Lecture 1

from sections 1.1, 1.2, 2.1

Solve E1.1, E1.2, E1.3, E1.4, 1.11, 1.15, 1.26, 1.29

E2.1, E2.2, 2.1, 2.4, 2.5, 2.6, 2.8

Some Basic Concepts

* System of units:

milli (m) = 10^{-3}, micro (μ) = 10^{-6},

nano (n) = 10^{-9}, pico (p) = 10^{-12}

Kilo (K) = 10^{3}, Mega (M) = 10^{6}

GiGa (G) = 10^{9}

example: $R = 5.0\,M\Omega = 5.0\times10^{6}\,\Omega$

$F = 10\,GHz = 10*10^{9}\,Hz$

Basic Concepts (Cnt'd)

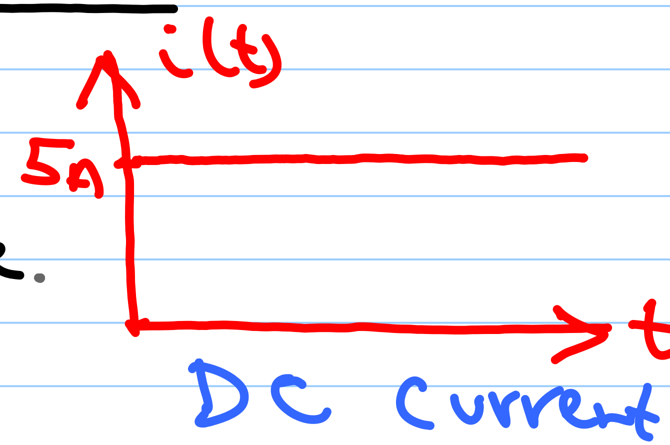
* movement of charges create electric current $i = \frac{dq}{dt}$

* Example: a charge of 0.02 C passes through a cross section in 1.0 msec. The current is

$$i = \frac{dq}{dt} \simeq \frac{\Delta q}{\Delta t} = \frac{0.02}{1.0 \times 10^{-3}} = 20\,A$$

