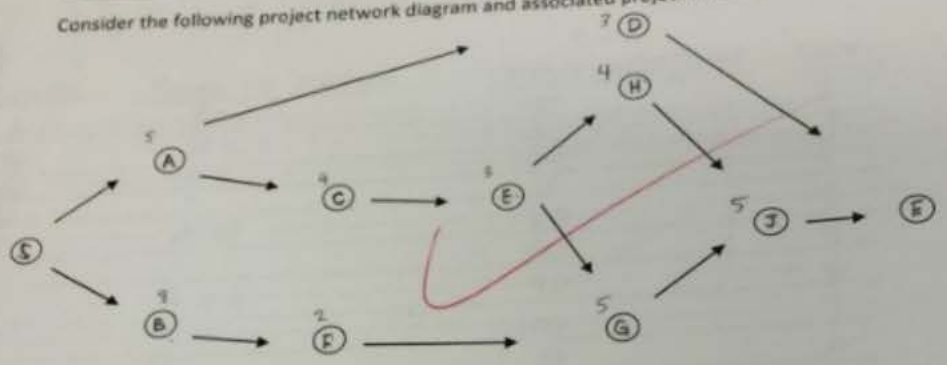
Question No. 1 (4 Marks)

Consider the following project network diagram and associated project information



Activity	Immediate Predecessor	Mean Expected Duration (days)	Normal Cost	Crashed Duration	DAYS TO CRASH	Crash Cost ($)	
A	-	5	100	3	2	190	
B	-	8	170	6	2	250	
C	A	4	200	3	1	300	
D	A	3	100	2	1	150	
E	C	3	180	2	1	240	60
F	B	2	200	1	1	280	80
G	E,F	5	500	3	2	680	90
H	E	4	200	3	1	300	100
J	H,G	5	250	5	0	250	0
			1900				

a) *Fill the activity Name in each Node in above diagram. Use 'S' for start Node and 'E' for End Node. What is the critical path and total project duration ?* critical path = ACEGJ Du

b) *Determine the minimum completion time of the project after crash. What is the Total Project cost after complete crash. To get full credit show all steps showing which activities need to be crashed at what stage.*

PATHS	Normal Duration
A-D	7 6
* A-C-E-H-J	22 20 19 18 17 16
* A-C-E-G-J	22 21 20 19 18 17 16
B-F-G-J	20 19 18 17 16

(A) Before CRASH critical path 3
A-C-E-G-J
Duration 22

(B)

Activity	Days to crash	Crash cost/day	Rank
A	2 + 0	45	2
B	2 + 0	40	1
C	1 0	100	3
D	1 0	50	4
E	1	60	5
F	1 0	80	6
G	2 + 0	90	7
H	1 0	100	8
J	0	0	

C+B 100 + 40 = 140
G+H 90 100 = 190

Crash Days	Critical Path	Activity to Crash	Cost	Cumulative Cost	New Duration
				45	21
1	A-C-E-G-J	A	45	90	20
2	A-C-E-G-J	A	45	180	19
3	A C E G J B F G J	G	90	280	18
4	A C E G J B F G J A C E H J	B+E	100	420	17
5	A C E G J A C E H J B F G J	C+B	140	610	16
6	A C E G J A C E H J B F G J	H+G	190	610	16

maximum CRASH since A C E H J and A C E G J have no more activities to crash

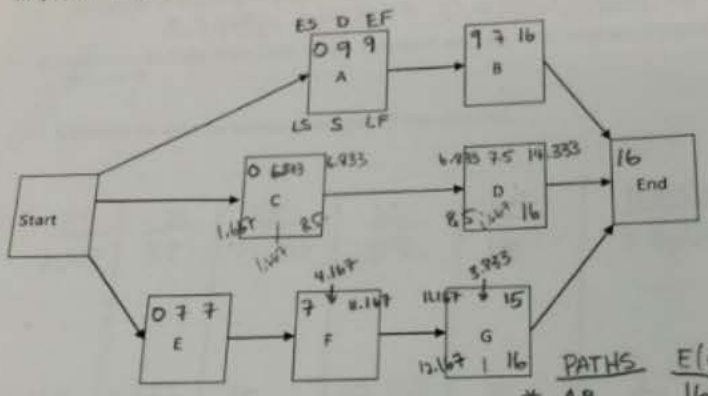
min completion time = 16 days

CRASH COST = 610

Total project cost = 1900 + 610 = 2510 $

Question No. 2 (5 Marks)

