

PART—B

Answer any forty questions

96. A coil having an inductance of one henry and a resistance of 10 ohms is suddenly connected to a battery of e.m.f. of 50 volts and negligible internal resistance. The energy stored in the magnetic field of the inductor is
- (a) 12.5 joules
 - (b) 25 joules
 - (c) 250 joules
 - (d) 125 joules

97. An isochoric process is governed by
- (a) Gay-Lussac's law
 - (b) Dalton's law
 - (c) Charles' law
 - (d) Boyle's law

98. Hydrogen atom does not emit X-rays because
- (a) its energy levels are too close to each other
 - (b) its energy levels are too far apart
 - (c) it is too small in size
 - (d) it has a single electron

99. Consider the Gaussian wave packet

$$\psi(x, t = 0) = A \exp\left[\frac{-x^2}{2a^2} + ik_0 x\right]$$

The width of the wave packet in k -space is

- (a) $\frac{1}{\sqrt{2}a}$
 - (b) $\frac{1}{a}$
 - (c) a
 - (d) $\sqrt{2}a$
100. A cyclotron with Dee radius of 0.9 m has a magnetic field of 0.8 tesla. In this cyclotron, a doubly ionized helium (He^{++}) can attain a maximum energy of
- (a) ~14.81 keV
 - (b) ~22.48 MeV
 - (c) ~18.68 MeV
 - (d) ~24.83 MeV

101. For a graded index fibre of core diameter d mm, the maximum number of modes, which can be guided by the core, is proportional to

- (a) $d^{3/2}$ (b) d^2
(c) d (d) $d^{1/2}$

102. Quantum mechanical operator for momentum is represented by

- (a) $-i\hbar\vec{\nabla}$ (b) $i\hbar\vec{\nabla}$
(c) $i\hbar\frac{\partial}{\partial t}$ (d) $-\frac{\hbar^2}{2}\vec{\nabla}$

103. A superconducting material is

- (a) diamagnetic
(b) paramagnetic
(c) ferromagnetic
(d) ferrimagnetic

104. The value of Legendre polynomial $P_3(x)$ for $x = -1$ is

- (a) 2
(b) 3
(c) 1
(d) -1

105. Pauli matrices are expressed as

- (a) $(i) = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ $(ii) = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$
 $(iii) = \begin{bmatrix} 0 & -i \\ i & 0 \end{bmatrix}$ $(iv) = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$
- (b) $(i) = \begin{bmatrix} 0 & 0 \\ 1 & -1 \end{bmatrix}$ $(ii) = \begin{bmatrix} 0 & -1 \\ -1 & 0 \end{bmatrix}$
 $(iii) = \begin{bmatrix} 0 & i \\ i & 1 \end{bmatrix}$ $(iv) = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$
- (c) $(i) = \begin{bmatrix} 1 & 1 \\ 1 & 0 \end{bmatrix}$ $(ii) = \begin{bmatrix} 0 & 1 \\ 2 & 0 \end{bmatrix}$
 $(iii) = \begin{bmatrix} 0 & i \\ i & 0 \end{bmatrix}$ $(iv) = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$
- (d) $(i) = \begin{bmatrix} 2 & 2 \\ 1 & 0 \end{bmatrix}$ $(ii) = \begin{bmatrix} 0 & 1 \\ 2 & 0 \end{bmatrix}$
 $(iii) = \begin{bmatrix} 0 & -i \\ i & 0 \end{bmatrix}$ $(iv) = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$

106. Sound travels in rocks in the form of
- longitudinal elastic waves only
 - transverse elastic waves only
 - both longitudinal and transverse elastic waves
 - neither longitudinal nor transverse elastic waves
107. A rectangular carbon block has dimensions $1 \text{ cm} \times 1 \text{ cm} \times 50 \text{ cm}$. What will be the resistance between two square ends, if the resistivity of carbon is $3.5 \times 10^{-5} \text{ ohm-m}$?
- 1 ohm
 - 2 ohms
 - 0.18 ohm
 - 0.35 ohm
108. A lead pellet flying with a velocity $v_1 = 100 \text{ m/s}$ pierces a board and after that its velocity becomes $v_2 = 60 \text{ m/s}$. What would be the increase in temperature of the pellet, assuming that the fraction 0.4 of its lost kinetic energy is spent for increasing the internal energy? Given, specific heat of lead, $C = 125 \text{ J/(kg-K)}$.
- 9.5 °C
 - 7.6 °C
 - 13.4 °C
 - 10.2 °C
109. The average kinetic energy of free electron gas at 0 K is
- E_f
 - $\frac{1}{2} E_f$
 - $\frac{3}{5} E_f$
 - $\frac{1}{3} E_f$
- (where E_f is Fermi energy)
110. If ψ_n is the normalized eigenfunction of a harmonic oscillator and \hat{a} is annihilation operator, then $\hat{a}\psi_n$ will be
- $\sqrt{n} \psi_{n-1}$
 - $\sqrt{n-1} \psi_{n-1}$
 - $n \psi_{n-1}$
 - $\sqrt{n-1} \psi_n$

111. The wavelength of the most energetic X-ray emitted when a metal target is bombarded by a 40 keV electron is approximately
- 300 Å
 - 10 Å
 - 4 Å
 - 0.31 Å
112. A spinning charge has a magnetic dipole moment $\vec{\mu}$ and spin angular momentum \vec{s} . Identify the correct relation.
- $|\vec{\mu}| \propto |\vec{s}|$
 - $|\vec{\mu}| \propto |\vec{s}|^2$
 - $|\vec{\mu}| \propto \sqrt{|\vec{s}|}$
 - $|\vec{\mu}| \propto |\vec{s}|^{3/2}$
113. The Laplace transform of $f(t) = t$ is
- $\frac{1}{s}$
 - $\frac{1}{s^2}$
 - $\frac{\sqrt{\pi}}{s}$
 - 1
114. The directional derivative of the function $(x^2 + y^2 + z^2)^{3/2}$ at the point $(-1, 1, 2)$ in the direction $\vec{i} - 2\vec{j} + \vec{k}$ is
- 1
 - 2
 - 3
 - 4
115. If matrix A has an eigenvalue -2 , then the eigenvalue of matrix A^3 will be
- 2
 - 8
 - 4
 - 6
116. If C is the rectangle with vertices at $(-1, 0)$, $(2, 0)$, $(2, 2)$ and $(-1, 2)$, the value of the integral $\oint_C (xy^2 dx + 5x^3 dy)$ is
- 60
 - 64
 - 74
 - 84

117. A differential equation of the form $y = xy' + f(y')$, where $y' = \frac{dy}{dx}$, is called

- (a) Clairaut's equation
- (b) Riccati's equation
- (c) Bernoulli's equation
- (d) Euler-Cauchy equation

118. Which of the following functions is *not* analytic for all z values?

- (a) $z\bar{z}$
- (b) z^2
- (c) e^z
- (d) $\sin z$

119. Which one of the following vectors is *not* an eigenvector of the matrix

$$\begin{bmatrix} 3 & 1 & -1 \\ -2 & 1 & 2 \\ 0 & 1 & 2 \end{bmatrix} ?$$

(a) $\begin{bmatrix} 1 \\ -1 \\ 1 \end{bmatrix}$

(b) $\begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix}$

(c) $\begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix}$

(d) $\begin{bmatrix} -1 \\ 2 \\ -1 \end{bmatrix}$

120. The principal value of $(i)^i$, where $i = \sqrt{-1}$, is

- (a) $e^{\pi/2}$
- (b) $e^{-\pi/2}$
- (c) -1
- (d) $e^{\pi/4}$

121. The Durbin-Watson d statistic is computed to test

- (a) homoscedasticity
- (b) heteroscedasticity
- (c) serial correlation
- (d) the significance of difference of means

122. The ACF (auto-correlation function) of a time-series data decays exponentially while its PACF (partial auto-correlation function) has significant spikes up to lag 2. The time series represents
- an auto-regressive process of order 1
 - an auto-regressive process of order 2
 - a moving average process of order 1
 - a moving average process of order 2

123.
$$\mu(x) = \begin{cases} 0 & \forall x < a \\ (x-a)/(b-a) & \forall a \leq x \leq b \\ (c-x)/(c-b) & \forall b \leq x \leq c \\ 0 & \forall x > c \end{cases}$$

The above expression represents which type of membership function of a fuzzy set?

