Biology

1. Offspring formed by sexual reproduction exhibit more variation than those formed by asexual reproduction because

   A. each gamete has unique genetic composition.
   B. sexual reproduction is a lengthy process.
   C. genetic material comes from parents of two different species.
   D. greater amount of DNA is involved in sexual reproduction.

2. In the human body which element is most abundant by weight and by number respectively?

   A. carbon, hydrogen.
   B. oxygen, hydrogen.
   C. oxygen, carbon.
   D. carbon, nitrogen.

3. Approximately how many cells of staphylococci will be able to fit in the volume of a human red blood cell?

   A. 10.
   B. 1000.
   C. 10000.
   D. 50000.

4. Although intracellular bacterial infection can be treated by giving an antibiotic that blocks protein synthesis, it doesn't affect human cells. Why?

   A. Antibiotic molecules can't enter human cells.
   B. Antibiotic gets degraded by human cell.
   C. Human ribosomes are different from bacterial ribosomes.
   D. Human genetic code is different from bacterial genetic code.

5. Which of the following groups of animals you would expect to evolve chemical defences against predators?

   A. slow moving with hard shell.
   B. sedentary without a hard shell.
   C. burrowing.
   D. arboreal.

6. Which of the following techniques will be useful for tracing the origin of Onge tribe in Andamans?

   A. blood grouping.
   B. mitochondrial DNA analysis.
   C. DNA fingerprinting.
   D. karyotyping.

7. Under which of the following conditions is Semelparous reproduction (where organisms produces all its offspring in a single reproductive event) is most likely to be favoured?

   A. Adult survival rate is low.
   B. Adult survival rate is high.
   C. Breeding is perennial.
   D. Breeding is seasonal.

8. Which of the following characters is seen only in prokaryotes and not in eukaryotes?

   A. Antibiotic production.
   B. Unicellular life.
   C. Reproduction by budding.
   D. Nitrogen fixation.

9. A scientist wants to express human protein Y in bacteria. For effective expression of this protein he should use

    A. promoter of human gene Y.
    B. promoter of bacterial gene.
    C. operator of any human gene.
    D. operator of any bacterial gene.

10. During growth of an individual animal some components of the body grow in size but not in number (type 1) while some others increase in number but not in size (type 2). Which of the following is correct?

    A. type 1: bones and muscle cells; type 2: hair follicles, red blood cells and epithelial cells.
    B. type 1: bones and red blood cells; type 2: hair follicles, muscle cells and epithelial cells.
    C. type 1: hair follicles and muscle cells; type 2: bones, red blood cells and epithelial cells.
    D. type 1: epithelial cells and bones; type 2: hair follicles, red blood cells and muscle cells.

11. Small mammals are not found in polar region because

    A. they have small surface to volume ratio.
    B. they have large surface to volume ratio.
    C. they cannot make burrows because of ice cover.
    D. of scarcity of food.

12. Which of the following growth curves represents growth of bacteria in a culture medium that contains both glucose and lactose?
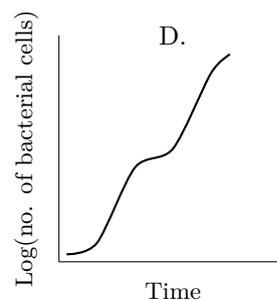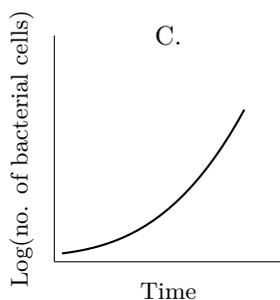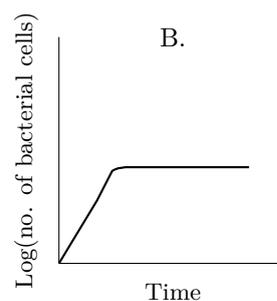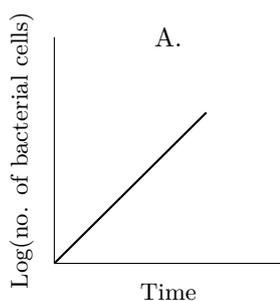
13. Most stable nucleic acid is

    A. DNA.
    B. mRNA.
    C. rRNA.
    D. tRNA.

14. A matured mRNA has 300 bases with a single stop codon. What would be the length of the polypeptide synthesized from this mRNA?

