

Kinetic Theory — NEET Physics PYQ (2006-2020)

Class 11 Physics · 13 real NEET & AIPMT questions, year-tagged · answers checked by RankUp

NEET 2020 · Q139

1. A cylinder contains hydrogen gas at pressure of 249 kPa and temperature 27°C. Its density is : ($R = 8.3 \text{ J mol}^{-1} \text{ K}^{-1}$)

- (A) 0.5 kg/m^3
- (B) 0.2 kg/m^3
- (C) 0.1 kg/m^3
- (D) 0.02 kg/m^3

NEET 2020 · Q155

2. The mean free path for a gas, with molecular diameter d and number density n can be expressed as :

- (A) $1/(\sqrt{2} n \pi d)$
- (B) $1/(\sqrt{2} n \pi d^2)$
- (C) $1/(\sqrt{2} n^2 \pi d^2)$
- (D) $1/(\sqrt{2} n^2 \pi^2 d^2)$

NEET 2020 · Q162

3. The average thermal energy for a mono-atomic gas is : (k_B is Boltzmann constant and T , absolute temperature)

- (A) $(1/2) k_B T$
- (B) $(3/2) k_B T$
- (C) $(5/2) k_B T$
- (D) $(7/2) k_B T$

NEET 2019 · Q12

4. Increase in temperature of a gas filled in a container would lead to:

- (A) increase in its mass
- (B) increase in its kinetic energy
- (C) decrease in its pressure
- (D) decrease in intermolecular distance

NEET 2018 · Q3

5. At what temperature will the rms speed of oxygen molecules become just sufficient for escaping from the Earth's atmosphere? (Given: Mass of oxygen molecule (m) = $2.76 \times 10^{-26} \text{ kg}$, Boltzmann's constant $k_B = 1.38 \times 10^{-23} \text{ J K}^{-1}$)

- (A) $5.016 \times 10^4 \text{ K}$
- (B) $8.360 \times 10^4 \text{ K}$
- (C) $2.508 \times 10^4 \text{ K}$
- (D) $1.254 \times 10^4 \text{ K}$

NEET 2017 · Q158

6. A gas mixture consists of 2 moles of O_2 and 4 moles of Ar at temperature T . Neglecting all vibrational modes, the total internal energy of the system is:

- (A) $4 RT$
- (B) $15 RT$
- (C) $9 RT$
- (D) $11 RT$

NEET 2016 Phase 2 · Q19

7. A given sample of an ideal gas occupies a volume V at a pressure P and absolute temperature T . The mass of each molecule of the gas is m . Which of the following gives the density of the gas?

- (A) $P/(kT)$
- (B) $Pm/(kT)$
- (C) $P/(kTV)$
- (D) mkT

NEET 2016 Phase 1 · Q25

8. The molecules of a given mass of a gas have r.m.s. velocity of 200 ms^{-1} at 27°C and $1.0 \times 10^5 \text{ Nm}^{-2}$ pressure. When the temperature and pressure of the gas are respectively, 127°C and $0.05 \times 10^5 \text{ Nm}^{-2}$, the r.m.s. velocity of its molecules in ms^{-1} is:

- (A) $100\sqrt{2}$
- (B) $400/\sqrt{3}$
- (C) $100\sqrt{2/3}$
- (D) $100/3$

AIPMT 2015

9. The ratio of the specific heats $C_p/C_v = \gamma$ in terms of degrees of freedom (n) is given by:

- (A) $(1 + n/2)$
- (B) $(1 + 1/n)$
- (C) $(1 + n/3)$
- (D) $(1 + 2/n)$

AIPMT 2014

10. The mean free path of molecules of a gas, (radius ' r ') is inversely proportional to:

- (A) r^2
- (B) r
- (C) $\sqrt{r}$
- (D) r^3

NEET 2013

11. The molar specific heats of an ideal gas at constant pressure and volume are denoted by C_p and C_v , respectively. If $\gamma = C_p/C_v$ and R is the universal gas constant, then C_v is equal to

- (A) $(1 + \gamma)/(1 - \gamma)$
- (B) $R/(\gamma - 1)$
- (C) $(\gamma - 1)/R$
- (D) γR

AIPMT 2008 Prelims · Q16

12. At 10°C the value of the density of a fixed mass of an ideal gas divided by its pressure is x . At 110°C this ratio is

- (A) $(283/383)x$
- (B) x
- (C) $(383/283)x$
- (D) $(10/110)x$

AIPMT 2006 Prelims · Q33

13. The molar specific heat at constant pressure of an ideal gas is $(7/2)R$. The ratio of specific heat at constant pressure to that at constant volume is :

- (A) $7/5$
- (B) $6/7$
- (C) $9/7$
- (D) $4/7$

Answer key and explanations

1. Answer: (B) 0.2 kg/m^3

$\rho = PM/RT = (249 \times 10^3 \times 2 \times 10^{-3}) / (8.3 \times 300) = 498/2490 = 0.2 \text{ kg/m}^3$. Using $M = 1 \text{ g/mol}$ (atomic H) instead of 2 g/mol for H_2 would give the 0.1 kg/m^3 trap.

