BOILING HEAT TRANSFER

- BOILING OCCURS AT A SOLID – LIQUID INTERFACE WHEN THE TEMPERTURE of THE SOLID, T_s, IS SUFFICENTLY ABOVE THE SATURATION TEMPERTURE of THE LIQUID, T_{SAT}.
- THE DIFFERENCE BETWEEN THE SURFACE & SATURATION TEMPERATURES IS KNOWN AS THE _____ .

BOILING IS CONSIDERED A FORM of CONVECTION, & BOILING HEAT FLUX IS EXPRESSED AS

$$\dot{q}_{BOILING} = h\left(T_s - T_{SAT}\right) = \underline{\hspace{3cm}} \quad (W/m^2)$$

SINGLE – PHASE CONVECTION DEPENDS ON MANY PROPERTIES SUCH AS $g, \mu, k, C_p, etc.$ BOILING ALSO DEPEND ON THESE, FOR BOTH PHASES, AS WELL AS

$$h_{fg}: \underline{\hspace{5cm}} \&$$

$$\sigma: \underline{\hspace{5cm}} .$$

- DEPENDING ON THE STATE of BULK MOTION of THE FLUID, BOILING CAN BE CLASSIFIED AS

$$\underline{\hspace{3cm}} \quad OR \quad \underline{\hspace{3cm}} \quad BOILING.$$
$$(1) \qquad\qquad\qquad (2)$$

- BOILING CAN ALSO BE CLASSIFIED BASED ON THE <u>BULK</u> LIQUID TEMPERATURE. IN THE CASE WHERE THE BULK LIQUID TEMPERATURE IS

  1) LESS THAN T_{SAT}, WE HAVE _____.

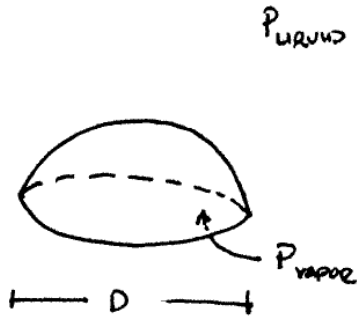 2) IF $T_{BULK,LIQUID} = T_{SAT}$, WE HAVE _____.

- IN ADDITION TO THE INHERENT COMPLEXITY OF CONVECTION (NATRURAL &/OR FORCED) & PHASE CHANGE, BOILING IS FURTHER COMPLICATED BY

  <u>THERMODYNAMIC NON-EQUILIBRIUM</u>.

