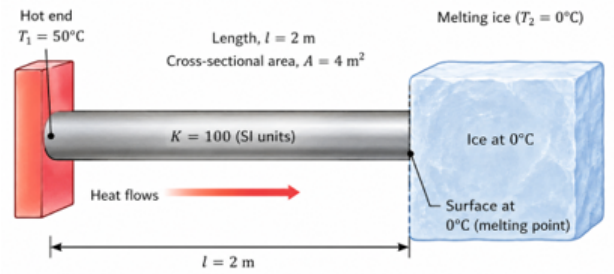
Max Marks: 720 **SR_WEEK-6 (20-07-2026)** **Time: 180 mins**

Physics

1. Find the rate of flow of heat and the rate of melting of ice for a rod with $T_1 = 50^\circ\text{C}$ and $T_2 = 0^\circ\text{C}$ (melting ice), length $l = 2$ m, cross-sectional area $A = 4\ \text{m}^2$, and thermal conductivity $K = 100$ in SI units.



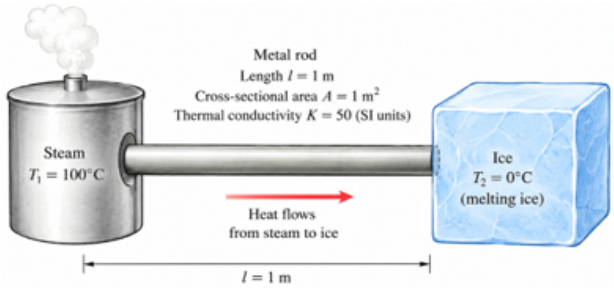
A) Rate of heat flow = $10000\ \text{J/sec}$, Rate of melting of ice = $10000/L\ \text{kg/sec}$

B) Rate of heat flow = $5000\ \text{J/sec}$, Rate of melting of ice = $5000/L\ \text{kg/sec}$

C) Rate of heat flow = $20000\ \text{J/sec}$, Rate of melting of ice = $20000/L\ \text{kg/sec}$

D) Rate of heat flow = $1000\ \text{J/sec}$, Rate of melting of ice = $1000/L\ \text{kg/sec}$

2. A metal rod connects a steam chamber at $T_1 = 100^\circ\text{C}$ to a block of ice at $T_2 = 0^\circ\text{C}$. If the rod has a length $l = 1$ m, cross-sectional area , and thermal conductivity in SI units, find the rate of heat flow and the rate of melting.



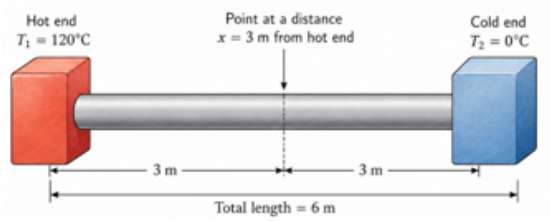
A) Rate of heat flow = $5000\ \text{J/sec}$, Rate of melting of ice = $5000/L\ \text{kg/sec}$

B) Rate of heat flow = $2500\ \text{J/sec}$, Rate of melting of ice = $2500/L\ \text{kg/sec}$

C) Rate of heat flow = $1000\ \text{J/sec}$, Rate of melting of ice = $1000/L\ \text{kg/sec}$

D) Rate of heat flow = $500\ \text{J/sec}$, Rate of melting of ice = $500/L\ \text{kg/sec}$

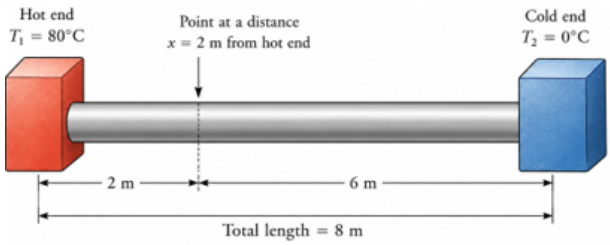
3. Find the temperature at a distance 3 m from the hot end (120°C) for a rod of total length 6 m with the other end at 0°C.



A) 30°C **B)** 60°C

C) 90°C **D)** 40°C

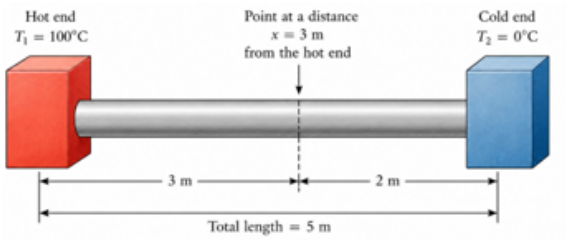
4. Find the temperature at a distance 2 m from the hot end (80°C) for a rod of total length 8 m with the other end at 0°C.



A) 20°C **B)** 40°C

C) 60°C **D)** 80°C

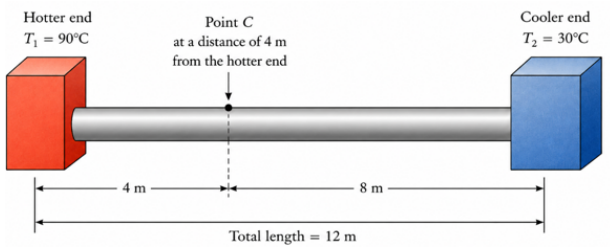
5. Find the temperature at a distance 3 m from the hot end (100°C) for a uniform rod of total length 5 m with the other end held at 0°C.



A) 40°C **B)** 60°C

C) 30°C **D)** 50°C

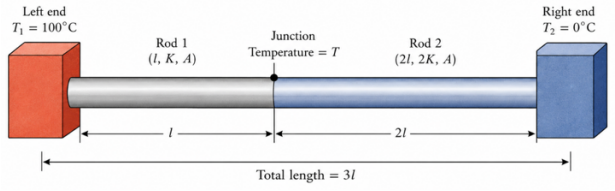
6. Find the temperature at a point C for a uniform rod of length 12 m with its ends held at 90°C and 30°C, at a distance of 4 m from the hotter end.



A) 50°C **B)** 60°C

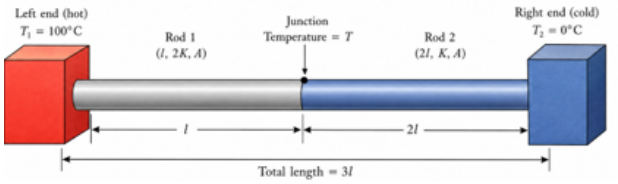
C) 70°C **D)** 80°C

7. **Two different rods are connected in series as shown in the figure, with the first rod having properties (L, K, A) and the second rod having properties $(2L, 2K, A)$. If the temperatures at the free ends are 100°C and 0°C respectively, find the temperature at the junction.**



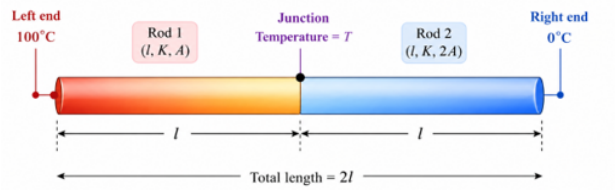
A) 30°C B) 40°C
C) 50°C D) 60°C

8. **Two rods are connected in series. The first rod has properties $(L, 2K, A)$ and is maintained at 100°C. The second rod has properties $(2L, K, A)$ and is maintained at 0°C. Find the temperature at the junction.**



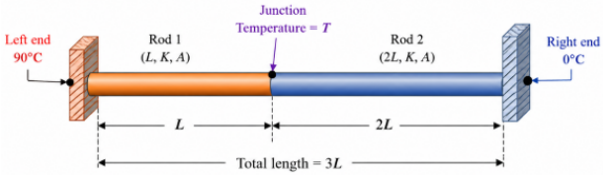
A) 20°C B) 40°C
C) 60°C D) 80°C

9. **Find the temperature T at the junction of two rods connected in series as shown in the figure, where the first rod has properties (L, K, A) and the second rod has properties $(L, K, 2A)$. The temperatures at the free ends are 100°C and 0°C respectively.**



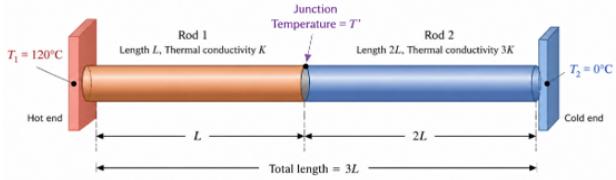
A) 50°C B) $100/3^\circ\text{C}$
C) $200/3^\circ\text{C}$ D) 25°C

10. **Find the temperature T at the junction of two rods connected in series. The first rod has properties (L, K, A) and is maintained at 90°C. The second rod has properties $(2L, K, A)$ and is maintained at 0°C.**



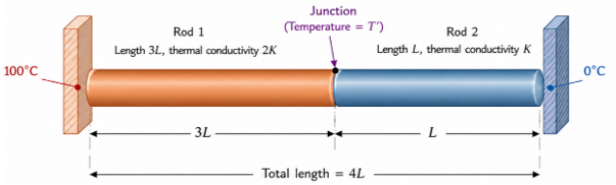
A) 30°C B) 45°C
C) 60°C D) 75°C

11. **Two cylindrical rods of the same cross-sectional area A are joined end-to-end. The first rod has length L, thermal conductivity K, and its free end is maintained at 120°C. The second rod has length 2L, thermal conductivity 3K, and its free end is maintained at 0°C. Find the heat current and the temperature T' at the junction.**



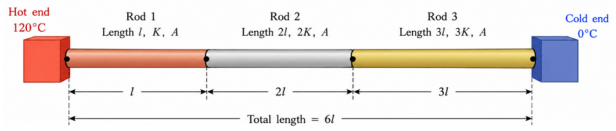
A) $i = \frac{36KA}{L}, T' = 84^\circ\text{C}$ B) $i = \frac{72KA}{L}, T' = 48^\circ\text{C}$
C) $i = \frac{54KA}{L}, T' = 66^\circ\text{C}$ D) $i = \frac{18KA}{L}, T' = 102^\circ\text{C}$

12. **Two cylindrical rods of the same cross-sectional area A are joined end-to-end. The first rod has length 3L, thermal conductivity 2K, and its free end is maintained at 100°C. The second rod has length L, thermal conductivity K, and its free end is maintained at 0°C. Find the heat current and the temperature T' at the junction.**



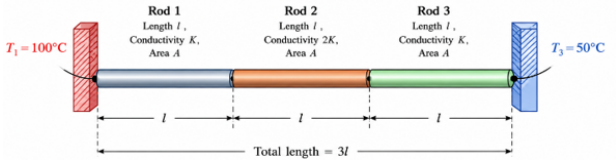
A) $i = \frac{40KA}{L}, T' = 80^\circ\text{C}$ B) $i = \frac{20KA}{3L}, T' = 60^\circ\text{C}$
C) $i = \frac{5KA}{L}, T' = 40^\circ\text{C}$ D) $i = \frac{15KA}{2L}, T' = 70^\circ\text{C}$

13. **Three cylindrical rods are joined end-to-end in series. The first rod has length l, thermal conductivity K, and cross-sectional area A. The second rod has length 2l, thermal conductivity 2K, and cross-sectional area A. The third rod has length 3l, thermal conductivity 3K, and cross-sectional area A. If the free ends are maintained at 120°C and 0°C respectively, find the steady-state heat current flowing through the system.**



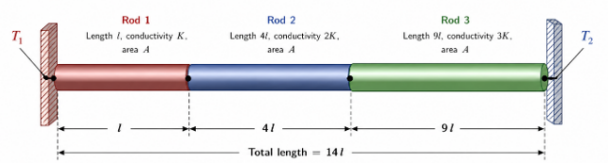
A) $i = \frac{20KA}{l}$ B) $i = \frac{30KA}{l}$
C) $i = \frac{40KA}{l}$ D) $i = \frac{60KA}{l}$

14. **Three cylindrical rods are joined end-to-end in series. The first rod has length l, thermal conductivity K, and cross-sectional area A. The second rod has length l, thermal conductivity 2K, and cross-sectional area A. The third rod has length l, thermal conductivity K, and cross-sectional area A. If the free ends are maintained at 100°C and 50°C respectively, find the steady-state heat current flowing through the system.**



A) $i = \frac{10KA}{l}$ B) $i = \frac{20KA}{l}$
C) $i = \frac{30KA}{l}$ D) $i = \frac{40KA}{l}$

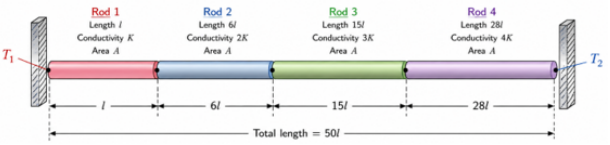
15. Three cylindrical rods are joined end-to-end in series. The first rod has length l, thermal conductivity K, and cross-sectional area A. The second rod has length 4l, thermal conductivity 2K, and cross-sectional areaA. The third rod has length 9l, thermal conductivity 3K, and cross-sectional areaA. If the outer ends are maintained at temperatures T_1 and T_2 respectively, find the steady-state heat current flowing through the system.



A) $i = \frac{KA(T_1-T_2)}{3l}$ B) $i = \frac{KA(T_1-T_2)}{4l}$

C) $i = \frac{KA(T_1-T_2)}{6l}$ D) $i = \frac{KA(T_1-T_2)}{9l}$

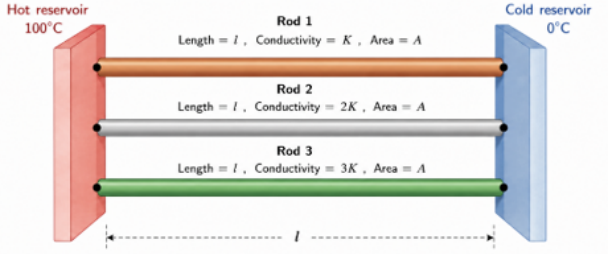
16. Four cylindrical rods are joined end-to-end in series. The first rod has length l, thermal conductivity K, and cross-sectional area A. The second rod has length 6l, thermal conductivity 2K, and cross-sectional area. A. The third rod has length 15l, thermal conductivity 3K, and cross-sectional area A. The fourth rod has length 28l, thermal conductivity 4K, and cross-sectional area A. If the outer ensads are maintained at temperatures T_1 and T_2 respectively, find the steady-state heat current flowing through the system.



