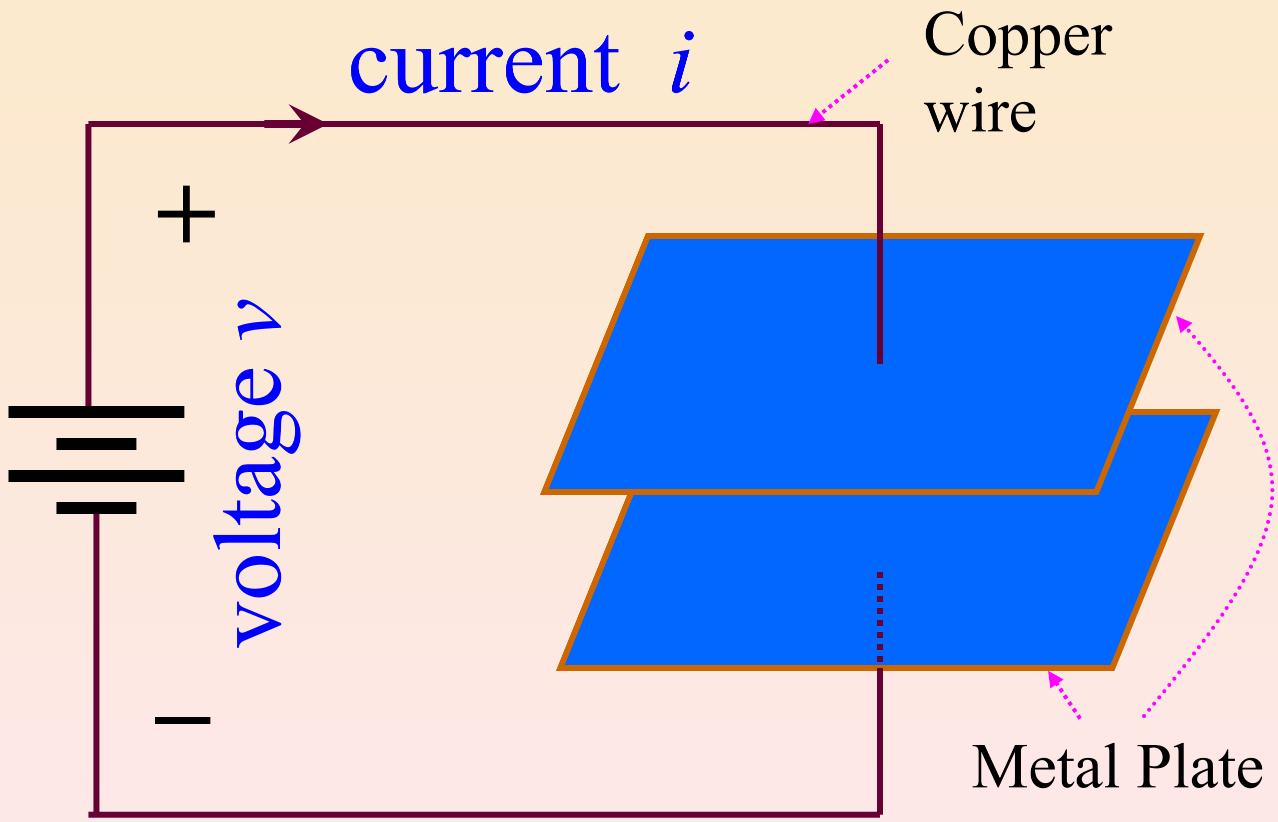
Capacitor *C*

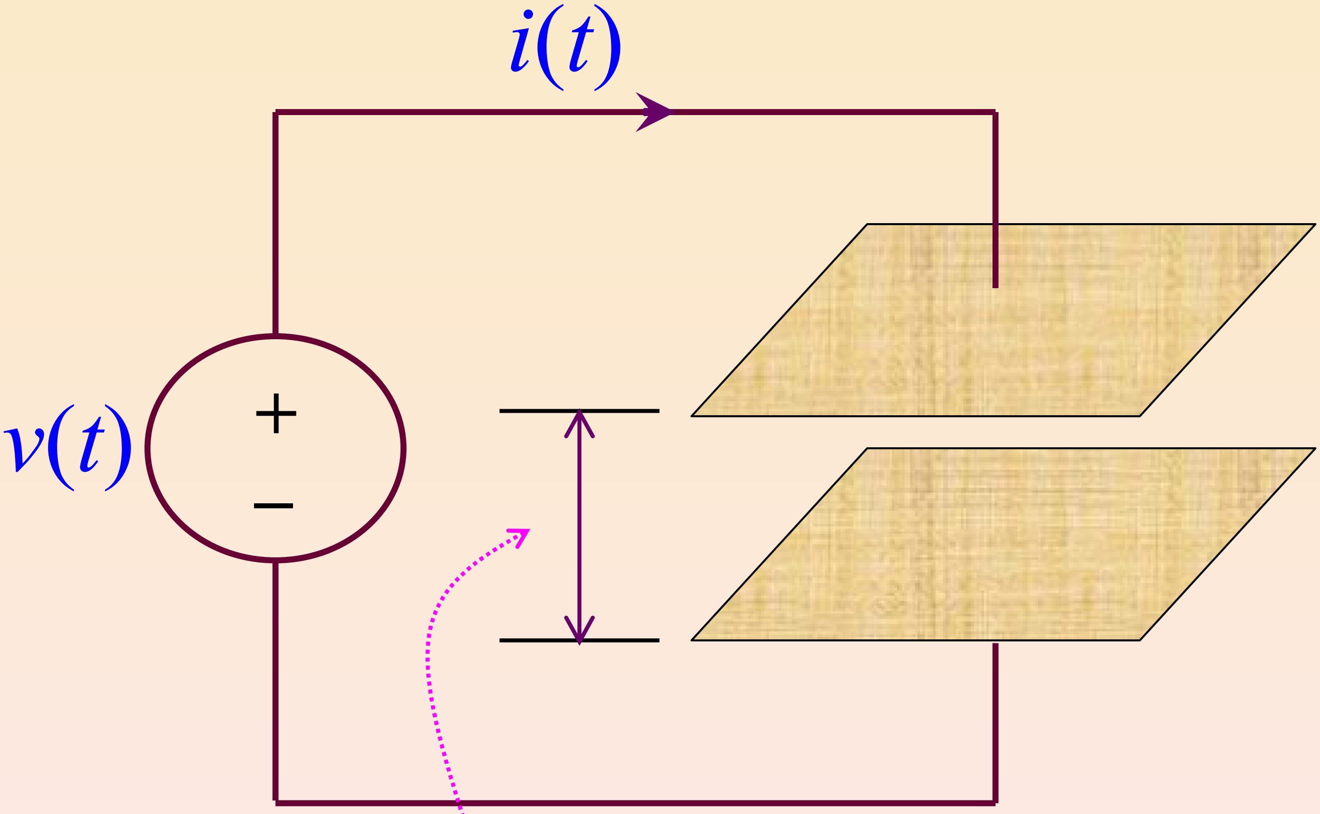


$$i = C\frac{dv}{dt}$$

C is called the

Capacitance of the *Capacitor* *C*

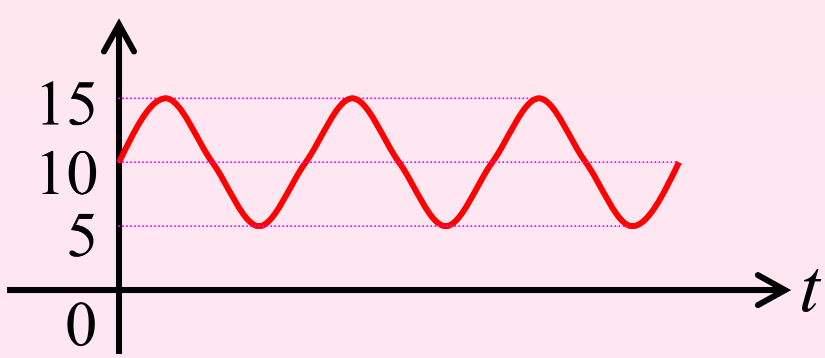
Time-varying Capacitance $C(t)$



distance changes as a function of time, giving a *time-varying capacitance* $C(t)$

