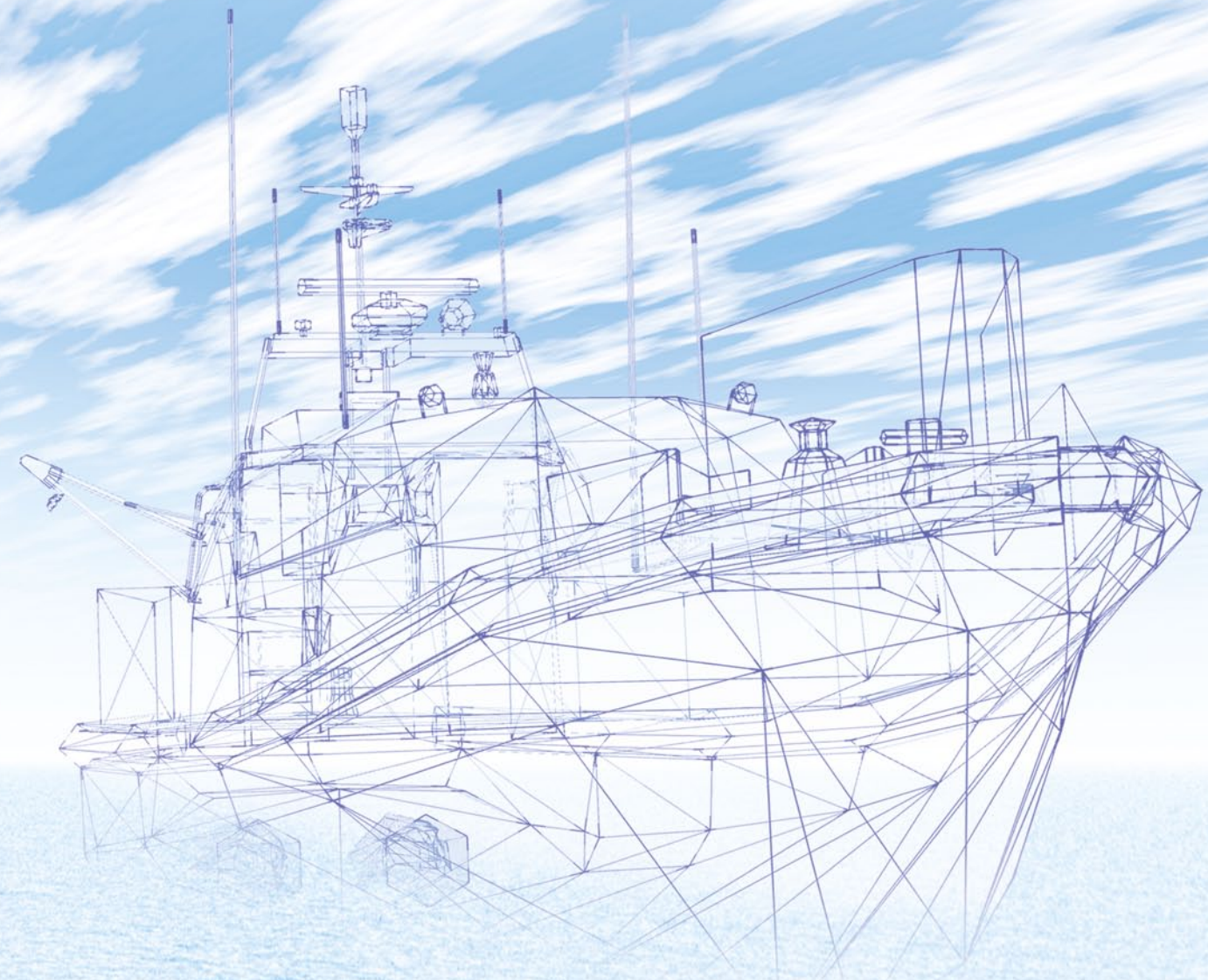
LIFE Support Team

Teacher's guide

RNLI Education Resource



Lifeboats

LIFE
Support Team

Welcome

This resource uses the essential work of the RNLI to provide an exciting, real life context for students to explore key STEM topics.

The resource is made up of four curriculum based lesson plans, each of which focuses on a different element of the RNLI's work: Launch, Navigation, Propulsion, and Survival. All lessons are curriculum linked and developed by practising teachers.