    A. always 100 amino acids.
    B. always 99 amino acids.
    C. maximum of 99 amino acids.
    D. maximum of 100 amino acids.

15. A diploid organism is heterozygous for four unlinked loci. How may types of gametes can be produced?

    A. 8.
    B. 16.
    C. 32.
    D. 128.

16. The correct stability order of $-C\equiv N$, $-C\equiv P$, $-C\equiv As$, and $-C\equiv Sb$ bonds would be

    A. $-C\equiv N > -C\equiv As > -C\equiv Sb > -C\equiv P$.
    B. $-C\equiv As > -C\equiv N > -C\equiv P > -C\equiv Sb$.
    C. $-C\equiv N > -C\equiv P > -C\equiv As > -C\equiv Sb$.
    D. $-C\equiv Sb > -C\equiv As > -C\equiv P > -C\equiv N$.

17. As predicted by VSEPR theory, the molecular shapes of XeF_2 and XeF_4 are respectively

    A. Bent and square planar.
    B. Linear and tetrahedral.
    C. Bent and tetrahedral.
    D. Linear and square planar.

18. Which of the following statements holds true for Cu(I) and Cu(II) complexes?

    A. Cu(II) complexes are diamagnetic but Cu(I) complexes are paramagnetic.
    B. Both Cu(I) and Cu(II) complexes are paramagnetic.
    C. Both Cu(I) and Cu(II) complexes are diamagnetic.
    D. Cu(II) complexes are paramagnetic but Cu(I) complexes are diamagnetic.

19. What is the relationship between the two molecules shown below?
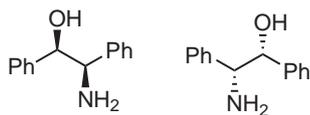
    A. Enantiomers.
    B. Diastereomers.
    C. Geometrical isomers.
    D. Both are identical molecules.

20. Which of the following are aromatic?
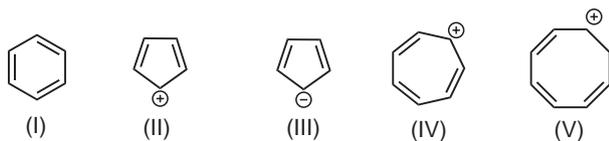
    A. I, II, and IV.
    B. I, III, and V.
    C. I, III, and IV.
    D. I, IV, and V.

21. Arrange the following molecules in increasing order of acidity.
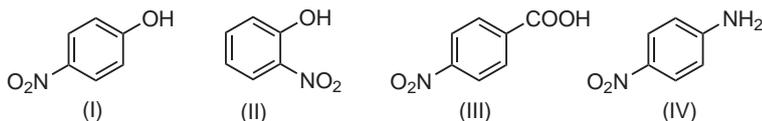
    A. IV < II < I < III.
    B. IV < I < II < III.
    C. III < IV < I < II.
    D. I < II < IV < III.

22. What will be the final outcome of the following sequence of reactions?

A.

B.

C.

D.
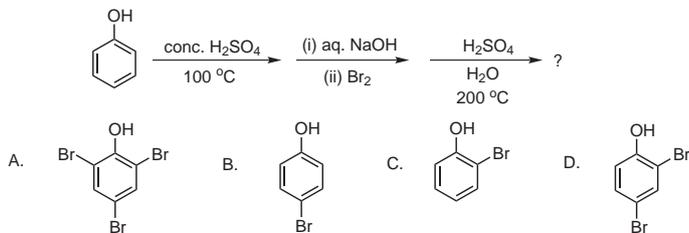
23. Predict the final product in the following sequence of reactions?

A.

B.

C.

