Q1. The temperature of a gas is $-78^{\circ}\mathrm{C}$ and the average translational kinetic energy of its molecules is K. The temperature at which the average translational kinetic energy of the molecules of the same gas becomes 2 K is :

09 Apr 2024 (E)

(1) $127^{\circ}\mathrm{C}$ (2) $117^{\circ}\mathrm{C}$

(3) $-39^{\circ}\mathrm{C}$ (4) $-78^{\circ}\mathrm{C}$

Q2. A mixture of one mole of monoatomic gas and one mole of a diatomic gas (rigid) are kept at room temperature $(27^{\circ}\mathrm{C})$. The ratio of specific heat of gases at constant volume respectively is: ***08 Apr 2024 (M)***

(1) $\frac{7}{5}$ (2) $\frac{3}{5}$

(3) $\frac{5}{3}$ (4) $\frac{3}{2}$

Q3. Given below are two statements :

Statement (I) : The mean free path of gas molecules is inversely proportional to square of molecular diameter.

Statement (II) : Average kinetic energy of gas molecules is directly proportional to absolute temperature of gas.

In the light of the above statements, choose the correct answer from the options given below: ***08 Apr 2024 (E)***

(1) Statement I is true but Statement II is false (2) Both Statement I and Statement II are false

(3) Both Statement I and Statement II are true (4) Statement I is false but Statement II is true

Q4. A sample contains mixture of helium and oxygen gas. The ratio of root mean square speed of helium and oxygen in the sample, is: ***06 Apr 2024 (M)***

(1) $\frac{1}{32}$ (2) $\frac{2\sqrt{2}}{1}$

(3) $\frac{1}{2\sqrt{2}}$ (4) $\frac{1}{4}$

Q5. The specific heat at constant pressure of a real gas obeying $PV^2 = RT$ equation is: ***06 Apr 2024 (M)***

(1) $\frac{R}{3} + C_V$ (2) $C_V + R$

(3) $C_V + \frac{R}{2V}$ (4) R

Q6. Energy of 10 non rigid diatomic molecules at temperature T is : ***06 Apr 2024 (E)***

(1) $70\ \mathrm{K_BT}$ (2) $35\ \mathrm{K_BT}$

(3) $\frac{7}{2}\mathrm{RT}$ (4) $35\mathrm{RT}$

Q7. If the collision frequency of hydrogen molecules in a closed chamber at $27^{\circ}\mathrm{C}$ is Z, then the collision frequency of the same system at $127^{\circ}\mathrm{C}$ is : ***05 Apr 2024 (M)***

(1) $\frac{\sqrt{3}}{2}\mathrm{z}$ (2) $\frac{2}{\sqrt{3}}\mathrm{Z}$

(3) $\frac{3}{4}\mathrm{Z}$ (4) $\frac{4}{3}\mathrm{Z}$

Q8. If n is the number density and d is the diameter of the molecule, then the average distance covered by a molecule between two successive collisions (i.e. mean free path) is represented by : ***05 Apr 2024 (E)***

(1) $\sqrt{2}\mathrm{n}\pi\mathrm{d}^2$ (2) $\frac{1}{\sqrt{2n\pi d^2}}$

(3) $\frac{1}{\sqrt{2}n\pi d^2}$ (4) $\frac{1}{\sqrt{2}n^2\pi^2 d^2}$

Q9. During an adiabatic process, if the pressure of a gas is found to be proportional to the cube of its absolute temperature, then the ratio of $\frac{C_P}{C_V}$ for the gas is : ***05 Apr 2024 (E)***

(1) $\frac{5}{3}$ (2) $\frac{9}{7}$
(3) $\frac{3}{2}$ (4) $\frac{7}{5}$

Q10. The translational degrees of freedom (f_t) and rotational degrees of freedom (f_r) of CH_4 molecule are:

04 Apr 2024 (E)

(1) $f_t = 2$ and $f_r = 2$ (2) $f_t = 3$ and $f_r = 3$
(3) $f_t = 3$ and $f_r = 2$ (4) $f_t = 2$ and $f_r = 3$

Q11. Two moles of a monoatomic gas is mixed with six moles of a diatomic gas. The molar specific heat of the mixture at constant volume is :

01 Feb 2024 (M)

(1) $\frac{9}{4}R$ (2) $\frac{7}{4}R$
(3) $\frac{3}{2}R$ (4) $\frac{5}{2}R$

Q12. If the root mean square velocity of hydrogen molecule at a given temperature and pressure is 2 km s^{-1}, the root mean square velocity of oxygen at the same condition in km s^{-1} is:

01 Feb 2024 (E)

(1) 2.0 (2) 0.5
(3) 1.5 (4) 1.0

Q13. The parameter that remains the same for molecules of all gases at a given temperature is :

31 Jan 2024 (M)

(1) kinetic energy (2) momentum
(3) mass (4) speed

Q14. A gas mixture consists of 8 moles of argon and 6 moles of oxygen at temperature T. Neglecting all vibrational modes, the total internal energy of the system is

31 Jan 2024 (E)

(1) 29 RT (2) 20 RT
(3) 27 RT (4) 21 RT

Q15. At which temperature the r.m.s. velocity of a hydrogen molecule equal to that of an oxygen molecule at 47°C ?

30 Jan 2024 (M)

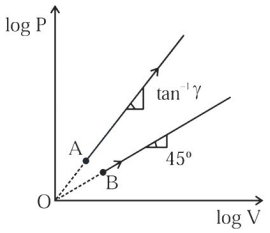
(1) 80 K (2) −73 K
(3) 4 K (4) 20 K

Q16. If three moles of monoatomic gas $\left(\gamma = \frac{5}{3}\right)$ is mixed with two moles of a diatomic gas $\left(\gamma = \frac{7}{5}\right)$, the value of adiabatic exponent γ for the mixture is:

30 Jan 2024 (E)

(1) 1.75 (2) 1.40
(3) 1.52 (4) 1.35

Q17. Two thermodynamical process are shown in the figure. The molar heat capacity for process A and B are C_A and C_B. The molar heat capacity at constant pressure and constant volume are represented by C_P and C_V, respectively. Choose the correct statement.



