SNS COLLEGE OF PHARMACY AND HEALTH SCIENCES

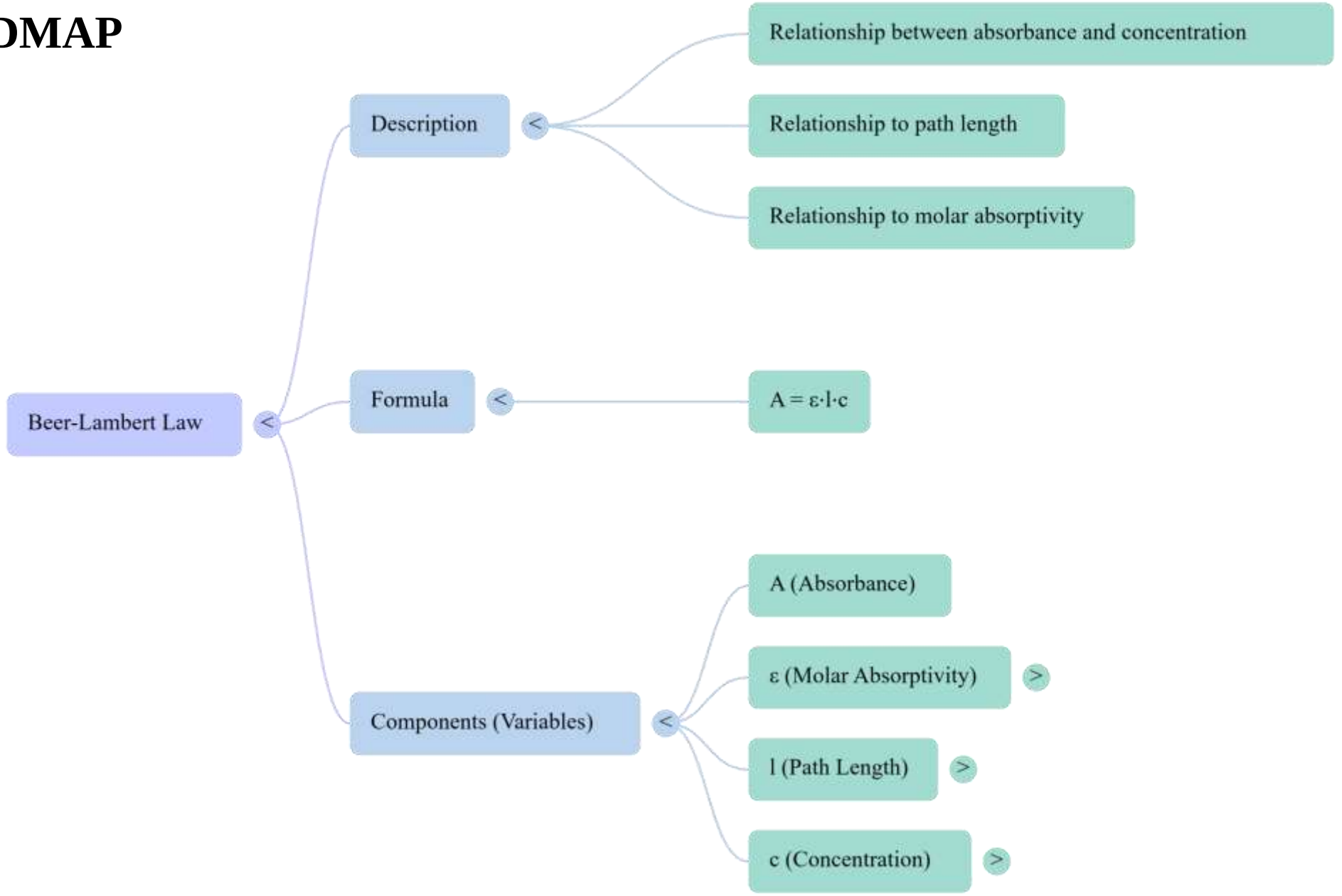
Affiliated To The Tamil Nadu Dr. MGR Medical University, Chennai
Approved by Pharmacy Council of India, New Delhi.
Coimbatore -641035

COURSE NAME: INSTRUMENTAL METHODS OF ANALYSIS (BP 701 T)

