Q1 (Ref: Q. 13-3, p.618): A firm is faced with the attractive situation in which it can obtain immediate delivery of an item it stocks for retail sale. The firm has therefore not bothered to order the item in any systematic way. However, recently profits have been squeezed due to increasing competitive pressures, and the firm has retained a management consultant to study its inventory management. The consultant has determined that the various costs associated with making an order for the item stocked are approximately $70 per order. She has also determined that the costs of carrying the item in inventory amount to approximately $27 per unit per year (primarily direct storage costs and forgone profit on investment in inventory). Demand for the item is reasonably constant over time, and the forecast is for 16,500 units per year. When an order is placed for the item, the entire order is immediately delivered to the firm by the supplier. The firm operates 6 days a week plus a few Sundays or approximately 320 days per year. Determine the following: (a) Optimal order quantity per order, (b) Total annual inventory costs, (c) Optimal number of orders to place per year, (d) Number of operating days between orders, based on the optimal ordering.

Answers: (a) Optimal order quantity per order = 292.5, (b) Total annual inventory costs = $7897.47, (c) Optimal number of orders to place per year = 56.41 , (d) Number of operating days between orders, based on the optimal ordering = 5.67 days

Given: $D = 16,500$, $C_o = \$70$, $C_c = \$27$

a. $$Q = \sqrt{\frac{2C_oD}{C_c}} = \sqrt{\frac{2(70)(16,500)}{27}} = 292.5$$

b. $$TC = \frac{C_oD}{Q} + \frac{C_cQ}{2} = \frac{(70)(16,500)}{292.5} + \frac{(27)(292.5)}{2} = \$7,897.47$$

c. $$\frac{D}{Q} = \frac{16,500}{292.5} = 56.41 \text{ orders}$$

d. $$\frac{320}{56.41} = 5.67 \text{ days}$$

Q2 (Ref: Q. 13-11, p.618): The Shotz Brewery produces an ale, which it stores in barrels in its warehouse and supplies to its distributors on demand. The demand for ale is 1800 barrels per day. The brewery can produce 3000 barrels per day. It costs $7500 to set up a production run for ale. Once it is brewed, the ale is stored in a refrigerated warehouse at an annual cost of $60 per barrel. Determine the economic order quantity and the minimum total annual inventory cost.

Answers: Economic order quantity = 20,263.88 and the minimum total annual inventory cost = $486,333.22

$d = 1,800$, $p = 3,000$, $D = 657,000$, $C_o = \$7,500$, $C_c = \$60$

$$Q = \sqrt{\frac{2C_oD}{C_c\left(1-\frac{d}{p}\right)}} = \sqrt{\frac{2(7,500)(657,000)}{50\left(1-\frac{1,800}{3,000}\right)}} = 20,263.88$$

$$TC = \frac{C_oD}{Q} + \frac{C_cQ}{2}\left(1-\frac{d}{p}\right) = (7,500)\frac{657,000}{20,263.88} + (60)\frac{20,263.88}{2}\left(1-\frac{1,800}{3,000}\right) = \$486,333.22$$

Q3 (Ref: Q. 13-15, p.619): The Deer Valley Farm produces a natural organic fertilizer, which it sells mostly to gardeners and homeowners. The annual demand for fertilizer is 220,000 pounds. The farm is able to produce 305,000 pounds annually. The cost to transport the fertilizer from the plant to the farm is $620 per load. The annual carrying cost is $0.12 per pound. (a) Compute the optimal order size, the maximum inventory level, and the total minimum cost.
(b) If the farm can increase production capacity to 360,000 pounds per year, will it reduce total inventory cost?

Answers: (a) optimal order size = 90,317.52, the maximum inventory level = 25,179.46, and the total minimum cost =$ 3020.45 (b) If the farm can increase production capacity to 360,000 pounds per year, optimal order size = 76,457.27, and the total minimum cost =$ 30568.01. It increase the inventory cost.

a. $d = 220,000$, $C_c = \$0.12/lb$, $C_o = 620$, $p = 305,000$

$$Q = \sqrt{\frac{2C_oD}{C_c\left(1-\frac{d}{p}\right)}} = \sqrt{\frac{2(620)(220,000)}{(0.12)\left(1-\frac{220}{305}\right)}} = 90,317.52$$

$$\text{maximum level} = Q\left(1-\frac{d}{p}\right) = (90,317.52)(0.2787) = 25,170.46$$

$$TC = \frac{C_oD}{Q} + \frac{C_cQ}{2}\left(1-\frac{d}{p}\right) = \frac{(620)(220,000)}{90,317.52} + \frac{(0.12)(90,317.52)}{2}(0.2787) = \$3020.45$$

b. $P = 360,000$

$$Q = \sqrt{\frac{2(620)(220,000)}{(0.12)\left(1-\frac{220}{305}\right)}} = 76,457.27$$

$$TC = \frac{(620)(220,000)}{76,457.27} + \frac{(0.12)(76,457.27)}{2}(0.25) = \$3,568.01$$

No, the total inventory cost increases.

Q4 (Ref: Q. 13-25, p.620 of textbook): The office manager for the Metro Life Insurance Company orders letterhead stationery from an office products firm in boxes of 500 sheets. The company uses 6500 boxes per year. Annual carrying costs are $3 per box, and ordering costs are $28. The discount price schedule is provided by the office supply in the table below. Determine the optimal order quantity and the total annual inventory cost.

