Lesson plan

Engineering Gold
Ski Lubricants Enquiry

Timetable

Teacher:	.....	**Lesson:**	.....
Group:	.....	**SEN students:**	.....
Date:	.....	**Support Staff:**	.....
Room:	.....		.....

Focus

In this enquiry students will work in small groups to discuss and carry out an enquiry into the effect of lubricants on ski movement. This activity will take two lessons.

Objectives

Students will:

- Develop their skills of planning, interpreting and evaluating an enquiry.

Outcomes

All students will be able to:

- Plan their enquiry.
- Interpret and evaluate their own data and make some judgement about its reliability.

Most students will be able to:

- Interpret and evaluate class data and judge its reliability.
- Draw a conclusion and use their interpretation of data to explain how confident they are of this conclusion.

Some students will also be able to:

- Explain whether their data sets show real differences between the lubricants.

Resources

Students following an open approach to the investigation will require access to all the following equipment, plus raw liquids and glassware to measure/mix their own lubricants.
Students following a more structured approach should be provided with ready-mixed lubricants.
Each group will need 20cm^3 - 30cm^3 of lubricants A – E.

Lubricant A: water
Lubricant B: per 100cm^3: 75cm^3 water, 1cm^3 detergent, 25cm^3 veg oil
Lubricant C: per 100cm^3: 50cm^3 water, 1cm^3 detergent, 50cm^3 veg oil
Lubricant D: per 100cm^3: 25cm^3 water, 1cm^3 detergent, 75cm^3 veg oil
Lubricant E: vegetable oil

Per group:

- 'Engineering Gold' programme
- worksheet *On the Slopes* and *Ski Lubricant Enquiry*
- sheet of hard vinyl flooring (linoleum) 1.3m x 40cm (approximately)
- large brick wrapped in bubble wrap
- ceramic tile with 1kg mass firmly attached to base with blutac
- 2 x metre ruler
- 10cm^3 measuring cylinders
- 25 cm^3 measuring cylinders
- pipettes
- access to water and paper towels to clean equipment between lubricants

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Starter (20 mins)

1. Show first section of the film 'Engineering Gold' introducing the context and Professor Styring's 'big idea'.
2. Give students data for Great Britain's performance in recent winter Olympics (see worksheet *On the Slopes*). They should determine the difference between this performance and the gold medal winning speed.

Main (75 mins)

1. Show remainder of the film, pausing as appropriate to emphasise key points, e.g. how Peter Styring developed the lubricant, how the lubricants were tested in the lab, explanation of graphs from ski slope data.
2. Use students' sheets to introduce the enquiry. Clue cards are provided to accommodate different approaches to the enquiry.
3. Demonstrate the equipment to students, and provide students with following basic information: water freezes at 0°C, vegetable oils are very viscous, sunflower oil freezes at -17°C, detergent helps water and oil to mix.
4. Clarify expected outcomes and timescale for the enquiry, and respond to student queries.
5. In pairs students following an open approach draft a plan for the enquiry. Provide students with clue cards as necessary.
6. In fours students peer assess their plans and agree the group approach. Alternatively provide students with method sheet to follow.
7. Students collect data.
8. Collate class data. Students interpret and evaluate data, using questions as guidance if you wish.

Plenary (20 mins)

Students write a summary of their enquiry findings, recommending an appropriate ski lubricant, and suggesting further work required to improve confidence in their conclusion.
The activities *On the Slopes*, *Laboratory Data 1* and *Laboratory Data 2* provide support for data interpretation. Other support is available from the 'Engineering Gold in the classroom' programme.

Answers to questions

1. Lubricant recommendation will depend on students' results.
2. Reference to whole class data to support choice of lubricant.
3. Reference to key information provided during the lesson, and additional information (such as explanation of emulsification) as appropriate for class.
4. Identification of outliers from student's own data.
5. Scientists review the procedure for an explanation of how the outlier may have occurred. If it can be explained by an error in carrying out the procedure the outlier data may be ignored when the data is interpreted. If the outlier cannot be explained by an error in carrying out the procedure they may consider this result an anomaly which requires further investigation.
6. Reference to repetition of data collection to increase reliability.
7. Reference to reliability of student's own data, reliability of class data set,
8. Suggestions for changes to the procedure, with explanation for how these would be improvements, e.g. more thorough cleaning of slope between lubricants to remove build up between tests, which affects subsequent results.

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Notes

Extension:

The approach to the activity may be varied to provide sufficient extension/support for students.
(a) Provide students with equipment. Class determines method and ranges. Groups within class collect data to contribute to whole class data set.
(b) Provide students with lubricants A – E but groups determine own method.
(c) Provide students with full details of methodology.

On-line material:

The film 'Engineering Gold in the classroom' available on www.teachers.tv shows a teacher introducing the enquiry to students, the students at work on their enquiry, and the teacher discussing the data with small groups. This latter footage includes discussion of how students can approach outliers, and how students can begin to determine whether there is a significant difference between data for two values.