VII SEM/ IV YEAR

TOPIC 4: Beer's-Lambert's Law

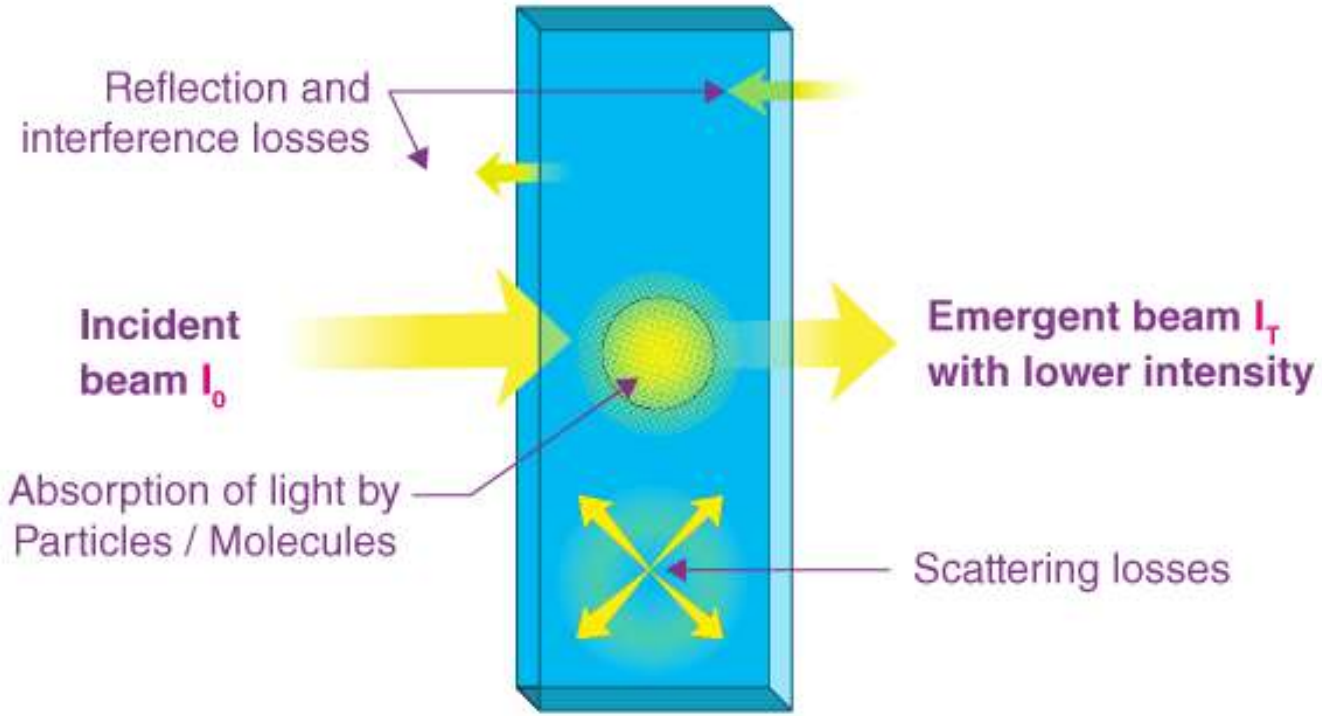
MINDMAP


Beer-Lambert Law
Description
Relationship between absorbance and concentration
Relationship to path length
Relationship to molar absorptivity
Formula
A = ε·l·c
Components (Variables)
A (Absorbance)
ε (Molar Absorptivity)
l (Path Length)
c (Concentration)

Laws Governing Light Absorption

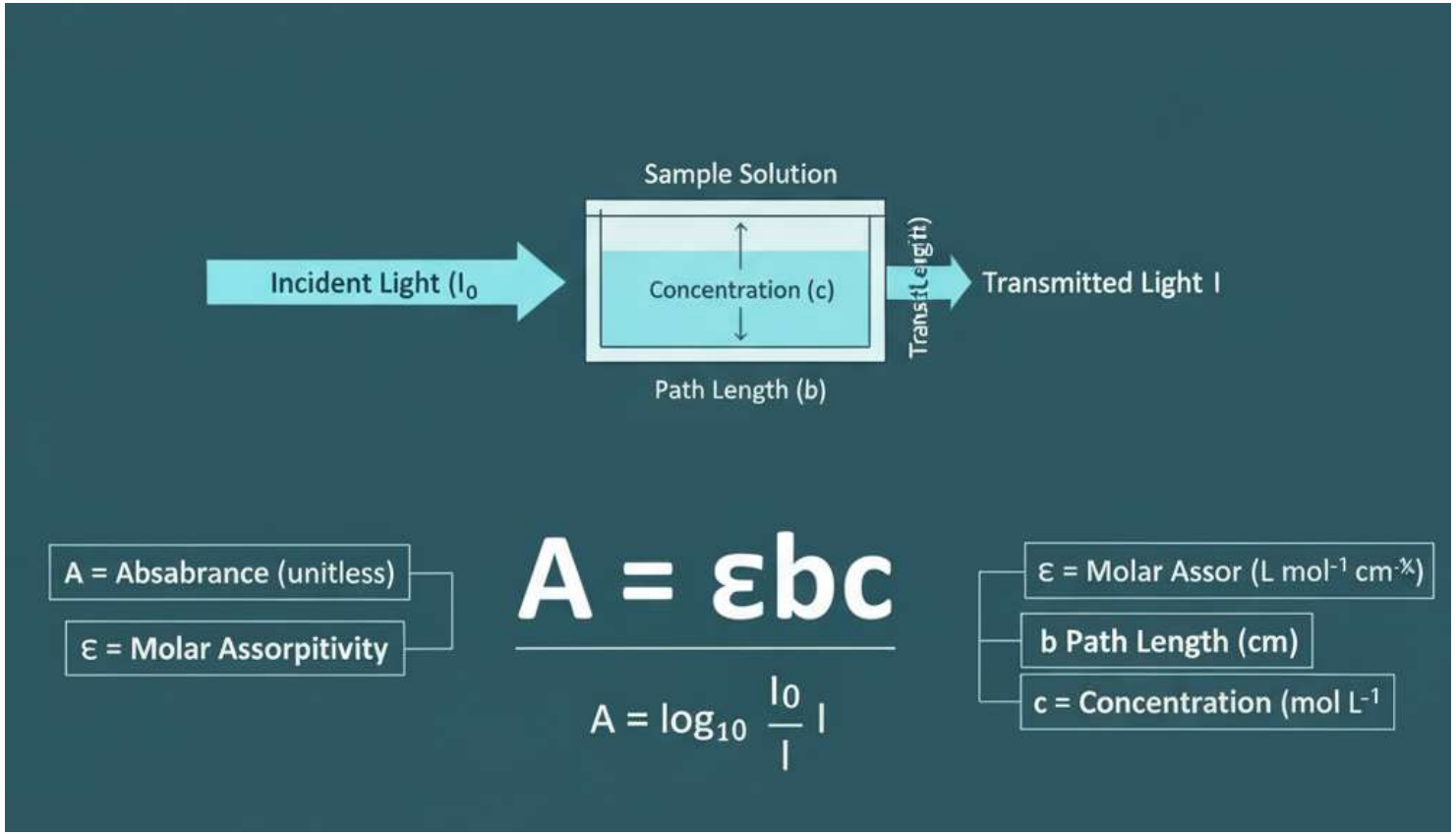
There are two laws which govern the absorption of light by the molecules.