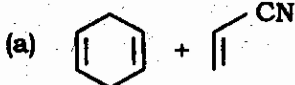
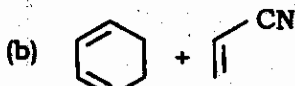
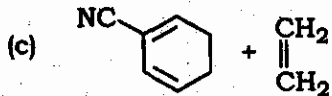
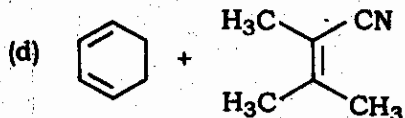
- Triangular membership function
 - Trapezoidal membership function
 - Gaussian membership function
 - Sigmoidal membership function
124. The logit model is useful when
- the dependent variable is dichotomous
 - the independent variable is dichotomous
 - there is more than one dependent variable
 - there is more than one independent variable
125. Which one of the following is a very fine-grained material composed of siliceous shells and micro-organism and does **not** react with HCl?
- Coquina
 - Diatomite
 - Oolitic limestone
 - All of the above
126. Long-term sea-level changes due to interaction of tectonics and climate result in the formation of
- emergent shoreline
 - submergent shoreline
 - advancing shoreline
 - flat shoreline

127. Which one of the following is a fine-grained massive gypsum mineral?
- (a) Alabaster
 - (b) Asbestos
 - (c) Agate
 - (d) Azurite
128. Major symptom of desertification is
- (a) increase in areal extent of surface water in streams, ponds and lakes
 - (b) decline of groundwater level
 - (c) control of soil erosion and stabilization of sand dunes
 - (d) no damage to native vegetation in deserts
129. The material injected into atmosphere during volcanic eruption blast is known as
- (a) pyroclastic debris
 - (b) tephra
 - (c) lahar
 - (d) clastic debris
130. The process of removal of clay, silt and sand particles from the land surface by wind is called as
- (a) deflation
 - (b) depletion
 - (c) deposition
 - (d) abrasion
131. Perched aquifers occur in
- (a) saturation zone
 - (b) aeration zone
 - (c) saturation as well as aeration zones
 - (d) sandy deposits
132. Which one of the following statements regarding human activities and hydrologic cycle is *false*?
- (a) Human contribution to global and local warming can change the storage of water in reservoirs
 - (b) Building roads and parking lots increases the amount of infiltration and percolation
 - (c) Global warming can lead to melting of frozen water and glacial ice
 - (d) Rainwater harvesting helps to augment the groundwater resources

133. Kimberlite pipes contain
- (a) gold
 - (b) silver
 - (c) coal
 - (d) diamond
134. The slowest type of mass wasting process is
- (a) debris flow
 - (b) rock slide
 - (c) creep
 - (d) avalanche
135. Sediment deposit of different size sorting and shape formed due to glacial meltwaters are called
- (a) till and tilloids
 - (b) moraines and non-moraines
 - (c) till and outwash
 - (d) varves and silt
136. Chromite-rich serpentinite is known as
- (a) chromitite
 - (b) fuchsite
 - (c) uvarovite
 - (d) chrome mica
137. Rapakivi texture is
- (a) an overgrowth of sodic plagioclase on potassium feldspar
 - (b) an overgrowth of potash feldspar on quartz
 - (c) an overgrowth of mica over quartz
 - (d) an overgrowth of potash feldspar on biotite
138. Normalized Difference Salinity Index formula of soil is
- (a) $NDSI = [(Red - Thermal)/(Red + Thermal) \times 100]$
 - (b) $NDSI = [(Red - IR)/(Red + IR) \times 100]$
 - (c) $NDSI = [(Green - IR)/(Green + IR) \times 100]$
 - (d) $NDSI = [(Red - Green)/(Red + Green) \times 100]$

139. Essexite is a
- (a) rock with plagioclase feldspar and titanite
 - (b) mineral with sodium ion
 - (c) fossil of plant
 - (d) meteorite
140. Fossil *stromatolites* containing filamentous structures resemble
- (a) *Glossopteris*
 - (b) *Gangopteris*
 - (c) Cyanobacteria
 - (d) Seaweeds
141. Columbite mineral occurs in
- (a) limestone
 - (b) sandstone
 - (c) pegmatite
 - (d) shale
142. Gas hydrates are
- (a) methane molecules trapped in biogenous ooze
 - (b) methane molecules trapped in a cage of frozen water
 - (c) methane molecules trapped in seawater
 - (d) methane molecules trapped in pelagic clays
143. A dam formed in a stream channel by tributary-deposited sediments is known as
- (a) check dam
 - (b) fluvial dam
 - (c) subsurface dam
 - (d) channel dam
144. If the chlorinity of a seawater sample is 10‰, its salinity will be
- (a) 18.07‰
 - (b) 9.03‰
 - (c) 36.13‰
 - (d) 10.00‰

145. The melting points of olivine and biotite minerals are
- (a) 1600 °C and 400 °C respectively
 - (b) 1600 °C and 1800 °C respectively
 - (c) 1400 °C and 800 °C respectively
 - (d) 400 °C and 800 °C respectively
146. Which one of the following is an ore of zinc and isometric mineral of the spinel group found as octahedral black crystal?
- (a) Sphalerite
 - (b) Zincite
 - (c) Zircon
 - (d) Franklinite
147. The formal charges on H, C and N respectively, in the molecule $\text{H}-\text{C}\equiv\text{N}$: are
- (a) +1, +4, +5
 - (b) -1, -4, -3
 - (c) 0, 0, 0
 - (d) 0, +1, +1
148. How long would it take to electroplate 0.100 g of gold on a jewellery item used as the cathode in an electrolysis cell containing AuCl_4^- , if a current of 0.500 A is used?
- (a) 33 s
 - (b) 57900 s
 - (c) 98 s
 - (d) 294 s
149. Which one of the following contains primary, secondary, tertiary and quaternary carbons?
- (a) 2,2,4-Trimethylhexane
 - (b) Ethylcyclohexane
 - (c) 2-Methyl-4-ethylcyclohexane
 - (d) 2,2-Dimethylcyclohexane
150. Which of the following molal aqueous solutions would have the greatest freezing-point depression?
- (a) 0.10 m $(\text{NH}_4)_2\text{SO}_4$
 - (b) 0.10 m MnSO_4
 - (c) 0.10 m NaF
 - (d) 0.10 m KCl

151. Which of the following equimolar solutions has the lowest pH?
- NH_4Cl
 - NaCl
 - K_3PO_4
 - Na_2CO_3
152. Which reaction proceeds through a vinylic radical?
- Hg-catalyzed hydration of an alkyne
 - Li/NH_3 reduction of an alkyne
 - Catalytic hydrogenation of an alkyne
 - Treatment of an alkyne with a strong base
153. ^{13}C -NMR can provide all the following information, **except**
- the presence or absence of symmetry in a molecule
 - the connectivity of the carbons in a molecule
 - the chemical environment of a carbon atom
 - the number of hydrogens bonded to a carbon atom
154. Which of the following combinations is most likely to undergo a successful Diels-Alder reaction?
-  (a) C=CC=C + C=CC#N
 -  (b) C1=CCCC=C1 + C=CC#N
 -  (c) C=CC=C#N + C=C
 -  (d) C1=CCCC=C1 + CC(C)=CC#N
155. Which of the following coordination compounds is named correctly?
- $[\text{Mn}(\text{H}_2\text{O})_6]\text{Cl}_2$, manganese chloride hexahydrate
 - $[\text{FeBr}_2(\text{NH}_3)_4]\text{Br}$, tetraammoniairontribromide
 - $\text{K}_2[\text{NiCl}_4]$, potassium nickel(IV) chloride
 - $[\text{Cu}(\text{NH}_3)_4]\text{SO}_4$, tetraamminecopper(II) sulphate

156. If CN^- is a strong field ligand, the number of unpaired electrons in the complex ion, $[\text{Fe}(\text{CN})_6]^{3-}$ will be
- (a) 5
 - (b) 1
 - (c) 2
 - (d) 3
157. Total number of vibrational degrees of freedom in methane molecule is
- (a) 9
 - (b) 10
 - (c) 5
 - (d) 8
158. An infrared absorption at 1650 cm^{-1} indicates the presence of
- (a) aromatic acid chloride
 - (b) *N, N*-disubstituted amide
 - (c) α, β -unsaturated ketone
 - (d) aromatic ester
159. Which one of the following statements is **true** about the control rods and moderators in a nuclear power plant?
- (a) Moderator absorbs the neutrons while control rods slow the neutrons down
 - (b) Moderator and control rods slow the neutrons down
 - (c) Moderator and control rods absorb the neutrons
 - (d) Moderator slows the neutrons down while the control rods absorb the neutrons
160. Which one of the following combinations of metals is found naturally higher in chocolate and cocoa?
- (a) Iron and Aluminium
 - (b) Iron and Cobalt
 - (c) Cadmium and Lead
 - (d) Cadmium and Mercury

161. If the two wavefunctions $\psi_1(x)$ and $\psi_2(x)$ satisfy the condition

$$\int_{-\infty}^{+\infty} \psi_1^*(x) \psi_2(x) dx = 0$$

then the two wavefunctions are

- (a) orthogonal
- (b) normalized
- (c) continuous
- (d) symmetrical

162. The reaction $\text{CO(g)} + \text{Cl}_2\text{(g)} \rightarrow \text{COCl}_2\text{(g)}$ was studied and the following data were obtained :

| Experiment | Initial $[\text{CO}]$ (mol L^{-1}) | Initial $[\text{Cl}_2]$ (mol L^{-1}) | Initial rate of formation of $[\text{COCl}_2]$ ($\text{mol L}^{-1} \text{min}^{-1}$) |
|------------|--|--|---|
| 1 | 0.200 | 0.100 | 3.9×10^{-25} |
| 2 | 0.100 | 0.200 | 3.9×10^{-25} |
| 3 | 0.200 | 0.200 | 7.8×10^{-25} |

What is the rate law for this reaction?