The following diagram shows activities required to complete the launching of new product. At the end of the project, the new product would be ready for launching.



a) Calculate the missing expected times and missing variances

Activity	Optimistic Time (days)	Most Likely Time (days)	Pessimistic Time (days)	Expected Time (days)	Variance of Activity
A	7	9	11	9.000	0.444
B	5	7	9	7.	0.444
C	5	7	8	6.833	0.25
D	4	8	9	7.500	0.694
E	5	7	9	7	0.444
F	3	4	6	4.167	0.25
G	3	4	4	3.833	0.028

PATHS	E(d)	Total σ^2	σ
* AB	16	0.888	0.94234
CD	14.333	0.944	0.9716
EFG	15	0.722	0.84971

PATHS	Z	P
AB	1.06	0.8554
CD	2.745	0.9977
EFG	2.354	0.9906

$0.8554 \times 0.9977 \times 0.9906$
$= 0.84482$

b) *Calculate the probability that the project would be completed before 17 days (multiply all path probabilities)*

Probabilit completed before 17 days = 0.84482

means

c) If the probability of the project finishing before 16 days is 0.4213, then what would be the probability of finishing the project between 16 and 17 days.

0.84482 - 0.4213 = 0.42352 probability comp between 16 & 17

d) Calculate the Early Start, Early Finish, Late Start, and Late Finish in terms of expected time for Activity D.

e) Calculate the slack for activity G in terms of expected time.

	ES	D	EF	LS	LF	SLACK	
(D)	6,833	7.5	14.333	8.5	16	1.667	← Activity D
e)	11.167	3833	15	12.167	16	1	← Activity G

ACT	D
A	
B	
C	
D	
E	
F	
G	

Question No. 3 (4 Marks)

Paramount Bookstore sells an interesting novel entitled "*The Goal*" written by Goldratt. The novel narrates a story in a manufacturing system identifying the bottlenecks (constraints), and how to reduce their impacts. The novel has been a huge success, however the demand has been stable recently. Paramount wants to be cautious in ordering the right quantities of books, so the bookstore manager uses the forecasting methods for predicting monthly demand, based on the past demand figures. The following table presents the actual demand figures for last 4 months.

Month	June	July	August	September
Actual (A_t)	36	40	35	39

a) Using simple exponential smoothing with a smoothing constant of 0.5, forecast the number of books to be demanded for October 2014. Start with an initial forecast of 38 books for June.

b) What is the demand forecast for October 2014 using the trend adjusted exponential smoothing method (Double Exponential Smoothing) with $\alpha = 0.4$ and $\beta = 0.2$? (Assume $S_1 = A_1$, and $T_1 = A_2 - A_1$).

c) Based on the mean absolute deviation (MAD) for August and September period only, which forecast, (a) or (b) above, do you recommend for October 2014?

Period	Month	Actual	$F_t = F_{t-1} + \alpha(A_{t-1} - F_{t-1})$
1	June	36	38
2	July	40	$38 + .5(36-38) = 37$
3	Aug	35	$37 + .5(40-37) = 38.5$
4	Sep	39	$38.5 + .5(35-38.5) = 36.75$
5	Oct		$36.75 + .5(39-36.75) = 37.875$

