

## Equations for Exam 2

### Thermodynamics / Entropy

$$PV = nRT, \quad \Delta U = Q + W, \quad Q = mc\Delta T, \quad Q = mL$$

$$R = 8.314 \frac{\text{J}}{\text{mol} \cdot \text{K}} \quad 1 \text{ atm} \cdot \text{L} = 101.3 \text{ J} \quad T(\text{K}) = T(^{\circ}\text{C}) + 273$$

Process	Definition	Q	W	$\Delta U$
isovolumetric	$\Delta V = 0$	$nC_V\Delta T$	0	$nC_V\Delta T$
isobaric	$\Delta P = 0$	$nC_P\Delta T$	$P\Delta V$	$nC_V\Delta T$
isothermal	$\Delta T = 0$	$-W$	$nRT \ln\left(\frac{V_i}{V_f}\right)$	0
adiabatic	$Q = 0$	0	$\Delta U$	$nC_V\Delta T$

$$dS = \frac{dQ}{T}, \quad \Delta S = \int \frac{dQ}{T}, \quad \Delta S = nC_V \ln\left(\frac{T_f}{T_i}\right) + nR \ln\left(\frac{V_f}{V_i}\right)$$

### Electrostatic Forces and Electric Fields

$$\vec{F} = \frac{kq_1q_2}{r_{12}^2} \hat{r} \quad \vec{F} = q\vec{E} \quad \vec{E} = \int \frac{kdq}{r^2} \hat{r} = \int \frac{kdq}{r^3} \vec{r}$$

$$k = \frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 \frac{\text{Nm}^2}{\text{C}^2}, \quad \epsilon_0 = 8.85 \times 10^{-12} \frac{\text{C}^2}{\text{Nm}^2} = 8.85 \frac{\text{pF}}{\text{m}}$$

### Gauss's Law

$$\Phi_e = \int E_{\perp} dA = \int \vec{E} \cdot d\vec{A}, \quad \oint \vec{E} \cdot d\vec{A} = \frac{Q_{\text{in}}}{\epsilon_0}$$

### Electrostatic Energy and Electric Potential

$$U = \frac{kq_1q_2}{|r_{12}|}, \quad U = \sum_{i<j} \frac{kq_iq_j}{|r_{ij}|}, \quad U = qV, \quad U = \frac{1}{2} \int Vdq$$

$$V = - \int \vec{E} \cdot d\vec{s}. \quad E_x = -\frac{\partial V}{\partial x}, \quad E_y = -\frac{\partial V}{\partial y}, \quad E_z = -\frac{\partial V}{\partial z}. \quad 1 \text{ V} = 1 \text{ J/C}.$$

### Capacitance

$$Q = C\Delta V, \quad U = \frac{1}{2} CV^2 = \frac{Q^2}{2C}, \quad u = \frac{1}{2} \epsilon_0 E^2, \quad 1 \text{ F} = 1 \text{ C/V}.$$