At the ship builders:
Teacher's Notes

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Preface:

At the ship builders is an activity designed to highlight the role of physics, design and technology principles to the real world by illustrating the processes involved in designing and making ships. This lesson gives pupils an insight into careers-based learning, by illustrating how ships are commissioned, designed and built from start to finish.

Audience: Key Stage 3 pupils – Year 9

Length: 3 hours if the plenary practical element is included (plus technician time to prepare the four water samples). If not, 1 hour for the theoretical element, i.e. just the PowerPoint presentation.

Learning Objectives:

- To set the physical principles of buoyancy, stability and drag to real world application, using the example of ship design and building.
- To encourage pupils to enquire about the role of physics in ship building, and its wider application to enterprise using careers-based teaching.
- To give pupils an appreciation for the value of the shipping industry in our everyday lives and the role design principals relating directly to physics behind shipping links to this.
- To give pupils practical experience in applying theoretical physics and design principles in a way relevant to real world industrial practice and enterprise, using the example of calculating load lines on cargo ships.

Running the activity:

***Starter* – 10 minutes:** Using whole class discussion, ask pupils what relevance shipping has to our everyday lives. Write their answers up on the white board.

***Main* – 50 minutes:** Present the *at the ship builders slideshow* using the notes provided on each slide. Note if a practical element is not being included as part of the suggested plenary activity for this exercise, only present up to slide 23.

***Plenary* – 2 hours:** In order to undertake the plenary activity associated with this resource pupils will need to create model ships. This can be carried out in a complementary Design and Technology

lesson prior to this resource being used or incorporated into the lesson itself. Pupils should create their ships in teams. Pupils will also need a copy of the *safety on ships the load line* activity worksheet; one per group. Pupils will be testing the load line of their own cargo ships in various bodies of water. This applies the principles of density into practice while getting pupils to carry out an activity that is of industrial relevance to shipping.

The simplest way to make the model ships is to purchase some home insulation polystyrene foam. This material is high density but still easy to mould and shape using hack saws and other school approved design and technology equipment and is therefore perfect for modelling ships quickly and easily. The material is relatively cheap and can be purchased under the following link:

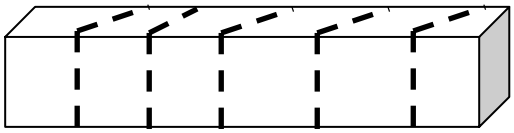
http://www.diy.com/diy/jsp/bq/nav/nav.jsp?action=detail&fh_secondid=9374253&fh_view_size=6&fh_start_index=6&fh_location=%2f%2fcatalog01%2fen_GB&fh_search=kaunf&fh_eds=%c3%9f&fh_refview=search&ts=1220944345860&isSearch=true

To make the model ships follow the instructions below. Once the strips and blocks have been cut its over to the pupils to cut out and shape their ships. Instructions for pupils are provided in detail on the *At the ship builders slideshow* on slide 24. These model ships will be useful for other resources in Module A, such as *Ship-shape!*, so can be retained for future use.

To make the model ships pupils will need:

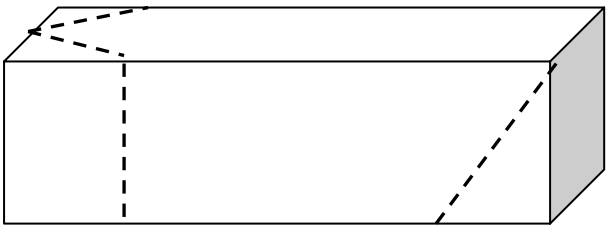
- Junior hacksaws
- Stanley knives
- Flathead screwdrivers
- Sand paper (various grades)
- Waterproof markers
- Safety rulers
- Nuts (various sizes) to function as cargo

Steps: (before class)
1 – Cut the foam board into strips of equal width. The width is up to you, but approximately 35mm works best. Further cut each strip into blocks of approximately 150-200mm in length.

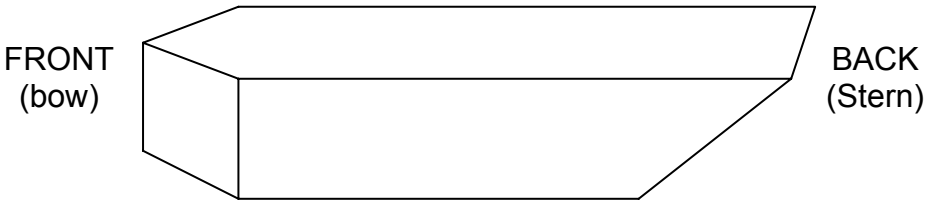


Steps: (in class)
1 – Provide pupils in groups with one cut foam block, one junior hacksaw, one Stanley knife, some sandpaper, a flathead screwdriver, a safety ruler and a waterproof marker.