35 - 39

b) $\alpha = 0.4$ $\beta = 0.2$ 7

MONTH	ACTUAL	TAF_T	S_T	T_T	TAF_{T+1}
1 June	36		36	40-36 = 4	40
2 July	40	40	40 + 0.4(40-40) = 40	4 + .2(40-36-4) = 4	44
3 Aug	35	44	44 + 0.4(35-44) = 40.4	4 + .2(40.4-40-4) = 3.28	43.68
4 Sep	39	43.68	43.68 + .4(39-43.68) = 41.808	3.28 + .2(41.808-40.4-3.28) = 2.9056	44.7136
5 OCT		44.7136			

MONTH	ACTUAL	EXPO SMOOTHING F	EXPO SMOOTHING |E|	TAF F	TAF |E|
AVG	35	38.5	3.5	44	9
EP	39	36.75	2.25	43.68	4.68
e|			5.75		13.68
			÷ 2		÷ 2
D			2.875		6.84

c) I recommend A (Ex. Smoothing) since its MAD is lower than for TAF

Question No. 4 (5 Marks)

You have been assigned to prepare a forecast for major accidents in Montreal highways in the 2017. The actual quarterly data for year 2013 1nd 2014 and the quarterly seasonal indexes have been already calculated as given in the following table.

Major Accidents

Quarter	1	2	3	4
Year 2013	42	58	74	44
Year 2014	48	70	95	50
seasonal index	0.81	1.09	1.37	?? = 4

0.73

(A) $4 - (0.81 - 1.09 - 1.37) = 0.73$

(a) Compute the Seasonal Index for 4th Quarter. = 0.73

(b) Fit a linear trend line model based on the de-seasonalized figures of the above given data and forecast number of accidents for all four quarters of 2017. 2017 ⇒ Q1 = 17, Q2 = 18, Q3 = 19, Q4 = 20

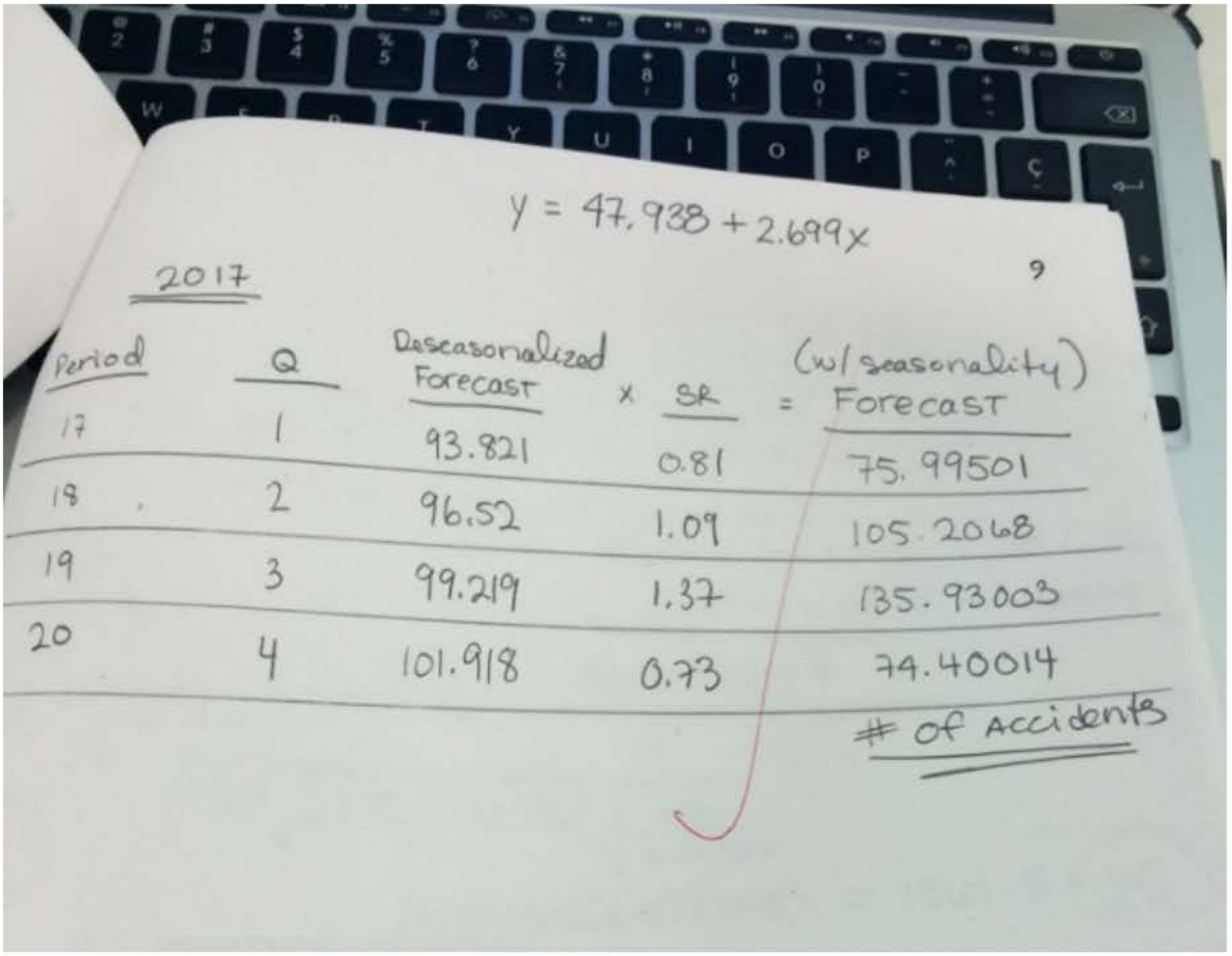
(B)

