General Certificate of Education
Advanced Level Examination
June 2011

Human Biology HBI6T/Q11/task

Unit 6T A2 Investigative Skills Assignment
Task Sheet

The effect of use on features of the arm

Introduction

Most people use one hand and arm more than they use the other hand and arm which leads to their being described as left-handed or right-handed. This may cause differences in the development of the muscles and bones of the left and right arms.

You will measure the circumference of forearms and the diameter of the wrists of a group of people of similar age. You will then calculate how many times bigger each forearm circumference is than the wrist diameter. You will do this for each arm, for each person.

You will first measure the features of the arm they use most frequently, and then measure the other arm.

Materials

You are provided with

- length of string
- ruler
- 2 set-squares
- Plasticine or Blu-Tack
- marker pen

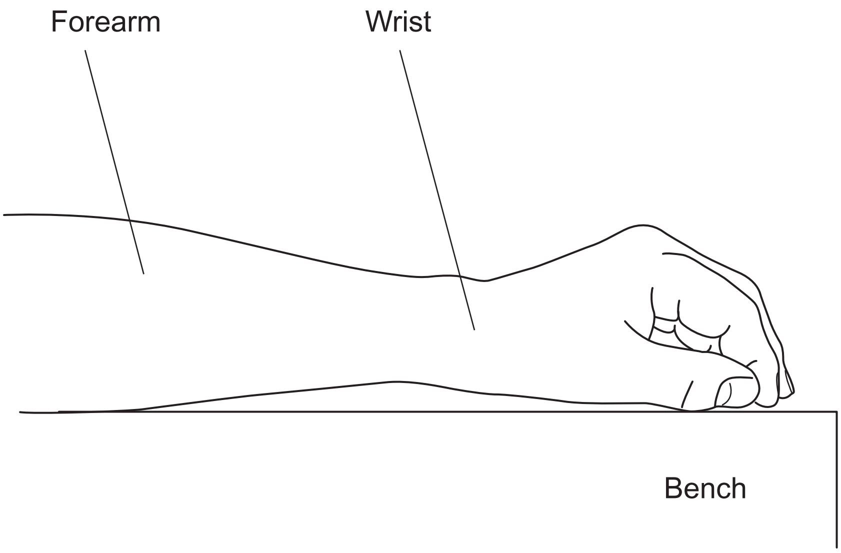
You may ask your teacher for any other apparatus you require.

A copy of the AQA Students' Statistics Sheet is provided at the back of this Task Sheet. This may be used at any Stage during the investigation and examination.

Outline Method

Read these instructions carefully before you start your investigation.

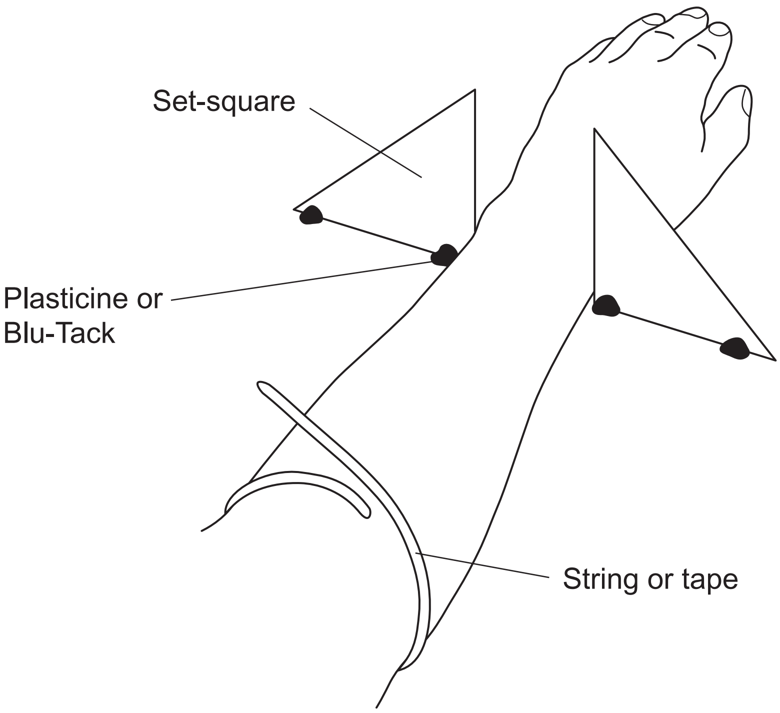
1. Choose a group of people of similar age to you.
2. Tell one person to sit down at a bench or table.
3. Ask this person which arm and hand he or she uses most; this will be referred to as the dominant arm.
4. Tell the person to place the dominant arm on the bench as shown in the diagram.