These are: **1. Beer's law, 2. Lambert's Law**



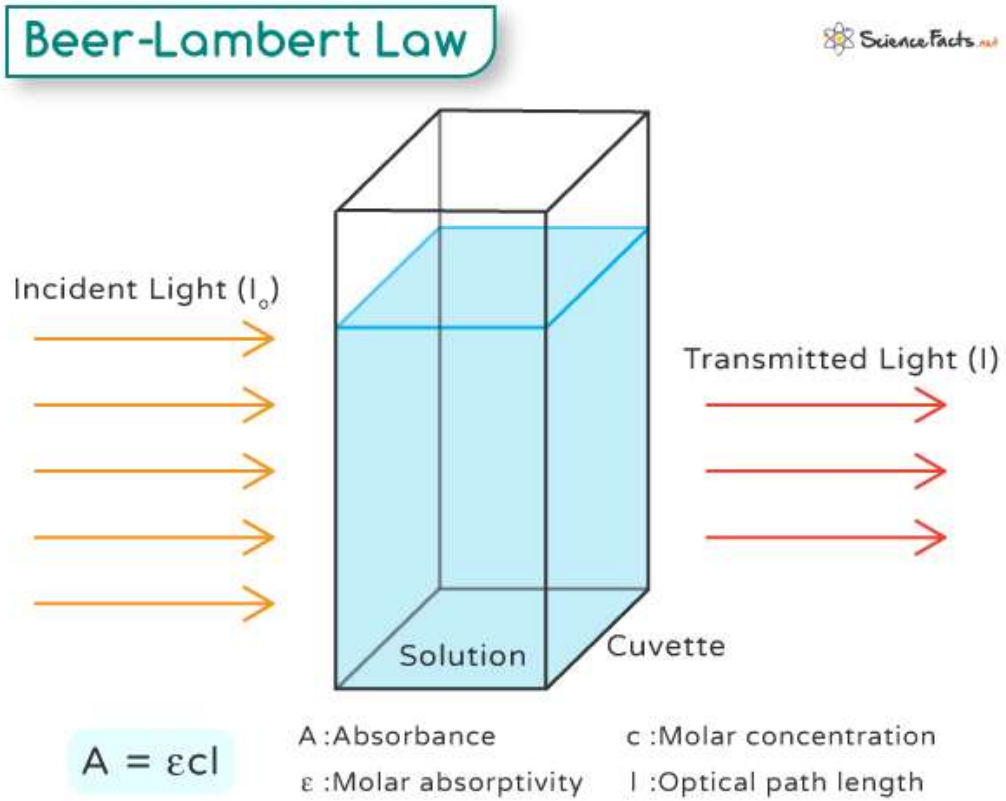
Why Beer's Lambert's Law?

Quantifies light absorption by a substance to determine its concentration.



