1) **The relation between ΔH and ΔU :**

For a system containing liquids, solids and gases, the relation $\Delta H = \Delta U + RT\Delta n$, assumes :

a) Δn is the variation of the number of moles of the whole system during the process (-50%)
b) The volumes of the liquids and solids are negligible in front of the volume of the gases (33%)
c) The process is reversible (-50%)
d) The process is monothermal (33%)
e) The gases are ideal (33%)

(1.00 point)

2) **Processes :**

Out of the following statements concerning processes, select the one(s) you think is/are correct:

a) An isothermal process is a monothermal process for which at all points of the sytem the temperature of the system stays at all times equal to the external temperature. (25%)
b) A reversible process is such as at all times the system is at equilibrium with the surroundings. (25%)
c) The compression of a gas can be reversible or irreversible depending on the operating mode. (25%)
d) An irreversible process is either i) abrupt or ii) slow with dissipation of energy. (25%)
e) An adiabatic container prevents temperature variations of the system. (-100%)

(1.00 point)

3) **Saturating vapor pressure :**

Consider an undeformable container, initially vacuumed, of volume 1.00 L, maintained at 325 K. A mass of 1.03 g of liquid water is introduced in the container. The saturating vapour pressure at this temperature is 0.133 bar. The vapour is assumed an ideal gas. The molar mass of water is M = 18.0 g.

Select the correct answers about the final state :

a) None of the above propositions is correct. (0%)
b) There is only liquid. (0%)
c) There is 5×10^{-3} mol of gas and 5.2×10^{-2} mol of liquid. (50%)
d) All the liquid is vaporized and $P = 1.5 \times 10^5$ Pa. (0%)
e) There is 8.9×10^{-2} g of gas and 0.941 g of liquid. (50%)
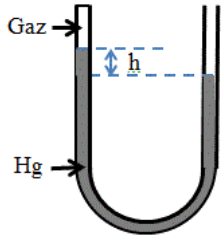f) The temperature has no influence on the mass of gas. (0%)

(2.25 points)

4) Pressure calculation:

Consider the U tube with the characteristics displayed on the sketch :

P_{gaz} = 0.70 bar P_{atm} = 1.01 bar ρ_{Hg}= 13.5 g.cm^{-3}

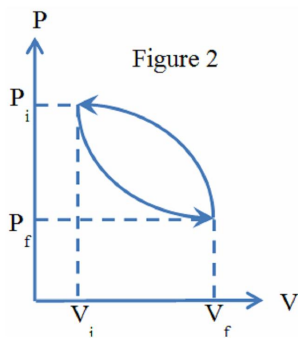What is the mercury height *h*?   (select the correct answer)

a) 45 cm   (0%)
b) none of the above propositions is correct (0%)
c) 12 cm   (0%)
d) 23 cm (100%)
e) 3.4 cm (0%)
f) 6.0 mm (0%)

(2.25 points)

5) Clapeyron's diagram 2:

Let's consider the reversible process sketched on the Clapeyron diagram below :

Figure 2

W is the work of the pressure forces and ΔU the internal energy variation for the cycle described on figure 2 (from i to f, then back to i following the arrows).

Out of the following statements, select the one(s) you think is/are correct:

a) ΔU can't be determined exactly (-20%)
b) $W = 0$ (-20%)
c) $\Delta U > 0$ (-20%)
d) W > 0 (50%)
e) $\Delta U = 0$ (50%)
f) $W < 0$ (-20%)
g) $\Delta U < 0$ (-20%)

(1.25 points)

6) Work calculation:

A reversible compression from state 1 to state 2 is conducted on dinitrogen, assumed an ideal gas, along three different processes. The first process is isochoric then isobaric, the second one is isobaric then isochoric and the third one is such that $P.V$ = constant.

The different processes are displayed on the graph $P = f(V)$ below.
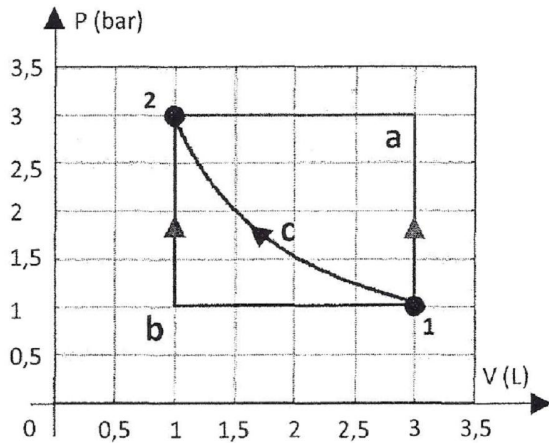
Select the correct statement(s):

a) The work W_b corresponding to the process b is equal to 200 J. (33%)
b) The work W_c corresponding to the process c is between 300 and 400 J. (33%)
c) The first process is described by path *a* and the second one by path *b* (33%)
d) The first process is described by path *b* and the second one by path *c* (-33%)
e) The work W_a corresponding to the process *a* is equal to 1200 J. (-33%)
f) None of the above propositions is correct. (-33%)
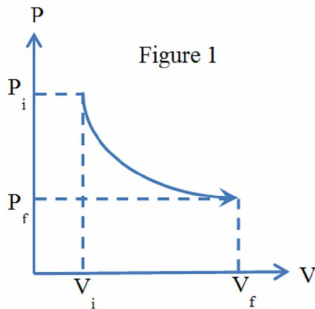
(2.25 points)

