HOJA 9: VARIABLE ALEATORIA.

1

	1	2	3	4	5	6
1	0	1	2	3	4	5
2	1	0	1	2	3	4
3	2	1	0	1	2	3
4	3	2	1	0	1	2
5	4	3	2	1	0	1
6	5	4	3	2	1	0

$X = \{0, 1, 2, 3, 4, 5\}$

$p(X=0) = \frac{6}{36} = \frac{1}{6}$; $p(X=3) = \frac{6}{36} = \frac{1}{6}$

$p(X=1) = \frac{10}{36} = \frac{5}{18}$; $p(X=4) = \frac{4}{36} = \frac{1}{9}$

$p(X=2) = \frac{8}{36} = \frac{2}{9}$; $p(X=5) = \frac{2}{36} = \frac{1}{18}$

x_i	$p_i = p(X=x_i)$	$p(X \le x_i)$
0	1/6	6/36 = 1/6
1	5/18	16/36 = 4/9
2	2/9	24/36 = 2/3
3	1/6	30/36 = 5/6
4	1/9	34/36 = 17/18
5	1/18	36/36 = 1.
	$\Sigma = 1$	

———— o ————

2 a) $0'4 + p + 0'2 + 0'07 + 0'02 = 1 \Rightarrow p = 0'31$

b) $E(X) = \Sigma x_i p_i = 1 \cdot 0'4 + 2 \cdot 0'31 + 3 \cdot 0'2 + 4 \cdot 0'07 + 5 \cdot 0'02 = 2$

———— o ————

3 $P(1) = \frac{1^2+1}{20} = \frac{2}{20} = \frac{1}{10}$; $P(2) = \frac{2^2+2}{20} = \frac{6}{20} = \frac{3}{10}$; $P(3) = \frac{3^2+3}{20} = \frac{12}{20} = \frac{3}{5}$

x_i	p_i	$x_i p_i$	$x_i^2 p_i$
1	1/10	1/10	1/10
2	3/10	6/10	12/10
3	6/10	18/10	54/10
		$\Sigma = 25/10$	$\Sigma = 67/10$

$\mu = \Sigma x_i p_i = \frac{25}{10} = 2'5$

$\sigma^2 = \Sigma x_i^2 p_i - \mu^2 = \frac{67}{10} - 2'5^2 = 0'45$

$\sigma = \sqrt{0'45} = 0'671.$

———— o ————

4 a) $p(\text{múltiplo de } 3) = \frac{2}{6} = \frac{1}{3}$; $p(\text{no múltiplo de } 3) = \frac{4}{6} = \frac{2}{3}$

Sea X = "ganancia en el juego".

x_i	p_i	$x_i p_i$
6	1/3	2
−4	2/3	−8/3
		$\Sigma = 2 - \frac{8}{3} = -\frac{2}{3}$

$\mu = -\frac{2}{3}$, en promedio pierde, luego no debe aceptar el juego.

b)

x_i	p_i	$x_i p_i$
a	1/3	a/3
−4	2/3	−8/3

$\Sigma = \frac{a}{3} - \frac{8}{3} = \frac{a-8}{3} = 0 \Rightarrow a = 8$ €

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(5)

x_i	p_i	$x_i p_i$
6000	0'03	180
3500	0'12	420
1000	0'35	350
0	0'50	0
		$\Sigma = 950$

$\mu = 950$ €

$950 + 80 = 1030$ € debe cobrar al menos.

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(6) Sea X = "ganancia en el juego" $\Rightarrow X = \{0, K\}$

x_i	p_i	$x_i p_i$
0	0'6	0
K	0'4	0'4K
		$\Sigma = 0'4K$

Luego: $\mu = 0'4K$

Para que el juego sea justo: $0'4K = 10$

$\Rightarrow K = \frac{10}{0'4} = 25$

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(7) a) $p(X>1) = p(X=2) + p(X=3) = r + 0'2 = 0'5 \Rightarrow r = 0'3$

b) $E(X) = 0 \cdot p + 1 \cdot q + 2 \cdot 0'3 + 3 \cdot 0'2 = 1'4 \Rightarrow q + 0'6 + 0'6 = 1'4$

$\Rightarrow q = 0'2$.

$p + 0'2 + 0'3 + 0'2 = 1 \Rightarrow p + 0'7 = 1 \Rightarrow p = 0'3$.

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8) a)

3;9	4;9	5;9
3;10	4;10	5;10
3;10	4;10	5;10

b) $S = \{12; 13; 14; 15\}$

c)

12	13	14
13	14	15
13	14	15

$p(12) = \frac{1}{9}$; $p(13) = \frac{3}{9} = \frac{1}{3}$; $p(14) = \frac{3}{9} = \frac{1}{3}$

$p(15) = \frac{2}{9}$

d)

S	pi
12	1/9
13	3/9
14	3/9
15	2/9

$\Sigma x_i p_i = \frac{12}{9} + \frac{39}{9} + \frac{42}{9} + \frac{30}{9} = \frac{123}{9} = 13'67$.

e)

xi	pi	xi·pi
50	4/9	200/9
-30	5/9	-150/9
		$\Sigma = \frac{50}{9}$

Luego: $\frac{50}{9} \cdot 36 = 200$ \$.

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9) $B(4; 0'7)$

a) $p(X=4) = \binom{4}{4} \cdot 0'7^4 \cdot 0'3^0 = 0'2401 = 24'01\%$

b) $p(X=0) = \binom{4}{0} \cdot 0'7^0 \cdot 0'3^4 = 0'0081 = 0'81\%$

c) $p(X \geq 2) = 1 - p(X \leq 1) = 1 - 0'0837 = 0'9163 = 91'63\%$

d) $\mu = n \cdot p = 4 \cdot 0'7 = 2'8$.

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10) a) 2 calculadoras (2% de 100).

b) $B(100; 0'02)$; $p(X=3) = \binom{100}{3} \cdot 0'02^3 \cdot 0'98^{97} = 0'1823 = 18'23\%$

c) $p(X>1) = 1 - p(X \leq 1) = 1 - 0'40327 = 0'5967 = 59'67\%$

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(11) $B(20;\ \frac{1}{6})$

a) $p(X=5)=\binom{20}{5}\cdot\left(\frac{1}{6}\right)^{5}\left(\frac{5}{6}\right)^{15}=0'12941=12'94\%$

b) $12'94\%$ de $100=12'94\simeq 13$ viajeros.

———— o ————

(12) èxito = ser niña ; $p=0'5 \Rightarrow B(10;\ 0'5)$.

a) $p(X\leq 3)=0'17 19=17'19\%$

b) $p(X\geq 1)=1-p(X=0)=1-0'000977=0'999=99'9\%$

c) Al menos 8 niños = 2 niñas o menos $\Rightarrow p(X\leq 2)=0'05469=5'47\%$

d) $1-\left(p(X=0)+p(X=10)\right)=1-(0'000977+0'000977)=0'998=99'8\%$.

———— o ————

(13) èxito = no tener etiqueta $\Rightarrow B(6;\ 0'15)$.

a) $p(X=6)=0'0000114=0'00114\%$

b) Al menos la mitad etiquetados = 3 o más con etiqueta =

= 3 o menos sin etiqueta.

$p(X\leq 3)=0'99411=99'41\%$.

———— o ————

(14) a) $B(50;\ \frac{1}{2})\Rightarrow \mu=n\cdot p=50\cdot\frac{1}{2}=25$ caras.

b) $B(60;\ \frac{1}{6})\Rightarrow \mu=n\cdot p=60\cdot\frac{1}{6}=10$ "seises".

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(15) $B(800;\ 0'49)$

a) $p(X=392)=0'028206=2'82\%$

b) $p(X>400)=1-p(X\leq 400)=1-0'72617=0'27383=27'38\%$

c) $p(398\leq X\leq 405)=p(X\leq 405)-p(X\leq 397)=0'83015-0'65141=$
$=0'17874=17'87\%$

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16) $B(5;\ 1/3)$ a) $p(X=5) = 0'00412 = 0'412\%$

b) $p(X=3) = 0'1646 = 16'46\%$.

