## TEST QUESTIONS - CHAPTER #1

**Short Answer Questions**

1. Define specific heat.

*Ans. The amount of energy required to raise the temperature of a substance by 1oC.*

1. Define cavitation.

*Ans. Cavitation is rapid water vaporization that occurs in closed systems (e.g., pipelines or pumps) in regions where the pressure drops below the vapor pressure.*

1. The amount of energy required to change water from one phase to another is called
2. heat of fusion b) heat of vaporization c) specific heat d) latent energy

*Ans. (d)*

1. (T or F) To change water from one phase to another requires a change in heat or pressure.

*Ans. True*

1. Two locations in closed hydraulic systems where cavitation is likely are (pressure tanks, pipelines, nozzles, pumps, hydraulic jacks).

*Ans. Pipelines and pumps*

1. What would be the ramification to our planet if a) water did not have a high heat capacity? b) water did not have a high dissolving capacity? c)water did not have a unique temperature-density relationship? (Give one answer to each question.)

*Ans. a) Temperature differences between locations on the planet would be much greater. b) Nutrients would not be easily absorbed by plants and animals. c) Lakes that froze completely from the bottom up would kill most life forms each winter.*

1. What is the difference between density and specific weight?

*Ans. Density is mass per unit volume and specific weight is weight per unit volume.*

1. Define specific gravity of a liquid.

*Ans. Specific gravity is the ratio of the specific weight of any liquid to that of water at 4˚C.*

1. (T or F) Water, like most substances, becomes denser as its temperature decreases.

*Ans. False – water becomes less dense at temperatures lower than 4˚C and expands even more when it freezes.*

1. (T or F) The density of ice is the same as that of liquid water at the same temperature.

*Ans. False*

1. Derive the relationship between specific weight and density using Newton’s 2nd Law (F=ma)

*Ans. F = m∙a Letting a = g results in Equation 1.1:*

*W = m∙g, and dividing both sides of the equation by volume yields* ***γ = ρ∙g***

1. All of the following are true except:
2. The density of water is greatest at *4˚C.*
3. Specific weight can be found by multiplying density and gravitational acceleration.
4. The densities of objects on the moon are the same as they are on earth.
5. The specific weights of objects on the moon are the same as they are on earth.

*Ans. (d) is not true*

1. Dividing the specific weight by the mass density of a liquid yields
2. the specific gravity of the liquid.
3. the weight of the liquid.
4. the gravitational acceleration
5. none of the above.

*Ans. (c) is true*

1. Define absolute viscosity.

*Ans. Absolute viscosity is the proportionality constant relating shearing stress to the rate of angular deformation (dθ/dt) in Newtonian fluids.*

1. (T or F) Newtonian fluids were consumed in great quantities by Sir Isaac Newtonian.

*Ans. False*

1. Kinematic viscosity
2. is the proportionality constant relating shearing stress to the rate of angular deformation.
3. is expressed in units of stress times the time interval (N∙sec/m2).
4. is found by dividing the absolute viscosity by the mass density at the same temperature.
5. is not related to the density of a fluid.

*Ans. c*

1. Shear stresses in water are related to all of the following except:
2. The surface tension of the water.
3. The velocity difference between adjacent layers.
4. The distance between adjacent layers.
5. The temperature of the water.

*Ans. (a) is not true*

1. Define surface tension.

*Ans. Surface tension is the property of a fluid that causes it to seek a minimum possible surface area. It occurs because fluid molecules seek to bond with other fluid particles, but at the surface are not able to bond in all directions and therefore form stronger bonds with adjacent liquid molecules.*

1. (T or F) Determination of the capillary rise in a small tube is based on a force balance.

*Ans. True*

1. Give two examples of surface tension at work (i.e., evidence of surface tension).

*Ans. A steel needle floating on water, the spherical shape of dewdrops, and the rise or fall of liquid in capillary tubes are the results of surface tension.*

1. Capillary rise of water in a small tube is dependent on all of the following except:
2. the elasticity of water.
3. the nature of the solid surface.
4. the temperature of the water.
5. the diameter of the tube.
6. the angle of contact between the water and the tube.

*Ans. a*

1. Define bulk modulus of elasticity.

*Ans. The bulk modulus of elasticity is the inverse of the compressibility of a fluid. Expressed mathematically, it is the ratio of the pressure change that is exerted on a liquid to the ratio of the change in volume over the original volume.*

1. (T or F) Water is less compressible than steel, hence it is commonly assumed to be incompressible.

*Ans. False*

1. The bulk modulus of elasticity is not dependent upon:

a) initial pressure b) initial volume c) pressure change d) volume change

*Ans. a*

**Problems**

1. How much energy must be added to ice at -20˚C to produce 250 liters of water at +20˚C?

*Ans.* E1 = energy req’d to bring ice temp. to 0°C = (250 L)(1000 g/L)(20°C)(0.465 cal/g∙°C)

E1 = 2.33x106 cal. E2 = energy required to melt ice = (250 L)(1000 g/L)(79.7 cal/g∙°C)

E2 = 1.99x107 cal. E3 = energy required to raise the water temperature to 20°C

E3 = (250 L)(1000 g/L)(20°C)(1 cal/g∙°C) = 5.00x106 cal

**Etotal** = E1 + E2 + E3 = **2.72x107 cal**

1. At 0˚C and an absolute pressure of 611 N/m2, 100 g of water, 100 g of water vapor, and 100 g of ice are in equilibrium in a sealed thermal container. Determine how much energy should be removed to freeze all the water and vapor.

