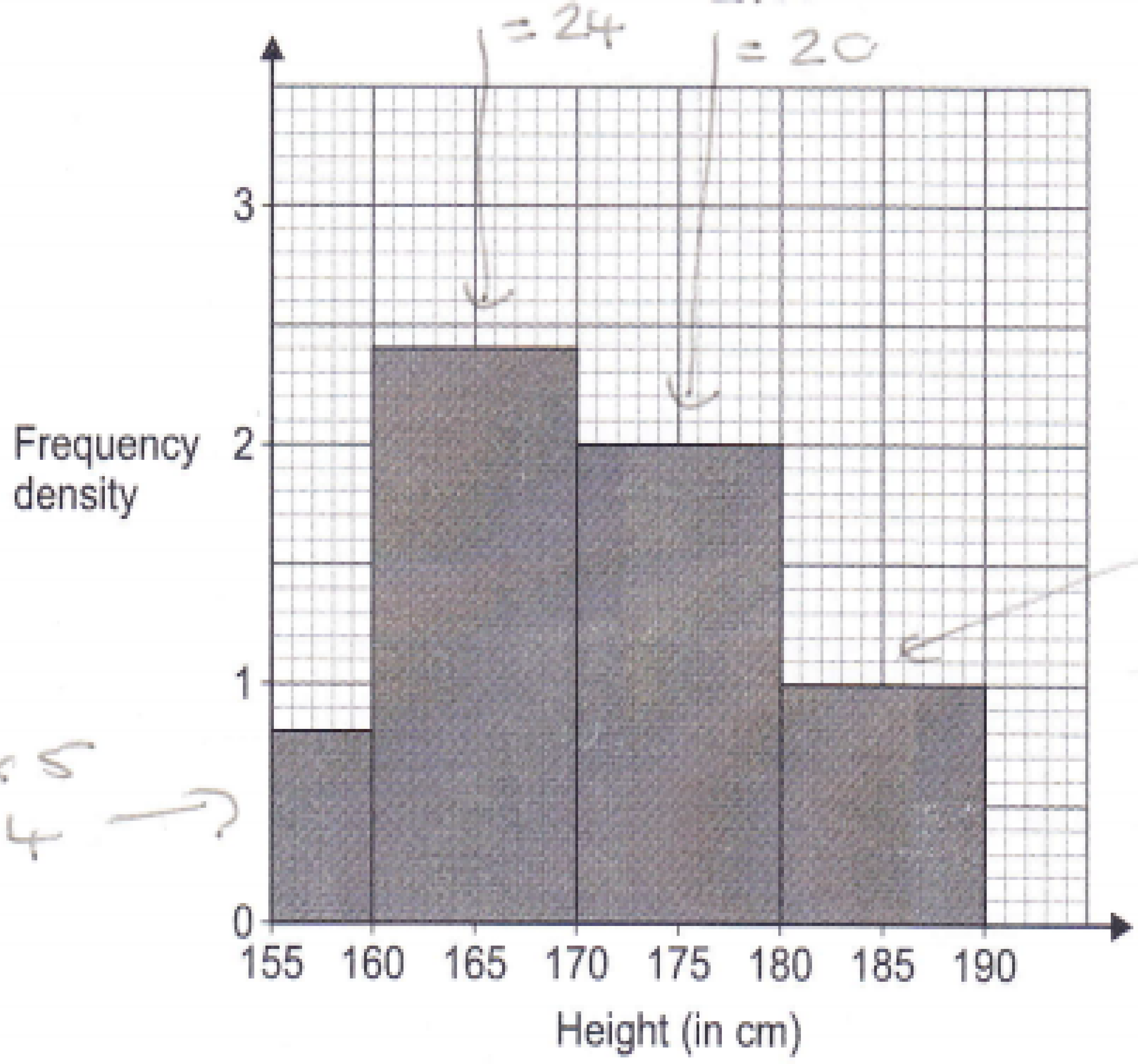
**12** The histogram below shows the heights, in cm, of male A-level students at a particular school.




Total frequency = 58

Which class interval contains the median height?

Median = 29.5th value

Circle your answer.