Fundraising challenge

The amazing technology which the RNLI relies on to carry out the crucial work of saving lives at sea provides inspiring examples of STEM theory in action. In order to help the RNLI maintain and invest in this amazing technology we have also provided all the information required for pupils to take part in a fundraising challenge.

This applied challenge will give pupils experience in developing a focussed, well thought out fundraising program with a clear message and effective mechanic. The fundraising challenge could be run as a competition, with students competing to see who can raise the most money to support the RNLI's critical work.

How to use this resource

Detailed delivery notes for each of the lesson plans can be found in this teacher booklet. Each lesson plan is also supported by engaging PowerPoint slides, student worksheets and exciting video clips.

All supporting assets can be downloaded for free on the RNLI website at **www.rnli.org/lifesupportteam** A technician's guide containing detailed information on the other materials which will be required to deliver each lesson is also provided on page 7

About the RNLI

The RNLI is the charity that saves lives at sea.

We provide, on call, a 24-hour lifeboat search and rescue service and a seasonal lifeguard service. We do not seek funding from central government so our lifesaving service is provided wherever possible by volunteers, generously supported by voluntary donations and legacies.

Our exceptional expertise is in the preservation of life at sea and on the water through prevention and rescue. Since the RNLI was founded in 1824, its lifeboats, and since 2001, its lifeguards, have saved more than 140,000 lives.

More and more people are using beaches and the sea for leisure and RNLI crews and lifeguards are responding to an increased number of incidents.






Lesson plans

LIFE Support Team

Lifeboats

Lesson 1

Launch

Duration
60 mins

Lesson Objectives

- Be able to describe how forces can be transmitted through a liquid
- Be able to explain how hydraulic systems can be used as a force multiplier
- Understand how pressure, force and area are related

Stage	Timings	Delivery	Resources required
Starter	5 mins 	• Using video 1 show the SupaCat launcher in action. • Display slide 3 and discuss how a 32 tonne machine is able to drive across soft sand? • Revise the link between forces, area and pressure (large force (weight) but large area (caterpillar tracks) means low pressure generated & no sinking into the sand).	Slides 1-3 Video 1
Activity 1	10 mins 	• Students investigate the relationship between force, area and pressure by carrying out the experiment on worksheet 1. The experiment involves pushing wooden blocks with 5 different sized faces into fine sand using a consistent mass (2kg). • Students collect data on the area of the block pressing on sand, force (changing kg into N) and the depth of impression created in the sand and record their results on worksheet 1. • Students create a graph plotting pressure against the depth of indentation. What can they see from their graph? • Discuss what would happen if the wooden blocks were shaped differently e.g. narrow at one end. Show example.	Slide 4 Worksheet 1a & b
Activity 2	25 mins 	• Display slide 5 and explain that the Supacat also uses hydraulics which rely on the relationship between pressure and surface area to create a large force. Use slide 6 to introduce the principles behind force multipliers. • Distribute worksheet 2 and ask students to investigate the effect of hydraulic systems by conducting an experiment using paired syringes filled with water. They measure the forces generated by different combinations of syringes and record their results on worksheet 2. • Students complete the extension questions on worksheet 2. • Display slide 8 and discuss where hydraulic systems can be used on the SupaCat launch and recovery system.	Slides 5-8 Worksheet 2
Activity 3	15 mins 	• Explain that the Shannon class lifeboat uses hydraulics as a propulsion system. Use video 2 to show it in action. • Distribute worksheet 3. Using a balloon and a piece of ' tapered' tubing that can be cut to different diameters students design a simple 'force meter' (this could be a hanging piece of card which they use to record the angle of deflection) that can be used to compare amount of force generated by different nozzle sizes. Students record their results on worksheet 3. • Discuss students' results.	Slide 9 Video 2 Worksheet 3
Plenary	5 mins 	• Supply students with the costs of the SupaCat launcher and Shannon propulsion system on slides 10 -11. • Discuss how the RNLI can justify the cost of the new vehicles to the public. • Display video 3 which shows how quickly the Shannon class can leave the water, ready for transportation back to the station.	Slides 10-11 Video 3

Lesson 2

Navigation

Duration
60 mins

Lesson Objectives

- Be able to describe the differences between scalar and vector quantities
- Be able to calculate velocity, acceleration and distance covered
- Be able to calculate resultant velocity of parallel vectors (F tier) and vectors at right angles to each other (H tier)

