Physicsaholics

Exercise

Thermo-1

Elasticity, Calorimetry,

Thermal Expansion, Heat Transfer

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Exercise-1

(Objective Type: Single Correct)

Level-1

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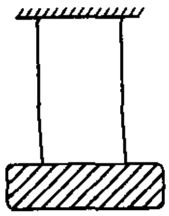
Questions Highlighted in Grey Colour: Calorimetry

Questions Highlighted in Cyan Colour: Heat Transfer

Rest of the questions which are left unhighlighted are from Elasticity and Thermal Expansion and will be covered later.

Q 1. Two wires of equal length and cross-section are suspended as shown. Their Young's modulii are Y_1 and Y_2 respectively. The equivalent Young's modulus will be:

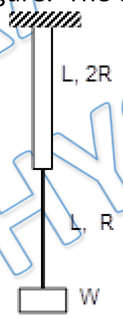


(A) $Y_1 + Y_2$ (B) $\frac{Y_1 + Y_2}{2}$ (C) $\frac{Y_1 Y_2}{Y_1 + Y_2}$ (D) $\sqrt{Y_1 Y_2}$

Q 2. The maximum load a wire can withstand without breaking, when its length is reduced to half of its original length, will

(A) be double. (B) be half. (C) be four times. (D) remain same.

Q 3. Two wires of the same material (Young's modulus Y) and same length L but radii R and 2R respectively are joined end to end and a weight W is suspended from the combination as shown in the figure. The elastic potential energy in the system is



(A) $\frac{3W^2L}{4\pi R^2 Y}$ (B) $\frac{3W^2L}{8\pi R^2 Y}$

(C) $\frac{5W^2L}{8\pi R^2 Y}$ (D) $\frac{W^2L}{\pi R^2 Y}$

Q 4. The temperature of a wire is doubled. The Young's modulus of elasticity

(A) will also double. (B) will become four times.

(C) will remain same. (D) will decrease.

Q.5 the scale on steel meter stick is calibrated at 15°c. what is the error in the reading of 60 cm at 27°c? $\alpha_{steel} = 1.2 \times 10^{-5}$ (°c)$^{-1}$.

(A) 0.00864 cm (B) 0.0864 cm
(C) 0.00864 mm (D) 0.000864 mm

Q 6. A spring is stretched by applying a load to its free end. The strain produced in the spring is
(A) volumetric. (B) shear.
(C) longitudinal and shear. (D) longitudinal.

Q 7. The mean density of sea water is ρ, and bulk modulus is B. The change in density of sea water in going from the surface of water to a depth of h is:

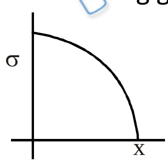
(A) $\frac{B\rho^2}{gh}$ (B) Bρgh (C) $\frac{\rho^2 gh}{B}$ (D) $\frac{\rho gh}{B}$

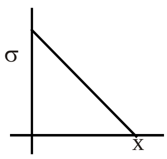
Q 8. Overall changes in volume and radii of a uniform cylindrical steel wire are 0.2% and 0.002% respectively when subjected to some suitable force. Longitudinal tensile stress acting on the wire is (Y = 2.0×10^{11} Nm^{-2})
(A) 3.2×10^9 Nm^{-2} (B) 3.2×10^7 Nm^{-2} (C) 3.6×10^9 Nm^{-2} (D) 3.9×10^8 Nm^{-2}

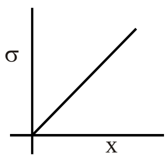
Q 9. A long cylindrical vessel of volume V and linear coefficient of expansion α is fully filled by a liquid. on heating vessel remains fully filled without any overflow. The volume coefficient of real expansion of liquid is
(A) $(V - \alpha)/V$ (B) $(V + \alpha)/V$
(C) $V/(V - \alpha)$ (D) 3α.

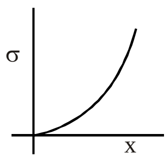
Q 10. A solid sphere of radius R made of material of bulk modulus K is surrounded by a liquid in a cylindrical container. A massless piston of area A floats on the surface of the liquid. When a mass m is placed on the piston to compress the liquid, the fractional change in the radius of the sphere $\delta R/R$ is
(A) mg/AK (B) mg/3AK (C) mg/A (D) mg/3AR

Q 11. A uniform rod rotating in gravity free region with certain constant angular velocity. The variation of tensile stress with distance x from axis of rotation is best represented by which of the following graphs.

