ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Advanced Level

MARKING SCHEME

NOVEMBER 2018

$E\,a(X) + E\,b(Y)$

STATISTICS **6046/2**

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1 (a) Any three from the following:

- It allows quicker contact with respondents B1
- callbacks can be made if the respondent is not initially available B1
- probing is possible B1
- a larger sample of respondents can be reached in a short space of time

(b) (i)

0	6	7	8	8	8						
1	0	1	2	3	4	6	6	7	7	8	9
2	0	2	3	6	7						
3	3	5	7								
4	0	2	3	6	7						

B1 Correct stem

B1 Correct 10 leaves

B1 all correct

B1 key

Key 3/ 5 means 35

(ii) Original data is preserved B1 [8]

2 (a) In permutations, order of arrangement is important whilst in combinations, order is not important B1 B1 [2]

(b) (i) ${}^{8}C_{2} = \frac{8!}{6!2!}$ M1

$= 28$ A1

(ii) ${}^{5}C_{1} \times {}^{3}C_{1} = 5 \times 3$ M1

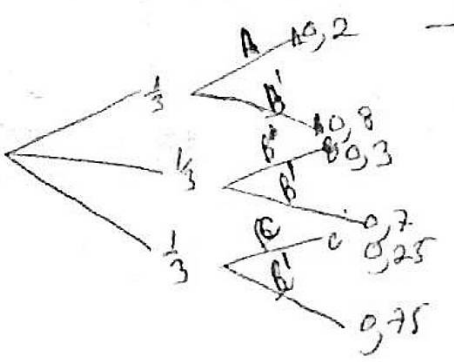
$= 15$ A1

(iii) P(1 faulty) $= \frac{15}{28}$ M1

$= 0,54$ A1 [8]

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3 (a)



B1 construction of tree diagram with labels 3 branches (A, B, C)

B1 correct prob either set of branch

B1 for all correct prob with $\frac{1}{3}$

(b) (i) $\left(\frac{1}{3} \times 0{,}2\right) + \left(\frac{1}{3} \times 0{,}3\right) + \left(\frac{1}{3} \times 0{,}25\right)$ M1

$= 0{,}25$ A1

(ii) $P\left(C/_{bd}\right) = \frac{P(C \cap bd)}{P(bd)}$

$= \frac{\frac{1}{3} \times 0{,}25}{0{,}25}$ correct numerator B1; M1 for his denominator

$= \frac{1}{3}$ A1

4 (a)

x	2	3	4	5	6
$P(X = x)$	$\frac{1}{36}$	$\frac{4}{36}$	$\frac{10}{36}$	$\frac{12}{36}$	$\frac{9}{36}$

B1 values of x

B1 Any 2 correct prob

B1 All correct probs values

3	4	5	6
2	3	4	5
1	2	3	4
	1	2	3

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(b) P(Prime) $= \frac{17}{36}$ } correct answer
$= 0,4722$ } B1

(c) (i) $E(X) = 2\times\frac{1}{36} + 3\times\frac{4}{36} + 4\times\frac{10}{36} + 5\times\frac{12}{36} + 6\times\frac{9}{36}$ ✓ M1
$= 4,6667 = 4\frac{2}{3}$
$4,6 \approx 4,7$ A1

(ii) $Var(X) = 4\times\frac{1}{36} + 9\times\frac{4}{36} + 16\times\frac{10}{36} + 25\times\frac{12}{36} + 36\times\frac{9}{36} - (4,6667)^2$ M1
$\frac{10}{9} = 1,11$ A1 [8]

5 (a) $\int_0^\infty ke^{-\frac{x}{3}}dt = 1$

$\left[-3ke^{-\frac{x}{3}}\right]_0^\infty = 1$ attempt to $\int^\infty$ with correct limits and $= 1$ M1

$3k = 1$

$k = \frac{1}{3}$ A1

(b) $\frac{1}{3}\int_0^\infty x.e^{\frac{-x}{3}}dx$ correct ~~M1~~

Let $u = x$ $\frac{dv}{dx} = e^{\frac{-x}{3}}dx$

$du = dx$ $v = -3e^{\frac{-x}{3}}$

$= \frac{1}{3}\left[-3xe^{\frac{-x}{3}} - \int -3e^{\frac{-x}{3}}dx\right]$ attempt to $\int$ by parts M1