Absorbance and Transmittance

- **Absorbance (A)**: $A = -\log T = \log(I_0/I_t)$
- **Transmittance (T)**: $T = I_t/I_0$ (I_t = transmitted light intensity, I_0 = initial light intensity)



Beer's Law: Absorption vs. Concentration

Intensity decrease proportional to concentration (c) and incident intensity (I_0)

Rate of intensity loss:

$$-dI/I = K\ c\ dx$$

(K = constant, c = concentration, x = distance)

Integrate from I_0 (c = 0) to I_t (c = c):

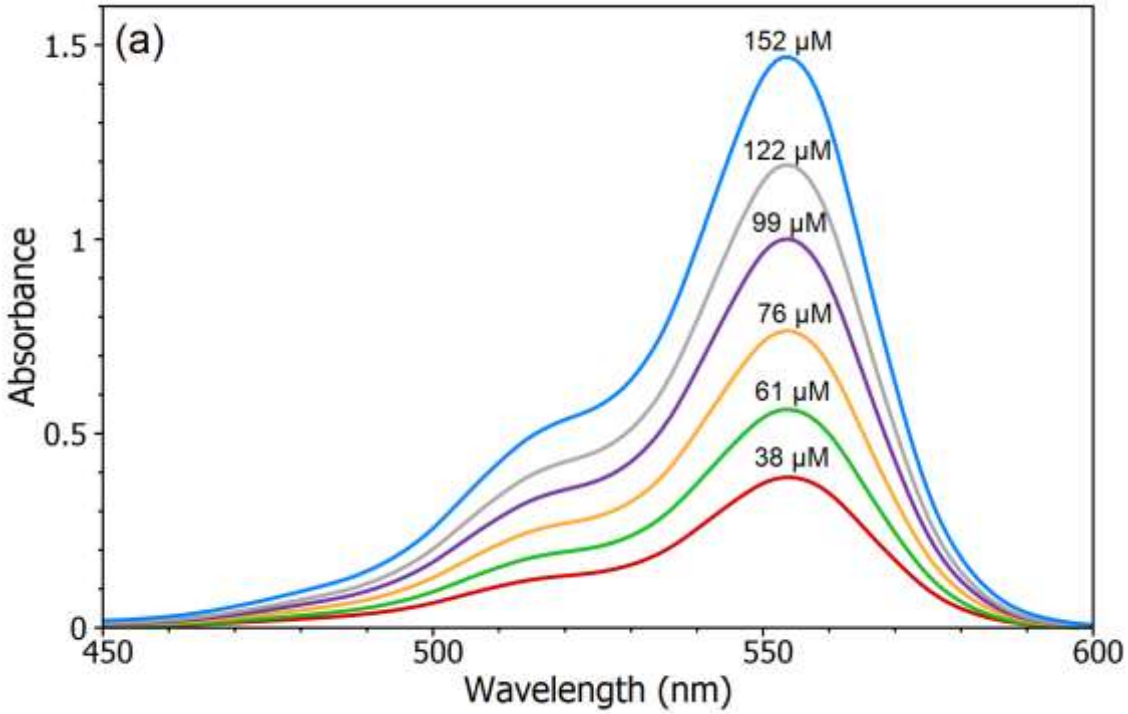
$$\int(-dI/I) = \int K\ c\ dx$$

Result:

$$-[\ln I_t - \ln I_0] = K\ c \rightarrow \ln(I_0/I_t) = K\ c$$

Convert:

$$I_t = I_0\ e^{(-Kc)}$$



Lambert's Law: Absorption vs. Path Length

Intensity decrease proportional to path length (t) and incident intensity (I_0)

Rate of intensity loss:

$$-dI/I = K\,dt \quad (K = \text{constant}, t = \text{path length})$$

Integrate from I_0 ($t = 0$) to I_t ($t = t$):