Stage	Timings	Delivery	Resources required
Starter	3 mins	• Display video 4 which shows the launch and use of a Mersey lifeboat in a rescue situation. • Show the newspaper report about a real life rescue on slide 3. How did the RNLI lifeboat get there in time?	Slides 1-3 Video 4
Activity 1	25 mins	• Distribute worksheets 1a-d. Display slide 4 and, describe and explain the sections of graph a as a class. Pupils complete the questions on graphs a & b. • Students complete the questions for graphs c & d. • Display slide 5 and ask students to discuss the advantages of the Shannon class over the Mersey class and put them in order of importance.	Slides 4-5 Worksheet 1a-d
Activity 2	15 mins	• Using slides 6-8, discuss the differences between scalar and vector quantities. What would affect the heading taken by a lifeboat navigator on setting out to an incident? • Use slides 9-13 to outline how to work out resultant velocity using parallel and right angle vectors. • Explain how to calculate the angle of a resultant vector.	Slides 6-13
Activity 3	10 mins	• Use the vector questions on worksheet 2 (higher tier) or 3 (foundation tier) to assess students.	Worksheet 2&3
Plenary	7 mins	• Ask students to look at the Engine Failure scenario on Worksheet 2 and discuss why it is so important that the RNLI keep all lifeboats in good working order.	Slides 14

Lesson 3

Propulsion

Duration
60 mins

Lesson Objectives

- Be able to calculate work done during an energy transfer
- Be able to calculate power and kinetic energy

Stage	Timings	Delivery	Resources required
Starter	10 mins	• Display video 5 to show the Mersey class lifeboat in action. • Ask students to recap by identifying different types of energy, capture these on the board. • Distribute worksheet 1 and ask students to write down all the different types of energy they think would be present in the photo of the Shannon class. Then ask students to classify the types of energy as input, useful and wasted. • Display the answers on slide 4&5.	Slides 1-5 Worksheet 1 Video 4
Activity 1	20 mins	• Show the news article on slide 6 and give out worksheet 2 which contains information on the Mersey and Shannon class lifeboats. • Using slides 7-11 guide students through calculations of work done, power, and efficiency for the Mersey and Shannon class. They should record their calculations on worksheet 2.	Slides 6-11 Worksheet 2
Plenary 1	10 mins	• Use the table of results from the Mersey and Shannon lifeboats to compare and contrast. • Using slide 12 ask students to put themselves in the position of a propulsion engineer who has to justify whether it is worth replacing a Mersey class with a new Shannon (their opinion should be based solely on data).	Slide 12
Activity 3	15 mins	• Using slide 13 introduce the RNLI guideline "twenty is plenty" for coxswains of faster lifeboats. • Students carry out calculations to compare 25 knots versus 20 knots and complete worksheet 3 (many calculations can be simplified by calculating 80% of previous values).	Slides 13-14 Worksheet 3
Plenary 2	5 mins	• Discuss the difference which travelling at 20 knots makes to the time it takes to cover the same distance, the power output, energy output and amount of fuel used.	None required

Lesson 4

Survival

Duration
60 mins

Lesson Objectives

- Be able to describe how temperature is monitored and controlled by the body
- Be able to explain how body temperature can be maintained in extreme conditions
- Be able to investigate different methods of temperature control and evaluate their effectiveness

Stage	Timings	Delivery	Resources required

Starter	15 mins 	• Display video 5 which shows a 'mock' emergency with a casualty in the water.
		• Discuss the problems which could be caused by cold water immersion – e.g. heat loss, drop in body temp, hypothermia.
		• Display slide 3 and ask students to consider:
		  • What the human body will do to try and maintain body temperature in cold water (e.g. shivering, vasoconstriction).
		  • The different strategies that the casualties can adopt to reduce heat loss from their bodies.
		• Recap on how the body maintains its temperature.
		• Display slide 4 which outlines four survival strategies which can be adopted by casualties.
			Slides 1-4
			Video 5

Activity 1	20 mins 	• Split the class into pairs and ask students to model the different survival strategies with simple lab equipment. Designate one of the experiments on worksheet 1 to each of the pairs:
		  • Effect of huddling versus non-huddling
		  • Effect of correct PPE versus no PPE
		  • Effect of life raft versus no life raft
		  • Effect of using a HELP (heat escape lessening position) versus normal body position.
		• Highlight that all experiments contain a control test tube to compare results against.
		• Make sure that all investigations are run for the same amount of time.
			Slide 5
			Worksheet 1

