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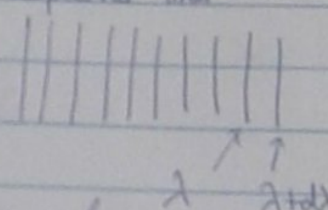
Q2. A)
→

The diffraction grating produces the diffraction of incident light in the form of closely spaced spectral lines. The ratio of wavelength of one spectral line to the wavelength difference with adjacent spectral line is known as resolving power of grating.

$$R.P = \frac{\lambda}{d\lambda}$$



Consider two adjacent spectral lines of wavelength λ and $\lambda+d\lambda$. These two wavelengths will be just resolved if the pricipal maxima of $\lambda+d\lambda$ falls over the first minimum of λ.

The condition for principal maxima is $(a+b)\sin(\theta+d\theta) = m(\lambda+d\lambda)$

Multiplying by N, we get $N(a+b)\sin(\theta+d\theta) = Nm(\lambda+d\lambda)$ —— ①

The condition for first minimum is $N(a+b)\sin\theta = m\lambda$.

The first minimum of λ adjacent to principal maxima of $\lambda+d\lambda$ can occur by putting $m = (mN+1)$ and $\theta = \theta+d\theta$.

$$\therefore N(a+b)\sin(\theta+d\theta) = (mN+1)\lambda \quad \text{—— ②}$$

from eqn ① and ②

$$mN(\lambda+d\lambda) = (mN+1)\lambda$$

$$mN(d\lambda) = \lambda$$

$$\boxed{\therefore R.P = \frac{\lambda}{d\lambda} = mN}$$

Thus R.P of grating increases with order of spectrum and number of lines.

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Q2. B)

→ Given: $d = 29 \times 10^{-6}$ m, $\lambda = 1.3 \times 10^{-6}$ m, $\mu_1 = 1.52$

$\Delta = 0.007$

Formulae: $\Delta = \frac{\mu_1 - \mu_2}{\mu_1}$, $V = \frac{\pi d}{\lambda} \sqrt{\mu_1^2 - \mu_2^2}$, $N_m = \frac{V^2}{2}$

Solution:

$$\Delta = \frac{\mu_1 - \mu_2}{\mu_1}, \quad \therefore 0.007 \times 1.52 = 1.52 - \mu_2$$

$$\boxed{\therefore \mu_2 = 1.5189.}$$

$$\therefore V = \frac{3.14 \times 29 \times 10^{-6}}{1.3 \times 10^{-6}} \times \sqrt{(1.52)^2 - (1.5189)^2}$$

$$\boxed{\therefore V = 4.049}$$

$$\therefore N_m = \frac{V^2}{2} = \frac{(4.049)^2}{2} = 8.19 \approx 8 \text{ modes.}$$

$$\boxed{\therefore N_m = 8 \text{ modes.}}$$

Conclusion: The fibre V-number is 4.049 and the fibre will support 8 modes.

Q2- D) (i)

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Inertial frame of reference	Non inertial frame of reference.
(1) Newton's laws of motion are obeyed (First law)	Newton's first law of motion is not obeyed.
(2) The body does not accelerate	The body accelerates.
(3) The body moves with constant velocity	Body moves with variable velocity -
(4) Force acting on a body is real force	Force acting on the body is ~~pse~~ a pseudo force.

(ii) $x = 150\,m$, $y = 20\,m$, $z = 10\,m$.

$t = 1 \times 10^{-4}\,s$, $v = 2.5 \times 10^{8}\,m/s$.

common xx' $c = 3 \times 10^{8}\,m/s$.

→

Using Galilean transformation, common xx'.

$$x' = x - vt, \quad y' = y, \quad z' = z, \quad t' = t.$$

$$x' = x - vt = 150 - 2.5 \times 10^{8} \times 1 \times 10^{-4}$$

$$= 150 - 25000$$

$$\boxed{\begin{aligned} x' &= -24{,}850\,m. \\ y' &= 20\,m \\ z' &= 10\,m \\ t' &= 1 \times 10^{-4}\,s. \end{aligned}}$$