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EXPERIMENT: No. 8 Solar Cell Characteristics

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- **AIM:** To determine I-V characteristics and the suitability of the solar cell in electric power generation.

- **APPARATUS:** Solar cell characteristic kit, light source, LEDs

- **FORMULA USED:**

→ $$P_{max} = I_m \times V_m \text{ (Watts)}$$

P_{max} → Maximum Power [Area of largest rectangle under the I-V curve]

I_m → Maximum Current

V_m → Maximum Voltage

→ $$FF = \frac{P_{max}}{V_{oc} \times I_{sc}}$$ (No unit)

FF → Fill Factor

V_{oc} → Open Circuit Voltage

I_{sc} → Short Circuit Voltage

→ $$\eta = \left(\frac{P_{max}}{A \times I_o}\right) \times 100\%$$

η → Efficiency

A → Area of solar cell (m^2)

I_o → Intensity of solar light radiation (Watts/m^2)

Maximum efficiency is when power delivered to solar cell is P_{max}

· OBSERVATION TABLE :

(i) d = 10cm : $I_0 = 11.49 \frac{W}{cm^2}$ $A = 6 \times 10^{-4} cm^2$

$V_{OC} = 1.8V$ $I_{sc} = 2.8mA$

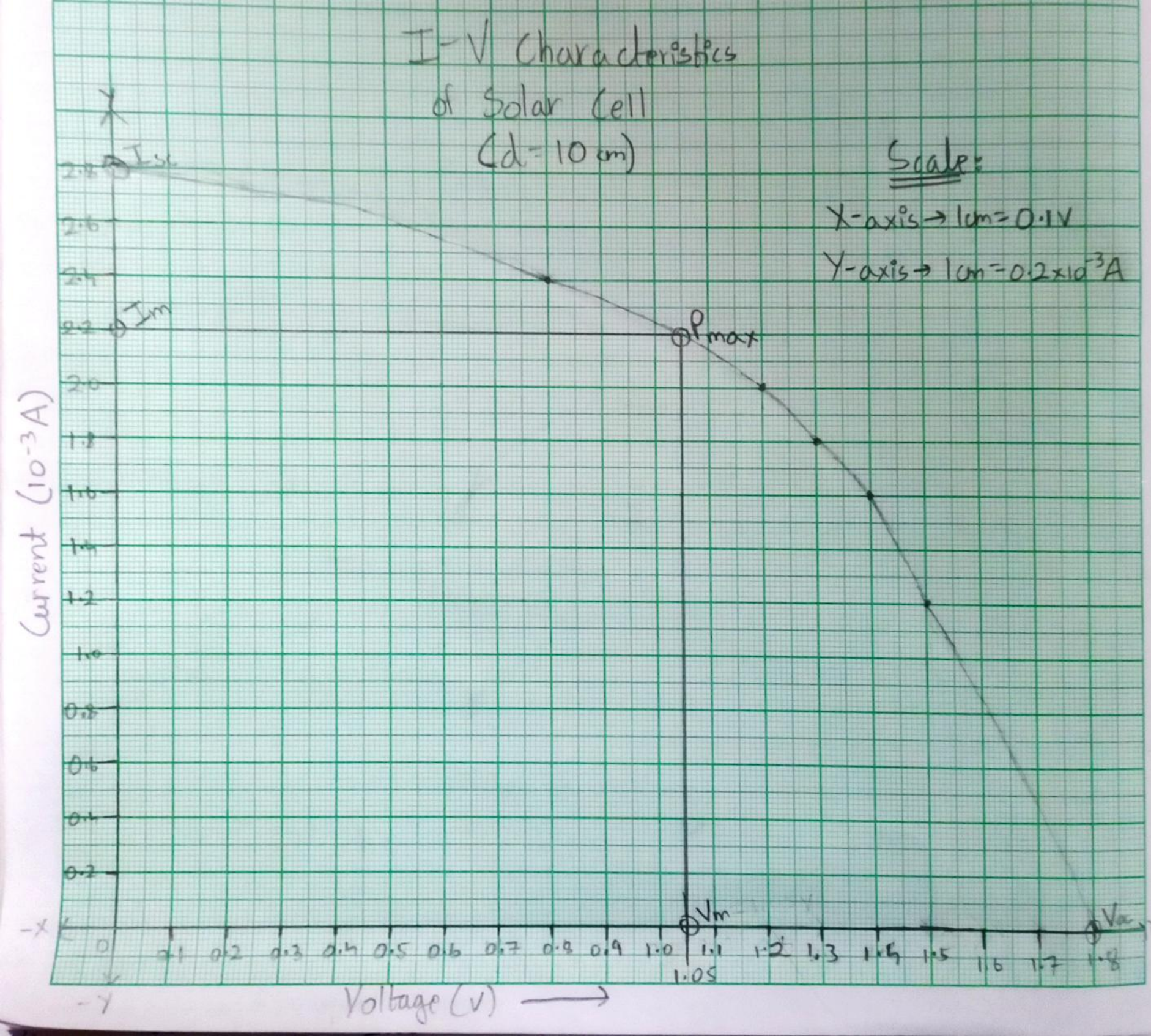
S.No.	Resistance (Ω)	Voltage (V)	Current (mA)	Power (W)
1.	300	0.8	2.4	1.92×10^{-3}
2.	400	1.2	2	2.4×10^{-3}
3.	500	1.3	1.8	2.34×10^{-3}
4.	600	1.4	1.6	2.24×10^{-3}
5.	900	1.5	1.2	1.8×10^{-3}

