Biology

1. Which of the following produces a dikaryotic phase in Basidiomycetes?

   A. Karyogamy
   B. Plasmogamy
   C. Apogamy
   D. Karyokinesis

2. In the standard nomenclature used for depicting floral formula, which type of flower is represented by K(5)?

   A. Polysepalous
   B. Syncarpous
   C. Gamosepalous
   D. Gamopetalous

3. Which one of the following statements is TRUE?

   A. Blood is a connective tissue which does not secrete collagen
   B. Tendons are a type of dense, irregular connective tissue
   C. Adipose tissue is an example of a fluid connective tissue
   D. Saliva is secreted by an endocrine gland

4. Match the entries in column I and column II. Which one of the following choices is correct?

ColumnI	ColumnII
(a)Haem	(1)Cofactor
(b)NAD	(2)Vitamin
(c)Zinc	(3)Coenzyme
(d)Niacin	(4)Prostheticgroup

   A. a-3, b-1, c-4, d-2
   B. a-4, b-3, c-1, d-2
   C. a-2, b-1, c-3, d-4
   D. a-4, b-1, c-3, d-2

5. Which one of the following helps in bacterial motility?

   A. Centrioles
   B. Fimbriae
   C. Microtubules
   D. Flagella

6. During light reaction in chloroplasts of tobacco plants, where is the proton gradient generated?

   A. Between stroma and intermembrane space of chloroplasts

   B. Between thylakoid lumen and intermembrane space of chloroplasts

   C. Between stroma and thylakoid lumen

   D. Between inner and outer chloroplast membranes

7. Which of the following will NOT be triggered by the release of acetyl choline in the synapse at the neuromuscular junction during muscle contraction?

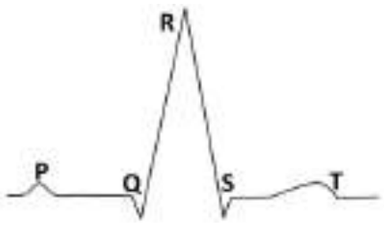
   A. Generation of an action potential in the muscles

   B. Release of Ca2+ from the sarcoplasmic reticulum

   C. Binding of ATP molecules to the myosin head

   D. Shifting of tropomyosin to expose the myosin binding sites on actin filaments

8. The diagram below shows a typical ECG.



   If the AV node is not functional, which of the following options correctly represents the changes seen in the ECG?

   A. P wave will sustain longer with smaller amplitude

   B. The QRS complex will be absent

   C. The T wave will sustain longer with smaller amplitude

   D. The distance between the P wave and the QRS complex will be smaller

9. Listed below are different plant reproductive strategies.
   I. Parthenocarpy
   II. Syngamy
   III. Apomixis
   IV. Polyembryony
   Which of them can give rise to a clonal progeny having the same genotype as that of the mother plant?

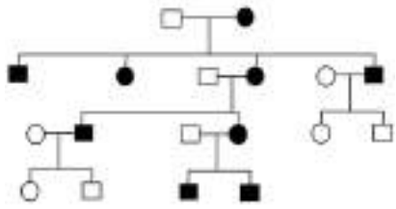
   A. III and IV

   B. I and II

   C. II and III

   D. I and IV

10. The diagram below represents the pedigree of a certain genetic disease (affected individuals are shaded). What is the mode of inheritance of the gene responsible for this disease?



A. X-linked recessive

B. Y-linked

C. X-linked dominant

D. Mitochondrial

11. An *E. coli* whose DNA is fully labeled by 15N is grown in a medium containing 14NH4Cl. What will be the percentage of hybrid (15N/14N) and light (14N/14N) DNA molecules at the end of 80 minutes (assume that doubling time of *E. coli* is 20 minutes)?

