ANSWER KEY: External Tank

Directions:

Answer these questions based on today's reading and discussion about the External Tank.

1. Height (meters):
47 meters

2. Weight (empty):
66,000 pounds

3. Weight (full):
1,655,600 pounds

4. Diameter (meters):
8.4 meters

5. What fuel does it hold?
Hydrogen

6. What oxidizer does it hold?
Oxygen

7. How long is it attached to the obiter after launch?
Approximately 8.5 minutes

8. When does fuel begin to be used by the SSMEs?
T minus 6 seconds

9. In inches, how large in diameter is the tube that transports oxygen to the SSMEs?
17 inches

10. How many gallons can the oxygen tank hold?
143,351 gallons

11. What is the weight of a full oxygen tank in pounds?
1,361,936 pounds

12. What is one function of the intertank?
It houses ET instrumentation; contains umbilical plate, which detects hazardous gas; releases excess gas supplies; helium

13. How many gallons can flow from the hydrogen tank per a minute at maximum flow?
47,365 gallons/minute

14. What is the weight of a full liquid hydrogen tank?
226,237 pounds

15. The liquid oxygen tank operates in a pressure range of **20** to **22** psig.

16. Why does the liquid oxygen tank weigh so much more than the liquid hydrogen tank when the hydrogen tank has a much greater volume?
The atomic mass of O_2 is much greater than H_2

17. What does Monocoque mean?
Structural load is supported using an object's external skin; the skin supports the structure

18. The liquid oxygen tank is a(n)
a. aluminum semimonocoque
b. steel and aluminum semimonocoque
c. aluminum monocoque

19. The Intertank is a(n)
a. aluminum semimonocoque
b. steel and aluminum semimonocoque
c. aluminum monocoque

20. The liquid hydrogen is a(n)
a. aluminum semimonocoque
b. steel and aluminum semimonocoque
c. aluminum monocoque

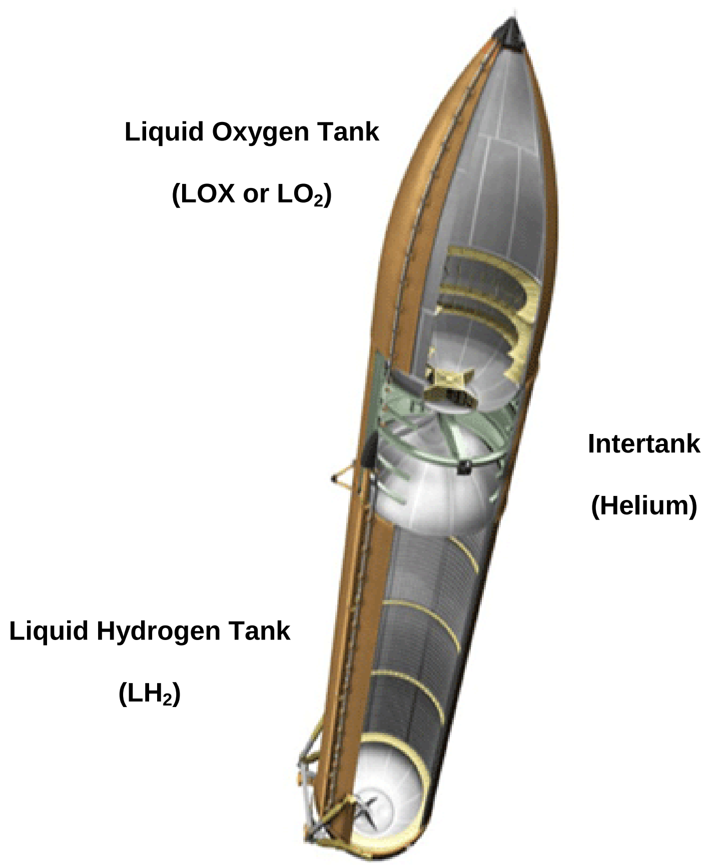
21. The liquid hydrogen tank operates in a pressure range of **32** to **34** psig.

22. When sitting on the launch pad, the oxygen's tank pressure must be regulated, because temperature changes can cause the liquid oxygen to revert to **gas**. Pressure is vented from the **beanie cap**.

Directions:

Label the parts of the External Tank (ET). Each of the terms below should fit on a line next to the ET.

Intertank | Liquid Oxygen Tank | Liquid Hydrogen | (LOX or LO_2) | (Helium) | (LH_2)



Directions:

As liquid oxygen is stored in the Shuttle's External Tank, it "boils off" by slowly transforming from a liquid into a gas. When it does this, pressure inside the tank increases since oxygen as a gas occupies more volume than liquid oxygen. To prevent rupturing of the tank from built-up pressure, there is a relief vent to release gaseous oxygen. There also is a button on the External Tank console that will turn the relief vent on and off. When the vent is releasing pressure, this button will display, "GOX RELF ON." When the vent is closed, the button will display, "GOX RELF OFF." Observe how the pressure changes when the button is pressed to release pressure.

1. Observe a one-minute sample reading and determine the rate (psi/sec) pressure changes. (For your timed samples, use the Elapsed Time clock in the Console.)
By taking 1-minute samples, LOX psi changed from 455 to 378 (77 psi/min, 1.28 psi/sec) for one sample and from 455 to 365 (90 psi/minute 1.5 psi/sec) for another sample. The system is designed to produce an average of 1.5 psi/sec, but since there is randomization built into the simulation, rates will vary.

2. Can you predict how much pressure will change after 1 minute? After 5 minutes?
For the above samples, the 1-minute average is 1.39 psi/sec, yielding a 1-minute change of 83.4 psi. Using the 1-minute change, we multiply and get 417 for the 5-minute change.

3. LO2 Level is the amount of liquid oxygen in the tank, and LO2 Flow is the rate liquid oxygen is flowing from the tank to the Shuttle's propulsion system. Observe the values for LO2 Level and LO2 Flow and estimate how long it will take for the tank to be depleted of liquid oxygen.
By dividing lbs by lbs/sec, we have total seconds. Dividing again by 60 gives us minutes. E.g., if LO2 Level is 1,359,137 lbs and LO2 Flow is 2,452 lb/sec,

$$1{,}359{,}137\,lbs \cdot \frac{1\sec}{2{,}452\,lbs} \cdot \frac{1\min}{60\sec} = 9.24\min$$

4. Can you also estimate how long it will take for the liquid hydrogen to be completely depleted?
If LH2 Level is 226,236 lbs and LH2 Flow is 414 lb/sec,

$$222{,}236\,lbs \cdot \frac{1\sec}{414\,lbs} \cdot \frac{1\min}{60\sec} = 8.94$$

5. In the ET Console, there are Depletion Sensors for both LO2 and LH2. These are important because the engines will need to shutdown before fuel and oxidizer are completely depleted. At what level of LO2 and LH2 should the depletion sensors turn on if the engines need 2 minutes to shut down?
For LO2,

$$\frac{2{,}452\,lbs}{1\sec} \cdot \frac{60\sec}{1\min} \cdot 2\min = 294{,}220\,lbs$$

For LH2,

$$\frac{414\,lbs}{1\sec} \cdot \frac{60\sec}{1\min} \cdot 2\min = 49{,}680\,lbs$$