For Teachers

Teaching Guide

This module covers

a) the corrosion of sculptures as a problem solving exercise

b) investigations that can be conducted by students related to the problem in the laboratory

c) a decision making exercise whereby students put forward their views to the problem and carefully justify their position.

Learning Outcomes by Lesson

Lesson 1

At the end of this lesson, students are expected to be able to :

- Put forward ideas as to why bronze sculptures corrode.
- Suggest ways in which the problem can be investigated in the laboratory.

Lesson 2

At the end of this lesson, students are expected to be able to :

- Set up and perform experiments involving the corrosion of iron and copper.
- Explain the experimental outcomes and especially why iron corrodes faster when in contact with copper.

Lesson 3

At the end of this lesson, students are expected to be able to :

- Presentation of results to other groups.
- Set up a voltaic pile
- Measure the current flow when two dissimilar metals (or metal plus carbon) are placed in an electrolyte and connected externally through a multimeter.
- Answer explanatory questions related to corrosion of cultural monuments.

Lesson 4

At the end of this lesson, students are expected to be able to :

- Explain the manner in which metals and carbon can be paced in an electrochemical series.

Developer: Andrei Zhegin and Irina Titova. Published in Supplementary Teaching Materials (eds). Jack Holbrook and Miia Rannikmae, ICASE, 1997. Edited by: Jack Holbrook
Institution: International Council of Associations for Science Education (ICASE)
Country: UK

- Discuss whether more should be done to save cultural monuments.

Suggested Teaching Strategy

1. The lesson can begin with a brainstorming session in which students put forward their ideas on the causes of corrosion of monuments. In so doing they illustrate their knowledge of monuments and of the corrosion of metals. It is important at this stage that the teacher accepts all answers and does not pre-judge any response. The responses can be collected on the blackboard by writing the title (corrosion of monuments) in the middle of the board and linking each response to this by a line or arrow, thus creating a chart of thoughts related to the problem.
2. This can be followed by group discussion on ways in which the problem can be investigated in the laboratory. The teacher will need to suggest that copper is used in place of bronze and that experiments need to be set up that duplicate the situation in nature. But added to this need to be experiments that look at possible solutions, or ways in which the problem can be minimised.
3. Based on the discussion, students now set up experiments investigating corrosion. The experiments will take time to complete and hence it may be necessary to set them up in one lesson and the observations made and interpretations undertaken in a subsequent lesson.
4. Students will need to follow experimental instructions as it is suggested that agar solution is used to 'set' the experiments involving iron and copper. This will make it easier to observe the results. The corrosion of copper by acid (or acid in the presence of salt) is more straightforward and can be undertaken following student suggestions if deemed appropriate.
5. After setting up the experiments, they need to be left for a few days. After this time students, in their groups, can observe the results of their experiments and attempt an interpretation. The teacher needs to ensure that this discussion then focuses on a solution to the monument problem.
6. Groups can present their solutions to the rest of the class, including any theoretical explanations that may be required and also provide answers to questions posed.
7. The students can now investigate the iron/copper reaction by connecting a multimeter in the external circuit to show corrosion involves electron flow.

Notes for the class discussion

1. Study the literature from the library or by the use of other sources;
2. In prepare the group presentation on corrosion protection, include the following topics:
   Protection of corrosion dates back to very early times (Rhodos collossus destruction, ways of protection of sculpture in ancient Greece, corrosion of Knight's' ammunition.

Developer: Andrei Zhegin and Irina Titova. Published in Supplementary Teaching Materials (eds). Jack Holbrook and Miia Rannikmae, ICASE, 1997. Edited by: Jack Holbrook
Institution: International Council of Associations for Science Education (ICASE)
Country: UK

Modern technologies of corrosion protection (spraying, painting films of oxides, sulphides, natural and synthetic wax, polybutylmetacryl and others).

Achieving the Objectives

OBJECTIVES	This is achieved by
1. Illustrating to students the value of scientific knowledge in solving practical and social problems.	discussing the problem of the corrosion of monuments having carrying out practical investigations to better understand the theoretical background. Also answer questions posed.
2. Solving a problem of how to save and protect cultural monuments.	suggesting experiments to undertake and interpreting the results obtained.
3. Cooperating as a member of a group	discussing in groups and in carry out experiments on corrosion.
4. Communicating orally and in written format.	discussing in groups and presenting outcomes of the discussion to the rest of the class.
5. Developing students' knowledge on chemical and electrochemical corrosion based on a consideration of examples of sculpture destruction in cities.	students discussing and then presenting their solutions to the corrosion problem of monuments and deriving the electrochemical series for metals.
6. Making decisions on whether more should be done to save cultural monuments.	Students participating in the decision making activity, considering cultural heritage, scientific/technological know-how, cost factors and availability of skilled personnel etc.

Developer: Andrei Zhegin and Irina Titova. Published in Supplementary Teaching Materials (eds). Jack Holbrook and Miia Rannikmae, ICASE, 1997. Edited by: Jack Holbrook
Institution: International Council of Associations for Science Education (ICASE)
Country: UK