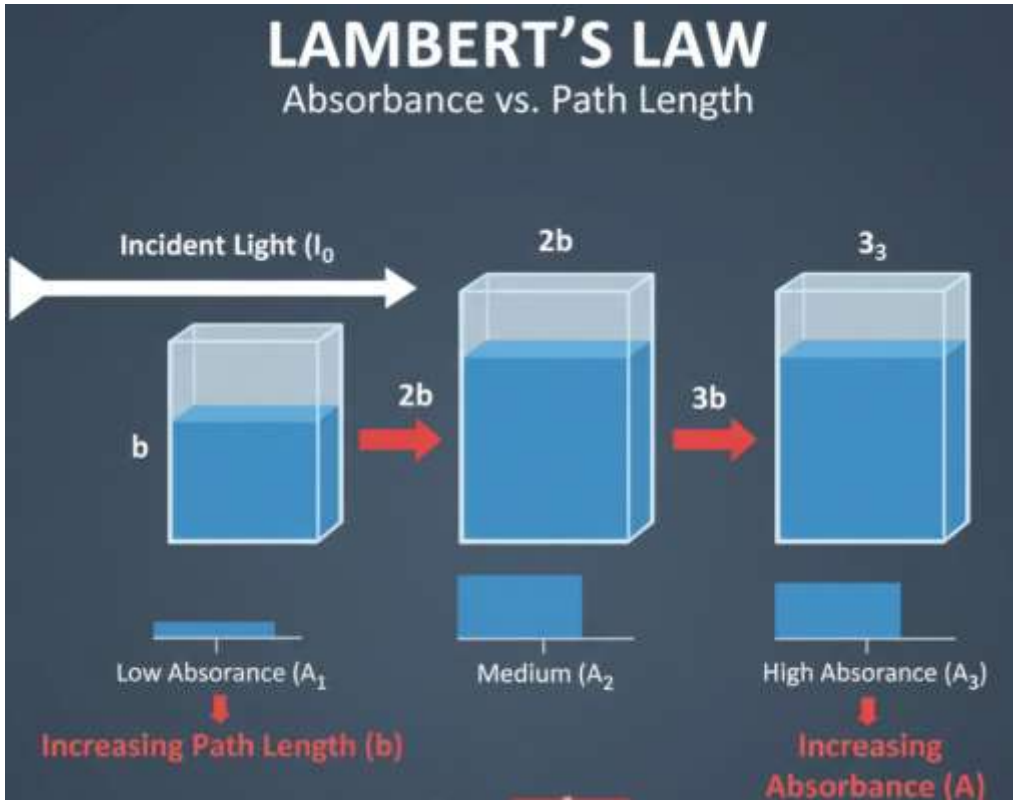
$$\int(-dI/I) = \int K\,dt$$

Result:

$$-[\ln I_t - \ln I_0] = K\,t \rightarrow \ln(I_0/I_t) = K\,t$$

Convert:

$$I_t = I_0\, e^{\wedge}(-Kt)$$



Combining Beer's and Lambert's Laws

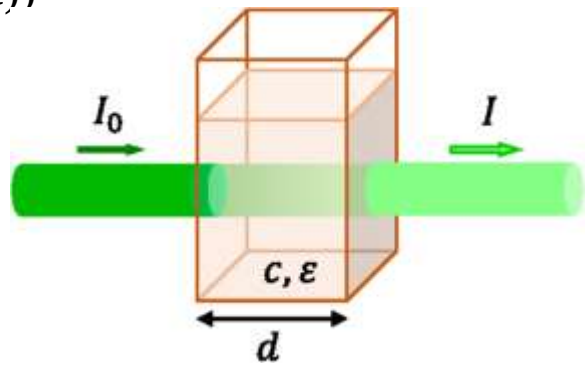
Combined Form:

$$I_t = I_0 e^{(-Kct)}$$

(combining Beer's $I_t = I_0 e^{(-Kc)}$ and Lambert's $I_t = I_0 e^{(-Kt)}$)

Base-10 Form:

$$\log(I_0/I_t) = a\ c\ t \quad (a = \text{extinction coefficient} = K/2.303)$$



Absorbance:

$$A = \log(I_0/I_t) = \varepsilon\ c\ t$$

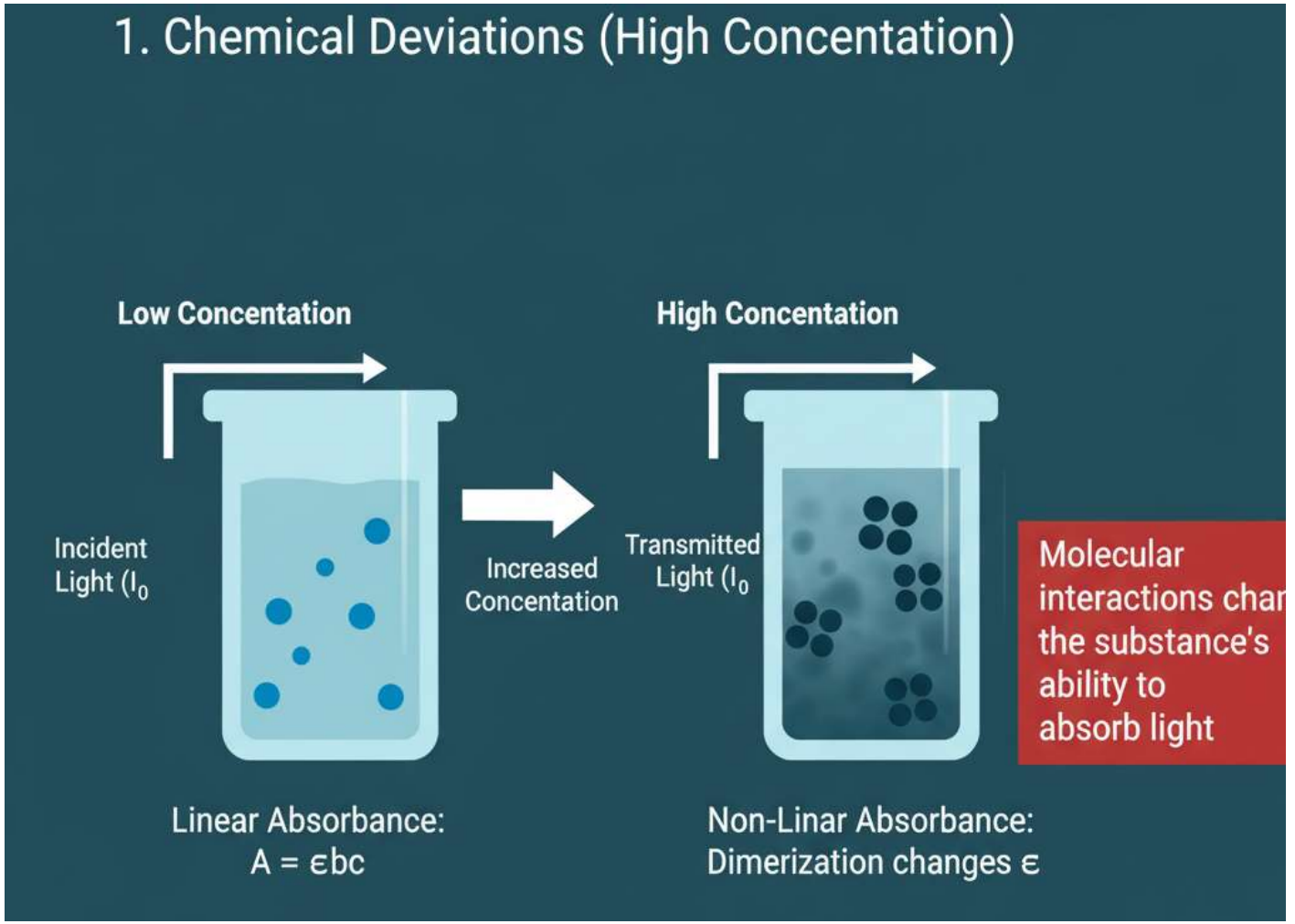
(ε = molar absorptivity, c = concentration in mol/L, t = path length in cm)