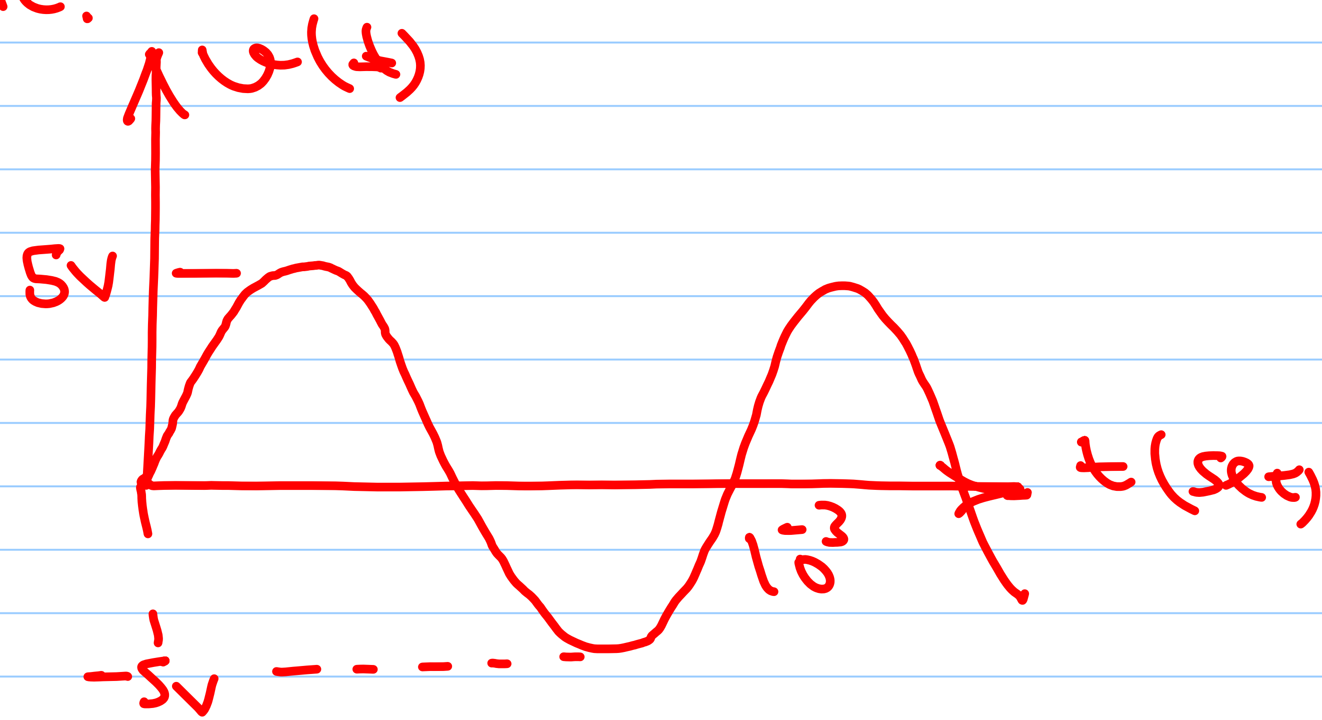
Direct and Alternating Signals

* Direct Current Signals Do not change with time.



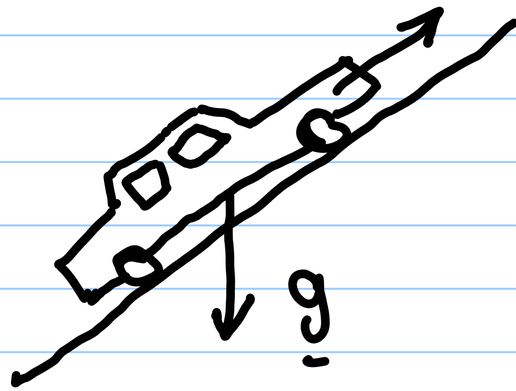
* Alternating current (AC) Signals change Sinusoidally with time

Example:

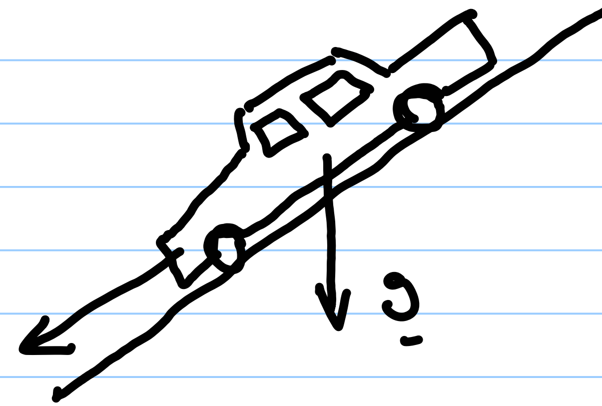


Write the mathematical expression for the shown AC voltage.

