

### Q3

Discussion could include, but is not limited to, items such as the following:

- a) Design problems are usually more vaguely defined than analysis problems. Analysis problems have only one answer, whereas the solution to a design problem is a system having specified properties, i.e. the ability to meet a specific need; there may be many possible devices to meet the need. Solving a design problem is usually an iterative process; as the solution to a design problem evolves, there may be continual refinement of the design. It may be the case that while implementing the solution to a design problem, the solution developed is found to be unsafe, too expensive, or will not work. Hence, design activity is cyclic or iterative in nature, whereas analysis problem solving is primarily sequential.
- b) 3 marks will be awarded to each of the following. One mark for the step definition and two for the discussion;
  1. **Define the problem;** This should start with a clear unambiguous definition of the problem. Once this has been done the problem definition should include;
    - i. Establish customer needs – what problem is the product solving?
    - ii. Develop problem statement – this should be broad enough not to preclude possible solutions but will specifically address the need identified.
    - iii. Criteria for success – this will involve input from many roles including managers, scientists, marketing and manufacturing.
  2. **Gather relevant information;** At this stage items such as the following could be considered;
    - i. Is the problem real and its statement accurate?
    - ii. Is there really a need for a new solution or has the problem already been solved?
    - iii. What are the existing solutions to the problem?
    - iv. What is wrong with the way the problem is currently being solved?
    - v. What is right with the way the problem is currently being solved?
    - vi. What companies manufacture the existing solution to the problem?
    - vii. What are the economic factors governing the solution?
    - viii. How much will customers pay for a solution to the problem?
    - ix. What other factors are important to the problem solution (such as safety, aesthetics & environmental issues)?
  3. **Generate multiple solutions;** At this stage items such as the following should be considered and used;
    - i. creative phase involving brainstorming,
    - ii. ‘synthesis’ of new ideas to solve design problem.
    - iii. Design teams should be free to take risks
    - iv. People from different disciplines should be involved

4. **Analyse and select solution;** At this stage the following analysis may be carried out;
  - i. Functional analysis
  - ii. Industrial design / ergonomics
  - iii. Mechanical / strength analysis
  - iv. Electrical / electromagnetic
  - v. Manufacturability / testability
  - vi. Product safety & reliability
  - vii. Economic and market analysis
  - viii. Regulations & standards
5. **Test and implement solution ;** At this stage items such as the following should be considered;
  - i. Prototyping and test under real conditions. These can be used to correlate the analytical work carried out in step 4 to gain confidence in the work carried out at this stage. In addition, contemporary manufacturing techniques such as 3D printing.
  - ii. Documentation. This may be particularly relevant if legislative testing is needed or if an audit is carried out on the final product to show what testing was carried out.
  - iii. Apply for Patents to protect the design.