5. Wrap the string around the forearm at its widest point ready to find its circumference.
6. Ask the person to clench the fist.
7. Mark the length of the string wrapped around the clenched arm with your fingernail or a marker pen.
8. Place the string alongside the ruler to determine the circumference of the arm.
9. Record this circumference.
10. Measure the diameter of the wrist using one of the methods on the next page.

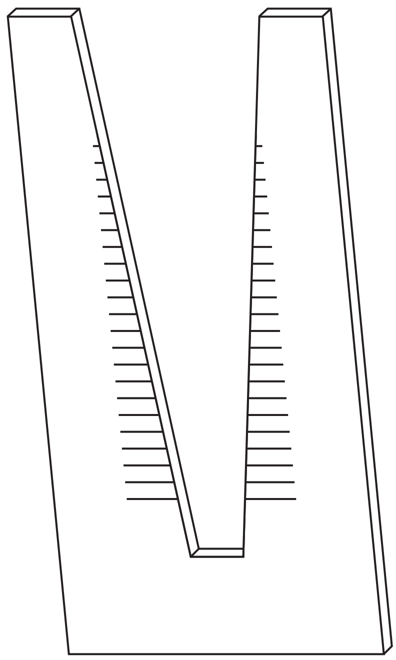
EITHER

10(a) On the same arm measure the greatest diameter of the bony part of the wrist. You should use two set-squares and a ruler. Place the set-squares on the bench against the wrist. Support the set-squares using Plasticine or Blu-Tack, making sure they are set firmly on the bench. Use a ruler to measure the distance between the set-squares. This is the diameter of the wrist.



OR

10(b) On the same arm measure the greatest diameter of the bony part of the wrist, using the cardboard measuring device. Place the arm through the gap, and let it rest lightly on the cardboard measuring device. The wrist should touch the cardboard each side at the widest part of the wrist.



Turn over ▶

11. Record the diameter of the wrist together with the forearm circumference of the same person.
12. Calculate how many times bigger the forearm circumference is than the wrist diameter.
13. Record the answer.
14. Repeat steps 4 to 13 with the person's other arm.
15. Repeat steps 2 to 14 with the next person.

You will need to decide for yourself

- where on the forearm to make the measurements
- how to make the wrist diameter measurements as reliable as you can
- how many measurements to carry out
- which statistical test to carry out.

ISA HBI6T/Q11 Candidate Results Sheet: Stage 1

The effect of use on features of the arm

Centre Number						Candidate Number				

Candidate Name ....

Record your data in a table in the space below.

Hand in this sheet at the end of each practical session. *(3 marks)*

3

ISA HBI6T/Q11 Candidate Results Sheet: Stage 2

The effect of use on features of the arm

Centre Number | | | | | | Candidate Number | | | | |

Candidate Name ....

Use the space below to analyse your data with a suitable statistical test. You may use a calculator and the Students' Statistical Sheet that has been provided to perform this test.