$= -xe^{-\frac{x}{3}} + \int e^{-\frac{x}{3}}dx$ Simplification ~~M1~~ A1

$= \left[xe^{-\frac{x}{3}} - 3e^{-\frac{x}{3}}\right]_0^\infty$ Attempt to $\int$ M1

$= 3$ CAO A1

(c) $P(X \geq 60) = \frac{1}{3}\int_{60}^\infty e^{-\frac{x}{3}}dx$

$= \left[-e^{-\frac{x}{3}}\right]_{60}^\infty$ attempt to $\int$ with limits M1

$= e^{-20}$ or equiv. (exact answer) A1

[8]

or $1 - \frac{1}{3}\int_0^{60} e^{-\frac{x}{3}}dx$

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6 (a) (i) $X \sim Bin(8; 0.9)$ B1

$P(x = 6) = {}^{8}C_{6}(0.9)^{6}(0,1)^{2}$ M1

$= 0,149$ A1

(ii) $X \sim Bin(20; 0.9)$ B1

$P(x < 18) = 1 - [P(x = 18) + P(x = 19) + P(x = 20)]$ B1

$= 1 - [0,285 + 0,27 + 0,12)$ M1

$= 0,32$ A1

(iii) $X \sim N(180; 18)$ B1

$P(X \leqslant 182) = P(X \leqslant 182.5)$ B1

$= P\left(Z < \frac{182.5 - 180}{\sqrt{18}}\right)$ M1

$= P(Z < 0,5892)$

$= 0.7224$ A1 [11]