Voltage

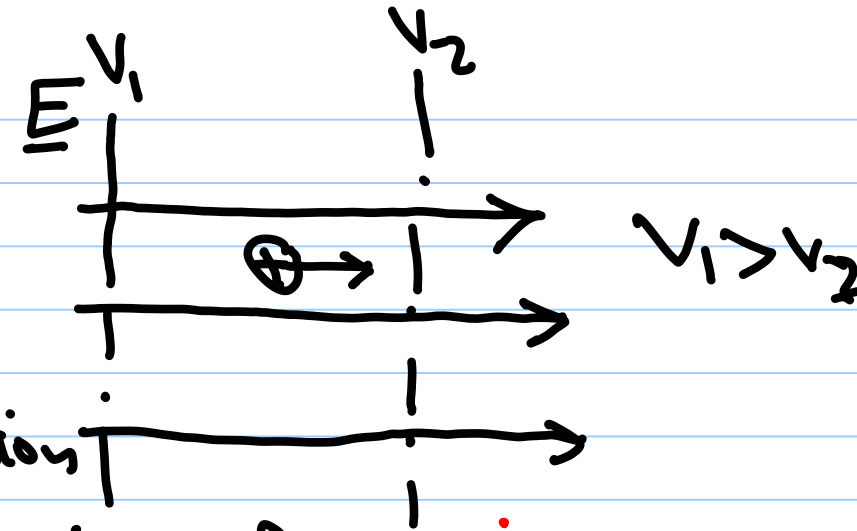


moving against gravity field → energy increases



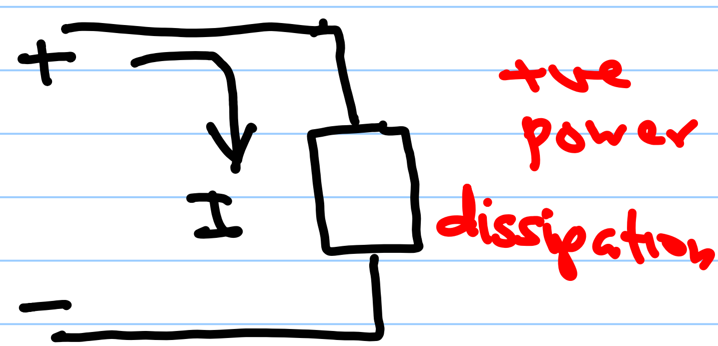
moving with gravity field → energy Decreases

Voltage (Cont'd)

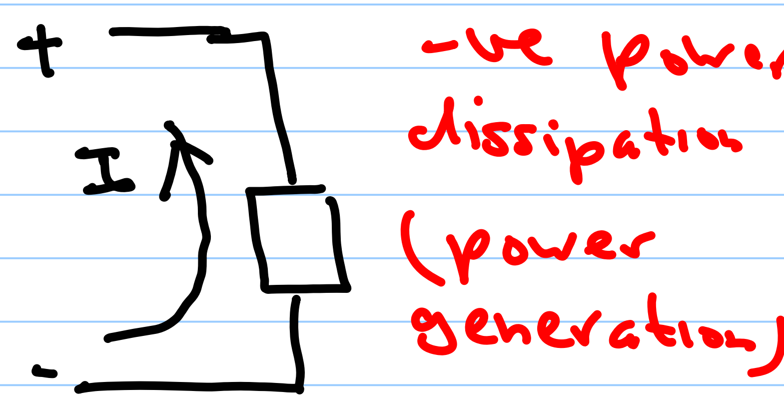


* Electric field moves the charges in its direction
* Moving **against** the electric field **increases** the energy of the charge
* The voltage difference between two points is the work done in moving a unit charge between the two points.

Power Concepts



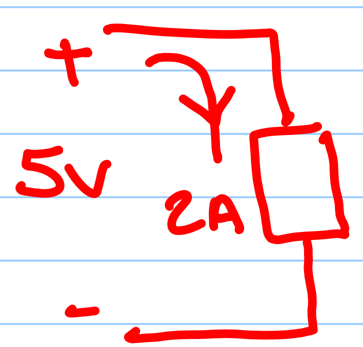
* positive charges move from high potential to low potential → They lose energy

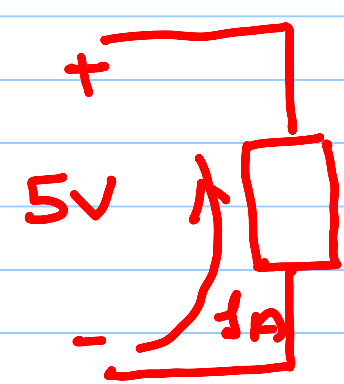


* positive charges move from low potential to high potential → They gain energy

Example

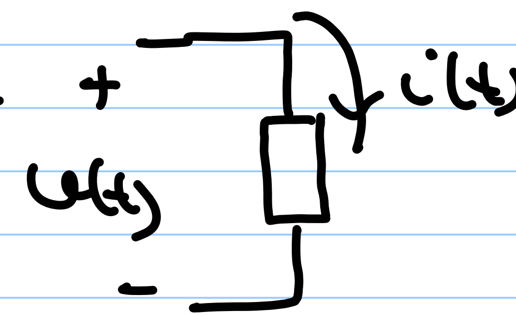
Find the dissipated power in the shown two cases