You should

- state your null hypothesis *(1 mark)*

- give your choice of statistical test *(1 mark)*

- give reasons for your choice of statistical test *(1 mark)*

- carry out the test and calculate the test statistic *(1 mark)*

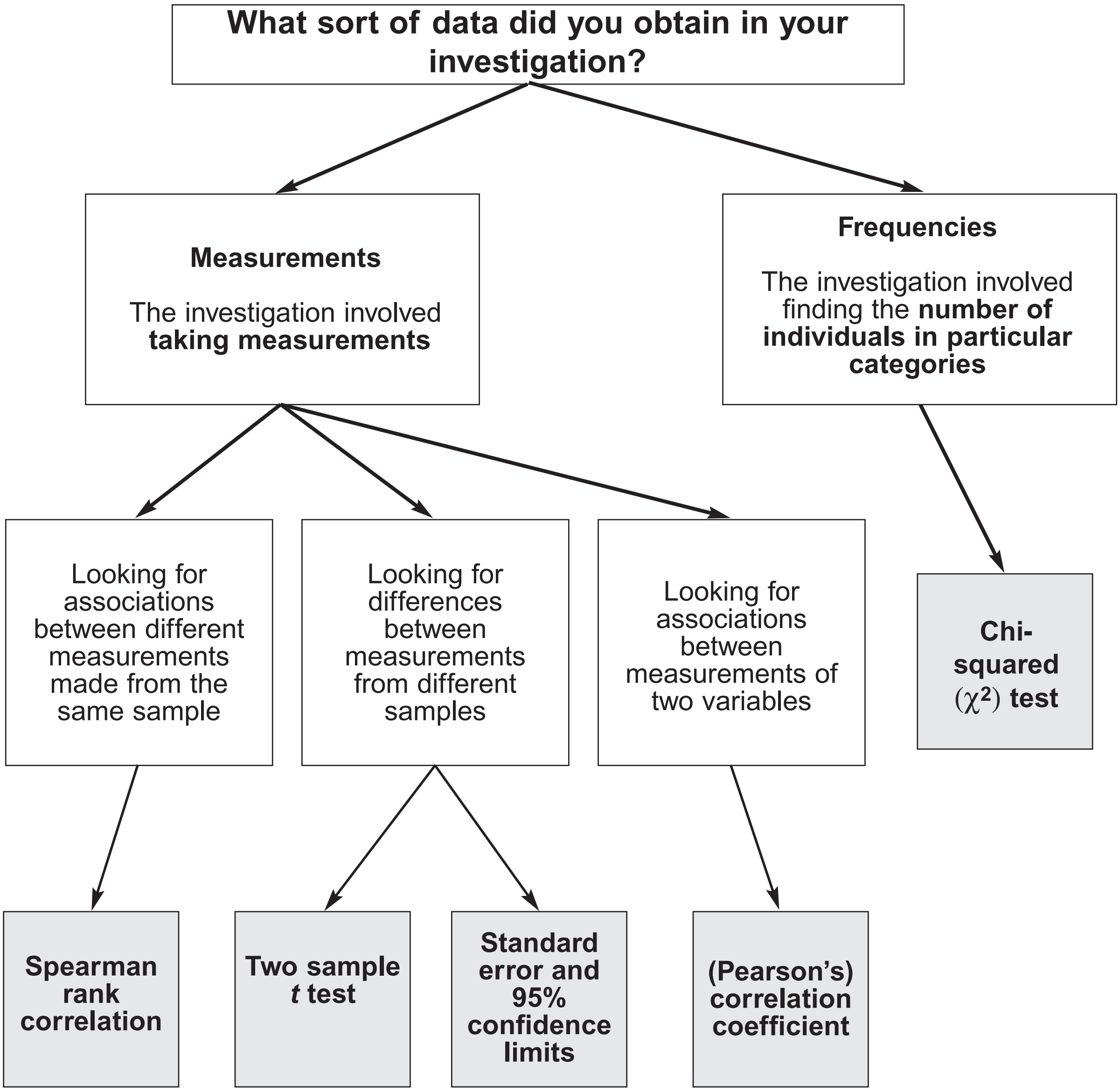
- interpret the test statistic in relation to the null hypothesis being tested.
  Use the words *probability* and *chance* in your answer. *(2 marks)*

6

This graph paper is provided for use if you need it.

Hand in this sheet at the end of the practical session.

Students' Statistics Sheet



For use in the A2 ISA and EMPA assessment

Statistical tests and tables of critical values

Tables of critical values

A table of critical values is provided with each statistical test. If your calculated test statistic is greater than, or equal to, the critical value, then the result of your statistical test is significant. This means that your null hypothesis should be rejected.

Spearman rank correlation test

Use this test when
- you wish to find out if there is a significant association between two sets of measurements from the same sample
- you have between 5 and 30 pairs of measurements.

Record the data as values of X and Y.

Convert these values to rank orders, 1 for largest, 2 for second largest, etc.