D.
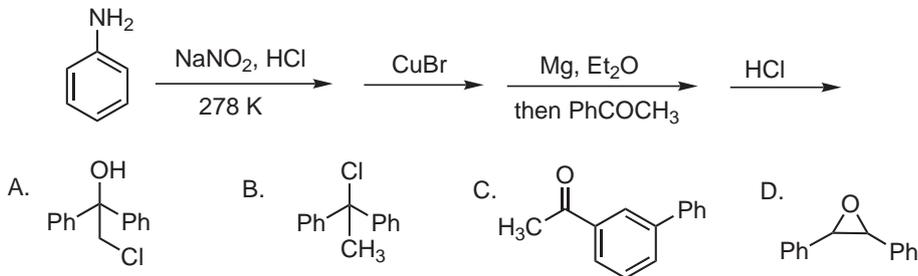
24. For the He^+ ion which of the following options is true?

A. Energy of 3s is less than 3p.

B. Energy of 3p is less than 3d.

C. Energies of 3s, 3p, and 3d are all the same.

D. Energy of 3s is same as 3p, but lower than 3d.

25. For a free expansion of an ideal gas in an isolated chamber, which of the following statements is true?

A. Entropy of the system increases.

B. Temperature of the system decreases.

C. Internal energy of the system decreases.

D. Positive work is done by the system.

26. When an aqueous solution was treated with $AgNO_3$, a white precipitate was obtained which was soluble in NH_4OH. The aqueous solution contained

A. Sulfate.

B. Chloride.

C. Acetate.

D. Carbonate.

27. A scientist measured the cell length of a cubic crystalline substance to be 3.0×10^{-8} cm. The substance was also found to have a density of 11 g/cc and an atomic mass of 60 u. The number of atoms per unit cell based on the data given above is:

A. 4.

B. 3.

C. 2.

D. 1.

28. The van der Waals coefficient a (expressed in $atm \cdot dm^6 \cdot mol^{-2}$) for four different gases are: He 0.0341; H_2 0.242; Kr 5.125; O_2 1.364. Based on the data given above, the gas that will be expected to have the lowest critical temperature T_c:

A. He.

B. H_2.

C. Kr.

D. O_2.

29. 1 mL of 10^{-5} M HCl was diluted to 1 L by adding water. The pH of the resultant solution is

   A. 8.
   B. 6.9.
   C. 5.
   D. 7.1.

30. A, B, and C are in equilibrium as shown in the diagram. Which of the following relations among the rate constants is true?
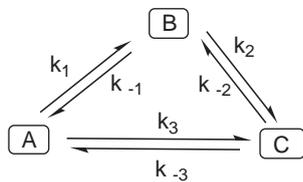
   A. $k_1 k_2 k_{-3} = k_3 k_{-1} k_{-2}$.
   B. $k_1 k_2 k_3 = k_{-3} k_{-1} k_{-2}$.
   C. $k_1 k_{-2} k_3 = k_{-3} k_{-1} k_2$.
   D. $k_{-1} k_2 k_3 = k_{-3} k_1 k_{-2}$.

31. The equations of two lines are $x + 2y = 1$ and $2x - y = 3$.

    A. These lines are parallel.
    B. These lines are perpendicular.
    C. These lines are at an angle of $60°$.
    D. These lines are at an angle of $30°$.

32. Suppose the matrix $\begin{pmatrix} 2 & a \\ 3 & b \end{pmatrix}$ with a and b integers has determinant 1. A possible value for b is

    A. 1.
    B. 2.
    C. 3.
    D. 9.

33. There are five students. Arul and Neeraj are Mathematics students. Sunny likes Biology. Mathematics students dislike Chemistry. Students who like Biology cannot dislike Chemistry. Students who want to take Physics must like all other subjects. Swati and Manas want to take Physics. The number of students who dislike Chemistry is

    A. 1.
    B. 2.
    C. 3.
    D. 4.

34. Let $a_1, a_2, \cdots, a_{10}$ be 10 observations with median 3. Then

    A. at least 5 observations are less than or equal to 3.
    B. at most 5 observations are less than or equal to 3.
    C. exactly 5 observations are less than or equal to 3.
    D. all observations are less than or equal to 3.

