Submarine Force Museum Lesson Plan

Lesson Name: Torpedo Energy Source Investigation **Number of minutes in the Lesson** 45 min.

Intended Audience Grade 4-9 Science Students

Content Standards: From Next Generation Science Standards:

4-PS3-1. Use evidence to construct an explanation relating the speed of an object to the energy of the object.
4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to a
MS-PS3-4. Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.
MS-PS3-5. Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.

Pre-Visit Materials/Activities: Describe the students' prior knowledge or skill related to the learning objective(s) and the content of this lesson, using data from pre-assessment as appropriate. What background knowledge or skills do you want students' to come to the museum prepared with, and what materials will you provide to groups ahead of time so they are prepared for this lesson?

Students should be familiar with the basic types of energy.

Set up Before the Lesson Begins: Describe any preparation that is necessary before the lesson.

Copies of the one-page activity sheet for each student, page 4 of this lesson plan.

Content Objective(s): Identify specific and measurable learning objectives for this lesson. Remember only one for a 45 minute class, two for a 90-minute class.

Types of energy and the transfer of energy: from the "fuel" within a torpedo to the kinetic energy of the torpedoes motion.

Language Objective(s): Distinguish between receptive skills (**listening and reading**) and productive skills (**speaking and writing**). Please **include how you would use them all where appropriate**: Listening, reading, speaking and writing.

Students will be required to listen and read the information presented in the PowerPoint presentation while writing the important information. Throughout the entire activity students will be extracting the required energy information.

Differentiation: Think about:

Students with special needs How will you differentiate this lesson for special education students?
Regular education students: Think about how you would differentiate the lesson for all students on all levels:

Differentiation is simple for this particular lesson because there a four different types of torpedoes displayed at the Submarine Force Museum; Whitehead Mark 3, Mark 14, Mark 37 and Mark 48. Each torpedo has a different number of sections (i.e. the Whitehead Mark 3 has three separate section where the Mark 48 has six separate sections). Extracting the relevant material will challenge each student to apply his or her level of understanding to a real-world problem.

Sheltered Instruction Observation Protocol (SIOP) Strategies for ELL and regular Ed Students:

Identify the S.I.O.P features that support English Learners and all learners including thorough and accurate explanations on how they will assist English Learners. Identify Sheltered Instruction strategies throughout the lesson.

- Preparation, Building Background
- Comprehensible Input, Strategies
- Interaction, Practice/Application
- Lesson Delivery
- Review/Assessment

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Initiation: Briefly describe how you will initiate the lesson. (Set expectations for learning; articulate to learners what they will be doing and learning in this lesson, how they will demonstrate learning, and why this is important)

Students will tour the Submarine Force Museum and Nautilus, including the several torpedo displays. This will gain students interests as a hook and familiarize them with torpedoes. Once in the classroom, the instructor will present the power point on torpedo history.

Lesson Development: (Add a Time for Each Segment of the Lesson)

Performance Tasks: Describe in outline how you will develop the lesson and what learning activities students will be engaged in order to gain the key knowledge and skills identified in the student learning objective(s).

Teaching and Learning Strategy: Strategies that you used during the lesson, including **modeling, guided practice and independent practice** where applicable.

PowerPoint (10-15 min): As a whole group guided by the instructor, the students will view a PowerPoint about the different torpedoes. During the demonstration the students will record information about torpedoes sources of energy, and define the general type of energy. The PowerPoint info is provided on pages 5 - 12. Copies of the PowerPoint can be obtained from the Submarine Force Museum Education Specialist.

Monitoring and Adjusting: How do you know the students have learned what you taught them and that they have achieved the objective?

Whether the student is able to extract the energy-related knowledge from the presenter, power point, handout or museum tour will vary from student to student.

Assessment: How will you ask students to demonstrate mastery of the student learning objectives? Attach a copy of any assessment materials you will use, along with assessment criteria.

Student handouts and class discussion will be used to demonstrate mastery of the student-learning objectives.

Post-Visit Materials/Activities: Provide additional materials if they would reinforce a good learning experience after leaving the museum.

Optional: students to conduct research and collect data on a torpedo not modeled at the museum.