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17) $B(80;\ 0'25)$

a) $p(X \geq 30) = 1 - p(X \leq 29) = 1 - 0'99106 = 0'00894 = 0'894\%$

b) $p(5 \leq X \leq 55) = p(X \leq 55) - p(X \leq 4) = 1 - 2'32 \cdot 10^{-6} \simeq 1$.

c) $p(X > 55) = 1 - p(X \leq 55) = 1 - 1 = 0$.

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18) a) Exito = extraer disco negro : $B(8;\ \frac{5}{40})$

$p(X=1) = 0'39269 = 39'27\%$

$p(X \geq 1) = 1 - p(X=0) = 1 - 0'3436 = 0'6564 = 65'64\%$

b) $B(400;\ \frac{5}{40})$; $\mu = n \cdot p = 400 \cdot \frac{5}{40} = 50$ discos.

$p(X \geq 48) = 1 - p(X \leq 47) = 1 - 0'35884 = 0'64116 = 64'12\%$

$p(X=48) = 0'058505 = 5'85\%$

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19) a) $B(3;\ \frac{1}{3})$; $p(X=3) = \binom{3}{3}\left(\frac{1}{3}\right)^3 \cdot \left(\frac{2}{3}\right)^0 = 0'037 = 3'7\%$

$p(X=2) = \binom{3}{2}\left(\frac{1}{3}\right)^2\left(\frac{2}{3}\right)^1 = 0'2222 = 22'22\%$

b) $B(12;\ \frac{1}{3})$; $\mu = n \cdot p = 12 \cdot \frac{1}{3} = 4$ caras.

x_i	p_i	$x_i p_i$
10	1/3	10/3
−6	2/3	−12/3
		$\Sigma = -\frac{2}{3}$

$\mu = -\frac{2}{3} \Rightarrow$ espera perder $\frac{2}{3}$ \$ por jugada.

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(20) a)

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

Pares cuya suma es 6:

(2,4) ; (3,3) ; (4,2)

b) $p = \frac{1}{16}$; $q = \frac{2}{16}$; $r = \frac{2}{16}$

c) $B(4; \frac{4}{16}) = B(4; 0'25)$

$p(X \geq 3) = 1 - p(X \leq 2) = 1 - 0'94921 = 0'05079 = 5'08\%$.

———— o ————

(21) $B(600; 0'4)$

a) i) $\mu = n \cdot p = 600 \cdot 0'4 = 240$ caras.

ii) $\sigma = \sqrt{n \cdot p \cdot q} = \sqrt{600 \cdot 0'4 \cdot 0'6} = 12$.

b) $\mu \pm \sigma = 240 \pm 12 = (228; 252)$

$p(228 < X < 252) = p(229 \leq X \leq 251) = 0'6621 = 66'21\%$ (con GDC).

———— o ————

(22) $B(3; \frac{1}{4})$

a) $\mu = n \cdot p = 3 \cdot \frac{1}{4} = \frac{3}{4} = 0'75$ veces.

b) i) $p(X = 2) = 0'1406 = 14'06\%$; ii) $p(X \geq 1) = 1 - p(X < 1) =$

$= 1 - p(X = 0) = 1 - 0'4219 = 0'5781 = 57'81\%$

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(23) a) $B(2; 0'4)$

i) $p(X = 0) = 0'36$; ii) $p(X = 1) = 0'48$

ii) $E(X) = \mu = n \cdot p = 2 \cdot 0'4 = 0'8$; o también:

x_i	0	1	2
p_i	0'36	0'48	0'16

$p(X = 2) = 1 - 0'36 - 0'48 = 0'16$

$\mu = 0 \cdot 0'36 + 1 \cdot 0'48 + 2 \cdot 0'16 = 0'8.$

b) $B(14; 0'4) \Rightarrow p(X=5) = 0'2066 = 20'66\%$

c) $p(X \leq 5) = 0'4859 = 48'59\%$

d) $p(X=5 / X \leq 5) = \dfrac{p(X=5 \cap X \leq 5)}{p(X \leq 5)} = \dfrac{p(X=5)}{p(X \leq 5)} = \dfrac{0'2066}{0'4859} =$