A. 25% hybrid and 75% light

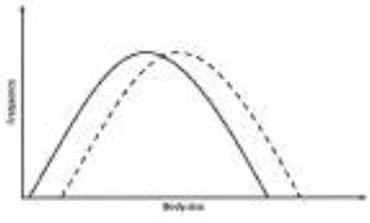
B. 50% hybrid and 50% light

C. 0% hybrid and 100% light

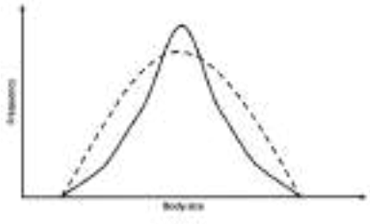
D. 12.5% hybrid and 87.5% light

12. The following plots represent the body size distributions of a fruit fly population. Dashed lines represent the ancestral distributions and continuous lines represent the distributions after a few generations. If the larger individuals have better survival as well as higher reproductive rates, which diagram below best represents the expected change in the distribution of body size (X-axis represents body size while Y-axis represents frequency)?

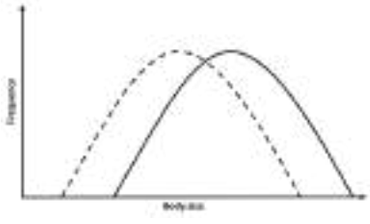
A.

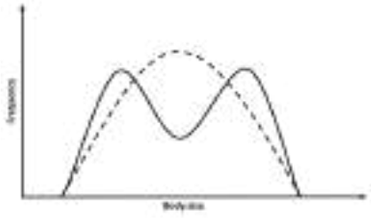


B.



C.



D. 

13. What are the types of immunity acquired by i) transfer of antibodies to the foetus via the placenta and ii) vaccination of an infant?

    A. Both are active immunity

    B. Both are passive immunity

    C. Active and passive immunity, respectively

    D. Passive and active immunity, respectively

14. Which among the following correctly represents the sequence of events for a normal polymerase chain reaction?

    A. Denaturation, annealing, extension

    B. Annealing, denaturation, extension

    C. Extension, annealing, denaturation

    D. Denaturation, extension, annealing

15. Loss of biodiversity occurs due to the growth of carrot grass (*Parthenium* sp.). This is an example of?

    A. Alien-species invasion

    B. Co-extinction

    C. Over-exploitation

    D. Habitat loss and fragmentation

Chemistry

16. What are the correct orders of bond lengths dX –X and bond dissociation enthalpies BDEX–X for F2 and Cl2? (where X = F or Cl)

A. dF–F < dCl–Cl and BDEF–F < BDECl–Cl

B. dF–F > dCl–Cl and BDEF–F > BDECl–Cl

C. dF–F > dCl–Cl and BDEF–F < BDECl–Cl

D. dF–F < dCl–Cl and BDEF–F > BDECl–Cl

17. Which is the appropriate combination of spin configuration and colour for the anionic complex [Co(L)–6]3 (Lisamonodentateandmonoanionicligand)?

A. high-spin and green

B. low-spin and green

C. low-spin and blue

D. high-spin and yellow

18. Which of the following combination of elements forms interstitial hydrides?

A. Na and Mg

B. Yb and Ti

C. Fe and Mn

D. B and Al

19. How many geometrical isomers are possible for the square planar complex [Pd(py)(Cl)(Br)(NH3)] (py = pyridine)?

A. 2

B. 4

C. 5

D. 3

20. A molecular adduct is formed between BF3 and Et2O. Which of the following values describe the coordination number (CN), valency (V) and oxidation state (OS) of B atom in this adduct?

A. CN=4,V=4andOS=+3

B. CN=4,V=3andOS=+4

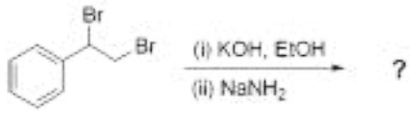
C. CN=4,V=3andOS=+3

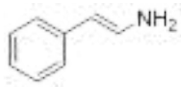
D. CN=3,V=3andOS=+4

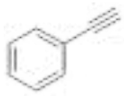
21. While making paneer (cottage cheese) from milk by adding dilute acetic acid, the milk proteins undergo

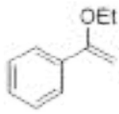
A. solubilization
B. degradation
C. denaturation
D. polymerization

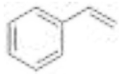
22. What is the final major product of the following reaction?