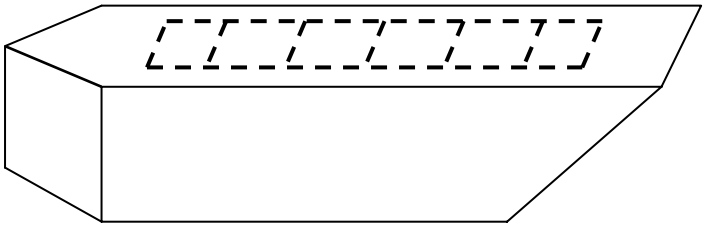
2 – Ask pupils to draw onto their foam strips the shape indicated below (or they could select their own shapes):



3 – Ask pupils to cut boats from their foam blocks using the safety ruler and the junior hack saw so they have something that looks like this.



4 – Pupils now need to make their cargo hold. Ask pupils, with their marker pens, to draw a box on the top of their ships similar to the one below. Under supervision, ask pupils to use their Stanley knives to cut along their shapes and also to score across the box too. This will help to remove the material during the next stage.



5 – Using the flathead screwdriver ask pupils to press the end of the screwdriver into the scores made on their model ships. By levering the screwdriver at the same time, sizable chunks of the cargo hold should come up in one go. Repeat the process until there is a hollowed out cargo hold approximately half the depth of the ship.

6 – Using the sandpaper, round-off the ship on the outside to make it smooth. Pupils should also sand flat the inside of the cargo hold. Once this is complete, pupils could decorate and name their ships.

To test the load line, you will need:

- Four plastic trays filled with water.
    - One with hot freshwater
    - One with hot saltwater (saturated)
    - One with cold freshwater
    - One with cold saltwater (saturated)
- Metal nuts (cargo)

Each group of pupils will need to measure the load line of their ships in each body of water by following the instructions on the *safety on ships the load line* activity worksheet. In order from deepest to shallowest load line, pupils should find the deepest load line on ships when placed in cold saltwater, followed by cold saltwater, followed by warm saltwater, followed by warm freshwater, which should have the shallowest load line.

Pupils should load their cargo ships up with metal nuts to the load line of their ships for each body of water and record their results in grams. If pupils have calculated their load lines accurately, they

should find very little change in the weight or cargo able to be carried before hitting the load line. Pupils should finally answer the question on the activity sheet to link their findings to density, relating to the variables temperature and salinity.

Discuss with the class their results and whether they found what they expected to find. If not, discuss with pupils why they think this was.

Where it fits in:

Module-based curriculum

1. Unit 7K- Forces and their effects
- Identify the origins of friction, water resistance, up thrust and weight and describe situations where these forces act.
- Why objects float in relation to the displacement of water

2 – Unit 9L - Pressure and moments
- That a force can make an object topple over about a pivot

3 – Unit 9E - Reactions of metals and metal compounds
- Reactions of metals (rusting).

4 – Unit 9F - Patterns of reactivity
- Metals are affected by air and water

5 – Unit 9I - Energy and electricity
- Range of useful energy transfers and transformations

6 – Unit 9K - Speeding up
- Relationship between forces, including balanced forces, on an object and its movement
- In order to increase speed without increasing thrust, resistance or drag has to be reduced
- Why streamlining is important

7 – Unit 9L - Pressure and moments
- Operation of levers depend on the turning effect of a force
- A lever is a simple machine which uses a pivot

Enquiry-based curriculum

1.1 – Scientific thinking
1.1a - Using scientific ideas and models to explain phenomena and developing them creatively to generate and test theories
1.1b - Critically analysing and evaluating evidence from observations and experiments

1.2 – Applications and implications of science
1.2a - Exploring how the creative application of scientific ideas can bring about technological developments and consequent changes to the way people think and behave

1.4 – Collaboration
1.4a - Sharing developments and common understanding across disciplines and boundaries

3.1 – Energy, electricity and forces
3.1b - Forces are interactions between objects and can affect their shape and motion

3.2 – Chemical and material behaviour
3.2a - The particle model provides explanations for the different physical properties and behaviour of matter

4 - Curriculum opportunities
4c - Use real life examples as a basis for finding out about science
4f - Use creativity and innovation in science and appreciate their importance in enterprise
4i - Prepare to specialise in a range of science subjects at Key Stage 4 and consider career opportunities both within science and in other areas that are provided by science qualifications
4k - Make links between science and other subject areas of the curriculum.

This resource also has history and design and technology links

Extension activity:

An interactive software game, entitled *at the ship builders,* is available for download from the *Inspiring Seas* website now! Why not download the game and allow your pupils to consolidate knowledge whilst they play. Enter the **Interactive games** area of the *Inspiring Seas* website and open the *at the ship builders* game. You will need to download Java to install this game. The readme file provides instructions on how to do this. Java is a completely free and entirely safe internet-based software programme. The game should take approximately five minutes to install.

A career profile, entitled: *what it's like to design ships*, is available from the *Inspiring Seas* website under **courses/careers > careers**, and illustrates the application of the principles learned from this resource to the world of naval architecture. You could provide pupils with a copy of this and ask them to summarise it and find more information on careers in ship design and building as homework.