

SUBMARINE

A Voyage into
Science Discovery

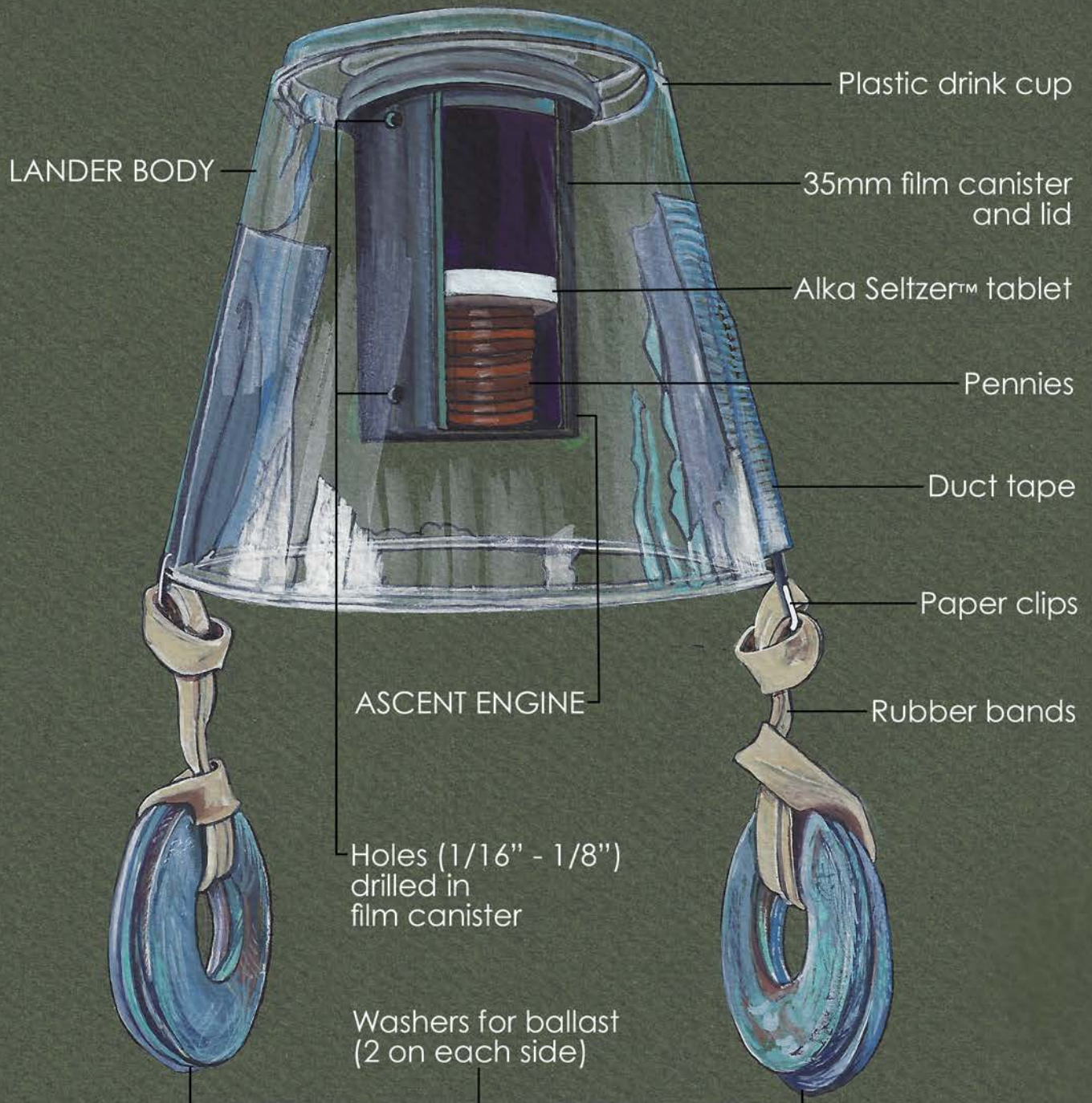
with
James Cameron
and
Kevin Hardy



SCRIPPS INSTITUTE OF
OCEANOGRAPHY

UC San Diego

SODA CUP LANDER



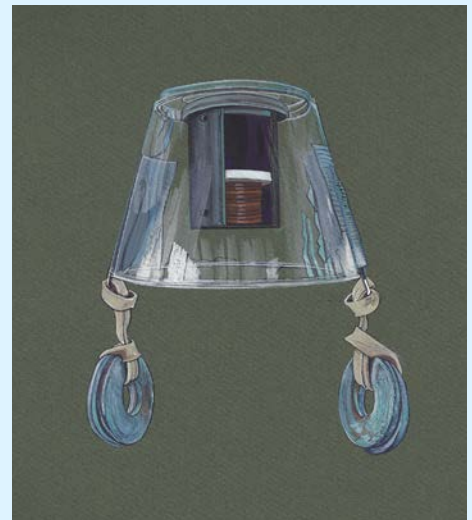
Created by Kevin Hardy, Scripps Institution of Oceanography, UC San Diego
Illustration and design by Tanya Young