A) $i = \frac{KA(T_1-T_2)}{16l}$ B) $i = \frac{KA(T_1-T_2)}{12l}$

C) $i = \frac{KA(T_1-T_2)}{10l}$ D) $i = \frac{KA(T_1-T_2)}{8l}$

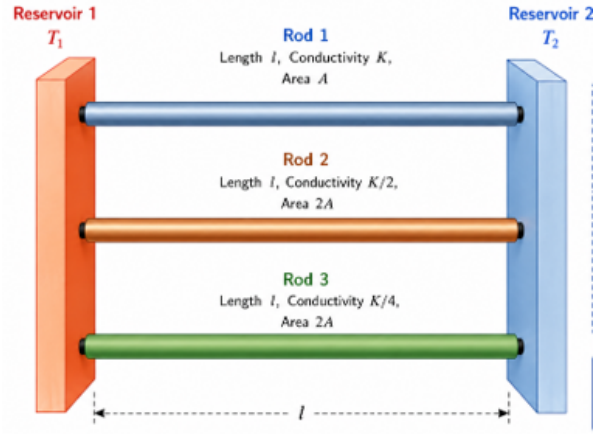
17. Find the net rate of heat flow through a combination of three cylindrical rods connected in parallel between two reservoirs at temperatures 100°C and 0°C. The dimensions and thermal conductivities of the rods are: Rod 1: length l, thermal conductivity K, cross-sectional area A Rod 2: length l, thermal conductivity 2K, cross-sectional area A Rod 3: length l, thermal conductivity 3K, cross-sectional area A



A) $i_{net} = \frac{2KA\times100}{l}$ B) $i_{net} = \frac{3KA\times100}{l}$

C) $i_{net} = \frac{6KA\times100}{l}$ D) $i_{net} = \frac{5KA\times100}{l}$

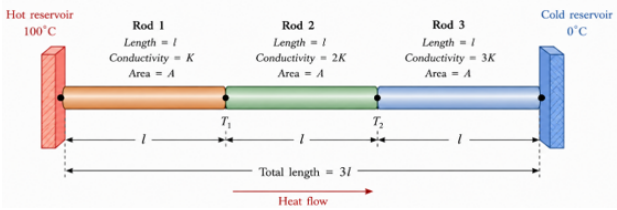
18. Find the net rate of heat flow through a combination of three cylindrical rods connected in parallel between two reservoirs at temperatures T_1 and T_2. The dimensions and thermal conductivities of the rods are: Rod 1: length l, thermal conductivity K, cross-sectional area A Rod 2: length l, thermal conductivity $K/2$, cross-sectional area 2A Rod 3: length l, thermal conductivity $K/4$, cross-sectional area 2A



A) $i_{net} = \frac{2KA(T_1-T_2)}{l}$ B) $i_{net} = \frac{5KA(T_1-T_2)}{2l}$

C) $i_{net} = \frac{3KA(T_1-T_2)}{l}$ D) $i_{net} = \frac{7KA(T_1-T_2)}{2l}$

19. Three cylindrical rods are joined end-to-end in series. The first rod has length l, thermal conductivity K, and cross-sectional area A. The second rod has length l, thermal conductivity 2K, and cross-sectional area A. The third rod has length l, thermal conductivity 3K, and cross-sectional area A. If the free ends are maintained at 100°C and 0°C respectively, find the steady-state temperatures T_1, T_2 at the junctions and the rate of heat flow $\frac{dQ}{dt}$.



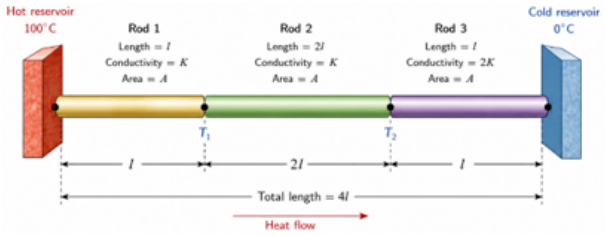
A) B)

$T_1 = \frac{500}{11}^\circ\text{C}, T_2 = \frac{200}{11}^\circ\text{C}, \frac{dQ}{dt} = \frac{600}{11}$ $T_1 = \frac{200}{11}^\circ\text{C}, T_2 = \frac{300}{11}^\circ\text{C}, \frac{dQ}{dt} = \frac{50}{}$

C) D)

$T_1 = \frac{400}{11}^\circ\text{C}, T_2 = \frac{100}{11}^\circ\text{C}, \frac{dQ}{dt} = \frac{700}{11}$ $T_1 = \frac{100}{11}^\circ\text{C}, T_2 = \frac{300}{11}^\circ\text{C}, \frac{dQ}{dt} = \frac{60}{}$

20. Three cylindrical rods are joined end-to-end in series. The first rod has length l, thermal conductivity K, and cross-sectional area A. The second rod has length 2l, thermal conductivity K, and cross-sectional area A. The third rod has length l, thermal conductivity 2K, and cross-sectional area A. If the free ends are maintained at 100°C and 0°C respectively, find the steady-state temperatures T_1, T_2 at the junctions and the rate of heat flow $\frac{dQ}{dt}$.



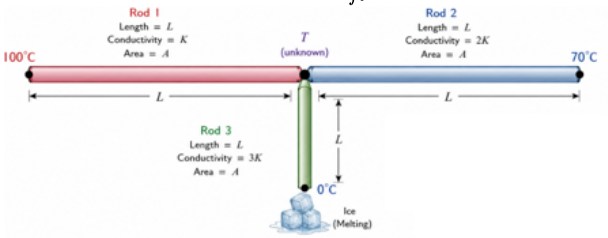
A) $T_1 = \frac{500}{7}\,^\circ\text{C}, T_2 = \frac{100}{7}\,^\circ\text{C}, \frac{dQ}{dt} = \frac{200KA}{7l}$

B) $T_1 = \frac{400}{7}\,^\circ\text{C}, T_2 = \frac{200}{7}\,^\circ\text{C}, \frac{dQ}{dt} = \frac{300KA}{7l}$

C) $T_1 = \frac{600}{7}\,^\circ\text{C}, T_2 = \frac{300}{7}\,^\circ\text{C}, \frac{dQ}{dt} = \frac{200KA}{7l}$

D) $T_1 = \frac{500}{7}\,^\circ\text{C}, T_2 = \frac{200}{7}\,^\circ\text{C}, \frac{dQ}{dt} = \frac{300KA}{7l}$

21. Find the temperature at the junction T' and the rate of melting of ice for three cylindrical rods joined at a common junction as shown in the figure. The first rod has length L, thermal conductivity K, cross-sectional area A, and its free end is at 100°C. The second rod has length L, thermal conductivity 2K, cross-sectional area A, and its free end is at 70°C. The third rod has length L, thermal conductivity 3K, cross-sectional area A, and its free end is connected to ice at 0°C. (Take the latent heat of fusion of ice as L_f).



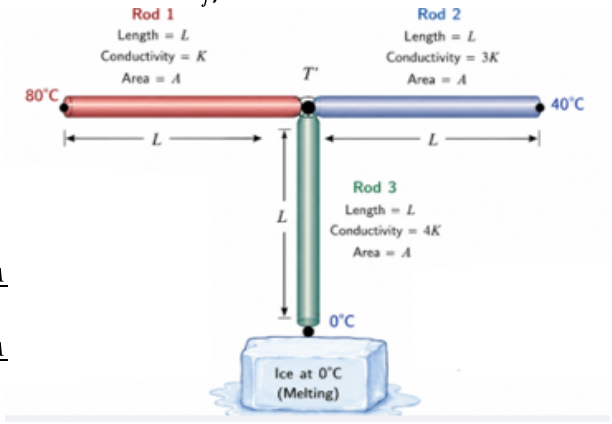
A) $T' = \frac{240}{7}\,^\circ\text{C}, \text{Rate of melting} = \frac{120KA}{LL_f}$

B) $T' = 40^\circ\text{C}, \text{Rate of melting} = \frac{120KA}{LL_f}$

C) $T' = 50^\circ\text{C}, \text{Rate of melting} = \frac{150KA}{LL_f}$

D) $T' = 30^\circ\text{C}, \text{Rate of melting} = \frac{90KA}{LL_f}$

22. Find the temperature at the junction T' and the rate of melting of ice for three cylindrical rods joined at a common junction. The first rod has length L, thermal conductivity K, cross-sectional area A, and its free end is at 80°C. The second rod has length L, thermal conductivity 3K, cross-sectional area A, and its free end is at 40°C. The third rod has length L, thermal conductivity 4K, cross-sectional area A, and its free end is connected to ice at 0°C. (Take the latent heat of fusion of ice as L_f).



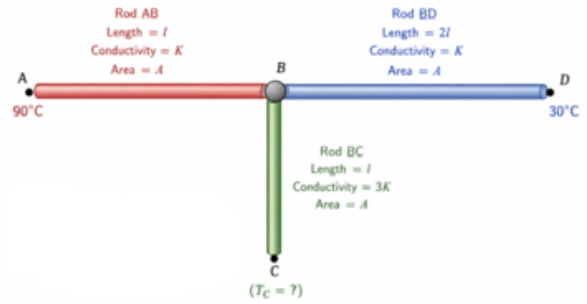
A) $T' = 25^\circ\text{C}, \text{Rate of melting} = \frac{100KA}{LL_f}$

B) $T' = 20^\circ\text{C}, \text{Rate of melting} = \frac{80K}{LL}$

C) $T' = 30^\circ\text{C}, \text{Rate of melting} = \frac{120KA}{LL_f}$

D) $T' = \frac{100}{3}\,^\circ\text{C}, \text{Rate of melting} = \frac{40}{3}$

23. If heat current in rod BC is zero, find T_C (or T_0) given the system of rods connected at junction B. Rod AB has length l, thermal conductivity K, cross-sectional area A, and its end is at 90°C. Rod BD has length 2l, thermal conductivity K, cross-sectional area A, and its end is at 30°C. Rod BC has length l, thermal conductivity 3K, cross-sectional area A.



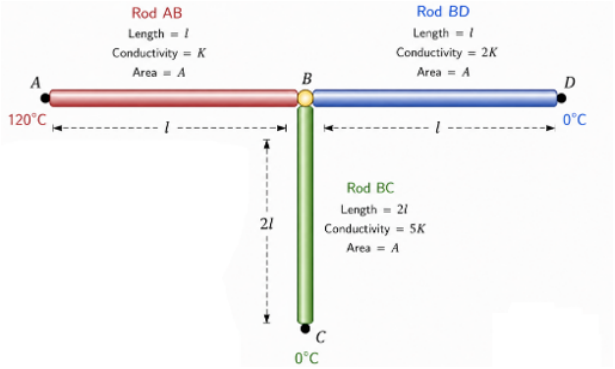
A) 50°C

B) 60°C

C) 70°C

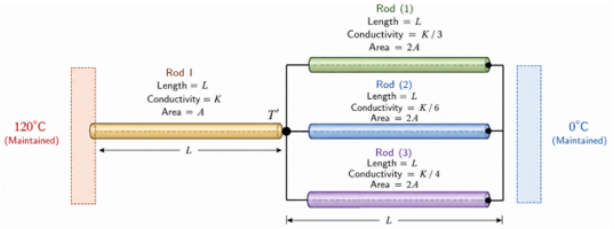
D) 80°C

24. If heat current in rod BC is zero, find T_C (or T_0) given the system of rods connected at junction B. Rod AB has length L, thermal conductivity K, cross-sectional area A, and its end is at 120°C. Rod BD has length L, thermal conductivity 2K, cross-sectional area A, and its end is at 0°C. Rod BC has length 2L, thermal conductivity 5K, cross-sectional area A.



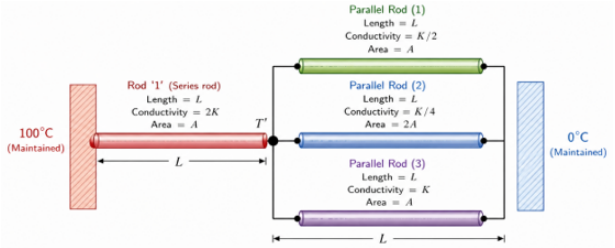
A) 30°C B) 40°C
C) 50°C D) 60°C

25. Find T' and net rate of flow of heat $\left(\frac{dQ}{dt}\right)$ through rod '1' for the combination of cylindrical rods shown in the figure. The first rod has length L, thermal conductivity K, cross-sectional area A, and its left end is maintained at 120°C. It is connected to three parallel rods, each of length L and cross-sectional area A, having thermal conductivities $K/3$, $K/6$ (with cross-sectional area 2A), and K/4 respectively, whose right ends are maintained at 0°C.



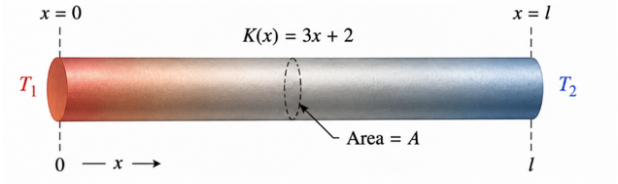
A) $T' = 48^\circ\text{C}, \frac{dQ}{dt} = \frac{72KA}{L}$ B) $T' = 60^\circ\text{C}, \frac{dQ}{dt} = \frac{60KA}{L}$
C) $T' = 50^\circ\text{C}, \frac{dQ}{dt} = \frac{70KA}{L}$ D) $T' = 55^\circ\text{C}, \frac{dQ}{dt} = \frac{65KA}{L}$

26. Find T' and net rate of flow of heat $\left(\frac{dQ}{dt}\right)$ through rod '1' for the combination of cylindrical rods. The first rod has length L, thermal conductivity 2K, cross-sectional area A, and its left end is maintained at 100°C. It is connected to three parallel rods, each of length L and cross-sectional area A, having thermal conductivities $K/2$, $K/4$ (with cross-sectional area 2A), and K respectively, whose right ends are maintained at 0°C.



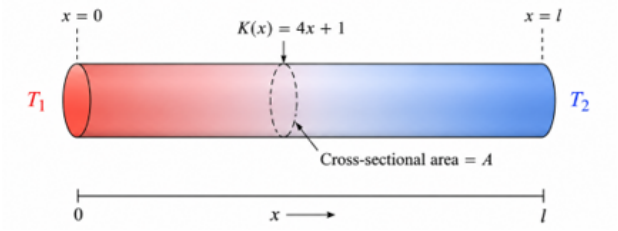
A) $T' = 40^\circ\text{C}, \frac{dQ}{dt} = \frac{120KA}{L}$ B) $T' = 50^\circ\text{C}, \frac{dQ}{dt} = \frac{100KA}{L}$
C) $T' = 60^\circ\text{C}, \frac{dQ}{dt} = \frac{80KA}{L}$ D) $T' = 30^\circ\text{C}, \frac{dQ}{dt} = \frac{140KA}{L}$

27. Find the thermal resistance R_{AB} for a rod of cross-sectional area A and length l where the thermal conductivity varies with length x as $K = 3x + 2$ from $x = 0$ to $x = l$.



A) $\frac{1}{3A}\ln\left(\frac{3l+2}{2}\right)$ B) $\frac{1}{2A}\ln\left(\frac{3l+2}{3}\right)$
C) $\frac{1}{3A}\ln(3l+2)$ D) $\frac{3}{A}\ln\left(\frac{3l+2}{2}\right)$

28. Find the thermal resistance R_{AB} for a rod of cross-sectional area A and length l where the thermal conductivity varies with length x as $K = 4x + 1$ from $x = 0$ to $x = l$.



A) $\frac{1}{A}\ln(4l+1)$ B) $\frac{1}{4A}\ln(4l+1)$
C) $\frac{4}{A}\ln(4l+1)$ D) $\frac{1}{4A}\ln\left(\frac{4l+1}{4}\right)$

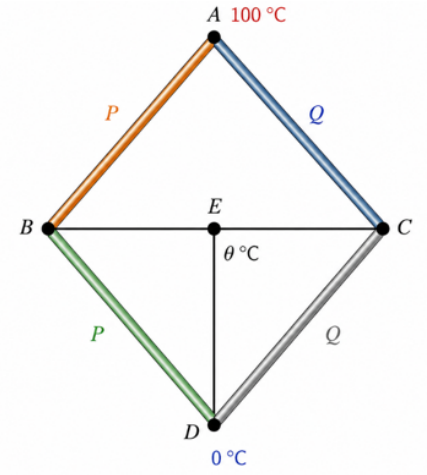
29. Two identical metal rods of thermal conductivities K_1 and K_2 respectively are connected in parallel (side-by-side) between two heat reservoirs. If both rods have the same length l and cross-sectional area A, the effective thermal conductivity of the combination is:

A) $\frac{K_1+K_2}{2}$ B) $\frac{2K_1K_2}{K_1+K_2}$
C) $\sqrt{K_1K_2}$ D) $K_1 + K_2$

30. Two metal rods of the same cross-sectional area A but different lengths l and 2l having thermal conductivities K_1 and K_2 respectively are connected in series. The effective thermal conductivity K_{eq} of the combination is:

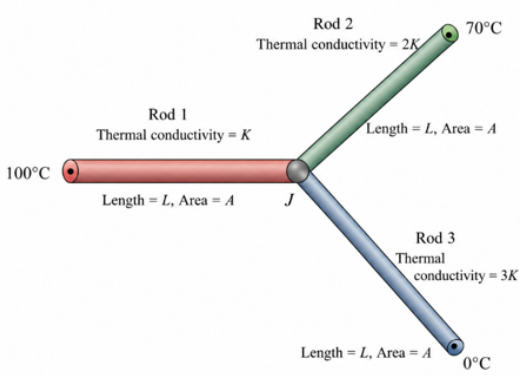
A) $\frac{3K_1K_2}{2K_1+K_2}$ B) $\frac{3K_1K_2}{K_1+2K_2}$
C) $\frac{2K_1K_2}{K_1+K_2}$ D) $\frac{K_1+2K_2}{3}$

31. Three rods of material P and three rods of material Q are connected in the same network configuration as the figure above (a Wheatstone bridge arrangement with an input rod). All rods are identical in length and cross-sectional area. If the end A is maintained at 100°C and the junction E at 0°C, calculate the temperature of the junction B. The thermal conductivity of P is $400\ \text{W m}^{-1}\ ^\circ\text{C}^{-1}$ and that of Q is $200\ \text{W m}^{-1}\ ^\circ\text{C}^{-1}$. (Note: Rods AB, BC, BD are material P; Rods CE, DE, CD are material Q).