$= 0'4252 \simeq 0'43.$

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(24) $N(2; 0'1)$; $p(1'85 \leq X \leq 2'15) = p\left(\dfrac{1'85-2}{0'1} \leq Z \leq \dfrac{2'15-2}{0'1}\right) =$

$= p(-1'5 \leq Z \leq 1'5) = p(Z \leq 1'5) - p(Z \leq -1'5) =$

$= p(Z \leq 1'5) - [1 - p(Z \leq 1'5)] = 0'93319 - 1 + 0'93319 = 0'86638$

$10000 \cdot 0'86638 = 8663'8 \simeq 8664$ tornillos válidos.

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(25) Proveedor 1: $N(8'5; 1)$ (*)

Proveedor 2: $N(8'5; 0'75)$ (**)

(*) $p(X \leq 10) = p\left(Z \leq \dfrac{10-8'5}{1}\right) = p(Z \leq 1'5) = 0'93319 = 93'32\%$

(**) $p(X \leq 10) = p\left(Z \leq \dfrac{10-8'5}{0'75}\right) = p(Z \leq 2) = 0'97724 = 97'72\%$

Sí debería cambiar de proveedor.

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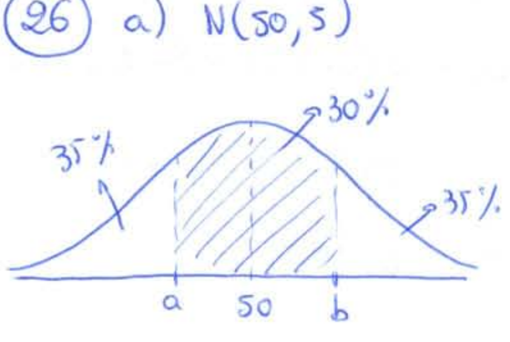
(26) a) $N(50, 5)$



$p(X \leq b) = 0'65 \Rightarrow p\left(Z \leq \dfrac{b-50}{5}\right) = 0'65 \Rightarrow$

$\Rightarrow \dfrac{b-50}{5} = 0'38532 \Rightarrow b = 50 + 5 \cdot 0'38532 =$

$= 51'93$; $a = 50 - 5 \cdot 0'38532 = 48'07$

b) $p(47 \le \bar{X} \le 56) = p\left(\frac{47-50}{5} \le Z \le \frac{56-50}{5}\right) = p(-0'6 \le Z \le 1'2) =$

$= p(Z \le 1'2) - p(Z \le -0'6) = p(Z \le 1'2) - [1 - p(Z \le 0'6)] = 0'88493 - 1 + 0'72574 =$

$= 0'61067 = 61'07\,\%$ $\qquad 100\% - 61'07\% = 38'93\,\%$

$38'93\%$ de $300 = 116'79 \simeq 117$ personas.

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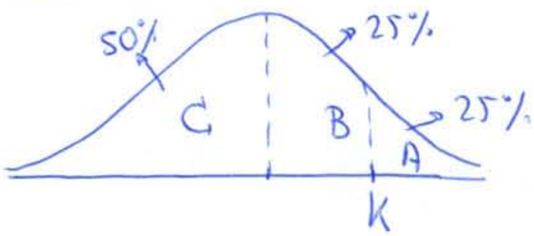
(27) $N(85; 15)$



$p(X \le K) = 0'75 \Rightarrow p\left(Z \le \frac{K-85}{15}\right) = 0'75$

$\frac{K-85}{15} = 0'67448 \Rightarrow K = 95'12$ Kg.

