DPP – 3 (KTG)

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Q 1. Calculate the total number of degree of freedom for a mole of diatomic gas at STP

(a) 30.10×10^{23} (b) 3.10×10^{23}
(c) 12.24×10^{20} (d) 3.14×10^{17}

Q 2. At what temperature, the kinetic energy of a gas molecule is half of the value at 27°C?

(a) 123℃ (b) $123\ K$ (c) $-123\ K$ (d) -123℃

Q 3. The number of degrees of freedom for a rigid diatomic molecule is

(a) 3 (b) 5 (c) 6 (d) 7

Q 4. The energy associated with each degree of freedom of a molecule

(a) $\frac{1}{2}RT$ (b) $\frac{1}{2}KT$ (c) $\frac{3}{2}RT$ (d) $\frac{3}{2}KT$

Q 5. A polyatomic gas with (n) degress of freedom has a mean energy per molecule given by

(a) $\frac{n}{2}RT$ (b) $\frac{1}{2}RT$ (c) $\frac{n}{2}kT$ (d) $\frac{1}{2}kT$

Q 6. The number of degrees of freedom of molecules of argon gas is

(a) 1 (b) 3 (c) 5 (d) 7

Q 7. Helium gas is filled in a closed vessel (having negligible thermal expansion coefficient) when it is heated from 300 K to 600 K, then average kinetic energy of helium atom will be

(a) $\sqrt{2}$ times (b) 2 times (c) unchanged (d) half

Q 8. The average rotational kinetic energy of hydrogen molecule at a temperature T is E. The average translational kinetic energy of helium at same temperature will be:

(a) $\frac{2E}{3}$ (b) $\frac{5E}{3}$ (c) E (d) $\frac{3E}{2}$

Q 9. The average translational energy and the rms speed of molecules in a sample of oxygen gas at 300 K are 6.21×10^{-21}J and 484m/s respectively The corresponding values at 600 K are nearly (assuming ideal gas behavior)

(a) 12.42×10^{-21}J, 928 m/s (b) 8.78×10^{-21}J, 684 m/s
(c) 6.21×10^{-21}J, 968 m/s (d) 12.42×10^{-21}J, 684 m/s

Q 10. One kg of a diatomic gas is at a pressure of $8 \times 10^4\ N/m^2$. The density of the gas is $4\text{kg}/m^3$. What is the energy of the gas due to its thermal motion?

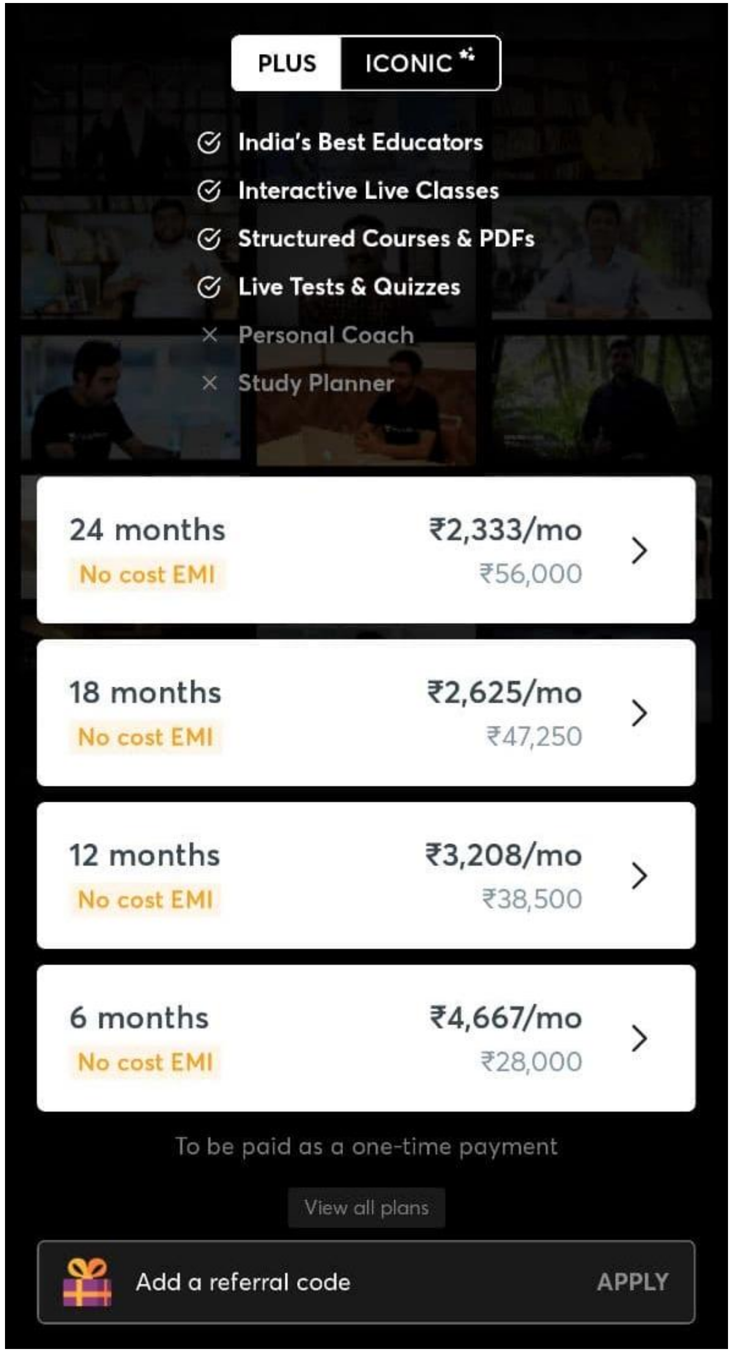
(a) 5×10^4J (b) 6×10^4J (c) 7×10^4J (d) 4×10^4J

