



General Certificate of Education  
Advanced Level Examination  
June 2013

## Biology

## BIO6T/P13/task/replacement

### Unit 6T A2 Investigative Skills Assignment Task Sheet

#### An investigation of human variation

##### Introduction

You will investigate variation in two ways.

##### Hand and wrist measurements

First, you will measure the span of your right hand and your left hand and the circumference of your right wrist and your left wrist. You **will not** use these data in your statistical analysis.

##### Human characteristics

Second, you will investigate the frequency of certain human characteristics. You will assume that each of these characteristics is determined by a single gene which has a dominant and recessive allele.

You will collect data from a group of ten 15 to 25-year-olds and you will be given data for a group of ten older people. You will assume that the older group represents a previous generation. The phenotypes of these older people will allow you to determine **expected** frequencies of different combinations of these characteristics. You will **only** use data from the two different age groups for your statistical analysis.

According to the Hardy-Weinberg principle, without natural selection, allele frequencies, and thus phenotype frequencies of human characteristics, should remain the same from one generation to the next. You will use your data to find **observed** frequencies of different combinations of these characteristics. You will then determine whether there has been any change in the frequencies of phenotypes between a previous generation and your generation.

##### Materials

You are provided with the following:

- 30 cm ruler
- 30 cm piece of string
- access to ten 15 to 25-year-olds
- reference sheet for identification purposes.

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

## Method

**Read these instructions carefully before you start your investigation.**

### Hand and wrist measurements

1. Measure your hand span, in millimetres, by spreading the fingers of your right hand as wide as possible on the ruler.
2. Repeat step 1 with your left hand.
3. Measure your wrist circumference by wrapping the piece of string around your right wrist. Mark the string where the free end meets it. Place the string against the ruler to measure the circumference of your wrist in millimetres.
4. Repeat step 3 with your left wrist.

### Human characteristics

5. With the first subject in front of you, use the reference sheet on page 3 to help you to determine which of the following characteristics they have:
  - right-handed or left-handed
  - clasps their fingers with right thumb or left thumb on top
  - straight thumb or can bend it back 'hitch-hiker' style
  - brown eyes (include brown or green) or blue eyes (include blue or grey)
  - can roll their tongue or not.
6. Repeat step 5 with the other nine subjects.

You will carry out your statistical analysis using data for just two of these characteristics. Your teacher will tell you which two characteristics you must use.


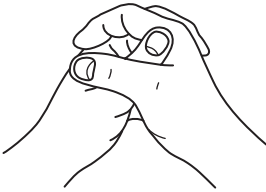
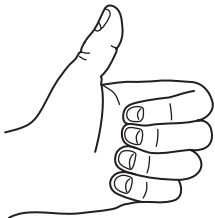
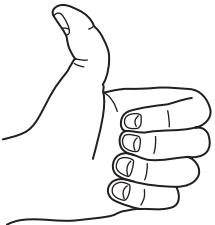


You may assume that steps 5 and 6 will give you sufficient data for a statistical test.

### You will need to decide for yourself:

- which form of a characteristic is shown by each subject.

**BIO6T/P13/task/Reference sheet**

Use this reference sheet to help you identify the phenotype shown by the subject for each characteristic. The reference sheet shows the phenotypes produced by the dominant and recessive alleles for each characteristic.

<b>Characteristic</b>	<b>Phenotype produced by dominant allele</b>	<b>Phenotype produced by recessive allele</b>
<b>Handedness</b>	Right-handed	Left-handed
<b>Finger clasp</b>	Left thumb on top 	Right thumb on top 
<b>Thumb</b>	Straight thumb 	Hitch-hiker thumb 
<b>Eye colour</b>	Brown (includes brown and green)	Blue (includes blue and grey)
<b>Tongue</b>	Tongue roller 	Non-tongue roller 

Turn over ►

**ISA BIO6T/P13 Candidate Results Sheet: Stage 1**

An investigation of human variation

Centre Number Candidate Number 

Candidate Name.....

Record your data in the tables below.