Technology: Please explain the technology used: why you will use it, how you will use it and how you will assess the results of using this technology.

- PowerPoint presentation including projecting capabilities

Key Vocabulary: Words students need to know in order to reach the objectives.

- Torpedo vocabulary: speed, range, energy source, warhead, air flask, engine room, afterbody, tail, nose, fuel tank, extender, sonar, control, and propulsion.
- Energy vocabulary: heat, thermal, electromagnetic, chemical, mechanical, nuclear, kinetic, potential, rotational, biological.

Extension: What do you have in place in case during the lesson you finish early, run out of time or need to accommodate students who complete the class work before other students, or your technology fails?

Finish Early: Students can roam the museum.

Run out of time: Compare and contrast results with other students, have teams work together.

Technology Fails: Students can view PowerPoint or handout post-museum visit.

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Materials: List the materials you will use in each learning activity.

- PowerPoint presentation including projecting capabilities
- Copies of student handouts (page 4).

Resources: Include any resources you may use such as textbooks and any technological resources.

Dence, David. *The Mk 14 Submarine-launched Torpedo: Four Decades of Service*. Newport, RI: Naval Undersea Warfare Center Division, 1994. Print.

Jolie, E. W. *A Brief History of U.S. Navy Torpedo Development*. Newport, RI: U.S. Naval Underwater Systems Center, 1978. Print.

"Mark 37C Torpedo System Technical Description." *Mark 37C Torpedo System Technical Description*. Web. 17 July 2015. http://www.maritime.org/doc/torpedomk37/index.htm

McCandless, Bruce, Admiral. "The Howell Automobile Torpedo." *U.S. Naval Institute Proceedings* Oct. 1966: 174-76. Print.

PBS. PBS. Web. 17 July 2015. http://www.pbs.org/wgbh/nova/subsecrets/nauttorhi.html

"Submarine Force Museum Home of Historic Ship Nautilus." *Historic Ship NAUTILUS Virtual Tour*. Web. 17 July 2015. http://www.ussnautilus.org/virtualTour/torpedo.shtml

Submarine Force Library and Archives. Archives/Vertical Files/Torpedoes. Library. Groton, CT

The Whitehead Torpedo: U.S.N. 45c/m. X 3.55m. Mark I, Mark II, Mark III, and 45c/m. X 5m. Mark I. General Description. Newport, RI: Naval Torpedo Station, 1898. Print.

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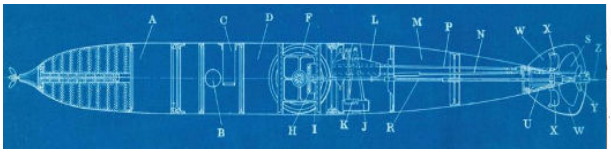
https://en.wikipedia.org/wiki/Howell_torpedo
https://en.wikipedia.org/wiki/Whitehead_torpedo
https://en.wikipedia.org/wiki/Mark_14_torpedo
https://en.wikipedia.org/wiki/Mark_37_torpedo
https://en.wikipedia.org/wiki/Mark_48_torpedo
https://en.wikipedia.org/wiki/Axial_engine
https://en.wikipedia.org/wiki/File:Howell_torpedo_fly_wheel.jpg

Submarine Force Museum Lesson Plan

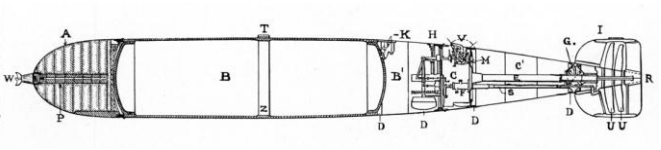
Activity: Energy Sources for Torpedo Propulsion

Using the information from the presentation used in the "Torpedo Dimension Investigation" classify the U.S Navy Torpedoes pictured below, by the type of energy used to turn the propellers to develop thrust. Write the torpedo names next to correct type of energy source.