30 Jan 2024 (M)

(1) $C_P > C_B > C_V$ (2) $C_A = 0$ and $C_B = \infty$

(3) $C_P > C_V > C_A = C_B$ (4) $C_A > C_P > C_V$

Q18. Two vessels A and B are of the same size and are at same temperature. A contains 1 g of hydrogen and B contains 1 g of oxygen. P_A and P_B are the pressures of the gases in A and B respectively, then $\frac{P_A}{P_B}$ is :

29 Jan 2024 (M)

(1) 16 (2) 8

(3) 4 (4) 32

Q19. The temperature of a gas having 2.0×10^{25} molecules per cubic meter at 1.38 atm (Given, $k = 1.38 \times 10^{-23} \mathrm{J\ K^{-1}}$) is : ***29 Jan 2024 (E)***

(1) 500 K (2) 200 K

(3) 100 K (4) 300 K

Q20. N moles of a polyatomic gas($f = 6$) must be mixed with two moles of a monoatomic gas so that the mixture behaves as a diatomic gas. The value of N is: ***29 Jan 2024 (E)***

(1) 6 (2) 3

(3) 4 (4) 2

Q21. The total kinetic energy of 1 mole of oxygen at 27°C is :

[Use universal gas constant $(\mathrm{R}) = 8.31\ \mathrm{J\ mol^{-1}\ K^{-1}}$] ***27 Jan 2024 (E)***

(1) 6845.5 J (2) 5942.0 J

(3) 6232.5 J (4) 5670.5 J

Q22. The average kinetic energy of a monatomic molecule is 0.414 eV at temperature:

(Use $K_B = 1.38 \times 10^{-23}\ \mathrm{J\ mol^{-1}\ K^{-1}}$)

27 Jan 2024 (M)

(1) 3000 K (2) 3200 K

(3) 1600 K (4) 1500 K

Q23. A flask contains Hydrogen and Argon in the ratio 2 : 1 by mass. The temperature of the mixture is 30°C. The ratio of average kinetic energy per molecule of the two gases $\left(\frac{K_{\text{argon}}}{K_{\text{hydrogen}}}\right)$ is: (Given : Atomic Weight of $Ar = 39.9$) ***15 Apr 2023 (M)***

(1) 2 (2) 1

(3) 39.9 (4) $\frac{39.9}{2}$

Q24. The rms speed of oxygen molecule in a vessel at particular temperature is $\left(1 + \frac{5}{x}\right)^{\frac{1}{2}} v$, when v is the average speed of the molecule. The value of x will be:

(take $\pi = \frac{22}{7}$)

13 Apr 2023 (M)

(1) 27 (2) 8

(3) 28 (4) 4

Q25. The mean free path of molecules of a certain gas at STP is $1500d$, where d is the diameter of the gas molecules. While maintaining the standard pressure, the mean free path of the molecules at 373 K is

approximately: ***13 Apr 2023 (E)***

(1) $750d$ (2) $1098d$

(3) $2049d$ (4) $1500d$

Q26. If the r.m.s speed of chlorine molecule is $490\ \text{m s}^{-1}$ at 27°C, the r.m.s speed of argon molecules at the same temperature will be (Atomic mass of argon $= 39.9$ u, molecular mass of chlorine $= 70.9$ u)

12 Apr 2023 (M)

(1) $551.7\ \text{m s}^{-1}$ (2) $651.7\ \text{m s}^{-1}$

(3) $451.7\ \text{m s}^{-1}$ (4) $751.7\ \text{m s}^{-1}$

Q27. The root mean square speed of molecules of nitrogen gas at 27°C is approximately: (Given mass of a nitrogen molecule $= 4.6 \times 10^{-26}$ kg and take Boltzmann constant $k_B = 1.4 \times 10^{-23}\text{J K}^{-1}$) ***11 Apr 2023 (E)***

(1) $27.4\ \text{m s}^{-1}$ (2) $91\ \text{m s}^{-1}$

(3) $1260\ \text{m s}^{-1}$ (4) $523\ \text{m s}^{-1}$

Q28. Three vessels of equal volume contain gases at the same temperature and pressure. The first vessel contains neon (monoatomic), the second contains chlorine (diatomic) and third contains uranium hexafluoride (polyatomic). Arrange these on the basis of their root mean square speed (v_{rms}) and choose the correct answer from the options given below: ***11 Apr 2023 (M)***

(1) $\text{v}_{rms}(\text{mono}) > \text{v}_{rms}(\text{dia}) > \text{v}_{rms}(\text{poly})$ (2) $\text{V}_{rms}(\text{mono}) = \text{V}_{rms}(\text{dia}) = \text{V}_{rms}(\text{poly})$

(3) $\text{v}_{rms}(\text{mono}) < \text{v}_{rms}(\text{dia}) < \text{v}_{rms}(\text{poly})$ (4) $\text{v}_{rms}(\text{dia}) < \text{v}_{rms}(\text{poly}) < \text{v}_{rms}(\text{mono})$

Q29. Match List I with List II:

List I		List II	
(A)	3 Translational degrees of freedom	(I)	Monoatomic gases
(B)	3 Translational, 2 rotational degrees of freedoms	(II)	Polyatomic gases
(C)	3 Translational, 2 rotational and 1 vibrational degrees of freedom	(III)	Rigid diatomic gases
(D)	3 Translational, 3 rotational and more than one vibrational degrees of freedom	(IV)	Nonrigid diatomic gases

Choose the correct answer from the options given below:

10 Apr 2023 (M)

(1) (A) – (I), (B) – (III), (C) – (IV), (D) – (II)

(2) (A) – (IV), (B) – (III), (C) – (II), (D) – (I)

(3) (A) – (IV), (B) – (II), (C) – (I), (D) – (III)

(4) (A) – (I), (B) – (IV), (C) – (III), (D) – (II)

Q30. A gas mixture consists of 2 moles of oxygen and 4 moles of neon at temperature T. Neglecting all vibrational modes, the total internal energy of the system will be: ***10 Apr 2023 (E)***

(1) $11RT$ (2) $8RT$

(3) $4RT$ (4) $16RT$

Q31. The temperature at which the kinetic energy of oxygen molecules becomes double than its value at 27°C is

08 Apr 2023 (E)

(1) $927^{\circ}C$ (2) $327^{\circ}C$
(3) $1227^{\circ}C$ (4) $627^{\circ}C$

Q32. The temperature of an ideal gas is increased from 200 K to 800 K. If r.m.s. speed of gas at 200 K is v_0. Then, r.m.s. speed of the gas at 800 K will be:

06 Apr 2023 (E)

(1) $\frac{v_0}{4}$ (2) v_0
(3) $4v_0$ (4) $2v_0$

Q33. The number of air molecules per cm^3 is increased from 3×10^{19} to 12×10^{19}. The ratio of collision frequency of air molecules before and after the increase in number respectively is :