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(28) a) $N(2000; 250)$; $p(X \le 2100) = p\left(Z \le \frac{2100-2000}{250}\right) = p(Z \le 0'4) =$

$= 0'65542 = 65'54\,\%$

b) $p(X \ge 1500) = p\left(Z \ge \frac{1500-2000}{250}\right) = p(Z \ge -2) = p(Z \le 2) =$

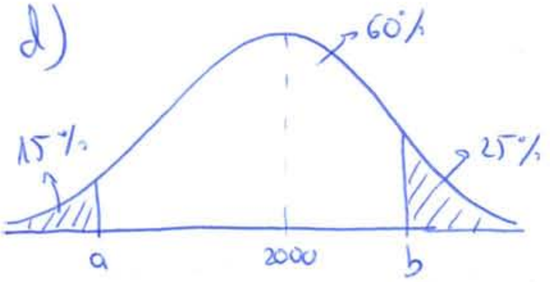
$= 0'97724 = 97'72\,\%$

c) $p(X \ge 2210) = p\left(Z \ge \frac{2210-2000}{250}\right) = p(Z \ge 0'84) =$

$= 1 - p(Z \le 0'84) = 1 - 0'79954 = 0'20046 = 20'05\,\%$

$30 \cdot 0'20046 = 6'0138 \simeq 6$ días.

d)



$p(X \le b) = 0'75 \Rightarrow p\left(Z \le \frac{b-2000}{250}\right) = 0'75$

$\Rightarrow \frac{b-2000}{250} = 0'67448 \Rightarrow$

$\Rightarrow b = 2000 + 250 \cdot 0'67448 = 2168'62.$

$p(X \le a) = 0'15 \rightarrow p\left(Z \le \frac{a-2000}{250}\right) = 0'15 \Rightarrow p(Z \le y) = 0'15 \Rightarrow$

$\Rightarrow p(Z \le y') = 0'85 \Rightarrow y' = 1'0364 \Rightarrow y = -1'0364.$

$-1'0364 = \frac{a-2000}{250} \Rightarrow a = 2000 - 1'0364 \cdot 250 = 1740'9.$

Luego las cuotas son: $\simeq 1741$ y 2169.

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(29) a) $N(187'5\ ;\ 9'5)$ $\quad p(\bar{X} \geq 197) = p\left(Z \geq \frac{197-187'5}{9'5}\right) =$

$= p(Z \geq 1) = 1 - p(Z \leq 1) = 1 - 0'84134 = 0'15866 = 15'9\%$

b) $p(X \leq K) = 0'99 \Rightarrow p\left(Z \leq \frac{K-187'5}{9'5}\right) = 0'99 \Rightarrow \frac{K-187'5}{9'5} = 2'3263$

$\Rightarrow K = 209'6$ cm ; Altura de la puerta: $17 + 209'6 = 226'6 \simeq 227$ cm.

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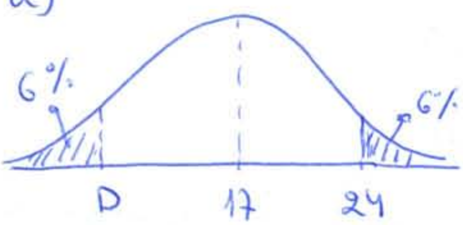
(30) a)



$p(X \geq 24) = 0'06$

$p(X \leq 24) = 1 - 0'06 = 0'94 = 94\%$

b) Por simetría: $24 - 17 = 7$; luego: $D = 17 - 7 = 10$ m.

c) $p(17 \leq X \leq 24) = 0'5 - 0'06 = 0'44 = 44\%$

44% de 200 = $200 \cdot 0'44 = 88$ árboles.

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(31) $N(80; \sigma)$; $p(X \leq 87) = 0'7495 \Rightarrow p\left(Z \leq \frac{87-80}{\sigma}\right) = 0'7495$

$\Rightarrow p\left(Z \leq \frac{7}{\sigma}\right) = 0'7495 \Rightarrow \frac{7}{\sigma} = 0'67291 \Rightarrow \sigma = 10'4$

———— o ————

(32) $N(\mu, 10)$; $p(X \geq 50) = 0'3 \Rightarrow p\left(Z \geq \frac{50-\mu}{10}\right) = 0'3 \Rightarrow$

$\Rightarrow p\left(Z \leq \frac{50-\mu}{10}\right) = 0'7 \Rightarrow \frac{50-\mu}{10} = 0'5244 \Rightarrow 50 - \mu = 5'244$

$\Rightarrow \mu = 44'756$ Km/h.