**[1 mark]**

[155, 160) [160, 170) [170, 180) [180, 190]

11 Lenny is one of a team of people interviewing shoppers in a town centre.

He is asked to survey 50 women between the ages of 18 and 29

Identify the name of this type of sampling.

Circle your answer.

**[1 mark]**

simple random    stratified    quota    systematic

Do not write outside the box

**16** An educational expert found that the correlation coefficient between the hours of revision and the scores achieved by 25 students in their A-level exams was 0.379

Her data came from a bivariate normal distribution.

Carry out a hypothesis test at the 1% significance level to determine if there is a positive correlation between the hours of revision and the scores achieved by students in their A-level exams.

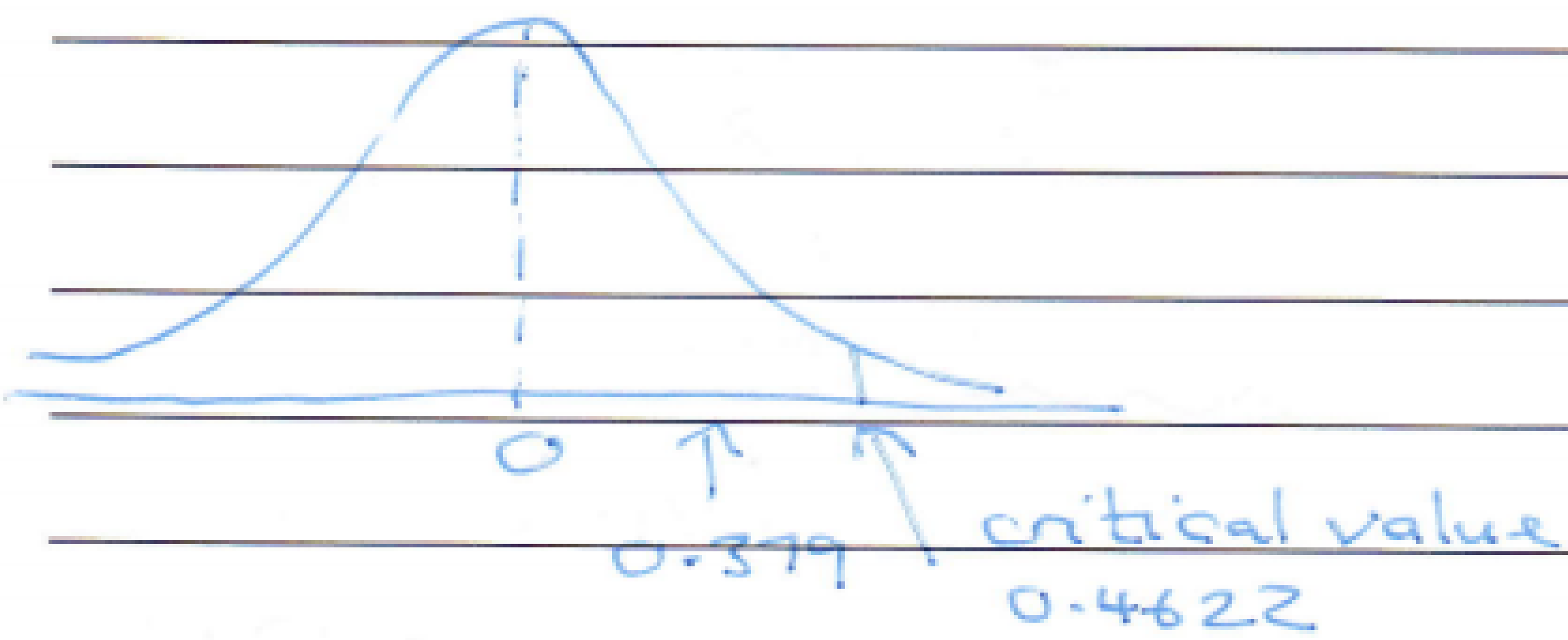
The critical value of the correlation coefficient is 0.4622

**[4 marks]**

$r = 0.379$

$H_0 : \rho = 0$ (no correlation)

$H_1 : \rho > 0$ (positive correlation)




As the test statistic $r = 0.379 < 0.4622$ (not in tail)

accept $H_0$

There is insufficient evidence to suggest there is a positive correlation between the hours of revision and the scores achieved in their A level exams

**Turn over for the next question**

**14** A survey was conducted into the health of 120 teachers.

The survey recorded whether or not they had suffered from a range of four health issues in the past year.

