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THE CARPENTER WHO BEAT THE ASTRONOMERS

THE WRECK ON THE ROCKS

On an October night in 1707, four WARSHIPS of a British fleet returning from the Mediterranean ran onto the rocks of the Isles of SCILLY, the low granite islands off the southwest tip of England. The NAVIGATORS knew how far north they were. They had no dependable way to know how far east or west they had come, and hundreds of men drowned for it. Seven years later Parliament offered twenty thousand pounds to anyone who could solve the problem. The man who did was a YORKSHIRE carpenter's son who taught himself clockmaking in a Lincolnshire village.

SPELL Spell: NAVIGATORS

NAVIGATORS

SPELL Spell: WARSHIPS

WARSHIPS

KNOWN What is the name of the low granite islands off the southwest tip of England where the fleet struck the rocks?

SCILLY

KNOWN Which English county did the carpenter's son who solved the problem come from?

YORKSHIRE

OPEN The navigators knew how far north they were but not how far east or west. Which of those two would you want to be sure of first, and why?

Open response - use practitioner judgment

MATH The Earth turns 15 degrees of longitude every hour. How many degrees does it turn in 6 hours?

90

TWO COORDINATES

LATITUDE - how far north or south of the EQUATOR you are - can be read from the height of the sun at noon. The other COORDINATE cannot. Earth turns three hundred sixty degrees in twenty-four hours, fifteen degrees an hour, so a captain who knows the hour back at the Royal Observatory in GREENWICH can turn the gap between that and his own local noon into distance around the globe. He needs only a clock that survives the crossing. MOTION, TEMPERATURE, HUMIDITY, and shifts in GRAVITY all defeat one.

SPELL Spell: COORDINATE

COORDINATE

SPELL Spell: EQUATOR

EQUATOR

KNOWN What is the term for how far north or south of the equator you are?

LATITUDE

KNOWN Which place's Royal Observatory kept the hour a captain measured his own local noon against?

GREENWICH

SEMI_OPEN Name two of the shipboard conditions that defeat a clock at sea.

NEEDS 2 OF MOTION / TEMPERATURE / HUMIDITY / GRAVITY

OPEN Motion, temperature, damp and gravity all defeat a clock at sea. Which of those would worry you most?

Open response - use practitioner judgment

OAK, BRASS, AND DIAMONDS

Harrison worked in whatever material solved the problem: OAK for gear wheels that ran without a drop of oil, BRASS and STEEL for temperature, DIAMONDS for the surfaces that took the most wear. He invented the grasshopper ESCAPEMENT, a nearly frictionless release that lets the timekeeper's own swing push the gears forward, and the GRIDIRON pendulum, alternating rods of brass and steel whose unequal expansion cancels out so warmth cannot stretch the swing. His final sea watch replaced the pendulum with a fast balance corrected by a BIMETALLIC strip.

SPELL Spell: BIMETALLIC

BIMETALLIC

SPELL Spell: GRIDIRON

GRIDIRON

KNOWN What is the name of the nearly frictionless release Harrison invented, which lets the timekeeper's own swing push the gears forward?

ESCAPEMENT

SEMI_OPEN Name two of the materials Harrison used in his machines.

NEEDS 2 OF OAK / BRASS / STEEL / DIAMONDS

OPEN Harrison used oak, brass, steel and diamonds, whatever solved the problem. What unusual material would you reach for to fix something?

Open response - use practitioner judgment

MATH A classic gridiron pendulum uses 9 rods in all, and 5 of them are steel. How many rods are brass?

4

MASKELYNE'S RIVAL METHOD

The prize was controlled by the Board of Longitude, and Nevil MASKELYNE, who became ASTRONOMER Royal in 1765, sat on it while championing a rival solution. His LUNAR distance method fixed the hour by measuring the angle between the moon and a chosen star and reading the answer off printed tables - no machine to break. When Harrison's watch crossed to Jamaica in 1761 and lost about five seconds in eighty-one days at sea, the Board ordered a second trial to Barbados, then took possession of all four machines, then required duplicates.

SPELL Spell: MASKELYNE

MASKELYNE

SPELL Spell: ASTRONOMER

ASTRONOMER

KNOWN What is the one-word name of Maskelyne's method, which fixed the hour by measuring the angle between the moon and a chosen star?

LUNAR

OPEN The Board took all four of his machines. What would you have done next in his place?

Open response - use practitioner judgment

MATH The Nautical Almanac listed the moon's distance from a chosen star for every 3 hours. How many of those entries covered one full 24-hour day?

8

THE PRIZE AND THE ORBIT

By 1772 Harrison was nearly eighty and had gone over the Board's head, petitioning King George the Third, who had tested one of his TIMEKEEPERS at his own observatory. Parliament voted him eight thousand seven hundred fifty pounds the following year - most of what he was promised, though the prize itself was never awarded to anyone. You use his answer constantly without noticing: satellite NAVIGATION fixes your position by comparing time signals from atomic CLOCKS in orbit, still turning a difference between clocks into a distance.

SPELL Spell: NAVIGATION

NAVIGATION

SPELL Spell: TIMEKEEPERS

TIMEKEEPERS

KNOWN Satellites keep time by counting the steady vibrations of atoms. What are those instruments called?

CLOCKS

OPEN He kept going for forty years and was paid at nearly eighty. What would have kept you going that long?

Open response - use practitioner judgment