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(33) $N(20;5)$ a) $p(X \leq 22'9) = 0'7190 = 71'90\%$ (con GDC)

b) $p(X < K) = 0'55 \Rightarrow K = 20'63$ (con GDC)

——— o ———

(34) $A \to N(46, 10)$
$B \to N(\mu, 12)$

a) $p(X \geq 60) = p\left(Z \geq \frac{60-46}{10}\right) = p(Z \geq 1'4) =$
$= 1 - p(Z \leq 1'4) = 1 - 0'91924 = 0'08076 = 8'076\%$

b) $p(X \leq 60) = 0'85 \Rightarrow p\left(Z \leq \frac{60-\mu}{12}\right) = 0'85 \Rightarrow \frac{60-\mu}{12} = 1'0364 \Rightarrow$
$\Rightarrow 60 - \mu = 12'4368 \Rightarrow \mu = 47'56$ minutos

c) Camino A: $p(X \leq 60) = 1 - p(X \geq 60) = 1 - 0'08076 = 0'91924 = 91'9\%$

Camino B: $p(X \leq 60) = 0'85 = 85\%$

Debería ir por el camino A.

d) $B(5; 0'85)$ i) $p(X=5) = \binom{5}{5} \cdot 0'85^5 \cdot 0'15^0 = 0'4437 = 44'37\%$

ii) $p(X \geq 3) = 1 - p(X \leq 2) = 1 - 0'026611 = 0'9734 = 97'34\%$

——— o ———

(35) $N(53; 8)$

a) i) $p(X > 60) = p\left(Z > \frac{60-53}{8}\right) = p(Z > 0'875) = 1 - p(Z < 0'875) =$
$= 1 - 0'80921 = 0'19079 = 19'08\%$

ii) $p(X>70 / X>60) = \frac{p(X>70 \cap X>60)}{p(X>60)} = \frac{p(X>70)}{p(X>60)} \overset{\text{con GDC}}{=} \frac{0'016793}{0'19079} =$
$= 0'08802 = 8'8\%$

b) $B(2; 0'1908)$; $p(X=2) = 0'036404 = 3'64\%$

c) $B(100; 0'1908)$ i) $\mu = n \cdot p = 100 \cdot 0'1908 = 19'08 \simeq 19$ árboles.

ii) $p(X \geq 25) = 1 - p(X \leq 24) = 1 - 0'91304 = 0'08696 = 8'696\%$

——— o ———

36 $L \to N(50, \sigma^2)$

a) $p(50-\sigma < L < 50+2\sigma) = p\left(\frac{50-\sigma-50}{\sigma} < z < \frac{50+2\sigma-50}{\sigma}\right) = p(-1 < z < 2) =$

$= 0'81859 = 81'9\%$ (con GDC).

b) $p(L < 53'92) = 0'975 \Rightarrow p\left(z < \frac{53'92-50}{\sigma}\right) = 0'975 \Rightarrow p\left(z < \frac{3'92}{\sigma}\right) = 0'975$

$\Rightarrow p(z < a) = 0'975 \Rightarrow a = 1'9599 \Rightarrow \frac{3'92}{\sigma} = 1'9599 \Rightarrow \sigma = 2'00.$

c) $p(L \geq t) = 0'75 \Rightarrow p\left(z \geq \frac{t-50}{2}\right) = 0'75 \Rightarrow p(z \geq b) = 0'75$

$\Rightarrow p(z \leq b) = 0'25 \Rightarrow b = -0'67448 \Rightarrow \frac{t-50}{2} = -0'67448 \Rightarrow$ (con GDC)