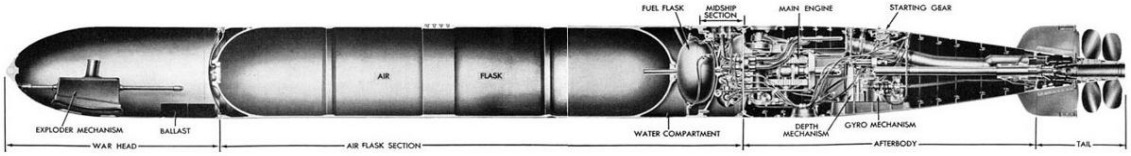
Howell:



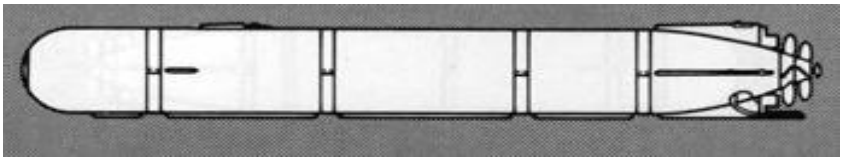
Whitehead:



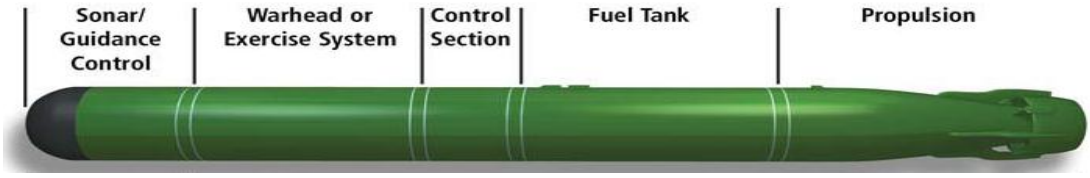
Mark 14:



Mark 37:



Mark 48/ADCAP:



General Types of Energy:

Mechanical Energy:

Electrical Energy:

Chemical Energy & Heat:

Compare the Speed and Range of the Torpedoes, relative to the type of energy used.

Which torpedo(s) source is like that of a: balloon, gyroscope, ChevyVolt, turbo-prop plane?

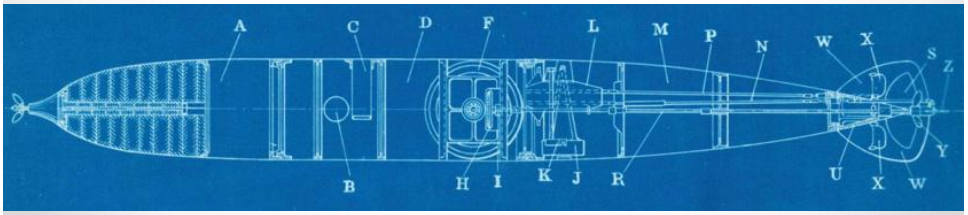
TORPEDOS

Howell - Whitehead - MK 3 - MK 14 - MK 37 - MK 48/ADCAP

The decommissioned Australian navy warship Torrens is blown up by a Mark 48 homing torpedo fired by one of the navy's new Collins class submarines HMAS Farncomb, off the coast of Western Australia 15 June 1999.

Howell Torpedo

The Howell MarK 1 was the first self-propelled torpedo produced in quantity by the United States Navy. It was conceived by Lieutenant Commander John A. Howell, United States Navy in 1870 and served from 1890 – 1899. With a length of 132 inches, diameter of 14.2 inches, and weighting 580 pound and containing 20,000 cubic inches it could travel 400 yards at 25 knots.



Howell Torpedo

The Howell Torpedo used a 60 kg (130 lb) flywheel spun at very high speed (10000 to 12000 rpm) to store energy and drive propellers. The energy to spin the flywheel came from a small external steam driven turbine to spin-up the flywheel.