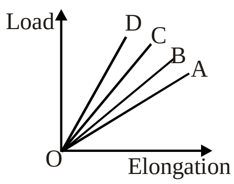
(A) 

(B) 

(C) 

(D) 

Q 12. The load versus strain graph for four wires of the same material is shown in the figure. The thickest wire is represented by the line



(A) OB (B) OA (C) OD (D) OC

Q 13. On decreasing distance between two molecules from large separation, magnitude of intermolecular force

(A) increases.
(B) first increases then decreases
(C) first increases then decreases then increases
(D) None of the above

Q 14. Equal amount of heat energy are transferred into equal mass of ethyl alcohol and water sample. The rise in temperature of water sample is 25°C. The temperature rise of ethyl alcohol will be.

(Specific heat of ethyl alcohol is one half of the specific heat of water).

(A) 12.5°C (B) 25°C
(C) 50°C (D) It depends on the rate of energy transfer.

Q 15. A block of mass 2.5 kg is heated to temperature of 500°C and placed on a large ice block. What is the maximum amount of ice that can melt (approx.). Specific heat for the body = 0.1 Cal/gm°C.

(A) 1 kg (B) 1.5 kg (C) 2 kg (D) 2.5 kg

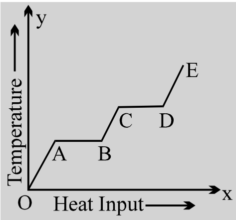
Q 16. 10 gm of ice at 0°C is kept in a calorimeter of water equivalent 10 gm. How much heat should be supplied to the apparatus to evaporate the water thus formed? (Neglect loss of heat)

(A) 6200 cal (B) 7200 cal (C) 13600 cal (D) 8200 cal

Q 17. A continuous flow water heater (geyser) has an electrical power rating = 2 kW and efficiency of conversion of electrical power into heat = 80%. If water is flowing through the device at the rate of 100 cc/sec, and the inlet temperature is 10°C, the outlet temperature will be

(A) 12.2°C (B) 13.8°C (C) 20°C (D) 16.5°C

Q 18. A solid material is supplied with heat at a constant rate. The temperature of material is changing with heat input as shown in the figure. What does slope DE represents?



(A) latent heat of liquid (B) latent heat of vapour
(C) heat capacity of vapour (D) inverse of heat capacity of vapour

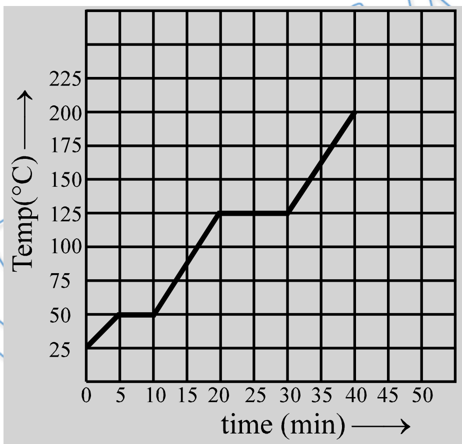
Q 19. A block of ice with mass m falls into a lake. After impact, a mass of ice m/5 melts. Both the block of ice and the lake have a temperature of 0°C. If L represents the heat of fusion, the minimum distance the ice fell before striking the surface is

(A) $\frac{L}{5g}$ (B) $\frac{5L}{g}$ (C) $\frac{gL}{5m}$ (D) $\frac{mL}{5g}$

Q 20. The specific heat of a metal at low temperatures varies according to $S = aT^3$ where a is a constant and T is the absolute temperature. The heat energy needed to raise unit mass of the metal from T = 1 K to T = 2 K is

(A) 3 a (B) $\frac{15a}{4}$ (C) $\frac{2a}{3}$ (D) $\frac{12a}{5}$

Q 21. The graph shown in the figure represent change in the temperature of 5 kg of a substance as it abosrbs heat at a constant rate of 42 kJ min^{-1}. The latent heat of vapourisation of the substance is :



(A) 630 kJ kg^{-1} (B) 126 kJ kg^{-1} (C) 84 kJ kg^{-1} (D) 12.6 kJ kg^{-1}

Q 22. The density of a material A is 1500 kg/m^3 and that of another material B is 2000 kg/m^3. It is found that the heat capacity of 8 volumes of A is equal to heat capacity of 12 volumes of B. The ratio of specific heats of A and B will be