Alternative:

$$A = E\% \times (c/100) \times t$$

(E% = absorbance of 1% w/v solution, t = 1 cm)

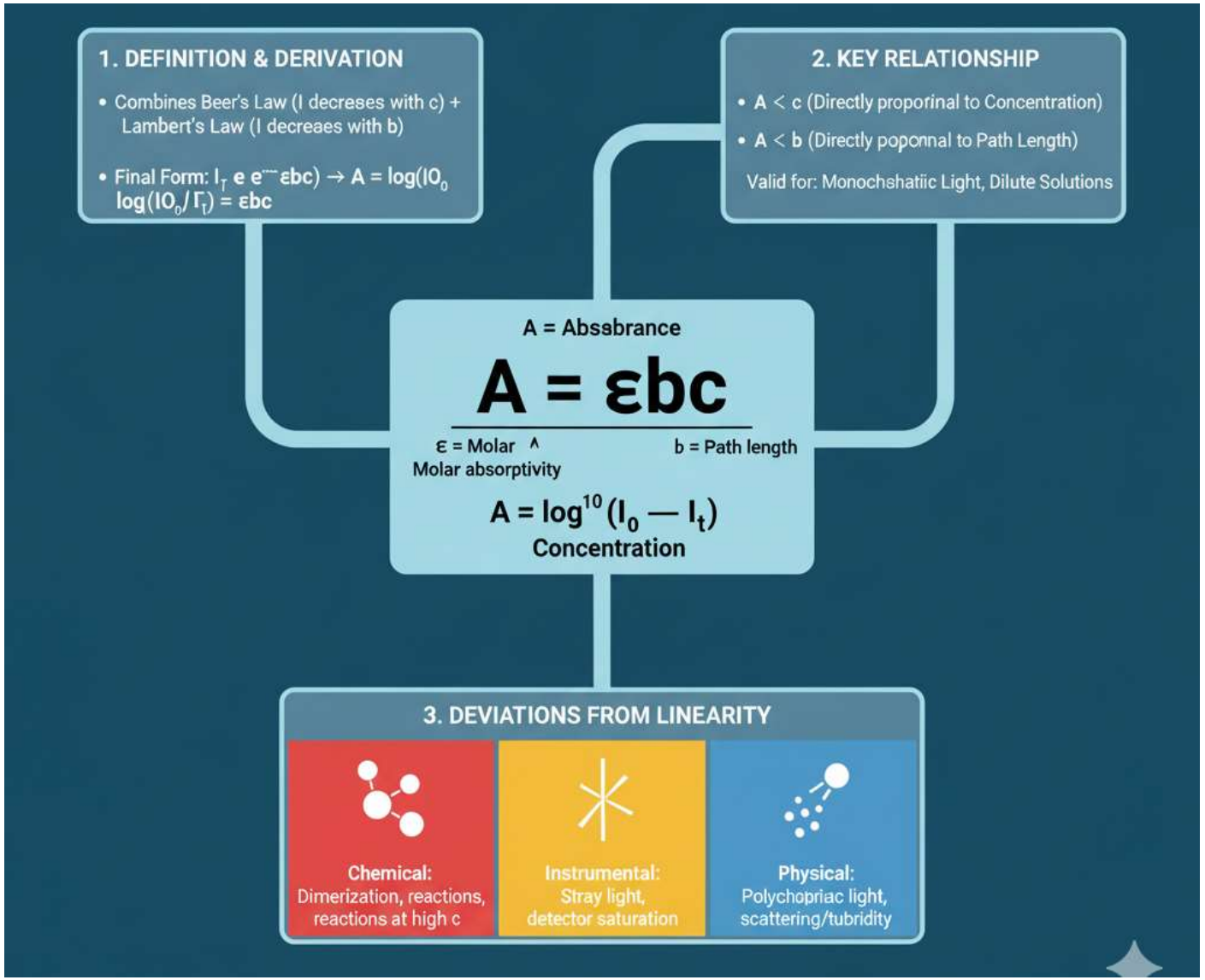
Deviations from Beer's-Lambert's Law



Deviations from Beer's-Lambert's Law

Applications of Beer's-Lambert's Law

Summary


1. DEFINITION & DERIVATION
• Combines Beer's Law (I decreses with c) + Lambert's Law (I decreaes with b)
• Final Form: I_T e e$^{\cdots}$ εbc) → A = log(IO$_0$ log(IO$_0$/ Γ$_t$) = εbc
2. KEY RELATIONSHIP
• A < c (Directly proporinal to Concentration)
• A < b (Directly poponnal to Path Length)