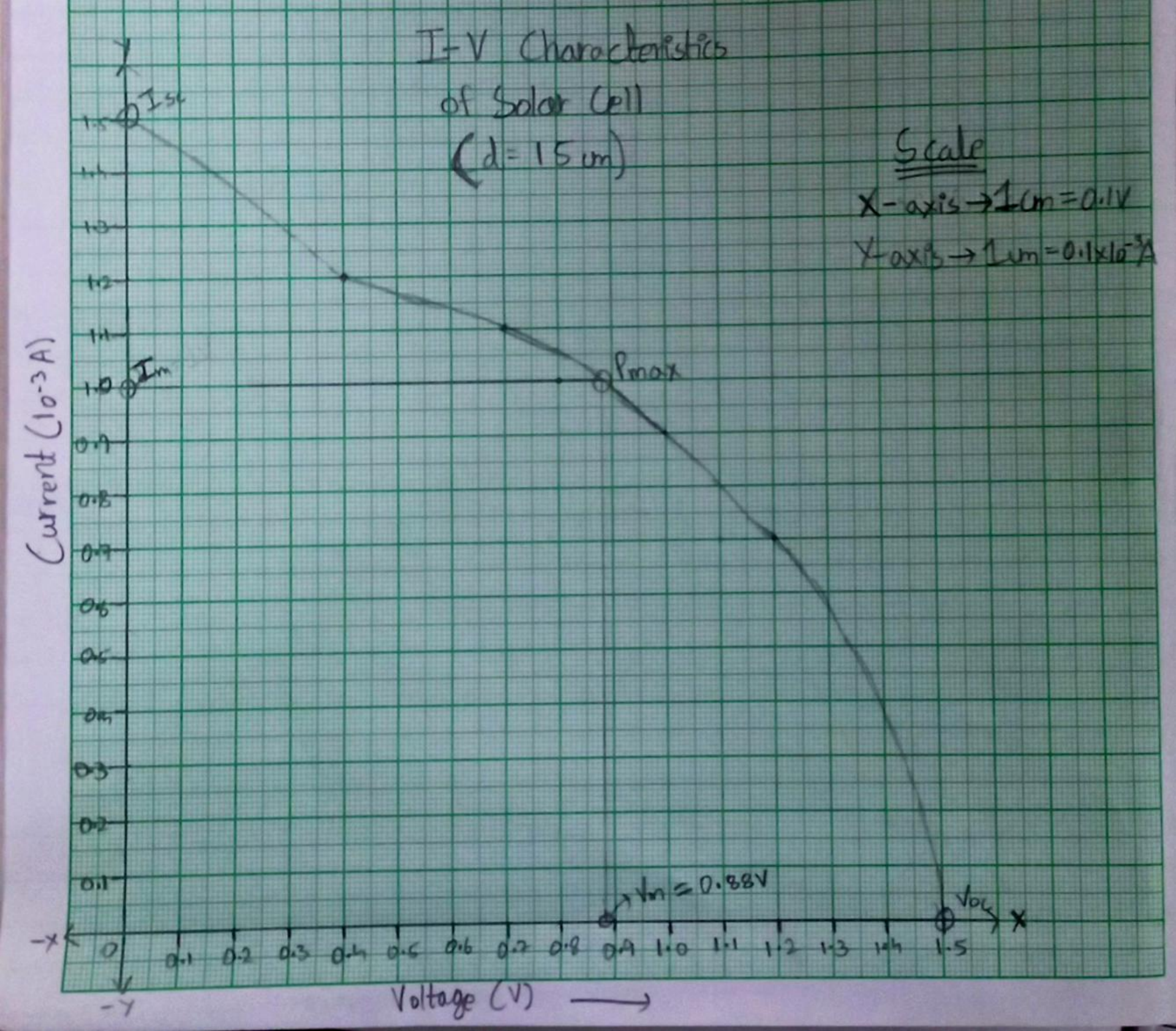
(ii) d = 15cm : $I_0 = 6.12 \frac{W}{cm^2}$ $A = 6 \times 10^{-4} cm^2$