(A) 1 : 2 (B) 3 : 1 (C) 3 : 2 (D) 2 : 1

Q 23. Some steam at 100°C is passed into 1.1 kg of water contained in a calorimeter of water equivalent 0.02 kg at 15°C so that the temperature of the calorimeter and its contents rises to 80°C. What is the mass of steam condensing? (in kg)

(A) 0.130 (B) 0.065 (C) 0.260 (D) 0.135

Q 24. A black body calorimeter filled with hot water cools from 60°C to 50°C in 4 min and 40°C to 30°C in 8 min. The approximate temperature of surrounding is :

(A) 10°C (B) 15°C (C) 20°C (D) 25°C

Q 25. A system S receives heat continuously from an electrical heater of power 10W. The temperature of S becomes constant at 50°C when the surrounding temperature is 20°C. After the heater is switched off, S cools from 35.1°C to 34.9°C in 1 minute. The heat capacity of S is

(A) 100J/°C (B) 300J/°C (C) 750J/°C (D) 1500J/°C

Q 26. The radius of a metal sphere at room temperature T is R, and the coefficient of linear expansion of the metal is α. The sphere is heated a little by so that its new temperature is T + ΔT. The increase in the volume of the sphere is approximately

(A) $2\pi R\alpha\Delta T$ (B) $\pi R^2\alpha\Delta T$ (C) $4\pi R^3\alpha\Delta T$ (D) $4\pi R^3\alpha\Delta T/3$

Q 27. A hole is made in a metal plate, when the temperature of metal is raised then the diameter of the hole will

(A) Decrease

(B) Increase

(C) Remain same

(D) Answer depends upon the initial temperature of the metal

Q 28. A rod of length 2m rests on smooth horizontal floor. If the rod is heated from 0°C to 20°C. Find the longitudinal strain developed? ($\alpha = 5 \times 10^{-5}$/°C)

(A) 10^{-3} (B) 2×10^{-3} (C) Zero (D) None

Q 29. A steel tape gives correct measurement at 20°C. A piece of wood is being measured with the steel tape at 0°C. The reading is 25 cm on the tape, the real length of the given piece of wood must be:

(A) 25 cm (B) < 25 cm (C) > 25 cm (D) cannot say

Q 30. The bulk modulus of copper is 1.4×10^{11} Pa and the coefficient of linear expansion is 1.7×10^{-5} (C°)$^{-1}$. What hydrostatic pressure is necessary to prevent a copper block from expanding when its temperature is increased from 20°C to 30°C?

(A) 6.0×10^5 Pa (B) 7.1×10^7 Pa (C) 5.2×10^6 Pa (D) 40 atm

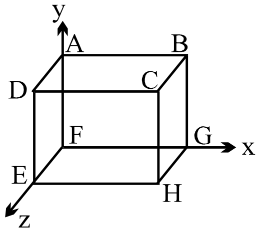
Q 31. A thin copper wire of length L increase in length by 1% when heated from temperature T_1 to T_2. What is the percentage change in area when a thin copper plate having dimensions 2L × L is heated from T_1 to T_2?

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

Q 32. A metallic rod l cm long with a square cross-section A is heated through t°C. If Young's modulus of elasticity of the metal is E and the mean coefficient of linear expansion is α per degree Celsius, then the compressional force required to prevent the rod from expanding along its length is :(Neglect the change of cross-sectional area)

(A) $EA\alpha t$ (B) $EA\alpha t/(1 + \alpha t)$ (C) $EA\alpha t/(1-\alpha t)$ (D) $E/\alpha t$

Q 33. A cuboid ABCDEFGH is anisotropic with $\alpha_x = 1 \times 10^{-5}$ /°C, $\alpha_y = 2 \times 10^{-5}$/°C, $\alpha_z = 3 \times 10^{-5}$ /°C. Coefficient of superficial expansion of faces can be



(A) $\beta_{ABCD} = 5 \times 10^{-5}$ /°C (B) $\beta_{BCGH} = 4 \times 10^{-5}$ /°C
(C) $\beta_{CDEH} = 3 \times 10^{-5}$ /°C (D) $\beta_{EFGH} = 2 \times 10^{-5}$ /°C

Q 34. The coefficient of apparent expansion of a liquid in a copper vessel is C and in a silver vessel is S. The coefficient of volume expansion of copper is γ_c. What is the coefficient of linear expansion of silver?