Order Quantity (boxes)	*Price per Box*
200-999	*$16*
1000-2999	*14*
3000-5999	*13*
6000+	*12*

Answers: Optimal order quantity = 6,000 and the total annual inventory cost = $87,030.33

$D = 6,500$, $C_o = \$28$, $C_c = \$3$

$$Q = \sqrt{\frac{2C_oD}{C_c}} = \sqrt{\frac{2(28)(6,500)}{3}} = 348.32 = 348$$

$$TC = \frac{(28)(6,500)}{348} + \frac{(3)(348)}{2} + (16)(6,500), = \$105,045$$

$Q = 1,000$:

$$TC = \frac{(28)(6,500)}{1,000} + \frac{(3)(1,000)}{2} + (14)(6,500), = \$92,682$$

$Q = 3,000$:

$$TC = \frac{(28)(6,500)}{3,000} + \frac{(3)(3,000)}{2} + (13)(6,500), = \$89,060.67$$

$Q = 6,000$:

$$TC = \frac{(28)(6,500)}{6,000} + \frac{(3)(6,000)}{2} + (12)(6,500), = \$87,030.33$$

Select $Q = 6,000;\ TC = \$87,030.33.$

Q5 (Ref: Q. 13-27, p620): The amount of denim used daily by the Southwest Apparel Company in its manufacturing process to make jeans is normally distributed with an average of 4000 yards of denim and a standard deviation of 600 yards. The lead time required to receive an order of denim from the textile mill is a constant 7 days. Determine the safety stock and reorder point if the company wants to limit the probability of a stock out and work stoppage to 5%.

Answers: Safety stock = 2603.42 yards and Reorder point = 30,603.42 yards.

$$d = 4,000,\ L = 7,\ \sigma_d = 600,\ R = \bar{d}L + Z\sigma_d\sqrt{L}$$

$$R = 4,000(7) + 1.64(600)\sqrt{7} = 30,603.42$$

$$\text{Safety stock} = 2,603.42 \text{ yd}$$

Q6 (Ref: Q. 13-30, p585): In Problem 13-27, what level of service would a safety stock of 2000 yards provide?

Answers: Service Level = 90%.

$$\text{If safety stock} = 2,000,\ Z(600)\left(\sqrt{7}\right) = 2,000,\ Z = 1.26,$$ which corresponds to a 90% service level

Q7 (Ref: Q. 13-35, p620): Food Place Market stocks frozen pizzas in a refrigerated display case. The average daily demand for the pizzas is normally distributed, with a mean of 8 pizzas and a standard deviation of 2.5 pizzas. A vendor for a packaged food distributor checks the market's inventory of frozen foods every 10 days; during a particular visit there were no pizzas in stock. The lead time to receive an order is three days. Determine the order size for this order period that will result in a 98% service level. During the vendor's following visit there were 5 frozen pizzas in stock. What is the order size for the next order period?

Answers: Order size for the next order period = 122 pizzas.

$$\bar{d} = 8$$
$$t_b = 10$$

$$L = 3$$
$$\sigma_d = 2.5$$
$$I = 0$$
$$Q = \bar{d}\left(t_b + L\right) + Z\sigma_d\sqrt{t_b + L} - I\,, = 8\left(10+3\right) + 2.33\left(2.5\right)\sqrt{10+3} - 0\,, = 122 \text{ pizzas}$$

$$122 - 5 = 117 \text{ pizzas}$$

Q7 (Ref: Q. 13-37, p.621): The Aztec Company stocks a variety of parts and materials it uses in its manufacturing processes. Recently, as demand for its finished goods has increased, management has had difficulty managing parts inventory; they frequently run out of some crucial parts and seem to have an endless supply of others. In an effort to control inventory more effectively, they would like to classify their inventory of parts according to the ABC approach. Following is a list of selected parts and the annual usage and unit for each:

Classify the inventory items according to the ABC approach using dollar value of annual demand.

Answers:

Item	Usage	Unit Cost	Annual Usage	% Annual Value	% Annual Usage	Class
25	870	105	$91,350	15.97%	10.43%	A
23	30	2,710	81,300	14.21	0.36	A
20	19	3,200	60,800	10.63	0.23	A
22	12	4,750	57,000	9.97	0.14	A
24	24	1,800	43,200	7.55	0.29	A
16	60	610	36,600	6.40	0.72	A
5	18	1,900	34,200	5.98	0.22	A
10	67	440	29,480	5.15	0.80	B
12	682	35	23,870	4.17	8.18	B
2	510	30	15,300	2.68	6.11	B
4	300	45	13,500	2.36	3.60	B
1	36	350	12,600	2.20	0.43	B
27	750	15	11,250	1.97	8.99	B
9	344	28	9,632	1.68	4.12	B
29	46	160	7,360	1.29	0.55	B
26	244	30	7,320	1.28	2.92	B
28	45	110	4,950	0.87	0.54	B
13	95	50	4,750	0.83	1.14	C
30	165	25	4,125	0.72	1.98	C
18	270	15	4,050	0.71	3.24	C
6	500	8	4,000	0.70	5.99	C
7	710	4	2,840	0.50	8.51	C
21	910	3	2,730	0.48	10.91	C
17	120	20	2,400	0.42	1.44	C
19	45	50	2,250	0.39	0.54	C
8	80	26	2,080	0.36	0.96	C
3	50	23	1,150	0.20	0.60	C
11	510	2	1,020	0.18	6.11	C
15	820	1	820	0.14	9.83	C
14	10	3	30	0.01	0.12	C
	8,342		571,957	100.00%	100.00%	