Flywheel: Naval Undersea Museum, Keyport, WA

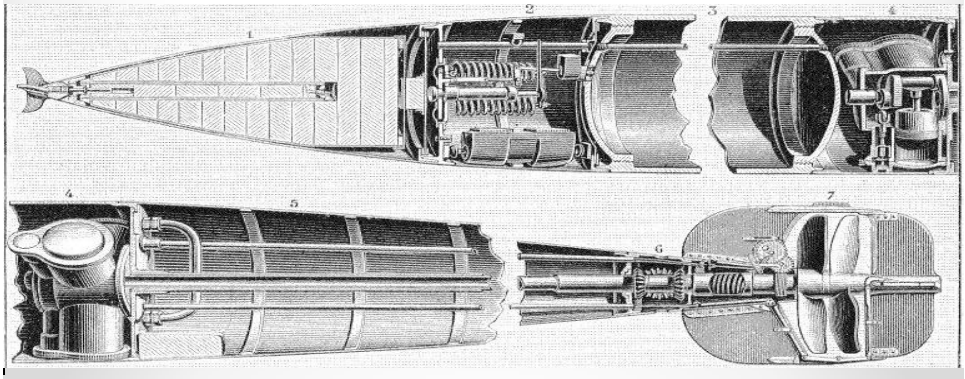
Whitehead MK 3

Robert Whitehead was an Englishman who developed a practical torpedo in 1869. Used through the first World War (1916-1918), the Whitehead was one of the earliest to use gyroscope to control the aim of the 845 pound torpedo. Serviced from 1894 to 1922.

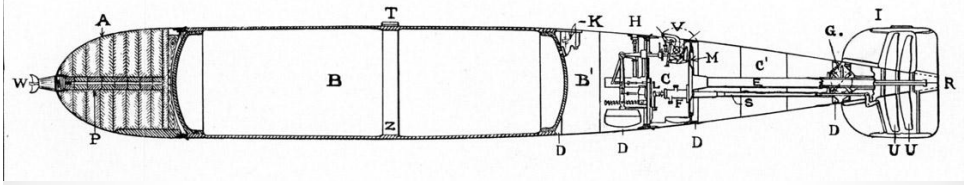
Robert Whitehead with a battered test torpedo
Rijeka (Croatia), c.1875

Whitehead MK 3

The war head contained 200 pounds of explosive which detonated upon impact with the target. The center portion of the torpedo help compressed air at 1300 per square inch (90 atmosphere). This air operated three piston engine which turned the counter–rotating propellers. The torpedo can obtain speeds up to 26.5 knots with a range of 800 yds.



Whitehead MK 3



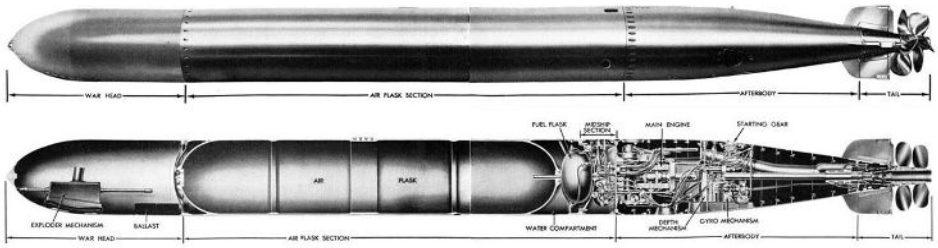
A: Warhead **B: Air Flask** **C: Engine Room**

B': immersion chamber
C': after body
D: drain holes
E: shaft tube
F: steering engine
G: bevel gear box
H: depth index
I: tail
K: charging and stop valves
L: locking gear

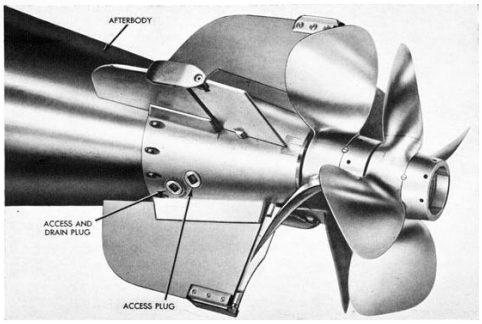
M: engine bed plate
P: primer case
R: rudder
S: steering rod tube
T: guide stud
U: propellers
V: valve group
W: war nose
Z: strengthening band

MK 14

The Mark 14 torpedo, developed in the 1930s, is a steam-driven torpedo weighing 3209 pounds. It is 20.5 feet long and 21 inches in diameter. It had a maximum range of 4.5 miles (9,000 yards) but was usually used for much shorted engagements (4,500 yards). Its maximum speed was 46 knots and a minimum speed was 31 knots. U.S. submarines used this torpedo throughout World War Two and into the 1970s. Serviced from 1931 – 1980.