(A) $\frac{(C+\gamma_c+S)}{3}$ (B) $\frac{(C-\gamma_c+S)}{3}$ (C) $\frac{(C+\gamma_c-S)}{3}$ (D) $\frac{(C-\gamma_c-S)}{3}$

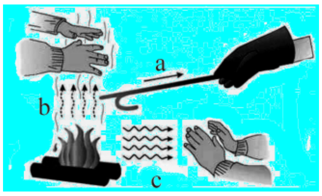
Q 35. In a vertical U-tube containing a liquid, the two arms are maintained at different temperatures, t_1 and t_2. The liquid columns in the two arms have heights l_1 and l_2 respectively. The coefficient of volume expansion of the liquid is equal to

(A) $\frac{l_1-l_2}{l_2t_1-l_1t_2}$ (B) $\frac{l_1-l_2}{l_1t_1-l_2t_2}$ (C) $\frac{l_1+l_2}{l_2t_1+l_1t_2}$ (D) $\frac{l_1+l_2}{l_1t_1+l_2t_2}$

Q 36. A thin walled cylindrical metal vessel of linear coefficient of expansion 10^{-3} °C^{-1} contains benzene of volume expansion coefficient 10^{-3} °C^{-1}. If the vessel and its contents are now heated by 10°C, the pressure due to the liquid at the bottom.
(A) increases by 2% (B) decreases by 1%
(C) decreases by 2% (D) remains unchanged

Q 37. An open vessel is filled completely with oil which has same coefficient of volume expansion as that of the vessel. On heating both oil and vessel,
(A) the vessel can contain more volume and more mass of oil
(B) the vessel can contain same volume and same mass of oil
(C) the vessel can contain same volume but more mass of oil
(D) the vessel can contain more volume but same mass of oil

Q 38. Diagram shows a heat source 'S' and three position of heat recover (hand). The main mode of heat transfer is given as 'a', 'b' & 'c'. Choose the correct matching



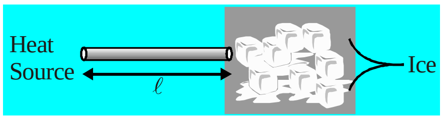
(A) a-conduction; b-convection; c-radiation

(B) a-radiation; b-conduction; c-convection

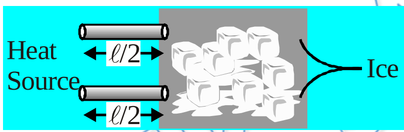
(C) a-convection; b- conduction; c- radiation

(D) a-conduction; b-radiation; c-convection

Q 39. A rod of length 'l' and cross-section 'A' is used to melt a piece of ice as shown.



Now if the rod broken into two equal parts and is arranged as shown.



Time taken to melt ice in second use becomes.

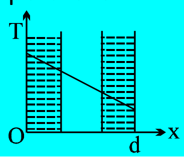
(A) Half (B) One-fourth (C) Twice (D) Four times

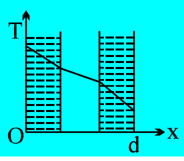
Q 40. One end of a 2.35m long and 2.0cm radius aluminium rod ($K = 235\ W.m^{-1}K^{-1}$) is held at 20^0C. The other end of the rod is in contact with a block of ice at its melting point. The rate in $kg.s^{-1}$ at which ice melts is

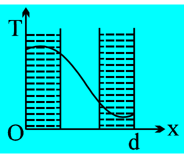
[Take latent heat of fusion for ice as $\frac{10}{3} \times 10^5\ J.kg^{-1}$]

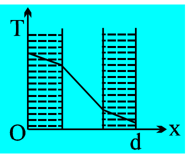
(A) $48\pi \times 10^{-6}$ (B) $24\pi \times 10^{-6}$ (C) $2.4\pi \times 10^{-6}$ (D) $4.8\pi \times 10^{-6}$

Q 41. The wall with a cavity consists of two layers of brick separated by a layer of air. All three layers have the same thickness and the thermal conductivity of the brick is much greater than that of air. The left layer is at a higher temperature than the right layer and steady state condition exists. Which of the following graphs predicts correctly the variation of temperature T with distance d inside the cavity?