35. The value of the integral $\displaystyle\int_{-1}^{1} \left(x^2 + \frac{x^{2013}}{x^2 + 2|x| + 1} \right) dx$ is

    A. positive.
    B. negative.
    C. 0.
    D. ∞.

36. The sum of the infinite series $\dfrac{9}{10} + \dfrac{9}{100} + \dfrac{9}{1000} + \ldots$ is

    A. ∞.
    B. $\dfrac{11}{9}$.
    C. 1.
    D. $\dfrac{10}{9}$.

37. The angle between the tangents to the circles $x^2 + y^2 = 1$ and $x^2 + (y-1)^2 = 2$ at the point $(1, 0)$ is

    A. $90°$.
    B. $30°$.
    C. $60°$.
    D. $45°$.

38. The length of the shortest path in space between the z-axis and the line given by the equations $z = 0$ and $y = 1$ is

   A. 1.

   B. 2.

   C. $\sqrt{2}$.

   D. $\dfrac{1}{2}$.

39. Consider the inequalities $x + y < 3$, $x - y < 5$, $5x - 3y < 15$ and $2x + y > 2$. The region in the plane that consists of points satisfying these inequalities is

   A. empty.

   B. rectangular.

   C. triangular.

   D. square.

40. The number of solutions of $\tan x = x - x^3$ with $-1 \le x \le 1$ is

   A. 1.

   B. 2.

   C. 3.

   D. 4.

41. Let $f(x) = |x|^a$ where a is a non-zero real number. For what values of a is $f(x)$ differentiable at $x = 0$?

   A. For all non-zero a.

   B. For all $a > 1$.

   C. For no values of a.

   D. For all a different from 1 and 0.

42. The set of solutions in complex numbers of the equation $z^4 = -1$ is

   A. the empty set.

   B. $\{i, -i\}$.

   C. $\left\{ \dfrac{-1 + i\sqrt{3}}{2}, \dfrac{-1 - i\sqrt{3}}{2}, \dfrac{1 + i\sqrt{3}}{2}, \dfrac{1 - i\sqrt{3}}{2} \right\}$.

   D. $\left\{ \dfrac{-1 + i}{\sqrt{2}}, \dfrac{-1 - i}{\sqrt{2}}, \dfrac{1 + i}{\sqrt{2}}, \dfrac{1 - i}{\sqrt{2}} \right\}$.

43. Let $f(x) = \lfloor x \rfloor / (x^2 + 1)$ where $\lfloor x \rfloor$ denotes the greatest integer less than or equal to x. Then

   A. f is continuous for all x.

   B. f is continuous only when x is an integer.

   C. f is continuous only when x is not an integer.

   D. f is not continuous at any value of x.

44. An unbiased usual six-sided die is thrown three times. The sum of the numbers coming up is 10. The probability that 2 has appeared at least once is

   A. $\dfrac{1}{36}$.

   B. $\dfrac{5}{36}$.

   C. $\dfrac{91}{216}$.

   D. $\dfrac{1}{18}$.

45. The number of solutions of $a + b + c = 15$ with non-negative integer values for a, b and c is

A. $\dfrac{15!}{3! \, 12!} = 455$.

B. $\dfrac{14!}{2! \, 12!} = 91$.

C. $\dfrac{17!}{2! \, 15!} = 136$.

D. $\dfrac{15!}{5! \, 5! \, 5!} = 756756$.

46. Dimension of Planck's constant is equivalent to the dimension of which of the following quantities?

    A. Force.

    B. Energy.

    C. Linear momentum.

    D. Angular momentum.

47. The figure below shows the displacement vs time plot of a particle undergoing simple harmonic motion. The acceleration of the particle at time $t = \frac{4}{3}$ sec would be
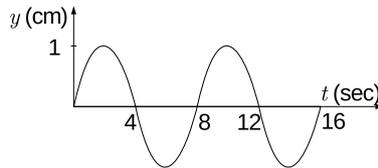
    A. $\dfrac{\sqrt{3}\pi^2}{16}$ cm/sec^2.