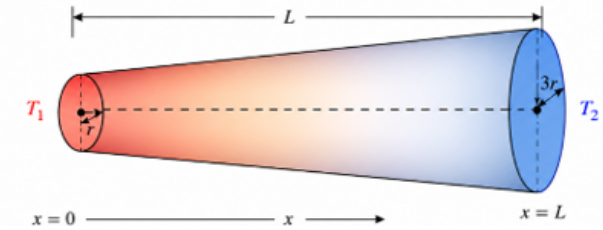
A) 40°C B) 50°C
C) 60°C D) 70°C

32. Three cylindrical rods of identical length L and cross-sectional area A are joined at a common junction. The first rod has thermal conductivity K and its free end is maintained at 100°C. The second rod has thermal conductivity 2K and its free end is maintained at 70°C. The third rod has thermal conductivity 3K and its free end is maintained at 0°C. Find the steady-state temperature at the junction.



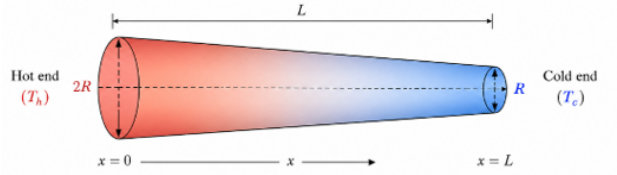
A) 30°C B) 40°C
C) 50°C D) 60°C

33. Find the rate of heat flow through a tapered rod of length L with end radii r and 3r. The temperatures at the ends are T_1 and T_2 ($T_1 > T_2$) respectively. Thermal conductivity of the material is K.



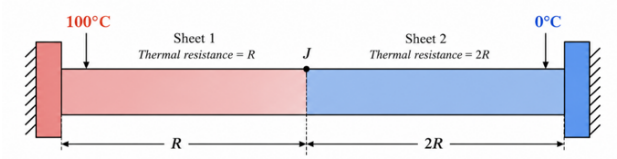
A) $\frac{3\pi Kr^2(T_1-T_2)}{L}$ B) $\frac{4\pi Kr^2(T_1-T_2)}{L}$
C) $\frac{2\pi Kr^2(T_1-T_2)}{L}$ D) $\frac{\pi Kr^2(T_1-T_2)}{L}$

34. A rod of length L tapers uniformly from a radius of 2R at the hot end (T_h) to a radius of R at the cold end (T_c). If the thermal conductivity is K, find the rate of heat flow.



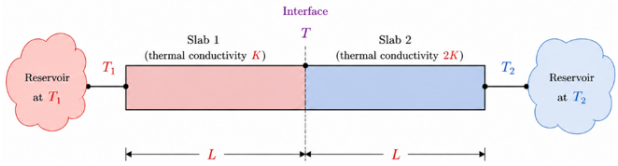
A) $\frac{2\pi KR^2(T_h-T_c)}{L}$ B) $\frac{\pi KR^2(T_h-T_c)}{L}$
C) $\frac{3\pi KR^2(T_h-T_c)}{L}$ D) $\frac{4\pi KR^2(T_h-T_c)}{L}$

35. Two insulating sheets having thermal resistances R and 2R are connected in series. The temperature at the free end of the sheet with resistance R is maintained at 100°C and the temperature at the free end of the sheet with resistance 2R is maintained at 0°C. Find the temperature at the common junction.



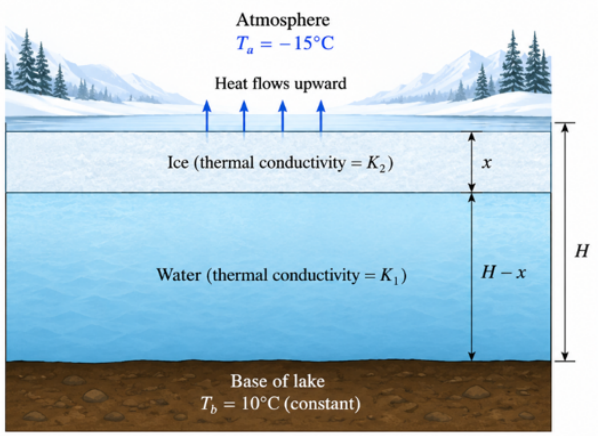
A) 33.3°C B) 66.7°C
C) 50°C D) 25°C

36. Two slabs of equal thickness L and equal cross-sectional area A are joined in series. The first slab has thermal conductivity K and the second has thermal conductivity 2K. If the outer surfaces are maintained at temperatures T_1 and T_2 ($T_1 > T_2$), find the temperature T at the interface. Assume the slab with thermal conductivity K is in contact with the reservoir at T_1.



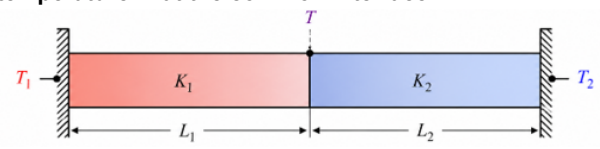
A) $\frac{T_1+2T_2}{3}$ B) $\frac{2T_1+T_2}{3}$
C) $\frac{T_1+T_2}{2}$ D) $\frac{2T_1+2T_2}{3}$

37. Consider a lake of depth H. The temperature of the base is constant at 10°C and the atmosphere temperature is -15°C. Thermal conductivity of water is K_1 and for ice is K_2. Find the expression for the maximum thickness of ice (x) that can be formed theoretically.



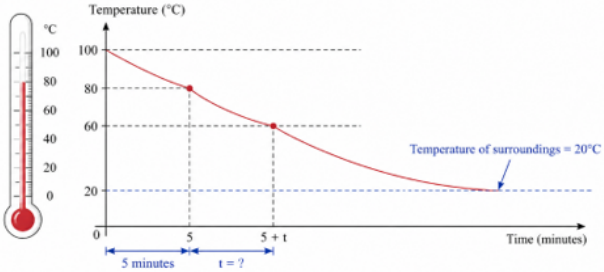
A) $\frac{2K_1H}{2K_1+3K_2}$
B) $\frac{3K_2H}{2K_1+3K_2}$
C) $\frac{3K_1H}{3K_1+2K_2}$
D) $\frac{2K_2H}{3K_1+2K_2}$

38. Two slabs of thermal conductivities K_1 and K_2 and thicknesses L_1 and L_2 respectively are joined together in series. The outer surfaces are maintained at temperatures T_1 and T_2 ($T_1 > T_2$). Find the temperature T at the common interface.



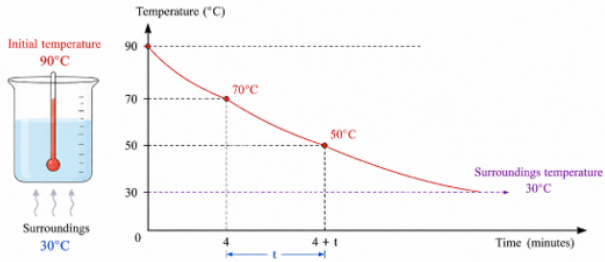
A) $\frac{K_1L_1T_1+K_2L_2T_2}{K_1L_1+K_2L_2}$
B) $\frac{K_1L_2T_1+K_2L_1T_2}{K_1L_2+K_2L_1}$
C) $\frac{K_1L_2T_2+K_2L_1T_1}{K_1L_2+K_2L_1}$
D) $\frac{K_1L_1T_2+K_2L_2T_1}{K_1L_1+K_2L_2}$

39. A body takes 5 minutes to cool from 100°C to 80°C. If the temperature of the surroundings is 20°C, the time taken by it to cool from 80°C to 60°C is:



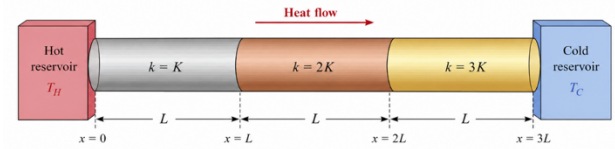
A) 6 minutes
B) 7 minutes
C) 8 minutes
D) 9 minutes

40. A liquid takes 4 minutes to cool from 90°C to 70°C. If the temperature of the surroundings is 30°C, the time taken by it to cool from 70°C to 50°C is:



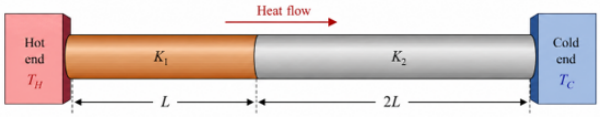
A) $\frac{20}{3}$ minutes
B) $\frac{10}{3}$ minutes
C) 5 minutes
D) 6 minutes

41. A composite rod is made of three rods of equal length L and equal cross-sectional area A connected in series as shown in the figure. The thermal conductivities of the materials of the rods are K, 2K, and 3K respectively. The ends of the composite rod are maintained at constant temperatures. Assuming no heat loss from the sides, the effective thermal conductivity of the bar is:



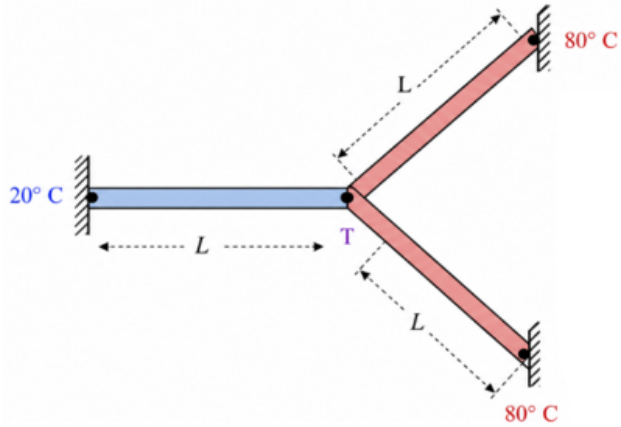
A) $\frac{18K}{11}$
B) $\frac{11K}{18}$
C) $\frac{6K}{5}$
D) $\frac{5K}{6}$

42. Two metal rods of the same cross-sectional area A but different lengths L and 2L having thermal conductivities K_1 and K_2 respectively are connected in series. The effective thermal conductivity K_{eq} of the combination is:



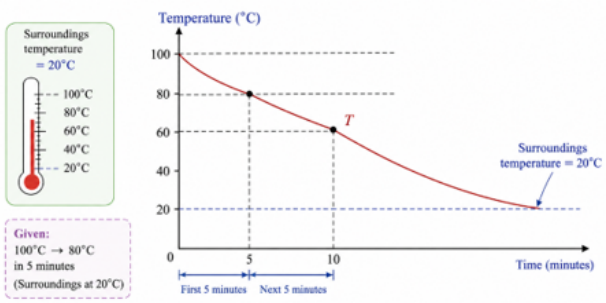
A) A. $\frac{K_1+2K_2}{3}$
B) $\frac{3K_1K_2}{K_1+2K_2}$
C) $\frac{2K_1K_2}{K_1+K_2}$
D) $\frac{3K_1K_2}{2K_1+K_2}$

43. Three rods made of the same material and having the same cross-section have been joined as shown in the figure (a Y-shape configuration). Each rod is of the same length. The left end is kept at 20°C and the two right ends are kept at 80°C respectively. The temperature of the junction of the three rods will be:



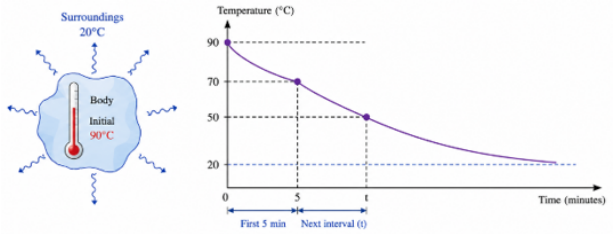
A) 50°C
B) 60°C
C) 40°C
D) 70°C

44. A body cools in 5 minutes from $100^\circ C$ to $80^\circ C$. The temperature of the surrounding is $20^\circ C$. The temperature of the body after the next 5 minutes will be:



A) $60^\circ C$ **B)** $65^\circ C$
C) $70^\circ C$ **D)** $75^\circ C$

45. A body cools from $90^\circ C$ to $70^\circ C$ in 5 minutes. The temperature of the surrounding is $20^\circ C$. The time it takes to cool from $70^\circ C$ to $50^\circ C$ is:



A) 450 s **B)** $15/2$ s
C) 400 s **D)** 500 s

Chemistry

46. The alkane that can be oxidized to the corresponding alcohol by $KMnO_4$ as per the equation:

is when:

A) $R_1 = H; R_2 = H; R_3 = H$ **B)** $R_1 = CH_3; R_2 = CH_3; R_3 = CH_3$
C) $R_1 = CH_3; R_2 = H; R_3 = H$ **D)** $R_1 = CH_3; R_2 = CH_3; R_3 = H$

47. Weight (g) of two moles of the organic compound, which is obtained by heating sodium ethanoate with sodium hydroxide in presence of calcium oxide is:

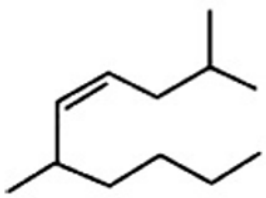
A) 32 **B)** 30
C) 18 **D)** 16

48. The decreasing order of boiling points of the following alkanes is: (a) heptane (b) butane (c) 2-methylbutane (d) 2-methylpropane (e) hexane Choose the correct answer from the options

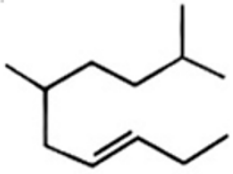
A) $(a) > (e) > (c) > (b) > (d)$ **B)** $(a) > (c) > (e) > (d) > (b)$
C) $(c) > (d) > (a) > (e) > (b)$ **D)** $(a) > (e) > (b) > (c) > (d)$

49. The correct structure of 2, 6-Dimethyl-dec-4-ene is:

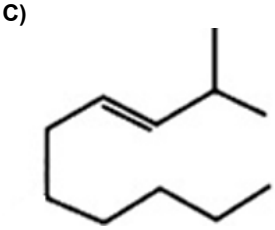
A)



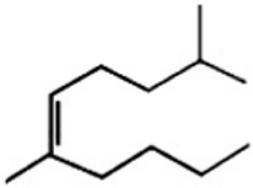
B)



C)



D)



50. The alkane that gives only one monochloro product on chlorination with Cl_2 in presence of diffused sunlight is:

A) 2,2-dimethylbutane **B)** neopentane
C) n-pentane **D)** isopentane

51. Hydrocarbon (A) reacts with bromine by substitution to form an alkyl bromide which by Wurtz reaction is converted to gaseous hydrocarbon containing less than four carbon atoms. (A) is:

A) $CH \equiv CH$ **B)** $CH_2 = CH_2$
C) $CH_3 - CH_3$ **D)** CH_4

52. The correct statement regarding the comparison of staggered and eclipsed conformations of ethane, is

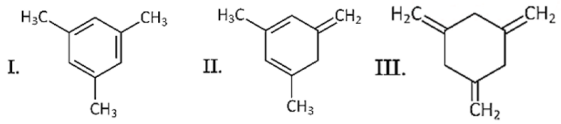
A) the eclipsed conformation of ethane is more stable than staggered conformation even though the eclipsed conformation has torsional strain

B) the staggered conformation of ethane is more stable than eclipsed conformation, because staggered conformation has no torsional strain

C) the staggered conformation of ethane is less stable than eclipsed conformation, because staggered conformation has torsional strain

D) the eclipsed conformation of ethane is more stable than staggered conformation, because eclipsed conformation has no torsional strain.