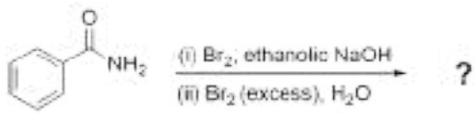
A. 

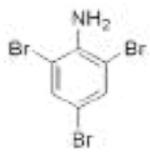
B. 

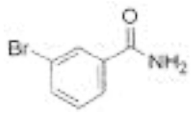
C. 

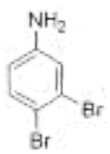
D. 

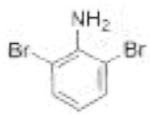
23. Identify the final major product in the following reaction sequence.



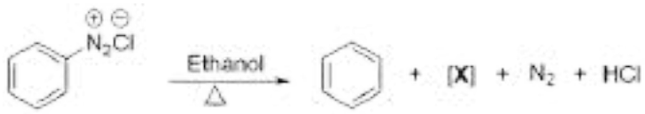
A. 

B. 

C. 

D. 

24. Identify the compound [X] in the following reaction.



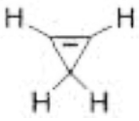
A. CH3COOH B. OHC-CHO

C. CH3CH2OCH2CH2Cl

D. CH3CHO

25. Which one among the following compounds is aromatic?

A. 

B. 

C. 

D. 

26. Using the Arrhenius equation, find out the value of k at T → ∞ ?

A.A

B.-A

C.eA

D. e−A

27. Which one of the following is NOT an example of heterogeneous equilibrium?

A. Equilibrium between water vapour and liquid water in a closed container

B. Equilibrium attained during acid catalysed hydrolysis of ethyl acetate

C. Equilibrium between solid Ca(OH)2 and its saturated solution

D. Equilibrium attained on heating solid CaCO3 in a closed container

28. At 60 ◦ C, 50% of N2O4 (g) is dissociated to NO2 (g). What is the standard Gibbs free energy change at 60 ◦ C and 1 atm pressure for this process? (R = 8.314 JK−1mol−1)

A. 763 Jmol−1

B. -790 Jmol−1

C. -863 Jmol−1

D. 500 Jmol−1

29. For a cell Ag |Ag+,Cl−|AgCl(s)|Ag,E ◦ Redforthehalfcellsaregivenas: EAg+|Ag=0.79V, $E^{\circ}_{Cl^-}$ |AgCl(s)|Ag = 0.22 V at 25 ℃. What is the value of lnK, where K is the equilibrium constant for the reaction AgCl(s) ! Ag+ + Cl−? Given, 1 F = 96485 C.

A. -22.2

B. -18.5

C. -29.3

D. -26.8

30. Match the following:

i) Ge doped with In 1. n-type semiconductor
ii) Si doped with N 2. Schottky defect
iii)ZnS 3.p-typesemiconductor
iv)CsCl 4.Frenkeldefect

A.i −1, ii−3, iii−2, iv−4
−1, ii−3, iii−4, iv−2
B.i −3, ii−1, iii−2, iv−4
−3, ii−1, iii−4, iv−2

C.i

D.i

Mathematics

31. Let $1, \zeta_2, \zeta_3, \ldots, \zeta_n$ be the roots of the equation $x^n = 1$, for $n \geq 3$. Then, the sum

$$\frac{1}{2-\zeta_2} + \frac{1}{2-\zeta_3} + \cdots + \frac{1}{2-\zeta_n}$$

equals to

A. $\frac{(n-2)2^n + 1}{2^n - 1}$.

B. $\frac{n2^{n-1} - 2^n + 1}{2^n - 1}$.

C. $\frac{n2^{n-1} + 1}{2^n - 1}$.

D. $\frac{(n-2)2^{n-1} + 1}{2^n - 1}$

32. How many solutions does the equation

$$\sin^2 x - 15 \sin x \cos x + 50 \cos^2 x = 0$$

have in the interval $[0, 2\pi]$?

A.4.

B.0.

C.1.

D.2.

