
2.  $\frac{2\pi}{\lambda} (\mu_1 - \mu_2)t$
3.  $\frac{2\pi}{\lambda} \left( \frac{t}{\mu_1} - \frac{t}{\mu_2} \right)$
4.  $\frac{2\pi}{\lambda} \left( \frac{t}{\mu_1} + \frac{t}{\mu_2} \right)$



195. An AC-voltage is applied across AB and the resonance condition for the circuit is checked. It is observed that it resonates at a frequency  $f_1$  with  $L_1$  only, at  $f_2$  with  $L_2$  only and at  $f$  with both  $L_1$  and  $L_2$ .

Then,



1.  $f = f_1 + f_2$
2.  $\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$
3.  $f^2 = f_1^2 + f_2^2$
4.  $\frac{1}{f^2} = \frac{1}{f_1^2} + \frac{1}{f_2^2}$

196. Two particles of equal mass  $m$  and charge  $q$  move in a circular orbit of radius  $r$  under the influence of a magnetic field  $B$ . The kinetic energy of the particles is proportional to (assume that the particles don't exert electrostatic forces on each other):

1.  $q^2$
2.  $B^2$
3.  $r^2$
4. All of the above

197. An equiconvex lens of focal length 50 cm is made of glass of refractive index,  $\mu=1.5$ . It is split into two identical plano-convex lenses, and a glass-slab of the same refractive index, and of thickness 300 cm is inserted between the two half-lenses (plano-convex). When a parallel beam is incident on the combination, the emerging beam

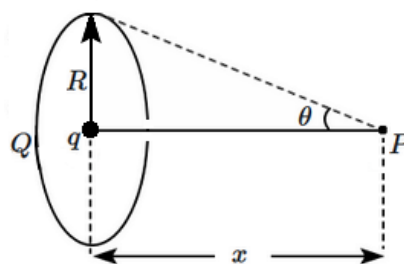
1. focuses at a distance of 100 cm from the second lens.
2. focuses at 200 cm from second lens.
3. focuses at 150 cm from second lens.
4. emerges as a parallel beam.

**Hint:** You may use symmetry to reduce your work significantly.

198. Point charges  $q$ , each, are placed at the eight vertices of a cube of edge  $l$ . The flux of the net electric field through a face of the cube is

1.  $\frac{4q}{3\epsilon_0}$
2.  $\frac{2q}{3\epsilon_0}$
3.  $\frac{q}{3\epsilon_0}$
4.  $\frac{q}{6\epsilon_0}$

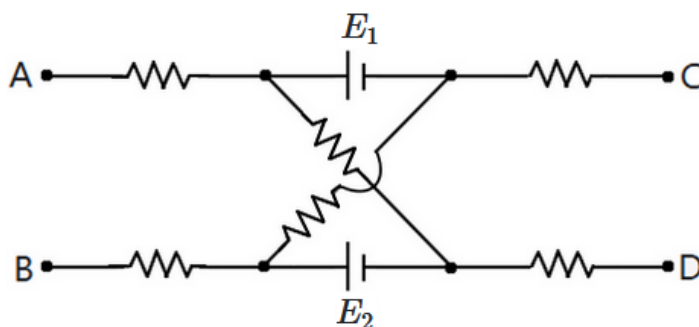
199. A uniformly charged circular ring (of radius  $R$ ) has a total charge  $Q$ ; a second point charge  $q$  is placed at the center of the ring. Consider a point  $P$  on the axis of the ring, at a distance  $x$  from its center. The radius of the ring subtends an angle  $\theta$  at the point  $P$ .



If the potential at  $P$  due to all the charges is zero, then,

1.  $\cos\theta = \left| \frac{q}{Q} \right|$
2.  $\cos^2\theta = \left| \frac{q}{Q} \right|$
3.  $\cos^3\theta = \left| \frac{q}{Q} \right|$
4.  $\cos^{\frac{1}{2}}\theta = \left| \frac{q}{Q} \right|$

200. All the resistances in circuit are  $2\ \Omega$  each,  $E_1 = 4\text{ V}$  and  $E_2 = 1\text{ V}$ . The potential difference between C and D (i.e.  $V_C - V_D$ ) is



1. 1.5 V
2. -1.5 V
3. 1.2 V
4. -1.2 V

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