Period (X)	YEAR	Q	A	A ÷ SR (Y) De Seasonalized	(X)(Y)	(X^2)
1	2013	1	42	51.85185	51.85185	1
2		2	58	53.21100	106.42200	4
3		3	74	54.0146	162.0438	9
4		4	44	60.27397	241.09588	16
5	2014	1	48	59.25926	296.2963	25
6		2	70	64.2202	385.3212	36
7		3	95	69.34307	485.40149	49
8		4	50	68.49315	547.9452	64
Σ 36				480.66710	2,276.37772	204

$$b = \frac{(8)(2276.37772) - (36)(480.66711)}{(8)(204) - (36)^2} = \frac{18,211.02176 - 17,304.01596}{1632 - 1296} = 2.699$$

$$a = \frac{480.66711 - (2.699)(36)}{8} = 47.938$$

$$y = 47.938 + 2.699(x)$$



$y = 47.938 + 2.699x$

2017

Period	Q	Deseasonalized Forecast	× SR	= (w/ seasonality) Forecast
17	1	93.821	0.81	75.99501
18	2	96.52	1.09	105.2068
19	3	99.219	1.37	135.93003
20	4	101.918	0.73	74.40014

# of Accidents

year = 250 D = 50,000 u ÷ 250 = 200/day = d
P = 600/day
H = $25/u
S = 2 × 1.1 × 15 = 33$

Question No. 5 (6 Marks) 10

A bicycle part supplier utilizes a press to produce a number of parts supplied to a major bicycle manufacturer. One of the parts manufactured on the press has an annual demand of 50,000 units. The part is produced at a rate of 600 units per working day. There are 250 working days in a year. The annual inventory cost is estimated to be $25 per part. Each set-up is done by two employees working as a team and takes 66 minutes to complete. Each employee is paid $15 / hr. The company estimates a profit of $341 / hr. when the press is producing a part.

a) Using the information provided, show that the set-up cost is $408.10 / set-up.