In addition, their physical exercise level was categorised as low, medium or high.

50 teachers had a low exercise level, 40 teachers had a medium exercise level and 30 teachers had a high exercise level.

The results of the survey are shown in the table below.

| | **Low exercise** | **Medium exercise** | **High exercise** |
|---|---|---|---|
| **Back trouble** | 14 | 7 | 10 |
| **Stress** | 38 | 14 | 5 |
| **Depression** | 9 | 2 | 1 |
| **Headache/Migraine** | 4 | 5 | 5 |

**14 (a)** Find the probability that a randomly selected teacher:

**14 (a) (i)** suffers from back trouble and has a high exercise level;

**[1 mark]**

$\frac{10}{120}$

**14 (a) (ii)** suffers from depression.

**[2 marks]**

$\frac{9+2+1}{120} = \frac{12}{120}$

*outside the box*

**14 (a) (iii)** suffers from stress, given that they have a low exercise level.

**[2 marks]**

$\frac{38}{50}$

**14 (b)** For teachers in the survey with a low exercise level, explain why the events 'suffers from back trouble' and 'suffers from stress' are **not** mutually exclusive.

**[2 marks]**

14 + 38 = 52

52 > 50

↑ low exercise number

so back trouble and stress cannot be mutually exclusive

**Turn over for the next question**

**14** It is known that a hospital has a mean waiting time of 4 hours for its Accident and Emergency (A&E) patients.

After some new initiatives were introduced, a random sample of 12 patients from the hospital's A&E Department had the following waiting times, in hours.

| | | | | | |
|---|---|---|---|---|---|
| 4.25 | 3.90 | 4.15 | 3.95 | 4.20 | 4.15 |
| 5.00 | 3.85 | 4.25 | 4.05 | 3.80 | 3.95 |

Carry out a hypothesis test at the 10% significance level to investigate whether the mean waiting time at this hospital's A&E department has changed. 2 tail test

You may assume that the waiting times are normally distributed with standard deviation 0.8 hours.

**[7 marks]**

$\bar{x}$ = Sample mean = (4.25 + 3.9 + 4.15 + 3.95 + 4.2 + 4.15 + 5 + 3.85 + 4.25 + 4.05 + 3.8 + 3.95) ÷ 12 = 4.125

