## 练习十四　　光的衍射

1、D　2、B　3、B　4、B　5、 $30^\circ$　6、625 nm

7、第一级明纹　第二级暗纹　8、$2.23\times10^{-4}$rad

9、解：由光栅衍射主极大公式得

$$d\sin\theta_1 = k_1\lambda_1$$
$$d\sin\theta_2 = k_2\lambda_2$$

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{k_1\lambda_1}{k_2\lambda_2} = \frac{k_1\times440}{k_2\times660} = \frac{2k_1}{3k_2}$$

当两谱线重合时有　$\theta_1 = \theta_2$

即　$$\frac{k_1}{k_2} = \frac{3}{2} = \frac{6}{4} = \frac{9}{6}$$

由光栅公式可知　$d\sin30^\circ = 6\lambda_1$

$$d = \frac{6\lambda_1}{\sin30^\circ} = 5.28\times10^{-3}\ \text{mm}$$

10、解：（1）$(b+b')\sin\theta = \pm k\lambda \quad \Rightarrow b+b' = \dfrac{k\lambda}{\sin\theta} = 60000\,\overset{0}{A}$

（2）$\begin{cases}(b+b')\sin\theta = \pm k\lambda \\ b\sin\theta = \pm k'\lambda\end{cases} \quad \Rightarrow \dfrac{b+b'}{b} = \dfrac{k}{k'} = \dfrac{4}{k'}$时缺级，

当$k'=1$时，$\begin{cases}b = 15000\,\overset{0}{A} \\ b' = 45000\,\overset{0}{A}\end{cases}$；当$k'=2$时，舍去；当$k'=3$时，$\begin{cases}b = 45000\,\overset{0}{A} \\ b' = 15000\,\overset{0}{A}\end{cases}$

（3）$(b+b')\sin\theta = \pm k\lambda \quad \Rightarrow k < \dfrac{b+b'}{\lambda} \quad \Rightarrow k < 10$

当$\begin{cases}b = 15000\,\overset{0}{A} \\ b' = 45000\,\overset{0}{A}\end{cases}$时，实际出现级数：$0,\pm1,\pm2,\pm3,\pm5,\pm6,\pm7,\pm9$。

当$\begin{cases}b = 45000\,\overset{0}{A} \\ b' = 15000\,\overset{0}{A}\end{cases}$时，实际出现级数：$0,\pm1,\pm2,\pm3,\pm5,\pm6,\pm7,\pm9$。

11、解　（1）$\theta_0 = 1.22\dfrac{\lambda}{D} = 2.2\times 10^{-4}$ rad

（2）$s = l\theta_0 = 2.2$ mm　　等号两横线间距不小于 2.2 mm

12、解：（1）由单缝衍射明纹公式可知

$$b\sin\theta_1 = \frac{1}{2}(2k+1)\lambda_1 = \frac{3}{2}\lambda_1 \qquad （取 k=1）$$

$$b\sin\theta_2 = \frac{1}{2}(2k+1)\lambda_2 = \frac{3}{2}\lambda_2$$

由于　$\tan\theta_1 = \dfrac{x_1}{f}$，$\tan\theta_2 = \dfrac{x_2}{f}$

$\sin\theta_1 \approx \tan\theta_1$，$\sin\theta_2 \approx \tan\theta_2$

所以　$x_1 = \dfrac{3f\lambda_1}{2b}$，$x_2 = \dfrac{3f\lambda_2}{2b}$

则两个第一级明纹之间距为　$\Delta x = x_2 - x_1 = \dfrac{3f\ \Delta\lambda}{2b} = 0.27$ cm

（2）由光栅衍射主极大的公式

$$d\sin\theta_1 = k\lambda_1 = 1\lambda_1$$
$$d\sin\theta_2 = k\lambda_2 = 1\lambda_2$$

且有　$\sin\theta \approx \tan\theta = \dfrac{x}{\lambda}$

所以　$\Delta x = x_2 - x_1 = f\Delta\lambda / d = 1.8\text{cm}$

13、解：（1）由光栅衍射主极大公式得

$$(b+b')\sin 30^\circ = 3\lambda_1$$

$$b+b' = \frac{3\lambda_1}{\sin 30^\circ} = 3.6\times 10^{-4}\ \text{cm}$$

（2）$(b+b')\sin 30^\circ = 4\lambda_2$

$$\lambda_2 = (b+b')\sin 30^\circ / 4 = 450\,\text{nm}$$