(b) (i) $\frac{1-p}{p^2} = 12$ M1

$12p^2 + p - 1 = 0$

$(3p + 1)(4p - 1) = 0$ M1

$p = \frac{1}{4}$ and $p = -\frac{1}{3}$

$\therefore p = \frac{1}{4}$ A1

(ii) $P(X > 3) = 1 - P(X \leq 3)$

$= 1 - [P(x = 1) + P(x = 2) + P(x = 3)]$

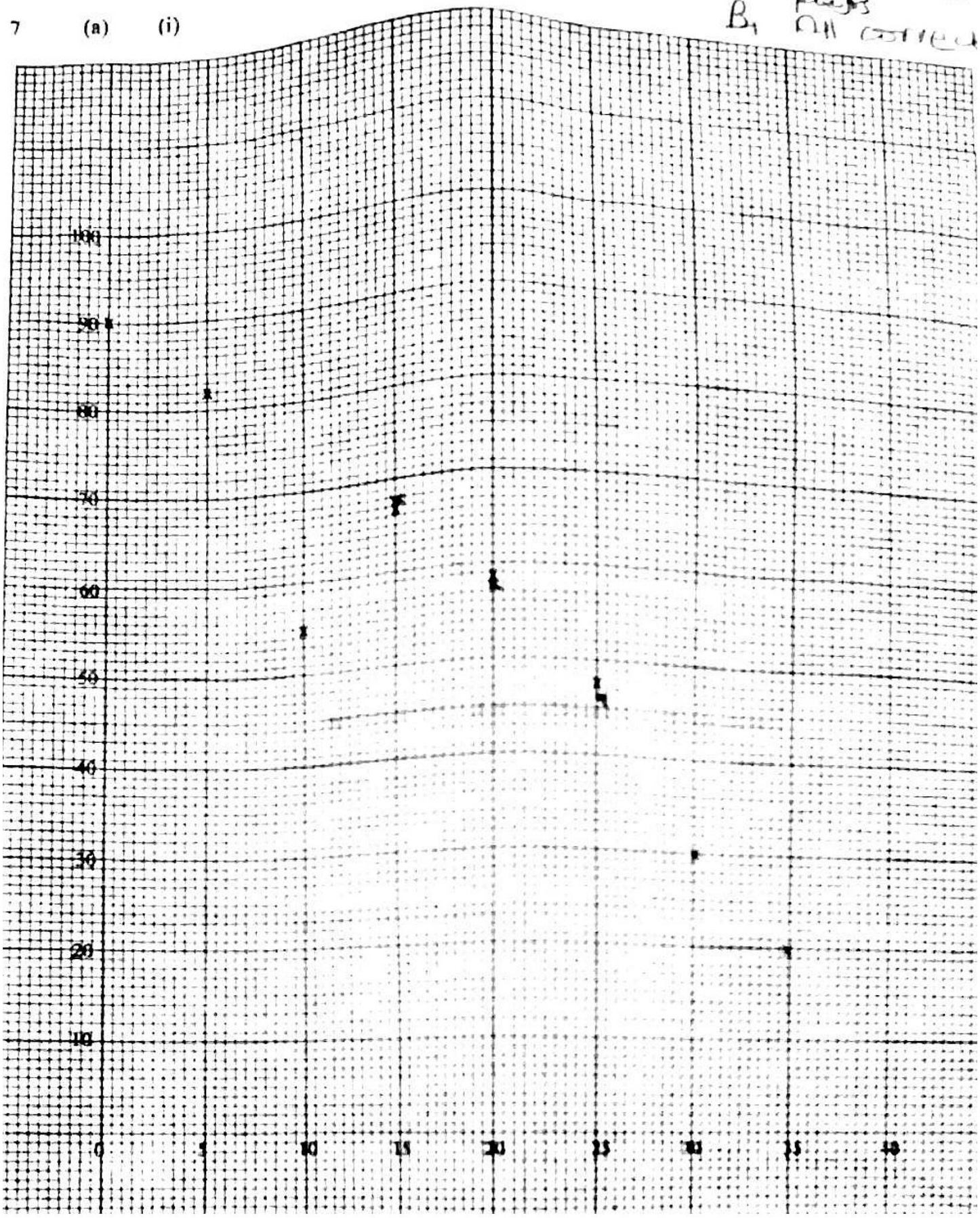
$= 1 - \left[\frac{1}{4} + \frac{3}{4} \times \frac{1}{4} + \left(\frac{3}{4}\right)^2 \times \frac{1}{4}\right]$ M1

$= 0,422$ A1 [5]

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B_1 Scale and La
Any 4 cor
plots
B_1 All correct

7 (a) (i)



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$= -0,9576$ A1

(ii) There is a very strong negative linear correlation B1B1 [4]

(c) (i) $m = \frac{8(5\,900)-(140)(450)}{8(3\,500)-140^2}$ M1

$= -1,88$ A1

$M - 56,25 = -1,88(D - 17,5)$ Substitution M1A1 [4]

(ii) (a) When $D = 12$, $M = -1,88(12 - 17,5) + 56,25$ Substitution M1

$= 66,59$ A1

(b) Not possible, it is out of range. B1 B1B1 [4]

8 (a) (i) $\bar{x} = 50 + \frac{123,5}{100}$ M1

$= 51,235$ A1

$\hat{\sigma}^2 = \frac{1}{99}\left(238,4 - \frac{123,5^2}{100}\right)$ M1

$= 0,867$ A1

(ii) $51,235 \pm 2,17\sqrt{\frac{0,867}{100}}$ B1M1

$51,235 \pm 0,202$

$(51,\dot{2}3 - 51,437)$ A1A1

(iii) $P(\bar{x} > 51) = P\left(Z > \frac{51-51,235}{\sqrt{\frac{0,867}{100}}}\right)$ M1

$= P(Z > -0,2524)$

$= 0,5994$ A1 [10]

(b) (i) $X \sim Po(6)$

$P(X \leq 2) = P(X = 0) + P(X = 1) + P(X = 2)$

$= \frac{e^{-6}6^0}{0!} + \frac{e^{-6}6^1}{1!} + \frac{e^{-6}6^2}{2!}$ Substitution M1

$= e^{-6}(1 + 6 + 18)$

$= 0,0619$ A1

(ii) $X \sim Po(3)$ B1

$P(X = 0) = \frac{e^{-3}3^0}{0!}$ M1

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9 = 0,0498

(a) $L_1 + L_2 + L_3 + \ldots + L_5 \sim N(2\,100; 67{,}08^2)$ A1 [6]

