**Scrambled Science: Teachers Notes**

Scrambled science is an exercise to help students improve the clarity of their ideas and responses to questions in physics. It is most useful after they have already learnt the concepts.

This particular example is intended to be used as a review of Unit E “The Wave Model of Light”, either at the end of that unit or as an introduction to the unit on Quantum Mechanics. Exercises like this could also be useful on a test. It would allow you to evaluate their communication skills separately from their knowledge in the same way that a formula sheet helps in mathematical physics questions.

When faced with a question like “Which model of light is correct?” many students will start writing everything that they can recall about the topic before thinking about how to organize their answer. As a result the answer is over-long, contains much that is irrelevant and is not clear.

1. Before starting to answer, students need brainstorm what they already know of the topic. This part has already done for them. Later examples of scrambled science could have students do this individually or in small groups. When preparing to write an answer for a test, students should be asked to write down he key concepts needed to answer the question.

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1. Then next step is to classify and organize the ideas. This is a step that most students miss. To emphasize its importance and to get the students working together, it might be worth the trouble to photocopy the ideas onto cards that they can manipulate them in small groups. You can provide one set per group or one per student that they can glue to form part of their answer.

* Some of the ideas are simply irrelevant and should not be used.
* Some of the ideas should be grouped together; i.e. all the evidence for the wave model.
* Some of the ideas will be more important than others and should be emphasized; i.e. diffraction gives clear support to the wave model whereas reflection supports both models and is less useful.

1. The final step is to consider the overall order of the paragraph and then write it. A word limit has been provided because it forces students to be more concise and clarify what is truly important in the answer. The answer should start with the overwhelming evidence that supports the wave model but not the particle model. After that it should mention the remaining problem of how light travels through space. It should close by saying that there is no final answer to the question at this point but it is most likely that light is a wave and not a particle.

**Scrambled Science: Wave vs. Particle Model 1900 Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

In the late 1670’s Newton proposed that light was made of particles. Rival scientist Christian Huygens argued that it was made of waves. **All of the following facts are true** and were known by 1900.

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| **Statements of fact:** | Main concept in **1 or 2 words**: |
| 1. Light travels at 3.00 x 108 m/s. | speed |
| 1. White light is made of infinitely many colours. | colours |
| 1. When light passes through a narrow slit it spreads out. | diffraction |
| D) Crossed polarizers can block half to all of the light. | polarization |
| E) Sunlight reaches us by passing through empty space. | no medium |
| F) Light reflects with equal angles of incidence and reflection. | reflection |
| 1. Light passing through two slits form dark and bright spots. | double slit |
| 1. A light beam is straight. It does not curve down under gravity. | straight |
| 1. Light bends when travelling from air into water. | refraction |
| 1. Light passing through one slit can form dark and bright spots. | single slit |
| 1. A soap bubble is colourful. | thin film |

1. In the right-hand column write **one or two words** that sum up the main concept on that row.
2. Divide the statements into four groups:

i) evidence for light as a wave C, D, G, I, J, K ii) evidence for light as a particle E

iii) evidence that supports both models H, I iv) irrelevant statements A, B

1. Which model of light is correct? Explain in a well-organized answer of fewer than 60 words.

The answer should start with the overwhelming evidence for the wave model and then point out that a wave should not be able to travel through empty space. This suggests that there should be a medium – even in empty space or else light cannot be a wave. The answer should not waste space discussing the irrelevant statements and probably should not mention the phenomena that can be described by both models – not if restricted to 60 words.