UNIVERSITÀ DI PISA

Concorso pubblico anno accademico 2018/2019 per l'accesso al
Corso di dottorato in Scienze Chimiche e dei Materiali
(bandito con decreto rettorale n.39168 del 22 giugno 2018e successive modifiche e integrazioni)
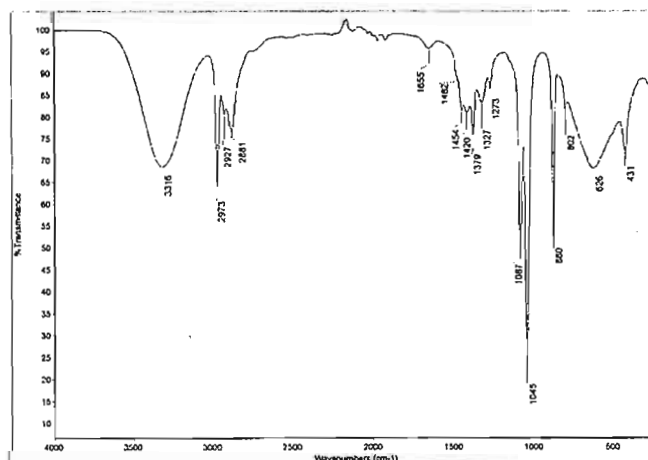
1. What is a certified reference material? What is it used for?

2. Describe how to perform the analysis of a solution in hexane of benzene, toluene and ethylbenzene in trace amounts. Which kind of chromatographic set-up (gas, liquid or thin layer? Which eluent and detector) would you use to separate and detect them?

3. The triplicate analyses of copper ion in three aliquots of a commercial wine yielded the following results: 10.1 ppm; 10.2 ppm; 10.4 ppm. Provide the final result of the analysis (critical values are reported in the attached table).

4. Discuss the temperature dependence of the equilibrium constant of a reaction.

5. The following graph is the phase diagram of CO_2
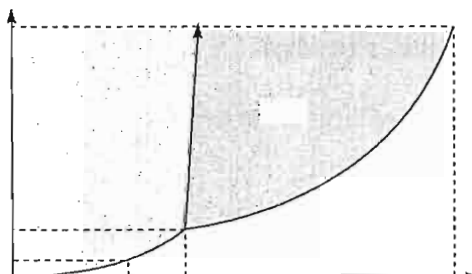
   - Report in y and x axis of the diagram the correct thermodynamic variables.

   - Show in the diagram where each phase (solid (S), liquid (L) and gas (G)) is thermodynamically stable.

   - Discuss the slope of the S/L phase boundary.

6. Assign the following IR spectrum to the right molecule: Ethanol or Acetone. Motivate your answer.

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7. Describe the energy levels of d orbitals in complexes with octahedral and tetrahedral geometries. Discuss the properties of these complexes

8. Metals: general features and the nature of metallic bond.

9. Group 14 (4A) elements: general features and outstanding differences.

10. Describe the key characteristics and difference of the two main types of polymerization: chain-reaction (or addition) and step-reaction (or condensation) polymerization (monomers, kinetics, obtained polymers).

11. 80% of industrial processes make use of catalysts in chemical reactions:
    a. Briefly define a catalyst and the most important properties of a catalyst
    b. What are the advantages and the disadvantages of (1) homogeneous catalysis and (2) heterogeneous catalysis?

12. What is 'Green chemistry' and what are the main principles of green chemistry (e.g. renewable resources)?

13. Select the words that best describe what happens to the <u>optical rotation</u> of the alkene shown when it is hydrogenated to the alkane according to the following equation:
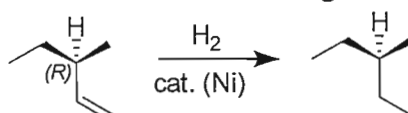

(a) Increases; (b) Changes to zero; (c) Changes sign; (d) Stays the same; (e) Decreases; (f) impossible to predict. Please, argument briefly your answer.

14. How many 13C NMR signals would be given by the following compound?
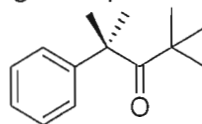
(a) 7; (b) 8; (c) 10; (d) 11; (e) 13

15. Discuss briefly Huckel's rule of Aromaticity, then indicate which of the following molecules or ions is not aromatic according to the rule:
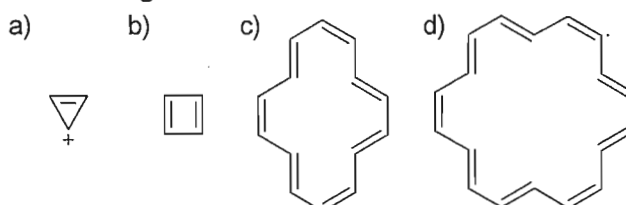
Molecola corretta riportata alla lavagna
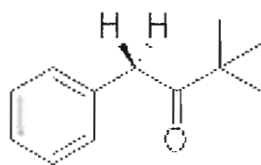
Table 1.1. *Value of t for Various Degrees of Freedom and Confidence Levels.*

Confidence level, % $\nu = N - 1$	50	90	95	99	99.9
1	1.000	6.314	12.706	63.657	636.619
2	0.816	2.920	4.303	9.925	31.598
3	0.765	2.353	3.182	5.841	12.941
4	0.741	2.132	2.776	4.604	8.610
5	0.727	2.015	2.571	4.032	6.859
6	0.718	1.943	2.447	3.707	5.959
7	0.711	1.895	2.365	3.500	5.405