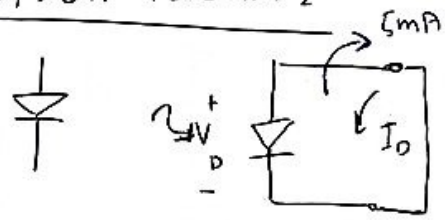
MA 2011 Tutorial 2

1.

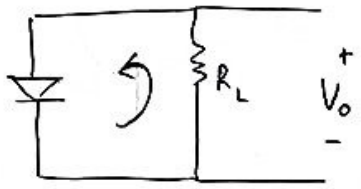


$I_D = f(V_D)$

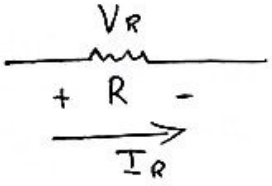
For the short-circuit condition,

$V_D = 0V$

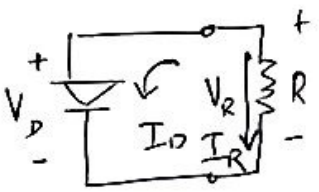
a)



1. No light
2. Medium light
3. Max. light



$V_R = R \cdot I_R$ —— (1)



Set condition $V_R = V_D$

$I_R = -I_D$

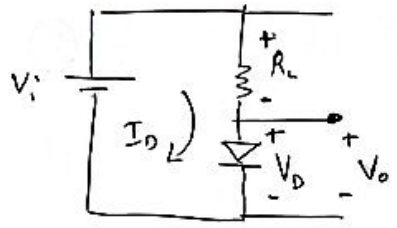
Rewrite eqn (1),

$$\boxed{V_D = -R \cdot I_D} \quad \text{—— (2)}$$

$1V = -(100\Omega) \cdot (-10mA)$

$2V = -(200\Omega) \cdot (-10mA)$

b)



From the circuit,
$V_o = V_D$

KVL,

$V_i = V_R + V_D \quad -(1)$

$V_R = R \cdot I_D \quad -(2)$

Sub. (2) in (1),

$$\boxed{V_i = R \cdot I_D + V_D} \quad -(3)$$

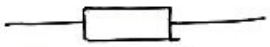
If $V_i = 0$,

$0 = R \cdot I_D + V_D$

If $V_i = -1$,

$-1 = R \cdot I_D + V_D$

2.



$R_1 = R(T_1)$

$R_o = R(T_o)$

$$\boxed{\frac{R_L}{R_o} = \exp\left[\beta\left(\frac{1}{T_1} - \frac{1}{T_o}\right)\right]} \Rightarrow \text{Comes with the device}$$

$R_1 = R(T_1) = 500\,\Omega$ at $T_1 = ?$

$R_o = R(T_o) = 20{,}000\,\Omega$ at $T_o = \underline{100\,^\circ C}$

$\beta = 3650K$

$T_o = 100^\circ = 373.15K$

$$\ln \frac{R_1}{R_o} = \beta\left(\frac{1}{T_1} - \frac{1}{T_o}\right)$$

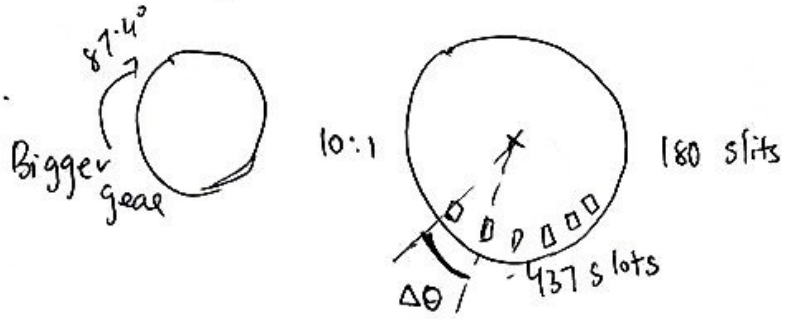
$$\frac{1}{\beta}\ln \frac{R_1}{R_o} = \frac{1}{T_1} - \frac{1}{T_o}$$

$$\frac{1}{T_1} = \frac{1}{T_0} + \frac{1}{\beta} \ln \frac{R_1}{R_0}$$

$$T_1 = \left[\frac{1}{T_0} + \frac{1}{\beta} \ln \frac{R_1}{R_0} \right]^{-1}$$

$$= \left[\frac{1}{373.15} + \frac{1}{3650} \ln \frac{500}{20000} \right]^{-1} \approx 599K \ (325.9°C)$$