    B. $-\dfrac{\sqrt{3}\pi^2}{32}$ cm/sec^2.

    C. $-\dfrac{\sqrt{3}\pi^2}{16}$ cm/sec^2.

    D. $\dfrac{\sqrt{3}\pi^2}{32}$ cm/sec^2.

48. Two infinitely long rods are arranged on a plane making an angle θ with each other, as shown in the figure. The rod B starts to move with a uniform velocity $\vec{v}$, in a direction perpendicular to rod A. Thus, the point of intersection P moves with a horizontal velocity $\vec{v}_P$. Which of the following statements is true?
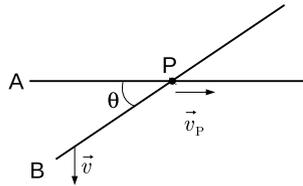
    A. v_P increases with increasing θ.

    B. v_P decreases with increasing θ.

    C. v_P is independent of θ.

    D. v_P is independent of v.

49. The figure shows a block of mass M, attached to an uncompressed spring of spring constant k, resting on a frictionless surface. A bullet of mass m, travelling with a constant horizontal velocity v hits the block and gets embedded inside. What is the maximum compression of the spring?

    A. $v\dfrac{m}{k}$.

    B. $v\sqrt{\dfrac{M}{k}}$.

    C. $v\sqrt{\dfrac{m+M}{k}}$.

    D. $v\sqrt{\dfrac{m}{k}}$.

50. An electron in a hydrogen atom falls from an orbit with principal quantum number $n = 2$ to $n = 1$. What is the wavelength (λ) of the emitted radiation? (where R denotes the Rydberg constant).

A. $\lambda = \dfrac{4}{3R}$.

B. $\lambda = \dfrac{4}{5R}$.

C. $\lambda = \dfrac{3R}{4}$.

D. $\lambda = -\dfrac{4}{3R}$.

51. The figure below shows a cylindrical tank filled with water upto a height h. A hole is punctured on the side of the tank, at a distance x below the water level. Water exits the hole and hits a point P (at a distance r from the base of the tank). Which of the following is true?
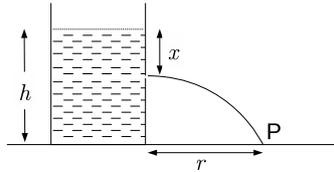
A. r is maximum when $x = \dfrac{h}{\sqrt{2}}$.

B. r is maximum when $x = \dfrac{h}{2}$.

C. r is maximum when $x = h$.

D. r is maximum when $x = \dfrac{2h}{3}$.

52. A tank with uniform cross-sectional area A is filled with a liquid of density ρ upto a height h. What is the potential erergy stored in the system? (where g denotes the acceleration due to gravity)

A. $\frac{1}{2}Ag\rho h^2$.

B. $Ag\rho h^2$.

C. $\frac{1}{2}Ag\rho h$.

D. $Ag\rho h$.

53. A sphere of radius R carries a positive charge density (ρ) that increases linearly with radial distance r from the centre ($\rho \propto r$). The radial dependence of the magnitude of electric field inside the sphere is given by

A. $E \propto r$.

B. $E \propto r^2$.

C. $E \propto r^{-1}$.

D. $E \propto r^{-2}$.

54. A magnet falling vertically under gravity, passes through a metal ring on its way. Which of the following is true about the acceleration a of the magnet? (where g denotes the acceleration due to gravity)

A. $a > g$ everywhere.

B. $a > g$ before crossing the ring and $a < g$ after crossing the ring.

C. $a < g$ before crossing the ring and $a > g$ after crossing the ring.

D. $a < g$ everywhere.

55. A point charge Q, is placed at the center of a cube of side a, in vacuum (permitivity ϵ_0). The flux of the electric field through the shaded face is given by
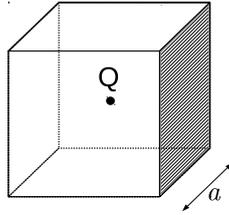
A. $\dfrac{Q}{\epsilon_0}$.

B. $\dfrac{Q}{4\epsilon_0}$.

C. $\dfrac{Q}{6\epsilon_0}$.

D. $\dfrac{Q}{8\epsilon_0}$.

56. Two isolated conducting spheres of radii 10 cm and 20 cm have charges Q_A and Q_B, respectively. What is the final charge on the first sphere if the spheres are brought in contact and separated subsequently?

