Thermal Physics Questions – OCR A Level Physics

Praneel Physics

1. Define specific heat capacity. **(P)**

Working and Answer:

The amount of energy required to raise the temperature of 1 kg of a substance by 1°C (or 1 K).

2. What is meant by internal energy? **(P)**

Working and Answer:

The total kinetic and potential energy of all the particles in a substance.

3. State the formula for energy change due to heating. **(P)**

Working and Answer:

$$Q = mc\Delta T$$

Where Q is heat energy, m is mass, c is specific heat capacity, and ΔT is temperature change.

4. What is the unit of specific latent heat? **(P)**

Working and Answer:

Joules per kilogram (J/kg).

5. State the difference between specific latent heat of fusion and vaporisation. **(P)**

Working and Answer:

Fusion: energy to change from solid to liquid.
Vaporisation: energy to change from liquid to gas.

6. Describe how the temperature of a substance changes during melting. **(PP)**

Working and Answer:

It remains constant as all supplied energy is used to break intermolecular bonds rather than increase kinetic energy.

7. What is absolute zero in terms of particle motion? **(PP)**

Working and Answer:

The temperature at which particles have minimum internal energy; zero kinetic energy.

8. Explain the term 'thermal equilibrium'. **(PP)**

Working and Answer:

Two objects are in thermal equilibrium when they are at the same temperature and no net heat flows between them.

9. What assumption is made about the gas in the ideal gas model? **(PP)**

Working and Answer:

Particles have negligible volume, no intermolecular forces, and collisions are elastic.

10. Calculate the energy required to heat 2.0 kg of water from 20°C to 80°C. Take $c = 4200\,\text{J/kgK}$. **(PPP)**

Working and Answer:

$$Q = mc\Delta T = 2.0 \times 4200 \times 60 = 504,000\,\text{J}$$

11. State the equation for the pressure of an ideal gas in terms of volume and temperature. **(PPP)**

Working and Answer:

$$pV = nRT$$

Where p is pressure, V is volume, n is moles, R is gas constant, T is temperature in K.

12. A 0.02 kg sample of ice at 0°C melts completely. Calculate the energy required. $L_f = 3.34 \times 10^5$ J/kg **(PPP)**

Working and Answer:

$$Q = mL_f = 0.02 \times 3.34 \times 10^5 = 6680\,\text{J}$$

13. Convert 27°C to Kelvin. **(PPP)**

Working and Answer:

$$T = 27 + 273 = 300\,\text{K}$$

14. A gas has volume $0.5\,\mathrm{m}^3$, pressure $1.0 \times 10^5\,\mathrm{Pa}$, and temperature $300\,\mathrm{K}$. Calculate the number of moles. **(PPP)**

Working and Answer:

$$n = \frac{pV}{RT} = \frac{1.0 \times 10^5 \times 0.5}{8.31 \times 300} \approx 20.05\,\mathrm{mol}$$

15. A gas at 300 K is heated to 900 K at constant volume. By what factor does the pressure increase? **(PPPP)**

Working and Answer:

Using $\frac{p_1}{T_1} = \frac{p_2}{T_2}$, and V constant:

$$\frac{p_2}{p_1} = \frac{T_2}{T_1} = \frac{900}{300} = 3$$

16. Describe how Brownian motion provides evidence for the particle nature of gases. **(PPPP)**

Working and Answer:

Random motion of visible particles results from collisions with much smaller, randomly moving gas molecules, implying a particle model.

17. A 1.5 kg block of metal is heated by 25000 J, and its temperature rises by 20°C. Calculate its specific heat capacity. **(PPPP)**

Working and Answer:

$$c = \frac{Q}{m\Delta T} = \frac{25000}{1.5 \times 20} = 833.3\,\text{J/kg°C}$$

18. State and explain two assumptions made in the kinetic model of gases. **(PPPP)**

Working and Answer:

1. Particles occupy negligible volume compared to container.
2. Collisions are elastic (no energy lost).

These simplify calculations and predict macroscopic gas behaviour.

19. Calculate the root mean square speed of molecules in 1 mol of oxygen gas at 300 K. (Molar mass = 0.032 kg/mol) **(PPPPP)**

Working and Answer:

$$c_{\text{rms}} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3 \times 8.31 \times 300}{0.032}} = 484\,\text{ms}^{-1}$$

20. A gas occupies $0.01\,\mathrm{m}^3$ at $2.0 \times 10^5\,\mathrm{Pa}$ and 300 K. Calculate number of moles. $R = 8.31\,\mathrm{J/mol\,K}$ **(PPPPP)**

Working and Answer:

$$n = \frac{pV}{RT} = \frac{2.0 \times 10^5 \times 0.01}{8.31 \times 300} = 0.802\,\mathrm{mol}$$

21. A kettle supplies 2.5 kW of power. How long does it take to boil 1.0 kg of water from 20°C to 100°C? $c = 4200\,\text{J/kg°C}$ **(PPPPP)**

Working and Answer:

$$Q = mc\Delta T = 1.0 \times 4200 \times 80 = 336000\,\text{J}$$

$$t = \frac{Q}{P} = \frac{336000}{2500} = 134.4\,\text{s}$$

22. Explain, using the first law of thermodynamics, what happens to internal energy when a gas expands doing work and loses heat. **(PPPPP)**

Working and Answer:

$$\Delta U = Q - W$$

If work W is done by the gas and heat Q is lost, both are negative, so internal energy decreases.