SOLUTION 1
Question 1a

Let a represent the number of tickets sold at GHC8

Let b represent the number of tickets sold at GHC6

then

$$8a + 6b = 3580$$
$$a + b = 525$$

$$\begin{pmatrix} 8 & 6 \\ 1 & 1 \end{pmatrix} \begin{pmatrix} a \\ b \end{pmatrix} = \begin{pmatrix} 3580 \\ 525 \end{pmatrix}$$

$$\begin{pmatrix} a \\ b \end{pmatrix} = \frac{1}{2} \begin{pmatrix} -6 \\ -18 \end{pmatrix} \begin{pmatrix} 3580 \\ 525 \end{pmatrix}$$

$$= \frac{1}{2} \begin{pmatrix} 1 \times 3580 + -6 \times 525 \\ -1 \times 3580 + 8 \times 525 \end{pmatrix}$$

$$= \frac{1}{2} \begin{pmatrix} 3580 - 3150 \\ -3580 + 4200 \end{pmatrix}$$

$$= \frac{1}{2} \begin{pmatrix} 430 \\ 620 \end{pmatrix}$$

$$= \begin{pmatrix} 215 \\ 310 \end{pmatrix}$$

Question 1a – alternative solution

(a) Let x represent the number of tickets sold at GHC8
Let y represent the number of tickets sold at GHC6
Then: $8x + 6y = 3580$
$x + y = 525$
Using elimination method

(2) x 6
$6x + 6y = 3150$
(1) – (3)
$2x = 430$
$x = 315$

From (1)
$x + y = 525$
$y = 525 – x$
$y = 525 – 512$
$y = 310$

(b) Let x = the amount invested at 11%
Then (60,000 – x) is the amount invested at

Let y = the total annual interest
Then

$$y = 0.11x + 0.15\,(60{,}000 - x)$$

For 14% on the total investment we have

$$y = 0.14\,(60{,}000) = 8{,}400$$

Therefore

$$8{,}400\ 0\ 0.11x + 9{,}000 - 0.15x$$
$$-600 = -0.04x$$
$$x = 15{,}000 \text{ At } 11\%$$

AND a/b

$$60{,}000 - 15{,}000 = 45{,}000 \text{ at } 15\%$$

Let x = the amount of fruits worth GHC45
Then (200 – x) is the amount of fruits worth GHC85.

Let y be the value of the mixture
They

$$y = 0.45x + 0.85\,(200 - x)$$

For GHC70

$$y = 200\,(0.70) = 140$$

Therefore

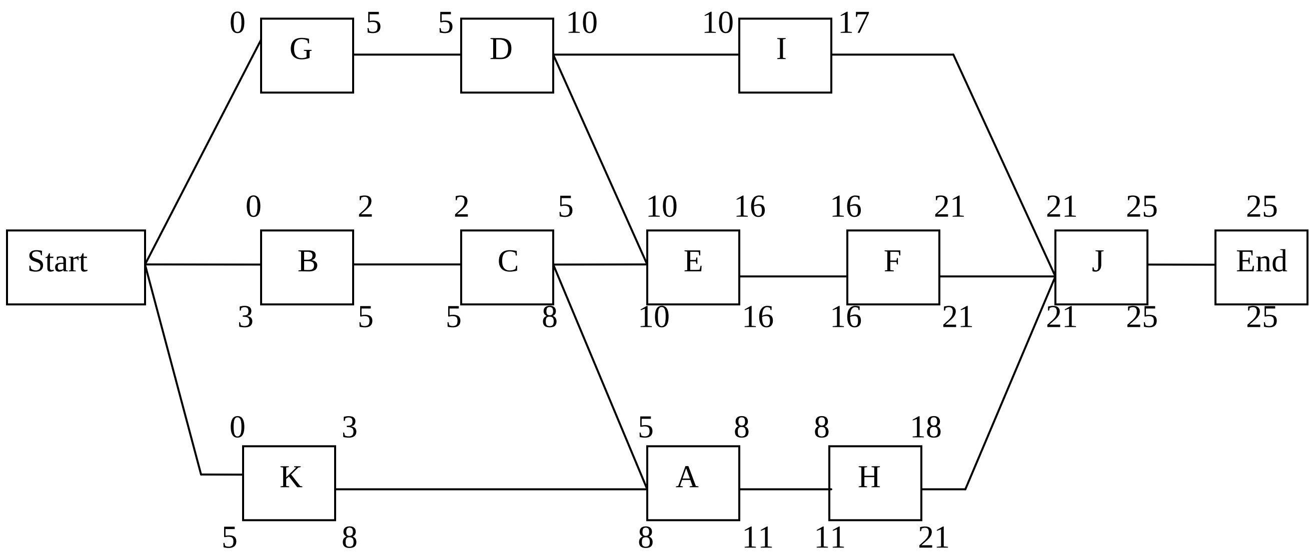
$$140 = 0.45x + 0.85\,(200 - x)$$
$$140 = 0.45x + 170 - 0.85x$$
$$-30 = -0.40x$$
$$x = 75 \text{ pounds at GHC45}$$

