BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE AND ENGINEERING

AEH 201

Department Of Engineering and Physics
Bachelor of Science (Honours) in Agricultural Engineering
Hydraulics and Fluid Mechanics

3 HOURS (100 MARKS)

INSTRUCTIONS

Answer any **FOUR** questions. Each question carries 25 marks.

Question 1

a. Briefly explain the following terms:
   - i.   Specific volume.   [2 marks]
   - ii. Fluid.   [2 marks]
   - iii. Viscosity.   [2 marks]
   - iv. Stress.   [2 marks]
   - v.   Steady flow.   [2 marks]
   - vi. Open channel.   [2 marks]
   - vii. Laminar flow.   [2 marks]

b. A U-tube manometer is used to measure the pressure of a fluid of density 800 kg/m3. If the density of the manometric liquid is 13.6×103 kg/m^3, Determine the gauge pressure in the pipe if
   - i. $h1 = 0.5$ m and D is 0.9 m above BC.   [6 marks]
   - ii. $h1 = 0.1$ m and D is 0.2 m below BC.   [5 marks]

Question 2

a. Discuss the Pascal's law   [5 marks]

b. Six objects (A-F) are in a liquid, as shown. None of them are moving. Arrange them in order of density, from lowest to highest.   [6 marks]
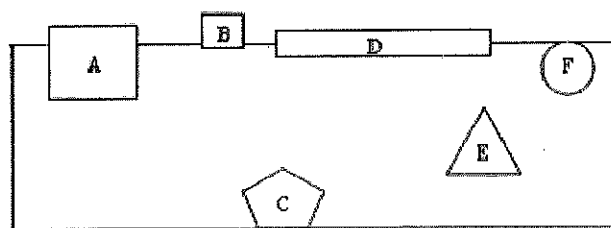

c. Water ice has a density of 0.91 g/cm^3, so it will float in liquid water. Imagine you have a cube of ice, 10 cm on a side.
   - i.   Determine is the cube's weight.   [5 marks]
   - ii. Compute the volume of liquid water must be displaced in order to support the floating cube.   [5 marks]
   - iii. Determine how much of the cube is under the surface of the water?   [4 marks]

Question 3

a. For the siphon shown, determine the discharge and pressure heads at A and B given that the pipe diameter is 200 mm and the nozzle diameter is 150 mm. Neglect friction in the pipe. **[10 marks]**
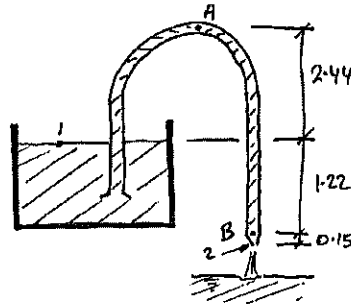
b. A sewerage pipe is to be laid at a gradient of 1 in 300. The design maximum discharge is 75 l/s and the design minimum flow is 10 l/s. Determine the required pipe diameter to carry the maximum discharge and maintain a self-cleansing velocity of 0.75 m/s at the minimum discharge. **[10 marks]**

c. At high altitude, explain why a car engine generates less power. **[5 marks]**

Question 4

a. Oil flows through a 25 mm diameter pipe with mean velocity of 0.3 m/s. Given that the viscosity $\mu = 4.8 \times 10^{-2}$ kg/ms and the density $\rho = 800$ kg/m3 , calculate:

   i. The friction head loss and resultant pressure drop in a 45 m length of pipe.

   [10 marks]

   ii. The maximum velocity. **[5 marks]**

   iii. The velocity 5 mm from the pipe wall. **[5 marks]**

b. Explain the law of conservation of matter **[5 marks]**

Question 5

a. A 50 mm inlet/25 mm throat Venturi meter with a coefficient of discharge of 0.98 is to be replaced by an orifice meter having a coefficient of discharge of 0.6. If both meters are to give the same differential mercury manometer reading for a discharge of 10 l/s, determine the diameter of the orifice. **[10 marks]**

b. A solid block is attached to a spring scale. When the block is suspended in air the scale reads 20.0 N; when it is completely immersed in water the scale reads 17.7 N. Determine the

   i. Volume of the block. **[5 marks]**

   ii. Density of the block. **[5 marks]**

c. Suppose that the radius of high-heeled shoes is 6.00 × 10-3 m. At times during a normal walking motion, nearly the entire body weight acts perpendicular to the surface of the heel. Find the pressure that is applied to the floor under the heel because of the weight of a 50.0 kg woman. **[5 marks]**

Question 6

a. A Venturi meter is introduced in a 300 mm diameter horizontal pipeline carrying water under a pressure of 150 kN/m2. The throat diameter of the meter is 100 mm and the pressure at the throat is 400 mm of mercury below atmosphere. If 3% of the differential pressure is lost between the inlet and outlet throat, determine the flow rate in the pipe.

[15 marks]

b. 50 mm inlet/25 mm throat Venturi meter with a coefficient of discharge of 0.98 is to be replaced by an orifice meter having a coefficient of discharge of 0.6. If both meters are to give the same differential mercury manometer reading for a discharge of 10 l/s. Determine the diameter of the orifice.

[10 marks]

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