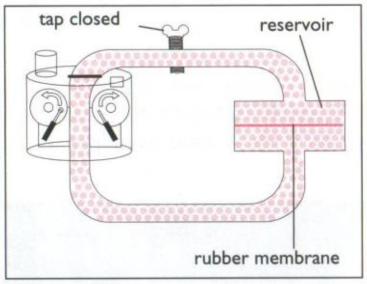


Figure 9.1a shows a reservoir of balls that can store energy. With the tap shut, the balls cannot move and the ball reservoir is uncharged.

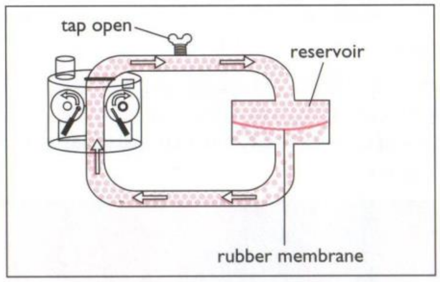


Figure 9.1b When the tap is open the engine pushes balls into the top half of the reservoir, the rubber membrane stretches, and this pushes balls out of the bottom half. The charged reservoir doesn't really store balls; it just has more balls in the top and fewer balls in the bottom.

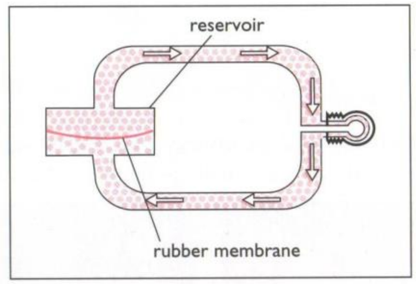


Figure 9.1c If you connect the charged reservoir to a load, the membrane will push balls from the top part of the reservoir to the bottom part, powering the load for a short time.

UNLIKE = ATTRACT

conv current

CAPACITORS

$I = \frac{\Delta Q}{\Delta t}$

Store charge (coulombs) $Q = CV$

In circuits

- Series: $\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} \dots$
- Parallel: $C = C_1 + C_2 \dots$

Two parallel plates → $C = \frac{\varepsilon A}{d}$ (ε → Permittivity)

Different Types – Dielectric

Electrolytic P326 → If connected wrong way round ~~electr~~ dielectric will dissolve

stronger

Fullick Chapter 4.3

Energy Stored P328

Charged capacitor can do work and so is an energy store.

Work done = $V \Delta Q$

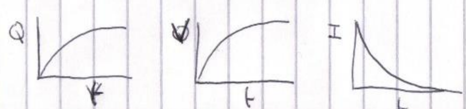
Total Work done = Energy transferred = $\frac{1}{2} QV$

$E = \frac{1}{2} CV^2$

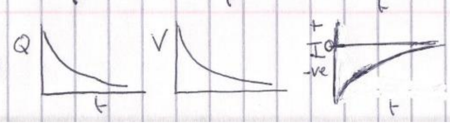
AC Fullick P342 P 345 → Charging + charge opposite

Rember UNITS

Charging



Discharging



$\Delta Q = -\frac{Q}{RC} \Delta t$

AS

def

$R = \frac{V}{I}$ $(\rightarrow V = IR)$

$g = \frac{\Delta I_d}{\Delta V_{gs}}$

$P = VI$ $\left(P = V\left(\frac{V}{R}\right) \rightarrow P = \frac{V^2}{R}\right)$

Pot Divider $V_{out} = \frac{V_{in} \; R_2}{(R_1 + R_2)}$

def

$V = \frac{W}{Q}$ (W: Energy, Q: charge)

Op Amp $V_{out} = A(V_1 - V_2)$ ($A \rightarrow 10^6$)