SODA CUP LANDER

ASSEMBLY AND OPERATION

THIS IS HOW TO MAKE IT:

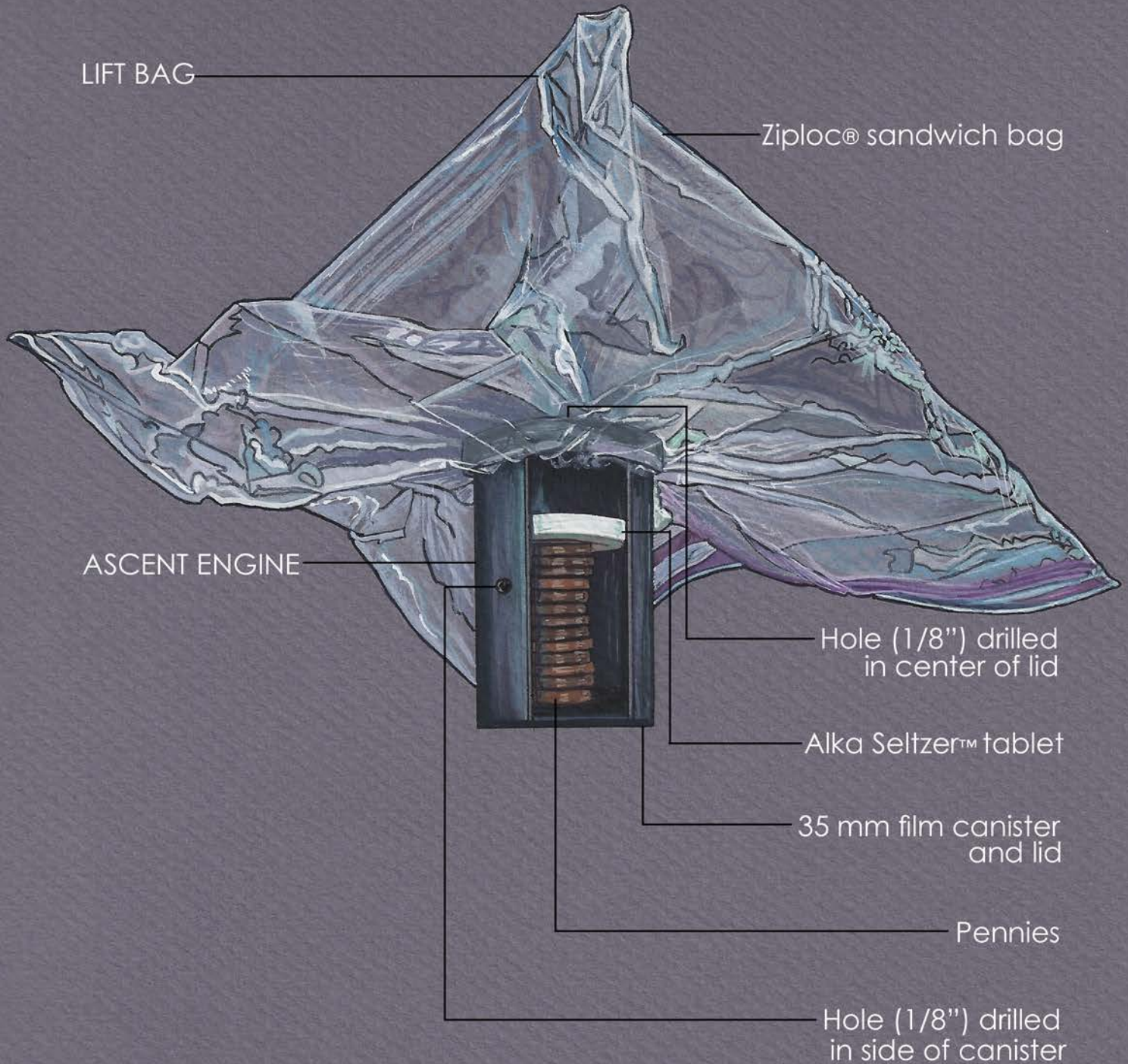
- Collect everything you need from the drawing on page 2. You will also need access to a tank or swimming pool to watch your submarine dive. Then, assemble as follows:
- Hot glue (or Velcro®) the film canister lid to the inside top of cup.
- Make two ballast weights as follows:
 - Loop rubber band through end of a paper clip.
 - Loop the other end of the rubber band through the hole of the washer.
- Attach the paper clip to the soda cup, one on each side, using the duct tape.
- Make sure the inside of the film canister is dry.
- Inside the film canister, place ten pennies.
- On top of the pennies, place one Alka Seltzer tablet.
- Snap the bottom of the film canister tightly to the lid.
- Place the assembly underwater and tip it to flood.
- Release.
- The Lander will sink to the bottom, then rise to the surface.



