

**Definitions**

Asymmetric unit of motif – that portion of the pattern or mesh within which no atoms are repeated by symmetry operations other than 1

Congruent – repetition of a motif which preserves its “handedness”

Enantiomorphous – repetition of a motif such that its “handedness” is reversed and thus cannot be superimposed upon the original

Equivalent point number – the number of times a motif is repeated in a particular, general, or special position

General position – arbitrary location which does not coincide with a symmetry element

Special position – location which coincides with one or more symmetry elements

Symmetry element – centers, rotation axes, and mirror planes relative to which a motif is repeated in a regular manner

Symmetry operation – rules by which a motif is repeated with respect to a symmetry element

**1) Point Group Symmetry**

a) For each of the objects pictured on pages 2-5, identify the point groups (ie.,  $2m$ ,  $3mm$ , etc.) and draw in the symbols for the symmetry operations (mirror lines, squares, etc.), label mirror  $m_1$ ,  $m_2$  as appropriate.

b) Draw a capital **R** on a small piece of paper. Using the two mirrors and the protractor provided, measure the angle between them needed to produce the symmetries:

1m

2mm

3mm

4mm

6mm

(hint: place the R close to the mirror, not in the middle.)

Can you produce the symmetries 2, 3, 4, 5, and 6 with the R? What property/properties must your motif have for you to be able to make 2, 3, 4, 5, or 6 fold symmetry?

**2) Plane group symmetry**

For each of the patterns pictured on pages 6 and 7, designate the unit cell and space group (ie.  $P3m1$ ,  $p6$ , etc.)

**3) Special and General Positions**

Page 8 shows the symmetry operations for the 2D space group  $p4m$ . If you were to place an object at point #1, what symmetry would it need to have in order to preserve the symmetry of the space group? How many times does the object get repeated by the symmetry operations? Answer the same question for point #2.