Def

$C = \frac{Q}{V}$ $(\rightarrow Q = CV)$

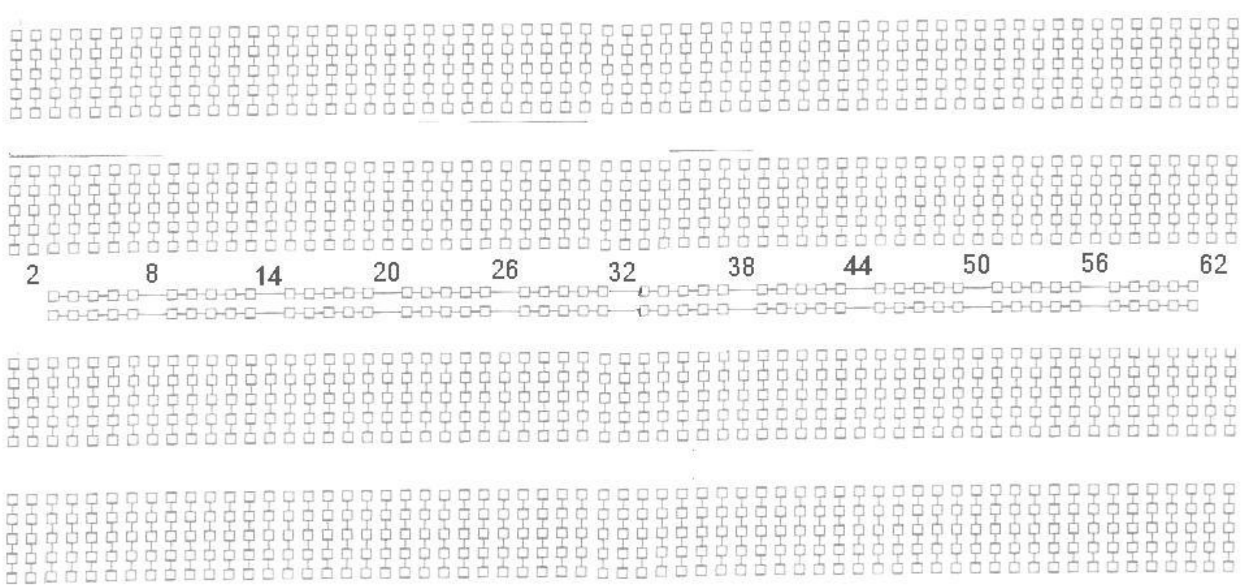
gain = $\frac{\text{output}}{\text{Input}}$

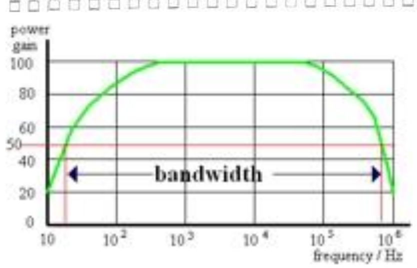
def

$I = \frac{Q}{t}$ $(\rightarrow Q = It)$

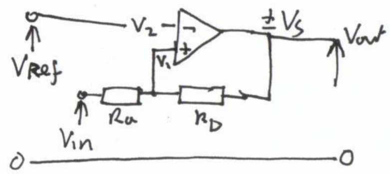
Dec	Bin	Hex
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
10	1010	A
11	1011	B
12	1100	C
13	1101	D
14	1110	E
15	1111	F

SEE DATA SHEET





Non-Inverting Schmitt Trigger



op amp tries to make both inputs equal $\Rightarrow V_1 = V_2 = V_{ref}$

I Through R_b $\quad I = \dfrac{(\pm V_S - V_{ref})}{R_b}$ $\quad$ $V_{in} = V_{in}$ at switch voltage

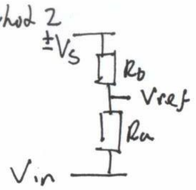
Infinite input impedance $\quad$ so $I_{Rb} = I_{Ra}$

V across $R_a \Rightarrow (V_{in} - V_{ref}) = \dfrac{(\pm V_S - V_{ref})}{R_b} R_a$

$$V_{in} = \frac{(\pm V_S - V_{ref})}{R_b} R_a + V_{ref}$$

$$V_{in} = \frac{\pm V_S R_a}{R_b} \qquad V_{ref} = 0$$

method 2



This is more complicated

$$I = \frac{\pm V_S - V_{in}}{(R_b + R_a)} = \frac{\cancel{V_{ref}} - V_{in}}{R_a}$$

