ACE YOUR PHYSICS EXAMS
With Sally Weatherly

Topic:

Formulae

Required Definitions

Common Diagrams

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Topic:

Common Graphs

Experiment Summaries

Other Notes / Learned From Past Papers

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IB PHYSICS
TOPIC 3: THERMAL PHYSICS
Revision Checklist

Learning Objective

1 Describe temperature change in terms of internal energy and define heat.

2 Understand that internal energy is taken to be the total intermolecular potential energy + the total random kinetic energy of the molecules

3 Use Kelvin and Celsius temperature scales and convert between them ($T/K = t/°C + 273$)

4 Define and know how to find specific heat capacity or specific latent heat experimentally

5 Solve problems involving specific heat capacity and specific latent heat of fusion and evaporization

6 Explain the physical differences between the solid, liquid and gaseous phases in terms of molecular structure and particle motion
(Note: be familiar with the terms melting, freezing, evaporating, boiling and condensing, and should be able to describe each in terms of the changes in molecular potential and random kinetic energies of molecules)

7 Sketch and interpret phase change graphs.
(Note: graphs may have axes of temperature vs time or temperature vs energy)

8 Explain in terms of molecular behaviour why temperature does not change during a phase change.

9 State the assumptions that underpin the molecular kinetic theory of ideal gases

10 Solve problems using the equation of state for an ideal gas and gas laws ($PV = nRT$)

11 Know that gas laws are limited to constant volume, constant temperature, constant pressure and the ideal gas law

12 Understand that a real gas approximates to an ideal gas at conditions of low pressure, moderate temperature and low density

13 Sketch and interpret changes of state of an ideal gas on pressure– volume, pressure–temperature and volume–temperature diagrams

14 Describe an experiment for one of the gas laws
(e.g. Boyle's Law, Charles' Law, Gay-Lussac Law)

15 Understand that the average kinetic energy of ideal gas molecules is directly proportional to the temperature (in kelvin) of the gas.

ACE YOUR PHYSICS EXAMS
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Topic: Thermal Physics (3)

Formulae

$T(K) = T(°C) + 273$

$Q = mc\Delta T$ (specific heat capacity)

$Q = mL$ (latent heat)

$p = F/A$ (pressure)

$n = N/N_A$ (no. of moles) ← avogardo's no.

$pV = nRT$ (ideal gas eq)
- only used when
  1. low pressure
  2. moderate temp
  3. low density

$\bar{E}_K = \frac{3}{2} k_B T = \frac{3}{2} \frac{R}{N_A} T$ and $k_B = \frac{R}{N_A}$

↳ $\bar{E}_K \propto T$

Required Definitions

Temperature: The property that determines the direction of thermal energy transfer between two objects.

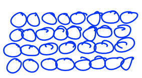
Internal Energy: Total potential energy and random kinetic energy of the molecules in a substance

Heat: Energy transferred between two substances in thermal contact due to a temperature difference.

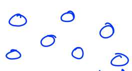
specific heat capacity: energy required per unit mass to raise the temperature of a substance by 1K.

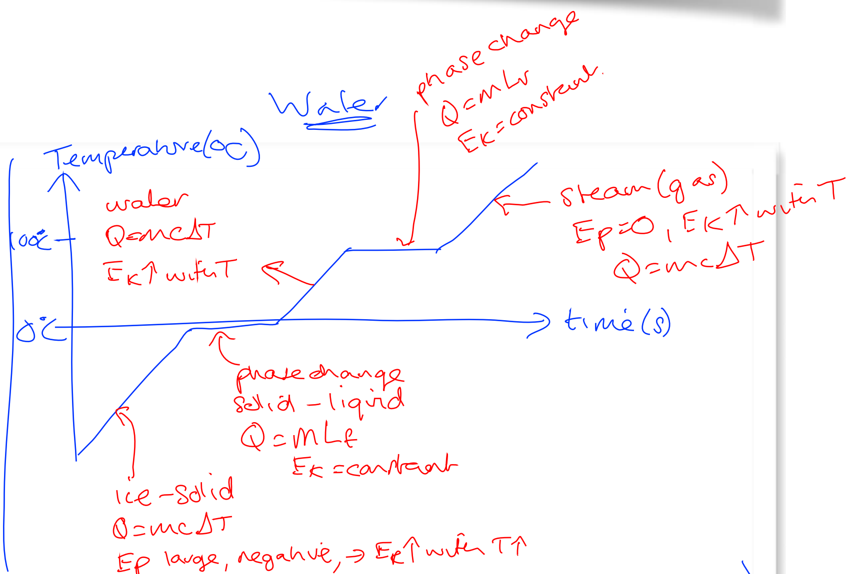
Specific Latent heat: energy per unit mass absorbed or released during a phase change.