A. $\dfrac{1}{3}(Q_A + Q_B)$.

B. $\dfrac{2}{3}(Q_A + Q_B)$.

C. $\dfrac{1}{2}(Q_A + Q_B)$.

D. remains unchanged.

57. Heat (Q) is supplied to a solid to raise its temperature (T) across its melting point (T_M) and boiling point (T_B). Which of the following graphs correctly represents the relation between heat supplied and temperature?
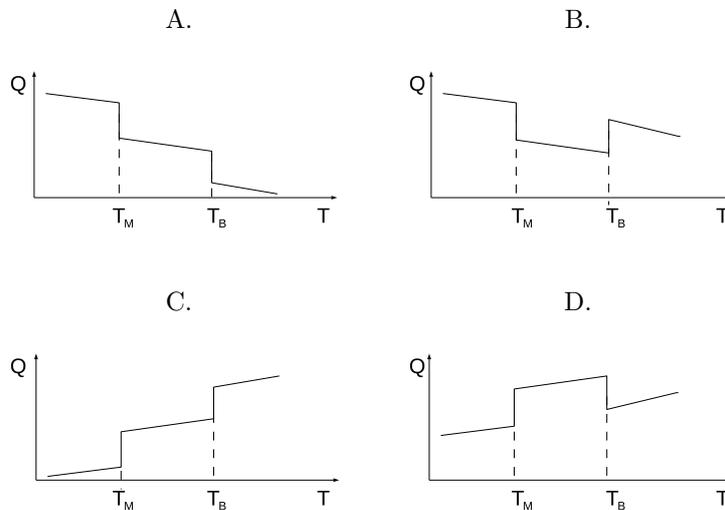
58. For the circuit given below, what is the effective resistance between points **a** and **b**.
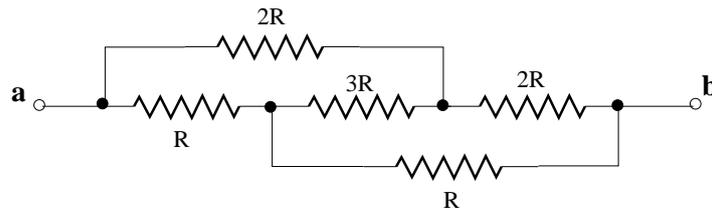
A. $3R/4$.

B. $3R/5$.

C. $4R/3$.

D. $5R/3$.

59. Consider the ray diagrams for a concave mirror (focal length f_M) and a convex lens (focal length f_L) in air, as shown in the figure below.
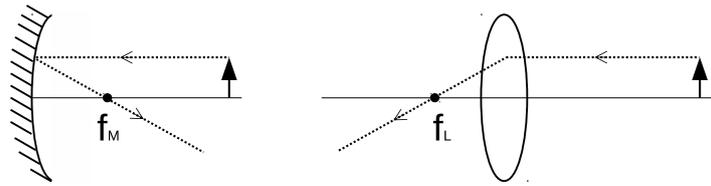
What happens to their focal lengths when they are immersed in a medium of refractive index higher than that of air?

A. f_M changes and f_L stays same.

B. f_M stays same and f_L changes.

C. both f_M and f_L changes.

D. both f_M and f_L stay same.

60. Consider a ray of light passing through a rectangular slab of refractive index μ ($\mu > 1$) and thickness h as shown below.
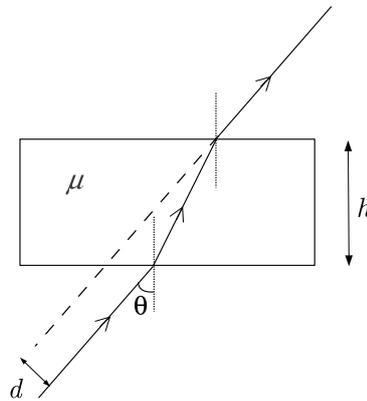
This leads to a parallel shift d in the path of the ray, which varies between 0 to d_{max} as θ varies. How does d_{max} change with μ?

A. d_{max} increases with μ.

B. d_{max} decreases with μ.

C. d_{max} first increases then decreases with μ.

D. does not change with μ.