- (a) Rate = $k[\text{CO}]$
 (b) Rate = $k[\text{CO}]^2[\text{Cl}_2]$
 (c) Rate = $k[\text{CO}][\text{Cl}_2]^2$
 (d) Rate = $k[\text{CO}][\text{Cl}_2]$
163. A certain reaction is non-spontaneous under standard conditions, but becomes spontaneous at higher temperature. What conditions may be drawn under standard conditions?
- (a) $\Delta H < 0$, $\Delta S > 0$ and $\Delta G > 0$
 (b) $\Delta H > 0$, $\Delta S < 0$ and $\Delta G > 0$
 (c) $\Delta H > 0$, $\Delta S > 0$ and $\Delta G > 0$
 (d) $\Delta H < 0$, $\Delta S < 0$ and $\Delta G > 0$
164. For a particle of mass m in a one-dimensional box of length L , the energy of the particle is given by the following equation :

$$E_n = \frac{n^2 h^2}{8mL^2}$$

Calculate the energy needed to promote the particle from the state with quantum number $n = 2$ to the state with quantum number $n = 3$.

- (a) $\frac{9h^2}{8mL^2}$ (b) $\frac{5h^2}{8mL^2}$
 (c) $\frac{4h^2}{8mL^2}$ (d) $\frac{h^2}{8mL^2}$
165. Chrome green used in preparation of distemper and paints has the chemical formula
- (a) CrO
 (b) Cr_2O_3
 (c) CrO_3
 (d) CrCl_2

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166. In a quadrupole mass spectrometer, quadrupole is used as a/an
- (a) detection device
 - (b) injection device
 - (c) collision device
 - (d) separation device
167. *cis*-1,4-Dimethylcyclohexane is
- (a) a mesocompound
 - (b) optically inactive
 - (c) having two stereocenters
 - (d) optically active
168. The reproducibility of a test is a measure of
- (a) precision
 - (b) accuracy
 - (c) recovery
 - (d) representativeness
169. *Osmunda regalis* is a rare
- (a) orchid
 - (b) royal fern
 - (c) cat
 - (d) tree
170. The scientific name of brown-backed hornbill, a Schedule I species, is
- (a) *Tragopan blythii*
 - (b) *Aceros nepalensis*
 - (c) *Anorrhinus tickelli*
 - (d) *Houbaropsis bengalensis*
171. The 'missing carbon sink' in global carbon cycle is estimated to be
- (a) ~3.8 billion metric tons/year
 - (b) ~6.3 billion metric tons/year
 - (c) ~2.9 billion metric tons/year
 - (d) ~0.8 billion metric tons/year

172. *Alnus nepalensis* enters into symbiotic relationship with
- (a) *Rhizobium*
 - (b) *Azotobacter*
 - (c) *Frankia*
 - (d) *Clostridium*
173. Low C:N ratio in plant litter
- (a) results into faster rates of microbial decomposition
 - (b) results into slower rates of microbial decomposition
 - (c) has no influence on microbial decomposition
 - (d) All of the above
174. Mineral cycling during early stages of ecological succession is
- (a) slow with more leakages
 - (b) rapid with more leakages
 - (c) rapid but no leakages
 - (d) slow but less leakages
175. Linear one-to-one positive relation between precipitation and net primary productivity is found in
- (a) temperate plant communities
 - (b) desert plant communities
 - (c) Himalayan forests
 - (d) alpine scrubs
176. Forests of India have been classified into
- (a) 16 major groups and 521 types
 - (b) 16 major groups and 221 types
 - (c) 18 major groups and 96 types
 - (d) 14 major groups and 121 types
177. The largest geographical area of India falls under
- (a) montane wet temperate forests
 - (b) tropical dry deciduous forests
 - (c) tropical wet evergreen forests
 - (d) tropical moist deciduous forests

178. In bacteria, which of the following subunits is needed for specific promoter recognition by RNA polymerase?
- (a) Alpha
 - (b) Beta
 - (c) Beta-prime
 - (d) Sigma
179. Errors during DNA replication are controlled by
- (a) replicative helicase
 - (b) beta clamp
 - (c) exonuclease activity of DNA polymerase
 - (d) single-strand binding protein
180. During DNA replication in *E. coli*, which of the following is required primarily for the lagging strand synthesis?
- (a) DNA B helicase
 - (b) DNA polymerase III—alpha subunit
 - (c) DNA polymerase III—tau subunit
 - (d) DNA ligase
181. The approximate length of DNA typically contained in a nucleosome core particle is
- (a) 150 bp
 - (b) 350 bp
 - (c) 1.5 kbp
 - (d) 3.5 kbp
182. In a given tissue, some genes are expressed while others are silent. Expressed genes are likely to differ from silent genes in
- (a) their nucleotide sequence
 - (b) their evolutionary conservation
 - (c) their DNA methylation status
 - (d) their promoter strength
183. Which of the following primers is used to convert total cellular mRNA from mammalian cells into complementary DNA?
- (a) Oligo d (T)
 - (b) Oligo d (A)
 - (c) Oligo d (C)
 - (d) Oligo d (G)

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184. Endosymbiosis is a model to explain the evolution of
- (a) ribosome
 - (b) mitochondria
 - (c) endocrine system
 - (d) signal transduction
185. Which of the following enzyme activities is associated with ribosomal RNA?
- (a) GTPase
 - (b) Peptidyl transferase
 - (c) Aminoacyl tRNA synthetase
 - (d) Deformylase
186. Which one of the following statements is *true* with respect to promoter for RNA polymerase II?
- (a) It is located upstream of the transcription start site
 - (b) It is located downstream of the transcription start site
 - (c) Its location is not important but its orientation is important
 - (d) Its location is not important but its sequence is important
187. By what factor (approximately) is the human genome larger compared with *E. coli* genome?
- (a) 10
 - (b) 100
 - (c) 1000
 - (d) 10000
188. Pseudogenes are
- (a) recessive genes
 - (b) dominant genes
 - (c) genes that code for structural RNAs
 - (d) genes that are non-functional due to mutations
189. Which of the following is *true* only for transposons?
- (a) They can insert in new genomic locations
 - (b) They are present in many copies in the genome
 - (c) They contain inverted repeat sequences
 - (d) They cause mutations in the genome

190. Net primary productivity of the earth is estimated as
- (a) 70×10^9 t/year
 - (b) 120×10^6 t/year
 - (c) 57×10^7 t/year
 - (d) 170×10^9 t/year
191. The major source of methane is
- (a) automobile
 - (b) air-conditioners
 - (c) wet paddy fields
 - (d) thermal power plants
192. According to Bureau of Indian Standards (BIS), the permissible limit of arsenic in drinking water is
- (a) 5 ppb
 - (b) 10 ppb
 - (c) 25 ppb
 - (d) 50 ppb
193. In the troposphere, $6^\circ\text{C}/\text{km}$ decrease in temperature is known as
- (a) dry adiabatic lapse rate
 - (b) environmental lapse rate
 - (c) wet adiabatic lapse rate
 - (d) All of the above
194. CuFeS_2 is chemical composition of
- (a) pyrrhotite
 - (b) chalcopyrite
 - (c) cuprite
 - (d) bornite
195. Eutrophic ecosystem is characterized by
- (a) low BOD
 - (b) low organic matter turnover
 - (c) high planktonic density
 - (d) high species diversity

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QUESTION PAPER
SERIES CODE

A

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ENTRANCE EXAMINATION, 2010

M.Phil./Ph.D. ENVIRONMENTAL SCIENCES

[Field of Study Code : SESP—ONEP (153)/TWOP (154)/THERP (155)/FORP (156)]

Time Allowed : 3 hours

Maximum Marks : 70

INSTRUCTIONS FOR CANDIDATES

Candidates must read carefully the following instructions before attempting the Question Paper :

- (i) Write your Name and Registration Number in the space provided for the purpose on the top of this Question Paper and in the Answer Sheet.
- (ii) Please darken the appropriate Circle of Question Paper Series Code on the Answer Sheet.
- (iii) The Question Paper is divided into two parts : Part—A and Part—B. Both parts have multiple-choice questions. All answers are to be entered in the Answer Sheet provided with the Question Paper for the purpose. The answer to each question is to be indicated by darkening the appropriate choice [i.e., (a), (b), (c) or (d)] in the circles, against each question number on the Answer Sheet.
- (iv) Part—A consists of 95 questions. Answer any 60 questions. Each question carries $\frac{1}{2}$ mark. There will be negative marking and $\frac{1}{2}$ mark will be deducted for each wrong answer.
- (v) Part—B consists of 100 questions. Answer any 40 questions. Each question carries 1 mark. There will be negative marking and $\frac{1}{2}$ mark will be deducted for each wrong answer.
- (vi) Calculators/Log Tables may be used.
- (vii) Answer written by the candidates inside the Question Paper will not be evaluated.
- (viii) Pages at the end have been provided for Rough Work.
- (ix) Return the Question Paper and Answer Sheet to the Invigilator at the end of the Entrance Examination. **DO NOT FOLD THE ANSWER SHEET.**

INSTRUCTIONS FOR MARKING ANSWERS

1. Use only Blue/Black Ballpoint Pen (do not use pencil) to darken the appropriate Circle.
2. Please darken the whole Circle.
3. Darken ONLY ONE CIRCLE for each question as shown in example below :

| | | | | |
|----------------------|------------------------------|------------------------------|--------------------------|----------------------------|
| Wrong ● (b) (c) ● | Wrong ● (a) (b) (c) (d) ● | Wrong ● (a) (b) (c) (d) ● | Wrong ● (a) (b) (c) ● | Correct ● (a) (b) (c) ● |
|----------------------|------------------------------|------------------------------|--------------------------|----------------------------|

4. Once marked, no change in the answer is allowed.
5. Please do not make any stray marks on the Answer Sheet.
6. Please don't do any rough work on the Answer Sheet.
7. Mark your answer only in the appropriate space against the number corresponding to the question.
8. Ensure that you have darkened the appropriate Circle of Question Paper Series Code on the Answer Sheet.

