20. An electron $(-|e|, m)$ is released in Electric field E from rest. Rate of change of de-Broglie wavelength with time will be

A) $-\frac{h}{2|e|}$ B) $-\frac{h}{2|e|t}$

C) $-\frac{h}{|e|Et^2}$ D) $-\frac{2ht^2}{|e|E}$

Ans. C

Sol. $\lambda_D = \frac{h}{mv}$

$\therefore v = at$

$v = \frac{eE}{m}t \qquad \left(a = \frac{eE}{m}\right)$

$\lambda_D = \frac{h}{m\left(\frac{eE}{m}\right)t}$

$\lambda_D = \frac{h}{eEt}$

$\frac{d\lambda_d}{dt} = -\frac{h}{|e|Et^2}$

21. In YDSE pattern with light of wavelength $\lambda_1 = 500\ nm$, 15 fringes are obtained on a certain segment of screen. If number of fringes for light of wavelength λ_2 on same segment of screen is 10, then the value of λ_2 (in nm) is

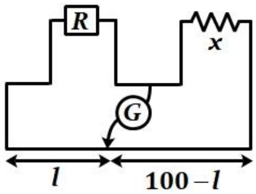
Ans. 750 nm

Sol. $15 \times 500 \times \frac{D}{d} = 10 \times \lambda_2 \times \frac{D}{d}$

$\lambda_2 = 15 \times 50\ nm$

$\lambda_2 = 750\ nm$

22. If in a meter bridge experiment, the balancing length l was 25 cm for the situation shown in the figure. If the length and diameter of the of wire of resistance R is made half, then find the new balancing length in centimeter is



Ans. 40.00

Sol. $\frac{x}{R} = \frac{75}{25} = 3$

$R = \frac{\rho l}{A} = \frac{4\rho l}{\pi d^2}$

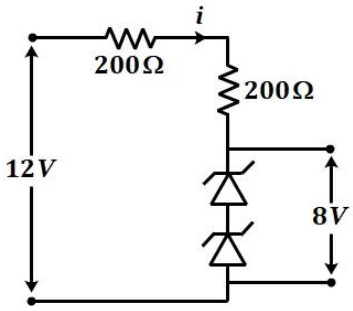
$R' = \frac{4\rho\left(\frac{l}{2}\right)}{\pi\left(\frac{d}{2}\right)^2} = 2R$

Then $\frac{x}{R'} = \left(\frac{100-l}{l}\right)$

$\frac{100-l}{l} = \frac{x}{2R} = \frac{3}{2}$

$l = 40.00\ cm$

23. Find the power loss in each diode (in mW), if potential drop across the zener diode is $8V$.



Ans. 40.00

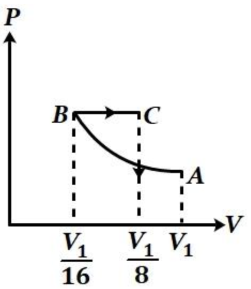
Sol. $i = \frac{(12-8)}{(200+200)}A = \frac{4}{400} = 10^{-2}A$

Power loss in each diode $= (4)(10^{-2})W = 40\ mW$

24. An ideal gas at initial temperature 300 K compressed adiabatically ($\gamma = 1.4$) to $\left(\frac{1}{16}\right)^{\text{th}}$ of its initial volume. The gas is then expanded isobarically to double its volume. Then final temperature of gas round to nearest integer is:

Ans. 1819 K

Sol.



$PV^y = \text{constant}$

$TV^{y-1} = \text{constant}$

$$300(V_1)^{1.4-1} = T_B\left(\frac{V_1}{16}\right)^{\frac{2}{5}}$$

$$T_B = 300 \times 2^{\frac{8}{5}}$$

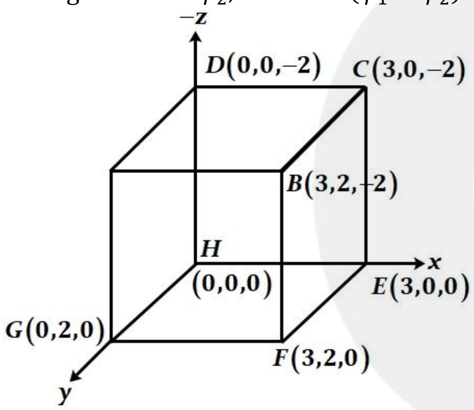
Now for BC process

$$\frac{V_B}{T_B} = \frac{V_C}{T_C}$$

$$T_C = \frac{V_C T_B}{V_B} = 2 \times 300 \times 2^{\frac{8}{5}}$$

$$T_C = 1819\ K$$

25. If electric field in the space is given by $\vec{E} = 4x\hat{\imath} - (y^2 + 1)\hat{\jmath}$, and electric flux through $ABCD$ is ϕ_1 and electric flux through $BCEF$ is ϕ_2, then find $(\phi_1 - \phi_2)$



Ans. −48

Sol. Flux via $ABCD$

$$\phi_1 = \int \vec{E} \cdot d\vec{A} = 0$$

Flux via $BCEF$

$$\phi_2 = \int \vec{E} \cdot d\vec{A}$$

$$\phi_2 = \vec{E} \cdot \vec{A} = (4x\hat{\imath} - (y^2 + 1)\hat{\jmath}) \cdot 4\hat{\imath} = 16x, x = 3$$

$$\phi_2 = 48\frac{N - m^2}{C}; \phi_1 - \phi_2 = -48\frac{N - m^2}{C}$$