33. Let A be a 4×4 matrix with real entries. Consider the sets

$$K = \left\{ \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{pmatrix} : \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix} \right\},$$

$$J = \left\{ \begin{pmatrix} c_1 \\ c_2 \\ c_3 \\ c_4 \end{pmatrix} : \begin{pmatrix} c_1 \\ c_2 \\ c_3 \\ c_4 \end{pmatrix} = A \begin{pmatrix} y_1 \\ y_2 \\ y_3 \\ y_4 \end{pmatrix} \text{ for some } y_1, y_2, y_3, y_4 \in \mathbb{R} \right\}.$$

Suppose $K = J$. Then, which one of the following statements is necessarily true?

A. $A^2 = 0$.

B. A is symmetric.

C. A is skew symmetric.

D. $A^2 = A$.

and no three of them

intersect at a point. Then, the number of disjoint regions into which the plane is divided by these lines equals to

A. 17.

B. 18.

C. 16.

D. 20.

35. Consider the circle C that passes through the points (1,0) and (0,1) having the smallest area. Then, the equation of the tangent to the circle C at (0, 1) is

A. $y = -x + 1$.

B. $y = x$

C. $y = x$.

D. $y = x + 1$.

36. Let $f : [-1, 1] \to R$ be a continuous function. Consider the region

$$S = \{(x,y) : -1 \le x \le 1 \text{ and } 0 \le y \le f(x).\}$$

For which one of the following functions f, the area of the region S is the largest?

A. $f(x) = \pi x$ B. $|\sin \pi x|$.

$f(x) = \pi x$

C. $f(x) = \pi^x (1 + \tan \pi x \perp 10)$.

D. $f(x) = \frac{|\pi x|}{|x|} + 1$.

37. Let $f : R \to R$ be a continuous function. Then, f is surjective if

A. $\lim_{x \to \infty} f(x) = \infty$ and $\lim_{x \to -\infty} f(x) = \infty$.

B. $\lim_{x \to \infty} f(x) = 0$ and $\lim_{x \to -\infty} f(x) = \infty$.

C. $\lim_{x \to \infty} f(x) = 0$ and $\lim_{x \to -\infty} f(x) =$

D. $\lim_{x \to \infty} f(x) = -\infty$ and $\lim_{x \to -\infty} f(x) = \infty$.

38. The limit $\lim_{n \to \infty} \frac{1}{n^{2020}} \sum_{k=1}^{n} k^{2019}$

A. is $\frac{1}{2018}$.

B. is $\frac{2020}{2019}$

C. is 1.

D. does not exist.

39. The sum of n consecutive terms of an arithmetic progression consisting of integers is 161. Then, a possible value of n is

A. 5.

B. 7.

C. 6.

D. 8.

40. Let $f : R \to R$ be a non-zero even function such that

$$\int_{-1}^{1} f(x)dx = \alpha.$$

Then, the value of the integral

$$\int_{-1}^{1} \frac{f(x)dx}{1+e^x}$$

is

A. α.

B. $\alpha e - \alpha$.

C. $\frac{\alpha}{2}$.

D. $\frac{e-\alpha}{2}$

41. What is the mean deviation about the mean for the following data?

x_i	1	2	3	4
f_i	5	10	15	20

A. $4\frac{5}{3}$.

B. $3\frac{}{}$

C. $2\frac{5}{}$.

D. 1.

42. Let S be a non-empty set such that the total number of subsets of S containing at most two elements is equal to 16. Then, the number of elements in S equals to

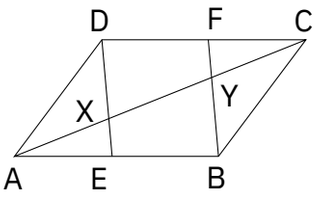
A. 5.

B. 6.

C. 16.

D. 7.

43. Consider the parallelogram $ABCD$ as shown in the figure, where $\frac{AE}{AB} = \frac{CF}{CD} = \frac{1}{n}$, for some positive integer n.