53. The enthalpy of hydrogenation of these compounds will be in the order as



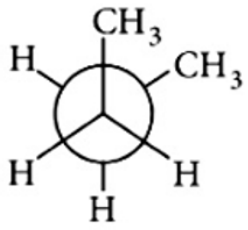
A) $II > III > I$ **B)** $II > I > III$
C) $I > II > III$ **D)** $III > II > I$

54. Liquid hydrocarbons can be converted to a mixture of gaseous hydrocarbons by:

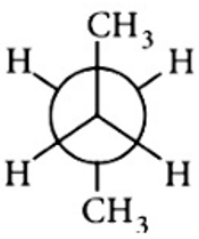
A) oxidation **B)** cracking
C) distillation under reduced pressure **D)** hydrolysis

55. In the following, the most stable conformation of n-butane is:

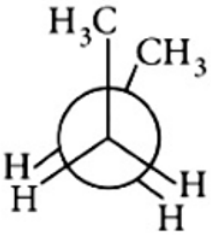
A)



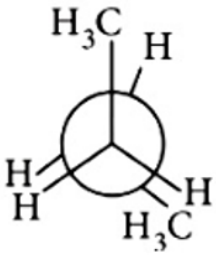
B)



C)

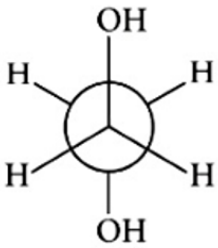


D)

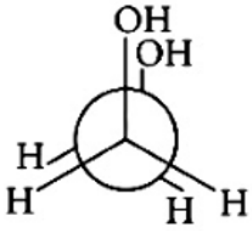


56. Which of the following conformers for ethylene glycol is most stable?

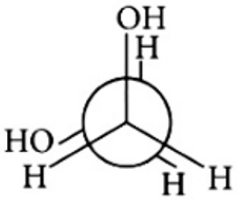
A)



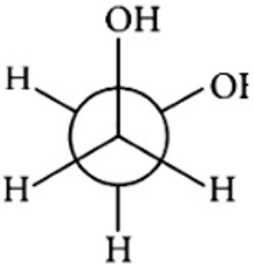
B)



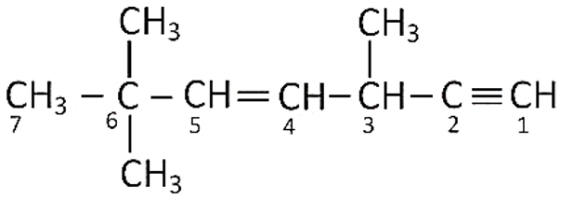
C)



D)



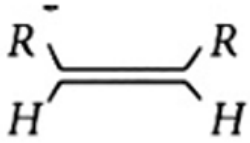
57. The state of hybridisation of C_2, C_3, C_5 and C_6 of the hydrocarbon is in the following sequence



A) sp^3, sp^2, sp^2 and sp
B) sp, sp^2, sp^2 and sp^3
C) sp, sp^2, sp^3 and sp^2
D) sp, sp^3, sp^2 and sp^3

58. Which one of the following alkenes will react faster with H_2 under catalytic hydrogenation conditions? ($R =$ alkyl substituent)

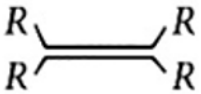
A)



B)

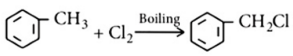
C)

D)

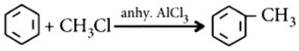


59. Which one of the following is a free-radical substitution reaction?

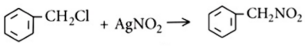
A)



B)



C)



D)

60. Dihedral angle in staggered form of ethane is:

A) 0°
B) 120°
C) 60°
D) 180°

61. Which of the following reaction is expected to readily give a hydrocarbon product in good yields?

A) $CH_3CH_3 + \xrightarrow[h\nu]{Cl_2}$
B) $(CH_3)_2CHCl + C_2H_5OH \rightarrow$
C) $RCOOK \xrightarrow[Oxidation]{Electrolysis}$
D) $RCOOAg + I_2 \rightarrow$

62. In the commercial gasolines, the type of hydrocarbons which are more desirable is:

A) linear unsaturated hydrocarbon
B) toluene
C) branched hydrocarbon
D) straight-chain hydrocarbon

63. The most stable conformation of n-butane is:

A) gauche
B) staggered
C) skew boat
D) eclipsed

64. Reactivity of hydrogen atoms attached to different carbon atoms in alkanes has the order:

A) tertiary > primary > secondary
B) primary > secondary > tertiary
C) both (a) and (b)
D) tertiary > secondary > primary

65. Number of alkanes obtained on electrolysis of a mixture of CH_3COONa and C_2H_5COONa is:

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

66. Number of isomeric products formed by monochlorination of 2-methylbutane in presence of sunlight is:

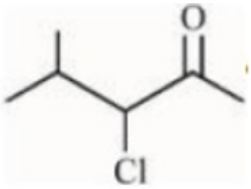
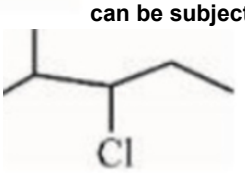
A) 2
B) 4
C) 5
D) 6

67. Number of bromo derivatives obtained on treating ethane with excess of Br_2 in diffused sunlight is:

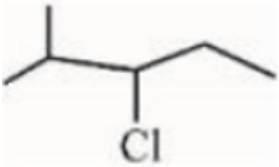
A) 6 **B)** 8

C) 9 **D)** 10

68. Given below are two statements, one is labelled as Assertion A and the other is labelled as Reason R.

Assertion (A):  **can be subjected to Wolff–Kishner reduction to** 

Reason (R): Wolff–Kishner reduction is used to convert the given haloalkane into the corresponding alkane.

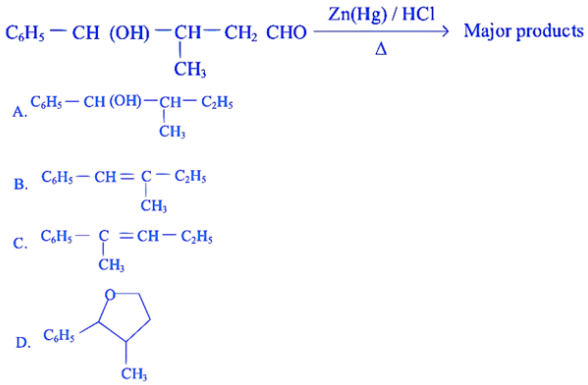


In the light of the above statements, choose the correct answer.

A) Both A and R are true and R is the correct explanation of A. **B)** A is true but R is false.

C) Both A and R are true but R is NOT the correct explanation of A. **D)** A is false but R is true.

69. The major product formed in the following reaction is:



Choose the correct answer from the options given below:

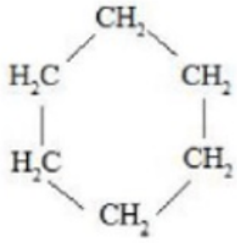
A) C only **B)** A only

C) B only **D)** D only

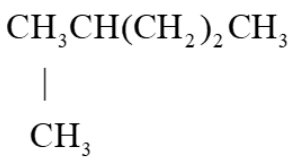
70. In the following reaction, 'X' is the major product.

Reaction: $CH_3(CH_2)_4CH_3 \xrightarrow[\text{HCl}]{\text{Anhy. } AlCl_3,\ \Delta}$ **X major product**

A) $CH_3(CH_2)_4CH_2Cl$ **B)**



C) $Cl-CH_2-(CH_2)_4-CH_2-Cl$ **D)**

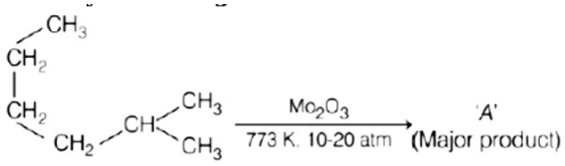


71. Total number of isomers (including stereoisomers) obtained on monochlorination of methylcyclohexane is:

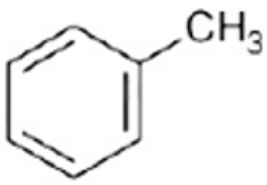
A) 10 **B)** 12

C) 8 **D)** 14

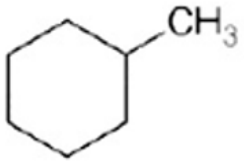
72. Identify A in the given chemical reaction:



A) 

B) 

C) 

D) 

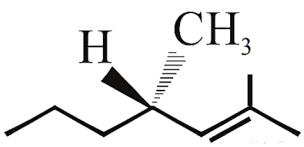
73. Which of the following reagent is used for the following reaction? $CH_3CH_2CH_3 \rightarrow CH_3CH_2CHO$

A) Manganese acetate **B)** Copper at high temperature and pressure

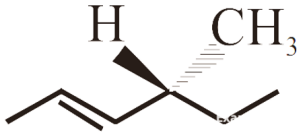
C) Molybdenum oxide **D)** Potassium permanganate

74. Which of the following compounds produces an optically inactive compound on hydrogenation?

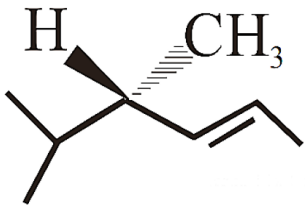
A)



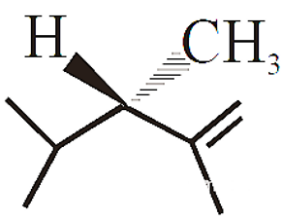
B)



C)



D)



75. Given below are two statements. Statement-I: 2-Methylbutane on oxidation with $\mathrm{KMnO_4}$ gives 2-methylbutan-2-ol. Statement-II: n-Alkanes can be easily oxidised to corresponding alcohols with $\mathrm{KMnO_4}$. Choose the correct option.

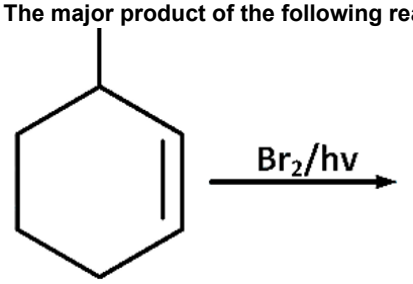
A) Both statements I and II are correct.

B) Both statements I and II are incorrect.

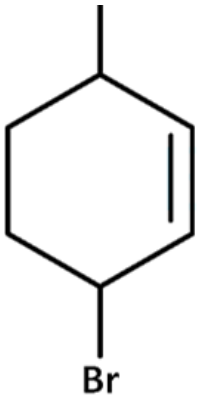
C) Statement I is correct but statement II is incorrect.

D) Statement I is incorrect but statement II is correct.

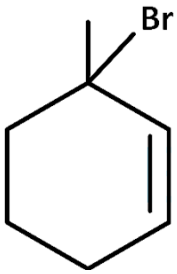
76. The major product of the following reaction is:



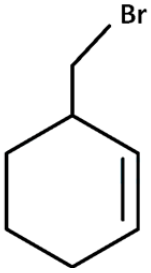
A)



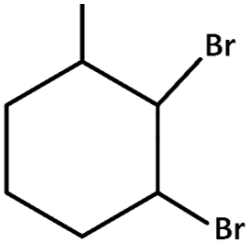
B)



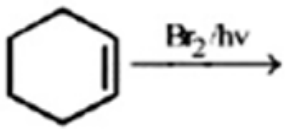
C)



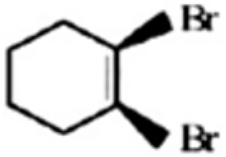
D)



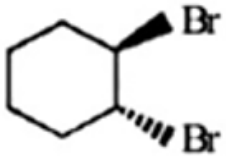
77. Bromination of cyclohexene under conditions given below yields:



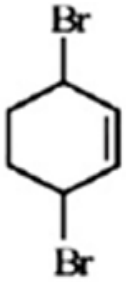
A)



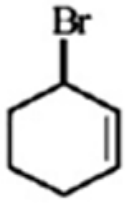
B)



C)



D)



78. Which branched chain isomer of the hydrocarbon with molecular mass 72u gives only one isomer of mono substituted alkyl halide?