06 Apr 2023 (M)

(1) 0.75 (2) 1.25
(3) 0.50 (4) 0.25

Q34. The average kinetic energy of a molecule of the gas is ***01 Feb 2023 (M)***

(1) proportional to absolute temperature (2) proportional to volume
(3) proportional to pressure (4) dependent on the nature of the gas

Q35. A flask contains hydrogen and oxygen in the ratio of $2 : 1$ by mass at temperature $27\ ^{\circ}C$. The ratio of average kinetic energy per molecule of hydrogen and oxygen respectively is : ***30 Jan 2023 (E)***

(1) $2 : 1$ (2) $1 : 1$
(3) $1 : 4$ (4) $4 : 1$

Q36. The pressure (P) and temperature (T) relationship of an ideal gas obeys the equation $PT^2 =$ constant. The volume expansion coefficient of the gas will be : ***30 Jan 2023 (M)***

(1) $3T^2$ (2) $\frac{3}{T^2}$
(3) $\frac{3}{T^3}$ (4) $\frac{3}{T}$

Q37. At 300 K, the rms speed of oxygen molecules is $\sqrt{\frac{\alpha+5}{\alpha}}$ times to that of its average speed in the gas. Then, the value of α will be (use $\pi = \frac{22}{7}$) ***29 Jan 2023 (E)***

(1) 32 (2) 28
(3) 24 (4) 27

Q38. The root mean square velocity of molecules of gas is ***25 Jan 2023 (M)***

(1) Proportional to square of temperature (T^2).
(2) Inversely proportional to square root of temperature $(\sqrt{\frac{1}{T}})$.
(3) Proportional to square root of temperature $\sqrt{T}$.
(4) Proportional to temperature (T).

Q39. Given below are two statements:

Statement I: The temperature of a gas is $-73\ ^{\circ}C$. When the gas is heated to $527\ ^{\circ}C$, the root mean square speed of the molecules is doubled.

Statement II : The product of pressure and volume of an ideal gas will be equal to translational kinetic energy

of the molecules.

In the light of the above statements, choose the correct answer from the options given below: ***24 Jan 2023 (M)***

(1) Both Statement I and Statement II are true
(2) Statement I is true but Statement II is false
(3) Both Statement I and Statement II are false
(4) Statement I is false but Statement II is true

Q40. Let γ_1 be the ratio of molar specific heat at constant pressure and molar specific heat at constant volume of a monoatomic gas and γ_2 be the similar ratio of diatomic gas. Considering the diatomic gas molecule as a rigid rotator, the ratio $\frac{\gamma_1}{\gamma_2}$ is: ***24 Jan 2023 (E)***

(1) $\frac{27}{35}$
(2) $\frac{35}{27}$
(3) $\frac{25}{21}$
(4) $\frac{21}{25}$

Q41. The root mean square speed of smoke particles of mass 5×10^{-17} kg in their Brownian motion in air at NTP is approximately.

[Given $k = 1.38 \times 10^{-23} \mathrm{J\ K^{-1}}$]

29 Jul 2022 (E)

(1) $60\ \mathrm{mm\ s^{-1}}$
(2) $12\ \mathrm{mm\ s^{-1}}$
(3) $15\ \mathrm{mm\ s^{-1}}$
(4) $36\ \mathrm{mm\ s^{-1}}$

Q42. One mole of a monoatomic gas is mixed with three moles of a diatomic gas. The molecular specific heat of mixture at constant volume is $\frac{\alpha^2}{4} R\ \mathrm{J\ mol\ K^{-1}}$; then the value of α will be _____ . (Assume that the given diatomic gas has no vibrational mode.) ***29 Jul 2022 (M)***

Q43. A vessel contains 14 g of nitrogen gas at a temperature of $27^{\circ}\mathrm{C}$. The amount of heat to be transferred to the gas to double the r.m.s. speed of its molecules will be : (Take $R = 8.32\ \mathrm{J\ mol^{-1}\ k^{-1}}$) ***28 Jul 2022 (E)***

(1) 2229 J
(2) 5616 J
(3) 9360 J
(4) $13,104$ J

Q44. Given below are two statements:

Statement I : The average momentum of a molecule in a sample of an ideal gas depends on temperature.

Statement II : The rms speed of oxygen molecules in a gas is v. If the temperature is doubled and the oxygen molecules dissociate into oxygen atoms, the rms speed will become $2v$.

In the light of the above statements, choose the correct answer from the options given below :

28 Jul 2022 (M)

(1) Both Statement I and Statement II are true
(2) Both Statement I and Statement II are false
(3) Statement I is true but Statement II is false
(4) Statement I is false but Statement II is true

Q45. Same gas is filled in two vessels of the same volume at the same temperature. If the ratio of the number of molecules is 1 : 4, then

A. The r.m.s. velocity of gas molecules in two vessels will be the same.
B. The ratio of pressure in these vessels will be 1 : 4.
C. The ratio of pressure will be 1 : 1.
D. The r.m.s. velocity of gas molecules in two vessels will be in the ratio of 1 : 4.

27 Jul 2022 (M)

(1) A and C only
(2) B and D only
(3) A and B only
(4) C and D only

Q46. Which statements are correct about degrees of freedom?

A. A molecule with n degrees of freedom has n^2 different ways of storing energy.

B. Each degree of freedom is associated with $\frac{1}{2}RT$ average energy per mole.

C. A monoatomic gas molecule has 1 rotational degree of freedom where as diatomic molecule has 2 rotational degrees of freedom

D. CH_4 has a total to 6 degrees of freedom.

Choose the correct answer from the option given below:

27 Jul 2022 (E)

(1) B and C only
(2) B and D only
(3) A and B only
(4) C and D only

Q47. A gas has n degrees of freedom. The ratio of specific heat of gas at constant volume to the specific heat of gas at constant pressure will be ***26 Jul 2022 (E)***

(1) $\frac{n}{n+2}$
(2) $\frac{n+2}{n}$
(3) $\frac{n}{2n+2}$
(4) $\frac{n}{n-2}$

Q48. Following statements are given

(1) The average kinetic energy of a gas molecule decreases when the temperature is reduced.

(2) The average kinetic energy of a gas molecule increases with increase in pressure at constant temperature.

(3) The average kinetic energy of a gas molecule decreases with increases in volume.

(4) Pressure of a gas increases with increase in temperature at constant volume.

(5) The volume of gas decreases with increase in temperature.

