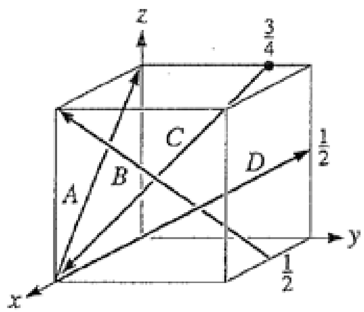
1- Determine the Miller indices for the directions in the cubic unit cell shown.



Solution:

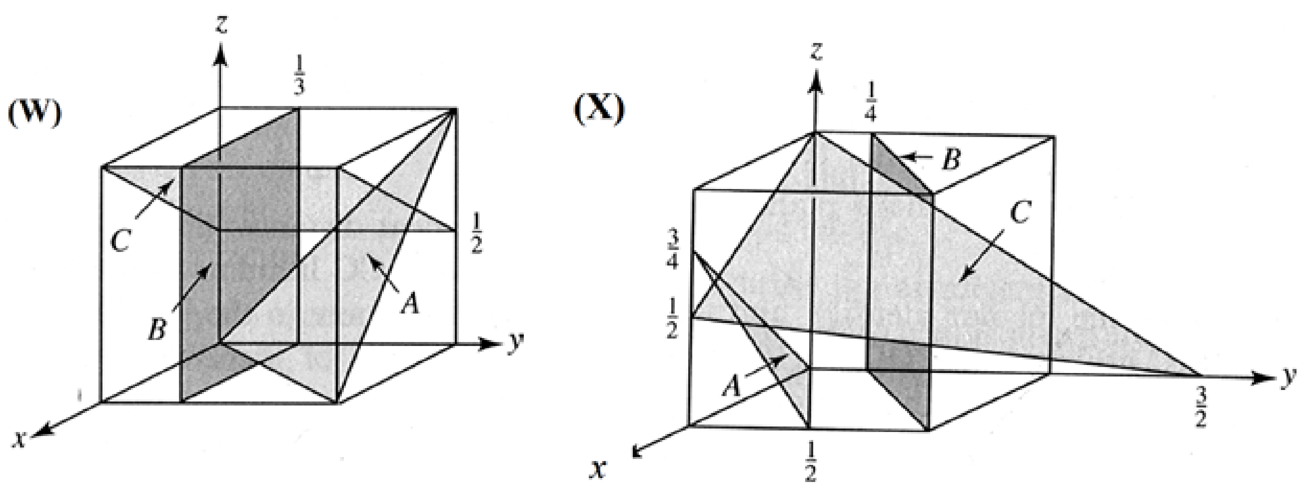
A: 0,0,1 − 1,0,0 = −1,0,1 = $[\bar{1}01]$

B: 1,0,1 − ½,1,0 = ½,−1,1 = $[1\bar{2}2]$

C: 1,0,0 − 0,¾,1 = 1,−¾,−1 = $[4\bar{3}\bar{4}]$

D: 0,1,½ − 0,0,0 = 0,1,½ = [021]

2- Determine the plane indices for the planes shown below.



Solution

(W) $(A)(1\bar{1}1)$ $(B)(010)$ $(C)(10\bar{2})$

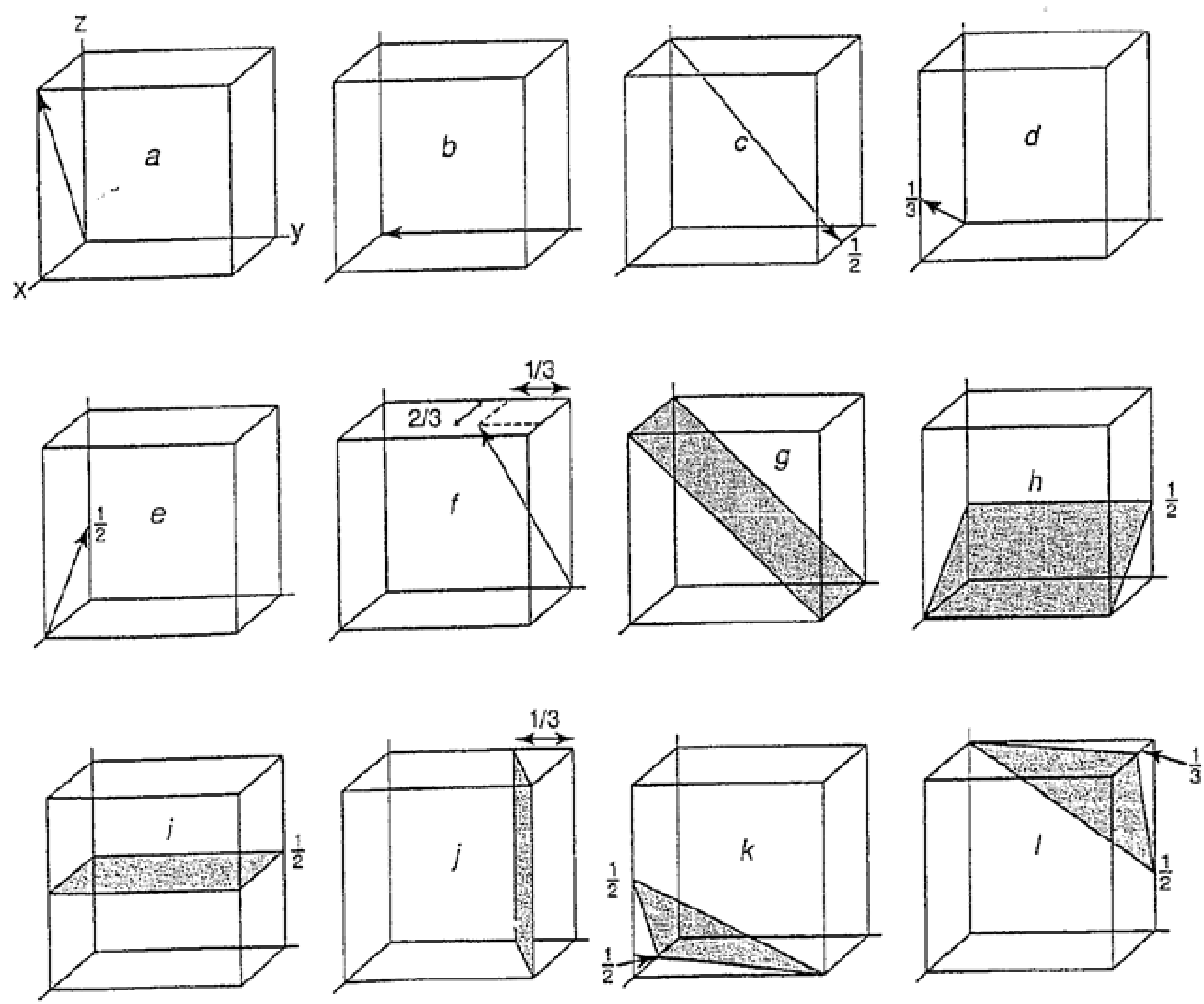
(X) $(A)(\bar{3}64)$ $(B)(3\bar{4}0)$ $(C)(346)$