Example:

$$C(t) = 10 + 5\sin t$$



Example : Time-varying Capacitance

$$C(t) = 10 + 5\sin t$$

$$i(t) = C(t)\,\frac{dv(t)}{dt}$$

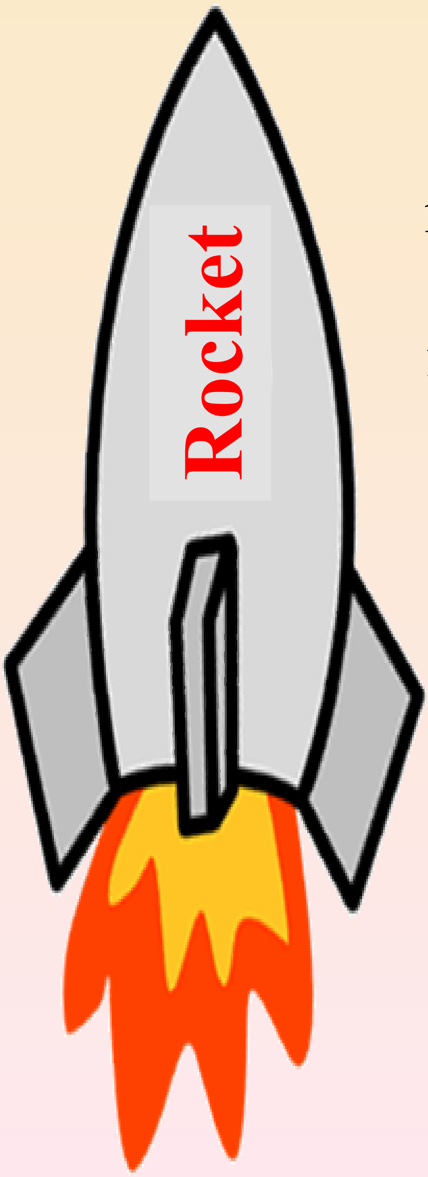
Does this obvious generalization of the formula

$$i = C\,\frac{dv}{dt}$$

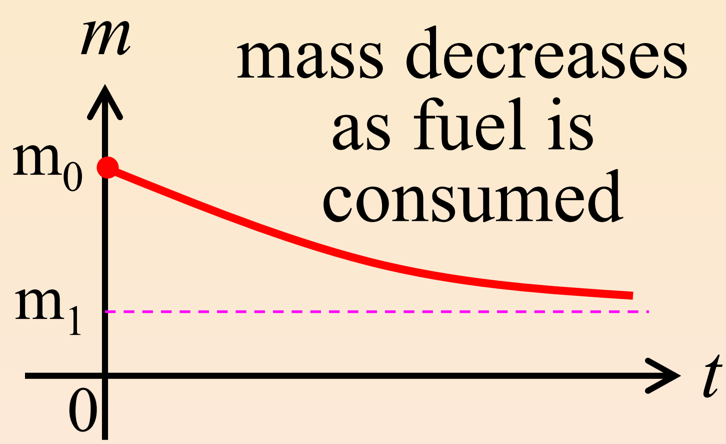
give the correct current $i(t)$ for any applied voltage $v(t)$?

Rocket Launching

velocity $v(t)$



force $f(t)$



Newton's Law of Motion

$$f(t) = m(t)\frac{dv}{dt}$$

Is this formula correct ?

NO !