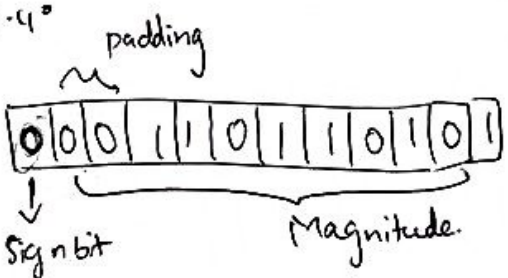
3.



a) $\Delta\theta = \frac{360°}{N_{slits}} = \frac{360°}{180} = 2°$

b) $\text{Resolution} = \frac{\Delta\theta}{N_{gear}} = \frac{2°}{10} = 0.2°$

c) positive 87.4°



if + = 0

if - = 1

$$\text{Steps} = \frac{87.4°}{\text{Resolution}} = \frac{87.4°}{0.2°} = 437 \text{ steps}$$

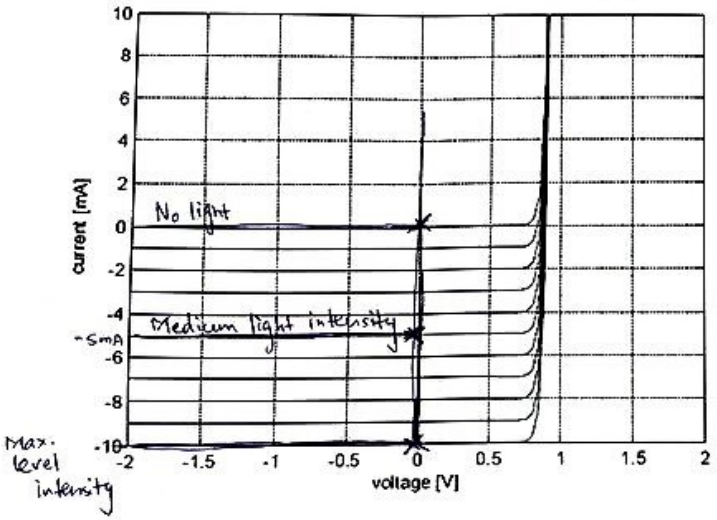
d) 8 4 2 1 | 8 (4) (2) (1) | (8) 4 (2) 1

0 0 1 1 | 0 1 1 1 | 1 0 1 0

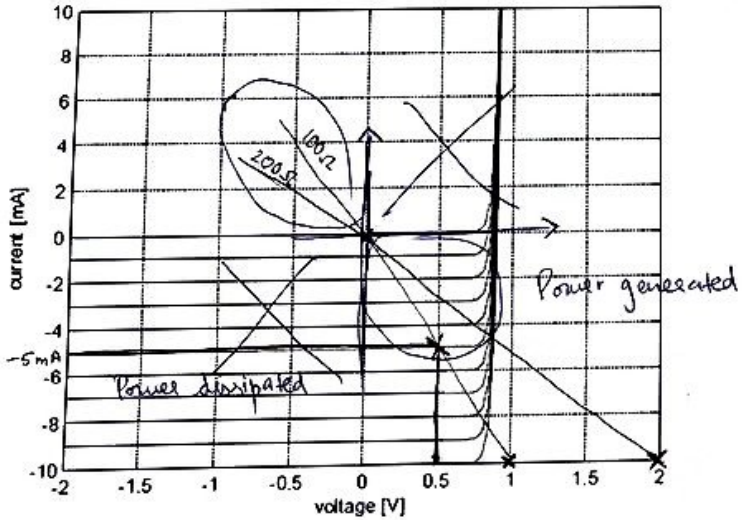
$3 \cdot 16^2 + 7 \cdot 2^4 + 10 = 890$ steps

$7 \cdot 16^1$

$890 \cdot \frac{0.2°}{\text{Res}} = 178°$



Max. level intensity



Power = -5mA . (0.5V)

= -2.5mW

$-1.5 = R \cdot I_D + V_D$