Now calculate the value of the Spearman rank correlation, r_s, from the equation

$$r_s = 1 - \left[\frac{6 \times \Sigma \mathrm{D}^2}{N^3 - N}\right]$$

where N is the number of pairs of items in the sample
D is the difference between each pair (X-Y) of measurements.

A table showing the critical values of r_s for different numbers of paired values

Number of pairs of measurements	Critical value
5	1.00
6	0.89
7	0.79
8	0.74
9	0.68
10	0.65
12	0.59
14	0.54
16	0.51
18	0.48

Correlation coefficient (Pearson's correlation coefficient)

Use this test when
- you wish to find out if there is a significant association between two sets of measurements measured on interval or ratio scales
- the data are normally distributed.

Record the data as values of variables X and Y.

Now calculate the value of the (Pearson) correlation coefficient, r, from the equation

$$r = \frac{\Sigma XY - [(\Sigma X)(\Sigma Y)]/n}{\sqrt{\{\Sigma X^2 - [(\Sigma X)^2/n]\}\ \{\Sigma Y^2 - [(\Sigma Y)^2/n]\}}}$$

where n is the number of values of X and Y.

A table showing the critical values of *r* for different degrees of freedom

Degrees of freedom	Critical value	Degrees of freedom	Critical value
1	1.00	12	0.53
2	0.95	14	0.50
3	0.88	16	0.47
4	0.81	18	0.44
5	0.75	20	0.42
6	0.71	22	0.40
7	0.67	24	0.39
8	0.63	26	0.37
9	0.60	28	0.36
10	0.58	30	0.35

For most cases, the number of degrees of freedom = $n - 2$

Turn over ▶

The *t* test

Use this test when

- you wish to find out if there is a significant difference between two means
- the data are normally distributed
- the sample size is less than 25.

t can be calculated from the formula

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{(s_1^2/n_1) + (s_2^2/n_2)}}$$

where $\bar{x}_1$ = mean of first sample
$\bar{x}_2$ = mean of second sample
s_1 = standard deviation of first sample
s_2 = standard deviation of second sample
n_1 = number of measurements in first sample
n_2 = number of measurements in second sample

A table showing the critical values of *t* for different degrees of freedom

Degrees of freedom	Critical value	Degrees of freedom	Critical value
4	2.78		
5	2.57	15	2.13
6	2.48	16	2.12
7	2.37	18	2.10
8	2.31	20	2.09
9	2.26	22	2.07
10	2.23	24	2.06
11	2.20	26	2.06
12	2.18	28	2.05
13	2.16	30	2.04
14	2.15	40	2.02

The number of degrees of freedom = $(n_1 + n_2) - 2$

Standard error and 95% confidence limits

Use this when
- you wish to find out if the difference between two means is significant
- the data are normally distributed
- the sizes of the samples are at least 30. For assessment purposes, five samples are acceptable providing that this is acknowledged either at a convenient place in the statistical analysis or in the conclusions.

Standard error
Calculate the standard error of the mean, SE, for each sample from the following formula:

$$SE = \frac{SD}{\sqrt{n}}$$

where SD = the standard deviation
n = sample size

95% confidence limits
In a normal distribution, 95% of datapoints fall within ± 2 standard deviations of the mean.

Usually, you are dealing with a sample of a larger population. In this case the 95% confidence limits for the sample mean is calculated using the following formula

95% confidence limits = $\bar{x} \pm 2 \times \frac{\text{SD}}{\sqrt{n}}$ **OR** $\bar{x} \pm 2 \times \text{SE}$

The chi-squared test

Use this test when
- the measurements relate to the number of individuals in particular categories
- the observed number can be compared with an expected number which is calculated from a theory, as in the case of genetics experiments.

The chi-square (χ^2) test is based on calculating the value of χ^2 from the equation

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

where O represents the observed results
E represents the results we expect.

A table showing the critical values of χ^2 for different degrees of freedom

Degrees of freedom	Critical value
1	3.84
2	5.99
3	7.82
4	9.49
5	11.07
6	12.59
7	14.07
8	15.51
9	16.92
10	18.31

The number of degrees of freedom = number of categories – 1