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PART—A

Answer any sixty questions

1. $\int_0^{2\pi} \cos^3 \theta \, d\theta$ is equal to
 - (a) 0
 - (b) 1
 - (c) $\frac{1}{2}$
 - (d) 2

2. $\lim_{x \rightarrow 0} \left[\frac{\sin x - \tan x}{x^3} \right]$ is equal to
 - (a) ∞
 - (b) $\frac{1}{2}$
 - (c) $-\frac{1}{2}$
 - (d) 1

3. If sides of a triangle are in the ratio $1 : \sqrt{3} : 2$, the angles opposite to the sides of the triangle are in the ratio of
 - (a) 1 : 3 : 2
 - (b) 3 : 2 : 1
 - (c) 1 : 2 : 3
 - (d) 3 : 1 : 2

4. $\frac{d}{dx} \log [\sin(\log x)]$ is equal to
 - (a) $\frac{\sin(\log x)}{x}$
 - (b) $\frac{\cos(\log x)}{x}$
 - (c) $\frac{\tan(\log x)}{x}$
 - (d) $\frac{\cot(\log x)}{x}$

5. $\lim_{x \rightarrow 0} \left[\frac{\tan x - x}{x^2 \tan x} \right]$ is equal to
 - (a) 0
 - (b) 1
 - (c) $\frac{1}{3}$
 - (d) $\frac{4}{3}$

6. Which one of the following infinite series is convergent?

(a) $\sum \sin \frac{1}{n}$

(b) $\sum \frac{1}{n} \sin \frac{1}{n}$

(c) $\sum \cos \frac{1}{n}$

(d) $\sum \tan^{-1} \frac{1}{n}$

7. The area bound by the curve $y = x(1-x)$ and the x -axis in the first quadrant is

(a) $\frac{1}{6}$ of the total area

(b) $\frac{5}{6}$ of the total area

(c) $\frac{1}{3}$ of the total area

(d) $\frac{1}{2}$ of the total area

8. A satellite moves round the earth. If m is the mass of the satellite, r is the radius of the orbit, v is the speed in the orbit and M is the mass of the earth, which one of the following is correct in respect of kinetic energy (KE) and potential energy (PE) of the satellite in the orbit?

(a) $KE = G \frac{Mm}{2r}$; $PE = -\frac{GMm}{r}$

(b) $KE = G \frac{Mm}{r}$; $PE = -\frac{GMm}{r}$

(c) $KE = 2G \frac{Mm}{r}$; $PE = -\frac{GMm}{r}$

(d) $KE = 2 \frac{GM}{r}$; $PE = -\frac{GMm}{2r}$

9. The order of separation of atoms in aluminium metal, with a density of 2700 kg/m^3 , relative atomic mass of 27 and Avogadro's number as $6 \times 10^{23} / \text{mol}$, is given as

(a) $2.6 \times 10^{-10} \text{ m}$

(b) $1.6 \times 10^{-10} \text{ m}$

(c) $2.6 \times 10^{-9} \text{ m}$

(d) $1.6 \times 10^{-9} \text{ m}$

10. The inverse of the matrix $\begin{bmatrix} 0 & 1 & 1 \\ 1 & 0 & 1 \\ 1 & 1 & 0 \end{bmatrix}$ is

(a) $\frac{1}{2} \begin{bmatrix} 1 & 1 & 1 \\ 1 & -1 & 1 \\ 1 & 1 & -1 \end{bmatrix}$

(b) $\frac{1}{2} \begin{bmatrix} -1 & 1 & 1 \\ 1 & -1 & 1 \\ 1 & 1 & -1 \end{bmatrix}$

(c) $\begin{bmatrix} 1 & 1 & 1 \\ 1 & -1 & 1 \\ 1 & 1 & -1 \end{bmatrix}$

(d) $\begin{bmatrix} -1 & 1 & 1 \\ 1 & -1 & 1 \\ 1 & 1 & -1 \end{bmatrix}$

11. The torque on rectangular coil at an angle θ in a uniform field is given as

- (a) $BANI \cos \theta$
- (b) $BANI \cos 2\theta$
- (c) $\frac{1}{2}BANI$
- (d) $BANI \sin \theta$

where B = Value of the magnetic field
 A = Area of the coil
 N = Number of turns of the coil
 I = Current through the coil

12. When a straight conductor of length l moves with a constant velocity v in a magnetic field \vec{B} , the induced electromotive force is

- (a) $\vec{B}lv$
- (b) zero
- (c) $\frac{1}{2}\vec{B}lv$
- (d) $2\vec{B}lv$

when l and v are both perpendicular to \vec{B} .

13. Function of an electron microscope is dependent upon the fact that

- (a) light can be polarized
- (b) light shows dual nature (wave and particle)
- (c) light travels in straight lines
- (d) light shows interference fringes

14. Newton's law of cooling can be derived from

- (a) Maxwell-Stefan law
- (b) Planck's quantum hypothesis
- (c) Maxwell's distribution law
- (d) displacement theorem

15.  indicates

- (a) NOR gate
- (b) NAND gate
- (c) ENOR gate
- (d) OR gate

6. The ratio of the sine of angle of incidence to the sine of angle of refraction for any two media is constant for a light of definite colour. This statement is called as
- (a) Huygens' principle
 - (b) Fermat's principle
 - (c) law of reflection
 - (d) Snell's law
17. Wien's law could be used with the spectral distribution of a radiation source to find
- (a) Planck's constant
 - (b) velocity of light
 - (c) temperature of the source
 - (d) size of the source
18. The bond theory of solids can be used to explain the
- (a) mechanical properties of solids
 - (b) optical properties of solids
 - (c) thermal properties of solids
 - (d) magnetic properties of solids
19. The physical phenomenon responsible for the colour of a soap bubble is
- (a) dispersion
 - (b) interference
 - (c) diffusion
 - (d) optical activity
20. Raman scattering provides information about
- (a) molecular structure
 - (b) atomic structure
 - (c) nuclear structure
 - (d) resonance structure
21. Two lenses of same material are placed at a distance of 4 cm between them. If the focal length of the first lens is 5 cm, then for the lens combination to be achromatic, the focal length of the second lens should be
- (a) 3 cm
 - (b) 4 cm
 - (c) 5 cm
 - (d) 2 cm

22. A stable nucleus, after absorbing a neutron, emits an electron and spontaneously decays into two α -particles. The original nucleus is
- (a) Be^8
 - (b) B^7
 - (c) Li^7
 - (d) C^{14}
23. An air-core solenoid (length = 20 cm; cross-sectional area = 10 cm^2 ; number of turns = 100) will have inductance
- (a) $\pi \times 10^{-4} \text{ H}$
 - (b) $2\pi \times 10^{-5} \text{ H}$
 - (c) $2\pi \times 10^{-3} \text{ H}$
 - (d) $4\pi \times 10^{-2} \text{ H}$
24. When hydrogen atom is excited from ground state ($n = 1$) ($E_0 = -21.8 \times 10^{-19} \text{ J}$) to the higher level ($n = 2$) ($E_1 = -5.4 \times 10^{-19} \text{ J}$) and then falls back to the ground state, wavelength of the emitted radiation is
- (a) $1.2 \times 10^{-7} \text{ m}$ (ultraviolet)
 - (b) $6.6 \times 10^{-7} \text{ m}$ (visible)
 - (c) $1.4 \times 10^{-7} \text{ m}$ (visible)
 - (d) $6.8 \times 10^{-7} \text{ m}$ (ultraviolet)
25. The frequency of the characteristic X-rays from metals as given by Moseley's law is
- (a) $f = a(z - b)$
 - (b) $f = a(z - b)^2$
 - (c) $f^2 = a(z - b)^3$
 - (d) $f^2 = a(z - b)^2$

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26. C—H bond length in benzene is
- (a) 1.46 Å
 - (b) 1.08 Å
 - (c) 1.39 Å
 - (d) 1.50 Å
27. An element ${}_{92}\text{A}^{238}$, in the process of disintegration, loses one α - and two β -particles. Atomic number and atomic weight of the new element are
- (a) 91 and 234, respectively
 - (b) 90 and 230, respectively
 - (c) 92 and 234, respectively
 - (d) 90 and 234, respectively
28. If it takes 10 nanoseconds for disappearance of hydrogen ion concentration of 0.010 M in a solution, the rate of reaction will be
- (a) 1.0×10^5 M/sec
 - (b) 1.0×10^6 M/sec
 - (c) 1.0×10^4 M/sec
 - (d) 1.0×10^3 M/sec
29. Isomers are compounds with the same
- (a) molecular formula with different structures
 - (b) molecular formula with different atomic masses
 - (c) atoms, but different molecular formulas
 - (d) structures, but different molecular formulas
30. As the temperature of water decreases, the solubility of carbon dioxide gas in water
- (a) increases
 - (b) decreases
 - (c) remains the same
 - (d) increases or decreases, depending on the specific temperature of water

