

Gas particles, pressure and heat conduction

AP Physics 2 (algebra-based) · Test answers (mark scheme)

The model answers show each step. In explanations, marks go to the correct physical idea in particle terms, not to long wording. Penalise only once for a wrong temperature scale and give follow-through credit when later parts use an earlier wrong value correctly.

Level: AP Physics 2 (algebra-based) · **Curriculum:** AP P2 Unit 9

Question 1 Kinetic model (2 marks)

- Particles have negligible volume; there are no forces between particles except in collisions (also acceptable: elastic collisions, random motion).
- Each collision gives the wall an impulse; the large number of collisions per second gives a steady average force per unit area.

Marking: 1 mark each part.

Question 2 Particles in a tank (3 marks)

- $n = pV/(RT) = (1.5 \times 10^5 \times 4.0 \times 10^{-3})/(8.31 \times 300) = \mathbf{0.24 \text{ mol}}$.
- $N = nN_A = 0.241 \times 6.02 \times 10^{23} = \mathbf{1.4 \times 10^{23}}$.

Marking: Part a: formula and unit conversion (1), answer (1). Part b: 1 mark.

Question 3 Temperature and speed (2 marks)

- Kelvin temperatures are 300 K and 600 K, so the ratio is **2.0**.
- $v_{\text{rms}} \propto \sqrt{T}$, so the ratio is $\sqrt{2} = \mathbf{1.41}$.

Marking: 1 mark each part; deduct 1 for using Celsius.

Question 4 A pressure graph (3 marks)

- Pressure is proportional to kelvin temperature at constant V and n; at 0 K the particles have no kinetic energy and exert no pressure.
- $(128 - 80) \text{ kPa}/(400 - 250) \text{ K} = \mathbf{0.32 \text{ kPa/K} = 320 \text{ Pa/K}}$.
- gradient = nR/V , so $n = 320 \times 5.0 \times 10^{-3}/8.31 = \mathbf{0.19 \text{ mol}}$.

Marking: 1 mark per part.

Question 5 A cool box lid (3 marks)

- a. $H = kA\Delta T/L = (0.033 \times 0.30 \times 26)/0.040 = \mathbf{6.4\ W}$.
- b. The rate halves, to about 3.2 W.

Marking: Part a: substitution (1), answer with unit (1). Part b: 1 mark.

Question 6 Metal and wood (3 marks)

- a. Steel has a much larger thermal conductivity, so heat flows from the hand into the handle at a much higher rate. The skin loses energy faster and you sense this faster cooling as a lower temperature.
- b. **Steel.**

Marking: Part a: larger k (1), larger heat flow rate from the hand (1). Part b: 1 mark.

Question 7 Faulty reasoning (2 marks)

- a. The temperature must be in kelvin, and v_{rms} depends on the square root of the kelvin temperature.
- b. $\sqrt{313/293} = \mathbf{1.034}$, an increase of about 3.4%.

Marking: 1 mark each part.

Question 8 Compressing air (2 marks)

- a. The pressure **doubles**.
- b. The particles keep the same speed but the container is half as long, so they hit the walls twice as often, doubling the average force per unit area.

Marking: 1 mark each part.