Suppose the length of AC is a, then the length of XY is

A. $a\frac{n}{}$.

B. $\frac{n+1}{}$.

C. $\frac{(n-1)a}{n+1}$.

D. $\frac{(n-1)a}{n}$

44. Let $\hat{i}, \hat{j}$ and $\hat{k}$ denote the standard unit vectors in R^3 along the x-axis, y-axis and z-axis, respectively. Consider the sets

$X = \{ a\hat{i}+b\hat{j}+c\hat{k} : a,b,c \in \{-1,0,1\} \}$ and

{($v1,$v2,$v3):$v1,$v2,$v3∈Xand$v1,$v2,$v3aremutuallyperpendicularunitvectors}.

Then, the number of elements in Y is

A. 27.

B. 24.

C. 36.

D. 48.

45. What is the probability that 3 randomly chosen elements x,y,z from the set $\{1, 2, \ldots, 10\}$ satisfy x+y+z=5?

A. $\frac{1000}{200}$.

B. $\frac{1}{}$

C. $\frac{1000}{500}$.

D. $\frac{3}{}$

Physics

46. A particle of mass m is rotating in a circular orbit of radius r under the action of gravity in the presence of another stationary particle of very large mass M (M (m). Consider that the gravitational potential energy is zero at infinite separation. If the total energy of the rotating particle is E, then, which of the following expressions correctly represents the angular momentum of the particle?

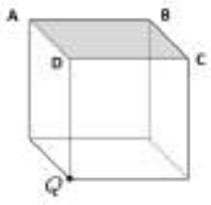
A.r $\sqrt{2Em}$

B.r $\sqrt{-2Em}$

C.r $\sqrt{-Em/2}$

D.r $\sqrt{Em/2}$

47.ApointelectricchargeQisplacedatacornerofacubeasshowninthefigure.Whatistheelectric flux passing through the shaded surface ABCD of the cube? (ε ◦ is permittivity of free space)



A. $\frac{Q}{18\varepsilon_\circ}$

B. $\frac{Q}{12\varepsilon_\circ}$

C. $\frac{Q}{6\varepsilon_\circ}$

D. $\frac{Q}{24\varepsilon_\circ}$

48. Neutral gas molecules, each of mass m, are at a temperature T in a container at zero gravity. How does the average de Broglie wavelength λ of a molecule depend on T?

A.$\lambda \propto \sqrt{T}$

B.$\lambda \propto 1/T^{3}2$

C.$\lambda \propto 1/\sqrt{T}$

D.$\lambda \propto 3T2$

49. Considering a particle of mass being thrown with an initial velocity v making an angle φ with the horizontal ground. What is the magnitude of the angular momentum of the particle about the point of projection at a time t after its projection while it is in flight?

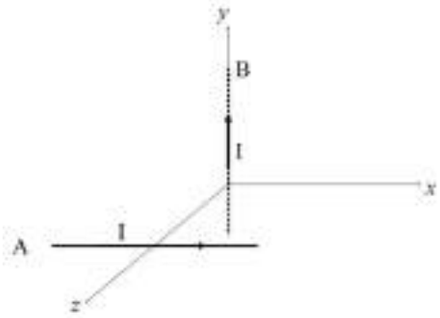
A. $\frac{1}{2}gt^2v \circ \cos\varphi$

B. $\frac{1}{2}gt^2v \circ \cos\varphi$

C. $\frac{1}{2}gt^2v \circ \sin\varphi$

D. $\frac{1}{2}gt^2v \circ \sin\varphi$

50. Consider two long thin conductors *A* and *B* each carrying current I as shown in the figure. Considering *A* to be fixed, which of the following statements is correct?



A. *B* experiences a net force along +x axis.

B. *B* experiences a net anticlockwise torque.

C. *B* experiences a net force along −x axis.

D. *B* experiences a net clockwise torque.

51. What is the average kinetic energy of molecules of an ideal gas leaking freely through an orifice of a container which has N molecules at pressure P in volume V ?

A. $\frac{3PV}{2N}$

B. $\frac{PV}{2N}$

C. $\frac{3PV}{N}$

D. $\frac{2PV}{3N}$

52. Which of the following is an expression for energy in terms of the Planck's constant h, the velocity of light c and the Gravitational constant G?

