

10 491.41  
 100 491.40  
 100 491.31  
 100 491.30  
 100 491.29  
  
 300 491.06  
 100 490.87  
 100 490.80  
 200 490.79  
 50 490.78

**1. What is the Bid-ask Spread?**

The bid –ask spread is: 491.06 (bid) for 300 shares to 491.29 (ask) at 100.

Also can be written as  $491.06 - 491.29, 300 \times 100$ .

The (quoted) bid-ask spread is 23 cents

**2. What is the Cumulative Depth to 490.80?**

The cumulative depth is measured away from the best bid or the best ask. Since 490.80 is below the best bid, we add the depth down from the best bid until we get to 490.80 (inclusive). So the cumulative depth to 490.80 is  $300+100+100 = 500$  shares

**3. What is the average effective spread if the following orders are executed: 491.27, 491.10, 491.15, 491.20?**

We first need to calculate the midpoint of the bid-ask spread. The midpoint is  $(491.29+491.06)/2 = 491.175$ .

Now we compare each trade to the midpoint, take the absolute value, and multiply by 2:

$$2 * |491.27 - 491.175| = 2 * .095 = 0.19$$

$$2 * |491.10 - 491.175| = 2 * .075 = 0.15$$

$$2 * |491.15 - 491.175| = 2 * .025 = 0.05$$

$$2 * |491.20 - 491.175| = 2 * .025 = 0.05$$

Add them up and divide by 4 to take an average:  $0.19+0.15+0.05+0.05 = 0.44$

$0.44/4 = 0.11$ . So the average effective spread is 11 cents

4. If a 100 share market order to buy comes in, what happens? What is the bid ask spread afterwards?

Buyers execute against people who want to sell. The lowest seller is at the ask, at 491.29. So 100 shares executes at 491.29. Now the limit order book looks different:

10	491.41
100	491.40
100	491.31
100	491.30
300	491.06
100	490.87
100	490.80
200	490.79
50	490.78

The new bid ask spread is 491.06 to 491.30, 300 x 100 shares, or 24 cents.

5. If a limit order to buy at 490.82 for 100 shares, what happens?

If a limit order to buy for 490.82 comes in, it will have to get in line behind all of the other buyers who are willing to pay more. So it would go **here**:

10	491.41
100	491.40
100	491.31
100	491.30
300	491.06
100	490.87
<b>100</b>	<b>490.82</b>
100	490.80
200	490.79
50	490.78

The bid-ask spread does NOT change, as nothing changed at the best bid or the best ask.

6. If a limit order to sell at 490.80 for 100 shares, what happens?

Well, now this is different. The seller is willing to sell as LOW as 490.80, but there is a willing buyer at 491.06. So there will be a trade for 100 shares at 491.06. The bid side depth decreases by 100 shares, so the new limit order book is:

10 491.41  
100 491.40  
100 491.31  
100 491.30

**200** 491.06  
100 490.87  
100 490.82  
100 490.80  
200 490.79  
50 490.78

The quoted spread is now 491.06 to 491.30, 200 x 100 shares.