$V_{OC} = 1.5V$ $I_{sc} = 1.5mA$

S.No.	Resistance (Ω)	Voltage (V)	Current (mA)	Power (W)
1.	300	0.4	1.2	0.48×10^{-3}
2.	400	0.7	1.1	0.77×10^{-3}
3.	500	0.8	1	0.8×10^{-3}
4.	600	1	0.9	0.9×10^{-3}
5.	900	1.2	0.7	0.84×10^{-3}

I-V Characteristics of Solar Cell (d = 10 cm)




I-V Characteristics of Solar Cell (d = 15 μm)
Scale
X-axis → 1 cm = 0.1 V
Y-axis → 1 cm = 0.1 × 10⁻³ A
Isc
Im
Pmax
Vm = 0.88V
Voc
Current (10⁻³ A)
Voltage (V) ⟶
Y
X
-X
-Y
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5

· CALCULATIONS :

① d = 10 cm : $I_m = 2.2\times10^{-3}$ A, $V_m = 1.05$ V, $I_{sc} = 2.8\times10^{-3}$ A, $V_{oc} = 1.8$ V
$A = 6\times10^{-4}$ cm², $I_o = 11.49 \frac{W}{cm^2}$

$P_{max} = (2.2\times10^{-3}\,A) \times (1.05\,V)$

$\Rightarrow \boxed{P_{max} = 2.31\times10^{-3}\,W}$

$$FF = \frac{2.31\times10^{-3}}{1.8\times2.8\times10^{-3}}$$

$\Rightarrow \boxed{FF = 0.46}$

$$\eta = \left(\frac{2.31\times10^{-3}}{6\times10^{-4}\times11.49}\right)\times 100$$

$\eta = (0.335)\times100$

$\Rightarrow \boxed{\eta = 33.5\,\%}$

② d = 15 cm : $I_m = 1\times10^{-3}$ A, $V_m = 0.88$ V, $I_{sc} = 1.5\times10^{-3}$ A, $V_{oc} = 1.5$ V
$A = 6\times10^{-4}$ cm², $I_o = 6.12 \frac{W}{cm^2}$

$P_{max} = (10^{-3}\,A)\times(0.88\,V)$

$\Rightarrow \boxed{P_{max} = 0.88\times10^{-3}\,W}$

$$FF = \frac{0.88\times10^{-3}}{1.5\times1.5\times10^{-3}}$$

$\Rightarrow \boxed{FF = 0.39}$

$$\eta = \left(\frac{0.88\times10^{-3}}{6\times10^{-4}\times6.12}\right)\times100$$

$\eta = (0.24)\times100 \Rightarrow \boxed{\eta = 24\,\%}$

- **RESULT:**

1. For $d = 10$ cm:
   a) $P_{max} = 2.31 \times 10^{-3}$ W
   b) FF = 0.46
   c) $\eta = 33.5\%$

2. For $d = 15$ cm:
   a) $P_{max} = 0.88 \times 10^{-3}$ W
   b) FF = 0.39
   c) $\eta = 24\%$