2. Answer: (B) $1/(\sqrt{2} n \pi d^2)$

A molecule sweeps a collision cross-section πd^2 , and allowing for the relative motion of molecules the mean free path is $\lambda = 1/(\sqrt{2} n \pi d^2)$. The number density appears only to the first power, and the cross-section must be an area (d^2) for λ to have units of length.

3. Answer: (B) $(3/2) k_{\text{BT}}$

A monatomic molecule has 3 translational degrees of freedom, each carrying $\frac{1}{2}k_{\text{BT}}$ by equipartition, so the average energy is $(3/2)k_{\text{BT}}$. $(5/2)k_{\text{BT}}$ applies to a diatomic molecule with two rotational degrees added.

4. Answer: (B) increase in its kinetic energy

Average molecular kinetic energy is proportional to absolute temperature, so heating raises it. In a closed container the mass is fixed and pressure increases (not decreases) with temperature.

5. Answer: (B) $8.360 \times 10^4 \text{ K}$

Set $v_{\text{rms}} = \sqrt{3k_{\text{BT}}/m}$ equal to the escape speed 11.2 km/s . $T = mv^2/(3k_{\text{B}}) = 2.76 \times 10^{-26} \times (1.12 \times 10^4)^2 / (3 \times 1.38 \times 10^{-23}) \approx 8.36 \times 10^4 \text{ K}$. Using $2k_{\text{BT}}$ or k_{BT} instead of $3k_{\text{BT}}$ gives the other values.

6. Answer: (D) 11 RT

Diatomic O_2 (no vibration) has 5 degrees of freedom: $U = 2 \times (5/2)RT = 5RT$. Monatomic Ar has 3: $U = 4 \times (3/2)RT = 6RT$. Total $U = 11RT$. Treating O_2 as having 3 degrees of freedom would give $9RT$.

7. Answer: (B) $Pm/(kT)$

$PV = NkT$ gives the number density $N/V = P/(kT)$. Multiplying by the mass of each molecule gives density $\rho = Pm/(kT)$. $P/(kT)$ alone is the number of molecules per unit volume, not mass per unit volume.

8. Answer: (B) $400/\sqrt{3}$

$v_{\text{rms}} = \sqrt{3RT/M}$ depends only on temperature, not pressure. $v_2 = 200 \times \sqrt{(400/300)} = 200 \times 2/\sqrt{3} = 400/\sqrt{3} \text{ m/s}$. Scaling with pressure is the trap that leads to the smaller values.

9. Answer: (D) $(1 + 2/n)$

With n degrees of freedom $C_v = (n/2)R$ and $C_p = (n/2 + 1)R$, so $\gamma = C_p/C_v = 1 + 2/n$. For a monatomic gas ($n = 3$) this gives $5/3$ as expected.

10. Answer: (A) r^2

$\lambda = 1/(\sqrt{2} n \pi d^2)$ with molecular diameter $d = 2r$, so the mean free path is inversely proportional to r^2 .

11. Answer: (B) $R/(\gamma - 1)$

Mayer's relation $C_p - C_v = R$ with $C_p = \gamma C_v$ gives $\gamma C_v - C_v = R$, so $C_v = R/(\gamma - 1)$. The expression $\gamma R/(\gamma - 1)$ would be C_p , and $(\gamma - 1)/R$ is the inverse of the correct result.

12. Answer: (A) $(283/383)x$

From $PV = (m/M)RT$, $\rho/P = M/(RT)$, so the ratio is inversely proportional to absolute temperature. At 383 K it becomes $x \times 283/383$. Using Celsius temperatures ($10/110$) is wrong because gas laws need kelvin.

13. Answer: (A) $7/5$

For an ideal gas $C_v = C_p - R = (7/2)R - R = (5/2)R$. Hence $\gamma = C_p/C_v = (7/2)/(5/2) = 7/5$, as for a diatomic gas. A ratio below 1 is impossible because C_p is always larger than C_v .

Questions as set in the AIPMT/NEET papers conducted by CBSE and NTA. Answers checked and explanations written by the RankUp team. RankUp is not affiliated with CBSE or NTA.