(A) 

(B) 

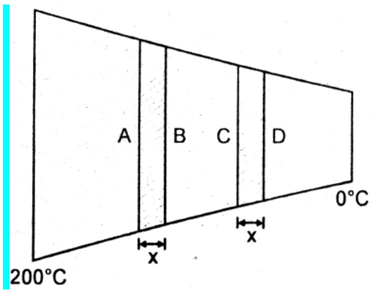
(C) 

(D) 

Q 42. A wall has two-layer A and B each made of different material, both the layers have the same thickness. The thermal conductivity of the material A is twice that of B. Under thermal equilibrium the temperature difference across the wall B is 36°C. The temperature difference across the wall A is

(A) 6°C (B) 12°C (C) 18°C (D) 72°C

Q 43. Two ends of a conducting rod of varying cross-section are maintained at 200°C and 0°C respectively. In steady state



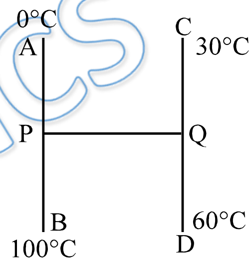
(A) temperature difference across AB and CD are equal

(B) temperature difference across AB is greater than that of across CD

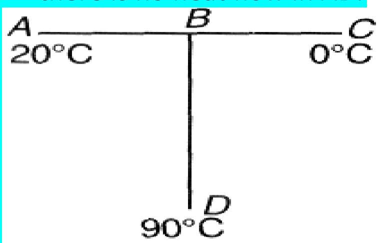
(C) temperature difference across AB is less than that of across CD

(D) temperature difference may be equal or different depending on the thermal conductivity of the rod.

Q 44. Three identical rods AB, CD and PQ are joined as shown. P and Q are mid points of AB and CD respectively. Ends A, B, C and D are maintained at 0°C, 100°C, 30°C and 60°C respectively. The direction of heat flow in PQ is
(A) from P to Q
(B) from Q to P
(C) heat does not flow in PQ
(D) data not sufficient

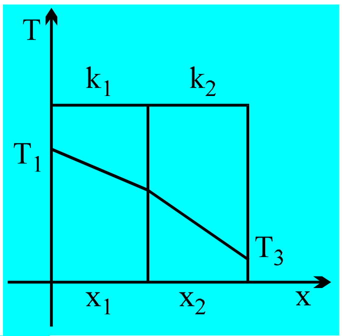


Q 45. For a system in figure, rods AC and BD are of same length, area of cross section and conductivity. For what value of $\frac{BD}{BC}$ there is no heat flow in AB?



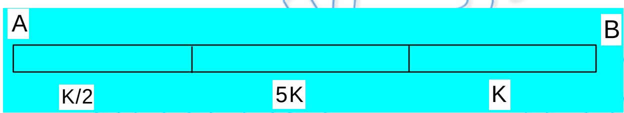
(A) $\frac{2}{7}$ (B) $\frac{7}{2}$ (C) $\frac{9}{2}$ (D) $\frac{2}{9}$

Q 46. The temperature drop through each layer of a two layer furnace wall is shown in figure. Assume that the external temperature T_1 and T_3 are maintained constant and $T_1 > T_3$. If the thickness of the layers x_1 and x_2 are the same, which of the following statements are correct.



(A) $k_1 > k_2$
(B) $k_1 < k_2$
(C) $k_1 = k_2$ but heat flow through material (1) is larger than through (2)
(D) $k_1 = k_2$ but heat flow through material (1) is less than that through (2)

Q 47. A composite rod made of three rods of equal length and cross-section as shown in the fig. The thermal conductivities of the materials of the rods are K/2, 5K and K respectively. The end A and end B are at constant temperatures. All heat entering the face A goes out of the end B there being no loss of heat from the sides of the bar. The effective thermal conductivity of the bar is

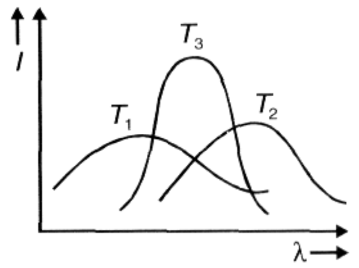


(A) 15K/16 (B) 6K/13 (C) 5K/16 (D) 2K/13.