$\mu = 4$

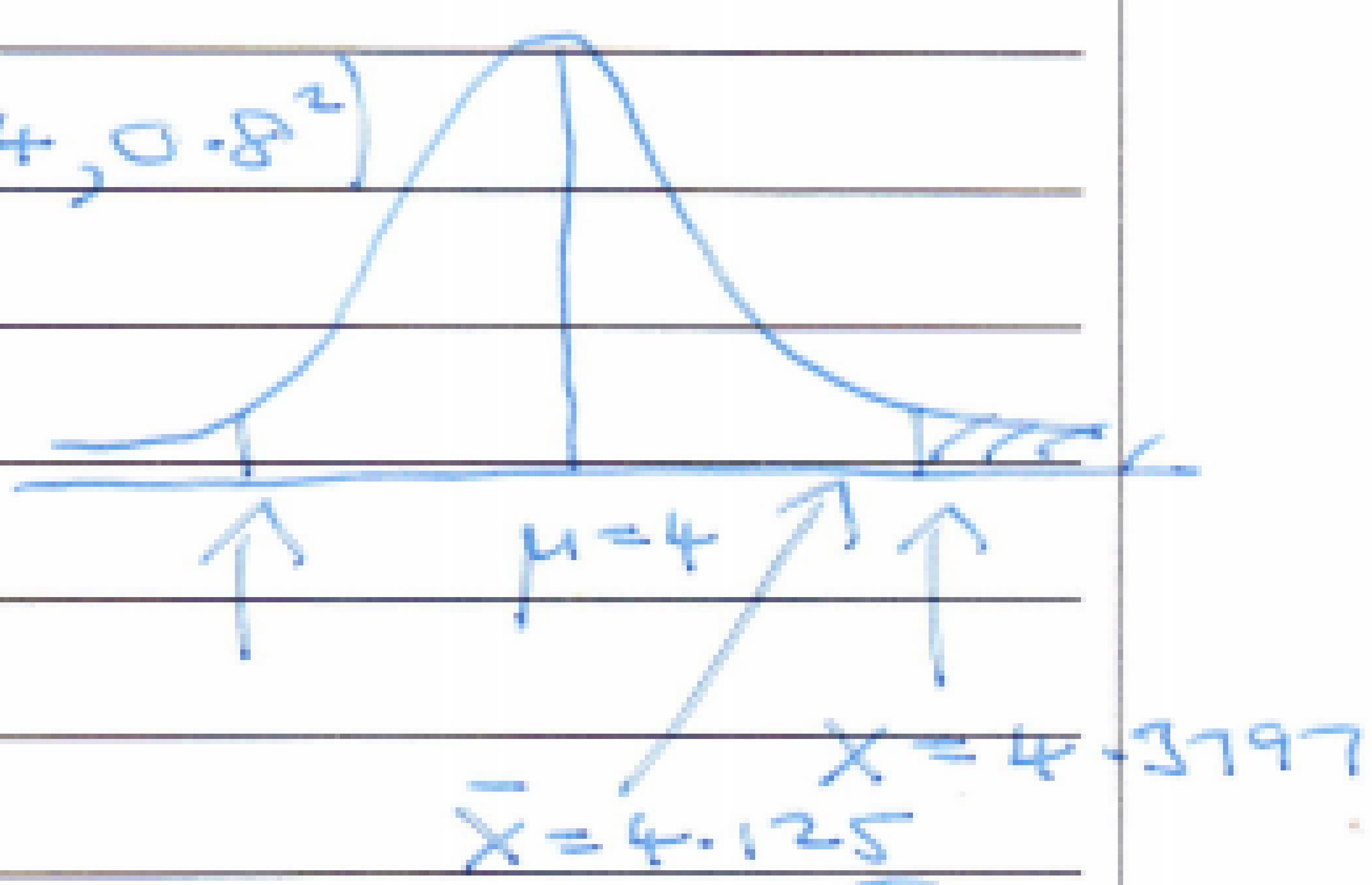
$\sigma = 0.8$ $\quad X \sim N(4, 0.8^2)$

$H_0: \mu = 4$

$H_1: \mu \neq 4$

5% lower tail

5% upper tail




Used a sample mean ∴ $\sigma = \frac{\sigma}{\sqrt{n}}$

$= \frac{0.8}{\sqrt{12}} = 0.2309$ (4dp)

Inverse normal

Area 0.95 (95%)

$\sigma = 0.2309$

$\mu = 4$

$x = 4.3797$

$\bar{x} < 4.3797$ so we accept $H_0$

There is insufficient evidence to suggest that the mean waiting time has changed



outside the box

**17** Suzanne is a member of a sports club.

For each sport she competes in, she wins half of the matches. $X \sim B(n, 0.5)$

**17 (a)** After buying a new tennis racket Suzanne plays 10 matches and wins 7 of them.

Investigate, at the 10% level of significance, whether Suzanne's new racket has made a difference to the probability of her winning a match.