**Table 1 Hand and wrist measurements**

Side of body	Hand span / mm	Wrist circumference / mm
Right		
Left		

**Table 2 Human characteristics (15 to 25-year-olds)**

Subject	Form of characteristic shown by subject				
	Handedness	Finger clasp	Thumb	Eye colour	Tongue
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

There are no marks awarded for the table at A2.

1 State the **two** characteristics your teacher told you to use.

Characteristic **A** .....

Characteristic **B** .....

Use your results from **Table 2** to complete **Table 3**. This will show the number of people with the combinations of phenotypes for these two characteristics in your population of 15 to 25-year-olds.

*Example for characteristics of handedness and eye colour: complete Box 1 to show how many people are both right-handed and brown-eyed and so on.*

You will use your results from **Table 3** as the **observed** number of people.

**Table 3 Observed number of people with combinations of phenotypes for characteristics A and B in 15 to 25-year-olds**

		Characteristic <b>B</b> .....	
		..... (Phenotype produced by dominant allele)	..... (Phenotype produced by recessive allele)
Characteristic <b>A</b> ..... .....	..... (Phenotype produced by dominant allele)	Box 1  No. of people = .....	Box 2  No. of people = .....
	..... (Phenotype produced by recessive allele)	Box 3  No. of people = .....	Box 4  No. of people = .....

(1 mark)

**Stage 1 continues on the next page**

**Turn over ►**

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**Table 4** shows data for ten people over 50 years old.

Select information for the **same two characteristics A** and **B** that you used in completing **Table 3**.

This will allow you to determine the number of people with the combinations of phenotypes for the same two characteristics in a previous generation.

**Table 4 Form of characteristics shown by people over 50 years old**

Subject	Form of characteristic shown by subject				
	Handedness	Finger clasp	Thumb	Eye colour	Tongue
1	Right	Right on top	Hitch-hiker	Blue	Roll
2	Right	Left on top	Straight	Blue	Non-roll
3	Left	Left on top	Hitch-hiker	Brown	Roll
4	Left	Right on top	Hitch-hiker	Blue	Roll
5	Right	Left on top	Straight	Brown	Roll
6	Right	Left on top	Straight	Brown	Roll
7	Right	Right on top	Straight	Brown	Roll
8	Right	Right on top	Hitch-hiker	Blue	Roll
9	Left	Right on top	Straight	Brown	Non-roll
10	Left	Left on top	Hitch-hiker	Blue	Non-roll

Complete **Table 5** to show the characteristics, phenotypes and number of people over 50 years old with the combinations of the phenotypes for these two characteristics.

You will use your results from **Table 5** as the **expected** number of people.

**Table 5 Expected number of people with combinations of phenotypes for characteristics A and B in group of people over 50 years old**

		Characteristic B	
		.....	
		..... (Phenotype produced by dominant allele)	..... (Phenotype produced by recessive allele)
Characteristic A	..... (Phenotype produced by dominant allele)	Box 1 No. of people = .....	Box 2 No. of people = .....
	..... (Phenotype produced by recessive allele)	Box 3 No. of people = .....	Box 4 No. of people = .....

Hand in these sheets at the end of each practical session.

(1 mark)

**End of Stage 1**

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**ISA BIO6T/P13 Candidate Results Sheet: Stage 2**

An investigation of human variation

Centre Number 

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Candidate Number 

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Candidate Name .....

For your statistical analysis, use:

- your calculation of the observed number of people (15 to 25-year-olds) with the combinations of phenotypes for two characteristics (**Table 3**)
- your calculation of the expected number of people (over 50 years old) with the combinations of phenotypes for the same two characteristics (**Table 5**).

Use a statistical test to analyse your data. You may use a calculator and the AQA Students' Statistics Sheet that has been provided.

A sheet of graph paper is supplied. You may use this if you wish.

**3** State your null hypothesis.

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.....

.....

.....

(1 mark)

**4 (a)** Give your choice of statistical test.

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(1 mark)

**4 (b)** Give the reasons for your choice of statistical test.

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.....

(1 mark)



**5** Carry out the test and calculate the test statistic. Show your working.

(1 mark)

**6** Interpret the test statistic in relation to your null hypothesis. Use the words *probability* and *chance* in your answer.

