1) Choose any TWO of the principles of Green Engineering; describe them in the essential details and explain with only two sentences why they are important.

2)* Do you agree with this opinion about Green Engineering or this definition must be implemented? "Green Engineering is the application to industry of Green Chemistry principles".

3) Explain with examples the different recycling strategy applied to wastes arising from organic synthetic polymers or from composite inorganic/organic polymers. Which are the environmental issues in the recovery of energy from these wastes?

4) The compound Diphenhydramine (II) can be obtained by interaction of benzhydrol (I) with 2-Chloro-N, N-dimethylethylamine hydrochloride (1:1 mol ratio) in benzene (10:1 mol ratio) in the presence of sodium hydroxide (1:1 mol ratio) and then converted to the salt III by addition of hydrochloric acid (1:1 mol ratio) in isopropanol (5:1 mol ratio) (scheme 1)

![Scheme 1]

Provide a preliminary evaluation of Green Metric parameters (AE, E, RME, SF…) and of safety/health issues involved in this process and explain if it is possible to produce (III) by alternative routes.

5) Define sustainability (2 pts) and what are three ways (with examples) that Triple Bottom Line companies promote sustainability. (3 pts).

6) “Industrial Symbiosis (IS) entails the coordinated work of manufacturing and service businesses to enhance environmental and economic performance in managing resources”. Is this sentence an acceptable definition of IS?

7)* A sustainable community include all these aspects except: a) resilient: adaptable to environment change, natural hazard mitigation; b) populated: stable death and birth rates; c) green: efficient land, water and air usage; d) livable: stable economy, affordable housing. Explain.

8) The biodegradability of a polymer has advantages and disadvantages. Which criteria are adopted to favor or moderate this property in a commercial new green product? Highlight two representative examples, one using a synthetic polymer and one using a bio-derived polymer.

9) LCA is considered a “powerful tool which provides an excellent knowledge-base for engineers and environmental managers in the assessment of potential improvements in the environmental performance of product process and systems”. Do you agree with this opinion about LCA? How LCA works and why it has been introduced into environmental laws only very recently?

10) Which elements and techniques are used in the Industrial Ecology to emphasize the biophysical basis of human activities? How Industrial Ecopark can support sustainability? Explain with examples.
11)** Cellulose and starch have 3 hydroxyl groups every glucose residue. Why both compounds are not soluble in water? Are these groups responsible for the tertiary and quaternary structures of these natural polymers and for their quite different biodegradability?

12)** Polylactic acid (PLA) is a bio-derived plastic. Evidence the positive and negative aspects connected to its introduction in the packaging market. Do you think that, overall, the introduction of PLA goes in the direction of sustainability?

13)** Which are the main structural differences and roles of nucleic acids DNA and RNA? Why the genetic therapy and GMO normally involves DNA and not RNA?

* Due for students in Chemical Engineering and Material Engineering
**Due for students in Environmental Engineering