66/60 = 1.1 h

1.1 × 2 ee × 15 = 33$ to do the work

1.1 × 341 = 375.1 opportunity cost of not running the machine

375.1 + 33 = 408.1 $

(1)

(Show all work when answering the questions below. Use the provided set-up cost of $408.10 in your relevant calculations.)

b) Calculate the economic production quantity.

$$EPQ = \sqrt{\frac{(2)(50,000)(408.1)}{25}}\sqrt{\frac{600}{600-200}}$$

$$(1277.6541)(1.224745) = 1564.8 \approx 1565 \text{ units}$$

(1)

c) Calculate the annual total minimum cost.

$$TC = \frac{1564.8}{2(600)}(600-200)(25) + \frac{50000}{1564.8}(408.1) = 13040 + 13040.005 = \$26080.01$$

yearly inv cost

(1)

d) How many working days each production run continue?

$$\frac{1564.8 \text{ units}}{600 \text{ units/day}} = 2.608 \text{ days production run}$$

(1/2)

e) What is the level of maximum inventory?

$$I_{max} = 1564.8\left(\frac{600-200}{600}\right) = 1043.2 \text{ units}$$

(1/2)

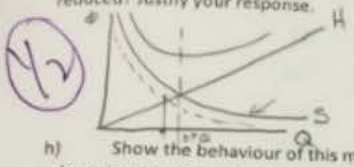
f) What is the time between two successive set-ups?

cycle time = $\frac{50,000}{1564.8}$ = 31.95 runs/year

$\frac{250 \text{ days}}{31.95}$ = 7.824 length of cycle ∴ time between set ups

½ off

g) If the company wants to reduce the economic production quantity, which cost should be reduced? Justify your response.

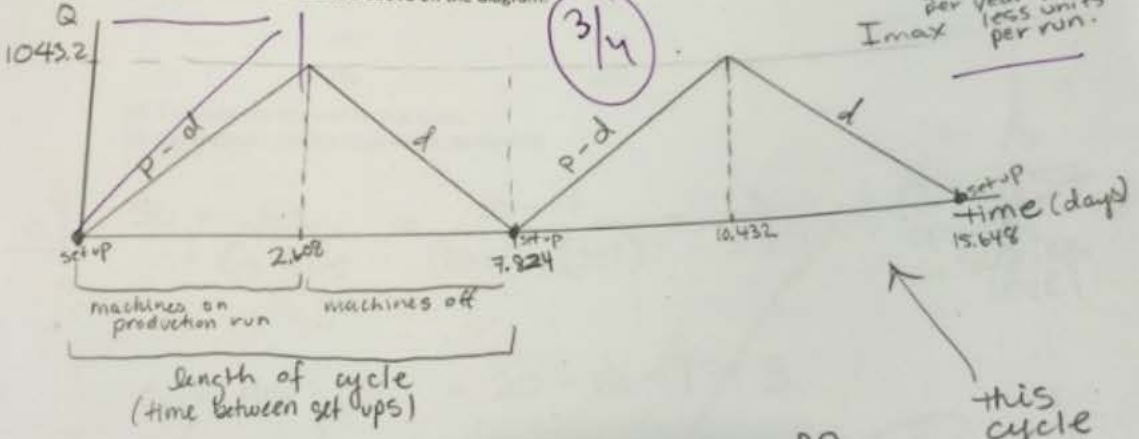


½

They would have to decrease set up costs in order to shift the S curve left (down), in order to shift EPQ left. If they reduced holding costs it would increase EPQ because it would be cheaper to hold items so we'd make them longer. If set up and hold costs decreases, we'll do more set ups ∴ more runs per year ∴ less units per run.

h) Show the behaviour of this model on a diagram (time vs. inventory level). Indicate all the relevant parameters calculated above on the diagram.