$P(L_1 + L_2 \ldots L_5 > 2\,100) = P(z > 0)$ B1

$= 0{,}5$ M1 A1 [3]

(b) $P(L_1 + L_2 \ldots + L_5 < S_1 + S_2 \ldots + S_{10})$

$P(Y - X < 0)$

$Y - X \sim N(-100; 5\,500)$ B1 B1

$P(Y - X < 0) = P\left(z < \frac{+100}{\sqrt{5\,500}}\right)$ M1

$= P(z < 1{,}348)$

$= 0{,}9113$

$= 0{,}0887$ A1 [4]

(c) $\theta(Y + X) \sim N(4\,300, \sqrt{5\,500^2})$ B1

$P(4\,250 < Y + X < 4\,400)$

$= P\left(\frac{4\,250 - 4\,300}{\sqrt{5\,500}} < z < \frac{4\,400 - 4\,300}{\sqrt{5\,500}}\right)$ M1

$= P(-0{,}67 < z < 1{,}34)$

$= \Phi(1{,}34) + \Phi(0{,}67) - 1$ M1

$= 0{,}9099 + 0{,}7486 - 1$

$= 0{,}6585$ A1 [4]

(d) $P(L \geq 2S) = P(L - 2S \geq 0)$

$L - 2S \sim N(-20; 1\,300)$ B1B1

$P(L - 2S \geq 0) = P\left(z \geq \frac{20}{\sqrt{1\,300}}\right)$ M1

$= P(z \geq 0{,}015)$

$= 1 - \Phi(0{,}5547)$

$= 1 - 0{,}7102$ M1

$= 0{,}2898$ A1 [5]

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10 (a) (i) A one tailed test looks for an increase or decrease whilst a two tailed test looks for a change in the mean — B1 B1

(ii) A statistic is a measure from a sample whilst a parameter is a measure from a population — B1 B1

(iii) A population is the entire group under study whilst a sample is part of a population — B1 B1

(b) $\bar{x} = 4,978$ — B1 [6]

$S^2 = 0,019^2$

$\frac{1}{9}\left(\Sigma x^2 - \frac{(\Sigma x)^2}{10}\right) = \frac{1}{9}(\quad - 4,978^2)$ → M1A1

$\frac{1}{9}(247,802 - \frac{49,78^2}{10})$ anw → B2

$= 9,000373\ldots$

$H_0: \mu = 5$

$H_1: \mu \neq 5$ — B1

$T_{cal} = \frac{4,978 - 5}{\frac{0,019}{\sqrt{10}}}$ — M1

$= -3,47$ $-3,6616$ → A1

$T_{99,5}(8) = 3,355$ $3,250$ B1 — B1B1

$3,6616 > 3,250$

Since $-3,47 < -3,355$, we reject Ho and conclude its not in good working order. — M1A1

[10]

11 (a) (i) A time series is a set of observations of a random variable in chronological (time) order. — B2

(ii) A trend is a general increase or decrease — B1

[3]