$\Rightarrow t = 50 - 2 \cdot 0'67448 = 48'65104 \simeq 48'7$ mm.

d) i) $p(L < 50'1\text{mm} / L > 48'7\text{mm}) = \frac{p(L < 50'1 \cap L > 48'7)}{p(L > 48'7)} =$

$= \frac{p(48'7 < L < 50'1)}{p(L > 48'7)} = \frac{0'26209}{0'75} = 0'34945 \simeq 34'95\%$ (con GDC)

ii) $B(10; 0'3495) \Rightarrow p(X \geq 2) = 1 - p(X \leq 1) = 1 - 0'086457 =$

$= 0'913543 \simeq 91'35\%$

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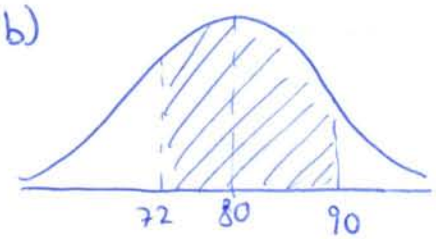
37 a) $N(80; 8)$ $p(X \leq 72) = p\left(z \leq \frac{72-80}{8}\right) = p(z \leq -1) = 1 - p(z \leq 1) =$

$= 1 - 0'84134 = 0'15866 = 15'87\%.$

b)



$p(72 \leq X \leq 90) = p\left(\frac{72-80}{8} \leq z \leq \frac{90-80}{8}\right) =$

$= p(-1 \leq z \leq 1'25) = p(z \leq 1'25) - p(z \leq -1) =$

$= 0'73569 \simeq 73'57\%$

c) $p(X \le x) = 0'04 \Rightarrow p\left(Z \le \frac{x-80}{8}\right) = 0'04 \Rightarrow p(Z \le y) = 0'04 \Rightarrow$

$\Rightarrow p(Z \le y') = 0'96 \Rightarrow y' = 1'7506 \Rightarrow y = -1'7506$

$\frac{x-80}{8} = -1'7506 \Rightarrow x = 65'99 \simeq 66$ meses.

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(38) a) $N(379; d) \Rightarrow N(379; 2'7)$.

$p(X \le 375) = p\left(Z \le \frac{375-379}{2'7}\right) = p(Z \le -1'4815) = 1 - p(Z \le 1'4815) =$

$= 1 - 0'93076 = 0'06924 = 6'92\,\%$

b) $d = 3'6$; $p(X \ge x) = 0'9 \Rightarrow p\left(Z \ge \frac{x-379}{3'6}\right) = 0'9 \Rightarrow$

$\Rightarrow p\left(Z \le \frac{x-379}{3'6}\right) = 0'1 \Rightarrow p(Z \le y) = 0'1 \Rightarrow p(Z \le y') = 0'9 \Rightarrow$

$\Rightarrow y' = 1'2815 \Rightarrow y = -1'2815 \Rightarrow \frac{x-379}{3'6} = -1'2815 \Rightarrow x = 374'4$ ml.

c) $p(X \le 370) = 0'01 \Rightarrow p\left(Z \le \frac{370-379}{d}\right) = 0'01 \Rightarrow$

$\Rightarrow p(Z \le y) = 0'01 \Rightarrow p(Z \le y') = 0'99 \Rightarrow y' = 2'3263 \Rightarrow y = -2'3263$

$\frac{370-379}{d} = -2'3263 \Rightarrow \frac{-9}{d} = -2'3263 \Rightarrow d = 3'87$.

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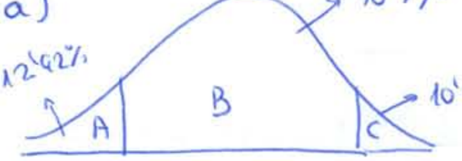
(39) a)



b) $N(6'84; 0'25)$.

$p(X \le t) = 0'8962 \Rightarrow t = 7'155$ cm (con GDC)

$p(X \le r) = 0'1292 \Rightarrow r = 6'557$ cm (con GDC)