Choose the correct answer from the options given below :

25 Jul 2022 (M)

(1) (1) and (4) only
(2) (1), (2) and (4) only
(3) (2) and (4) only
(4) (1), (2) and (5) only

Q49. A vessel contains 16 g of hydrogen and 128 g of oxygen at standard temperature and pressure. The volume of the vessel in cm^3 is : ***29 Jun 2022 (E)***

(1) 72×10^5
(2) 32×10^5
(3) 27×10^4
(4) 54×10^4

Q50. What will be the effect on the root mean square velocity of oxygen molecules if the temperature is doubled and oxygen molecule dissociates into atomic oxygen? ***28 Jun 2022 (E)***

(1) The velocity of atomic oxygen remains same

(2) The velocity of atomic oxygen doubles

(3) The velocity of atomic oxygen becomes half

(4) The velocity of atomic oxygen becomes four times

Q51. A mixture of hydrogen and oxygen has volume 2000 cm^3, temperature 300 K, pressure 100 kPa and mass 0. 76 g. The ratio of number of moles of hydrogen to number of moles of oxygen in the mixture will be [Take

gas constant $R = 8.3\ \text{J K}^{-1}\ \text{mol}^{-1}$]

27 Jun 2022 (M)

(1) $\frac{1}{3}$ (2) $\frac{3}{1}$

(3) $\frac{1}{16}$ (4) $\frac{16}{1}$

Q52. According to kinetic theory of gases,

A. The motion of the gas molecules freezes at 0°C.

B. The mean free path of gas molecules decreases if the density of molecules is increased.

C. The mean free path of gas molecules increases if temperature is increased keeping pressure constant.

D. Average kinetic energy per molecule per degree of freedom is $\frac{3}{2}k_BT$ (for monoatomic gases).

Choose the most appropriate answer from the options given below

27 Jun 2022 (E)

(1) A and C only (2) B and C only

(3) A and B only (4) C and D only

Q53. A flask contains argon and oxygen in the ratio of $3:2$ in mass and the mixture is kept at 27°C. The ratio of their average kinetic energy per molecule respectively ***26 Jun 2022 (E)***

(1) $3:5$ (2) $9:4$

(3) $2:3$ (4) $1:1$

Q54. The ratio of specific heats $\left(\frac{C_P}{C_V}\right)$ in terms of degree of freedom (f) is given by : ***25 Jun 2022 (E)***

(1) $\left(1+\frac{f}{3}\right)$ (2) $\left(1+\frac{2}{f}\right)$

(3) $\left(1+\frac{f}{2}\right)$ (4) $\left(1+\frac{1}{f}\right)$

Q55. When a gas filled in a closed vessel is heated by raising the temperature by 1°C, its pressure increases by 0.4% The initial temperature of the gas is _____ K. ***25 Jun 2022 (E)***

Q56. The relation between root mean square speed (v_{rms}) and most probable speed (v_{p}) for the molar mass M of oxygen gas molecule at the temperature of 300 K will be ***25 Jun 2022 (M)***

(1) $v_{\text{rms}} = \sqrt{\frac{2}{3}}v_{\text{p}}$ (2) $v_{\text{rms}} = \sqrt{\frac{1}{3}}v_{\text{p}}$

(3) $v_{\text{rms}} = \sqrt{\frac{3}{2}}v_{\text{p}}$ (4) $v_{\text{rms}} = v_{\text{p}}$

Q57. 0.056 kg of Nitrogen is enclosed in a vessel at a temperature of 127°C. The amount of heat required to double the speed of its molecules is_____ kcal.

(Take $R = 2\ \text{cal mole}^{-1}\,\text{K}^{-1}$) ***24 Jun 2022 (M)***

Q58. A monoatomic gas performs a work of $\frac{Q}{4}$ where Q is the heat supplied to it. The molar heat capacity of the gas will be _____ R during this transformation.

Where R is the gas constant.

24 Jun 2022 (E)

Q59. The average translational kinetic energy of N_2 gas molecules at _____$^\circ$C becomes equal to the K. E. of an electron accelerated from rest through a potential difference of 0.1 volt.

(Given $k_B = 1.38 \times 10^{-23}\ \text{J K}^{-1}$) (Fill the nearest integer).

01 Sep 2021 (E)

Q60. For an ideal gas the instantaneous change in pressure P with volume V is given by the equation $\frac{dP}{dV} = -aP$. If $P = P_0$ at $V = 0$ is the given boundary condition, then the maximum temperature one mole of gas can attain is: (Here R is the gas constant) ***31 Aug 2021 (M)***

(1) $\frac{aP_0}{eR}$ (2) infinity

(3) $0^\circ C$ (4) $\frac{P_0}{aeR}$

Q61. A mixture of hydrogen and oxygen has volume 500 cm^3, temperature 300 K, pressure 400 kPa and mass 0.76 g. The ratio of masses of oxygen to hydrogen will be: ***31 Aug 2021 (E)***

(1) 16 : 3 (2) 3 : 8

(3) 8 : 3 (4) 3 : 16

Q62. If the R.M.S. speed of oxygen molecules at $0^\circ C$ is 160 m s^{-1}. Find the R.M.S. speed of hydrogen molecules at $0^\circ C$. ***27 Aug 2021 (E)***

(1) 40 m s^{-1} (2) 80 m s^{-1}

(3) 640 m s^{-1} (4) 332 m s^{-1}

Q63. A balloon carries a total load of 185 kg at normal pressure and temperature of $27^\circ C$. What load will the balloon carry on rising to a height at which the barometric pressure is 45 cm of Hg and the temperature is $-7^\circ C$. Assuming the volume constant? ***27 Aug 2021 (M)***

(1) 214.15 kg (2) 123.54 kg

(3) 219.07 kg (4) 181.46 kg

Q64. The R.M.S. speeds of the molecules of Hydrogen, Oxygen, and Carbon dioxide at the same temperature are v_H, v_O and v_C respectively, then: ***26 Aug 2021 (M)***

(1) $v_C > v_O > v_H$ (2) $v_H = v_O > v_C$

(3) $v_H > v_O > v_C$ (4) $v_H = v_O = v_C$

Q65. A cylindrical container of volume 4.0×10^{-3} m^3 contains one mole of hydrogen and two moles of carbon dioxide. Assume the temperature of the mixture is 400 K. The pressure of the mixture of gases is : [Take gas constant as 8.3 J mol^{-1} K^{-1}] ***26 Aug 2021 (E)***

(1) 24.9×10^3 Pa (2) 249×10^1 Pa

(3) 24.9×10^5 Pa (4) 24.9 Pa

Q66. The number of molecules in one litre of an ideal gas at 300 K and 2 atmospheric pressure with mean kinetic energy 2×10^{-9} J per molecule is: ***27 Jul 2021 (M)***

(1) 0.75×10^{11} (2) 3×10^{11}

(3) 1.5×10^{11} (4) 6×10^{11}

Q67. For a gas $C_P - C_V = R$ in a state P and $C_P - C_V = 1.10R$ in a state Q, T_P and T_Q are the temperatures in two different states P and Q, respectively. Then ***25 Jul 2021 (M)***

(1) $T_P = T_Q$ (2) $T_P < T_Q$

(3) $T_P = 0.9T_Q$ (4) $T_P > T_Q$

Q68. A system consists of two types of gas molecules A and B having the same number density $2 \times 10^{25}\ \mathrm{m}^{-3}$. The diameter of A and B are $10A$ and $5A$ respectively. They suffer collisions at room temperature. The ratio of average distance covered by the molecule A to that of B between two successive collisions is _____ $\times 10^{-2}$

25 Jul 2021 (E)

Q69. What will be the average value of energy for a monoatomic gas in thermal equilibrium at temperature T?

22 Jul 2021 (M)

(1) $\frac{2}{3}\ k_BT$ (2) k_BT

(3) $\frac{3}{2}\ k_BT$ (4) $\frac{1}{2}\ k_BT$

Q70. Consider a mixture of gas molecule of types A, B and C having masses $m_{\mathrm{A}} < m_{\mathrm{B}} < m_{\mathrm{C}}$. The ratio of their root mean square speeds at normal temperature and pressure is:

20 Jul 2021 (M)

(1) $v_{\mathrm{A}} = v_{\mathrm{B}} = v_{\mathrm{C}} = 0$ (2) $\frac{1}{v_{\mathrm{A}}} > \frac{1}{v_{\mathrm{B}}} > \frac{1}{v_{\mathrm{C}}}$

(3) $v_{\mathrm{A}} = v_{\mathrm{B}} \neq v_{\mathrm{C}}$ (4) $\frac{1}{v_{\mathrm{A}}} < \frac{1}{v_{\mathrm{B}}} < \frac{1}{v_{\mathrm{C}}}$

Q71. The correct relation between the degrees of freedom f and the ratio of specific heat γ is:

20 Jul 2021 (E)

(1) $f = \frac{2}{\gamma - 1}$ (2) $f = \frac{2}{\gamma + 1}$

(3) $f = \frac{\gamma + 1}{2}$ (4) $f = \frac{1}{\gamma + 1}$

Q72. Consider a sample of oxygen behaving like an ideal gas. At 300 K, the ratio of root-mean-square (RMS) velocity to the average velocity of the gas molecule would be :
(Molecular weight of oxygen is 32 g mol^{-1}; $R = 8.3\ \mathrm{J\ K^{-1}\ mol^{-1}}$)

18 Mar 2021 (E)

(1) $\sqrt{\frac{3}{3}}$ (2) $\sqrt{\frac{8}{3}}$

(3) $\sqrt{\frac{3\pi}{8}}$ (4) $\sqrt{\frac{8\pi}{3}}$

Q73. For an adiabatic expansion of an ideal gas, the fractional change in its pressure is equal to (where γ is the ratio of specific heats):

18 Mar 2021 (E)

(1) $-\gamma \frac{\mathrm{d}V}{V}$ (2) $-\gamma \frac{V}{\mathrm{d}V}$

(3) $-\frac{1}{\gamma} \frac{\mathrm{d}V}{V}$ (4) $\frac{\mathrm{d}V}{V}$

Q74. What will be the average value of energy along one degree of freedom for an ideal gas in thermal equilibrium at a temperature T ? (k_B is Boltzmann constant)

18 Mar 2021 (M)

(1) $\frac{1}{2} k_{\mathrm{B}} T$ (2) $\frac{2}{3} k_{\mathrm{B}} T$

(3) $\frac{3}{2} k_{\mathrm{B}} T$ (4) $k_B T$

Q75. A polyatomic ideal gas has 24 vibrational modes. What is the value of γ?

17 Mar 2021 (M)

(1) 1.03 (2) 1.30

(3) 1.37 (4) 10.3

Q76. If one mole of the polyatomic gas is having two vibrational modes and β is the ratio of molar specific heats for polyatomic gas $\left(\beta = \frac{\mathrm{C_P}}{\mathrm{C_v}}\right)$ then the value of β is :

17 Mar 2021 (E)

(1) 1.02 (2) 1.2

(3) 1.25 (4) 1.35

Q77. Two ideal polyatomic gases at temperatures T_1 and T_2 are mixed so that there is no loss of energy. If F_1 and F_2, m_1 and m_2, n_1 and n_2 be the degrees of freedom, masses, number of molecules of the first and second gas respectively, the temperature of mixture of these two gases is: ***17 Mar 2021 (M)***

(1) $\frac{n_1 T_1+n_2 T_2}{n_1+n_2}$ (2) $\frac{n_1F_1T_1+n_2F_2T_2}{n_1F_1+n_2F_2}$

(3) $\frac{n_1 F_1 T_1+n_2 F_2 T_2}{F_1+F_2}$ (4) $\frac{n_1 F_1 T_1+n_2 F_2 T_2}{n_1+n_2}$

Q78. Calculate the value of the mean free path (λ) for oxygen molecules at temperature $27^{\circ}\mathrm{C}$ and pressure 1.01×10^5 Pa. Assume the molecular diameter 0.3 nm and the gas is ideal. $\left(k=1.38 \times 10^{-23}\ \mathrm{J\ K^{-1}}\right)$ ***16 Mar 2021 (E)***

(1) 58 nm (2) 32 nm

(3) 86 nm (4) 102 nm

Q79. The volume V of an enclosure contains a mixture of three gases, 16 g of oxygen, 28 g of nitrogen and 44 g of carbon dioxide at absolute temperature T. Consider R as universal gas constant. The pressure of the mixture of gases is : ***16 Mar 2021 (M)***

(1) $\frac{88RT}{V}$ (2) $\frac{3RT}{V}$

(3) $\frac{5}{2}\frac{RT}{V}$ (4) $\frac{4RT}{V}$

Q80. The internal energy (U), pressure (P) and volume (V) of an ideal gas are related as $U = 3PV + 4$. The gas is ***26 Feb 2021 (E)***

(1) either monoatomic or diatomic (2) polyatomic only

(3) monoatomic only (4) diatomic only

Q81. Given below are two statements:

Statement I: In a diatomic molecule, the rotational energy at a given temperature obeys Maxwell's distribution.

Statement II : In a diatomic molecule, the rotational energy at a given temperature equals the translational kinetic energy for each molecule.

In the light of the above statements, choose the correct answer from the options given below: ***25 Feb 2021 (E)***

(1) Statement I is false but Statement II is true. (2) Statement I is true but Statement II is false.

(3) Both Statement I and Statement II are true. (4) Both Statement I and Statement II are false.

Q82. A monoatomic gas of mass $4.0\ u$ is kept in an insulated container. The container is moving with velocity 30 m s^{-1}. If the container is suddenly stopped then a change in temperature of the gas (R =gas constant) is $\frac{x}{3R}$. Value of x is, ***25 Feb 2021 (M)***

Q83. A diatomic gas, having $C_P = \frac{7}{2}R$ and $C_V = \frac{5}{2}R$, is heated at constant pressure. The ratio $\mathrm{d}U : \mathrm{d}Q : \mathrm{d}W$ ***25 Feb 2021 (M)***

(1) 3 : 5 : 2 (2) 5 : 7 : 3

(3) 5 : 7 : 2 (4) 3 : 7 : 2

Q84. The root-mean-square speed of molecules of a given mass of a gas at 27 $^{\circ}$C and 1 atmosphere pressure is 200 m s^{-1}. The root-mean-square speed of molecules of the gas at 127 $^{\circ}$C and 2 atmosphere pressure is $\frac{x}{\sqrt{3}}$ m s^{-1}. The value of x will be _____. ***24 Feb 2021 (E)***

Q85. On the basis of kinetic theory of gases, the gas exerts pressure because its molecules: ***24 Feb 2021 (E)***

(1) continuously stick to the walls of container.

(2) suffer change in momentum when impinge on the walls of container.

(3) continuously lose their energy till it reaches wall.

(4) are attracted by the walls of container.

Q86. Molecules of an ideal gas are known to have three translational degrees of freedom. The gas is maintained at a temperature of T. The total internal energy, U of a mole of this gas, and the value of $\gamma = \left(\frac{C_p}{C_v}\right)$ are given, respectively, by ***06 Sep 2020 (M)***

(1) $U = \frac{5}{2}RT$ and $\gamma = \frac{6}{5}$

(2) $U = 5\,RT$ and $\gamma = \frac{7}{5}$

(3) $U = \frac{5}{2}RT$ and $\gamma = \frac{7}{5}$

(4) $U = 5RT$ and $\gamma = \frac{6}{5}$

Q87. In a dilute gas at pressure P and temperature 't', the time between successive collision of a molecule varies with T as : ***06 Sep 2020 (E)***

(1) T

(2) $\frac{1}{\sqrt{T}}$

(3) $\frac{1}{T}$

(4) $\sqrt{T}$

Q88. Assuming the nitrogen molecule is moving with r. m. s. velocity at 400 K, the de-Broglie wave length of nitrogen molecule is close to : (Given : nitrogen molecule weight : 4.64×10^{-26} kg, Boltzman constant : $1.38 \times 10^{-23}\ J\ K^{-1}$, Planck constant : $6.63 \times 10^{-34}\ J\ s$) ***06 Sep 2020 (E)***

(1) $0.24\ \mathring{A}$

(2) $0.20\ \mathring{A}$

(3) $0.34\ \mathring{A}$

(4) $0.44\ \mathring{A}$

Q89. Nitrogen gas is at 300 °C temperature. The temperature (in K) at which the rms speed of a H_2 molecule would be equal to the rms speed of a nitrogen molecule, is ..... (Molar mass of N_2 gas 28 g). ***05 Sep 2020 (E)***

Q90. A bullet of mass 5 gram, travelling with a speed of 210 m s^{-1} strikes a fixed wooden target. One half of its kinetic energy is converted into heat in the wood. The rise of temperature of the bullet if the specific heat of its material is $0.030\ (gram\ ^\circ C)^{-1}$ (1 calorie = 4.2×10^7 ergs) close to : ***05 Sep 2020 (M)***

(1) $87.5^\circ C$

(2) $83.3^\circ C$

(3) $119.2^\circ C$

(4) $38.4^\circ C$

Q91. Number of molecules in a volume of 4 cm^3 of a perfect monoatomic gas at some temperature T and at a pressure of 2 cm of mercury is close to? (Given, mean kinetic energy of a molecule (at T) is 4×10^{-14} erg, g = 980 cm s^{-2} density of mercury = 13.6 g cm^{-3}) ***05 Sep 2020 (M)***

(1) 4.8×10^{18}

(2) 4.0×10^{16}

(3) 5.8×10^{16}

(4) 5.8×10^{18}

Q92. Match the $\frac{C_p}{C_v}$ ratio for ideal gases with different type of molecules:

Molecule Type	C_p/C_v
(A) Monoatomic	(I) 7/5
(B) Diatomic rigid molecules	(II) 9/7

(C) Diatomic non-rigid molecules (III) $4/3$

(D) Triatomic rigid molecules (IV) $5/3$

04 Sep 2020 (M)

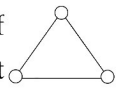
(1) (A) – (IV), (B) – (II), (C) – (I), (D) – (III) (2) (A) – (III), (B) – (IV), (C) – (II), (D) – (I)

(3) (A) – (IV), (B) – (I), (C) – (II), (D) – (III) (4) (A) – (II), (B) – (III), (C) – (I), (D) – (IV)

Q93. A closed vessel contains 0.1 mole of a monoatomic ideal gas at 200 K. If 0.05 mole of the same gas at 400 K is added to it, the final equilibrium temperature (in K) of the gas in the vessel will be close to _____

04 Sep 2020 (M)

Q94. Consider a gas of triatomic molecules. The molecules are assumed to be triangular and made of massless rigid rods whose vertices are occupied by atoms. The internal energy of a mole of the gas at temperature T is:



03 Sep 2020 (M)

(1) $\frac{5}{2}RT$ (2) $\frac{3}{2}RT$

(3) $\frac{9}{2}RT$ (4) $3RT$

Q95. To raise the temperature of a certain mass of gas by 50 $^{\circ}$C at a constant pressure,160 calories of heat is required. When the same mass of gas is cooled by 100°C at constant volume,240 calories of heat is released. How many degrees of freedom does each molecule of this gas have (assume gas to be ideal)? ***03 Sep 2020 (E)***

(1) 5 (2) 6

(3) 3 (4) 7

Q96. A gas mixture consists of 3 moles of oxygen and 5 moles of argon at temperature T. Assuming the gases to be ideal and the oxygen bond to be rigid, the total internal energy (in units of RT) of the mixutre is :

02 Sep 2020 (M)

(1) 15 (2) 13

(3) 20 (4) 11

Q97. An ideal gas in a closed container is slowly heated. As its temperature increases, which of the following statements are true ?

(A) the mean free path of the molecules decreases

(B) the mean collision time between the molecules decreases.

(C) the mean free path remains unchanged.

(D) the mean collision time relations unchanged.

02 Sep 2020 (E)

(1) (B) and (C) (2) (A)and (B)

(3) (C) and (D) (4) (A) and (D)

Q98. Two gases - argon (atomic radius 0.07nm, atomic weight 40) and xenon (atomic radius 0.1nm, atomic weight 140) have the same number density and are at the same temperature. The ratio of their respective mean free times is closest to: ***09 Jan 2020 (E)***

(1) 3.67 (2) 1.83

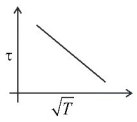
(3) 2.3 (4) 4.67

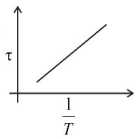
Q99. Consider two ideal diatomic gases A and B at some temperature T . Molecules of the gas A are rigid, and have a mass m . Molecules of the gas B have an additional vibrational mode and have a mass $\frac{m}{4}$. The ratio of the specific heats $\left(C_V\right)_A$ and $\left(C_V\right)_B$ of gas A and B, respectively is: ***09 Jan 2020 (M)***

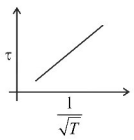
(1) $7:9$ (2) $5:9$

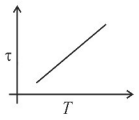
(3) $3:5$ (4) $5:7$

Q100. The plot that depicts the behavior of the mean free time τ (time between two successive collisions) for the molecules of an ideal gas, as a function of temperature (T), qualitatively, is: (Graphs are schematic and not drawn to scale) ***08 Jan 2020 (M)***

(1) 

(2) 

(3) 

(4) 

Q101. Consider a mixture of n moles of helium gas and $2n$ moles of oxygen gas (molecules taken to be rigid) as an ideal gas. Its $\frac{C_P}{C_V}$ value will be: ***08 Jan 2020 (E)***

(1) $\frac{19}{13}$ (2) $\frac{67}{45}$

(3) $\frac{40}{27}$ (4) $\frac{23}{15}$

Q102. Two moles of an ideal gas, with $\frac{C_P}{C_V}=\frac{5}{3}$, are mixed with three moles of another ideal gas $\frac{C_P}{C_V}=\frac{4}{3}$. The value of $\frac{C_P}{C_V}$ for the mixture is ***07 Jan 2020 (M)***

(1) 1.45 (2) 1.50

(3) 1.47 (4) 1.42

Q103. Two moles of helium gas is mixed with three moles of hydrogen molecules (taken to be rigid). What is the molar specific heat of mixture at constant volume? $(\mathrm{R}=8.3\ \mathrm{J/mol\ K})$ ***12 Apr 2019 (M)***

(1) 17.4 J/mol K (2) 19.7 J/mol K

(3) 15.7 J/mol K (4) 21.6 J/mol K

Q104. A diatomic gas with rigid molecules does 10 J of work when expanded at constant pressure. What would be the heat energy absorbed by the gas, in this process? ***12 Apr 2019 (E)***

(1) 40 J (2) 35 J

(3) 25 J (4) 30 J

Q105. The number density of molecules of a gas depends on their distance r from the origin as, $n(r)=n_0e^{-\alpha r^4}$. Then the numer of molecules is proportional to: ***12 Apr 2019 (E)***

(1) $n_0\alpha^{-3}$ (2) $\sqrt{n_0}\alpha^{\frac{1}{2}}$

(3) $n_0\alpha^{\frac{-3}{4}}$ (4) $n_0\alpha^{\frac{1}{4}}$

Q106. A $25\times10^{-3}\ \mathrm{m}^3$ volume cylinder is filled with 1 mol of O_2 gas at room temperature $(300\ \mathrm{K})$. The molecular diameter of O_2 , and its root mean square speed, are found to be 0.3 nm and 200 m/s , respectively. What is the average collision rate (per second) for an O_2 molecule? ***10 Apr 2019 (M)***

(1) ~10^{11} (2) ~10^{12}

(3) ~10^{10} (4) ~10^{13}

Q107. When heat Q is supplied to a diatomic gas of rigid molecules, at constant volume its temperature increases by Δ T . The heat required to produce the same change in temperature, at a constant pressure is:

10 Apr 2019 (E)

(1) $\frac{3}{2}$Q (2) $\frac{7}{5}$Q

(3) $\frac{5}{3}$Q (4) $\frac{2}{3}$Q

Q108. For given gas at 1 atm pressure, rms speed of the molecules is 200 m/s at 127° C. At 2 atm pressure and at 227° C, the rms speed of the molecules will be:

09 Apr 2019 (M)

(1) 100 m/s (2) 80 m/s

(3) $80\sqrt{5}$ m/s (4) $100\sqrt{5}$ m/s

Q109. The specific heats, C_p and C_v of a gas of diatomic molecules, A, are given (in units of J mol^{-1} K^{-1}) by 29 and 22, respectively. Another gas of diatomic molecules, B, has the corresponding values 30 and 21. If they are treated as ideal gases, then:

09 Apr 2019 (E)

(1) A has one vibrational mode and B has two (2) A has a vibrational mode but B has none.

(3) Both A and B have a vibrational mode each. (4) A is rigid but B has a vibrational mode.