7) First Law:

What formulation(s) is(are) correct for the first law on a system at rest on the macroscopic scale :

a) $\Delta U = W + Q$ (50%)
b) $dU = W + Q$ (-33%)
c) $dU = \delta W + \delta Q$ (50%)
d) $\Delta U = \Delta W + \Delta Q$ (-33%)
e) $dU = dW + dQ$ (-33%)

(1.00 point)

8) Clapeyron's diagram 1:

Let's consider the reversible process sketched on the Clapeyron diagram below :

Figure 1

W is the work of the pressure forces for the process from i to f on figure 1.

Out of the following statements, select the one(s) you think is/are correct:

a) W depends on the states i and f and on the followed path (50%)
b) $W > 0$ (-20%)
c) W depends only on the states i and f of the system (-20%)
d) $W < 0$ (50%)
e) $W = 0$ (-20%)
f) W depends only on the initial state i (-20%)
g) W depends only on the final state f (-20%)

(1.00 point)

9) State variables :

Select the intensive variables in the list below :

a) Molar fraction x (-17%)
b) Density ρ (-17%)
c) Mass m (25%)
d) Internal energy U (25%)
e) Concentration C (-17%)
f) Relative density d (-17%)
g) Pressure P (-17%)
h) Nomber of moles n (25%)
i) Volume V (25%)
j) Temperature T (-17%)

(1.00 point)

10) **Work and heat:**

In this question *P* is the pressure of the system and *V* the volume of the system. *W* represents the work and *Q* the heat exchanged by the system with the surroundings.

Out of the following statements, select the one(s) you think is/are correct:

a) **The work *W* can be negative during a cycle (33%)**
b) **Heat is a way of exchanging energy (33%)**
c) **During an isochoric process, *W* = 0 (33%)**
d) The elementary work of the pressure forces is $\delta W = -P\,dV$ (-50%)
e) During an isothermal process, Q = 0 (-50%)

(1.00 point)

11) **Definitions and conventions**:

Out of the following statements, select the one(s) you think is/are correct:

a) **The notation d represents a small variation but δ represents a small quantity. (33%)**
b) By convention, if the system gives work *W* to the surroundings : $W > 0$ (-50%)
c) **An open system can exchange matter and all sorts of energy with the surroundings. (33%)**
d) An isolated system can not exchange heat with the surroundings but can exchange work. (-50%)
e) **A closed system can't exchange matter with the surroundings but it can exchange all sorts of energy. (33%)**

(1.00 point)

12) **System equilibrium:**

Out of the following statements concerning the equilibrium of a system, select the one(s) you think is/are correct:

a) **In a system at equilibrium the intensive and extensive variables do not depend on time. (20%)**
b) **A system is at thermodynamical equilibrium when there is a mechanical, thermal and chemical equilibrium at the same time. (20%)**
c) **Pressure and temperature of the system are defined only when the system is at thermodynamical equilibrium. (20%)**
d) **Two systems and at thermal equilibrium one with the other are at the same temperature. (20%)**
e) **In a system at equilibrium, the state variables are uniform in the whole system. (20%)**

(1.00 point)

13) Internal energy and enthalpy :

Out of the following statements concerning the internal energy U and enthalpy H, select the one(s) you think is/are correct:

a) ΔH = Q for a monobaric process (33%)
b) ΔU = Q for a monobaric process (-50%)
c) The internal energy U of an ideal gas depends on its temperature T (33%)
d) The internal energy U of an ideal gas depends on its pressure P (-50%)
e) An enthalpy variation ΔH does not depend on the type of the process from the initial state to the final state. (33%)

(1.00 point)

14) Ideal Gas:

Out of the following statements concerning ideal gases, select the one(s) you think is/are correct:

a) The density of an ideal gas is independant of the temperature and the pressure. (-33%)
b) A noble gas can always be considered ideal. (-33%)
c) In an ideal gas, there is no distance-interaction between the molecules and the volume of the molecules is negligible. (50%)
d) In the same conditions of temperature and pressure, 10 m^3 of dioxygen (O_2) contains twice as much moles of gas than the same volume of helium (He). (-33%)
e) All gases at very low pressure can be considered ideal. (50%)

(1.00 point)