Common Diagrams

Solid 
- rigid structure
- E_p is large and negative

liquid 
- separation of atoms increases
- E_p is negative

gas 
- atoms completely separate
- $E_p = 0$ (NOTE: in an ideal gas, internal energy is only sum of E_K random, $E_p = 0$)



ACE YOUR PHYSICS EXAMS
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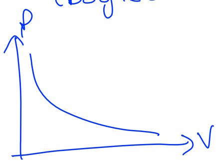
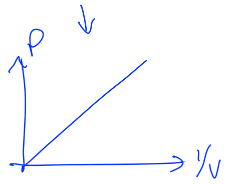
Topic: Thermal Physics (3)

Common Graphs

pressure-volume (Boyle's Law)

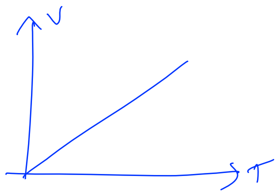




$p \propto \frac{1}{V} \rightarrow p_1V_1 = p_2V_2$

* T and no. of moles = constant

volume-temp (Charles' Law)

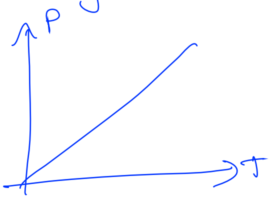


$V \propto T$

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$

* P and no. of moles = constant

pressure-temp (Gay-Lussac Law)



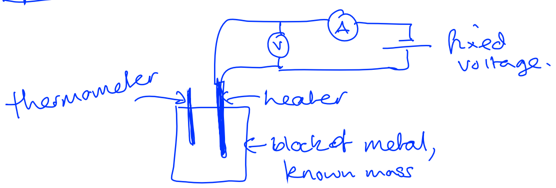
$p \propto T$

$\frac{p_1}{T_1} = \frac{p_2}{T_2}$

* V and no. of moles constant

Experiment Summaries

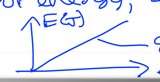
Specific heat capacity



- turn on heater and calculate power input. $P = IV$.
-

ΔT (°C)	t(s)	E(J)

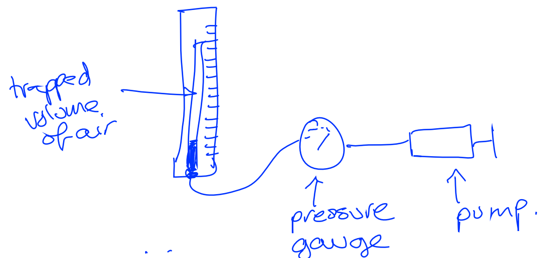
- Every 30s take ΔT of metal, calculate input energy, $E = Pt = IVt$
-



gradient = mc

assumes all electrical energy converts to heating block

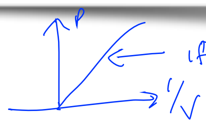
Boyle's Law



- record initial pressure, volume
-

Pressure	Volume

- increase pressure, record new value of volume
- repeat



if $p \propto \frac{1}{V}$ → Boyle's Law

Other Notes / Learned From Past Papers

- Understand that $E_K \propto T$ $\left(E_K = \frac{3}{2}k_BT\right)$
- Solve problems using
  1. $Q = mc\Delta T$
  2. $Q = mL$
  3. $pV = nRT$
  4. $p_1V_1 = p_2V_2$
  5. $\frac{p_1}{T_1} = \frac{p_2}{T_2}$
  6. $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

Kinetic theory assumptions

- molecules are perfectly elastic
- molecules are spheres
- molecules are identical
- no forces between molecules (constant velocity between collisions)
- molecular volume negligible
- gas has large no. of molecules.