31. Which one of the following molecules does *not* possess dipole moment?
- (a) SO_2
 - (b) H_2S
 - (c) SF_4
 - (d) CS_2
32. 2-Butyne and 1,3-butadiene are
- (a) position isomers
 - (b) chain isomers
 - (c) functional isomers
 - (d) tautomers
33. Which one of the following pairs represents isotones?
- (a) ${}_3\text{Li}^5$ and ${}_4\text{Be}^6$
 - (b) ${}_3\text{Li}^5$ and ${}_3\text{Li}^6$
 - (c) ${}_4\text{Be}^6$ and ${}_4\text{Be}^3$
 - (d) ${}_4\text{Be}^6$ and ${}_4\text{Be}^8$
34. Which of the following will hydrolyze at the fastest rate?
- (a) $\text{CH}_3\text{CH}_2\text{Cl}$
 - (b) CH_3Cl
 - (c) $\text{CH}_3\text{OCH}_2\text{Cl}$
 - (d) $(\text{CH}_3)_2\text{CHCl}$
35. Which of the following may be used as an anaesthetic?
- (a) Isobutane
 - (b) Butane
 - (c) Propane
 - (d) Cyclopropane

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36. Which of the following has the least octane number?
- (a) *n*-Heptane
 - (b) *n*-Cetane
 - (c) *n*-Octane
 - (d) 2,2,4-Trimethyl pentane
37. The equilibrium constant for the reaction $\text{H}_2 + \text{I}_2 \rightleftharpoons 2\text{HI}$ is 47. What will be the equilibrium constant for the reaction $\frac{1}{2}\text{H}_2 + \frac{1}{2}\text{I}_2 \rightleftharpoons \text{HI}$?
- (a) 47
 - (b) $(47)^{1/2}$
 - (c) $(47)^2$
 - (d) $\frac{1}{2}(47)$
38. Which of the following aqueous solutions has the highest boiling point?
- (a) 0.10 M sodium fluoride
 - (b) 0.10 M nitric acid
 - (c) 0.10 M ammonium hydroxide
 - (d) 0.10 M magnesium chloride
39. How many total sigma bonds are in the benzene molecule, C_6H_6 ?
- (a) 6
 - (b) 9
 - (c) 12
 - (d) 14
40. Which of the following series of elements is listed in order of increasing atomic radius?
- (a) Na, Mg, Al, Si
 - (b) C, N, O, F
 - (c) O, S, Se, Te
 - (d) I, Br, Cl, F
41. Which one of the following does *not* show hydrogen bonding?
- (a) Ammonia
 - (b) Hydrazine
 - (c) Hydrogen peroxide
 - (d) Dimethyl ether

42. What type of hybridization would you expect in BCl_3 ?
- (a) sp
 - (b) sp^2
 - (c) sp^3
 - (d) sp^3d^2
43. Which of the following has the highest magnetic moment?
- (a) V^{3+}
 - (b) Mn^{2+}
 - (c) Fe^{3+}
 - (d) Cu^{2+}
44. Phenol on reaction with concentrated HNO_3 will yield
- (a) *o*-nitrophenol
 - (b) *p*-nitrophenol
 - (c) *o,p*-dinitrophenol
 - (d) 2,4,6-trinitrophenol
45. The organic compound 2,2,4-trimethyl pentane is an isomer of
- (a) propane
 - (b) pentane
 - (c) heptane
 - (d) octane
46. If the pressure of a gas is reduced to one-fourth of its original value, the volume of the gas at constant temperature will
- (a) remain unchanged
 - (b) be four times larger
 - (c) be reduced to one-fourth of its original volume
 - (d) be reduced to half of its original volume
47. CaNCN reacts with H_2SO_4 to produce
- (a) cyanamide
 - (b) ammonia
 - (c) melamine
 - (d) urea

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46. Both $\text{:C}\equiv\text{O:}$ and $\text{:N}\equiv\text{N:}$
- (a) are examples of compound
 - (b) contain three non-bonding pairs of valency electrons
 - (c) are molecules
 - (d) contain two pairs of bonding electrons
49. The correct electron configuration for Ni^{2+} in the ground state (in order of increasing energy) is
- (a) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^8$
 - (b) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^8$
 - (c) $1s^2 2s^2 3s^2 2p^6 3p^6 3d^8$
 - (d) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 4d^8$
50. Reduction of an acid chloride with LiAlH_4 produces
- (a) an alkyl chloride
 - (b) an aldehyde
 - (c) a secondary alcohol
 - (d) a primary alcohol
51. Trellis drainage patterns are common in
- (a) gneissose granitic rocks
 - (b) volcanic rocks
 - (c) folded sedimentary rocks
 - (d) folded metamorphic rocks
52. A branching cave deposit with chemical composition of calcite is known as
- (a) stalactite
 - (b) helictite
 - (c) cave stone
 - (d) rock salt
53. Anthophyllite is a/an
- (a) variety of coal
 - (b) rock
 - (c) amphibole mineral
 - (d) pyroxene

54. A crack in fine-grained sediment formed by moisture loss during drying is known as
- (a) shrinkage crack
 - (b) rock crack
 - (c) sediment crack
 - (d) erosion crack
55. Aplite is a/an
- (a) fine-grained granite rock
 - (b) iron-bearing rock
 - (c) sedimentary dyke
 - (d) metamorphic vein
56. Which of the following is **not** an intrusive rock?
- (a) Rhyolite
 - (b) Gabbro
 - (c) Granite
 - (d) Diorite
57. Glaciers carve
- (a) only U-shaped valleys
 - (b) only V-shaped valleys
 - (c) only Y-shaped valleys
 - (d) both U- and V-shaped valleys
58. Faults show that the rocks behave in a/an
- (a) brittle manner
 - (b) ductile manner
 - (c) elastic manner
 - (d) plastic manner
59. Which one of the following is **not** a type of sedimentary rock?
- (a) Arkose
 - (b) Coal
 - (c) Limestone
 - (d) Carbonatite
60. Continent-continent collision will give rise to
- (a) a mid-ocean ridge
 - (b) a suture zone
 - (c) an island arc
 - (d) a subduction zone

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61. Average temperature of the earth crust decreases at a rate of about

- (a) $42\text{ }^{\circ}\text{C km}^{-1}$ with depth
- (b) $90\text{ }^{\circ}\text{C km}^{-1}$ with depth
- (c) $25\text{ }^{\circ}\text{C km}^{-1}$ with depth
- (d) $5\text{ }^{\circ}\text{C km}^{-1}$ with depth

62. Biotite mica belongs to

- (a) inosilicate group
- (b) cyclosilicates
- (c) tectosilicates
- (d) phyllosilicates

63. Giant volcanic craters are called

- (a) vent
- (b) fissure
- (c) fault
- (d) caldera

64. Rating of coal depends upon

- (a) colour and density
- (b) percentage of carbon and heat value on combustion
- (c) percentage of carbon and sulphur
- (d) percentage of chlorine

65. Value of Reynolds number less than 500, represents

- (a) laminar flow regime
- (b) turbulent flow regime
- (c) transitional flow regime
- (d) sinusoidal flow regime

66. Rubber is obtained from the plants of family

- (a) Euphorbiaceae
- (b) Moraceae
- (c) Apocynaceae
- (d) All the three families listed above

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67. When phylloclade has only one or two internodes and resembles a leaf, it is termed as
- (a) phyllode
 - (b) phylloclade
 - (c) phylloblade
 - (d) cladode
68. The cross between F_1 individual and recessive parents is known as
- (a) backcross
 - (b) testcross
 - (c) heterozygous cross
 - (d) homozygous cross
69. In which portion of the visible spectrum, chlorophyll molecules of eukaryotes and cyanobacteria absorb radiant energy?
- (a) Only red
 - (b) Only green
 - (c) Only blue
 - (d) Red and blue both
70. In oxygenic photosynthesis, water is split in order to produce
- (a) O_2 needed for the dark reactions
 - (b) electrons needed to reduce NADH
 - (c) electrons needed for cyclic photophosphorylation
 - (d) electrons needed to reduce P_{680}
71. Radioisotopes are frequently used in the study of cells. Assume a culture of *E. coli* is grown in a culture medium containing radioactive sulphur. In this culture, at the end of 48 hours, you would expect to find the radioactive label located in
- (a) enzymes
 - (b) DNA
 - (c) RNA
 - (d) phospholipids

72. Diploblastic animals are those that have
- (a) endoderm and ectoderm
 - (b) ectoderm and mesoderm
 - (c) mesoderm and endoderm
 - (d) endoderm, mesoderm and ectoderm
73. Person with Klinefelter syndrome will have the following chromosomes
- (a) XXX
 - (b) XYY
 - (c) XXY
 - (d) XXYY
74. Which of the following has the enzyme responsible for carbohydrate synthesis?
- (a) Grana
 - (b) Lumen
 - (c) Stroma
 - (d) All the three listed above
75. Pernicious anemia is caused by the deficiency of
- (a) vitamin A
 - (b) riboflavin
 - (c) cyanocobalamin
 - (d) pyridoxine
76. Which one of the following is related to inflammatory responses?
- (a) Neutrophil
 - (b) T lymphocyte
 - (c) Basophil
 - (d) Eosinophil
77. Verticillaster inflorescence is the peculiar feature of the family
- (a) Umbelliferae
 - (b) Asteraceae
 - (c) Labiatae
 - (d) Apocynaceae

