QUESTION:

a narrow beam of monocromatic lit is incident normally on a diffraction grating third order diffracted beam are formed at an angle of 45 to the original direction. what is the highest order of diffracted beam produced by this grating?

SOLUTION:

The diffracted light has maxima at angles φ given by

$$d\sin\varphi = m\lambda$$

Here d is grating period, m is order of diffraction and λ is wavelength of incident light.

So, the highest order of diffraction:

$$m_{max} = \frac{d\sin\varphi_{max}}{\lambda}$$

As diffracted beam is formed at an angle of 45:

$$d\sin 45 = 3\lambda$$

$$\frac{d}{\lambda} = \frac{3}{\sin 45} = \frac{3\cdot 2}{\sqrt{2}} = 3\sqrt{2} \approx 4.24$$

So, the highest order of diffraction is

$$m_{max} = \frac{d\sin\varphi_{max}}{\lambda} = 4.24\cdot\sin\varphi_{max}$$

$$m_{max} = 4 \ \ (\text{because } |\sin\varphi| \le 1)$$

ANSWER:

4