Valid for: Monochshatiic Light, Dilute Solutions
A = Abssbrance
A = εbc
ε = Molar ^ Molar absorptivity
b = Path length
$A = \log^{10}(I_0 - I_t)$
Concentration
3. DEVIATIONS FROM LINEARITY
Chemical: Dimerization, reactions, reactions at high c
Instrumental: Stray light, detector saturation
Physical: Polychopriac light, scattering/tubridity

Assessment: MCQ

1. Which graph should be linear if Beer-Lambert Law is obeyed?

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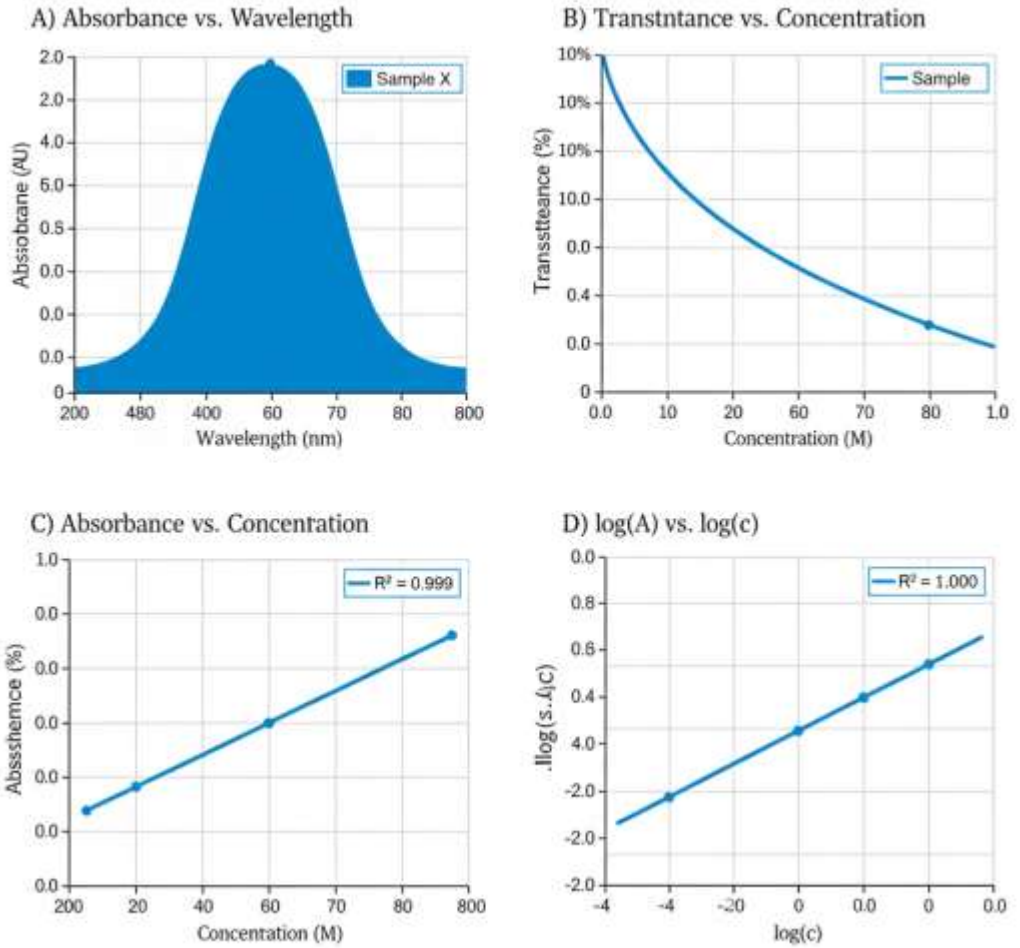