78. Which of the following is caused by bacteria?
- (a) Stem rust of wheat
 - (b) Brucellosis
 - (c) Valley fever
 - (d) Foot and mouth disease
79. The first hormone produced artificially by culturing bacteria is
- (a) thyroxine
 - (b) testosterone
 - (c) adrenalin
 - (d) insulin
80. Triceps and biceps are examples of
- (a) antagonistic muscles
 - (b) involuntary muscles
 - (c) sphincter muscles
 - (d) smooth muscles
81. Testosterone, the male sex hormone, is synthesized in the
- (a) seminiferous tubules
 - (b) interstitial cells
 - (c) vas deferens
 - (d) prostate gland
82. Which of the following can terminate translation of messenger RNA?
- (a) Uncharged tRNA
 - (b) Methionine codon
 - (c) Nonsense codon
 - (d) Missense codon
83. Errors in DNA replication are corrected by
- (a) 5' → 3' exonuclease
 - (b) 3' → 5' exonuclease
 - (c) 5' → 3' polymerase
 - (d) 3' → 5' polymerase

84. Which one of the following would induce transcription of the lactose operon of *E. coli*?
- (a) Lactose
 - (b) Glucose
 - (c) Galactose
 - (d) Lactic acid
85. Which of the following is found at the 5'-end of eukaryotic mRNAs?
- (a) AMP
 - (b) Poly (A)
 - (c) Methyl guanosine cap
 - (d) Shine-Dalgarno sequence
86. Which of the following is correct with regard to ribosomal RNA and transfer RNA?
- (a) Ribosomal RNA is smaller in size than transfer RNA
 - (b) Transfer RNA is smaller in size than ribosomal RNA
 - (c) Both ribosomal and transfer RNA are equal in size
 - (d) Size of both types of RNA varies according to cellular growth rate
87. Blooming of some blue-green bacteria is an indicator of
- (a) heavy metal pollution
 - (b) pesticide pollution
 - (c) cultural eutrophication
 - (d) all kinds of water pollution
88. Which one of the following statements is correct?
- (a) All leguminous plants can fix atmospheric nitrogen
 - (b) Nitrogenase is found in *Nitrosomonas*
 - (c) Nitrification is carried out by anaerobic bacteria
 - (d) Nitrogenase is found in nitrogen-fixing bacteria.
89. Which one of the following groups has suffered the highest rate of species extinction in the recent past?
- (a) Small mammals
 - (b) Birds
 - (c) Gymnosperms
 - (d) Pteridophytes

90. Which one of the following statements is correct?
- (a) Alleles are found only in higher plants
 - (b) Alleles are found only in higher plants and vertebrates
 - (c) Allele is one of several possible forms of a genome
 - (d) Allele is one of several possible forms of a gene and all alleles have similar locus
91. The pH of a carbonated drink is
- (a) less than 7
 - (b) more than 7
 - (c) equal to 7
 - (d) approximately 7.8
92. Which of the following is responsible for ozone layer depletion?
- (a) SO_2
 - (b) CO_2
 - (c) CFC
 - (d) HFC
93. Which of the following is used to increase the productivity of acidic soils?
- (a) Sand
 - (b) Lime
 - (c) Potash alum
 - (d) Caustic soda
94. An important rock for cement industry is
- (a) granite
 - (b) limestone
 - (c) sandstone
 - (d) magnesite
95. Which of the following is the major pollutant emitted by vehicular exhaust?
- (a) SO_2
 - (b) NO_x
 - (c) O_3
 - (d) Cl_2

PART—B

Answer any forty questions

96. When inputs of NAND gate are connected, it is equivalent to
- (a) NOT gate
 - (b) OR gate
 - (c) AND gate
 - (d) XOR gate
97. When the potential in an electron microscope is increased from 10 kV to 50 kV, resolving power of the microscope will increase by a factor of
- (a) $\sqrt{2}$
 - (b) $\sqrt{5}$
 - (c) 5
 - (d) 25
98. The ground-state wave function for a harmonic oscillator is given by the
- (a) Gaussian type function
 - (b) Hermite type function
 - (c) Poisson type function
 - (d) Delta type function
99. Coherence length of a laser beam of wavelength λ and width $\Delta\lambda$ is
- (a) $\Delta\lambda$
 - (b) $(\lambda - \Delta\lambda)$ to $(\lambda + \Delta\lambda)$
 - (c) $\frac{(\Delta\lambda)^2}{\lambda}$
 - (d) $\frac{\lambda^2}{\Delta\lambda}$
100. If \vec{s} is the spin of an electron, the magnitude of spin angular momentum is
- (a) $|\vec{s}|\hbar$
 - (b) $|\vec{s}|\frac{\hbar}{2}$
 - (c) $\sqrt{s(s+1)}\hbar$
 - (d) $\sqrt{(s+1)}\hbar$

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101. An $n-p-n$ transistor amplifier in common-emitter configuration has input impedance of $1\text{ k}\Omega$ and current gain (α) of 0.99. Voltage gain of the transistor amplifier is
- 90
 - 99
 - 900
 - 990
102. The magnetic susceptibility of a paramagnetic material changes with temperature T as
- T^{-1}
 - $T^{-3/2}$
 - $T^{-1/2}$
 - $T^{1/2}$
103. If $\frac{dy}{dx} \left(\frac{2 + \sin x}{1 + y} \right) = -\cos x$ and $y(0) = 1$, then $y\left(\frac{\pi}{2}\right) =$
- $\frac{1}{3}$
 - $\frac{2}{3}$
 - 1
 - $\frac{4}{3}$
104. The work function of a substance is 4.0 eV. The longest wavelength of light that can cause photoelectron emission from this substance is approximately
- 540 nm
 - 400 nm
 - 310 nm
 - 220 nm
105. In a $p-n$ junction diode not connected to any circuit
- the potential is same everywhere
 - the p -type side is at higher potential than the n -type side
 - there is an electric field at the junction directed from the n -type side to the p -type side
 - there is an electric field at the junction directed from the p -type side to the n -type side

106. If 3 natural numbers from 1 to 100 are selected randomly, the probability that all the three numbers are divisible by 2 and 3 both is
- (a) $\frac{4}{105}$
 - (b) $\frac{4}{33}$
 - (c) $\frac{4}{35}$
 - (d) $\frac{4}{1155}$
107. The SI unit of inductance, henry, can be written as
- (a) weber/ampere only
 - (b) volt-second/ampere or weber/ampere only
 - (c) weber/ampere or volt-second/ampere or ohm-second
 - (d) ohm-second only
108. A sample of K^{40} weighing 2×10^{-6} g decays at a rate of 2.76×10^6 decays per second. Its activity in curies would be
- (a) 7.46×10^{-5}
 - (b) 5.52
 - (c) 1.36×10^{12}
 - (d) 1.36×10^{-12}
109. The number of degrees of freedom of a rigid body consisting of N particles would be
- (a) $3N$
 - (b) $\frac{1}{2} N(N-1)$
 - (c) 6
 - (d) 9
110. Which one of the following energy ranges represents the visible light photon?
- (a) 1.7 eV to 3.0 eV
 - (b) 0.5 eV to 1.0 eV
 - (c) 5.0 eV to 6.1 eV
 - (d) 3.4 eV to 4.8 eV

111. Which one of the following statistical techniques would be useful for comparing means of more than two samples?
- (a) t -test
 - (b) z -test
 - (c) χ^2 -test
 - (d) Analysis of variance
112. Which one of the following is desirable for fitting a multiple linear regression model to the data?
- (a) Homoscedasticity
 - (b) Heteroscedasticity
 - (c) Multicollinearity
 - (d) Autocorrelation
113. The statistical analysis of a completely randomized design of experiments is analogous to
- (a) one-way analysis of variance
 - (b) two-way analysis of variance
 - (c) three-way analysis of variance
 - (d) None of the above
114. Which of the following statements is true for an autoregressive process of order 1?
- (a) Autocorrelation will be significant at $\log 1$
 - (b) Partial autocorrelation will be significant at $\log 1$
 - (c) Partial autocorrelation function will be decaying exponentially
 - (d) Both autocorrelation and partial autocorrelation will be significant at $\log 1$
115. In Raman scattering
- (a) only Stokes lines appear
 - (b) only anti-Stokes lines appear
 - (c) both Stokes and anti-Stokes lines appear
 - (d) scattering is inversely proportional to fourth power of the wavelength
116. Nuclear magnetic resonance is generally observed when atomic number of a nucleus is
- (a) even
 - (b) odd
 - (c) both even and odd
 - (d) both even and odd, and magnetic field is not applied

117. Existence of zero-point energy is relevant to explain
- (a) Heisenberg uncertainty principle
 - (b) Planck distribution law
 - (c) Compton scattering
 - (d) Rayleigh scattering
118. The binding energy per nucleon of a nucleus is approximately
- (a) 8 MeV
 - (b) 7 MeV
 - (c) 6 MeV
 - (d) 5 MeV
119. In the reaction ${}^{235}_{92}\text{U} + {}^1_0\text{n} \longrightarrow {}^{148}_{57}\text{La} + {}^{85}_{35}\text{Br} + x \text{ neutrons}$, the value of x is
- (a) 1
 - (b) 2
 - (c) 3
 - (d) 4
120. Microwave ovens and mobile phones operate at
- (a) 2.54 GHz, 0.9 GHz, respectively
 - (b) 1.45 GHz, 2.45 GHz, respectively
 - (c) 1.0 GHz, 1.0 GHz, respectively
 - (d) 0.915 GHz, 1.0 GHz, respectively
121. Phenol reacts with benzoyl chloride in the presence of dilute NaOH to form
- (a) diphenyl ether
 - (b) *o*-hydroxybenzophenone
 - (c) phenyl benzoate
 - (d) *p*-hydroxybenzophenone
122. Sodium nitroprusside is used to detect
- (a) sulphate ions
 - (b) sulphide ions
 - (c) sulphite ions
 - (d) thiosulphate ions

