Determine the relative errors in calculating the specific volume, specific internal energy, and specific enthalpy for liquid water at a temperature and pressure of 100 °C and 100 bar (abs), respectively, using thermodynamic property tables and using the compressed liquid approximations.

SOLUTION:
From the thermodynamic property tables for liquid water at 100 °C and 100 bar (abs),

v = 1.0385*10^{-3} m³/kg,
u = 416.23 kJ/kg,
h = 426.62 kJ/kg.

Using the saturated liquid approximations,

$v_{CL}(T,p) \approx v_l(T)$,
$u_{CL}(T,p) \approx u_l(T)$,
$h_{CL}(T,p) \approx h_l(T) + [p - p_{sat}(T)]v_l(T)$,

where,

v_l(100 °C) = 1.0435*10^{-3} m³/kg => $v \approx 1.0435*10^{-3}$ m³/kg,
u_l(100 °C) = 419.06 kJ/kg => $u \approx 419.06$ kJ/kg,
h_l(100 °C) = 419.17 kJ/kg,
p_{sat}(100 °C) = 1.0142 bar (abs),
=> $h \approx 429.499$ kJ/kg.

The relative error, ε, in a property, P, is,

$$\varepsilon_P = \frac{P_{approx} - P_{actual}}{P_{actual}} . \qquad (1)$$

Thus, $\varepsilon_v = 0.00481$, $\varepsilon_u = 0.00680$, and $\varepsilon_h = 0.00675$. The error is less than 1% in all cases, implying that the approximations are good ones.

Compressed Liquid Table for H2O

Temp. (C)	Volume (m³/kg)	Internal Energy (kJ/kg)	Enthalpy (kJ/kg)	Entropy (kJ/kg/K)	Volume (m³/kg)	Internal Energy (kJ/kg)	Enthalpy (kJ/kg)	Entropy (kJ/kg/K)
	p = 75 bar = 7.5 MPa, T$_{sat}$=290.54°C				p = 100 bar = 10.0 MPa, T$_{sat}$=311.00°C			
20	9.9843E-04	83.46	90.95	0.29489	9.9731E-04	83.31	93.28	0.29435
40	1.0046E-03	166.63	174.16	0.56949	1.0035E-03	166.33	176.36	0.56851
80	1.0256E-03	333.25	340.95	1.0707	1.0244E-03	332.69	342.94	1.0691
100	1.0397E-03	416.93	424.73	1.3015	1.0385E-03	416.23	426.62	1.2996
140	1.0753E-03	585.75	593.81	1.7319	1.0738E-03	584.71	595.45	1.7293
180	1.1220E-03	757.96	766.37	2.1304	1.1200E-03	756.48	767.68	2.1271
220	1.1838E-03	936.17	945.05	2.5082	1.1809E-03	934.00	945.81	2.5037
260	1.2703E-03	1125.00	1134.50	2.8775	1.2653E-03	1121.60	1134.30	2.8710
Sat.	1.3682E-03	1282.70	1292.90	3.1662	1.4526E-03	1393.50	1408.10	3.3606

Saturated Liquid Vapor Mixture Table for H2O, organized by temperature

Temp. (C)	Press. (bar)	Liquid				Vapor			
		Volume (v$_f$, m³/kg)	Internal Energy (u$_f$, kJ/kg)	Enthalpy (h$_f$, kJ/kg)	Entropy (s$_f$, kJ/kg/K)	Volume (v$_g$, m³/kg)	Internal Energy (u$_g$, kJ/kg)	Enthalpy (h$_g$, kJ/kg)	Entropy (s$_g$, kJ/kg/K)
100	1.0142	0.0010435	419.06	419.17	1.3072	1.6718	2506.0	2675.6	7.3541