Q.2

Ans: Suppose the coin is unbaised.
then the probability of getting head in a toss = 1/2

Expected no. of Success = $\frac{1}{2} \times 400 = 200$

the observed value of success = 216

thus the excess of observed value over expected value = $216 - 200 = 16$

SD of simple sampling = $\sqrt{npq}$

$$= \sqrt{(\cancel{400}^{\cancel{200}\,100} \times \frac{1}{\cancel{2}} \times \frac{1}{2})}$$

$$= 10$$

Hence

$$Z = \frac{x - np}{\sqrt{npq}} = \frac{16}{10} = 1.6$$

As $Z < 1.96$, the hypothesis is accepted at 5% level of significance i.e, we conclude that the coin is unbaised at 5% level of significance.

Null Hypothesis, H_0 :- Male and female are equally probable.

No. of boys	4	3	2	1	0
No. of Girls	0	1	2	3	4
No. of families	10	55	105	58	12

Alternate hypothesis H_1 :- Male and female birth are not equally probable. Calculation of expected frequencies $(q+p)^n$.

Probability of female birth $= p = 1/2$

Probability of Male birth $= q = 1/2$

$(q+p)^n = q^n + {}^nc_1\, p q^{n-1} + {}^nc_2\, p^2 q^{n-2} + {}^nc_3\, p^3 q^{n-3} \ldots p^n$

$= \left(\frac{1}{2}\right)^4 + 4\left(\frac{1}{2}\right)^1\left(\frac{1}{2}\right)^3 + 6\left(\frac{1}{2}\right)^2\left(\frac{1}{2}\right)^2 + 4\left(\frac{1}{2}\right)^3\left(\frac{1}{2}\right)^1 + \left(\frac{1}{2}\right)^4$

No. of girls $= 240\left[\frac{1}{16} + \frac{4}{16} + \frac{6}{16} + \frac{4}{16} + \frac{1}{16}\right]$

$= \overset{15}{\cancel{240}} \times \frac{1}{\cancel{16}} + \overset{15}{\cancel{240}} \times \frac{4}{\cancel{16}} + \overset{15}{\cancel{240}} \times \frac{6}{\cancel{16}} + \overset{15}{\cancel{240}} \times \frac{4}{\cancel{16}} + \overset{15}{\cancel{240}} \times \frac{1}{\cancel{16}}$

$= 15 + 60 + 90 + 60 + 15$

These are the expected frequencies of female births.

O	E	O - E	$(O-E)^2$	$\frac{(O-E)^2}{E}$
10	15	-5	25	1.67
55	60	-5	25	0.41
105	90	15	225	2.5
58	60	-2	4	0.067
12	15	-3	9	0.6
			Total	5.247

Given, $\chi^2_{0.05} = 9.49$ and 11.1 for d.f. and 5 d.f

Since the Calculated Value of $\chi^2 (5.247) < \chi^2$ value at 4 d.f and 5 d.f.

Hence, the male and female birth is equally Probable.

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