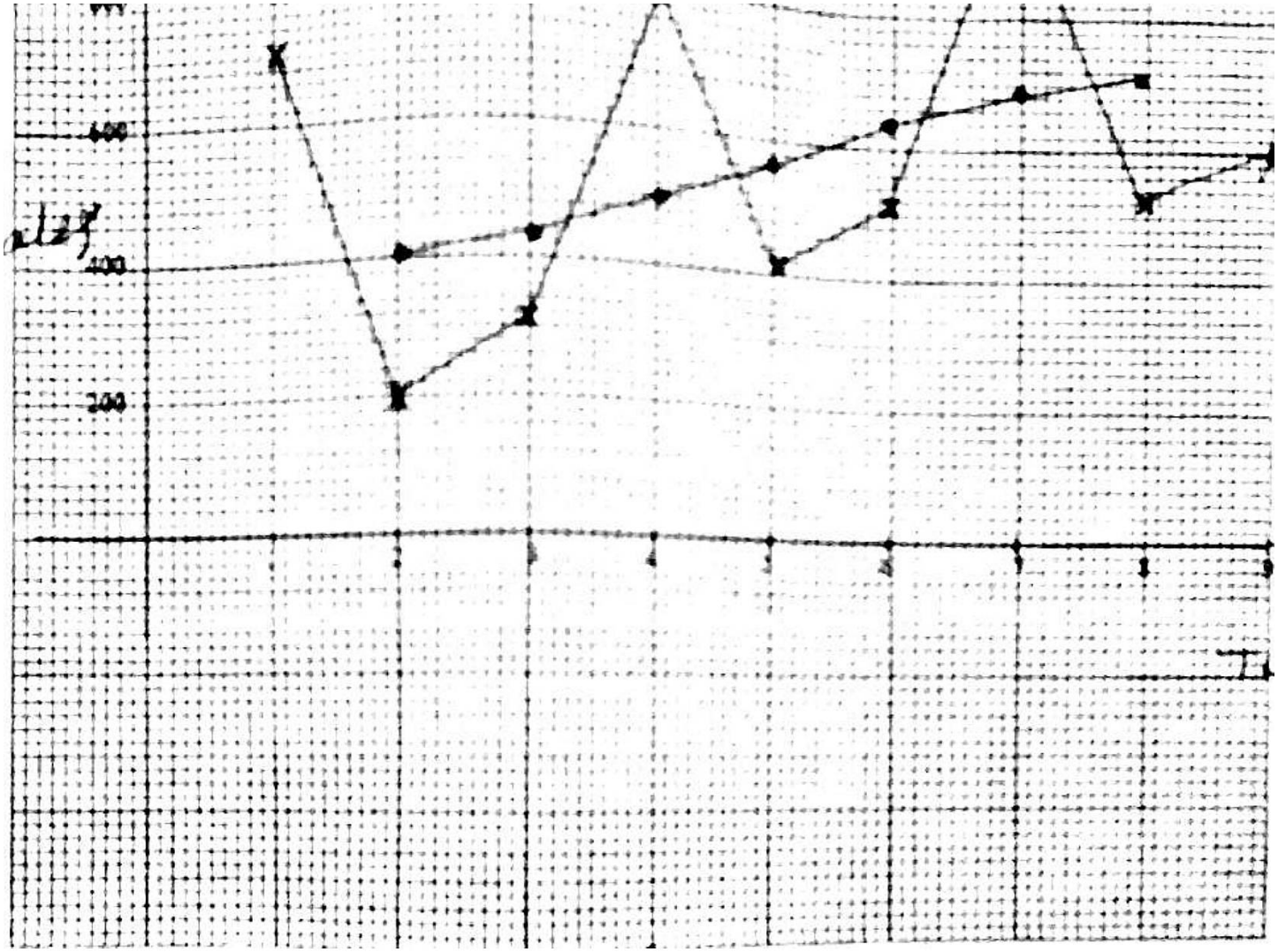
(b)(i)

	Sales	3 point M.A
1.	700	
2.	200	400
3.	300	433
4.	800	500
5.	400	566
6.	500	633
7.	1 000	666
8.	500	700
9.	600	766
10.	1 200	

M1 Any one correct
A1 all correct
A1 any 4 correct
★ All correct
B1 → Centering correctly B2

(ii) – There was a general increase in sales — B1

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12 H_0: the observations follow a Normal distribution with mean 163 — B1

H_1: the observations does not follow a Normal distribution with mean 163 — ~~B1~~

O	E	
4	2,65	3,58
18	18,18	20,47
40	36,9	36,55
20	22,8	20,47
3	4,47	3,9

M1A1 Any one correct E(H)

A1 — All correct E(H)

O	E	$\frac{(O-E)^2}{E}$
22	20,8	0,069
40	36,9	0,260
23	27,2	0,648
		0,977

B1 pooling

M1A1 → Any one correct

A1 → Second pair correct

M1A1 → 3rd pair correct

B1B1 → Reduction

$\chi^2_{5\%}(2) = 5,991$

Since 0,977 < 5,59 we accept Ho and conclude that it follows a Normal distribution with a mean of 163.

~~B1~~ M1 Comparison

~~B1~~ A1 Conclusion

[16]

Since 0,977 < 5,99

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