And

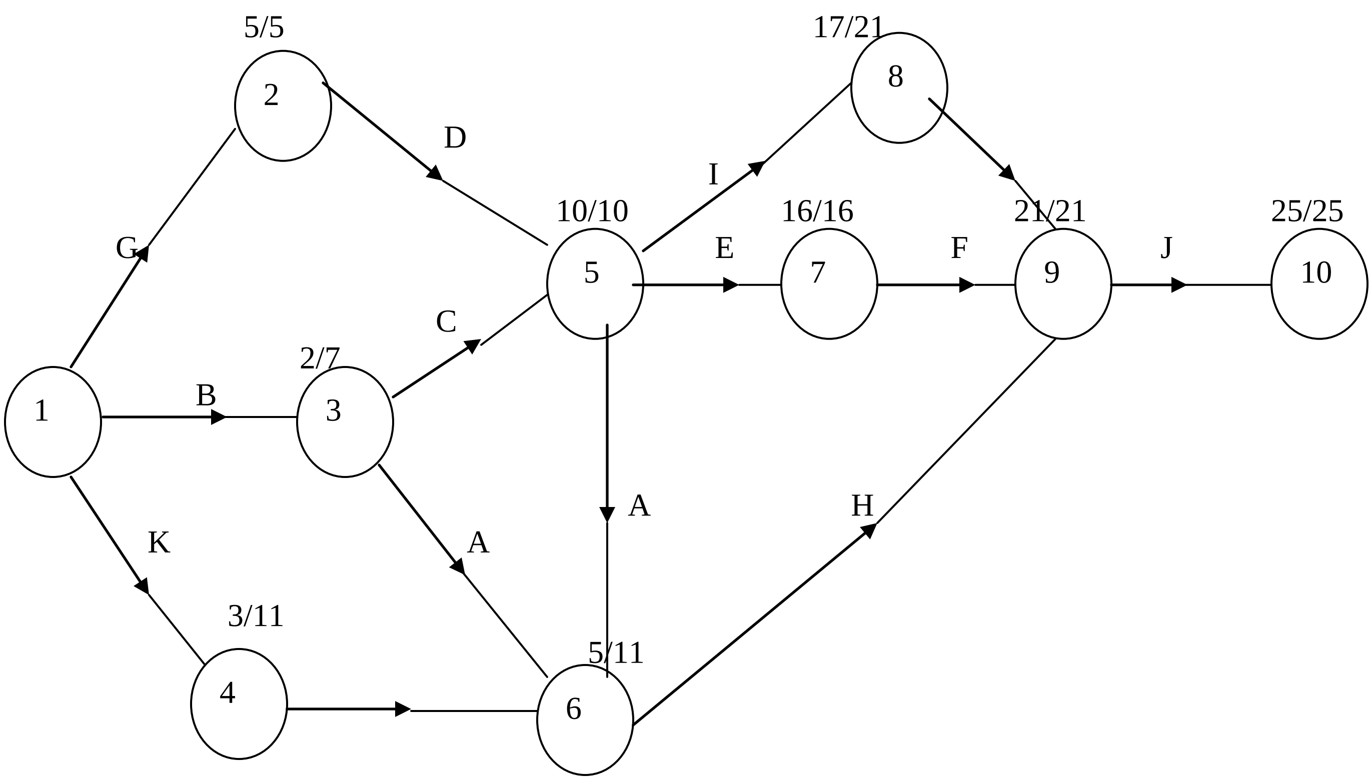
$$200 - 75 = 125 \text{ pounds at GHC85}$$

SOLUTION 2

(a) Network Diagram (AON)



Alternative Network Diagram (AOA)



(b) Critical path is : G – D – E – F – J

Project duration is: 25 days

(c) Let x be the project duration
Then x N (24.3, 1.1553)

$$P(x > 26) = P\left(\frac{x - 24.3}{1.1553} > \frac{26 - 24.3}{1.1553}\right)$$

$$= P(Z > 1.47)$$

From tables, P(x > 26) = 0.0708

(d) From the Gantt Chart the activities that were curtailed are E, H and I

SOLUTION 3

(a) The problem can be formulated as follows:

Max $Z = 25x_1 + 20x_2 + 15x_3$
S.t. $2x_1 + x_2 + 3x_3 \leq 400$ (Skilled Labour)
$4x_1 + 2x_2 + x_3 \leq 600$ (Leather)
$6x_1 + 2x_2 + x_3 \leq 1200$ (Glue)
$x_1 \leq 100$ (Demand for A)
$x_1, x_2, x_3 \leq 0$ (Non negativity)

(b) <u>Initial Simplex Tableau</u>

Basis	X1	X2	X3	S1	S2	S3	S4	Constant	……
S1	2	1	3	1	0	0	0	400	200
S2	4	2	1	0	1	0	0	600	150
S3	6	2	1	0	0	1	0	1200	200
S4	(1)	2	0	0	0	0	1	100	100
Ƶ	-25	-20	-15	0	0	0	0	0	

(c) From the illustration in the table above, the increase in total revenue is GH¢2500

(d) From the final Simplex Tableau;

(i) Production-mix is: $x_1 = 100$
$x_2 = 80$
$x_3 = 40$

(ii) Maximum total revenue = Max Ƶ = GH¢4900

(iii) Shadow price for skilled labour = GH¢2/hour

SOLUTION 4

(a) A time series is a numerical sequence in which individual values are generated at regular time intervals.

Examples:

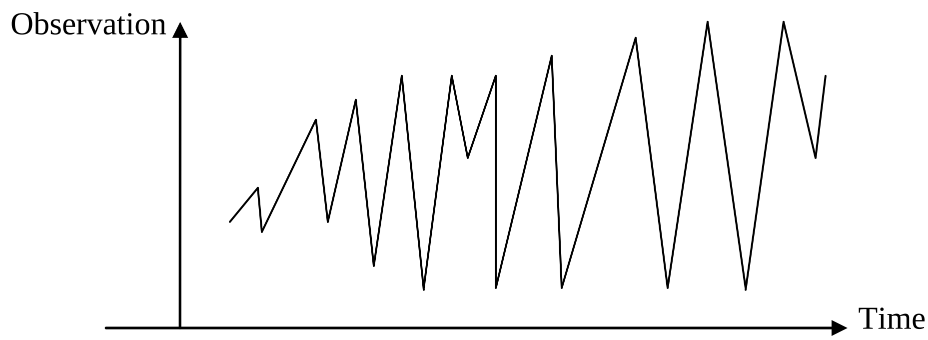
(i) Share prices on successive days

(ii) Average incomes in successive months

(iii) Company profits in successive years

(iv) Sales figures in successive weeks. etc.

(b) <u>Multiplication Model</u>



(c) (i) Let t be the coded time and T the trend sale figure (in GH¢'00).

Then $T = a + bt$

Where $b = \dfrac{n\Sigma tT - \Sigma t\Sigma T}{n\Sigma t^2 - (\Sigma t)^2}$

$a = \dfrac{\Sigma T - b\Sigma t}{n}$

Week	Day	t	T	tT	T^2	Trend	Seasonal Variation(s)
1	Mon	1	20	20	1	7.175	2.787
	Tue	2	19	38	4	10.464	1.816
	Wed	3	18	54	9	13.753	1.309
	Thur	4	19	76	16	17.042	1.115
	Fri	5	17	85	25	20.331	0.836
2	Mon	6	19	114	36	23.62	0.804
	Tue	7	20	140	49	26.909	0.743
	Wed	8	21	168	64	30.198	0.695
	Thur	9	20	180	81	33.487	0.597
	Fri	10	25	250	100	36.776	0.680
3	Mon	11	30	330	121	40.065	0.749
	Tue	12	40	480	144	43.354	0.923
	Wed	13	50	650	169	46.643	1.072
	Thur	14	65	910	196	49.932	1.302
	Fri	15	70	1050	225	53.221	1.315
		120	453	4545	1240		

$$\therefore\ b = \frac{15 \times 4545 - 120 \times 453}{15 \times 1240 - 120^2}$$

$$= 3.289$$

$$a = \frac{453 - 3.28 \times 120}{15}$$

$$\therefore\ T = 3.886 + 3.289t \text{ (Trend line)}$$

(ii) Seasonal Averages:

	Day					
Week	Mon	Tue	Wed	Thur	Fri	
1	2.787	1.816	1.309	1.115	0.836	
2	0.804	0.743	0.695	0.597	0.680	
3	0.749	0.923	1.072	1.302	1.315	Sum
S.A	1.447	1.161	1.025	1.005	0.944	= 5.582
Adj. Factor	x0.8957	x0.8957	x0.8957	x0.8957	x0.8957	
ASA	1.296	1.040	0.918	0.900	0.846	= 5

Daily Forecast for next week

Day	Trend (T)	SA1	Sale figure A(Y/GH¢'00)
Mon	3.886 + 3.289 (16) = 56.51	1.296	73.24
Tue	3.886 + 3.289 (17) = 59.799	1.040	62.19
Wed	3.886 + 3.289 (18) = 63.088	0.918	57.91
Thur	3.886 + 3.289 (19) = 66.377	0.900	59.74
Fri	3.886 + 3.289 (20) = 69.666	0.846	58.94

SOLUTION 5

(i) Total Cost (C) = $x^2 + 16x + 39$

Average Cost $\frac{C}{X} = \frac{x^2 + 16x + 39}{x}$

$= x + 16 + \frac{39}{x}$

(ii) Total Cost (C) = x2 + 16x + 39

Marginal Cost $= \frac{dc}{\dots} = 2x + 16$

$= 2x + 16$

(iii) Price (P) = $x^2 - 24x + 117$

Total Revenue (TR) = Px = $x^3 - 24x^2 + 117x$

Total Revenue (TR) $x^3 – 24x^2 + 117x$

(iv) Total Revenue (TR) = $x^3 – 24x^2 + 117x$

Marginal Revenue $= \frac{dTR}{dx} = 3x^2 - 48x + 117$

$= 3x^2 - 48x + 117$

x	0	1	2	3	4	5	6	7	8	9	10
x + 16 + 39/x	00	56	37.5	32	29.9	28.8	28.5	28.6	28.9	29.3	29.9
2x + 16	16	18	20	22	24	26	28	30	32	34	36
x2 – 48x + 117	117	72	33	0	-27	-48	-63	-72	-75	-72	-63

R = x3 – 24x2 + 117

Total Revenue (TR) is maximized where MR = c

$$MR = \frac{dTR}{dx} = 3x^2 - 48x + 117 = 0$$

$3x^2 - 48x + 117 = 0$

$3x^2 - 39x - 9x + 117 = 0$

$(x - 13)(3x - 9) = 0$

$x = 13, x = 3$

$$\frac{d\text{-}TR}{dx^2} = \frac{dMR}{dx} = 6x - 48$$

when x = 3, $\frac{dMR}{dx} = 18 - 48 = -30$

∴ x = 3 maximum

$P = x^2 - 24x + 117$

when x = 3

$P = 3^2 - 24(3) + 117 = 54$

P = x – 24x + 117 (Price function)

dP/dx – 2x – 24

$$\text{Elasticity } (x = 3) = \frac{P}{x} \cdot 1/dP/dx$$

$$= \frac{54}{3} \cdot \frac{1}{(2x - 24)}$$

$$= 18 \cdot \frac{1}{(6 - 24)} = -1$$

Elasticity = - 1

(v) Profit is maximized at mc = MR

From the graph at mc = MR

x = 2.35

$\text{Price } (x = 2.35) = (2.35)^2 - 24(2.35) + 117$

= 66.1225

$$\text{Elasticity } (x = 2.35) = \frac{66.1225}{2.35} \cdot [1/2(2.35) - 24)]$$

$$= \frac{28.137}{-19.3}$$

Elasticity = -1.458

SOLUTION 6

Random sampling is a sampling technique in which all observations have an equal chance to being selected. Example: if there are 10 balls in a box, the selection of any one of random has equal chance of 1/10 of being selected. Their sampling method is mostly used by Lotteries.

Quota sampling is a sampling technique where quotas are allotted to identifiable groups and from each group selection is made. The groups are homogenous in character. Example: if a representation is required for a university student's body, quotas can be given to each university then within each group another sampling method could be used to select the observations. This technique is used by FIFA to select representations for its tournaments.

Systematic sampling is a sampling technique of selecting sample members from a larger population according to a random starting point and a fixed, periodic interval. Typically, every "nth" member is selected from the total population for inclusion in the sample population.
For example, if you wanted to select a random group of 1,000 people from a population of 50,000 using systematic sampling, you would simply select every 50th person, since 50,000/1,000 = 50. Another example is selecting samples from a production line where every 10^{th} product can be selected for inspection.

