

TABLE Z.1 Three Bases for Experimentation on a Physical Analogue Model

<p>Basis for Analogy Between Physical Analogue Model & Thing Modeled</p>	<p>Knowledge Relied Upon</p>
<p>1. The equation governing a quantity or phenomenon in the model is the same equation governing the corresponding quantity or phenomenon in what is modelled, although the quantities in the equation refer to different physical things, processes, or systems when used to describe the model and what is modeled.</p> <p>Experimentation on the analogue model (e.g., flow currents in a fluid body) is used to inform the researcher about what will happen in the analogous setup modeled (e.g., electrical currents in an electrically conducting body), or vice versa.</p>	<p>In the example of a fluid body as an analogue of an electrically conducting body, the <i>knowledge relied upon</i> includes the partial differential equation for fluid flows governing the behavior of flow currents in the analogue model, the analogous equation for electrical current in the electrically conducting body, and that they can be put in the same form so as to permit drawing correspondences between the fluid quantities (e.g., flow velocity, pressure) and electrical quantities (e.g., current, voltage).</p> <p><i>Note:</i> Behavior of analogue model and thing modeled can diverge. Key example: Helmholtz's "On Discontinuous Movements Of Fluids" (1868) [Z.45] in which a 'surface of separation' arises in the case of fluids, but not in the case of electrical flows -- even though the partial differential equation takes the same form for both flows. Nevertheless, there are cases for which this discontinuity is known not to arise (the pressure does not become negative in the case of interest). Which cases are which is one piece of knowledge relied upon in using this kind of basis for the analogue model.</p>
<p>2. Characteristics essential to behavior of interest are the same in the model as in the thing or systems modeled.</p> <p>Sometimes the features are derived from equations and/or analyses of mechanisms.</p>	<p>Relies upon knowledge as to which characteristics are essential to the behavior of interest. Examples:</p> <p>(a) E. Mach identified characteristics essential a wave that did not depend upon the existence of a medium of transmission & showed the Doppler effect due to relative motion of source & observer was a consequence of these features, then verified by experiments on analogue model. [Z.1] [Z.2] [Z.3]</p> <p>(b) S. Weinfurter et al. identified classical features of Hawking process that did not depend upon quantum gravity or Planck-scale physics (e.g., wave pair formation), showed Hawking radiation a consequence of these features of waves, and then subsequently verified the phenomenon by experiment on the analogue model.) [Z.54] [Z.55]</p>
<p>3. Physically Similar Systems</p> <p>A (nonunique) set of dimensionless parameters that characterize the system with respect to a certain kind of behavior is identified; similarity of system behavior between S and S' is established when these parameters have the same value in S as in S'. (See [Z.19], this volume.)</p>	<p>Relies upon knowledge as to which quantities (e.g., viscosity, density) are relevant to the behavior of interest. (Generally this is <i>less</i> information than required in 1. above)</p> <p>(Note: There is also reliance on the basic assumption that the behavior is rule-governed, in that it is assumed that there is a relation (possibly unknown) between the quantities relevant to the behavior of interest, and that the relation(s) can be expressed by a physical equation.)</p>