Some Power Concepts

* Instantenous dissipated power



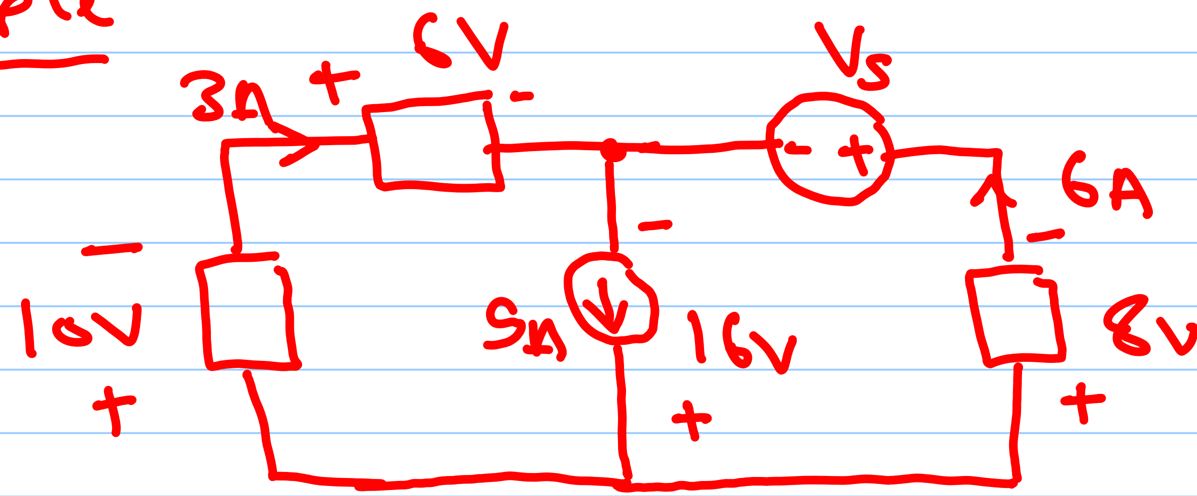
$$p(t) = v(t)\, i(t)$$

* Average power

$$P_{av} = \frac{1}{T}\int_0^T p(t)\, dt$$

where T is a chosen period of time

Example



Is the source Vs absorbing or supplying energy and how much?

