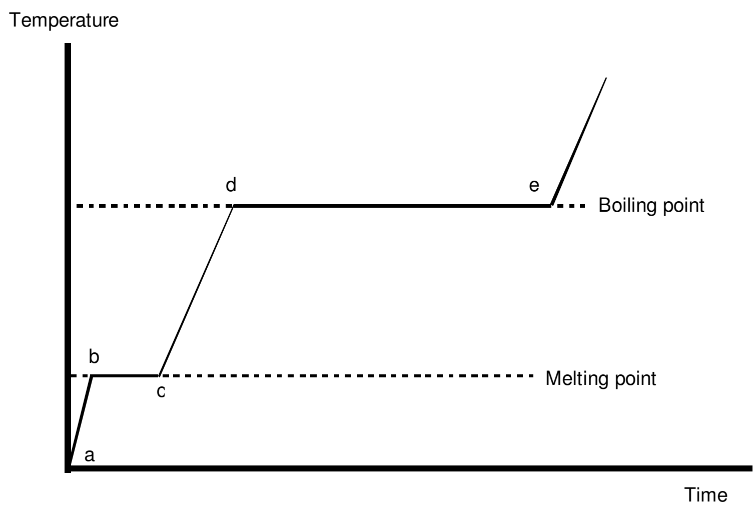
SEMESTER B REVIEW: EQUATIONS

HEAT

$$Q = mc\Delta T \qquad Q = \pm\, m h_{fusion} \qquad Q = \pm\, m h_{vaporization}$$

specific heat of liquid water	4186	joules per kilogram per degree Celsius (or K)
specific heat of ice	2090	joules per kilogram per degree Celsius (or K)
heat of fusion of water	3.35E05	joules per kilogram
heat of vaporization of water	2.26E06	joules per kilogram

Change-of-phase



For these problems, work across this graph from the starting point to the end point, and account for the heat energy *Q* required at each phase of the graph.

For regions (a→b), (c→d), and (e→), you will need the *Q = m c ΔT* version, while for (b→c) and (d→e), use the appropriate *Q = m h* version.

Be aware of the sign of *Q*, also, in each region; heat energy may need to be added, or removed. Add up the total *Q* across the entire change range.

$$T_f = \frac{\sum_{i=1}^{n} m_i c_i T_i}{\sum_{i=1}^{n} m_i c_i}$$

general equation for final temperature for *n* objects

Two volumes of the same material (e.g., water) $$T_f = \frac{V_1 T_1 + V_2 T_2}{V_1 + V_2}$$

Two masses of the same material $$T_f = \frac{m_1 T_1 + m_2 T_2}{m_1 + m_2}$$

Two masses of different materials $$T_f = \frac{m_1 c_1 T_1 + m_2 c_2 T_2}{m_1 c_1 + m_2 c_2}$$

ELECTRICITY AND MAGNETISM

Electrostatics

k = 9 x 10^9 N m^2 / C^2 e = 1.6 x 10^{-19} C

$$F_E = k\,\frac{(\pm q_1)\,(\pm q_2)}{r^2} \qquad E \equiv k\,\frac{\pm q_1}{r^2} = \frac{F_E}{+q_2} \qquad PE = k\,\frac{(\pm q_1)(\pm q_2)}{r} = F_E\, r$$

Potential difference

$$V \equiv \frac{PE}{q_2} = k\,\frac{\pm q_1}{r} \qquad \Delta V = \frac{\Delta PE}{q} = \frac{W}{q} \qquad \Delta V = E\,\Delta d \qquad \Delta PE = q\,E\,\Delta d = F_E\,\Delta d = W$$

Current, Ohm's Law, Power, Energy

$$I \approx \frac{\Delta q}{\Delta t} \qquad V = I\,R \qquad P = I\,V = \frac{V^2}{R} = I^2\,R \qquad \Delta energy = P\,\Delta t$$ (constant P only)

Basic DC circuit analysis (single voltage source)

$$R_{eff} = R_{series} + \sum R_{parallel} \qquad R_{series} = \sum_{i=1}^{n} R_i \qquad R_{parallel} = \frac{1}{\sum_{j=1}^{m} \frac{1}{R_j}} = \left(R_1^{-1} + R_2^{-1} + R_3^{-1} + \cdots + R_m^{-1}\right)^{-1}$$

$$R_{parallel} = \frac{R_1\,R_2}{R_1 + R_2} \quad \text{m} = 2\,\text{only} \qquad R_{parallel} = \frac{R_{equal}}{m} \quad \text{all m equal}$$

$$I_{total} = \frac{V}{R_{eff}} \qquad P_{total} = I_{total}\,V = \frac{V^2}{R_{eff}} \qquad \Delta V = I_{total}\,R$$

$$I_j = I_{total}\,\frac{R_{parallel}}{R_j} \qquad P_j = \frac{\left(I_{total}\,R_{parallel}\right)^2}{R_j}$$

current, power in j-th parallel resistor

$$I_i = I_{total} \qquad P_i = I_{total}^2\,R_i$$

current, power in i-th series resistor

Magnetic force

$$F_{\text{magnetic, charge}} = q\,v\,B\,\sin(\theta) \qquad F_{\text{magnetic, wire}} = L\,I\,B\,\sin(\theta)$$

assume θ is 90 degrees unless otherwise specified

Transformers

$$\frac{N_p}{N_s} = \frac{V_p}{V_s} \qquad (V\,I)_{in} = (V\,I)_{out} \qquad P_{in} = P_{out}$$

WAVES

$v = \lambda f$ speed of sound in air ~ 340 m/s speed of light (c) in vacuum = 3.00E8 m/s

REFRACTION / OPTICS

INDEX OF REFRACTION

$$n_{medium} \equiv \frac{c_{vacuum}}{c_{medium}} \geq 1$$

SNELL'S LAW

$$n_i \sin(\theta_i) = n_r \sin(\theta_r)$$

CRITICAL ANGLE

$$\theta_{critical} = \sin^{-1}\left(\frac{n_r}{n_i}\right)$$

MIRROR / LENS (PARAXIAL ASSUMPTION)

$$\frac{1}{s_{object}} + \frac{1}{s_{image}} = \frac{1}{f} \quad \Rightarrow \quad s_{image} = \frac{f\, s_{object}}{s_{object} - f} = \frac{f}{1 - \dfrac{f}{s_{object}}}$$

MAGNIFICATION

$$m = -\frac{s_{image}}{s_{object}} = \frac{f}{f - s_{object}} = \frac{1}{1 - \dfrac{s_{object}}{f}}$$

FOCAL LENGTH

$$f_{mirror} = \frac{R}{2} \qquad \frac{1}{f_{lens}} = (n-1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$