Group activity	20 mins 	• Ask all groups which carried out experiment 1 (etc.) to work together to produce a brief presentation on the effectiveness of their strategy on reducing heat loss – how many degrees centigrade were 'saved'? • Conduct a group discussion - if the RNLI were to suggest strategies for sailors to adopt if they were involved in an accident, what should their advice be?	Slide 6
Plenary	5 mins 	• Distribute worksheet 2 which contains information on the cost involved with the life-saving equipment which needs to be provided to a lifeboat for each strategy. • Do the costs associated with each method change their opinions on which strategy should be adopted nationwide? • As a homework task students write a report for the RNLI outlining the danger of cold water immersion and the body's reactions, methods of minimising heat loss and what strategy they would recommend to increase chances of survival.	Worksheet 2 Slides 7-9

Lesson 5

Fundraising challenge

Duration
60 mins

Lesson Objectives

- To recap on the role of the RNLI and the equipment they rely on
- To know that the work of the RNLI relies on donations
- To be able to develop and execute a successful fundraising campaign

Stage	Timings	Delivery	Resources required
Starter	10 mins 	• Using slides 1-4 introduce the RNLI and the work they do. • Display slides 5-6 and explain that the RNLI requires the best technology in order to carry out their job effectively. Introduce pupils to some of the hi-tech equipment which the RNLI use. • Display slide 7 and explain that, unlike the other emergency services, the RNLI does not receive government funding and relies on donations to carry out its crucial work.	Slides 1-7
Activity 1	15 mins 	• Split the class into groups and hand out worksheet 1, a briefing sheet to remind students about the investigations which they carried out during previous RNLI lessons. • Each sheet highlights the importance of different equipment to the work of the RNLI and shows its cost to the organisation. • Either ask each group to choose the briefing card for the area that they would most like to raise money towards or assign a briefing card to each group.	Worksheet 1
Group activity	30 mins 	• Using the understanding of the RNLI's requirements which they garnered from their briefing card students should develop a fundraising scheme to help support the RNLI. • Distribute Worksheet 2 which contains prompts to help students plan their fundraising scheme. • Once pupils have completed their plan they could put this scheme into action. Perhaps groups could compete to see which scheme raises the most for the RNLI. • Alternatively some fundraising ideas are provided on worksheet 3 which pupils could use to raise funds for the RNLI.	Worksheet 2 Worksheet 3 (optional)
Plenary	5 mins 	• Pupils could be asked to create an assembly or short presentation explaining their fundraising scheme, how they delivered it and the outcomes.	None required

Overview

A sequence of four lessons that use key STEM curriculum ideas to highlight the work of the RNLI. The following equipment will be required for each lesson

Lesson 1

Launch

Activity 1 – Pressure = Force/Area
Per group
Sand tray containing fine sand
Ruler
Wooden blocks (or similar) with 5 different sized faces
2kg mass

Activity 2 – Hydraulics
Per class
Many different sized syringes and short connector lengths of tubing

Per group
2 x 1-10N meter

Activity 3 – Jet Model
Per group
1 balloon
1 piece of tapered tubing/nozzle (must be able to be cut by students to different sizes of outflow) – this could be nozzles from sealant or slim cones made from card
Card
Sticky tape
Clamps

Lesson 2

Navigation

No practical but class sets of calculators would be useful

Lesson 3

Propulsion

No practical but class sets of calculators would be useful

Lesson 4

Survival

Circus of Four Activities
Per class
Ice cold water – this could be prepared in sinks around the classroom
Water bath at 37°c
Timer

Activity 1 – Huddling
Small test tubes with bungs
Large beakers
Thermometers

Activity 2 – Effect of PPE
Small test tubes with bungs
Material for insulating a test tube (bubble wrap)
Thermometers

Activity 3 – Effect of a life raft
Small test tubes with bungs
Polystyrene 'raft'
Thermometer

Activity 4 – Effect of HELP position
Small test tubes with bungs
Small beaker plus lid (cling film and elastic bands)
Thermometer






Lesson 1 – Launch

Worksheet 1b

(1) 2.7N/cm^2 (2) 8N/cm^2 (3) 0.19m^2 (1900cm^2)

Worksheet 2

(1) a) 400cm^2 = 0.04m^2

b) 8,000,000N/m^2 (Pa)

c) 0.0125m^2 or 125cm^2

(2) Example answers – students' answers will vary depending on the system of inputs/ outputs they have chosen.

