

Heat, work and engines on PV diagrams

AP Physics 2 (algebra-based) · Lab

Name: _____ Date: _____ Class: _____

When a gas is heated at constant pressure it expands and does work. In this lab you heat a trapped sample of air in a water bath, record its volume at six temperatures and use the results to find the work done, the amount of air and the fraction of the heat that becomes work. It links a graph to the first law.

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

Aim

Heat a fixed amount of air at constant pressure in a water bath, measure how its volume changes with temperature, and use the results to find the work done by the gas.

Equipment

- 50 mL gas syringe with a free-moving, lightly lubricated plunger
- rubber stopper or cap to seal the nozzle
- beaker of water, hot plate and stirrer
- thermometer
- clamp stand

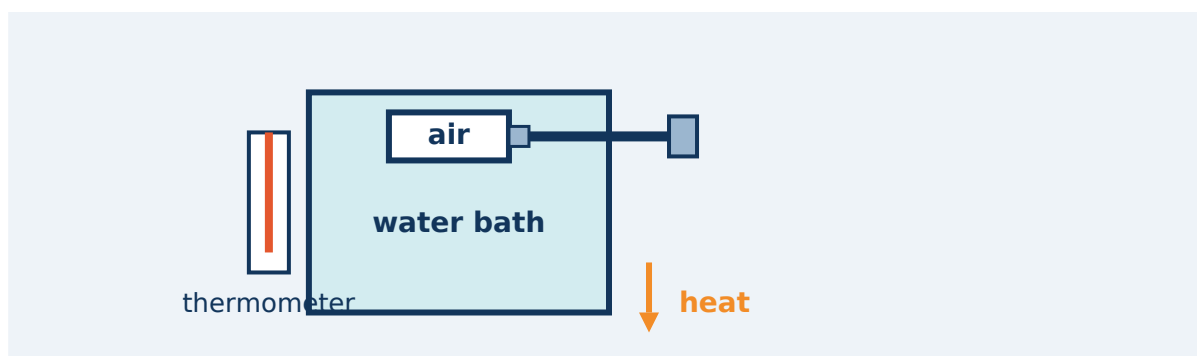
Safety

Safety

Hot water scalds. Use heat-proof gloves when moving the beaker and never seal a syringe that is clamped rigidly. Wear eye protection.

Method

1. Trap 50 mL of air in the syringe and seal the nozzle. Place it in a water bath at 20 °C with the air column below the water surface.
2. Stir and wait 2 minutes, then read the volume.
3. Raise the bath to 30 °C, 40 °C, 50 °C, 60 °C and 70 °C, waiting 2 minutes before each reading. Tap the plunger gently to avoid sticking.
4. Record the room pressure as 1.01×10^5 Pa.



Set-up: the plunger moves freely, so the pressure stays equal to the atmosphere.

Results

Sample measurements:

θ (°C)	T (K)	V (mL)
20	293	50.0
30	303	51.6
40	313	53.5
50	323	55.0
60	333	56.9
70	343	58.4

Analysis questions

Question 1 Constant pressure

Explain why the pressure of the trapped air stays constant, and state the name of this process.

Question 2 The graph

Plot V against T in kelvin and draw the best-fit line. Describe the shape.

Question 3 Gradient

Calculate the gradient of the line in mL/K, using the first and last points.

Question 4 Absolute zero

Extrapolate the line to $V = 0$ using your gradient. Estimate the temperature at which V would reach zero.

Question 5 Amount of air

Calculate the amount of air from the first reading using $n = pV/(RT)$.

Question 6 Work done

Calculate the work done by the gas between 20 °C and 70 °C.

Question 7 Heat needed

Air is diatomic, so $Q = (7/2)nR\Delta T$ at constant pressure. Calculate Q and the fraction of Q that becomes work.