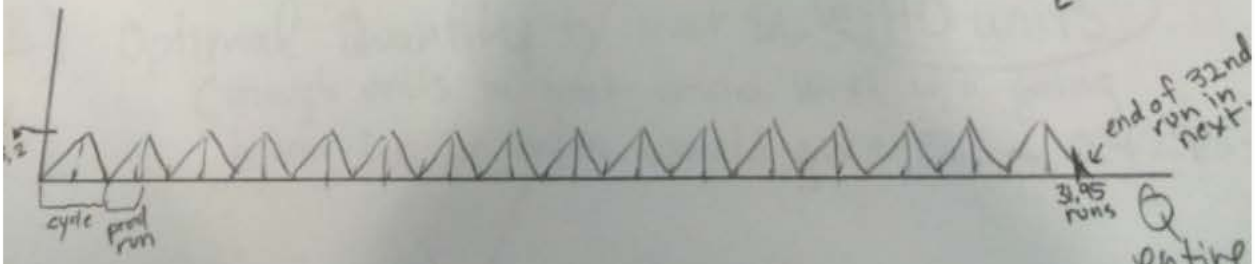
¾



this cycle would repeat 31.95 times in a year

7.824 - 2.608 = 5.216 time machine off

(600 - 200)2.608 = 1043.2



Q entire yea

Cost = 16/u + $1 = 17
price = 20/u
Ce = 3/u

12

Question No. 6 (4 Marks)

A particular product costs a retailer $ 16 per unit, plus an extra charge of $1 for transportation for each unit. The product is sold in market for $ 20 per unit. The wholesaler will take the unsold items back but will charge $3 per unit as a re-stocking charge. The demand distribution of the product is as follows:

No. of Items Demanded	Probability	Cum prob
80	0.05	0.05
90	0.15	0.20
100	0.20	0.40
110	0.25	~~0.65~~ 0.80
120	0.15	
130	0.10	
140	0.07	
150	0.03	

(a) Compute the Optimal Service Level.
(b) Compute the Optimal Quantity to be stocked.

a) $SL = \frac{C_s}{C_s + C_e} = \frac{20-17}{(20-17)+(3+1)} = \frac{3}{3+4} = 0.42857$ optimal service level

C_s = Rev − Cost = 20 − 16 − 1 = 3

C_e = 3 + 1
(3 ↑ restock, 1 ↑ transport)

Bravo!

B) Optimal Quantity to meet SL = 110 units
(enough units to meet service level w/o going below, i.e. 110 units would give SL < 0.4285

Q (7) [20*0.5=10 marks]: Answer the following questions on the OMR sheet.

[1] Which of the following is NOT a characteristic of exponential smoothing?
a. smoothes random variations in the data
b. uses an easily altered weighting scheme
c. weights each historical value equally
d. has minimal data storage requirements
e. uses the previous period's forecast

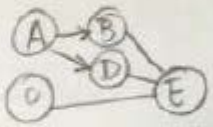
[2] WBS stands for which of the following project management tools?
a. work break schedule
b. work breakdown status
c. work breakdown schedule
d. work breakdown structure
e. work break status

[3] The critical path for the network activities shown below is _____ with duration _____.

Activity	Duration	Immediate Predecessors
A	4	---
B	2	A
C	7	--
D	4	A
E	5	B,C,D

A-D-E 13
A-B-E 11
C-E 12

a. A-D-E; 13
b. A-B-D; 10
c. A-B-E; 11
d. C-E; 12
e. A-B-C-D-E; 22



[4] The expected daily demand for a product is normally distributed with a mean of 500 units and a variance of 2500. The lead time for the component is 9 days. If the company sets a reorder point of 4500 units for this component then its service level is:
a. 50 %
b. 84 %.
c. 92 %.
d. 99.87 %
e. none of the above.

$\sigma_d^2 = 2500$
$D = 500/day$
$LT = 9$
$ROP = 4500$

[5] The expected daily demand for a product is normally distributed with a mean of 500 units and a variance of 2500. The lead time for the component is 9 days. If the company holds a safety stock of 450 units, then its service level is:
a. 50 %
b. 84 %.
c. 92 %.
d. 99.87 %
e. None of the above.