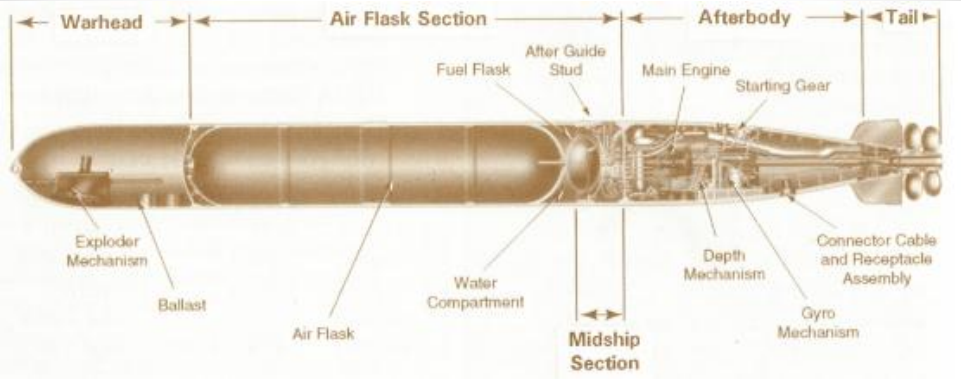


MK 14



The energy source was methanol, which combined with compressed air to burn in a Wet-heater combustion / steam turbine which rotated the propellers. The wet-heater used water to cool the combustion chamber of the methanol-air burning in the torpedo. This not only solved heating problems so more fuel could be burnt but also allowed additional power to be generated by feeding the resulting steam into the steam turbine together with the combustion products.

MK 14



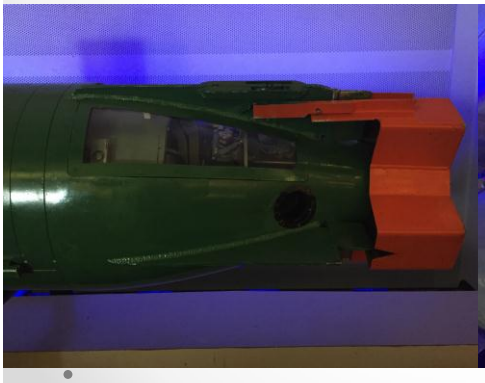
MK 37

Developed in 1946 and served from 1956 to 1972, the Mark 37 torpedo was an anti-submarine torpedo launched from U.S. submarines. It was a free running torpedo which employed active or passive homing. It is 11.5 feet long and weighs 1,690 pounds. The U.S. Submarine Force no longer uses this class of torpedo.

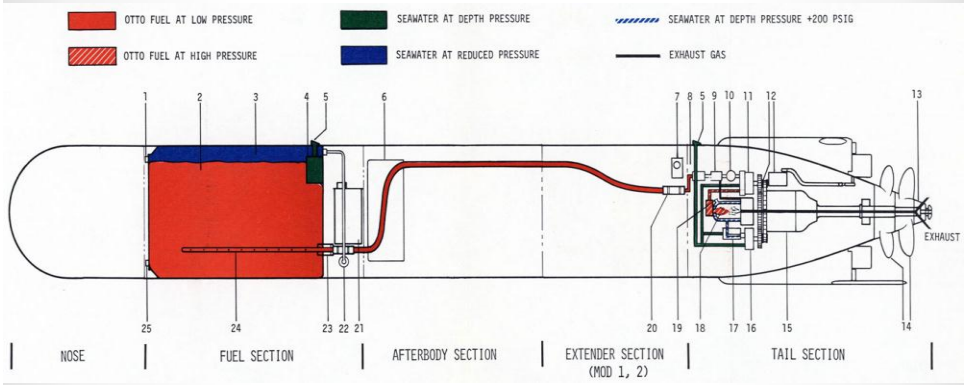
Mark 37 torpedo at the German Marine Museum Wilhelmshaven

MK 37

The energy source was stored chemical energy of a silver-zinc battery, used to make electrical power to operate a two speed electric DC motor, which turned the propellers. Giving it a maximum range of 23,000 yards at 17 knots and a minimum range of 10,000 yards at 26 knots.