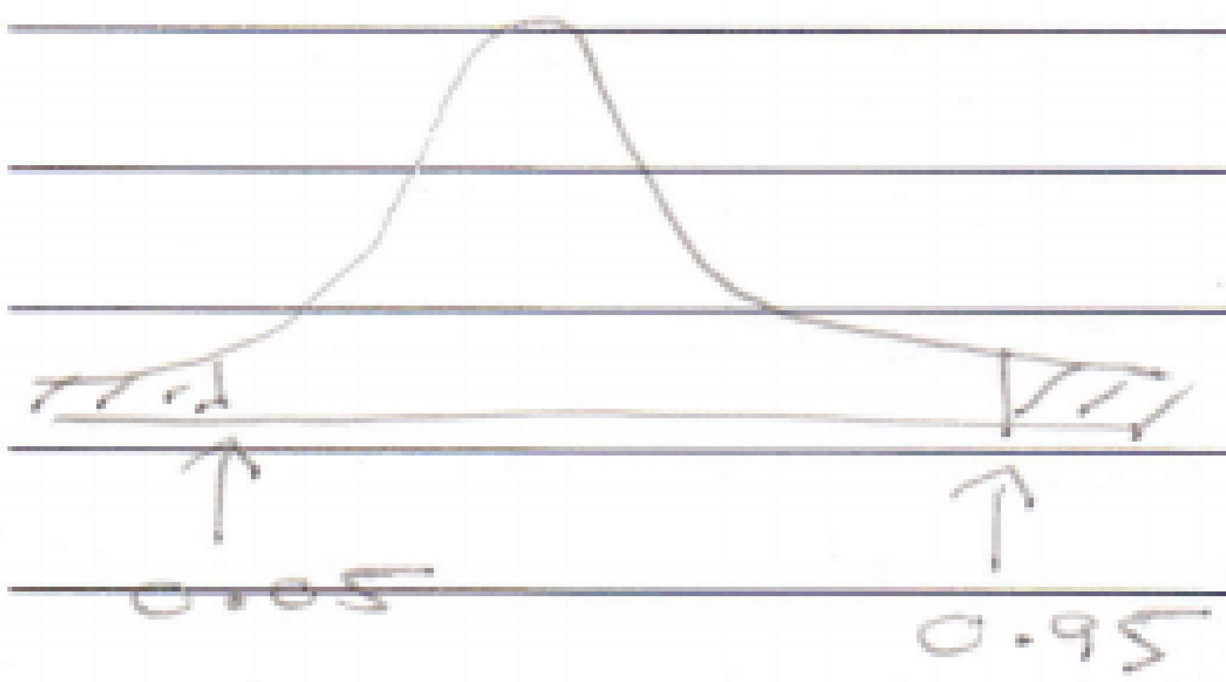
**[7 marks]**

$X$ = number of matches won

$X \sim B(10, 0.5)$

$H_0: p = 0.5 \quad H_1: p \neq 0.5$

2 tailed test




$P(X \leq 1) = 0.010742$ ← critical value

$P(X \leq 2) = 0.0546875$ ← 1st value above 0.05

$P(X \leq 6) = 0.828125$

$P(X \leq 7) = 0.9453125$

$P(X \leq 8) = 0.989257$ ← 1st value above 0.95

∴ Critical region is $X \leq 1$ and $X \geq 9$ ∴

(Binomial CD, $x = 8$, $n = 10$, $p = 0.5$ etc)