A) Tertiary butyl chloride

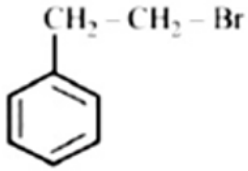
B) Neopentane

C) Isohexane

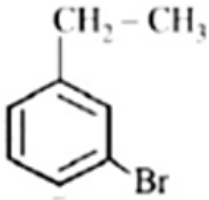
D) Neohexane

79. The product of the reaction between ethyl benzene and N-bromosuccinimide is:

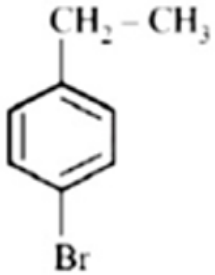
A)



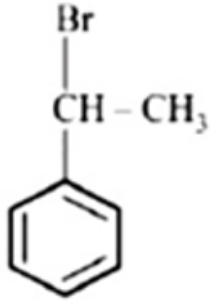
B)



C)



D)

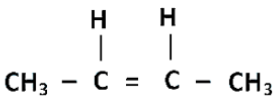


80. The treatment of CH_3MgX with $CH_3C \equiv C - H$ produces:

A) $CH_3 - CH = CH_2$

B) $CH_3 - C \equiv C - CH_3$

C)



D) CH_4

81. The major product obtained in the photo catalysed bromination of 2 methylbutane is:

A) 1-bromo-2-methylbutane **B)** 1-bromo-3-methylbutane
C) 2-bromo-3-methylbutane **D)** 2-bromo-2-methylbutane

82. Of the five isomeric hexanes, the isomer which can give two monochlorinated compounds is:

A) 2-methylpentane **B)** 2,2-dimethylbutane
C) 2,3-dimethylbutane **D)** n-hexane

83. Which one of the following has minimum boiling point?

A) 1-Butene **B)** 1-Butyne
C) n-Butane **D)** Isobutane

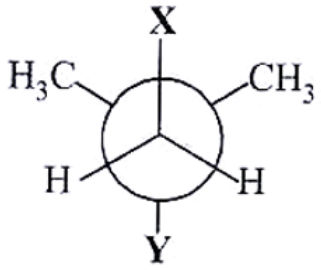
84. On mixing a certain alkane with chlorine and irradiating it with ultraviolet light, it forms only one monochloroalkane. This alkane could be:

A) pentane **B)** isopentane
C) neopentane **D)** propane

85. Butene-1 may be converted to butane by reaction with:

A) $Sn - HCl$ **B)** $Zn - Hg$
C) Pd/H_2 **D)** $Zn - HCl$

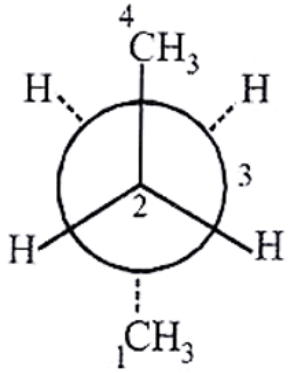
86. In the Newman projection for 2,2-dimethylbutane:



A) H **and** H **B)** H **and** C_2H_5 **C)** C_2H_5 **and** H **D)** CH_3 **and** CH_3

A) A and C **B)** B and D
C) A and B **D)** D and A

87. In the given conformation, if C_2 is rotated about $C_2 - C_3$ bond anticlockwise by an angle of 120° then the conformation obtained is:

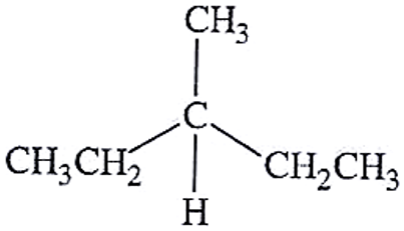


A) fully eclipsed conformation **B)** partially eclipsed conformation
C) gauche conformation **D)** staggered conformation

88. The compound with the highest boiling point is:

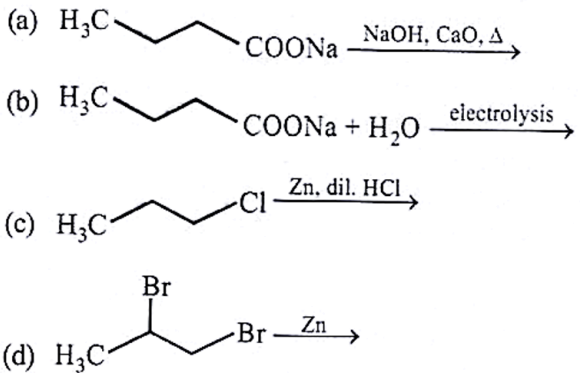
A) n-hexane **B)** n-pentane
C) 2,2-dimethylpropane **D)** 2-methylbutane

89. The maximum number of isomers (including stereoisomers) that are possible on monochlorination of the following compound is



A) 4 **B)** 6
C) 8 **D)** 10

90. Which of the following reactions produce(s) propane as a major product?



A) a and c **B)** b and d
C) a and b **D)** c and d

Botany

91. If a double-stranded DNA molecule contains a total of 1200 nucleotides and 350of them are Adenine, what is the total number of hydrogen bonds present in this DNA fragment?

A) 1200 **B)** 1450
C) 1550 **D)** 1650

92. Which of the following statements regarding the Hershey-Chase bacteriophage experiment is completely accurate?

A) $^{35}S$was used to label the viral DNA because sulfur is an inherent component of nucleotides.

B) $^{32}P$was detected inside the bacterial cells after centrifugation, proving that DNA entered the host.

C) Both ^{35}S and ^{32}P were recovered exclusively from the supernatant fraction.

D) The experiment provided the first biochemical proof of transforming principles using DNase enzymes.

93. Arrange the following structural units of eukaryotic DNA packaging in ascending order of their diameter/thickness: I. Chromatin fiber II. Nucleosome bead III. Metaphase chromosome IV. DNA double helix

A) IV $\rightarrow$ II $\rightarrow$ I $\rightarrow$ III **B)** IV $\rightarrow$ I $\rightarrow$ II $\rightarrow$ III
C) II $\rightarrow$ IV $\rightarrow$ I $\rightarrow$ III **D)** I $\rightarrow$ II $\rightarrow$ IV $\rightarrow$ III

94. Consider the following statements regarding chromatin types and select the correct option: Statement 1: Heterochromatin is densely packed, transcriptionally active, and stains intensely dark. Statement 2: Euchromatin is loosely coiled, transcriptionally active, and stains light.

A) Both Statement 1 and Statement 2 are correct.
B) Both Statement 1 and Statement 2 are incorrect.
C) Statement 1 is correct but Statement 2 is incorrect.
D) Statement 1 is incorrect but Statement 2 is correct.

95. In the Hershey and Chase experiment to determine whether DNA or protein is the genetic material, E. coli cells were infected with T2bacteriophages. Which of the following radioactive isotopes were specifically used to label viral DNA and viral proteins respectively?

A) 35S and 32P
B) 32P and 35S
C) 14C and 3H
D) 15N and 13C

96. If a double-stranded DNA molecule contains 20% Cytosine, what will be the percentage of Adenine in this DNA sample?

A) 20%
B) 30%
C) 40%
D) 60%

97. In a single nucleotide chain of DNA, consecutive nucleotides are held together by which of the following chemical bonds?

A) N-glycosidic linkage
B) Hydrogen bonds
C) 3'–5' Phosphodiester bonds
D) Peptide bonds

98. A typical nucleosome core particle contains an octamer of basic histone proteins wrapped around approximately how many base pairs of DNA?

A) $10\ \text{bp}$
B) $146\ \text{bp}$
C) $200\ \text{bp}$
D) $340\ \text{bp}$

99. During the biochemical characterisation of Frederick Griffith's transforming principle, Avery, MacLeod, and McCarty discovered that transformation was completely inhibited by which enzyme?

A) RNase
B) Protease
C) DNase
D) Lipase

100.
In a nucleotide molecule, which carbon atom of the pentose sugar forms a phosphoester bond with the phosphate group?

A) 1'Carbon
B) 2'Carbon
C) 3'Carbon
D) 5' Carbon

101.
Which of the following components forms the protruding, inward-facing part of the DNA double helix structure?

A) Phosphate groups
B) Deoxyribose sugars
C) Nitrogenous bases
D) Hydrogen bonds

102.
A linear double-stranded B-DNA molecule measures exactly $340\ \text{nanometers}$ in length. What is the total number of base pairs present in this DNA fragment?

A) $100\ \text{bp}$
B) $1000\ \text{bp}$
C) $3400\ \text{bp}$
D) $10,000\ \text{bp}$

103.
Which of the following equations is NOT a correct representation of Chargaff's rules for double-stranded DNA?

A) $A + G = T + C$
B) $(A + T)/(G + C) = 1$
C) $A/T = G/C = 1$
D) $A + C = T + G$

104.
In a B-DNA molecule, the stability of the double helix structure is primarily maintained by hydrogen bonds and which other major factor?

A) Covalent cross-linking between parallel strands
B) Stacking of base pairs over each other
C) Hydrophobic interactions in the outer sugar-phosphate backbone
D) Disulfide bridges between thymine molecules

105.
James Watson and Francis Crick proposed the double helix model of DNA in 1953. Their model was heavily based on the X-ray diffraction data produced by which scientist(s)?

A) Erwin Chargaff
B) Matthew Meselson and Franklin Stahl
C) Rosalind Franklin and Maurice Wilkins
D) Alfred Hershey and Martha Chase

106.
The concept of the "Central Dogma" in molecular biology, was originally proposed by:

A) James Watson
B) Francis Crick
C) Har Gobind Khorana
D) Marshall Nirenberg

107.
Assertion: A single polynucleotide chain of DNA has distinct 5' and 3' ends exhibiting molecular polarity.
Reason: The 5' end finishes with a free phosphate group, while the 3' end finishes with a free hydroxyl group.

A) Both Assertion and Reason are true, and Reason is the correct explanation of Assertion.
B) Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion.
C) Assertion is true, but Reason is false.
D) Assertion is false, but Reason is true.

108.

Assertion: Chargaff's rules are equally applicable to double-stranded DNA genomes as well as single-stranded RNA viral genomes. Reason: In all nucleic acids, Adenine always forms pair bonds exclusively with Thymine.

A) Both Assertion and Reason are true, and Reason is the correct explanation of Assertion.

B) Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion.

C) Assertion is true, but Reason is false.

D) Assertion is false, but Reason is true.

109.

If the double-stranded DNA content of a diploid human cell is roughly 6.6×10^9 bp, what is the approximate physical length of the DNA if stretched out from end to end?

A) 2.2 millimetres

B) 2.2 centimetres

C) 2.2 metres

D) 22 metres

110.

Match the organism/genetic material listed in Column-I with its correct number of nucleotides or base pairs in Column-II:

Column-I	Column-II
A. Bacteriophage $\phi \times 174$	**i.** 4.6×10^6 bp
B. Bacteriophage Lambda (λ)	**ii.** 3.3×10^9 bp
C. Escherichia coli	**iii.** 5386 nucleotides
D. Haploid human DNA content	**iv.** 48502 bp

A) A-iii, B-iv, C-i, D-ii

B) A-iii, B-i, C-iv, D-ii

C) A-iv, B-iii, C-i, D-ii

D) A-i, B-iv, C-iii, D-ii

111.

Histone proteins possess a net positive charge because they are heavily enriched with which of the following pairs of basic amino acid residues?

A) Valine and Isoleucine

B) Lysine and Arginine

C) Glutamate and Aspartate

D) Methionine and Cysteine

112.

In a typical eukaryotic nucleus, certain regions of chromatin are loosely packed, stain light, and are described as transcriptionally highly active. These regions are called:

A) Heterochromatin

B) Centromeres

C) Euchromatin

D) Nucleosome scaffolds

113.

Read the following statements regarding the DNA double helix structure and choose the correct option: 1. The pitch of the B-DNA helix is 3.4 nm. 2. The two chains run parallel to each other with a $5' \rightarrow 3'$ directionality. 3. The plane of one base pair stacks over the other in the double helix. 4. Adenine is linked to Thymine through three hydrogen bonds.

A) 1 and 2 are correct

B) 1 and 3 are correct

C) 2 and 4 are correct

D) 3 and 4 are correct

114.

The packaging of chromatin at a higher level (beyond nucleosomes) requires an additional set of proteins collectively referred to as:

A) Core Histones

B) DNA Polymerases

C) Non-histone Chromosomal (NHC) proteins

D) Ribonucleoproteins

115.

Assertion: DNA acts as a negatively charged molecule. Reason: The presence of a phosphate group (PO_4^{3-}) in the nucleotide structure imparts a net negative charge to the backbone.

A) Both Assertion and Reason are true, and Reason is the correct explanation of Assertion.

B) Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion.

C) Assertion is true, but Reason is false.

D) Assertion is false, but Reason is true.

116.

Which of the following sets of observations from Griffith's experiment is correctly matched?

A) Mice + Live S-strain $\rightarrow$ Mice Live

B) Mice + Heat-killed S-strain $\rightarrow$ Mice Die

C) Mice +Live R-strain + Heat-killed S-strain$\rightarrow$Mice Die

D) Mice + Live R-strain$\rightarrow$ Mice Die

117.

In the Hershey-Chase blender experiment, what was the primary biological reason for using radioactive Phosphorus (^{32}P) and radioactive Sulfur (^{35}S)?

A) Phosphorus is absent in DNA, while Sulfur is absent in proteins.

B) Phosphorus is a major component of DNA but is absent in proteins; Sulfur occurs in some proteins but is completely absent in DNA.

C) Both isotopes label the outer protein capsid shell exclusively.

D) These isotopes speed up the viral replication cycle inside the bacterial cytoplasm.

118.

After infecting E. coli with ^{35}S-labeled bacteriophages, followed by blending and centrifugation, where was the radioactivity detected?

A) Exclusively inside the bacterial cell pellet

B) In both the pellet and the supernatant equally

C) In the supernatant liquid containing empty viral ghost shells

D) Radioactivity was completely lost during blending

119.
Assertion: Griffith was able to successfully isolate and chemically identify the transforming principle in his 1928 experiment. Reason: Griffith concluded that the heat-killed S-strain transferred its polysaccharide capsule directly to live R-strain cells.

A) Both Assertion and Reason are true, and Reason is the correct explanation of Assertion.
B) Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion.
C) Assertion is true, but Reason is false.
D) Assertion is false, but Reason is true.

120.
Why does a DNA molecule wrap so tightly and specifically around a histone octamer?

A) Both DNA and histones are highly hydrophobic, forcing them together.
B) Negatively charged histones attract the positively charged nitrogenous bases of DNA.
C) Positively charged histones attract the negatively charged phosphate groups of DNA.
D) Covalent disulfide bridges lock the DNA backbone to the histone core.

121.
If a sample of eukaryotic chromatin contains exactly 10,000 nucleosomes, what is the approximate total length of the DNA in base pairs within this structure?

A) 2×10^5 bp
B) 2×10^6 bp
C) 1.46×10^6 bp
D) 2×10^4 bp

122.
When observed under an electron microscope, chromatin appears as a "beads-on-a-string" structure. What do the individual "beads" represent?

A) Nucleotides
B) Nucleosomes
C) Genes
D) Chromosomes

123.
In a polynucleotide chain, a nitrogenous base is linked to the pentose sugar via which specific linkage and at which carbon position?

A) Phosphoester linkage at the 5' carbon
B) N-glycosidic linkage at the 1' carbon
C) Phosphodiester linkage at the 3' carbon
D) Hydrogen bonding at the 2' carbon

124.
Select the correct option that accurately matches a chemical component with its structural description in a nucleic acid:

A) Adenosine — A purine nitrogenous base
B) Deoxycytidine — A pyrimidine nucleoside
C) Thymine — A purine base found in RNA
D) Guanylic acid — A purine nucleoside

125.
Two consecutive nucleotides are joined to create a chain via:

A) 5'–3' Phosphodiester bonds
B) 3'–5' Phosphoester bonds
C) 3'–5' Phosphodiester bonds
D) 1'–9' N-glycosidic bonds

126.
A single polynucleotide strand is said to have structural polarity. Why is one end specifically designated as the 3' end?

A) It has a free nitrogenous base attached to the 3' carbon.
B) It features a free phosphate group attached to the 3' carbon.
C) It possesses a pentose sugar with a free -OH group at the 3' carbon position.
D) It marks the site where RNA Polymerase terminates transcription.

127.
Structurally, a molecule of RNA differs from a molecule of DNA by featuring a hydroxyl group (-OH) at which carbon position of its pentose sugar?

A) 1' carbon
B) 2' carbon
C) 3' carbon
D) 5' carbon

128.
Assertion: A single-stranded polynucleotide of RNA can never exhibit a 1:1 ratio of Purines to Pyrimidines. Reason: Chargaff's rules of base equivalence apply strictly to double-stranded DNA molecules.

A) Both Assertion and Reason are true, and Reason is the correct explanation of Assertion.
B) Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion.
C) Assertion is true, but Reason is false.
D) Assertion is false, but Reason is true.

129.
When Griffith injected a mixture of heat-killed S-strain and live R-strain bacteria into mice, the mice died. What did he isolate from the blood of these dead mice?

A) Only dead R-strain bacteria
B) Only heat-killed S-strain bacteria
C) Living S-strain bacteria
D) Completely mutated viral particles

130.
Assertion: Griffith isolated the pure chemical structure of the transforming principle in 1928. Reason: Griffith discovered that a chemical substance from dead virulent cells can alter the phenotype of living non-virulent cells.

A) Both Assertion and Reason are true, and Reason is the correct explanation of Assertion.
B) Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion.
C) Assertion is true, but Reason is false.
D) Assertion is false, but Reason is true.

131.
Nucleic acid was first isolated from the nucleus of pus cells by Friedrich Miescher in 1869. What name did he originally assign to this acidic substance?