Q 11. The average kinetic energy of H_2 molecules at 300K is E at the same temperature the average kinetic energy of O_2 molecules is:

(a) E (b) $\frac{E}{4}$ (c) $\frac{E}{16}$ (d) $16E$

Answer Key

Q.1 a	**Q.2 d**	**Q.3 b**	**Q.4 b**	**Q.5 c**
Q.6 b	**Q.7 b**	**Q.8 d**	**Q.9 d**	**Q.10 a**
Q.11 a				



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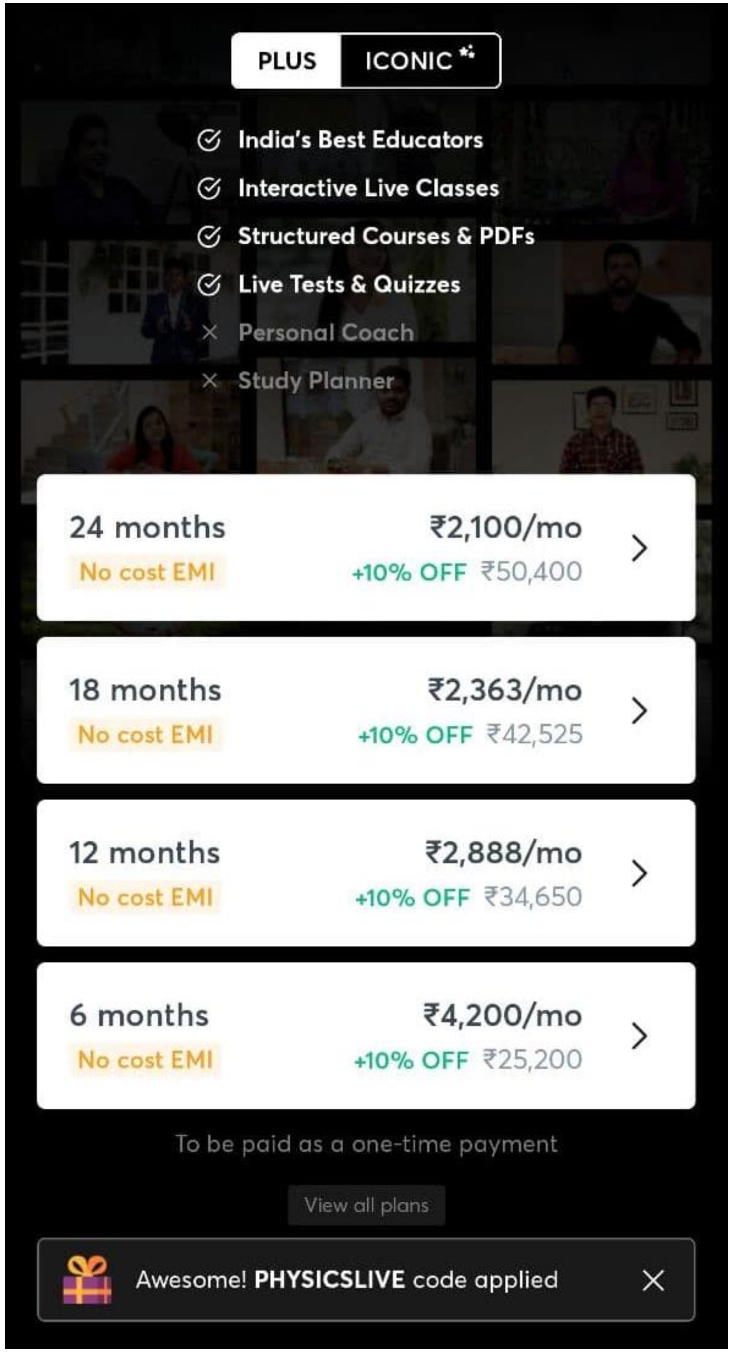