PRINCIPLES OF OPERATION:

- Pennies and ballast weights cause the Soda Cup Lander to sink to the bottom.
- Water will enter the film canister under pressure, slowly rising to contact Alka Seltzer. How fast it comes in (rate) is controlled by the size and number of holes in the canister.
- Tablet fizzes on contact with water to form a gas. Gas exits upper hole of canister and gets caught in top of cup, displacing the water from the cup.
- Captured gas displaces water until cup becomes buoyant and returns to the surface.

LIFT BAG LANDER



Created by Kevin Hardy, Scripps Institution of Oceanography, UC San Diego

Illustration and design by Tanya Young

LIFT BAG LANDER

ASSEMBLY AND OPERATION

THIS IS HOW TO MAKE IT:

- Collect everything you need from the drawing on page 4. You will also need access to a tank or swimming pool to watch your submarine dive. Then, assemble as follows:
- Poke a 1/4" hole in the center of one side of the Ziploc bag.
- Drill two 1/8" holes in the film canister: one in the center of the lid and the other in the side of the body.
- Make sure the inside of the film canister is dry.
- Fill the canister two-thirds full of pennies.
- On top of the pennies, place one Alka Seltzer tablet.
- Place the canister lid inside the Ziploc bag and line it up over the hole you poked in the side of the bag.
- Snap the lid tightly over the canister body.
- Zip the bag securely, then slowly squeeze all the air out of the bag. (Very important! If it is not completely closed, the air will escape and the Lander will malfunction!)
- Place underwater and release.



PRINCIPLES OF OPERATION:

- Weight of pennies will cause Lander to sink to the bottom.
- Water will enter the film canister under pressure, slowly rising to contact the Alka Seltzer tablet. (The flooding rate can be changed by the size and number of holes.)
- Tablet fizzes when water touches it, making a gas.
- Gas rises to top of canister, passing through the hole in the lid into the Ziploc bag.
- The captured gas expands the bag; it begins to float and returns to the surface.

OTHER FUN THINGS TO TRY

FOR YOUR SODA CUP LANDER:

- Hot glue a propeller to the top and cause the Lander to rotate like a gyroscope. Does it rotate in different directions or at different speeds, going up and down?
- Ballast weights could be lead tire or fishing weights, or metal nuts or bolts.
- A straw attached to the Ascent Engine pointing straight down will return a soft bottom sample to the surface. (Thanks to Harry Helling from the Ocean Institute, Dana Point, CA for this idea.)
- A clear plastic straw capped on the top and fastened to one side is a manometer to measure depth.

FOR YOUR LIFT BAG LANDER:

- For ballast, try rocks instead of pennies. Does it still sink? Why? *Hint:* The specific gravity of rocks is 2.7; iron is about 8.

TOPICS OF INTEREST:

- Chemistry (acid and base)
- Buoyancy, density and specific gravity
- Underwater archaeology (such as lifting artifacts from a sunken ship)
- Read about the DEEPSEA CHALLENGER EXPEDITION.



James Cameron, ocean frontier explorer and filmmaker (*Avatar*, *Titanic*, *The Abyss*) with Kevin Hardy. In 2012, James Cameron reached the bottom of the Mariana Trench (at 36,000 feet, the deepest place on earth) in the one-person submarine DEEPSEA CHALLENGER. Kevin Hardy, engineer and oceanographer, engineered and built the Deep Ocean Vehicle (DOV) or Lander that accompanied the CHALLENGER, collecting water, sediment cores and deep sea animals previously unknown to science.

NOTES