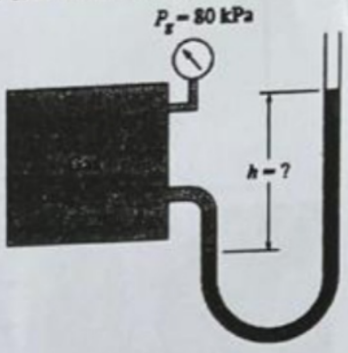
Q1 (20 marks): Choose the *most correct* answer. For computations, show the detailed solution for each question to guarantee the grade.

1) **Both a gage and a manometer are attached to a gas tank to measure its pressure as shown in the figure. If the reading on the pressure gage is 80 kPa, and the manometer fluid has a density of 980 kg/m³. The distance, h, between the two fluid levels of the manometer is:**



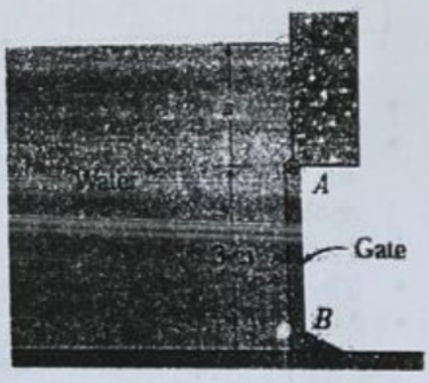
A. 6.52 m
B. 9.71 m
C. 10.73 m
D. 8.32 m
E. None of the above

2) **The barometer reading is 600 mm mercury, if the mercury density is 13,600 kg/m³ and g = 9.81 m/s². The atmospheric pressure at that location is:**

$P = \rho g h$

A. 80.05 kPa
B. 93.39 kPa
C. 102.73 kPa
D. 73.38 kPa
E. None of the above

[3-4]: A 3-m-high, 6-m-wide rectangular gate is hinged at the top edge at *A* and is restrained by a fixed ridge at B. Assume the density of the water is 1000 kg/m³. If s = 1 m, Answer Problems :



3) The hydrostatic pressure force on the gate is:
A. 618 kN
B. 706 kN
C. 441 kN
D. 530 kN
E. None of the above

4) **The center of pressure measured from the free surface of the water along the plane of the gate is:**
A. 3.71 m
B. 4.19 m
C. 3.25 m
D. 2.80 m
E. None of the above

[5-8] Water is pumped using a pump at a rate of 25 m³/s from the reservoir and out through the steel pipe, which has a diameter of 1.5 m as shown in the Figure. Assume $\alpha = 1$ for all calculations in this problem. Answer Problems (5-8):

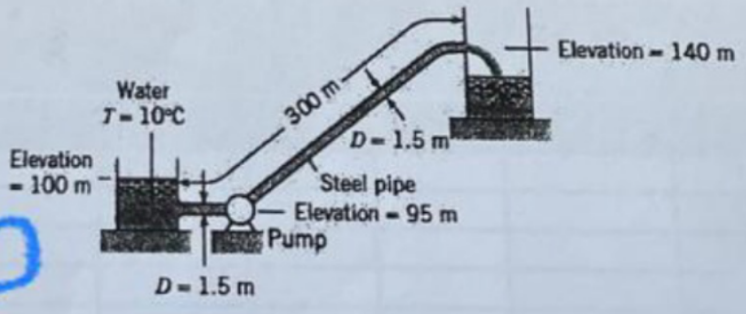
Note the following:

Water: $\mu = 1.31 \times 10^{-3}\ kg/m.s$, $\rho = 1000\ kg/m^3$ and $\gamma = 9810\ N/m^3$

Steel: roughness ($\varepsilon = 0.046$ mm)

K_L for inlet (well-rounded) = 0.03

K_L for exit (sharp-edged) = 1.0



5) Reynolds number in the pipe is:
A. 5.09×10^7
B. 1.62×10^7
C. 5.09×10^4
D. 2.31×10^4
E. None of the above

6) The friction factor is:
A. 0.004
B. 0.002

C. 0.12
D. 0.01
E. None of the above

7) The total head losses in the pipe system is:
A. 30.92 m
B. 20.72 m
C. 10.51 m
D. 41.13 m
E. None of the above

8) The pump head is:
A. 40.14 m
B. 70.05 m
C. 81.13 m
D. 60.21 m
E. None of the above

[9-10] A 0.6 cm diameter mild steel cylindrical rod at 100°C is suddenly immersed in a liquid at 20°C with convection heat transfer coefficient $h = 400$ W/m^2. K. The mild steel rod has $k = 43$ W/m. K, $c_p = 473$ J/kg. K and $\rho = 7801$ kg/m^3. Answer problems (16-17):

9) The time required for the rod to cool to 80°C is:
A. 4 s
B. 2 s
C. 1 s
D. 3 s
E. None of the above

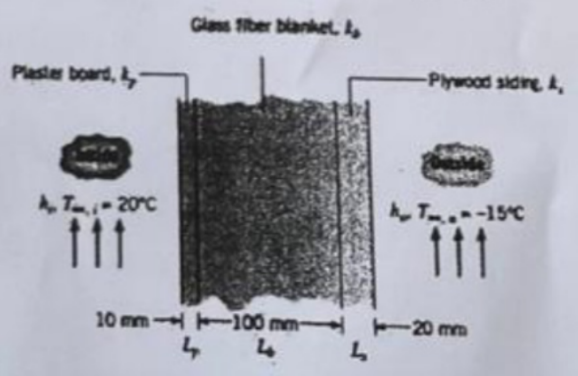
10) If the length of the rod is 50 cm, the heat transfer rate from the rod to the liquid when the rod temperature cooled to 80°C is:
A. 0.68 W
B. 75.4 W
C. 226.2 W
D. 301.6 W
E. None of the above

Q2 (10 marks): A house has a composite wall of wood, fiberglass insulation, and plaster board, as shown in the sketch. On a cold winter day, the convection heat transfer coefficients are h_o = 60 W/m^2. K and h_i = 30 W/m^2. K. The total wall surface area is 350 m^2. Knowing that the thermal conductivities are k_p = 0.17 W/m.K, k_b = 0.038 W/m.K and k_z = 0.12 W/m.K. Answer :

a) The total thermal resistance between the inside Air and the outside Air is:

b) The heat rate loss through the wall is:

c) The inside wall temperature is:



Q3 (10marks) Water flows from a large reservoir to a smaller one through a 5cm diameter cast iron piping system, as shown below. Determine the following for a flow rate of 6 L/s. known that, the flow is steady and incompressible, the elevations of the reservoirs remain constant, there are no pumps or turbines in the line and the properties are the density the dynamic viscosity with values $\rho = 999.7\ \mathrm{kg/m^3}$ and $\mu = 1.307 \times 10^{-3}\ \mathrm{kg/m \cdot s}$.