$d = 500$
$\sigma_d^2 = 2500$
$LT = 9$
$SS = 450$

[6] Which of the following smoothing constants would make an exponential smoothing forecast equivalent to a naive forecast?
a. 0
b. 1 divided by the number of periods
c. 0.5
d. 1.0
e. cannot be determined

[7] An activity on a PERT network has these time estimates: optimistic = 2, most likely = 3, and pessimistic = 8. What is its expected activity time and variance?
a. 3.67; 1
b. 3.67; 6
c. 4.33; 1
d. 4.33; 6
e. none of the above

3.67, 1

[8] Which of the following values of smoothing constant (α) would cause exponential smoothing to respond the most slowly to forecast errors?
a. 0.50
b. 0.15
c. 0.05
d. 0.51
e. none of the above

[9] A product whose EOQ is 40 units experiences a decrease in ordering cost from $90 per order to $10. The revised EOQ is
a. three times as large
b. one-third as large
c. nine times as large
d. one-ninth as large
e. cannot be determined

$D = 100 \quad H = 3$
$\sqrt{\frac{2(100)(90)}{3}} = 77.46$
$\sqrt{\frac{2(100)(10)}{3}} = 25.81$

[10] When quantity discounts are allowed, the cost-minimizing order quantity
a. is always an EOQ quantity
b. minimizes the sum of holding and ordering costs
c. minimizes the unit purchase price
d. minimizes the sum of holding cost and purchase cost
e. none of the above

[11] Which of the following is NOT a characteristic of service operations?

$\bar{x}$ = Mean of sam

a. intangible output
b. low uniformity of output
c. easy measurement of productivity—
d. high customer contact
e. high labor content

[12] The two most basic inventory questions answered by the typical inventory model are:
a. timing of orders and cost of orders
b. order quantity and cost of orders
c. timing of orders and order quantity
d. order quantity and service level
e. ordering cost and carrying cost

[13] The beta distribution is used in project management to:
a. calculate slack on activities not on the critical path.
b. calculate the probability that a project will be completed within its budget.
c. calculate pessimistic and optimistic activity times.
d. determine which activity should be crashed.
e. none of the above

[14] A firm that makes electronic circuits has been ordering a certain raw material 250 ounces at a time. The firm estimates that carrying cost is 30% per year, and that ordering cost is about $20 per order. The current price of the ingredient is $200 per ounce. The assumptions of the basic EOQ model are thought to apply. For what value of annual demand is their action optimal?
a. 93,750
b. 87,260
c. 101,700
d. 82,370
e. none of the above

Using Q = 250 oz
H = .3(200)
S = $20
$250 = \sqrt{\frac{2d20}{60}}$

[15] A six month moving average forecast is better than a three month moving average forecast if demand
a) has been changing due to recent promotional effort
b) has been changing due to seasonality
c) is rather stable
d) follow upward trend
e) none of the above

[16] ABC analysis is based upon the principle that:
a. all items in inventory must be monitored very closely.
b. there are usually a few critical items, and many items that are less critical.
c. an item is critical if its usage is high.
d. more time should be spent on class "C" items because there are many more of them.
e. as with grade distributions in many MBA courses, there should be more medium-level "B" items than either "A" or "C" items.

[17] For a project, if an activity with slack time of 2 weeks is delayed by 1 week, then:
a. the project will be delayed by one week
b. the probability of completing the project on time decreases
c. no other activity in the project is affected
d. the slack time of all activities that follow this activity is reduced by 1 week
e. none of the above

[18] Which of the following statements is true?
a. The term "slack" refers to the amount of time to complete an activity without delaying the project.
b. The term "slack" refers to the amount of time an activity can be delayed without delaying the project.
c. The term "slack" refers to the amount of time needed to complete the entire project.
d. The term "slack" refers to the amount of time required to complete the project's critical activities.
e. none of the above

[19] A product whose EOQ is 400 units experiences a 50% increase in demand. The new EOQ is:
a. unchanged
b. increased by less than 50%.
c. increased by 50%.
d. increased by more than 50%.
e. cannot be determined

[20] A company produces cast bronze valves on an assembly line. It currently produces 800 valves each 8-hour shift. If the production is increased to 1,200 valves each shift, the productivity increases by:
a. 67%
b. 25%
c. 50%
d. 33%
e. none of the above

$$\sqrt{\frac{40d}{60}} = 250$$
$$\sqrt{0.66667d}^2 = 250^2$$
$$\frac{0.6667d}{0.6667} = \frac{62,500}{0.6667}$$
$$d = 93,750$$