## 1-1 Book

circuit — interconnection of electrical devices

signal — time varying quantity

linear circuit — output amplitude proportional to input amplitude
e.g., $V_{out} = K V_{in}$

interface — pair of accessible terminals at which a signal can be measured

## 1-2 Symbols and Units

| | | |
|---|---|---|
| time | $t$ | seconds |
| frequency | $f$ | hertz |
| power | $p$ | watts |
| charge | $q$ | coulombs |
| voltage | $v$ | volts |
| impedance | $Z$ | ohms |
| resistance | $R$ | ohms |
| capacitance | $C$ | farads |
| inductance | $L$ | henrys |
| current | $i$ | amperes |

Table 1-2 Standard Prefixes

| | | |
|---|---|---|
| $10^{-12}$ | pico | p |
| $10^{-9}$ | nano | n |
| $10^{-6}$ | micro | μ |
| $10^{-3}$ | milli | m |
| $10^{-2}$ | centi | } not standard engineering notation |
| $10^{-1}$ | deci | } not standard engineering notation |
| $10^{3}$ | kilo | k |
| $10^{6}$ | mega | M |
| $10^{9}$ | giga | G |
| $10^{12}$ | tera | T |

ratio

$$dB = 20 \log_{10} \frac{V_2}{V_1}$$ for voltage, current, etc.

$$dB = 10 \log_{10} \frac{P_2}{P_1}$$ for power only

Some interesting specifications

micro acro $\approx$ 4 square millimeters

a Pentium IV contains about a kilometer of electrical connections

## 1-3 Circuit Variables

charge $q_E = 1.6 \times 10^{-19}$ coulomb

or 1 coulomb $= 6.25 \times 10^{18}$ electrons

the change passing through a point is $i = \frac{dq}{dt}$

$$1 \text{ ampere} = \frac{1 \text{ coulomb}}{\text{second}}$$

voltage is the change in energy of an electron as it passes through a circuit

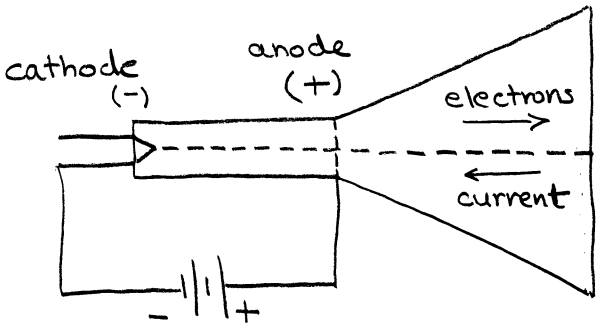
$$v = \frac{dw}{dq}$$

$$1 \text{ volt} = \frac{1 \text{ joule}}{\text{coulomb}}$$

Power is the time rate of change of energy

$$p = \frac{dw}{dt} = \frac{dw}{dq}\frac{dq}{dt} = vi$$

Example 1-1




The electron beam in the cathode-ray tube shown above carries $10^{14}$ electrons per second and is accelerated by a voltage of 50 kV. Find the power in the electron beam.

Note that charges (electrons) move from cathode to anode. But current (signed) moves from anode (+) to cathode (-).

$$i = q_E \frac{dn_E}{dt} = (1.6\times10^{-19})(10^{14}) = 1.6\times10^{-5} \text{ amperes}$$

$q_E$: charge on an electron; $\frac{dn_E}{dt}$: number of electrons/second

$= 16\,\mu$ amperes (in standard units)

$$p = vi = (50\times10^{3})(1.6\times10^{-5}) = 0.8 \text{ watts}$$