123. Which of the following is *not* an allotrope of carbon?
- (a) Diamond
 - (b) Graphite
 - (c) C_{60}
 - (d) C_2^{2-}
124. Which of the following can liberate CO_2 from $NaHCO_3$?
- (a) Cyclohexanol
 - (b) 3-Nitrophenol
 - (c) Phenol
 - (d) 2,4,6-Trinitrophenol
125. Synthetic rubber neoprene is prepared by the polymerization of
- (a) chloroethene
 - (b) 2-chloro-1,3-butadiene
 - (c) 2-methyl-1,3-butadiene
 - (d) 1,3-butadiene
126. $NaClO_4$ is made by the electrolysis of
- (a) aqueous $NaCl$ solution
 - (b) fused $NaCl$
 - (c) aqueous $NaClO_3$ solution
 - (d) aqueous $NaClO_2$ solution
127. A gas which initially occupies a volume of 6.0 litres at 4.0 atm is allowed to expand to a volume of 14.0 litres at a pressure of 1.0 atm. Calculate the value of work, w , done by the gas on the surroundings.
- (a) -8.00 L-atm
 - (b) -7.00 L-atm
 - (c) 8.00 L-atm
 - (d) 7.00 L-atm
128. Which of the following satisfies normalized function?
- (a) $\int \psi \psi^* dt = 1$
 - (b) $\int \psi \psi dt = 0$
 - (c) $\int_{-\infty}^{+\infty} \psi \psi^* dt = 0$
 - (d) $\int_{-\infty}^{+\infty} \psi \psi^* dt = 1$

129. Which of the following acts as a chromophore in natural dyes?
- COOH
 - NHR
 - N=N—
 - None of the above
130. Which of the following is prepared by the photolysis of mononuclear carbonyl?
- $Mn_2(CO)_{10}$
 - $Co_4(CO)_{12}$
 - $Co_2(CO)_8$
 - $Fe_2(CO)_9$
131. Cesium (atomic radius = 0.255 nm) crystallizes with a body-centered cubic unit cell. What is the approximate length of a side of the cell? ($\sqrt{3} = 1.73$)
- 0.4 nm
 - 0.5 nm
 - 0.6 nm
 - 0.8 nm

132. For the reaction $2A + B \rightarrow C$, experimental data was collected for three trials.

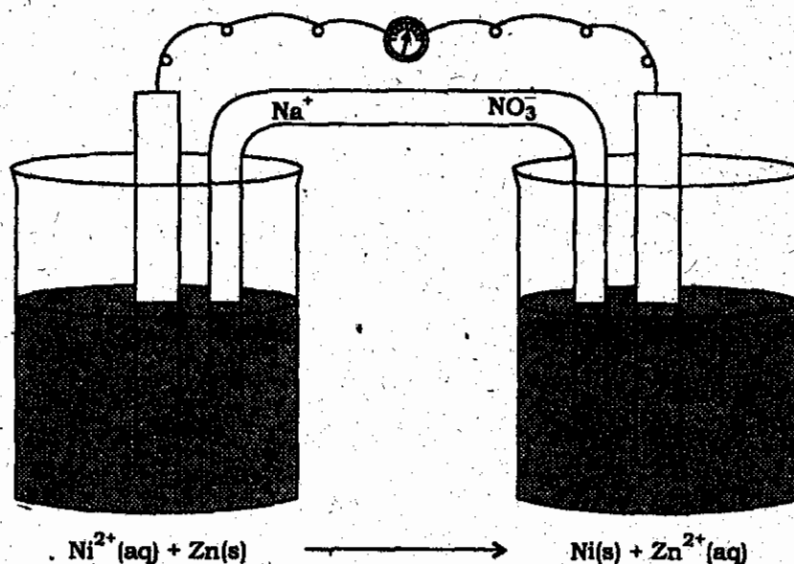
| Experiment | [A] M | [B] M | Rate, $M \cdot s^{-1}$ |
|------------|-------|-------|------------------------|
| 1 | 0.40 | 0.20 | 5.5×10^{-3} |
| 2 | 0.80 | 0.20 | 5.5×10^{-3} |
| 3 | 0.40 | 0.40 | 2.2×10^{-2} |

What is the rate law of the reaction?

- Rate = $k[A][B]$
 - Rate = $k[A]^0[B]^2$
 - Rate = $k[A]^2[B]^0$
 - Rate = $k[A]^2[B]^2$
133. How many faradays of charge are transferred if an electric current of 1 mA flows for 1 h in a system?
- 3.60 faradays
 - 3.73 faradays
 - 3.73×10^{-5} faraday
 - 3.60×10^5 faradays

134. Which of the following is a strong electrophile?
- (a) NO
 - (b) NO⁺
 - (c) NO₂
 - (d) NO₂⁺
135. Which of the following has the highest melting point?
- (a) *o*-Bromophenol
 - (b) *m*-Bromophenol
 - (c) *m*-Chlorophenol
 - (d) *p*-Chlorophenol
136. Which of the following have completely filled *d* orbitals?
- (a) Sc, V, Fe
 - (b) Ti, Fe, Ni
 - (c) Zn, Co, Cu
 - (d) Zn, Cd, Hg
137. Product of the reaction of toluene with CH₃Cl and AlCl₃ at 350 K will be
- (a) *o*-xylene
 - (b) *p*-xylene
 - (c) *m*-xylene
 - (d) a mixture of *ortho*- and *meta*-xylene
138. The number of aldol products obtained from the reaction of acetaldehyde with propionaldehyde in the presence of dilute NaOH is
- (a) four
 - (b) three
 - (c) two
 - (d) one

139. Given the following diagram, determine which of the following statements is *false* :



- (a) The solid zinc electrode is being reduced to $\text{Zn}^{2+}(\text{aq})$
 - (b) The nickel electrode is the cathode
 - (c) The zinc electrode is the anode
 - (d) The nickel(II) ions are being reduced
140. When comparing a single, double and triple bond between the two similar atoms in a molecule
- (a) the single bond will be the strongest
 - (b) the triple bond will be the weakest
 - (c) the double bond will be the shortest
 - (d) the triple bond will have the highest bond energy
141. Hollow cathode lamp is used in
- (a) UV-VIS spectrophotometer
 - (b) flame photometer
 - (c) atomic absorption spectrophotometer
 - (d) sun photometer
142. Which of the following organometallic carbonyl complexes obeys effective atomic number (EAN) rule?
- (a) $(\text{C}_2\text{H}_5)_2\text{W}(\text{CO})_2(\pi\text{-C}_5\text{H}_5)$
 - (b) $\text{Ni}(\pi\text{-C}_5\text{H}_5)_2$
 - (c) $(\pi\text{-C}_5\text{H}_5)_2\text{TiCl}_2$
 - (d) $\text{CO}(\text{C}_6\text{H}_6)$

143. Which of the following compounds is insoluble in water?

- (a) $\text{Ni}(\text{NO}_3)_2$
- (b) $\text{Al}(\text{OH})_3$
- (c) FeCl_3
- (d) Na_3PO_4

144. For two identical atoms to form a covalent bond

- (a) each atom must have an electronegativity of zero
- (b) one of the two atoms must supply both bonding electrons
- (c) there must be an unequal sharing of the bonding electrons
- (d) half-filled valence orbitals of each atom must overlap

145. Which of the following is the aldol condensation product of butanal?

- (a) $\text{CH}_3\text{CH}_2\text{CH}=\overset{\text{O}}{\parallel}\text{CCH}_2\text{CH}_2\text{CH}_3$
- (b) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}=\text{CHCH}_2\text{CH}_2\overset{\text{O}}{\parallel}\text{CH}$
- (c) $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}\overset{\text{O}}{\parallel}\text{CH}$
|
 CH_2CH_3
- (d) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}=\overset{\text{O}}{\parallel}\text{CCH}$
|
 CH_2CH_3

146. Which one of the following is the region in ocean where rate of dissolution of carbonate balances rate of its accumulation?

- (a) Calcium compensation depth
- (b) Limestone compensation depth
- (c) Carbonate composition depth
- (d) Carbon compensation depth

147. Which one of the following is the oldest fossil record containing spherical carbonated structure of filamentous bacteria found in finely stratified undulating sediments?

