

**40.16** A 1600rpm centrifugal pump with an 8in impeller requires 7.5bhp when delivering 250gpm of water at a head of 75ft. What is the new capacity when the impeller diameter is increased to 12in?

- A. 250gpm
- B. 305gpm
- C. 375gpm
- D. 560gpm

Make a table to organize the given information. Distinguish the two operational states as Case 1 and Case 2. There is more information about Case 1 than required to solve the problem. There's also more that could be specified about Case 2 than is necessary.

Case 1	Case 2
$n_1 = 1600rpm$	$n_2 = n_1$
$D_1 = 8in$	$D_2 = 12in$
$bhp_1 = 7.5hp$	
$Q_1 = 250gpm$	$Q_2 = ?$
$\Delta h_1 = 75ft H_2O$	

Look up **pump affinity laws** in the reference handbook and select the equation which relates volume flow rate and diameter. The relationship is linear; i.e. a 50% increase in the diameter of the impeller drives a 50% increase in the volume flow rate, provided all other parameters remain unchanged. Substitute and solve for  $Q_2$ :

$$\frac{Q_2}{Q_1} = \frac{D_2}{D_1} \rightarrow Q_2 = Q_1 \left( \frac{D_2}{D_1} \right)$$

$$Q_2 = (250gpm) \left( \frac{12in}{8in} \right) = 375gpm$$

**Answer C**

**40.17 Which of the following is not a reason for pumps to be placed in parallel?**

- A. To increase pressure
- B. To increase volume flow rate
- C. To improve efficiency
- D. To add redundancy

Examine each choice:

A: When pumps are run in parallel, the differential pressure across the pump set is equal, not greater. Therefore pumps would not be placed in parallel to increase pressure. They would need to be placed in *series* to add pressure.

B: Parallel pumps provide additional volume at the same pressure.

C: Parallel pumps may improve efficiency if using variable speed drives and programmed with the appropriate intent.

D: Parallel pumps may provide redundancy if a sufficient quantity are used.

**Answer A**

**40.18 Crude oil is pumped by a centrifugal pump with a performance curve given by the equation  $H_p = 50 - Q - \frac{Q^2}{25}$ , where head is in units of feet and flow rate is in units of cubic feet per second. The system curve is described by the equation  $H_s = \frac{Q^2}{25} + \frac{Q}{10}$ , with the same units. Neglecting efficiency and losses, what is the power required by the pump?**

- A. 16hp
- B. 30hp
- C. 35hp
- D. 53hp

The intersection between the performance curve for a given pump and the system curve is the operating point. By setting the equations equal, the volume flow rate and head pressure at the operating point can be determined, and then used to determine the power.

$$H_p = H_s$$

$$50 - Q - \frac{Q^2}{25} = \frac{Q^2}{25} + \frac{Q}{10}$$

$$\frac{2Q^2}{25} + \frac{11Q}{10} - 50 = 0$$

Multiply by 50 to eliminate fractions, then solve the quadratic equation: