

Gas laws, kinetic theory and thermal energy

Physics grades 11-12 (A Level · IB · Class 11-12) · Test

Name: _____ Date: _____ Class: _____ Mark: ____ / 20

This test covers the gas equation, kinetic theory, internal energy and thermal energy changes. Use $R = 8.31 \text{ J/(mol K)}$, $k = 1.38 \times 10^{-23} \text{ J/K}$ and $N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$. Show every step of the working and give each result with its unit.

Level: Physics grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** IB B.1-B.3

Time: 45 minutes · 9 questions · Total: 20 marks · Calculator allowed

Question 1 Ideal gas assumptions (2 marks)

State two assumptions of the kinetic model of an ideal gas.

Question 2 Helium cylinder (3 marks)

A 25 L cylinder contains helium at $4.0 \times 10^5 \text{ Pa}$ and 17°C .

- Calculate the amount of helium in the cylinder. (2 marks)
- Calculate the number of helium atoms. (1 mark)

Question 3 Heating fourfold (3 marks)

A fixed amount of ideal gas is heated from 300 K to 1200 K.

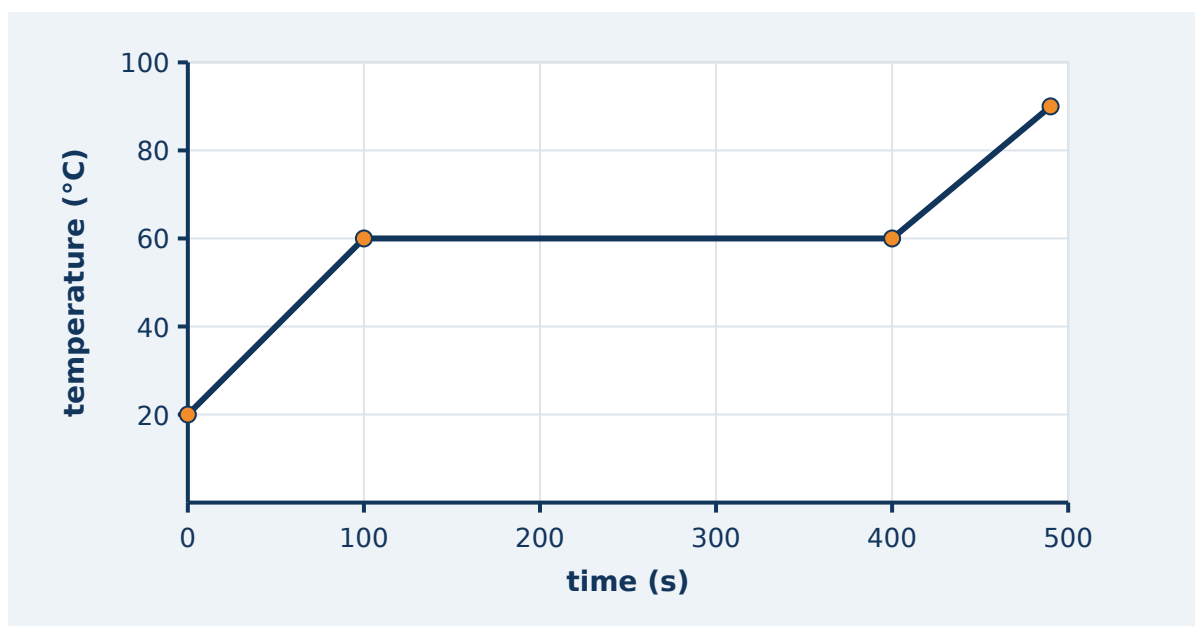
- State the factor by which the r.m.s. speed of the molecules increases. (1 mark)
- Calculate the mean kinetic energy of a molecule at 1200 K. (2 marks)

Question 4 Sealed can in a fire (2 marks)

Explain, using the kinetic model, why the pressure inside a sealed rigid can increases when the can is heated.

Question 5 Heating wax: melting (2 marks)

The graph shows the temperature of 0.50 kg of solid wax heated by a 400 W heater, with no energy lost.



A 400 W heater warms 0.50 kg of wax. The sample starts at 20 °C and no energy is lost.

- State the melting point of the wax. (1 mark)
- Explain why the temperature stays constant during melting. (1 mark)

Question 6 Heating wax: solid (2 marks)

Use the graph of the previous question to calculate the specific heat capacity of the solid wax.

Question 7 Heating wax: latent heat (2 marks)

From the flat section of the graph, determine the energy absorbed while the wax melts, and hence its specific latent heat of fusion.

Question 8 Kettle boiling dry (3 marks)

A 2.2 kW kettle keeps boiling after the thermostat has failed. The latent heat of vaporisation of water is 2.26×10^6 J/kg.

- Calculate the energy supplied in 90 s. (1 mark)
- Calculate the mass of water turned into steam in that time. (2 marks)

Question 9 No potential energy (1 mark)

State why the internal energy of an ideal gas contains no intermolecular potential energy.