- (a) Amphibolites
- (b) Ammonoids
- (c) Glossopteris
- (d) Stromatolite

148. Which of the following is a linear structure perpendicular to the shore which helps to trap portion of sand that is moving in littoral transport?
- (a) Levees
 - (b) Groins
 - (c) Spills
 - (d) Sea wall
149. *Aquaspirillum magnetotacticum* bacteria transform
- (a) lead compounds into galena
 - (b) iron compounds into magnetite
 - (c) iron compounds into pyrite
 - (d) bismuth compounds into stibnite
150. A metamorphic rock containing glaucophane is known as
- (a) gneiss
 - (b) phyllite
 - (c) blue schist
 - (d) schist
151. For mineral exploration, the satellite sensor should be
- (a) hyperspectral
 - (b) microwave
 - (c) ultraviolet
 - (d) optical
152. When the lines of inclusions are concordant with the structures in the matrix of the rock, it is known as
- (a) helicitic texture
 - (b) poikiloblastic texture
 - (c) crystalline
 - (d) cryptocrystalline
153. Pycnocline refers to
- (a) temperature gradient in the earth
 - (b) nutrient gradient in soil
 - (c) density gradient in ocean
 - (d) oxygen depletion zone in atmosphere

154. Destruction of rocks by the impacts of hypervelocity particles from outer space is known as
- (a) spatial erosion
 - (b) cosmic erosion
 - (c) local erosion
 - (d) surface erosion
155. The longest geological time period was
- (a) Cenozoic
 - (b) Mesozoic
 - (c) Palaeozoic
 - (d) Precambrian
156. The element, which is absent in limestone but present in dolomite, is
- (a) Ca
 - (b) Mg
 - (c) C
 - (d) O
157. The compositional change of a magma due to melting of surrounding country rock is called
- (a) magma mixing
 - (b) crystal settling
 - (c) partial melting
 - (d) assimilation
158. Which of the following pairs of rocks is compositionally equivalent?
- (a) Basalt and Rhyolite
 - (b) Rhyolite and Granite
 - (c) Gabbro and Dacite
 - (d) Dolerite and Syenite
159. The ratios of rare earth elements (REEs) such as low La/Cr and Th/Sc and high Cr/Th values are signatures of
- (a) sedimentary provenance only
 - (b) igneous provenance only
 - (c) metamorphic provenance only
 - (d) both sedimentary and igneous provenances

160. Dickite and nacrite clay minerals are generally of
- (a) sedimentary origin
 - (b) metamorphic origin
 - (c) hydrothermal origin
 - (d) hydrogeological origin
161. If relative abundance of the first isotope is 98.89% and of second isotope is 11.11% in each of the four pairs of carbon isotopes given below, which pair would be a useful tracer in terrestrial and aquatic systems?
- (a) ^{12}C and ^{13}C
 - (b) ^{14}C and ^{12}C
 - (c) ^{12}C and ^{14}C
 - (d) ^{12}C and ^{15}C
162. An underground reservoir of water that can be extracted for surface use is called as
- (a) zone of aeration
 - (b) field capacity
 - (c) aquifer
 - (d) specific retention
163. The structure characterized by rock layers which dip radially towards a centre point is known as
- (a) a basin
 - (b) a syncline
 - (c) a dome
 - (d) an anticline
164. When searching for coal deposits, geologists look for sedimentary rocks deposited in
- (a) swampy environment
 - (b) deep ocean environment
 - (c) volcanic environment
 - (d) sea floors
165. Dissolution of minerals by complete dissociation in water without depositing any new solid phase is known as
- (a) congruent dissolution
 - (b) incongruent dissolution
 - (c) semicongruent dissolution
 - (d) colloidal dissolution

166. Which of the following is *not* a blue-green alga?
- (a) Microcystis
 - (b) Aphanizomenon
 - (c) Anabaena
 - (d) Giardia
167. Which of the following promotes tumor in animals?
- (a) 7,12-Dimethylbenz[*a*]anthracene
 - (b) Tetradecanoyl phorbol acetate
 - (c) 2-Acetaminofluorene
 - (d) *N*-methyl-*N*-nitrosourea
168. pH of the vacuole is maintained by
- (a) H^+K^+ -ATPase
 - (b) H^+ -ATPase
 - (c) Na^+K^+ pump
 - (d) Ca^{++} -ATPase
169. Of all the global carbon reservoirs, the maximum carbon is contained in
- (a) atmosphere
 - (b) soil
 - (c) plants
 - (d) ocean
170. The lentic ecosystems have
- (a) littoral zone
 - (b) limnetic zone
 - (c) profundal zone
 - (d) All the three listed above
171. Non-leguminous symbiotic nitrogen-fixing plant is
- (a) *Tectona*
 - (b) *Myrica*
 - (c) *Shorea*
 - (d) *Mangifera*

172. The gene which occurs only on Y chromosome is known as
- (a) holandric gene
 - (b) recon gene
 - (c) muton gene
 - (d) neutral gene
173. The secretion of neurotransmitters out of the nerve cell, from vesicles at the end of the axon, can be considered an example of
- (a) exocytosis
 - (b) endocytosis
 - (c) pinocytosis
 - (d) osmoregulation
174. Protozoa lacks cell walls but possesses a pellicle.
- I. The outer part of the pellicle is the ectoplasm that is semisolid giving some rigidity to the cell body.
 - II. The inner part of the pellicle is the endoplasm which is more fluid and granular in composition and contains the cell organelles.
- (a) I is only true
 - (b) II is only true
 - (c) Both I and II are true
 - (d) Neither I nor II is true
175. OCT plasmid is responsible for degradation of
- (a) phenols
 - (b) alkanes
 - (c) herbicides
 - (d) dioxins
176. Microorganism with specific metabolic properties introduced in in-situ bioremediation is known as
- (a) biomagnification
 - (b) biodegradation
 - (c) bioaugmentation
 - (d) biostimulation
177. Which of the following is a primary electron acceptor in the photosystem II (PS II)?
- (a) Plastoquinone
 - (b) Pheophytin
 - (c) Plastoquinol
 - (d) Ferredoxin

178. Which of the following is a source of naturally occurring carcinogen, Elaiomycin?
- (a) *Streptomyces chrysomallus*
 - (b) *Streptomyces achromogenes*
 - (c) *Streptomyces hepaticus*
 - (d) *Aspergillus flavus*
179. Hypothalamus is present in
- (a) mesencephalon part of the brain
 - (b) prosencephalon part of the brain
 - (c) thombenaphalon part of the brain
 - (d) cerebellum part of the brain
180. Which of the following is *not* a neurotransmitter?
- (a) Acetylcholine
 - (b) Phosphatidylethanolamine
 - (c) Norepinephrine
 - (d) Gamma-aminobutyric acid
181. The production of ATP by oxidative phosphorylation is driven by energy from
- (a) coenzyme A
 - (b) isomerization of the cytochromes
 - (c) the formation of NADH
 - (d) the diffusions of photons from the intermembrane space to the matrix of the mitochondria
182. When oxygen is not available to a muscle cell, NADH formed during glycolysis does not pass electrons to the electron transport system. Instead, it passes hydrogen atoms to
- (a) acetyl CoA
 - (b) pyruvic acid
 - (c) fructose
 - (d) ADP
183. The acrosome of a sperm contains
- (a) DNA
 - (b) mitochondria
 - (c) fructose
 - (d) hydrolytic acid

184. When compared with genomic DNA, which part of a gene sequence would be missing in the complementary DNA (cDNA) sequence?
- (a) 5'-unsaturated region
 - (b) 3'-unsaturated region
 - (c) Introns
 - (d) All the three listed above
185. Transposons are different from rest of the genomic DNA, because
- (a) they do not contain any genes
 - (b) they undergo many rounds of replication per cell cycle
 - (c) they are mobile
 - (d) they contain terminal direct repeats
186. What is common in all restriction enzymes?
- (a) They recognize palindromic sequences
 - (b) They cut non-methylated DNA
 - (c) They produce sticky ends after cutting the DNA
 - (d) They cut in an endonucleolytic fashion
187. The function of primer in DNA replication is to
- (a) provide a free 3'-OH group
 - (b) transiently open the DNA helix at the origin
 - (c) enhance processivity of DNA polymerase
 - (d) assist in lagging strand synthesis
188. Which of the following does *not* bind to the repressor of the lactose operon of *Escherichia coli*?
- (a) Operator
 - (b) Lactose
 - (c) IPTG
 - (d) Beta-galactosidase
189. Elongation of RNA chain by RNA polymerase II is triggered by
- (a) its binding to the activation domain of basal transcription factor
 - (b) release of TATA binding protein
 - (c) TBP-associated factors
 - (d) phosphorylation of its C-terminal domain

190. Which of the following is **not** required for transcription of ribosomal RNA genes?
- (a) Alpha-amanitine
 - (b) RNA polymerase I
 - (c) TATA binding protein
 - (d) Transcription factors
191. Human immunodeficiency virus is not known to infect liver cells. Which of the following proteins, if expressed by liver cells, might make them susceptible to this virus?
- (a) Reverse transcriptase
 - (b) CD4
 - (c) Cytosine deaminase
 - (d) Tat
192. Which of the following is **not** true for histones?
- (a) They are highly conserved in evolution
 - (b) They are basic proteins
 - (c) They do not affect gene expression
 - (d) They can be methylated
193. Which of the following is involved at the first step of protein synthesis?
- (a) 30S ribosome
 - (b) 50S ribosome
 - (c) Hairpin loop in 5'-UTR of mRNA
 - (d) Peptidyl-transferase
194. Which one of the following statements is correct?
- (a) Loss of biodiversity over the last few decades is largely because of global warming
 - (b) C_3 species are likely to be more sensitive to increase in CO_2 concentration in the atmosphere as compared to C_4 species
 - (c) Mycorrhiza is found only in tropical plants
 - (d) C_3 and C_4 species do not differ in terms of their sensitivity to increase in CO_2 concentration in the atmosphere
195. Convention on Biological Diversity (CBD) is a commitment for
- (a) conservation of biodiversity in tropics for promoting equity
 - (b) establishment of legally protected areas in tropical rainforest biome
 - (c) utilization of biodiversity for rapid economic growth
 - (d) conservation and sustainable utilization of biodiversity and equitable sharing of benefits from biodiversity