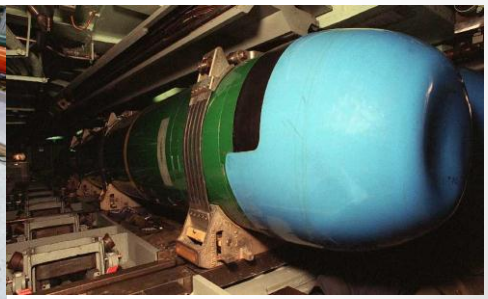
MK 37



Source: http://www.maritime.org/doc/torpedomk37/index.htm

MK 48 / ADCAP

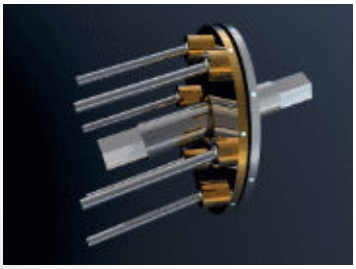
The Mark 48 torpedo is the Navy's primary submarine torpedo developed in 1965 and served from1971 to 1988. Submarines employ it against other submarines and surface ships. It is a long range, deep-diving weapon which uses wire guidance and acoustic homing. The Mark 48 is 19 feet long, 21 inches in diameter and weighs 3,480 pounds.



- Keyport Technicians working on a Mark 48 in early 1982
- Mark 48 ADCAP torpedo aboard USS Asheville (SSN-758)

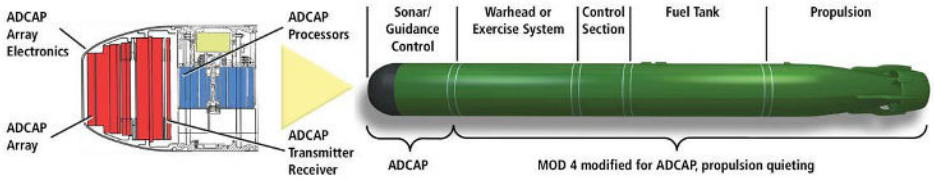
MK 48 / ADCAP

Both the Mark 48 and ADCAP use a swash-plate piston engine fueled by Otto fuel II, a monopropellant that decomposes into hot gas when ignited, which drives the piston engine to rotate the shaft. The thrust is generated in the rotating propulsor assembly at the tail of the torpedo. Giving them a maximum range of 80,000 yards at 55 knots and a minimum range of 46,000 yards at 55 knots.



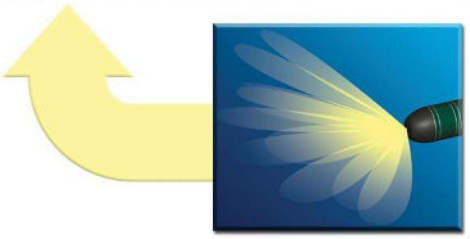
MK 48 / ADCAP

The ADCAP (Advance Capabilities) is the improved Mark 48 used today, starting in 1989. The 3,700 pound torpedo was designed to sink deep-diving nuclear-powered submariners and high-performance surface ships using sonar guidance and control.



Modern, Proven Sonar/Guidance and Control

MK 48 ADCAP Mod 6 AT Configuration



- Digital beam forming (transmit and receive)
- Mutiple steerable beams
- Multiple waveforms
- Very low self-noise (enhanced passive detection)

Resources

Dence, David. *The Mk 14 Submarine-launched Torpedo: Four Decades of Service*. Newport, RI: Naval Undersea Warfare Center Division, 1994. Print.

Jolie, E. W. *A Brief History of U.S. Navy Torpedo Development*. Newport, RI: U.S. Naval Underwater Systems Center, 1978. Print.