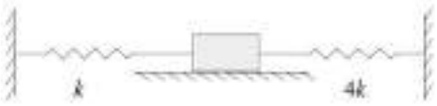
A. $\sqrt{\frac{hG}{c^3}}$

B. $\sqrt{\frac{hc^5}{G}}$

C. $\frac{hc}{5G}$

D. $\sqrt{\frac{Ghc^5}{2}}$

the left and right side
by springs of spring constants k and 4k respectively as shown in the figure. The time spent by the block in a complete cycle of oscillation on the left and the right side of the equilibrium position are tL and tR, respectively. Which of the following is correct?



A. tL = 2tR

B. tL = tR/2

C. tL = tR

D. tL = 4tR

54. A capacitor with capacitance C ◦ consists of two concentric spherical conductors. If the radii of the inner and the outer spherical conductors are halved, what is the new capacitance?

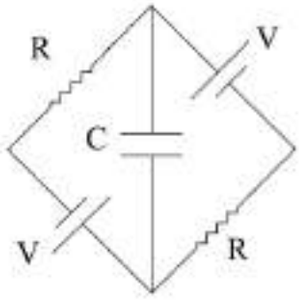
A.C ◦ / 2

B.4C ◦

C.C ◦

D.C ◦ √/2

55.Whatisthetimettakenbythecapacitorinthegivencircuittochargeto1/2πofitsfull√capacity?



A.t → ∞

B. t = 1/RC

C. t = 2πRC

D.t=RC

56. The allowed energy levels of electrons in a Hydrogen atom are given by E n= − 13.6/n2 eV.For electronic transition in Hydrogen atom, what is the maximum frequency of the emitted photon? (h = 6.62 × 10−34 Js; e = 1.6 × 10−19 C)

A. 2.1 × 106 GHz
× 106 GHz
× 106 GHz
× 106 GHz

B. 5.5

C. 3.3

D. 1.7

57. Which of the following statements about the P-V diagram of an ideal gas of fixed number of particles is incorrect?

A. Two distinct adiabats never cross each other.

B. Two distinct isotherms never cross each other.

C. An isotherm and an adiabat intersect at one point.

D. An isotherm and an adiabat intersect at more than one point.

58. A cube, a cylinder (of height equal to its diameter) and a sphere, all solid, are made of a metal and are of identical mass. If all the three shapes having initial temperature 50 ◦ C are put in a large reservoir of water at 10 ◦ C. Which of the above three shapes cools the fastest?

A. The cylinder.

B. The sphere.

C. The cube.

D. All three at the same rate.

59. An LED display consists of 100 pixels per cm2. Consider that the diameter of the pupil of the eye is 5 mm and the average wavelength of the display is 575 nm. What is the nearest distance from the display one can be at, such that the display does not appear pixelated?

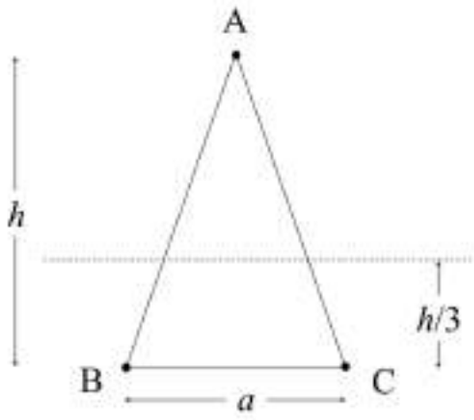
A. 30.23 m

B. 7.12 m

C. 4.52 m

D. 20.32 m

60. Two equal positive charges (q) are placed at the vertices B and C of an isosceles triangle of base a. It is found that at a point inside the triangle, the net electric field due to the three charges vanishes. If this point is at a height h/3, then what is q′?



A. $q' = -3\sqrt{3}q$

B. $q' = +3\sqrt{3}q$

C. $q' = +3\sqrt{3}q$

D. $q' = -3\sqrt{3}q$