Homework 3, 100 points
Due by February 7th

1.   Determine whether the following group-subgroup relations are *translationgleiche* or *klassengleiche* or isomorphic. If the unit cell of the subgroup is enlarged this is stated on top of the arrow

$$Cmcm \longrightarrow Pmcm$$
$$P2_1/c \longrightarrow P\text{-}1$$

$$Pbcm \xrightarrow{2a,\ b,\ c} Pbcn$$

$$C\ 1\ 2/m\ 1 \xrightarrow{a,\ 3b,\ c} C\ 1\ 2/m\ 1$$

$$P\ 6_3/mcm \longrightarrow P\ 6_322$$
$$P\ mmn \longrightarrow P\ mm2$$
$$Pmmn \longrightarrow P\ 1\ 2_1/m1$$

2.   Derive the space group $P\ 2_1/m$. Draw two projections. One down the a- axis and one down b-axis. Given a point on a general position x,y,z derive all other equivalent positions. What is the plane-group when this space group is project down the a-, b- and c-axes?

3.   Sodium bicarbonate $NaHCO_3$ is monoclinic and it was originally described with lattice parameters:

$a=7.51$ Å   space group $P\ 2_1/n$
$b=9.70$ Å
$c=3.53$ Å
$\beta=93.3$

The positional parameters were:

	x	y	z
Na	0.286	0.004	0.713
C	0.077	0.237	0.287
O1	0.071	0.367	0.261
O2	0.205	0.163	0.193
O3	0.940	0.171	0.436

Later workers however later chose a unit cell with
$a=3.53$ Å   space group $P\ 2_1/c$
$b=9.70$ Å
$c=8.11$ Å
$\beta =112.25$

Show graphically that these two cells (and space groups) are equivalent. Give the transformation matrix by which the original position parameters can be obtained in the $P\ 2_1/c$ space group and list the new coordinates.

4.   Derive the general positions for space groups $P\ mc2_1$. Obtain the special positions by considering the coordinates of points lying on the mirror plane.