Ohm's Law

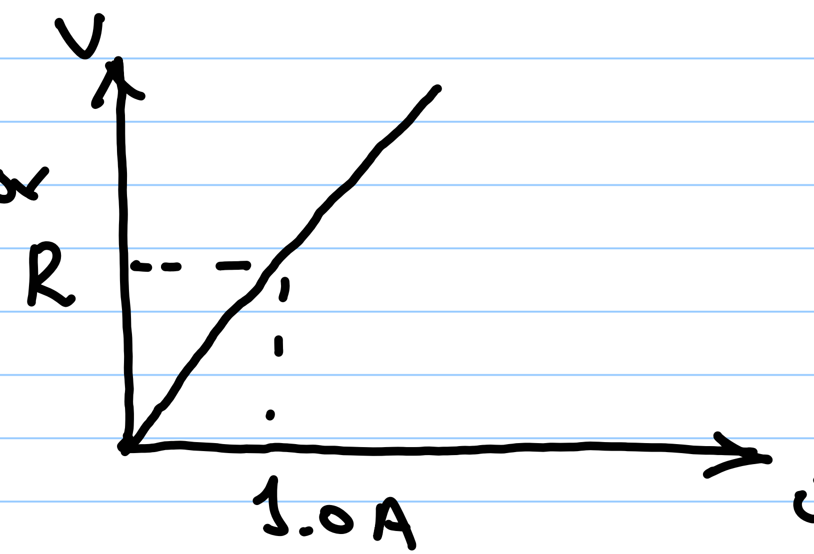
* For a linear resistor

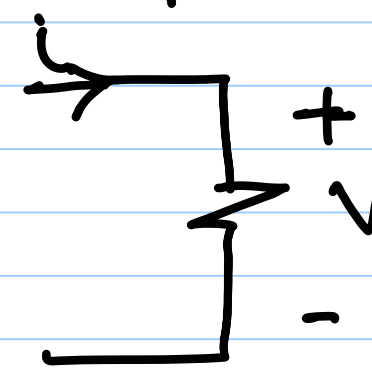
  $V = iR$

$\Rightarrow \quad i = \frac{V}{R} = GV$

where G is conductance in siemens

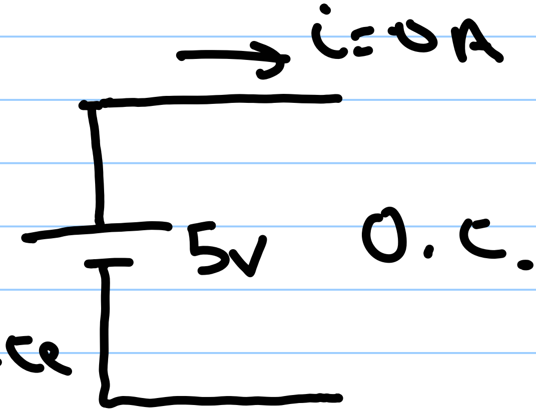
* Power $p = Vi = \frac{V^2}{R} = i^2 R$





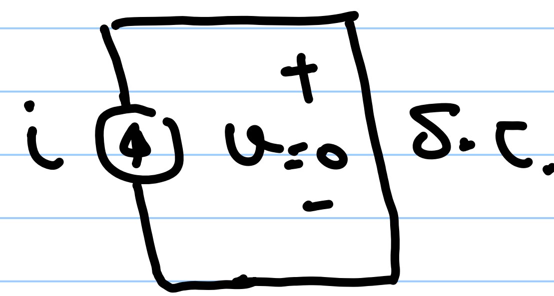
Special Cases

* Open circuit is an infinite resistance



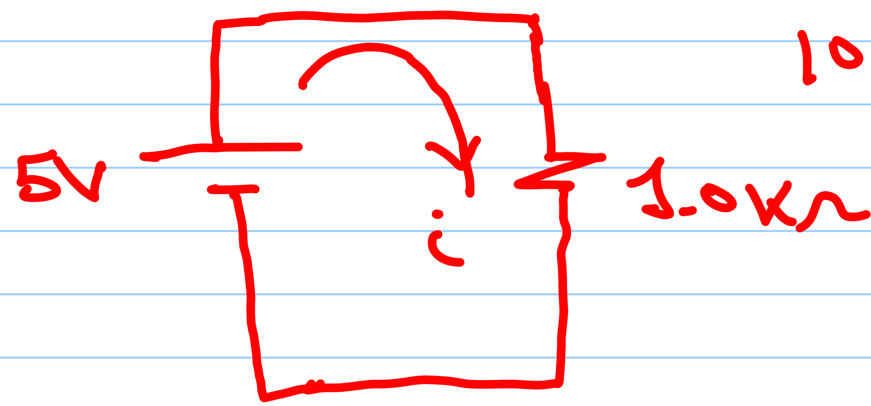
$\Rightarrow$ $i=0$ regardless of V

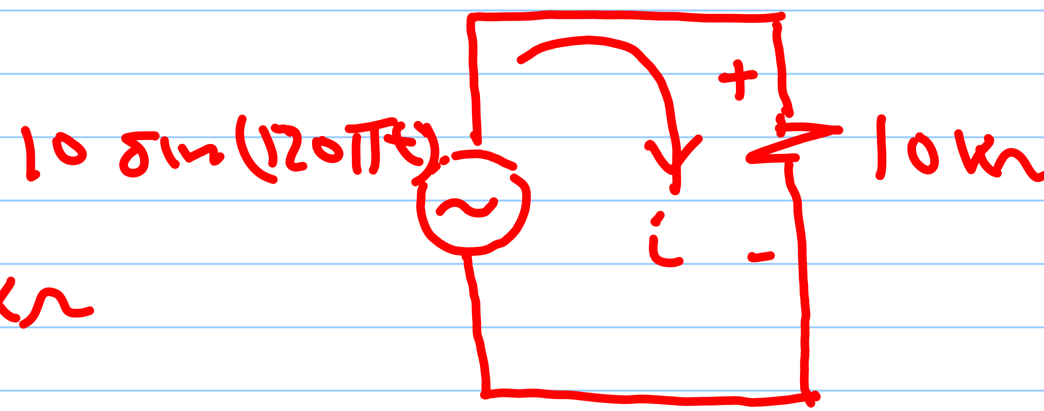
* Short circuit is zero resistance



$\Rightarrow$ $V=0$ regardless of i

Example





Find the current $i(t)$, the instantenous power $p(t)$ and the average power P_{av}