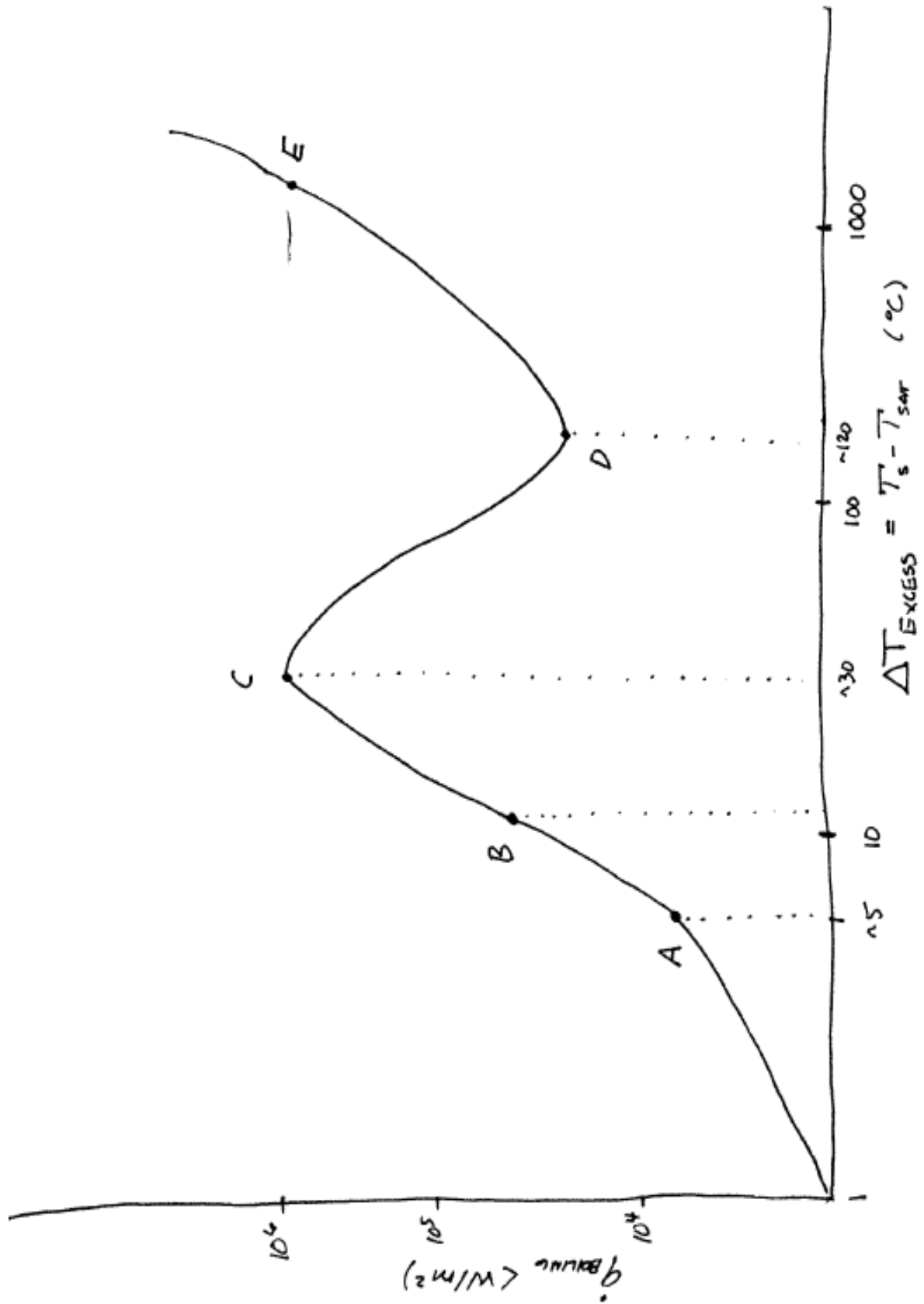 IN PARTICULAR, _____ ARE GENERALLY <u>NOT</u> IN THERMODYNAMIC EQUILIBRIUM WITH THE _____ _____.

CONSIDER A VAPOR BUBBLE:

(CUT IN HALF)

P_{LIQUID}

P_{VAPOR}

$\longmapsto D \longmapsto$

Find: RELN BETWEEN P_V, P_L & σ.

Soln:

FORCE BALANCE ON
THE BUBBLE:

POOL BOILING

BOILING REGIMES & THE BOILING CURVE:

A FUNCTIONAL DEPENDANCE EXISTS BETWEEN BOILING HEAT FLUX & EXCESS TEMPERATURE. THIS DEPENDENCE IS ILLUSTRATED ON THE _____ _____ .

THE BOILING CURVE IS DIVIDED INTO A NUMBER OF REGIMES.

1) NATURAL CONVECTION BOILING   (WHERE IS IT ON THE CURVE?)
                                              (WHAT ARE SOME CHARACTERISTICS
                                                   of THIS REGIME?)

2) NUCLEATE BOILING   (WHERE IS IT ON THE CURVE?)

3) TRANSITION BOILING

4) FILM BOILING

CRITICAL HEAT FLUX

• IN HEAT INPUT CONTROLLED SITUATIONS (MOST REAL SITUATIONS)
THE BOILING CURVE BETWEEN ____ & ____ IS BY-PASSED
ALMOST INSTANTANEOUSLY, RESULTING IN SURFACE
TEMPERATURES ON THE ORDER of 1000°C. FOR THIS
REASON, CRITICAL HEAT FLUX (CHF) IS ALSO KNOWN AS

THE _____ _____ OR SIMPLY

_____ .