Problem 1

Genotype	Obs	Exp	X^2
SS	99	94.86	0.18
Ss	418	426.27	0.16
ss	483	478.86	0.0357
	1000		0.3757

$$\text{Freq}(S) = \frac{(2 \cdot 99) + 418}{2 \cdot 1000} = 0.308 \qquad \text{Freq}(S) = p = 0.308$$

$$\text{freq}(s) = \frac{(2 \cdot 483) + 418}{2 \cdot 1000} = 0.692 \qquad \text{Freq}(s) = q = 0.692$$

$$\text{freq}(SS) = p^2 = 0.308^2 = 0.09486$$
$$\text{freq}(Ss) = 2pq = 2 \cdot 0308 \cdot 0.692 = 0.426272$$
$$\text{freq}(ss) = q^2 = 0.692^2 = 0.47886$$

$$X^2 = \frac{(O-E)^2}{E}$$

$X^2 = 0.3757$ $\qquad X^2_{0.05,1} = 3.84$ $\qquad$ This population is in HWE

$df = 3 - 1 - 1 = 1$

$0.3757 < 3.84$ Observed and expected are NOT different.

Problem 2

q = freq recessive allele = 0.01
p = freq dominant allele = 1 - 0.01 = 0.99

$$\text{Freq}(qq) = q^2 = \frac{1}{10000} \rightarrow q = \sqrt{\frac{1}{10000}} = 0.01$$

$$\text{Freq}(pq) = 2pq = 2 \cdot 0.01 \cdot 0.99 = 0.0198 \rightarrow 1.98\%$$

1.98% of the population is heterozygous for that allele

Problem 3

Dominant trait

Men

Dominant (trait) = $p = \frac{12}{100} = 0.12 \rightarrow 12\%$

Recessive (normal) = $q = 1 - p = 1 - 0.12 = 0.88$

Women

Dominant (trait)
- $p^2 = 0.0144$
- $2pq = 0.2112$

$\Big\}$ $0.2256 \rightarrow 22.56\%$

Recessive (normal) = $q^2 = 0.88^2 = 0.774$

Recessive trait

Men

Dominant (normal) = $p = 0.88$
Recessive (trait) = $q = 0.12$

Women

Dominant (normal)
- $p^2 = 0.774$
- $2pq = 0.2112$

$\Big\}$ 0.9856

Recessive (trait) = $q^2 = 0.12^2 = 0.0144 \rightarrow 1.44\%$

Problem 4

A = Stubble allele → freq (A) = p
a = Wild allele → freq (a) = q

Genotype	Obs	Exp	X^2
AA	0	4.41	4.41
Aa	42	33.18	2.34
aa	58	62.41	0.3116
	100		7.06

$p = \frac{2 \cdot 0 + 42}{2 \cdot 100} = 0.21$ $\quad q = \frac{2 \cdot 58 + 42}{2 \cdot 100} = 0.79$

freq (AA) = $0.21^2 = 0.0441$
freq (Aa) = $2 \cdot 0.21 \cdot 0.79 = 0.3318$
freq (aa) = $0.79^2 = 0.6241$

$X^2 = 7.06$ $\quad X^2_{0.05,1} = 3.84$
df = 1

$7.06 > 3.84$ The population is not in HWE.

Problem 5

Allele number = K = 4
Genotype number = $\frac{K(K+1)}{2} = \frac{4 \cdot 5}{2} = 10$

Expected frequency of heterozygotes =
$= 2pq + 2pr + 2ps + 2qr + 2qs + 2rs = 0.6454$

p = 0.43 $\quad$ q = 0.37 $\quad$ r = 0.18 $\quad$ s = 0.02

Problem 6

a = recessive allele → freq (a) = p
A = dominant allele → freq (A) = q

freq (aa) = $p^2 = 0.04$ → p = 0.2 q = 1 - 0.2 = 0.8

	A	a
A	AA	Aa
a	Aa	aa

$P(aa) = \frac{1}{4} = 0.25$ → 25%

Problem 7

$A_1A_1 = 0.226$
$A_1A_2 = 0.4$
$A_2A_2 = 0.374$

freq (A_1) = $0.226 + \frac{1}{2} \cdot 0.4 = 0.426$ (p)

freq (A_2) = $0.374 + \frac{1}{2} \cdot 0.4 = 0.574$ (q)

Genotype	Obs	Exp	X^2
A_1A_1	0.226	$p^2 = 0.182147$	0.011
A_1A_2	0.4	$2pq = 0.4890$	0.016
A_2A_2	0.374	$q^2 = 0.329447$	0.00601
			0.033

$X^2 = 0.033$ $X^2_{0.05,1} = 3.84$
df = 1

0.033 < 3.84 The population is in HWE

Problem 8

a = recessive → freq(a) = p = 0.592
A = dominant → freq(A) = q = 0.408

freq(aa) = 0.35 = p^2 → p = 0.592
q = 1 - p = 1 - 0.592 = 0.408

freq(aa) = 0.35
freq(Aa) = 2pq = 2·0.592·0.408 = 0.484
freq(AA) = q^2 = 0.408^2 = 0.166

Problem 9

freq(BB) = 0.81
freq(Bb) = 0.18
freq(bb) = 0.01
} cows

1 BB
2 Bb
} bulls

Possible offspring:
- BB × BB = BB
- BB × Bb = 1/2 BB, 1/2 Bb
- Bb × Bb = 1/4 BB, 1/2 Bb, 1/4 bb
- bb × BB = Bb
- bb × Bb = 1/2 Bb, 1/2 bb

Genotypes parents

0.81·3 = 2.43 (BB)
0.18·3 = 0.54 (Bb)
0.01·3 = 0.03 (bb)

$BB = \frac{2.43+1}{6} = 0.57$ $Bb = \frac{0.54+2}{6} = 0.423$ $bb = \frac{0.03}{6} = 5\cdot10^{-3}$

Alleles offspring
B = 0.57 + $\frac{1}{2}$ 0.423 = 0.7815
b = $5\cdot10^{-3}$ + $\frac{1}{2}$ · 0.423 = 0.2126

Genotypes offspring
BB = 0.7815^2 = 0.611
Bb = 2·0.7815·0.2126 = 0.332
bb = 0.2126^2 = 0.045

Genotype	Obs	Exp	X^2
BB	0.57	0.611	$2.75 \cdot 10^{-3}$
Bb	0.423	0.33	0.0262
bb	$5 \cdot 10^{-3}$	0.045	0.035
			0.064

$X^2 = 0.064$ $\quad X^2_{0.05,1} = 3.84$

df = 1

$0.064 < 3.84$ This population is in HWE

Problem 10

10 males
10 females
} 20 people → 40 alleles

2 c alleles → 2 cc individuals

$\frac{2}{40} = 0.05 = q \rightarrow q^2 = 0.05^2 = 0.0025 \rightarrow 0.25\%$.

The incidence of CF on the island will be 0.25%!
1 of 400 will have CF