Solutions

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

2.1

- the **random kinetic energy** of the molecules
- and the **potential energy** between the molecules

2.2

- it **increases** (the molecules' random kinetic energy rises)

2.3

- its molecules are assumed to have **no forces** between them (except during collisions), so there is no intermolecular potential energy

2.4

- $U = \frac{3}{2}nRT$ (or $\frac{3}{2}NkT$)

3.1 C

- for an ideal gas U depends only on **thermodynamic temperature**
- **A** pressure and **B** volume cancel for a given T; **D** mass matters only through n, not on its own once n is fixed

3.2

- it **doubles** ($U \propto T$ for an ideal gas)

3.3

- energy goes into increasing the molecular **potential energy** as bonds are broken/molecules separated
- the kinetic energy (temperature) stays the same, so U rises with constant T

3.4

- internal energy is the energy of the **random** molecular motion
- the container's motion is **bulk/ordered** kinetic energy of the whole body, which is separate from U

3.5

(a) the **sum of the random kinetic and potential energies** of all the molecules of the system

(b) the molecules of an ideal gas exert no forces on each other except in collisions, so their total **potential** energy is zero and the internal energy is purely kinetic

- the mean molecular kinetic energy is $\frac{3}{2}kT$, so the internal energy depends only on T — not on the volume or the pressure separately

(c) internal energy is proportional to T: it is U at T, $4U$ at $4T$ and $2U$ at $2T$

process	**work done on the gas**	**thermal energy supplied**	**increase in internal energy**
compression to $4T$	W	$3U - W$	$+3U$
cooling to $2T$	0	$-2U$	$-2U$

- $+3U$; $-2U$; the zero work at constant volume; both thermal-energy entries, from $\Delta U = q + w$

(d) the mean speed **decreases**

- because the mean kinetic energy $\frac{3}{2}kT$ falls with the temperature and the molecular mass is unchanged