<u>Frequency Distribution Table</u>

<table>
<tr><th>Yields (kg)</th><th>Tally</th><th>Frequency</th></tr>
<tr><td>10 – 14</td><td>|</td><td>1</td></tr>
<tr><td>15 – 19</td><td>||</td><td>2</td></tr>
<tr><td>20 – 24</td><td>卌</td><td>5</td></tr>
<tr><td>25 – 29</td><td>卌 |</td><td>6</td></tr>
<tr><td>30 – 34</td><td>卌 |||</td><td>8</td></tr>
<tr><td>35 – 39</td><td>卌 ||||</td><td>9</td></tr>
<tr><td>40 – 44</td><td>卌 ||</td><td>7</td></tr>
<tr><td>45 – 49</td><td>卌</td><td>5</td></tr>
<tr><td>50 – 54</td><td>|||</td><td>3</td></tr>
<tr><td>55 – 59</td><td>|||</td><td>3</td></tr>
<tr><td>60 - 64</td><td>|</td><td>1</td></tr>
<tr><td></td><td></td><td>Σf50</td></tr>
</table>

(ii) Cumulative Frequency Distribution Table

Less than	Σf
9.5-	0
14.5	1
19.5	3
24.5	8
29.5	14
34.5	22
39.5	31
44.5	38
49.5	43
54.5	46
59.5	49
64.5	50

Frequency Table

Fields	Frequency(f)	Mid- point (x)	fx	x^2	fx^2
- 14	1	12	12	144	144
- 19	2	17	34	289	578
- 24	5	22	110	484	2420
- 29	6	27	162	729	4374
- 34	8	32	256	1024	8192
- 39	9	37	333	1369	12 321
- 44	7	42	294	1764	12 348
5– 49	5	47	235	2209	11 045
2– 54	3	52	156	2704	8 112
5 – 59	3	57	171	3249	9 747
2 - 64	1	62	62	3844	3 844
	Σf50		Σfx1825		$\Sigma fx^2$73,125

$$\text{Mean } (x) = \frac{\Sigma fx}{\Sigma f} = \frac{1825}{50} = \underline{\underline{36.5\text{ kg}}}$$

$$\text{Std deviation} = \sqrt{\frac{\Sigma fx^2}{\Sigma f} - \left(\frac{\Sigma fx}{\Sigma f}\right)^2}$$

$$= \sqrt{\frac{73125}{50} - \left(\frac{1825}{50}\right)^2}$$

$$= \sqrt{1462.5 - 1332.25} = \sqrt{130.25}$$

$$\sigma = \underline{\underline{11.41\text{ kg}}}$$

From above

mean = 36.5 kg and

σ = 11.41 kg

Interval within one std deviation of mean

= [25.09, 47.91]

on the chart, ((41 – 63) = 35) 35 trees

…. Within x + σ, which is $\frac{35}{52}$ = 70%

SOLUTION 7

(a) Let L = {worker comes late}

M = {worker is male}

P(L/M) = 0.08

P(M) = $\frac{150}{500}$ = 0.30

Pr (A male late comer) = P(L∩M)

= P(M) P(L/M)

= 0.30 x 0.08

= 0.24

(b) Quarterly Production Levels Matrix:

P =

Q1	Q2	Q3	Q4	
4000	4500	4500	4000	A
2000	2600	2400	2200	B
5800	6200	6000	6000	C

(c) Unit Production Costs Matrix:

C =

A	B	C	
100	300	150	Raw materials
300	400	250	Labour
100	200	150	overheads

The matrix CP gives the quarterly costs

i.e

$$CP = \begin{pmatrix} 100 & 300 & 150 \\ 300 & 400 & 250 \\ 100 & 200 & 150 \end{pmatrix} \begin{pmatrix} 4000 & 4500 & 4500 & 4000 \\ 2000 & 2600 & 2400 & 2200 \\ 5800 & 6200 & 6000 & 6000 \end{pmatrix}$$

$$= \begin{pmatrix} 185000 & 216000 & 207000 & 196000 \\ 345000 & 394000 & 381000 & 358000 \\ 167000 & 190000 & 183000 & 174000 \end{pmatrix}$$

Hence the following table can be presented at the stockholders' meeting.

	Quarter				
Category	Q1	Q2	Q3	Q4	Total
Raw Material	185000	216000	207000	196000	806000
Labour	345000	394000	381000	358000	1478000
Overheads	167000	190000	183000	174000	714000
Total	699000	800000	771000	728000	2998000