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https://en.wikipedia.org/wiki/Howell_torpedo
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https://en.wikipedia.org/wiki/Mark_48_torpedo
https://en.wikipedia.org/wiki/Axial_engine
https://en.wikipedia.org/wiki/File:Howell_torpedo_fly_wheel.jpg

Submarine Force Museum Lesson Plan

Torpedo Dimension Investigation (ANSWERS)

Torpedo: Howell Torpedo

Year Developed: 1870 Years in service: 1890 - 1899

Brief Description of Torpedo:

_____
_____
_____
_____
_____

Complete the following chart: Round to the nearest hundredths

	Feet	Inches
Length	11 ft	132 in
Diameter	1.18 ft	14.20 in
Radius: $r = \frac{d}{2}$	0.59 ft	7.10 in
Circumference: $c = 2\pi r$	3.71 ft	44.61 in

Weight (pounds)	580 pounds (Volume 20,000 cubic inches)
Speed (knots)	25 Knots
Range (yards)	400 Yards
Energy source	Small external steam driven turbine spun a flywheel to store energy

Torpedo Dimension Investigation (ANSWERS)

Torpedo: Whitehead MK3

Year Developed: 1869 Years in service: 1894 - 1922

Brief Description of Torpedo:

_____
_____
_____
_____
_____

Complete the following chart: Round to the nearest hundredths

	Feet	Inches
Length	11.67 ft	140 in
Diameter	1.48 ft	17.70 in
Radius: $r = \frac{d}{2}$	0.74 ft	8.85 in
Circumference: $c = 2\pi r$	4.65 ft	55.61 in

Weight (pounds)	845 lb
Speed (knots)	26.50 knots
Range (yards)	800 yards
Energy source	3-cylinder reciprocating: compressed air to operate 3 piston engines

Torpedo Dimension Investigation (ANSWERS)

Torpedo: MK 14

Year Developed: 1930's Years in service: 1931-1980

Brief Description of Torpedo:

_____
_____
_____
_____
_____

Complete the following chart: Round to the nearest hundredths

	Feet	Inches
Length	20.50 ft	246 in
Diameter	1.75 ft	21 in
Radius: $r = \frac{d}{2}$	0.88 ft	10.5 in
Circumference: $c = 2\pi r$	5.53 ft	65.97 in

Weight (pounds)	3209 lb
Speed (knots)	31 knots or 46 knots
Range (yards)	9000 yards or 4500 yards
Energy source	Turbine: Methanol combined with compressed air burned in a wet heater – steam turbine

Torpedo Dimension Investigation (ANSWERS)

Torpedo: MK 37

Year Developed: 1946 Years in service: 1956 - 1972

Brief Description of Torpedo:

_____
_____
_____
_____
_____

Complete the following chart: Round to the nearest hundredths

	Feet	Inches
Length	13.42 ft	161 in
Diameter	1.75 ft	21 in
Radius: $r = \frac{d}{2}$	0.88 ft	10.5 in
Circumference: $c = 2\pi r$	5.53 ft	65.97 in

Weight (pounds)	1690 lb
Speed (knots)	17 knots or 26 knots
Range (yards)	23000 yards or 10000 yards
Energy source	Electric motor: Silver-Zinc battery used to make electrical power

Torpedo Dimension Investigation (ANSWERS)

Torpedo: MK 48 / ADCAP

Year Developed: MK 48 : 1965
ADCAP : 1970

Years in service: MK 48 : 1971 - 1988
ADCAP : 1989 - present

Brief Description of Torpedo:

_____
_____
_____
_____

Complete the following chart: Round to the nearest hundredths

	Feet	Inches
Length	19.17 ft	230 in
Diameter	1.75 ft	21 in
Radius: $r = \frac{d}{2}$	0.88 ft	10.5 in
Circumference: $c = 2\pi r$	5.53 ft	65.97 in

Weight (pounds)	MK 48 : 3480 lb ADCAP : 3700 lb
Speed (knots)	55 knots or 40 knots
Range (yards)	46000 yards or 80000 yards
Energy source	Positive displacement piston-type acoustic: Swash-plate piston engines fueled by Otto Fuel II