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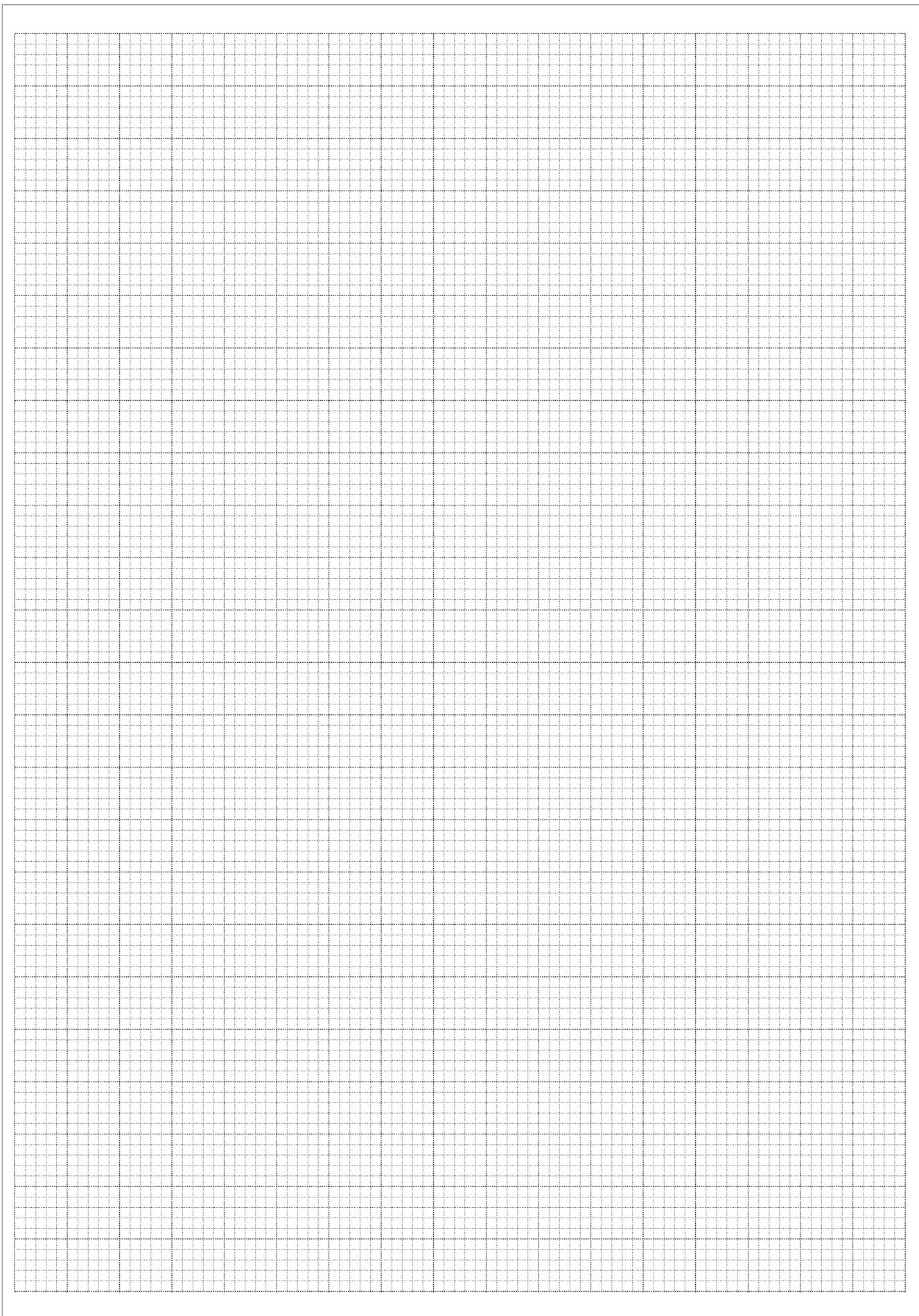
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(2 marks)

