Solutions

Each answer shows the steps, then the **result**.

2.1

- the **mole** (mol)

2.2

- $N_\mathrm{A} = 6.02 \times 10^{23}\ \mathrm{mol}^{-1}$

2.3

- $N = nN_\mathrm{A}$

$$N = (2.0\ \mathrm{mol})(6.02 \times 10^{23}\ \mathrm{mol}^{-1}) = \mathbf{1.2 \times 10^{24}}$$

3.1 B

- one mole contains 6.02×10^{23} molecules
- **A** is $N_\mathrm{A}/10$; **C** is $2N_\mathrm{A}$; **D** is a mass, not a number

3.2

- $n = N/N_\mathrm{A}$

$$n = \frac{3.0 \times 10^{24}}{6.02 \times 10^{23}\ \mathrm{mol}^{-1}} = \mathbf{5.0}\ \mathrm{mol}$$

3.3

- $m_0 = M_\mathrm{m}/N_\mathrm{A}$

$$m_0 = \frac{0.018\ \mathrm{kg\ mol}^{-1}}{6.02 \times 10^{23}\ \mathrm{mol}^{-1}} = \mathbf{3.0 \times 10^{-26}}\ \mathrm{kg}$$

3.4

(a) the number of particles per unit amount of substance — the number of particles in one mole

(b) $N_\mathrm{A} = R/k$

(c) $N = nN_\mathrm{A}$

$$N = (0.32\ \mathrm{mol})(6.02 \times 10^{23}\ \mathrm{mol}^{-1}) = \mathbf{1.9 \times 10^{23}}$$

molecules

(d) sample Y has $2N$ molecules in the same volume at the same temperature

quantity	**sample X**	**sample Y**
pressure	NkT/V	$2NkT/V$
amount of substance	N/N_A	$2N/N_\mathrm{A}$
mean kinetic energy per molecule	$\frac{3}{2}kT$	$\frac{3}{2}kT$
internal energy	$\frac{3}{2}NkT$	$3NkT$

- pressures; amounts; both mean kinetic energies the same; internal energies

(e) the mean kinetic energy of a molecule is $\frac{3}{2}kT$, which depends **only on the temperature** — and both samples are at T

- internal energy is the **total** for all the molecules, so twice as many molecules at the same energy each gives twice the internal energy

(f) axes labelled *root-mean-square speed* and *thermodynamic temperature / K*

- a curve from the **origin** rising with a **decreasing** gradient, since $c_{\text{r.m.s.}} \propto \sqrt{T}$ — quadrupling T only doubles the speed