Answer Key
Testname: TEST2

1) E
2) D
3) C
4) B
5) E
6) E
7) A
8) C
9) B
10) B
11) B
12) A
13) 2.4 cm
14) (a) The tube with the greater diameter has the higher pressure. (b) The tube with the smaller diameter has the higher speed of flow. (c) 1.8 m/s
13. **Picture the Problem**: The figure shows an object in front of a concave lens with focal length $-36$ cm. The magnification of the image is $m = \frac{1}{3}$. The object is to be moved so that the magnification becomes $m = \frac{1}{4}$.

**Strategy**: Solve equation 26-16 for the image distance and insert it into equation 26-18 to write an equation for the object distance as a function of magnification. Insert the two magnifications (1/3 and 1/4) to determine the distances and calculate the difference.

**Solution**: 1. (a) Solve equation 26-16 for the image distance:

$$d_i = \left(\frac{1}{f} - \frac{1}{d_o}\right)^{-1} = \frac{f d_o}{d_o - f}$$

2. Eliminate $d_i$ from the magnification equation:

$$m = -\frac{d_i}{d_o} = -\frac{1}{d_o} \left(\frac{f d_o}{d_o - f}\right) = \frac{f}{f - d_o}$$

3. Explain how the object must be moved to decrease the magnification:

Since $f$ is negative, increasing $d_o$ will decrease the magnification. The object should be moved farther away from the lens.

4. Solve for the object distance:

$$d_o = f \left(1 - \frac{1}{m}\right)$$

5. (b) Calculate the change in distance to increase the magnification:

$$d_{o4} - d_{o3} = f \left(1 - \frac{1}{m_4}\right) - f \left(1 - \frac{1}{m_3}\right) = f \left(\frac{1}{m_3} - \frac{1}{m_4}\right)$$

$$= -36 \text{ cm} \left(3 - 4\right) = 36 \text{ cm}$$

The object should be moved 36 cm further away from the lens.

**Insight**: As the object moves away from the lens, the magnification will decrease and approach zero as the object distance approaches infinity.
14. **Picture the Problem:** The figure shows water flowing through a pipe with initial diameter \( d_1 = 2.8 \) cm which decreases to \( d_2 = 1.6 \) cm. The pressure difference \( \Delta P \) is 7.5 kPa.

**Strategy:** Solve equation 15-14 for the water velocity in the first tube. Use equation 15-12 to write the velocity in the second tube in terms of the velocity in the first tube.

**Solution:**

1. (a) **The tube with the greater diameter** has the higher pressure. Since the volume flow rate is the same both tubes the speed in the narrower tube must be greater. Equation 15-14 shows that the tube with higher velocity must have the lower pressure.

2. (b) **The tube with the smaller diameter** has the higher speed of flow.

3. (c) Solve equation 15-12 for the velocity in the second tube:

   \[
   A_1 v_1 = A_2 v_2 \quad \Rightarrow \quad v_2 = \left( \frac{A_1}{A_2} \right) v_1 = \left( \frac{\pi D_1^2 / 4}{\pi D_2^2 / 4} \right) v_1 = \left( \frac{D_1}{D_2} \right)^2 v_1
   \]

4. Eliminate \( v_2 \) from equation 15-14:

   \[
   P_1 + \frac{1}{2} \rho v_1^2 = P_2 + \frac{1}{2} \rho v_2^2
   \]

   \[
   P_1 + \frac{1}{2} \rho v_1^2 = P_2 + \frac{1}{2} \rho \left( \frac{D_1}{D_2} \right)^4 v_1^2
   \]

5. Solve for \( v_1 \):

   \[
   v_1 = \sqrt{\frac{2(P_2 - P_1)/\rho}{1 - \left( \frac{D_1}{D_2} \right)^4}} = \sqrt{\frac{2(-7.5 \times 10^3 \text{ Pa})/(1000 \text{ kg/m}^3)}{1 - (2.8 \text{ cm}/1.6 \text{ cm})^4}} = 1.3 \text{ m/s}
   \]

**Insight:** The speed in the narrow pipe is 4.1 m/s.