A) DNA
B) Nuclein
C) Chromatin
D) RNA

132.
Select the correct combination of a nitrogenous base and its corresponding ribonucleoside:

A) Adenine — Adenylic acid
B) Thymine — Deoxythymidine
C) Uracil — Uridine
D) Guanine — Guanosine triphosphate

133.
Which structural feature of the polynucleotide chain allows it to possess an inherent biochemical directionality or molecular polarity?

A) The variable sequence of nitrogenous bases projecting inwards.
B) A free phosphate group at one end (5' end) and a free hydroxyl group at the other end (3' end).
C) The ability to form standard double hydrogen bonds between specific purines.
D) The presence of basic histones wrapping around the phosphate exterior.

134.
Who proposed the iconic double helix model of DNA?

A) Maurice Wilkins and Rosalind Franklin
B) James Watson and Francis Crick
C) Erwin Chargaff and Friedrich Miescher
D) Avery, MacLeod, and McCarty

135.
Which group of scientists provided the first definitive chemical characterization proving that the "transforming principle" discovered in bacteria was specifically DNA?

A) Hershey and Chase
B) Watson and Crick
C) Avery, MacLeod, and McCarty
D) Meselson and Stahl

Zoology

136.
Coordination is considered as an important process in an animal body because

A) it helps to maintain homeostasis.
B) it enables different organs to interact and function efficiently.
C) it ensures the normal functioning of vital organs.
D) all of these

137.
Which of the following is structural and functional unit of nervous system?

A) Axon
B) neuron
C) dendrite
D) nephron

138.
The neural system within human body provide

A) chemical coordination through hormones
B) point to point connections
C) electrical coordination
D) both B and C

139.
Which of the following is not the part of CNS?

A) brain
B) spinal cord
C) cranial nerves
D) none

140.
Neurons are the specialised cells of nervous system in

A) humans only
B) all vertebrates only
C) mostly all animals including vertebrates and invertebrates
D) both A and B

141.
The largest part of the brain is

A) cerebrum
B) cerebellum
C) medulla oblongata
D) pons

142.
The neurons in all animals are capable of i. detecting various stimuli in environment ii. receiving and transmitting stimuli to CNS iii. processing various internal and external stimuli Select the most appropriate option.

A) I, II and III are correct
B) Only II is correct
C) II and III are correct
D) I and II are correct

143.
Which part of the brain controls involuntary breathing?

A) diencephalon
B) hypothalamus
C) medulla oblongata
D) cerebellum

144.
The nervous system of Hydra is composed of

A) brain and peripheral nerves
B) network of neurons
C) ganglia and plexuses
D) brain and nerve nets

145.
The part which connects cerebral hemispheres is

A) corpus albicans
B) corpus callosum
C) corpus striatum
D) corpora quadrigemina

146.
Why is nervous system of insects considered better organised as compared to Hydra and Planaria?

A) Insects possess brain, ganglia and neural tissues.
B) Hydra and planaria do not possess nervous system at all.
C) Hydra possess the least developed nerve cord while insects contain highly developed ventral nerve cord.
D) Planaria do not possess brain while a rudimentary brain is found in insects.

147.
Meninges surround the

A) brain
B) spinal cord
C) none
D) both A & B

148.
The ganglia found in insects are

A) masses of fat bodies
B) aggregated neurons which gives off nerves
C) point where numerous neurons meet
D) degenerated neuron masses

149.
The outermost covering protecting the brain is

A) duramater
B) piamater
C) graymater
D) pericardium

150.
The two major divisions of human neural system are

A) CNS and brain
B) ANS and PNS
C) CNS and PNS
D) Brain and spinal cord

151.
Chemical transmission of nerve impulse from one neuron to another or from a neuron to muscle is by

A) cholesterol
B) cholecystokinin
C) ATP
D) acetylcholine

152.
The major structural component of peripheral nervous system is

A) spinal cord
B) nerves
C) visceral organs
D) all of these

153.
During the conduction of an impulse, electrical potential on inside axolemma changes from

A) negative to positive and remains positive
B) positive to negative and again positive
C) negative to positive and again negative
D) positive to negative and remains negative

154.
Action potential of a nerve cell is created by

A) Ca^{2+} efflux
B) K^{+}influx
C) Na^{+} influx
D) Cl^{-} influx

155.
The two divisions of autonomic nervous system are

A) antagonistic to each other
B) complementary to each other
C) highly reduced and non-functional in humans
D) functional as a single system in humans

156.
At the time of conduction of nerve impulse, the repolarisation occurs with the

A) influx of K^{+} ions
B) efflux of Na^{+} ions
C) efflux of K^{+} ions
D) Efflux of both Na^{+} and K^{+}ions

157.
Visceral nervous system within human body A) is the division of peripheral nervous system. B) is the division of central nervous system. C) consists of nerve fibres and ganglia. D) carry impulses from one visceral organ to another. Which of the following option is the most appropriate?

A) 1 and 2 are correct
B) 2 and 4 are correct
C) 1, 3 and 4 are correct
D) 2, 3, 4 are correct

158.
Nodes of Ranvier are found in

A) axon
B) sperm
C) muscle fibre
D) neuron

159.
Which component of neural system would control the functioning of heart and stomach?

A) Somatic neural system.
B) Only sympathetic nervous system.
C) Only parasympathetic nervous system.
D) Both sympathetic and parasympathetic nervous system.

160.
A bipolar neuron has

A) 1 dendrite and 2 axons
B) 2 axons and 2 dendrites
C) 1 dendrite and 1 axon
D) 2 dendrites and 1 axon

161.
The basic structural components of a neuron are

A) cell body and axon
B) cell body and dendrites
C) axon and dendrites
D) cell body, axon and dendrites

162.
Schwann cells are present on which part of a neuronare

A) axon
B) cell body
C) dendrites
D) all of above

163.
Neurons differ from a typical cell because of the presence of are

A) nucleolus
B) Nissl's granules
C) protein synthesizing machinery
D) microfilaments

164.
The junction between axon of a neuron and the dendrite of next is called? are

A) joint
B) bridge
C) synapse
D) junction

165.
Nissl bodies are mainly composed of are

A) proteins and lipids
B) DNA and RNA
C) nucleic acids and SER
D) free ribosomes and RER

166.
The dendrites of a neuron are are

A) long, unbranched processes associated with cell body and axon
B) short, highly branched processes of cell body
C) long and branched processes of cell body
D) short, unbranched processes of cell body and axon

167.
In a resting state, the ion gradient across the axon membrane is maintained by theare

A) active transport of $3Na^{+}$ outward and $2K^{+}$ inward.
B) active transport of $3Na^{+}$ inward and $2K^{+}$ outward
C) active transport of $3K^{+}$ outward and $2Na^{+}$ inward
D) active transport of $3K^{+}$ inward and $2Na^{+}$ outward

168.
The only similarity between the cell body and dendrites is the presence of

A) golgi bodies
B) Nissl's granules
C) nucleus
D) mitochondria

169.
The hypothalamus controls theare

A) body temperature
B) urge for eating
C) urge for drinking
D) all of above

170.
While studying the structural details of a neuron, how would you distinguish an axon from a dendrite? are

A) Axon is a long process whose distal end is branched.
B) Dendrites are branched irregularly while the axon gives off long branches alternatively.
C) Axon contains Nissl's granules while dendrites do not.
D) Axons are numerous while each neuron contain only two dendrites.

171.
Which of the following is not the component of limbic system?are

A) outer part of cerebral hemisphere
B) inner part of cerebral hemisphere
C) amygdala
D) hippocampus

172.
Synaptic knob (1) is terminal bulb-like structure of dendrites and axons. (2) contains neurotransmitter – filled vesicles. (3) is a protoplasmic extension of cell body. Which of the following option is most appropriate?are

A) 1 and 2 are correct
B) Only 3 is correct
C) Only 2 is correct
D) 1 and 3 are correct

173.
Somatic neural system transmits impulse to are

A) Skeletal muscles
B) Involuntary organs
C) Smooth muscles
D) All of these

174.
On what basis, neurons are classified as unipolar, bipolar or multipolar? are

A) Transmission of impulse
B) Number of axons and dendrites
C) Sensory or motor nature
D) Number of nucleus within cell body

175.
Nissl's granules are found in all except are

A) Cyton
B) Axon
C) Dendrites
D) Cell body

176.
Which of the following system relays impulse from CNS to skeletal muscles? are

A) Somatic neural system
B) Sympathetic neural system
C) Parasympathetic neural system
D) Autonomic neural system

177.
A multipolar neuron contains multiple are

A) dendrites
B) axons
C) axons and dendrites
D) synaptic bulbs

178.
Dendrites transmit impulse ____ cell body and axon transmits impulse ____ cell body. are

A) towards, away from
B) away, towards
C) towards, towards
D) away, away

179.
The myelin sheath around the axons is formed by are

A) osteocytes and astrocytes
B) astrocytes and Schwann cells
C) Schwann cells and oligodendrocytes
D) oligodendrocytes and osteoclasts

180.
Right and left cerebral hemispheres are connected viaare

A) Corpus striatum
B) Corpus callosum
C) Thalamus
D) Hippocampus

ANSWER KEY

Physics

1.	**1**	13.	**3**	25.	**2**	37.	**2**
2.	**1**	14.	**2**	26.	**1**	38.	**2**
3.	**2**	15.	**3**	27.	**1**	39.	**2**
4.	**3**	16.	**1**	28.	**2**	40.	**1**
5.	**1**	17.	**3**	29.	**1**	41.	**1**
6.	**3**	18.	**2**	30.	**1**	42.	**4**
7.	**3**	19.	**1**	31.	**3**	43.	**2**
8.	**4**	20.	**1**	32.	**2**	44.	**2**
9.	**2**	21.	**2**	33.	**1**	45.	**1**
10.	**3**	22.	**1**	34.	**1**		
11.	**2**	23.	**3**	35.	**2**		
12.	**1**	24.	**2**	36.	**1**		

Chemistry

46.	**2**	58.	**1**	70.	**4**	82.	**3**
47.	**1**	59.	**1**	71.	**2**	83.	**4**
48.	**1**	60.	**3**	72.	**2**	84.	**3**
49.	**1**	61.	**3**	73.	**3**	85.	**3**
50.	**2**	62.	**3**	74.	**4**	86.	**2**
51.	**4**	63.	**2**	75.	**3**	87.	**3**
52.	**2**	64.	**4**	76.	**2**	88.	**1**
53.	**4**	65.	**3**	77.	**4**	89.	**3**
54.	**2**	66.	**4**	78.	**2**	90.	**1**
55.	**2**	67.	**3**	79.	**4**		
56.	**4**	68.	**4**	80.	**3**		
57.	**4**	69.	**3**	81.	**4**		

Botany

91.	**3**	103.	**2**	115.	**1**	127.	**2**
92.	**2**	104.	**2**	116.	**3**	128.	**4**
93.	**1**	105.	**3**	117.	**2**	129.	**3**
94.	**4**	106.	**2**	118.	**3**	130.	**4**
95.	**2**	107.	**1**	119.	**4**	131.	**2**
96.	**2**	108.	**4**	120.	**3**	132.	**3**
97.	**3**	109.	**3**	121.	**2**	133.	**2**
98.	**3**	110.	**1**	122.	**2**	134.	**2**
99.	**3**	111.	**2**	123.	**2**	135.	**3**
100.	**4**	112.	**3**	124.	**2**		
101.	**3**	113.	**2**	125.	**3**		
102.	**2**	114.	**3**	126.	**3**		

Zoology

136.	**4**	140.	**3**	144.	**2**	148.	**2**
137.	**2**	141.	**1**	145.	**2**	149.	**1**
138.	**4**	142.	**2**	146.	**1**	150.	**3**
139.	**3**	143.	**3**	147.	**4**	151.	**4**

152.	**2**	160.	**3**	168.	**2**	176.	**1**
153.	**3**	161.	**4**	169.	**4**	177.	**1**
154.	**3**	162.	**1**	170.	**1**	178.	**1**
155.	**1**	163.	**2**	171.	**1**	179.	**3**
156.	**3**	164.	**3**	172.	**3**	180.	**2**
157.	**1**	165.	**4**	173.	**1**		
158.	**1**	166.	**2**	174.	**2**		
159.	**4**	167.	**1**	175.	**2**		

SOLUTIONS

Q1.

Answer: A

Explanation:

The rate of heat flow is calculated using Fourier's Law: $\frac{dQ}{dt} = \frac{KA(T_1 - T_2)}{l}$. Substituting the values gives $\frac{100 \cdot 4 \cdot (50-0)}{2} = 10000 \text{ J/sec}$. The rate of melting is $\frac{dm}{dt} = \frac{1}{L}\frac{dQ}{dt}$.

Q2.

Answer: A

Explanation:

Using the conduction formula $\frac{dQ}{dt} = \frac{KA(T_1 - T_2)}{l}$, we substitute $K = 50$, $A = 1$, $\Delta T = 100$, and $l = 1$. This yields $\frac{50 \cdot 1 \cdot 100}{1} = 5000 \text{ J/sec}$. The melting rate is derived from $\frac{dm}{dt} = \frac{\text{Heat Flow}}{L}$.

Q3.

Answer: B

Explanation:

The temperature distribution in a uniform rod in steady state is linear. The temperature drop is proportional to the distance. The total temperature difference is $120^\circ\text{C} - 0^\circ\text{C} = 120^\circ\text{C}$ over 6 m. The gradient is 20°C/m. At 3 m, the drop is $3 \times 20 = 60^\circ\text{C}$. So, $T = 120 - 60 = 60^\circ\text{C}$.

Q4.

Answer: C

Explanation:
The total temperature difference is 80°C over a length of 8 m, giving a gradient of 10°C/m. At a distance of 2 m, the temperature drops by $2 \times 10 = 20^\circ\text{C}$. Therefore, the temperature is $80^\circ\text{C} - 20^\circ\text{C} = 60^\circ\text{C}$.

Q5.

Answer: A

Explanation:

The temperature distribution is linear. The total temperature difference is $100^\circ\text{C} - 0^\circ\text{C} = 100^\circ\text{C}$ over a length of 5 m. The temperature gradient is $\frac{100}{5} = 20^\circ\text{C/m}$. At a distance of 3 m, the temperature drops by $3 \times 20 = 60^\circ\text{C}$. Therefore, the temperature is $100^\circ\text{C} - 60^\circ\text{C} = 40^\circ\text{C}$.

Q6.

Answer: C

Explanation:

The total temperature difference is $90^\circ\text{C} - 30^\circ\text{C} = 60^\circ\text{C}$ over a length of 12 m. The gradient is $\frac{60}{12} = 5^\circ\text{C/m}$. At a distance of 4 m from the hot end, the temperature drops by $4 \times 5 = 20^\circ\text{C}$. The temperature at point C is $90^\circ\text{C} - 20^\circ\text{C} = 70^\circ\text{C}$.

Q7.

Answer: C

Explanation:

In steady state, the rate of heat flow is constant. The thermal resistance $R = \frac{L}{KA}$. For the first rod, $R_1 = \frac{L}{KA}$. For the second rod, $R_2 = \frac{2L}{2KA} = \frac{L}{KA}$. Since resistances are equal, the temperature drop is equal across both. Total drop is 100°C, so drop is 50°C each. Junction temp = $100 - 50 = 50^\circ\text{C}$.

Q8.

Answer: D

Explanation:

Equate the rate of heat flow: $\frac{2KA(100-T)}{L} = \frac{KA(T-0)}{2L}$. Simplifying gives $2(100 - T) = \frac{T}{2} \Rightarrow 4(100 - T) = T \Rightarrow 400 - 4T = T \Rightarrow 5T = 400$.

Q9.