Q 48. A black metal foil is warmed by radiation from a small sphere at temperature ' T ' and at a distance ' d '. It is found that the power received by the foil is P. If both the temperature and distance are doubled, the power received by the foil will be:

(A) 16 P (B) 4 P (C) 2 P (D) P

Q 49. The plot of intensity versus wavelength for three black bodies at temperature T_1 T_2 and T_3 respectively as shown. Their temperatures are such that



(A)$T_1>T_2>T_3$ (b)$T_1>T_3>T_2$ (C)$T_2>T_3>T_1$ (D)$T_3>T_2>T_1$

Q 50. The rate of emission of radiation of a black body at 273°C is E, then the rate of emission of radiation of this body at 0°C will be

(A) $\frac{E}{16}$ (B) $\frac{E}{4}$ (C) $\frac{E}{8}$ (D) 0

Q 51. The power radiated by a black body is P and it radiates maximum energy around the wavelength λ_0. If the temperature of the black body is now changed so that it radiates maximum energy around wavelength $\frac{3}{4}\lambda_0$, the power radiated by it will increase by a factor of

(A) 4/3 (B) 16/9 (C) 64/27 (D) 256/81

Q 52. A body cools from 50°C to 40°C in 5 minute. Surrounding temperature is 20°C. Then what will be its temperature 5 minutes after reaching 40°C?

(A) 35°C (B) $\frac{100}{3}$°C (C) 32°C (D) 30°C

Q 53. Spheres P and Q are uniformly constructed from the same material which is a good conductor of heat and the radius of Q is thrice the radius of P. The rate of fall of temperature of P is x times that of Q when both are at the same surface temperature. The value of x is :

(A) 1/4 (B) 1/3 (C) 3 (D) 4

Q 54. Estimate temperature T_e of earth, assuming it is in radiative equilibrium with sun (Assume radius of sun $R_s = 7 \times 10^8$ m) temperature of solar surface T_s = 6000 K, earth sun distance d= 1.5×10^{11} m)

(A) 290 K (B) 300 K (C) 310 K (D)1000 K

Q 55. A 100 W electric light bulb has filament which is 0.6 m long and has diameter of 8×10^{-5} m. Estimate working temperature of filament, if its total emissivity e is 0.7

(A)1900 K (B) 2018 K (C) 2800 K (D) 2946

Q 56. Two thin blankets are better than one thick blanket in controlling effect of cold air since

(A) Perforation in thick blanket will be bigger

(B) Perforation in thin blanket will be smaller

(C) Air between thin blankets stops heat transfer

(D) Thin blanket absorb more energy

Q 57. Two spheres of emissive power 0.6 and 0.8 and radii 2 cm and 4 cm are heated to 27°C and 127°C and placed in room of temperature OK. The ratio of heat radiated per second is

(A) 0.059 (B) 0.044 (C) 0.079 (D) 0.831

Q 58. Temperature at which person can feel metal rod and wooden block to be equally hot is

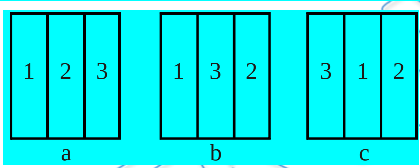
(A)His body temperature

(B)Twice has body temperature

(C)Four times equal to body temperature

(D)Temperature equal to their ratio of specific heat capacities

Q 59. Figure shows three different arrangements of materials 1, 2 and 3 to form a wall. Thermal conductivities are $k_1 > k_2 > k_3$. The left side of the wall is 20°C higher than the right side. Temperature difference ΔT across the material 1 has following relation in three cases :



(A) $\Delta T_a > \Delta T_b > \Delta T_c$ (B) $\Delta T_a = \Delta T_b = \Delta T_c$

(C) $\Delta T_a = \Delta T_b > \Delta T_c$ (D) $\Delta T_a = \Delta T_b < \Delta T_c$

Answer Key

Q.1) B	Q.2) D	Q.3) C	Q.4) D	Q.5) A
Q.6) C	Q.7) C	Q.8) D	Q.9) D	Q.10) B
Q.11) A	Q.12) C	Q.13) C	Q.14) C	Q.15) B
Q.16) D	Q.17) B	Q.18) D	Q.19) A	Q.20) B
Q.21) C	Q.22) D	Q.23) A	Q.24) B	Q.25) D
Q.26) C	Q.27) B	Q.28) C	Q.29) B	Q.30) B
Q.31) B	Q.32) B	Q.33) C	Q.34) C	Q.35) A
Q.36) C	Q.37) D	Q.38) A	Q.39) B	Q.40) C
Q.41) D	Q.42) C	Q.43) C	Q.44) A	Q.45) B
Q.46) A	Q.47) A	Q.48) B	Q.49) B	Q.50) A
Q.51) D	Q.52) B	Q.53) C	Q.54) A	Q.55) B
Q.56) C	Q.57) A	Q.58) A	Q.59) B	