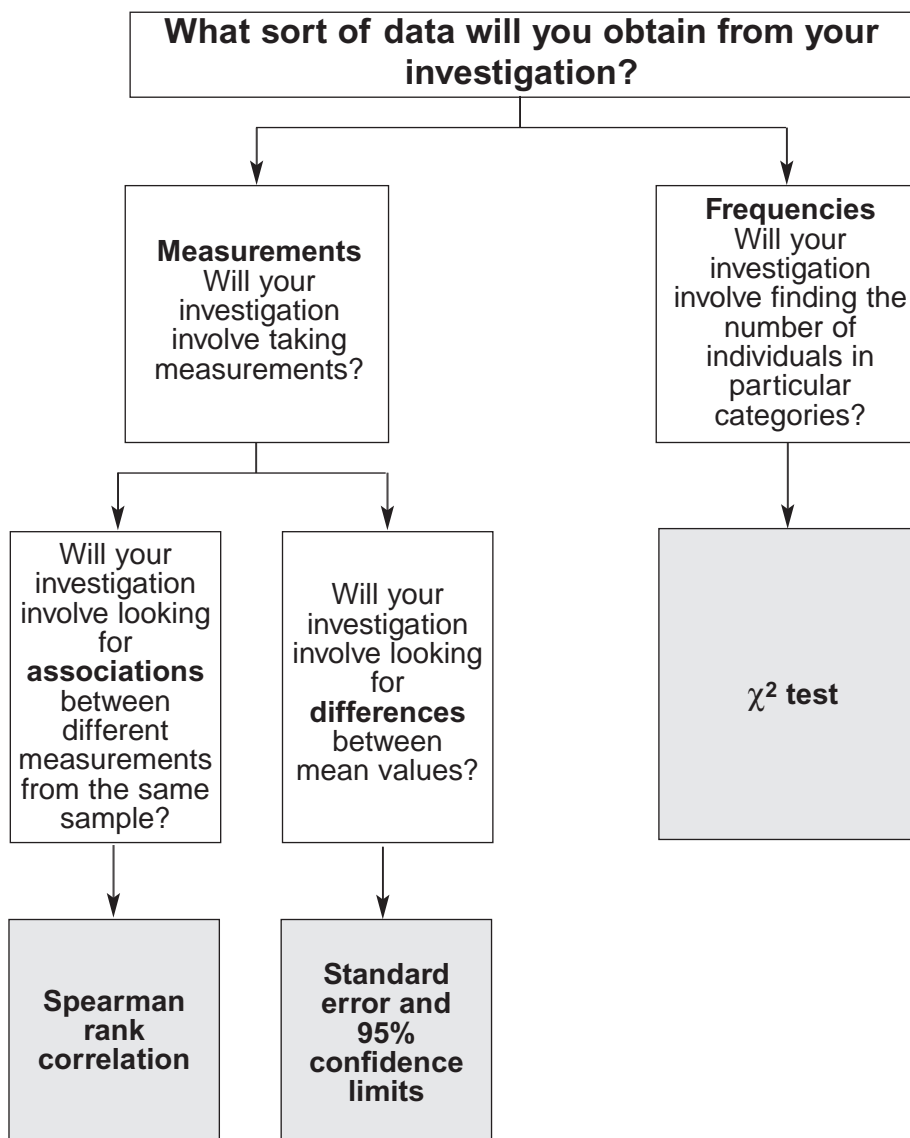
**END OF QUESTIONS**

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## AQA Students' Statistics Sheet (version 3)



### Standard error and 95% confidence limits

Calculate standard error,  $SE$ , for each sample from the following formula

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

where  $SD$  = standard deviation  
and  $n$  = sample size

95% confidence limits =  $2 \times SE$  above and below the mean

## The $\chi^2$ test

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

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

where  $O$  represents the results you observe in the investigation and  $E$  represents the results you expect.

**Table showing the critical values of  $\chi^2$  at P = 0.05 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

## Spearman rank correlation test

Calculate the value of the Spearman rank correlation,  $r_s$ , from the equation

$$r_s = 1 - \left[ \frac{6 \times \sum D^2}{n^3 - n} \right]$$

where  $n$  is the number of pairs of items in the sample and  $D$  is the difference between each pair of ranked measurements.

**Table showing the critical values of  $r_s$  at P = 0.05 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

**For use in the ISA and EMPA assessment**