*Ans.* E1 = energy required to change water to ice = (100 g)(79.7 cal/g) = 7.97x103 cal

E2 = energy required to change vapor to ice

E2 = (100 g)(597 cal/g) + (100 g)(79.7 cal/g) = 6.77x104 cal

Total energy removed to freeze water and vapor.

**Etotal = E1 + E2 = 7.57x104 cal**

1. A container weighs 863 N when filled with water and 49 N when empty. How much water (at 20˚C) does the container hold in cubic meters?

*Ans.* The weight of water in the container is 863 N – 49 N = 814 N.

m = W/g = (814 N)/(9.81 m/sec2) = 83.0 kg.

At 20˚C, = 1 m3 of water = 998 kg (Table 1.2) Therefore, the volume is:

**Vol** = (83.0 kg)(1 m3/998 kg) **= 8.32 x 10-2 m3**

1. Determine the weight and specific gravity of a gallon of liquid if it has a mass of 0.258 slugs.

*Ans.* **W** = mg = (0.258 slug)(32.2 ft/s2) **= 8.31 lb.** Note: a slug has units of (lb∙sec2)/(ft)

By definition, S.G. = γliquid/γwater at 4°C and γ = weight/volume

Volume of 1 gal = 0.134 ft3. γ = (8.31 lb)/(0.134 ft3) = 62.0 lb/ft3

**S.G.** = (62.0 lb/ft3)/(62.4 lb/ft3) **=** **0.994**

1. Determine the force required to drag a small, flat-bottom boat (3 m by 1 m) in a shallow canal (8 cm deep) in order to maintain a velocity of 1.5 m/sec. Assume the canal water (20˚C) is not moving and is behaving in a Newtonian fashion.

*Ans.* Assuming a Newtonian relationship: τ = μ(dv/dy) = μ(Δv/Δy)

τ = (1.00x10-3 N⋅sec/m2)[(1.5 m/sec)/(0.08 m)] = (1.88x10-2 N/m2)

**F** = τ∙A = (1.88x10-2 N/m2)(3 m)(1 m) **= 5.64 x 10-2 N**

1. A piston slides downward with a constant velocity through a vertical pipe. The piston is 5.5 inches in diameter and 9.50 inches in length. An oil film between the piston and pipe wall resists the downward motion. If the film thickness is 0.002 in. and the cylinder weighs 0.5 pounds, estimate the velocity. (Assume the oil viscosity is 0.016 lb∙sec/ft2.)

*Ans*. ∑Fy = 0 (constant velocity motion); W = Tshear force = τ⋅A; where A is the surface area

of the cylinder in contact with the oil film: A = (π)[(5.5/12)ft][(9.5/12)ft] = 1.14 ft2

Now, τ = W/A = (0.5 lb)/(1.14 ft2) = 0.439 lb/ft2; τ = μ(dv/dy) = μ(Δv/Δy), where

Δv = v (the velocity of the cylinder). Thus, v = (τ)(Δy)/μ

**v** = [(0.439 lb/ft2){(0.002/12)ft}] / (0.016 lb∙s/ft2) **= 4.57 x 10-3 ft/sec**

1. A capillary rise test is used to determine the surface tension of a liquid. The liquid is observed to rise to a height of 1.5 cm in a 0.5-mm-diameter glass tube with a contacting angle of 60˚. Determine the surface tension of the liquid in N/m if its density is 980 kg/m3.

*Ans*. By rearranging Equation 1.3 yields: σ = [(h)(γ)(D)] / [(4)(sinθ)],

where γ = ρg = (980 kg/m3)(9.81 m/sec2) = 9,610 N/m3

**σ** = [(0.015m)(9,610 N/m3)(0.0005m]/[(4)(sin 60°)] **= 2.08 x 10-2 N/m**

1. A steel tank holds 120 ft3 of water at atmospheric pressure (14.7 lbs/in.2 and 68.4˚F). The water is subjected to a 100-fold increase in pressure. Determine the initial weight and final density of the water if the volume decreases by 0.545 ft3.

*Ans*. ρi = 1.94 slugs/ft3 (based on temp. & pressure from the inside jacket of the book).

mi = ρi∙Voli = (1.94 slug/ft3)(120 ft3) = 233 slugs = mf **Note**: Mass does not change.

**W** = mg = (233 slugs)(32.2 ft/sec2) = **7,500 lb**

ρf = ρi/[1+(ΔVol/Vol)]; 🡺Based on Example 1.3

**ρf** = 1.94 slug/ft3/[1+(-0.545/120)] = **1.95 slug/ft3**

Altenatively, **ρf** = mf/Volf = 233slugs/(120 – 0.545)ft3 **= 1.95 slug/ft3**