

Reusable hydrometer for human specific gravity measurements

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Team Members: Jack Goss, Matthew Walker, Xiyu (Steve) Wang, Yue Yin

Function: Hydrometer is a tool to measure the specific gravity, or the relative density of a solution compared to the density of water. In our case, the hydrometer will be used to measure the specific gravity of patients' urine samples. Our client, Dr. Jhagroo, recently found that spot testing of urine specific gravity could be used to predict the urine output in the last 24 hours. In short, our client requires a hydrometer to accurately measure the specific gravity of urine samples.

Client requirements:

- Must be able to measure the specific gravity of urine
- Must be reusable and can be cleaned easily
- Portable to a degree (can fit in a suitcase or luggage)

Design requirements:

1. Physical and Operational Characteristics

- Performance requirements
 - Be able to operated by one person
 - The device will be used multiple times in a 24 hour period
 - The device will consist of a container that measures the quantity of urine and a hydrometer to measure urine specific gravity
 - Will not Require electrical power supply
- Safety
 - No sharp edges on the outer surface of container
 - The device must be washed thoroughly to prevent crystallization
- Accuracy and Reliability
 - Accurately measure the specific gravity to 0.001
 - Measures specific gravity from 1.000 to 1.032
 - Device must still measure accurately after multiple uses

- Life in Service
 - Given thorough cleaning by the patients, the device will last 5 year
- Shelf Life
 - 10 years in dry environment
- Operating Environment
 - Temperature range of 20 to 30 °C
 - Normal atmospheric pressure
 - Humidity can be varied
 - Preferably no dirt or dust
 - Chamber watertight
 - Sterilizable
 - All elements non-corroding
 - No vibrations
- Ergonomics
 - Easy to clean and sterilize
 - Compact
 - Allow for easy transport between locations
 - No restrictions on the height or weight of user
- Size
 - The device should be no bigger than 25 cm by 15 cm by 5 cm
 - The device must be able to be easily transported in a suitcase or luggage
- Weight
 - The device should weigh no more than 2 kg
 - The optimum weight for the device is 1 kg
- Materials
 - The device must be made in plastic
 - Any material used on the inside of the hydrometer needs to be:
 - Sterilizable
 - Inert/nonreactive with urine
 - Resist corrosion
- Aesthetics, Appearance, and Finish
 - The device will have a smooth finish
 - The device will be clear so that the measurements can be read easily

2. Production Characteristics

- Quantity
 - Only one hydrometer is desired and will be made following these specifications
- Production Costs
 - Not applicable at this time

3. Miscellaneous

- Standards and Specifications
 - Disk of commercially-available hydrometer is NIST calibrated to a specific density and mass
 - The plastic needle of hydrometer is calibrated according to ASTM standard E-126
- Customer
 - The customer would like the hydrometer to be small, simple, and accurate
- Patient-related Concerns
 - The hydrometer must be sterilized between each use
 - The device must be inspected before each use for any crystallization or contamination that may affect the data
- Competition
 - There are other medical devices that measure the specific gravity of urine; however, they are expensive and not portable
 - Other simpler forms of hydrometers are used to measure the specific gravity of aquariums

	Clinical Research Density Purity Instrument	Fish Tank Hydrometer	Digital Hydrometer
Price (30%)	3	5	2
Accuracy (25%)	5	4	5
Portability (20%)	2	4	4
Durability (15%)	5	4	5
Safety (10%)	4	4	4
Total Score (out of 100)	74	86	76