Input Force (N)	Input Area (m^2)	Pressure (N/m^2)	Output Area (m^2)	Output Force (N)
80,000	0.064	5,000,000	0.032	160,000
40,000	0.008	5,000,000	0.032	160,000

Lesson 2 – Navigation

Worksheet 1a-d

Graph A

a) 0.25km/min for 10 minutes. Stopped for 4 minutes.
Accelerated for 3 minutes
Steady speed for 103 minutes.

b) 43/103 = 0.4km/min

Graph B

a) 47.5/55 = 0.86km/min

Graph C & D

a) Accelerates at 30/0.5 = 60km/h/min. 30km/h for 4 mins. Accelerates at -60km/h/min (Decelerates). Stopped for 1.25 mins.

b) 50/0.25 = 200km/h/min

c) -50/3 = -16.6km/s^2 or -50/0.0083 = -6024km/h/min

d) i. 0.975 x 50 = 48.75km
ii. 0.06 x 30 = 2km

Worksheet 2a (Higher tier)

(1)

a) Resultant velocity = √1110.25 = 33.3km/h

b) 65/33.3 = 1.9h

c) sin Θ = 14.5/33.3 Θ = sin-1 0.435
= 25.7 degrees (southwards, from east)

d) 56.9km/h, 1.14h at 14.7°

(2)

a) Resultant velocity = √936 = 30.6km/h

b) 30/30.6 = 0.98h

c) sinΘ = 6/30.6 Θ = sin^{-1} 0.196
= 11.3° (northwards, from east)

d) x55.3km/h, 0.54h at 6.2°

Worksheet 2b

a) Resultant velocity = √435.25 = 20.86km/h
sin Θ = 14.5/20.86 Θ = sin^{-1} 0.695
= 44° (southwards, from east)

b) Resultant velocity = √331.25 = 18.2km/h
sin Θ = 14.5/18.220.86 Θ = sin-1 0.797
= 52.8° (southwards, from west)

Worksheet 3 (Foundation tier)

1 a) 25km/h
b) 2.6h
c) 50km/h and 1.3h

2 a) 36km/h
b) 0.83h
c) 61km/h and 0.49h

1 a) 15km/h in the same direction
b) 75km/h in the opposite direction

Lesson 3 – Propulsion

Worksheet 2

Sick Yachtsman Incident	Mersey class	Shannon class
Distance travelled (m)	6.9miles = 11,040m	11,040m
Time taken (s)	21mins=1260s	14mins=840s
Average speed (m/s)	8.8m/s	13.1 m/s
Work done (J)	33000x11040 = 364320000J	64kN (64000) x 11,040 = 706,560,000J
Power rating (W)	36432000/1260= 289143W	706,560,000/840 = 841,143W
Litres of fuel used	364.32/36 = 10.1 litres	706.56MJ/36 = 19.6 litres
fficiency (%)	Useful energy out/ energy in x 100= 14.4 MJ/36MJx 100 = 40% No need to multiply by 10.1 litres as cancels out.	Useful energy out/ energy in x 100= 21.6 MJ/36MJx 100 = 60% No need to multiply by 19.6 litres as cancels out.

Worksheet 2

Sick Yachtsman Incident	Normal Shannon class	"Twenty is Plenty" Guidelines
Distance travelled (m)	11,040	11,040
Time taken (s)	840	1568
Average speed (m/s)	13.1	7.04 (80% of 8.8)
Work done (J)	64kN (64000) x 11,040 = 706,560,000J	80% of 64kN x 11040 = 565,248,000J
Power rating (W)	706,560,000/840 = 841,143W	20% x 841,142 = 672,914
Litres of fuel used	706.56MJ/36 = 19.6 litres	565.25MJ/36 = 15.7

Lesson 4 –Survival

No questions






Glossary

RNLI:
The Royal National Lifeboat Institution is the charity that saves lives at sea. We provide, on call, a 24-hour lifeboat search and rescue service and a seasonal lifeguard service. We do not seek funding from central government. Our lifesaving service is provided wherever possible by volunteers, generously supported by voluntary donations and legacies.