Q110. An HCl molecule has rotational, translational and vibrational motions. If the rms velocity of HCl molecules in its gaseous phase is $\bar{\nu}$, m is its mass and k_B is Boltzmann's constant, then its temperature will be:

09 Apr 2019 (M)

(1) $\frac{m\bar{\nu}^2}{5k_B}$ (2) $\frac{m\bar{\nu}^2}{6k_B}$

(3) $\frac{m\bar{\nu}^2}{3k_B}$ (4) $\frac{m\bar{\nu}^2}{7k_B}$

Q111. The temperature, at which the root mean square velocity of hydrogen molecules equals their escape their escape velocity from the earth, is closest to:

[Boltzmann Constant $k_B = 1.38 \times 10^{-23}$ J/K, Avogadro number $N_A = 6.02 \times 10^{26}$ /kg

Radius of Earth: 6.4×10^6 m, Gravitational acceleration on Earth = 10 ms^{-2}]

08 Apr 2019 (E)

(1) 3×10^5K (2) 650 K

(3) 800 K (4) 10^4 K

Q112. An ideal gas occupies a volume of 2 m^3 at a pressure of 3×10^6 Pa. The energy of the gas is:

12 Jan 2019 (M)

(1) $10^8 J$ (2) $9 \times 10^6 J$

(3) $3 \times 10^2 J$ (4) $6 \times 10^4 J$

Q113. An ideal gas is enclosed in a cylinder at pressure of 2 atm and temperature, 300 K. The mean time between two successive collisions is $6 \times 10^{-8} s$. If the pressure is doubled and temperature is increased to 500 K, the mean time between two successive collisions will be close to:

12 Jan 2019 (E)

(1) 2 x $10^{-7} s$ (2) 3 x $10^{-6} s$

(3) 0. 5 x $10^{-8} s$ (4) 4 x $10^{-8} s$

Q114. A gas mixture consists of 3 moles of oxygen and 5 moles of argon at temperature T. Considering only translational and rotational modes, the total internal energy of the system is ***11 Jan 2019 (M)***

(1) 15RT (2) 12RT

(3) 4RT (4) 20RT

Q115. When 100 g of a liquid A at 100°C is added to 50 g of a liquid B at temperature 75°C, the temperature of the mixture becomes 90°C. The temperature of the mixture, if 100 g of liquid A at 100°C is added to 50 g of liquid B at 50°C, will be: ***11 Jan 2019 (E)***

(1) 85°C (2) 60°C

(3) 80°C (4) 70°C

Q116. A metal ball of mass 0.1 kg is heated upto 500°C and dropped into a vessel of heat capacity $800 \mathrm{JK}^{-1}$ and containing 0.5 kg water. The initial temperature of water and vessel is 30°C. What is the approximate percentage increment in the temperature of the water? [Specific Heat Capacities of water and metal are, respectively, $4200 \mathrm{Jkg}^{-1} \mathrm{K}^{-1}$ and $400 \mathrm{Jkg}^{-1} \mathrm{K}^{-1}$] ***11 Jan 2019 (E)***

(1) 15% (2) 30%

(3) 25% (4) 20%

Q117. 2 kg of a monoatomic gas is at a pressure of $4 \times 10^4 \mathrm{~N} \mathrm{~m}^{-2}$. The density of the gas is 8 kg m^{-3}. What is the order of energy of the gas due to its thermal motion? ***10 Jan 2019 (E)***

(1) 10^5 J (2) 10^6 J

(3) 10^4 J (4) 10^3 J

Q118. An unknown metal of mass 192 g heated to a temperature of 100°C was immersed into a brass calorimeter of mass 128 g containing 240 g of water at a temperature of 8.4^oC. Calculate the specific heat of the unknown metal if water temperature stabilizes at 21.5^oC. (Specific heat of brass is $394 J\,kg^{-1}K^{-1}$) ***10 Jan 2019 (E)***

(1) 916 $J\,kg^{-1}K^{-1}$ (2) 458 $J\,kg^{-1}K^{-1}$

(3) 654 $J\,kg^{-1}K^{-1}$ (4) 1232 $J\,kg^{-1}K^{-1}$

Q119. A mixture of 2 moles of helium gas (atomic mass = 4u) , and 1 mole of argon gas (atomic mass = 40 u) is kept at 300 K in a container. The ratio of their rms speeds $\left[\frac{V_{rms}(helium)}{V_{rms}(argon)}\right]$, is close to: ***09 Jan 2019 (M)***

(1) 0.45 (2) 2.24

(3) 0.32 (4) 3.16

Q120. A 15 g mass of nitrogen gas is enclosed in a vessel at a temperature, 27°C. The amount of heat transferred to the gas, so that $R.M.S.$ velocity of molecules is doubled, is about.

$\left[R=8.3 \mathrm{~J}(\mathrm{~K} \text{ mole})^{-1}\right]$ ***09 Jan 2019 (E)***

(1) 14 kJ (2) 10 kJ

(3) 6 kJ (4) 0.9 kJ

ANSWER KEYS

1. (2)	**2.** (2)	**3.** (3)	**4.** (2)	**5.** (3)	**6.** (2)	**7.** (2)	**8.** (3)
9. (3)	**10.** (2)	**11.** (1)	**12.** (2)	**13.** (1)	**14.** (3)	**15.** (4)	**16.** (3)
17. (1)	**18.** (1)	**19.** (1)	**20.** (3)	**21.** (3)	**22.** (2)	**23.** (2)	**24.** (3)
25. (3)	**26.** (2)	**27.** (4)	**28.** (1)	**29.** (1)	**30.** (1)	**31.** (2)	**32.** (4)
33. (4)	**34.** (1)	**35.** (2)	**36.** (4)	**37.** (2)	**38.** (3)	**39.** (2)	**40.** (3)
41. (3)	**42.** (3)	**43.** (3)	**44.** (4)	**45.** (3)	**46.** (2)	**47.** (1)	**48.** (1)
49. (3)	**50.** (2)	**51.** (2)	**52.** (2)	**53.** (1)	**54.** (2)	**55.** (250)	**56.** (3)
57. (12)	**58.** (2)	**59.** (500)	**60.** (4)	**61.** (1)	**62.** (3)	**63.** (2)	**64.** (3)
65. (3)	**66.** (3)	**67.** (4)	**68.** (25)	**69.** (3)	**70.** (4)	**71.** (1)	**72.** (3)
73. (1)	**74.** (1)	**75.** (1)	**76.** (2)	**77.** (2)	**78.** (4)	**79.** (3)	**80.** (2)
81. (2)	**82.** (3600)	**83.** (3)	**84.** (400)	**85.** (2)	**86.** (3)	**87.** (2)	**88.** (1)
89. (41)	**90.** (1)	**91.** (1)	**92.** (3)	**93.** (267)	**94.** (4)	**95.** (2)	**96.** (1)
97. (1)	**98.** (2)	**99.** (4)	**100.** (3)	**101.** (1)	**102.** (4)	**103.** (1)	**104.** (2)
105. (3)	**106.** (2)	**107.** (2)	**108.** (4)	**109.** (2)	**110.** (3)	**111.** (4)	**112.** (2)
113. (4)	**114.** (1)	**115.** (3)	**116.** (4)	**117.** (3)	**118.** (1)	**119.** (4)	**120.** (2)