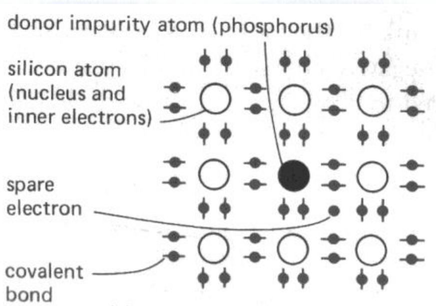
Take $V_{ref} = 0$

$$\frac{(R_b + R_a)(\pm V_S) - V_{in}\cancel{(R_b + R_a)}}{\cancel{(R_b + R_a)}} = -\frac{V_{in}(R_b + R_a)}{R_a}$$

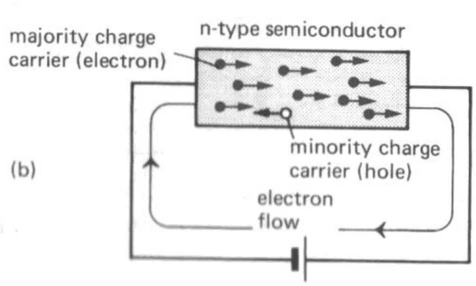
$$\pm V_S = V_{in}\left(1 - \frac{(R_b + R_a)}{R_a}\right)$$

$$\pm V_S = V_{in}\left(1 - \frac{R_b}{R_a} + \frac{R_a}{R_a}\right) = V_{in}\left(1 - \frac{R_b}{R_a} - 1\right)$$

$$\pm V_S = V_{in}\left(\frac{-R_b}{R_a}\right) \Rightarrow V_{in} = \frac{\pm V_S R_a}{R_b}$$



(a) Crystal lattice of n-type silicon



(b)

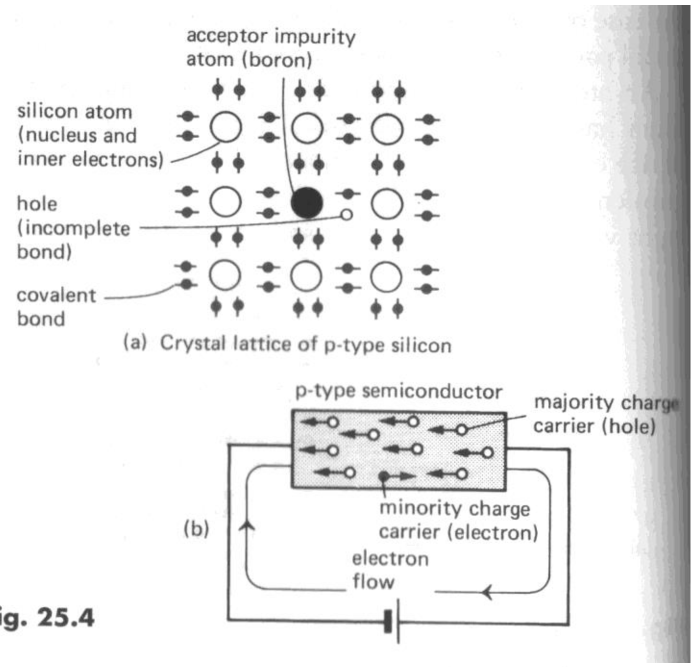
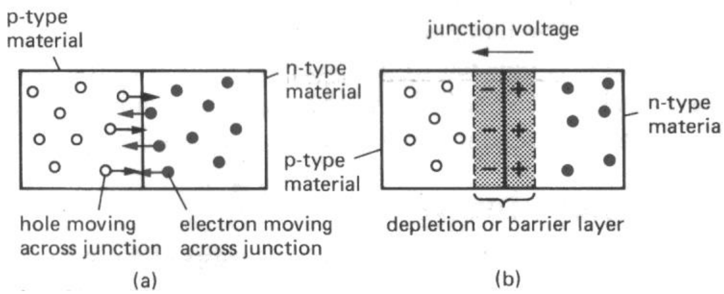
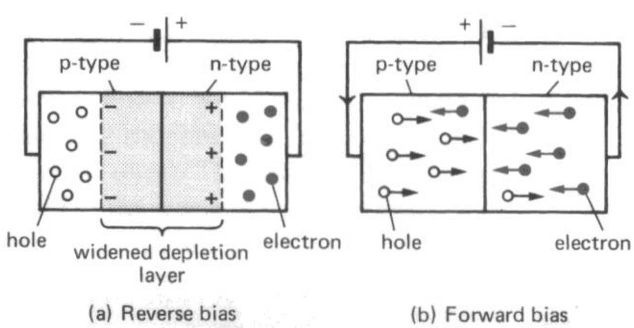
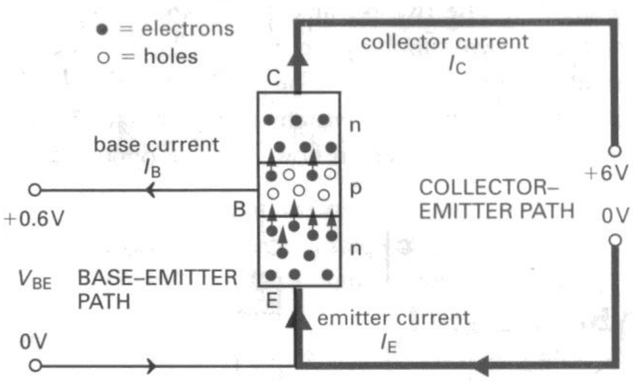
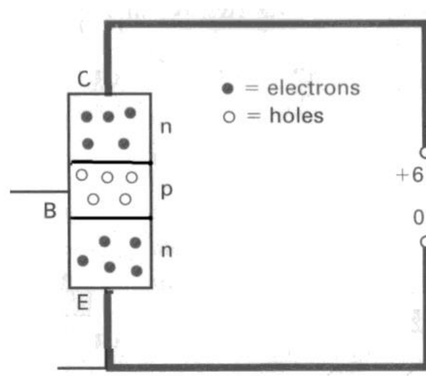