Correct Newton's Formula is:

$$f = \frac{dp}{dt}$$

$$p = mv$$ ← momentum

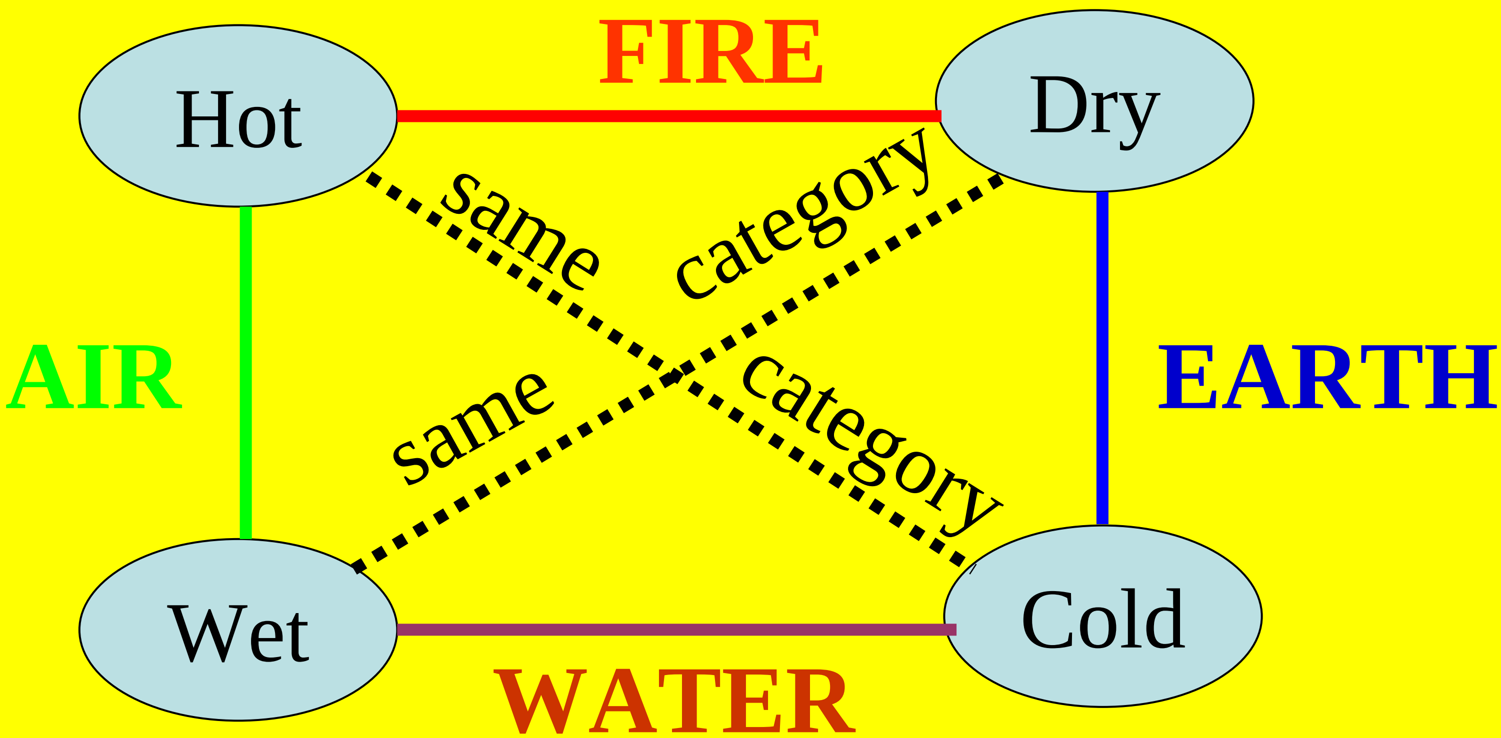
For *time-varying mass*, we have:

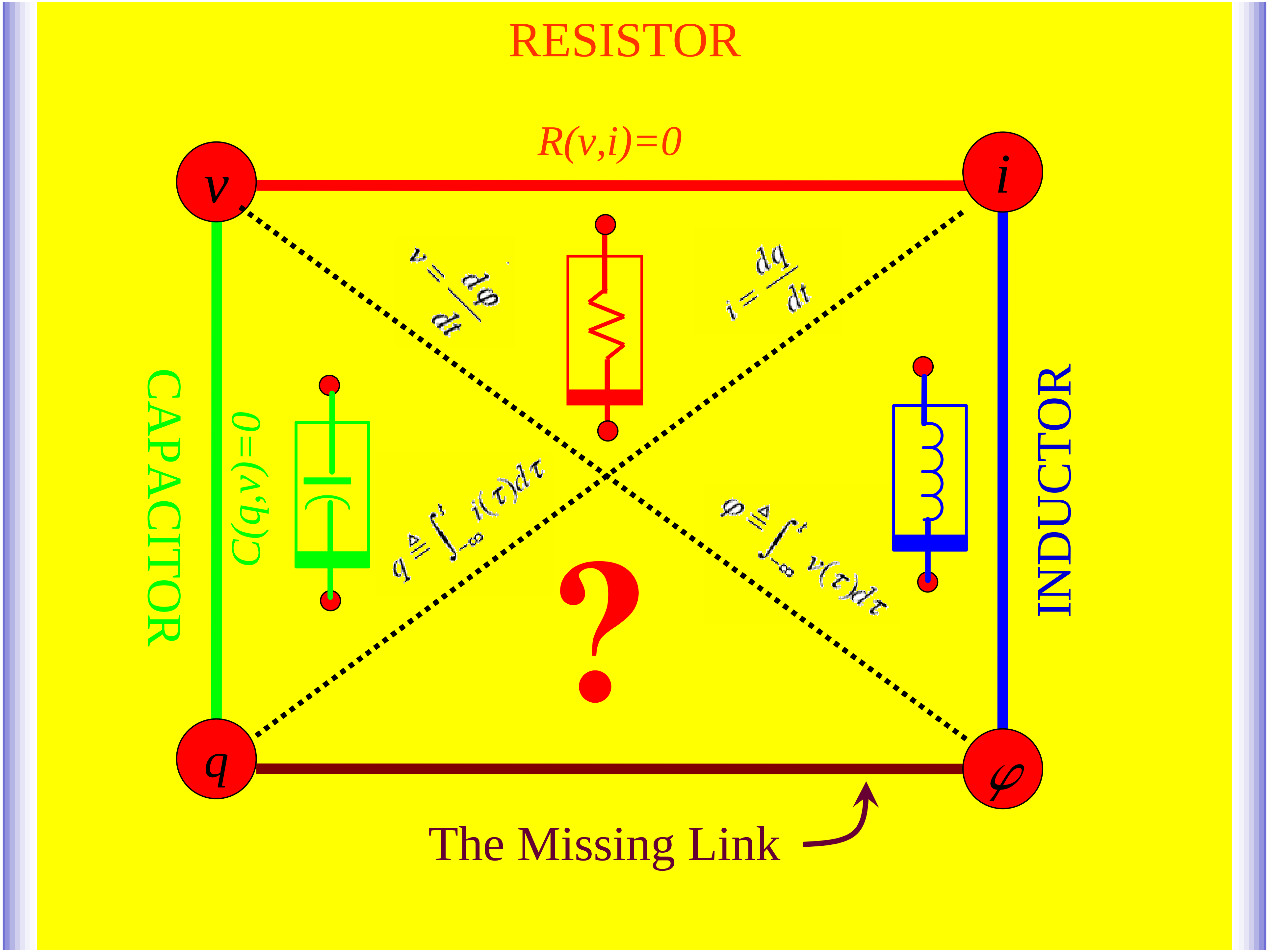
$$p = m(t)\, v$$

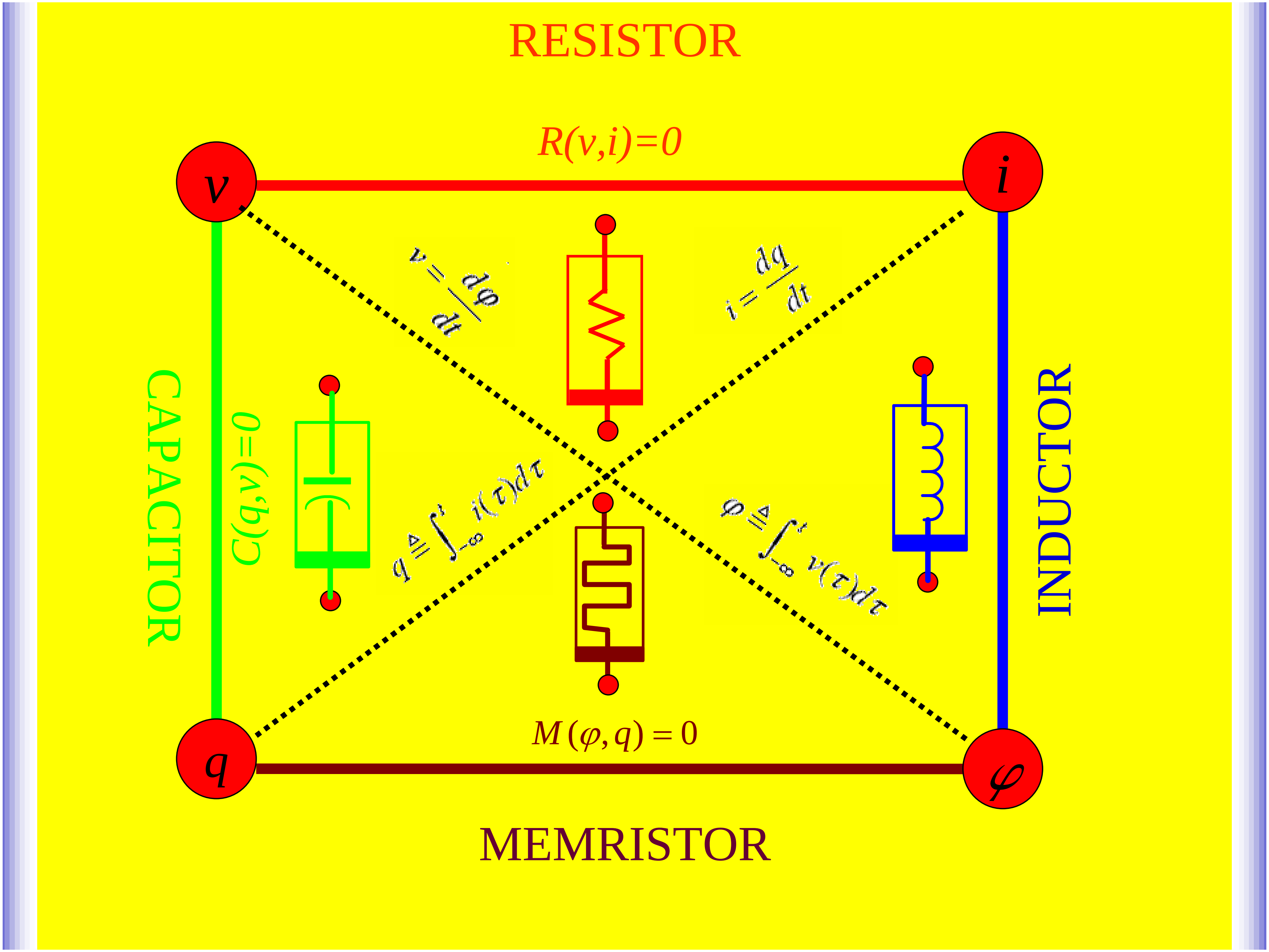
$\therefore$

$$f(t) = m(t)\frac{dv}{dt} + \underbrace{v(t)\frac{dm(t)}{dt}}_{\text{extra term !}}$$

Aristotle's 4 Building Blocks of Nature




RESISTOR
R(v,i)=0
v
i
q
φ
v = dφ/dt
i = dq/dt
q ≜ ∫_{-∞}^{t} i(τ)dτ
φ ≜ ∫_{-∞}^{t} v(τ)dτ
CAPACITOR
C(q,v)=0
INDUCTOR
?
The Missing Link


RESISTOR
R(v,i)=0
v
i
v = dφ/dt
i = dq/dt
CAPACITOR
C(q,v)=0
INDUCTOR
q ≜ ∫_{-∞}^{t} i(τ)dτ
φ ≜ ∫_{-∞}^{t} v(τ)dτ
M(φ,q) = 0
q
φ
MEMRISTOR