Supacat launcher:
A new launch and recovery system designed to allow RNLI crews to get lifeboats in and out of the water quickly and safely.

Mersey class:
A class of 11 metre long, all-weather lifeboats operated by the RNLI all around Great Britain and Ireland.

Shannon class:
A new 13 metre long lifeboat with a top speed of 27 knots developed by the RNLI and intended to replace the Mersey class. Dungeness lifeboat station will receive the first operative boat in 2013.

Personal Protective Equipment (PPE):
Clothing designed to protect the wearer's body during a specific set of circumstances (i.e. cold water immersion).

Hydraulics:
The dynamic behaviour of fluids.

Control group:
A group in which the subjects are not exposed to the condition which is being altered in related experiments. This helps to isolate the independent variable's effect on the experiment.

Dependent variable:
The dependent variable is the variable which you measure the value of for each and every change in the independent variable.

Independent variable:
The independent variable is a variable whose values are changed or by the investigator over the course of an experiment in order to observe its effect on a dependent variable.

Scalar quantity:
Quantities that are fully described by a magnitude (or numerical value) alone.

Vector quantity:
Quantities that are fully described by both a magnitude and a direction.

Resultant velocity:
The sum of two velocity vectors.

Propulsion engineer:
A job which involves designing, testing and providing feedback on the way in which vehicles are propelled.

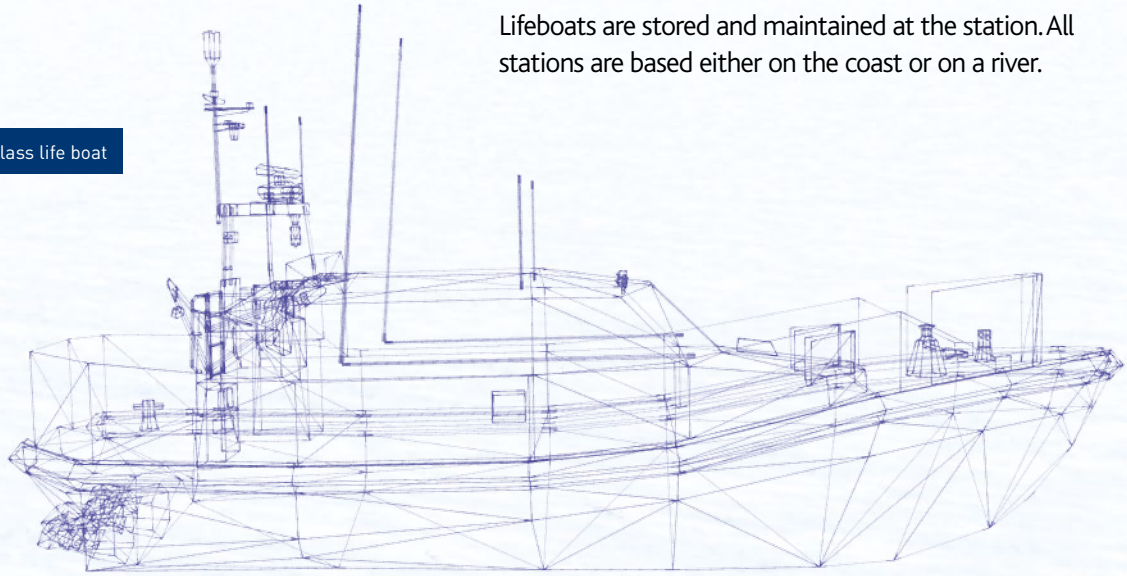
"Twenty is plenty":
A guideline issued to RNLI coxswains instructing them to drive at a top speed of 20 knots in non-emergency situations.

Hypothermia:
The condition of having a dangerously low body temperature.

Vasoconstriction:
The constriction of blood vessels.

HELP (Heat escape lessening position):
The HELP is a way to position oneself in order to reduce heat loss in cold water. It involves drawing ones knees up and crossing your arms across your chest.

Lifeboat station:
A lifeboat station is the base for an RNLI volunteer crew and their lifeboats. Crew will carry out administrative work and wait for call outs at the lifeboat station. Lifeboats are stored and maintained at the station. All stations are based either on the coast or on a river.



The new Shannon class life boat