acceptor impurity atom (boron)
silicon atom (nucleus and inner electrons)
hole (incomplete bond)
covalent bond
(a) Crystal lattice of p-type silicon
p-type semiconductor
majority charge carrier (hole)
minority charge carrier (electron)
(b)
electron flow

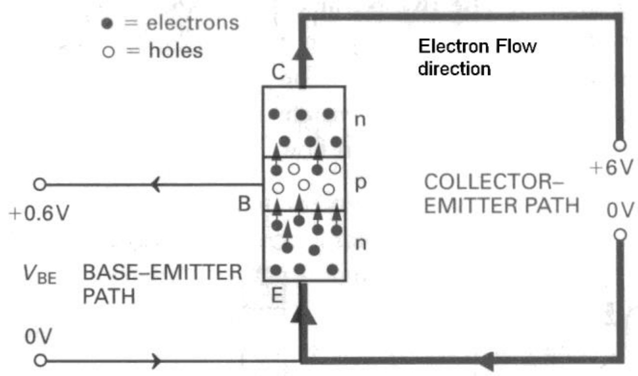
Fig. 25.4


p-type material
n-type material
hole moving across junction
electron moving across junction
(a)
junction voltage
n-type materia
p-type material
depletion or barrier layer
(b)


p-type
n-type
hole
widened depletion layer
electron
(a) Reverse bias
p-type
n-type
hole
electron
(b) Forward bias

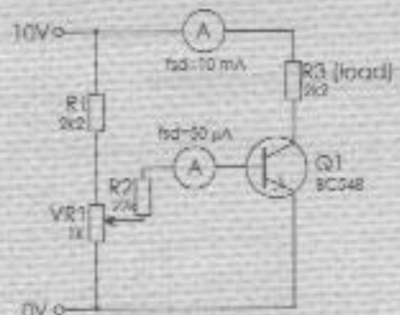

● = electrons
○ = holes
collector current
I_C
C
n
p
n
base current
I_B
+0.6V
B
V_{BE}
BASE–EMITTER PATH
0V
E
emitter current
I_E
COLLECTOR–EMITTER PATH
+6V
0V


C
● = electrons
○ = holes
n
p
n
B
E
+6V
0V



Things to do

This circuit has two meters, a microammeter to measure the base current and a milliammeter to measure the collector current. You will also need a digital voltmeter (fsd=10 V) , but this is not to be connected into the circuit.



The diagram specifies a BC548 BJT, but you can try it with other types, such as BC337, 2N2222A, or 2N3904.

Transistor action

The results you obtain from the investigation may vary slightly depending on the type of transistor tested. With a typical transistor, the graph of collector current against base current looks like this.