$X = 7$ is not in the critical region ∴ accept $H_0$

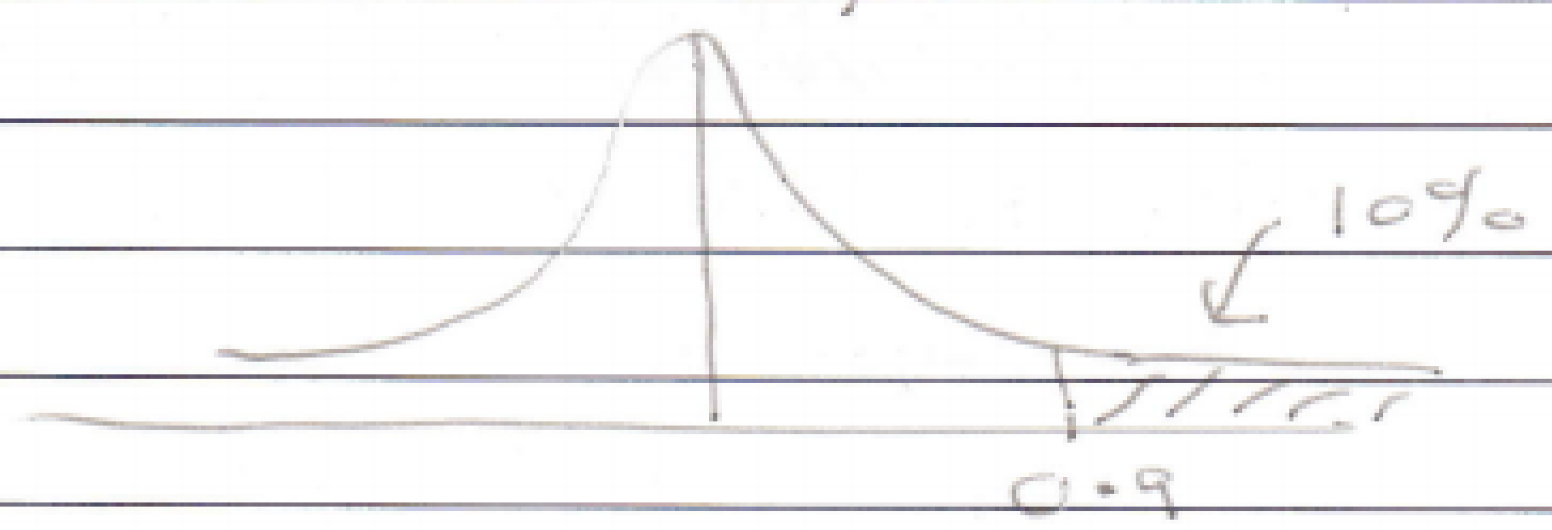
There is not sufficient evidence that Suzanne's new racket has made a difference.

**17 (b)** After buying a new squash racket, Suzanne plays 20 matches. Find the minimum number of matches she must win for her to conclude, at the 10% level of significance, that the new racket has improved her performance.

one tail test

**[5 marks]**

$X \sim B(20, 0.5)$




$H_0: p = 0.5$ $H_1: p > 0.5$

one tail test at 90%

Binomial CD
$x = 11$
$n = 20$
$p = 0.5$

$P(X \leq 11) = 0.74827$

$P(X \leq 12) = 0.86841$

$P(X \leq 13) = 0.94234$ ⟵ first one above 0.9

∴ add one — critical region $X \geq 14$

Minimum number of matches = 14

**Turn over for the next question**

outside the box

**17** Elizabeth's Bakery makes brownies.

It is known that the mass, $X$ grams, of a brownie may be modelled by a normal distribution.

10% of the brownies have a mass less than 30 grams.

80% of the brownies have a mass greater than 32.5 grams.

**17 (a)** Find the mean and standard deviation of $X$.

**[7 marks]**

$X \sim N(\mu, \sigma^2)$

$P(X < 30) = 0.1$

Z value (Inverse normal, Area = 0.1, $\sigma = 1$, $\mu = 0$) $Z_1 = -1.28155$

$P(X \leqslant 32.5)$ 0.2 $Z_2 = -0.84162$

$Z_1 = \frac{x-\mu}{\sigma}$ $-1.28155 = \frac{30-\mu}{\sigma}$ ①

$Z_2 = \frac{x-\mu}{\sigma}$ $-0.84162 = \frac{32.5-\mu}{\sigma}$ ②

$-1.28155\sigma = 30 - \mu$ ①

$-0.84162\sigma = 32.5 - \mu$ ②

② − ① gives $0.43993\sigma = 2.5$

$\sigma = 5.682722$

① gives $\mu = 30 + 1.28155 \times 5.682722$

$\mu = 37.2826$

$\mu = 37.3$ $\sigma = 5.68$ (3sf)

**17 (b) (i)** Find $P(X \neq 35)$

**[1 mark]**

**17 (b) (ii)** Find $P(X < 35)$

**[2 marks]**

Normal CD
Lower = 0
Upper = 35
$\sigma = 5.68$
$\mu = 37.3$

$= 0.34276$
$= 0.343$ (3sf)

**17 (c)** Brownies are baked in batches of 13.

Calculate the probability that, in a batch of brownies, no more than 3 brownies are less than 35 grams.

You may assume that the masses of brownies are independent of each other.

**[2 marks]**

$Y \sim B(13, 0.343)$

Binomial CD
2: Variable
$x = 3$
$N = 13$
$p = 0.343$

$P(Y \leq 3)$
$= 0.296$