Assessment: MCQ

2. The unit of molar absorptivity (ϵ) is

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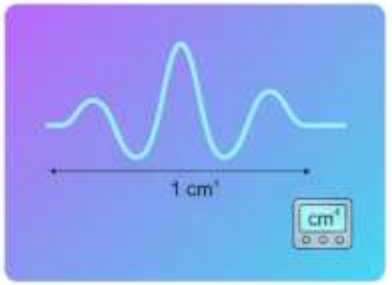
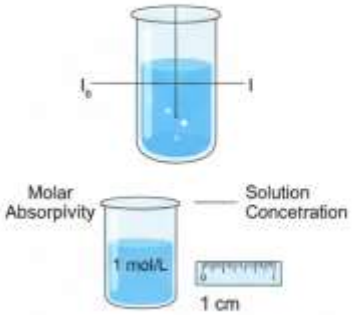
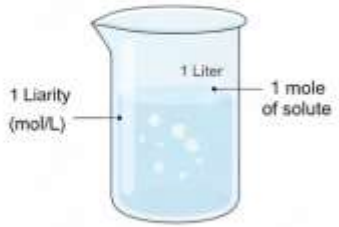
A) cm^{-1}



B) $L\ mol^{-1}\ cm^{-1}$



C) Malarity (mol/L^{-1})



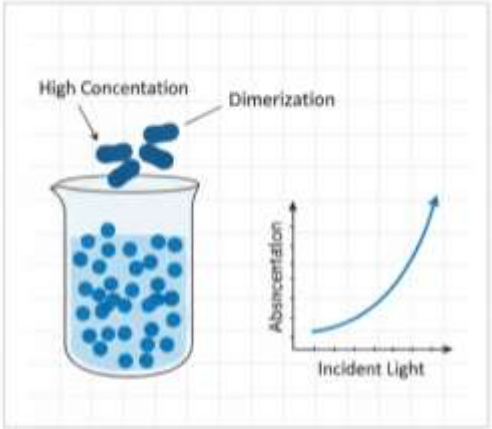
D) cm

Assessment: MCQ

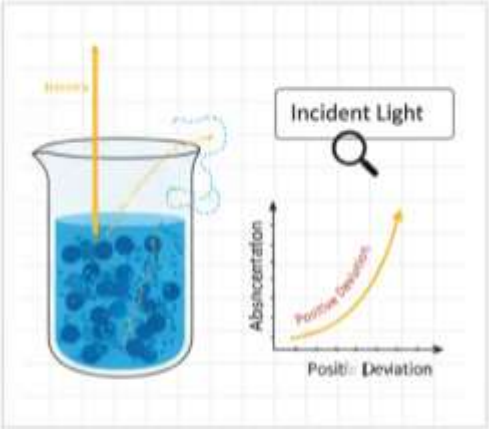
3. A solution shows positive deviation from Beer-Lambert Law at high concentration. This is most likely due to:

3. A solution shows positive deviation from Beer-Lambert Law at high concentration. This is most likely due to:

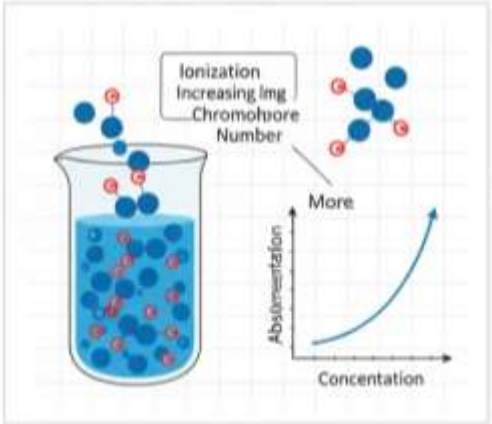
A) Dimerization Solution



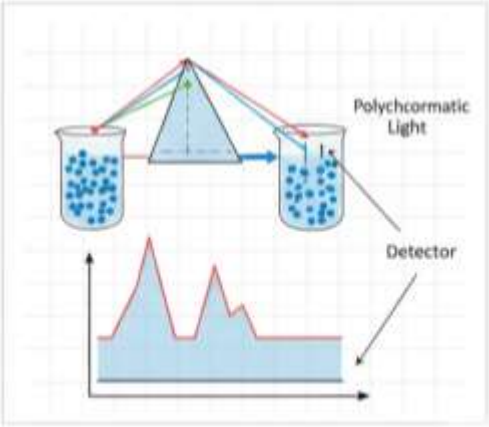
B) Change in Refrative Index



C) Change in Refrative Index



D) Polychcormatic Light



References

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Thank you!