

**Copy of a printed diagram referenced as "Heryberg p69" [possibly variation on Herzberg]**

**Contributors**

Price, William Charles, 1909-1993

**Publication/Creation**

March 1952

**Persistent URL**

<https://wellcomecollection.org/works/z7ks525s>

**License and attribution**

You have permission to make copies of this work under a Creative Commons, Attribution, Non-commercial license.

Non-commercial use includes private study, academic research, teaching, and other activities that are not primarily intended for, or directed towards, commercial advantage or private monetary compensation. See the Legal Code for further information.

Image source should be attributed as specified in the full catalogue record. If no source is given the image should be attributed to Wellcome Collection.



Wellcome Collection  
183 Euston Road  
London NW1 2BE UK  
T +44 (0)20 7611 8722  
E [library@wellcomecollection.org](mailto:library@wellcomecollection.org)  
<https://wellcomecollection.org>

vibrations and eigenfunctions, that is, just as many as there are possible combinations of + and - in sets of three: +++, ++-, +-+, -++, +--, -+-, ---+, ---. The point group  $V_h \equiv D_{2h}$  to which the plane molecule  $C_2H_4$  belongs is the only one with three necessary symmetry elements that are not more-than-two-fold axes. As such necessary symmetry elements we may choose any three independent ones of the seven elements of symmetry (see Table 1), for example, the three mutually perpendicular planes of symmetry  $\sigma(xy)$ ,  $\sigma(xz)$ ,  $\sigma(yz)$ . The possible behavior of normal vibrations (eigenfunctions) with respect to these three elements is given in columns 3, 4, and 5 of Table 14. All the eight possibilities mentioned

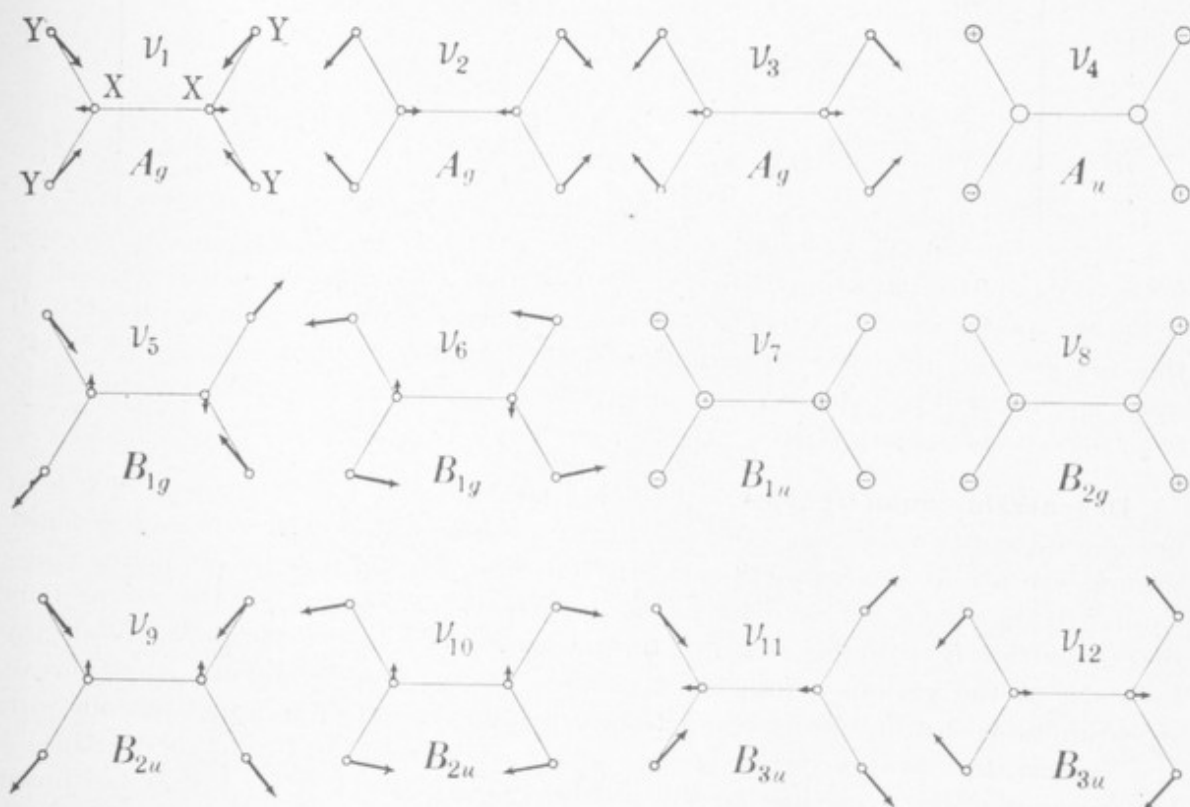


FIG. 44. Normal vibrations of an  $X_2Y_4$  molecule of point group  $V_h$ .—It is assumed that the mass of X is larger than that of Y as in  $C_2H_4$  or  $C_2D_4$ .

above are given. The designations of these species (symmetry types) are indicated in the first column.

Since an inversion may be replaced by successive reflections at three mutually perpendicular planes, the behavior of the normal vibrations of point group  $V_h$  with respect to an inversion (column 6) may be obtained simply by multiplying together columns 3, 4, and 5 in Table 14. Since a rotation by  $180^\circ$  about a two-fold axis may be replaced by an inversion followed by a reflection at a plane perpendicular to the two-fold axis (see p. 5), the behavior with respect to the three  $C_2$ 's (columns 7, 8, and 9) is obtained by multiplying columns 3, 4, and 5 respectively by column 6.

As an example, in Fig. 44 the normal vibrations of a plane molecule  $X_2Y_4$  of point group  $V_h$  (such as ethylene,  $C_2H_4$ , see p. 325) are given. For each vibration the species to which it belongs is indicated. The correctness of this assignment can