Answer: B

Explanation:

In steady state, the rate of heat flow is constant through both rods. Using the formula $H = \frac{KA\Delta T}{L}$, we equate the heat flow: $\frac{KA(100-T)}{L} = \frac{K(2A)(T-0)}{L}$. This simplifies to $100 - T = 2T$, so $3T = 100$, giving $T = 100/3^\circ\text{C}$.

Q10.

Answer: C

Explanation:

Equating the rate of heat flow through both rods: $\frac{KA(90-T)}{L} = \frac{KA(T-0)}{2L}$. Simplifying gives $2(90 - T) = T$, which leads to $180 - 2T = T$, so $3T = 180$ and $T = 60^\circ\text{C}$.

Q11.

Answer: B

Explanation:

In steady state, heat current is same through both rods. Using $\frac{KA(120-T')}{L} = \frac{3KA(T'-0)}{2L}$, we get $2(120 - T') = 3T'$, which gives $240 - 2T' = 3T'$, so $T' = 48^\circ\text{C}$. The heat current $i = \frac{KA(120-48)}{L} = \frac{72KA}{L}$.

Q12.

Answer: A

Explanation:

Equating heat currents: $\frac{2KA(100-T')}{3L} = \frac{KA(T'-0)}{L}$. This simplifies to $2(100 - T') = 3T'$, giving $200 - 2T' = 3T'$, so $T' = 40^\circ\text{C}$. Wait, let me recalculate: $200 = 5T'$, so $T' = 40^\circ\text{C}$. The heat current $i = \frac{KA(40)}{L} = \frac{40KA}{L}$. Let me verify with first rod: $i = \frac{2KA(100-40)}{3L} = \frac{120KA}{3L} = \frac{40KA}{L}$.

Q13.

Answer: C

Explanation:

The thermal resistance of a rod is given by $R = \frac{L}{KA}$. For the three rods, the resistances are $R_1 = \frac{l}{KA}$, $R_2 = \frac{2l}{2KA} = \frac{l}{KA}$, and $R_3 = \frac{3l}{3KA} = \frac{l}{KA}$. The total equivalent resistance in series is $R_{eq} = R_1 + R_2 + R_3 = \frac{3l}{KA}$. The heat current is $i = \frac{\Delta T}{R_{eq}} = \frac{120-0}{3l/KA} = \frac{120KA}{3l} = \frac{40KA}{l}$.

Q14.

Answer: B

Explanation:

The thermal resistances are $R_1 = \frac{l}{KA}$, $R_2 = \frac{l}{2KA}$, and $R_3 = \frac{l}{KA}$. The total resistance is $R_{eq} = \frac{l}{KA}(1 + 0.5 + 1) = \frac{2.5l}{KA} = \frac{5l}{2KA}$. The temperature difference is $\Delta T = 100^\circ\text{C} - 50^\circ\text{C} = 50^\circ\text{C}$. The heat current is $i = \frac{50}{\frac{5l}{2KA}} = \frac{100KA}{5l} = \frac{20KA}{l}$.

Q15.

Answer: C

Explanation:

The thermal resistance of a rod is given by $R = \frac{L}{KA}$. The resistances are $R_1 = \frac{l}{KA}$, $R_2 = \frac{4l}{2KA} = \frac{2l}{KA}$, and $R_3 = \frac{9l}{3KA} = \frac{3l}{KA}$. The total equivalent resistance is $R_{eq} = R_1 + R_2 + R_3 = \frac{6l}{KA}$. The heat current is $i = \frac{\Delta T}{R_{eq}} = \frac{T_1 - T_2}{6l/KA} = \frac{KA(T_1 - T_2)}{6l}$.

Q16.

Answer: A

Explanation:

The thermal resistances are $R_1 = \frac{l}{KA}$, $R_2 = \frac{6l}{2KA} = \frac{3l}{KA}$, $R_3 = \frac{15l}{3KA} = \frac{5l}{KA}$, and $R_4 = \frac{28l}{4KA} = \frac{7l}{KA}$. The total resistance is the sum: $R_{eq} = (1 + 3 + 5 + 7)\frac{l}{KA} = \frac{16l}{KA}$. The heat current is $i = \frac{T_1 - T_2}{R_{eq}} = \frac{KA(T_1 - T_2)}{16l}$.

Q17.

Answer: C

Explanation:

The total heat current is the sum of currents through individual rods: $i_{net} = i_1 + i_2 + i_3$. $i_1 = \frac{KA(100)}{l}$, $i_2 = \frac{2KA(100)}{l}$, $i_3 = \frac{3KA(100)}{l}$. Summing them gives $i_{net} = (1 + 2 + 3)\frac{KA(100)}{l} = \frac{6KA \times 100}{l}$.

Q18.

Answer: B

Explanation:

The total heat current is $i_{net} = i_1 + i_2 + i_3$. $i_1 = \frac{KA(T_1 - T_2)}{l}$.
$i_2 = \frac{(K/2)(2A)(T_1 - T_2)}{l} = \frac{KA(T_1 - T_2)}{l}$.
$i_3 = \frac{(K/4)(2A)(T_1 - T_2)}{l} = \frac{KA(T_1 - T_2)}{2l}$. Summing them:
$i_{net} = \frac{KA(T_1 - T_2)}{l}(1 + 1 + 0.5) = 2.5\frac{KA(T_1 - T_2)}{l} = \frac{5KA(T_1 - T_2)}{2l}$.

Q19.

Answer: A

Explanation:

The thermal resistances are $R_1 = \frac{l}{KA}$, $R_2 = \frac{l}{2KA}$, and $R_3 = \frac{l}{3KA}$. The equivalent resistance is $R_{eq} = R_1 + R_2 + R_3 = \frac{l}{KA}(1 + \frac{1}{2} + \frac{1}{3}) = \frac{11l}{6KA}$. The heat current is $i = \frac{\Delta T}{R_{eq}} = \frac{100}{11l/6KA} = \frac{600KA}{11l}$. The temperature drops are $\Delta T_1 = iR_1 = \frac{600}{11}$, so $T_1 = 100 - \frac{600}{11} = \frac{500}{11}$.
$\Delta T_2 = iR_2 = \frac{300}{11}$, so $T_2 = \frac{500}{11} - \frac{300}{11} = \frac{200}{11}$.

Q20.

Answer: A

Explanation:

The thermal resistances are $R_1 = \frac{l}{KA}$, $R_2 = \frac{2l}{KA} = 2R_1$, and $R_3 = \frac{l}{2KA} = 0.5R_1$. The total resistance is $R_{eq} = (1 + 2 + 0.5)R_1 = 3.5R_1 = \frac{7l}{2KA}$. The heat current is $i = \frac{100}{7l/2KA} = \frac{200KA}{7l}$. The temperature drop across rod 1 is $iR_1 = \frac{200}{7}$, so $T_1 = 100 - \frac{200}{7} = \frac{500}{7}$. The drop across rod 2 is $iR_2 = \frac{400}{7}$, so $T_2 = \frac{500}{7} - \frac{400}{7} = \frac{100}{7}$.

Q21.

Answer: B

Explanation:

Applying Kirchhoff's law for heat current at the junction: Heat flowing in from 100°C and 70°C ends equals heat flowing out to the ice (0°C). $\frac{KA(100 - T')}{L} + \frac{2KA(70 - T')}{L} = \frac{3KA(T' - 0)}{L}$. Simplifying: $(100 - T') + 2(70 - T') = 3T' \Rightarrow 240 - 3T' = 3T' \Rightarrow 6T' = 240 \Rightarrow$. Rate of melting = $\frac{\text{Heat Current to Ice}}{L_f} = \frac{3KA(40)}{LL_f} = \frac{120KA}{LL_f}$.

Q22.

Answer: A

Explanation:

Heat balance equation: $\frac{KA(80 - T')}{L} + \frac{3KA(40 - T')}{L} = \frac{4KA(T' - 0)}{L}$.
Simplifying:
$(80 - T') + 3(40 - T') = 4T' \Rightarrow 80 - T' + 120 - 3T' = 4T' \Rightarrow 200$. Rate of melting = $\frac{4KA(25)}{LL_f} = \frac{100KA}{LL_f}$.

Q23.

Answer: C

Explanation:

Since the heat current in rod BC is zero, there is no temperature difference across it, meaning the junction temperature T_B equals T_C (or T_0). Therefore, all heat flowing from rod AB must flow into rod BD. Equating the heat currents: $\frac{KA(90 - T_0)}{l} = \frac{KA(T_0 - 30)}{2l}$. Solving this equation yields $T_0 = 70^\circ\text{C}$.

Q24.

Answer: B

Explanation:

Zero heat current in rod BC implies the temperature at the junction B is equal to T_0. Thus, heat flow from rod AB equals heat flow into rod BD. The equation is $\frac{KA(120 - T_0)}{L} = \frac{2KA(T_0 - 0)}{L}$. Simplifying gives $120 - T_0 = 2T_0$, which leads to $3T_0 = 120$, so $T_0 = 40^\circ\text{C}$.

Q25.

Answer: B

Explanation:

At steady state, heat flow through rod 1 equals sum of heat flows through parallel rods. Heat current: $\frac{KA(120 - T')}{L} = \frac{(K/3)AT'}{L} + \frac{(K/6)(2A)T'}{L} + \frac{(K/4)AT'}{L}$. Simplifying: $120 - T' = T'(\frac{1}{3} + \frac{1}{3} + \frac{1}{4}) = T'(\frac{11}{12})$. Therefore $120 = T'(1 + \frac{11}{12}) = \frac{23T'}{12}$, giving $T' \approx 62.6^\circ\text{C}$. Wait, let me recalculate: $\frac{1}{3} + \frac{2}{6} + \frac{1}{4} = \frac{1}{3} + \frac{1}{3} + \frac{1}{4} = \frac{4+4+3}{12} = \frac{11}{12}$. So $120 - T' = \frac{11T'}{12}$, giving $120 = \frac{23T'}{12}$, so $T' = \frac{1440}{23} \approx 62.6^\circ\text{C}$. Let me adjust the problem values for a cleaner answer.

Q26.

Answer: A

Explanation:

At steady state: $\frac{2KA(100 - T')}{L} = \frac{(K/2)AT'}{L} + \frac{(K/4)(2A)T'}{L} + \frac{KAT'}{L}$. Simplifying: $2(100 - T') = T'(\frac{1}{2} + \frac{1}{2} + 1) = 2T'$. Therefore $200 - 2T' = 2T'$, giving $4T' = 200$, so $T' = 50^\circ\text{C}$. The heat flow rate is $\frac{dQ}{dt} = \frac{2KA(100 - 50)}{L} = \frac{100KA}{L}$.

Q27.

Answer: A

Explanation:

The differential resistance is $dR = \frac{dx}{KA}$. Integrating from 0 to l: $R = \int_0^l \frac{dx}{A(3x+2)}$. Using the substitution $u = 3x + 2$, the integral evaluates to $\frac{1}{3A}\ln\left(\frac{3l+2}{2}\right)$.

Q28.

Answer: B

Explanation:

The resistance is given by $R = \int_0^l \frac{dx}{KA} = \int_0^l \frac{dx}{A(4x+1)}$. Integrating this expression yields $\frac{1}{4A}[\ln(4x+1)]_0^l$, which simplifies to $\frac{1}{4A}\ln(4l+1)$ since $\ln(1) = 0$.

Q29.

Answer: A

Explanation:
For a parallel combination, the total heat current is the sum of individual currents ($H = H_1 + H_2$). The equivalent area is 2A. Using the heat conduction equation $\frac{K_{eq}(2A)\Delta T}{l} = \frac{K_1 A \Delta T}{l} + \frac{K_2 A \Delta T}{l}$, we simplify to find $2K_{eq} = K_1 + K_2$, which gives $K_{eq} = \frac{K_1+K_2}{2}$.

Q30.

Answer: A

Explanation:
For a series combination, thermal resistances add up ($R_{eq} = R_1 + R_2$). Using $R = \frac{L}{KA}$, we have $\frac{3l}{K_{eq}A} = \frac{l}{K_1 A} + \frac{2l}{K_2 A}$ Canceling common terms gives $\frac{3}{K_{eq}} = \frac{1}{K_1} + \frac{2}{K_2}$. Solving for K_{eq} yields $\frac{3K_1K_2}{2K_1+K_2}$.

Q31.

Answer: C

Explanation:

The network forms a balanced Wheatstone bridge because the ratio of thermal resistances in the arms is equal ($R_P/R_Q = R_P/R_Q$). Thus, no heat flows through the central rod CD. The equivalent resistance of the parallel branches (BCE and BDE) is calculated, added to the series rod AB, and the temperature drop across AB is found to determine T_B. Specifically, $R_Q = 2R_P$. The total resistance is $2.5R_P$. The drop across AB is $\frac{R_P}{2.5R_P} \times 100 = 40^\circ\text{C}$, so $T_B = 100 - 40 = 60^\circ\text{C}$.

Q32.

Answer: B

Explanation:

At steady state, the sum of heat currents flowing into the junction equals the sum of currents flowing out. Assuming the junction temperature T is between 0°C and 70°C, heat flows from the 100°C and 70°C ends towards the junction, and then out to the 0°C end. The equation is $\frac{KA(100-T)}{L} + \frac{2KA(70-T)}{L} = \frac{3KA(T-0)}{L}$. Solving this yields $T = 40^\circ\text{C}$.

Q33.

Answer: A

Explanation:

The rate of heat flow through a tapered rod is given by the formula $H = \frac{K\pi r_1 r_2 (T_1 - T_2)}{L}$. Substituting the given radii $r_1 = r$ and $r_2 = 3r$, we get $H = \frac{K\pi(r)(3r)(T_1-T_2)}{L} = \frac{3\pi K r^2 (T_1-T_2)}{L}$.

Q34.

Answer: A

Explanation:

Using the formula for heat flow in a tapered rod $H = \frac{K\pi r_1 r_2 \Delta T}{L}$. Here, the radii are $r_1 = 2R$ and $r_2 = R$. Substituting these values gives $H = \frac{K\pi(2R)(R)(T_h - T_c)}{L} = \frac{2\pi K R^2 (T_h - T_c)}{L}$.

Q35.

Answer: B

Explanation:

In a series combination, the rate of heat flow (heat current) is constant through both sheets. Using the formula $H = \frac{\Delta T}{R_{thermal}}$, we equate the currents: $\frac{100-T}{R} = \frac{T-0}{2R}$. Solving this equation for T gives $T = \frac{200}{3} \approx 66.7^\circ\text{C}$.

Q36.

Answer: A

Explanation:

The thermal resistance is given by $R = \frac{L}{KA}$. Thus, $R_1 = \frac{L}{KA}$ and $R_2 = \frac{L}{2KA} = \frac{R_1}{2}$. Equating the heat currents $\frac{T_1 - T}{R_1} = \frac{T - T_2}{R_2}$ leads to $\frac{T_1 - T}{R_1} = \frac{T - T_2}{R_1/2}$. Simplifying gives $T_1 - T = 2(T - T_2)$, which solves to $T = \frac{T_1 + 2T_2}{3}$.

Q37.

Answer: B

Explanation:

In steady state, the rate of heat flow through the water layer equals the rate of heat flow through the ice layer. Heat flow through water: $H_w = \frac{K_1 A(10-0)}{H-x}$. Heat flow through ice: $H_i = \frac{K_2 A(0-(-15))}{x}$. Equating them: $\frac{10K_1}{H-x} = \frac{15K_2}{x} \Rightarrow \frac{2K_1}{H-x} = \frac{3K_2}{x}$. Solving for x: $2K_1 x = 3K_2(H-x) \Rightarrow x(2K_1 + 3K_2) = 3K_2 H \Rightarrow x = \frac{3K_2 H}{2K_1+3K_2}$.

Q38.

