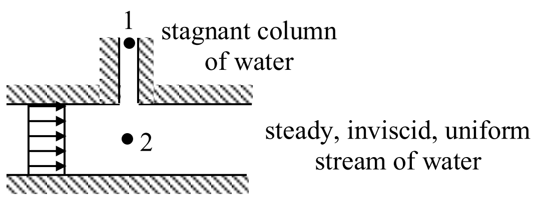
In which of the following scenarios is applying the following form of Bernoulli's equation:

$$\frac{p}{\rho g} + \frac{V^2}{2g} + z = \text{constant}$$

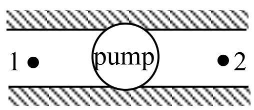
from point 1 to point 2 valid?

a.

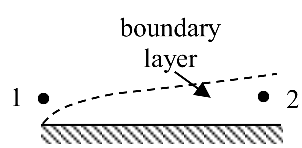



b.

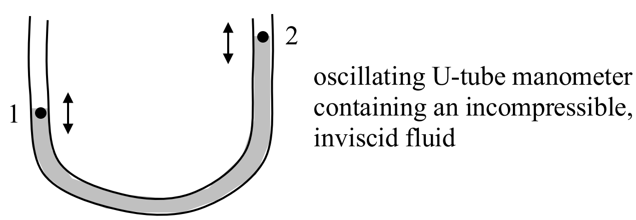

c.




d.




e.



SOLUTION:

Bernoulli's equation, as written in the problem statement, can be used in NONE of the scenarios presented.

a. The flow is rotational at the interface between the vertical and horizontal channels and, hence, Bernoulli's equation cannot be applied across the flow streamlines.

b. Since Ma > 0.3, the flow should be considered compressible. The given form of Bernoulli's equation is valid only for incompressible flows. An alternate form of Bernoulli's equation that takes compressibility effects into account could be used, however.

c. The pump between points 1 and 2 adds energy to the flow and, hence, the constant in Bernoulli's equation changes across the pump. The Extended Bernoulli's Equation (aka energy equation) could be used in this scenario instead of the given form of Bernoulli's equation.

d. Bernoulli's equation assumes inviscid flow. Viscous effects are significant in boundary layers and thus Bernoulli's equation may not be used.

e. The given form of Bernoulli's equation assumes steady flow. The oscillating U-tube is unsteady and the given Bernoulli's equation cannot be used. Note that it is possible to derive an unsteady form of Bernoulli's equation that could be used in the given situation.