Chi-Square.

1. No. of cards = 1600 Since 4 suits => 400.

∴ Expected for each suit would be 400.

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

Obs

Spades – 404

Hearts – 420

Diamonds – 400

Clubs – 376

$$= \frac{(4)^2 + (20)^2 + (0) + (-24)^2 + (76)^2}{400}$$

$$= 16 + 400 + 5776/400$$

$$\chi^2 = 2.48$$

χ^2_{crit} with df = 3 and 0.05 significance => 7.815

Since 2.48 < 7.815. Suits are equally likely, accept the null hypothesis.

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2. No. of cards = 1662 , 4 suits => 400 + 62 (Jokers)

$$\Rightarrow \frac{(4)^2 + (20)^2 + (0) + (-44)^2}{400} + \frac{(20)^2}{62}$$

Spades – 404

Hearts – 420

Diamonds – 400

Clubs – 356

Jokers – 82

$$\Rightarrow \frac{16 + 400 + 1936}{400} + \frac{400}{62}$$

$$\Rightarrow 5.88 + 6.451$$

$$\Rightarrow 12.331$$

χ^2_{crit} with df = 4 and 0.05 significance => 9.488

Hence 12.331 > 9.488, hence reject null hypothesis as there will not be uniformity adding joker.

3. 4 stripes : 3 spots : 9 stripes and spots.

after cross;

50 : 41 : 85 $\Rightarrow$ 176; (Observed)

Total; $\frac{4}{16} \times 176 \Rightarrow 44$, $\frac{3}{16} \times 176 \Rightarrow 33$, $\frac{9}{16} \times 176 \Rightarrow 99$ } Expected

$\chi^2 = 0.818 + 1.939 + 1.979$

$\chi^2 = 4.736$

df $\Rightarrow$ 2 and 0.05 sig; $\chi^2 = 5.991$

Since $4.736 < 5.991$, accept null hypothesis.

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4. Observed; 193 : 184 : 556 : 61 $\Rightarrow$ 994

Expected; 9 : 3 : 3 : 1 (Punnet's ratio)

∴ In numbers instead of ratio;

$\frac{9}{16} \times 994 = 559.125$; $\frac{3}{16} \times 994 = 186.375$

$\frac{1}{16} \times 994 = 62.125$

$\chi^2 = 0.017 + 0.013 + 0.235 + 0.20$

$\chi^2 = 0.482$

df = 3 and 0.05 significance $\Rightarrow$ 7.8

$0.482 < 7.8$, hence accept null hypothesis.

5. Number of shops = 5

Number of shoppers = 1100

Since null hypothesis is to determine if the preferences are split equally against 5 shops.

20% of 1100 would be 220.

Hence expected would be 220.

Observed ; 262, 234, 204, 190, 210

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

$$\chi^2 = 8.018 + 0.890 + 1.163 + 4.09 + 0.45$$

$$\chi^2 = 14.611$$

χ^2_{crit} at df = 4 and 0.05 significance => 9.488

Since 14.611 > 9.488, reject null hypothesis.

Hence shoppers does not prefer equally.