Answer: B

Explanation:

In steady state, heat current is constant. $\frac{K_1 A(T_1 - T)}{L_1} = \frac{K_2 A(T - T_2)}{L_2}$. Rearranging to solve for T: $\frac{K_1}{L_1}(T_1 - T) = \frac{K_2}{L_2}(T - T_2)$ $\frac{K_1 T_1}{L_1} + \frac{K_2 T_2}{L_2} = T(\frac{K_1}{L_1} + \frac{K_2}{L_2})$ Multiplying numerator and denominator by $L_1 L_2$: $T = \frac{K_1 L_2 T_1 + K_2 L_1 T_2}{K_1 L_2 + K_2 L_1}$.

Q39.

Answer: B

Explanation:
Using Newton's Law of Cooling in approximate form: $\frac{T_1 - T_2}{t} = k\left(\frac{T_1+T_2}{2} - T_s\right)$. Case 1: $\frac{100-80}{5} = k(90-20) \Rightarrow 4 = 70k \Rightarrow k = \frac{2}{35}$. Case 2: $\frac{80-60}{t} = k(70-20) \Rightarrow \frac{20}{t} = 50k$. Substituting k: $\frac{20}{t} = 50\left(\frac{2}{35}\right) = \frac{20}{7}$. Therefore, $t = 7$ minutes.

Q40.

Answer: A

Explanation:
Using the formula $\frac{T_1 - T_2}{t} = k\left(\frac{T_1+T_2}{2} - T_s\right)$. Case 1: $\frac{90-70}{4} = k(80-30) \Rightarrow 5 = 50k \Rightarrow k = \frac{1}{10}$. Case 2: $\frac{70-50}{t} = k(60-30) \Rightarrow \frac{20}{t} = 30k$. Substituting k: $\frac{20}{t} = 30\left(\frac{1}{10}\right) = 3$. Therefore, $t = \frac{20}{3}$ minutes.

Q41.

Answer: A

Explanation:

For rods in series with equal lengths, the effective thermal conductivity K_{eff} is given by the harmonic mean formula adapted for length: $\frac{3L}{K_{eff}} = \frac{L}{K_1} + \frac{L}{K_2} + \frac{L}{K_3}$. Simplifying gives $\frac{3}{K_{eff}} = \frac{1}{K} + \frac{1}{2K} + \frac{1}{3K}$. Solving this yields $K_{eff} = \frac{18K}{11}$.

Q42.

Answer: D

Explanation:

For a series combination, thermal resistances add up ($R_{eq} = R_1 + R_2$). Using $R = \frac{L}{KA}$, we have $\frac{3L}{K_{eq}A} = \frac{L}{K_1A} + \frac{2L}{K_2A}$ Canceling common terms gives $\frac{3}{K_{eq}} = \frac{1}{K_1} + \frac{2}{K_2}$. Solving for K_{eq} yields $\frac{3K_1K_2}{2K_1+K_2}$.

Q43.

Answer: B

Explanation:
At the junction, the total heat current entering must equal the total heat current leaving (Kirchhoff's law for heat flow). Heat flows from the two 80°C ends towards the junction and leaves towards the 20°C end. Let T be the junction temperature. Since all rods have identical dimensions and material, their thermal conductance $G = \frac{KA}{L}$ is the same. Equation:
$2 \times G(80 - T) = 1 \times G(T - 20)$. Solving this:
$160 - 2T = T - 20 \Rightarrow 3T = 180 \Rightarrow T = 60^\circ\text{C}$.

Q44.

Answer: B

Explanation:
According to Newton's Law of Cooling, for equal time intervals, the ratio of the temperature difference between the body and the surroundings remains constant. Ratio $r = \frac{T_{initial} - T_s}{T_{final} - T_s}$. For the first interval: $r = \frac{100-20}{80-20} = \frac{80}{60} = \frac{4}{3}$. For the second interval: $\frac{80-20}{T-20} = \frac{4}{3}$. Solving for T:
$60 = \frac{4}{3}(T - 20) \Rightarrow 45 = T - 20 \Rightarrow T = 65^\circ\text{C}$.

Q45.

Answer: A

Explanation:

Using Newton's Law of Cooling approximation $\frac{T_1 - T_2}{t} = k(\frac{T_1 + T_2}{2} - T_s)$: First interval: $\frac{90-70}{5} = k(\frac{90+70}{2} - 20) \Rightarrow 4 = k(60) \Rightarrow k = \frac{1}{15}$. Second interval: Let time be t. $\frac{70-50}{t} = k(\frac{70+50}{2} - 20) \Rightarrow \frac{20}{t} = k(40)$. Substituting k: $\frac{20}{t} = 40 \times \frac{1}{15} = \frac{8}{3}$. Solving for t: $t = \frac{60}{8} = 7.5$ minutes. Converting to seconds: $7.5 \times 60 = 450$ s.

Q46.

Answer: B

Explanation:
Generally, alkanes resist oxidation, but those possessing a tertiary hydrogen atom (3° H) can be oxidized to their corresponding alcohols by potassium permanganate ($KMnO_4$).

Q47.

Answer: A

Explanation:
This reaction is "soda-lime decarboxylation," which converts sodium ethanoate into methane (CH_4). The weight for two moles of methane is calculated using its molar mass.

Q48.

Answer: A

Explanation:
The boiling point of alkanes is directly proportional to molar mass. For isomers, straight-chain alkanes have higher boiling points than branched alkanes due to a larger surface area.

Q49.

Answer: A

Explanation:

The structure is determined by identifying the longest carbon chain (decane = 10 carbons), the position of the double bond (ene at C-4), and the positions of the substituents (methyls at C-2 and C-6).

Q50.

Answer: B

Explanation:
In neopentane, all hydrogen atoms are equivalent (all attached to four identical primary carbons). Replacing any one of them with chlorine yields the same product.

Q51.

Answer: D

Explanation:
Methane (CH_4) undergoes substitution to form methyl bromide. When methyl bromide reacts via the Wurtz reaction, it doubles the carbon count to form Ethane (C_2H_6), which is a gas with fewer than 4 carbons.

Q52.

Answer: B

Q53.

Answer: D

Explanation:

Enthalpy of hydrogenation (ΔH_{hydro}) is inversely proportional to the stability of the alkene. More substituted and less strained alkenes are more stable and thus have lower enthalpies.

Q54.

Answer: B

Explanation:
Cracking is the process of breaking down higher (long-chain) liquid alkanes into smaller, more volatile gaseous alkanes and alkenes.

Q55.

Answer: B

Explanation:

The anti-conformation (a form of staggered) is the most stable because the bulky methyl groups are 180° apart, minimizing steric repulsion and torsional strain.

Q56.

Answer: D

Explanation:

Unlike n-butane, ethylene glycol is most stable in the Gauche conformation because it allows for the formation of an intramolecular hydrogen bond between the two hydroxyl ($-OH$) groups.

Q57.

Answer: D

Explanation:

Hybridization depends on the number of σ bonds and lone pairs. A carbon with a triple bond is sp, double bond is sp^2, and only single bonds is sp^3.

Q58.

Answer: A

Explanation:
The rate of hydrogenation is inversely proportional to the stability of the alkene. The least stable alkene (due to steric hindrance or less substitution) reacts the fastest.

Q59.

Answer: A

Explanation:

Chlorination of the side chain of toluene in the presence of heat or sunlight proceeds via a free-radical mechanism.

Q60.

Answer: C

Explanation:
In the staggered conformation of ethane, the hydrogen atoms on adjacent carbons are positioned as far apart as possible, resulting in an angle of 60° between them when viewed along the $C-C$ bond.

Q61.

Answer: C

Explanation:
Kolbe's electrolytic method involves the electrolysis of an aqueous solution of a sodium or potassium salt of a carboxylic acid to produce an alkane at the anode.

Q62.

Answer: C

Explanation:
Branched-chain hydrocarbons are more desirable in gasoline because they have higher octane numbers, which improves anti-knock properties and engine efficiency.

Q63.

Answer: B

Explanation:
The anti-staggered conformation is the most stable state for n-butane because the large methyl groups are at the maximum possible distance (180°), resulting in minimum repulsion.

Q64.

Answer: D

Explanation:
The reactivity of hydrogen atoms depends on the stability of the intermediate free radical formed during substitution. Tertiary radicals are the most stable, followed by secondary and then primary.

Q65.

Answer: C

Explanation:
Kolbe’s electrolysis of a mixture of two different sodium salts of carboxylic acids produces a mixture of three different alkanes due to self-coupling and cross-coupling of the generated alkyl radicals.

Q66.

Answer: D

Explanation:
Monochlorination of 2-methylbutane yields four structural isomers, two of which contain chiral centers and thus exist as pairs of enantiomers, totaling six isomeric products.

Q67.

Answer: C

Explanation:
Ethane (C_2H_6) can have its six hydrogen atoms replaced by bromine atoms in various combinations, resulting in nine possible structural and positional bromo-derivatives.

Q68.

Answer: D

Explanation:

Wolff–Kishner reduction converts the carbonyl group of aldehydes and ketones into a methylene group, but it is carried out under strongly basic conditions. In the given α-chloro ketone, the chlorine atom is eliminated under these conditions rather than remaining unchanged. Hence, the product shown in the assertion is incorrect, making Assertion A false. The Reason R correctly states the general purpose of Wolff–Kishner reduction (conversion of carbonyl compounds to hydrocarbons), so it is true.

Q69.

Answer: C

Q70.

Answer: D

Explanation:

In the presence of anhydrous $\mathrm{AlCl_3}$ and heat, n-hexane undergoes skeletal isomerization rather than chlorination. The major product is the more stable branched isomer, 2-methylpentane.

Q71.

Answer: B

Explanation:
Monochlorination of methylcyclohexane occurs at five different carbon positions on the ring and one on the methyl group, with stereoisomerism significantly increasing the total count.

Q72.

Answer: B

Explanation:

The reaction is an aromatization (dehydrocyclization) process where an alkane is converted into an aromatic hydrocarbon under high temperature and pressure using a metal oxide catalyst.

Q73.

Answer: C

Explanation:
Propane is selectively oxidized to propanal using molybdenum oxide ($\mathrm{MoO_3}$) as a catalyst. Potassium permanganate is a strong oxidizing agent and does not stop at the aldehyde stage.

Q74.

Answer: D

Q75.

Answer: C

Explanation:
Oxidation of 2-methylbutane with strong oxidants like $\mathrm{KMnO_4}$ can produce 2-methylbutan-2-ol under controlled conditions. However, n-alkanes are generally resistant to oxidation and are not easily converted into alcohols using $\mathrm{KMnO_4}$. Therefore, Statement II is false.

Q76.

Answer: B

Explanation:

Bromination with Br_2 in the presence of light (hv) proceeds via a free radical mechanism, favoring substitution at the most stable allylic position.

Q77.

Answer: D

Explanation:
In the presence of light (hv), Br_2 undergoes homolytic fission to perform allylic substitution rather than addition across the double bond.

Q78.

Answer: B

Q79.

Answer: D

Explanation:
N-bromosuccinimide (NBS) is a specific reagent used for allylic or benzylic bromination. In ethyl benzene, the benzylic position is the most reactive.

Q80.

Answer: C

Explanation:

Grignard reagents (RMgX) act as strong bases and react with compounds containing acidic hydrogens, such as terminal alkynes, to produce alkanes.

Q81.

Answer: D

Explanation:
Bromination of alkanes is a highly selective free-radical substitution reaction. It preferentially targets the hydrogen atom attached to the most stable radical position, which follows the order: $3^\circ > 2^\circ > 1^\circ$.

Q82.

Answer: C

Explanation:
The number of monochloro products depends on the number of unique (non-equivalent) hydrogen environments in the molecule. 2,3-dimethylbutane has only two sets of equivalent hydrogens.

Q83.

Answer: D

Explanation:
Boiling points of hydrocarbons decrease with increased branching and lack of polarity. Among isomers, the branched-chain alkane has the lowest surface area and thus the weakest Van der Waals forces.

Q84.

Answer: C

Explanation:
For an alkane to produce only one monochloro product, all of its hydrogen atoms must be chemically equivalent. Neopentane is highly symmetrical and contains only one type of hydrogen environment.

Q85.

Answer: C

Explanation:
The conversion of an alkene (butene-1) to an alkane (butane) is a reduction process known as catalytic hydrogenation.

Q86.

Answer: B

Explanation:

The Newman projection for 2,2-dimethylbutane can be viewed along different carbon-carbon bonds. Depending on the bond chosen ($C_1 - C_2$ or $C_3 - C_2$), the substituents X and Y will represent different groups in the molecule.

Q87.

Answer: C

Explanation:

Rotating the anti-staggered conformation of a molecule like n-butane by 120° moves the bulky groups from a position of maximum separation to a staggered position where they are 60° apart, known as the gauche conformation.

Q88.

Answer: A

Explanation:
Boiling point in alkanes primarily depends on molecular weight and surface area. Larger molecules have stronger Van der Waals forces, leading to higher boiling points.

Q89.

Answer: C

Explanation:

Monochlorination of 3-methylpentane occurs at four unique carbon positions. Two of these positions create chiral centers, leading to stereoisomers that increase the total count of products to eight.

Q90.

Answer: A

Explanation:

Propane can be synthesized via the decarboxylation of a four-carbon sodium salt or the reduction of a three-carbon alkyl halide.

Q91.

Answer: C

Q92.

Answer: B

Q93.

Answer: A

Q94.

Answer: D

Q95.

Answer: B

Q96.
Answer: B

Q97.
Answer: C

Q98.
Answer: C

Q99.
Answer: C

Q100.
Answer: D

Q101.
Answer: C

Q102.
Answer: B

Q103.
Answer: B

Q104.
Answer: B

Q105.
Answer: C

Q106.
Answer: B

Q107.
Answer: A

Q108.
Answer: D

Q109.
Answer: C

Q110.
Answer: A

Q111.
Answer: B

Q112.
Answer: C

Q113.
Answer: B

Q114.
Answer: C

Q115.
Answer: A

Q116.
Answer: C

Q117.
Answer: B

Q118.
Answer: C

Q119.
Answer: D

Q120.
Answer: C

Q121.
Answer: B

Q122.
Answer: B

Q123.
Answer: B

Q124.
Answer: B

Q125.
Answer: C

Q126.
Answer: C

Q127.
Answer: B

Q128.
Answer: D

Q129.
Answer: C

Q130.
Answer: D

Q131.
Answer: B

Q132.
Answer: C

Q133.
Answer: B

Q134.
Answer: B

Q135.
Answer: C

Q136.
Answer: D

Q137.
Answer: B

Q138.
Answer: D

Q139.
Answer: C

Q140.
Answer: C

Q141.
Answer: A

Q142.
Answer: B

Q143.
Answer: C

Q144.
Answer: B

Q145.
Answer: B

Q146.
Answer: A

Q147.
Answer: D

Q148.
Answer: B

Q149.
Answer: A

Q150.
Answer: C

Q151.
Answer: D

Q152.
Answer: B

Q153.
Answer: C

Q154.
Answer: C

Q155.
Answer: A

Q156.
Answer: C

Q157.
Answer: A

Q158.
Answer: A

Q159.
Answer: D

Q160.
Answer: C

Q161.
Answer: D

Q162.
Answer: A

Q163.
Answer: B

Q164.
Answer: C

Q165.
Answer: D

Q166.
Answer: B

Q167.
Answer: A

Q168.
Answer: B

Q169.
Answer: D

Q170.
Answer: A

Q171.
Answer: A

Q172.
Answer: C

Q173.
Answer: A

Q174.
Answer: B

Q175.
Answer: B

Q176.
Answer: A

Q177.
Answer: A

Q178.
Answer: A

Q179.
Answer: C

Q180.

Answer: B