Correspondence Table for analogous physical properties in physics 51 By Todd Sauke

Mechanical system property	Electrical circuit property	Notes/relations
x (position)	q (charge)	
x-motion - Change of position↓ $\Delta x = (x_{final} - x_{initial})$	q-motion – Change of charge↓ $\Delta q = (q_{final} - q_{initial})$	always *final* - *initial*
instantaneous velocity↓ $v = \text{limit } \Delta t \to 0 \ \Delta x/\Delta t = dx/dt$	instantaneous current↓ $i = \text{limit } \Delta t \to 0 \ \Delta q/\Delta t = dq/dt$	
instantaneous acceleration↓ $a = \text{limit } \Delta t \to 0 \ \Delta v/\Delta t = dv/dt$	we don't give it a name↓ just use di/dt, or d^2q/dt^2	
force	voltage	$\mathcal{E}$ = electromotive *force*
mass, m	inductance, L	
$\Sigma F_x = m a_x$	$V = L\, di/dt$	
spring constant, k	capacitance, C (is like 1 / k)	we could call 1/k the spring "acceptance"
$F = k x$	$V_C = q / C$	
springs in *series* ↓ (forces are equal) (and Δx's add)	capacitors in *parallel* ↓ (V's are equal) (and q's add)	
$1 / k_{equiv} = 1 / k_1 + 1 / k_2$	$C_{equiv} = C_1 + C_2$	spring "acceptances" add
springs in *parallel* ↓ (forces add) (and Δx's are equal)	capacitors in *series* ↓ (V's add) (and q's are equal)	
$k_{equiv} = k_1 + k_2$	$1 / C_{equiv} = 1 / C_1 + 1 / C_2$	inverse "acceptances" add
resistance to motion through fluid	electrical resistance, R	
$F_{fluid} = - b v$	$V = (-) R I$	(minus) because it's a voltage *drop*
work (energy), $W = \int F(x)\, dx$	electrical energy, $U = \int V(q)\, dq$	
kinetic energy = $\frac{1}{2} m v^2$	energy of an inductor = $\frac{1}{2} L i^2$	
spring potential energy = $\frac{1}{2} k x^2$	energy of a capacitor = $\frac{1}{2} q^2 / C$	
mechanical power, $P = F v$	electrical power, $P = V I$	(V is voltage on the right)

approach to equilibrium position of a light (massless, overdamped) spring in response to applied force	charging a capacitor through a resistor with an applied voltage (RC circuit)	
$x = x_{max}\,(1 - \exp(- t / \tau))$	$q = q_{max}\,(1 - \exp(- t / \tau))$	
$x_{max} = F / k \quad , \quad \tau = b/k$	$q_{max} = V\,C \quad , \quad \tau = RC$	
mass on a spring oscillates	L C circuit oscillates	
$x = x_{max} \cos(\omega t + \phi)$	$q = q_{max} \cos(\omega t + \phi)$	
$v = - v_{max} \sin(\omega t + \phi)$	$i = - i_{max} \sin(\omega t + \phi)$	
$\omega = \sqrt{(k / m)}$	$\omega = \sqrt{1 / (L\,C)}$	
add resistance : motion damps	add resistance : current damps	(R L C circuit)
$x = x_{max} \exp(t/\tau) \cos(\omega' t + \phi)$	$q = q_{max} \exp(t/\tau) \cos(\omega' t + \phi)$	
$\tau = 2\,m / b$	$\tau = 2\,L / R$	
$\omega' = \sqrt{(k / m) - b^2/(4\,m^2)}$	$\omega' = \sqrt{1 / (L\,C) - R^2/(4\,L^2)}$	
approach to terminal speed	approach to final current in RL circuit	
$v = v_{term}\,(1 - \exp(- t / \tau))$	$i = i_{final}\,(1 - \exp(- t / \tau))$	
$\tau = m/b \quad , \quad i_{final} = (mg) / b$	$\tau = L/R \quad , \quad i_{final} = \mathcal{E} / R$	(mg) = weight (force) of object
driven mechanical oscillation with resonance	driven electrical oscillation with resonance	driven at angular frequency ω_d
$A = F_{max} / \sqrt{(k - m\,\omega_d^2)^2 + b^2\omega_d^2}$	$q_{max} = V_{max} / \sqrt{(1/C - L\,\omega_d^2)^2 + R^2\omega_d^2}$	