3-

Draw the following directions and planes

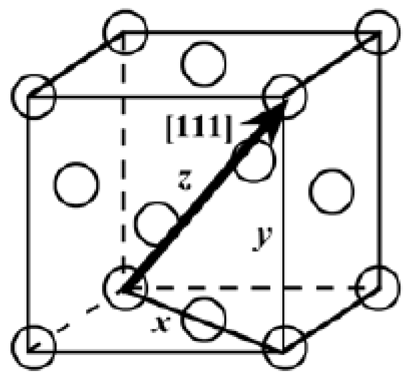
a)	[101]	g)	(011)
b)	$[0\bar{1}0]$	h)	(102)
c)	$[12\bar{2}]$	i)	(002)
d)	[301]	j)	$(1\bar{3}0)$
e)	[102]	k)	$(\bar{2}12)$
f)	$[2\bar{1}3]$	l)	$(3\bar{1}\bar{2})$

Solution:



(4) Derive linear density expressions for FCC [111] direction in terms of the atomic radius R.

An FCC unit cell within which is drawn a [111] direction is shown below.



For this [111] direction, the vector shown passes through only the centers of the single atom at each of its ends, and, thus, there is the equivalence of 1 atom that is centered on the direction vector. The length of this direction vector is denoted by z in this figure, which is equal to

$$z = \sqrt{x^2 + y^2}$$

where x is the length of the bottom face diagonal, which is equal to $4R$. Furthermore, y is the unit cell edge length, which is equal to $2R\sqrt{2}$ (Equation 3.1). Thus, using the above equation, the length z may be calculated as follows:

$$z = \sqrt{(4R)^2 + (2R\sqrt{2})^2} = \sqrt{24R^2} = 2R\sqrt{6}$$

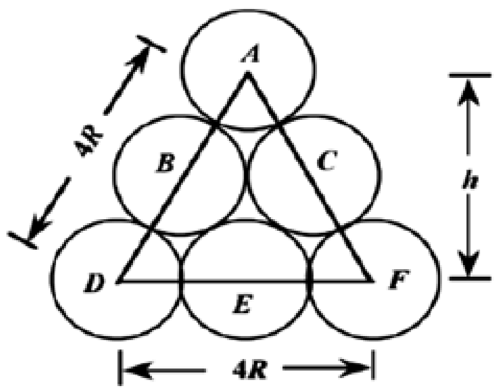
Therefore, the expression for the linear density of this direction is

$$\mathrm{LD}_{111} = \frac{\text{number of atoms centered on [111] direction vector}}{\text{length of [111] direction vector}}$$

$$= \frac{1 \text{ atom}}{2R\sqrt{6}} = \frac{1}{2R\sqrt{6}}$$

(5) Derive planar density expressions for FCC (111) plane in terms of the atomic radius R.

That portion of an FCC (111) plane contained within a unit cell is shown below.



There are six atoms whose centers lie on this plane, which are labeled *A* through *F*. One-sixth of each of atoms *A*, *D*, and *F* are associated with this plane (yielding an equivalence of one-half atom), with one-half of each of atoms *B*, *C*, and *E* (or an equivalence of one and one-half atoms) for a total equivalence of two atoms. Now, the area of the triangle shown in the above figure is equal to one-half of the product of the base length and the height, *h*. If we consider half of the triangle, then

$$(2R)^2 + h^2 = (4R)^2$$

which leads to $h = 2R\sqrt{3}$. Thus, the area is equal to

$$\text{Area} = \frac{4R(h)}{2} = \frac{(4R)(2R\sqrt{3})}{2} = 4R^2\sqrt{3}$$

And, thus, the planar density is

$$PD_{111} = \frac{\text{number of atoms centered on (111) plane}}{\text{area of (111) plane}}$$

$$= \frac{2 \text{ atoms}}{4R^2\sqrt{3}} = \frac{1}{2R^2\sqrt{3}}$$