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NEET & JEE Main
Physics DPP- Solution

DPP- 3 Kinetic Energy of Gas, Degree of freedom of gas molecules

By Physicsaholics Team

Solution 1:

Dof for Diatomic gas Molecule = f = 5

No. of Molecules in 1 mole = 6.02×10^{23}

$\therefore$ Total Dof. = $5 \times 6.02 \times 10^{23}$

Total D.o.f. = 30.10×10^{23}

Ans. a

Solution 2:

$$KE = \frac{3}{2}kT$$

$$KE \propto T$$

$$\frac{KE_1}{KE_2} = \frac{T_1}{T_2}$$

& $KE_2 = \frac{1}{2}KE_1$

& $T_1 = 27^\circ C = 300\,K$

$$\therefore \frac{KE_1}{\frac{1}{2}KE_1} = \frac{300\,K}{T_2}$$

$$2 = \frac{300\,K}{T_2}$$

$$\boxed{T_2 = 150\,K}$$

or

$$\boxed{T_2 = -123\,^\circ C}$$

Ans. d

Solution 3:

Rigid diatomic molecules have 3 translational degrees of freedom and 2 rotational degrees of freedom

$3 + 2 = 5$ degree of freedom

Ans. b

Solution 4:

Dof for Diatomic gas Molecule = f = 5

No. of Molecules in 1 mole = 6.02×10^{23}

$\therefore$ Total Dof. = $5 \times 6.02 \times 10^{23}$

Total D.o.f. = 30.10×10^{23}

When Degree of freedom = f

then $KE = \frac{f}{2} kT$

$\therefore$ KE. associate with each D.of

$= \frac{KE}{f} = \frac{1}{2} kT$

Ans. b

Solution 5:

$$KE = \frac{f}{2} kT$$

when ; f = degree of freedom,

here, f = n (given)

$$\therefore \boxed{KE = \frac{n}{2} kT}$$

Ans. c

Solution 6:

Argon gas has monoatomic molecules of Ar.
$\therefore$ It has only translational degree of freedom
So, degree of freedom for argon gas is = 3

Ans. b

Solution 7:

For He gas

$$KE = \frac{3}{2} kT$$

$$KE \propto T$$

$T_1 = 300 K \qquad T_2 = 600 K$

$$\frac{KE_1}{KE_2} = \frac{T_1}{T_2} = \frac{300}{600} = \frac{1}{2}$$

$$\boxed{KE_2 = 2 KE_1}$$

Ans. b

Solution 8:

rotation degree of freedom for H_2 molecule = 2

$$\therefore \quad E_R = \frac{f_R}{2} kT = \frac{2}{2} kT$$

$$E_R = kT = E \quad \text{---(1)}$$

↳ Rotation K.E of H_2 gas molecule.

Now for He gas molecule,

Translational D of = 3

$$E_T = \frac{f_T}{2} kT = \frac{3}{2} kT$$

from eq^n (1) ; $kT = E$

$$\therefore \quad E_T = \frac{3}{2} kT = \frac{3}{2} E$$

$$\boxed{E_T = \frac{3}{2} E}$$

Ans. d

Solution 9:

$$KE = \frac{f}{2} kT$$

$$KE \propto T$$

$$\frac{KE_1}{KE_2} = \frac{T_1}{T_2}$$

$$\frac{6.21 \times 10^{-21}}{KE_2} = \frac{300}{600}$$

$$KE_2 = 2 \times 6.21 \times 10^{-21}$$

$$KE_2 = 12.42 \times 10^{-21} \, J$$

$$V_{rms} = \sqrt{\frac{3RT}{M}}$$

$$V_{rms} \propto \sqrt{T}$$

$$\frac{V_{rms-1}}{V_{rms-2}} = \sqrt{\frac{T_1}{T_2}}$$

$$\frac{V_1}{V_2} = \sqrt{\frac{300}{600}}$$

$$\frac{484}{V_2} = \frac{1}{\sqrt{2}}$$

$$V_2 \simeq 684 \, m/s$$

Ans. d

Solution 10:

$$KE = \frac{5}{2} PV \quad [\text{Dof} = 5 \text{ for diatomic gas}]$$

$$KE = \frac{5}{2} \times P \times \left(\frac{\text{Mass}}{\text{density}}\right)$$

$$KE = \frac{5}{2} \times 8 \times 10^4 \times \left(\frac{1 \text{ kg}}{4 \text{ kg/m}^3}\right)$$

$$KE = \frac{5}{2} \times 8 \times 10^4 \times \frac{1}{4}$$

$$\boxed{KE = 5 \times 10^4 \text{ J}}$$

Ans. a

Solution 11:

The mean kinetic energy of a gas depends only on temperature and is independent of molecular weight

Ans. a

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Chalo Niklo