Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use
Total Task 2

General Certificate of Education
Advanced Level Examination
June 2011

Human Biology HBI6X/PM2

Unit 6X A2 Externally Marked Practical Assignment
Task Sheet 2

To be completed before the EMPA Written Test

For submission by 15 May 2011

For this paper you must have:
- a ruler with millimetre measurements
- a calculator.

Investigating the relationship between the mass of a food substance and the energy content of the food substance

Introduction

For Task 2, you will investigate whether seeds with greater mass release more energy.

Task 2

Materials

You are provided with

- 10 runner bean seeds
- boiling tubes
- 25 cm^3 measuring cylinder
- distilled water
- clamp and stand
- glass rod
- thermometer
- rack for boiling tubes
- mounted needle to hold a seed
- access to a balance
- Bunsen burner
- heat-resistant mat
- method of lighting Bunsen burner
- marker pen.

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

Method

Read these instructions carefully before you start your investigation.

1. Use the measuring cylinder to put 20 cm^3 of distilled water into a boiling tube.
2. Use the clamp and stand to hold the boiling tube at an angle of about 45^o and facing away from you and anyone else.
3. Record the temperature of the water in the boiling tube.
4. Weigh one runner bean seed.
5. Carefully use a mounted needle to hold the seed.
6. Light the Bunsen burner and use it to set fire to the seed. As soon as the seed is burning, move it under the boiling tube so that it heats the water in the tube as it burns. To keep the seed burning, it might help to rotate it slowly. Relight the seed if necessary.
7. When the seed stops burning, immediately use the glass rod to stir the water in the boiling tube and then record the temperature of the water.
8. Determine the increase in temperature.
9. Use a clean boiling tube and repeat steps 1 to 8 with each of the remaining runner bean seeds.

You will need to decide for yourself

- when the seed is alight
- when the seed has finished burning
- whether there are other variables to control that might influence the data to be collected.

In this investigation you can assume that

- 1 cm^3 of distilled water weighs 1 g
- 4.2 joules is the amount of energy required to increase the temperature of 1 g of distilled water by 1 ^oC.

Calculate the energy content of each runner bean seed using the formula:

$$\text{Energy content in joules} = \text{mass of water} \times \text{increase in temperature} \times 4.2$$

Turn over ▶

7 Record the results of your investigation in an appropriate table in the space below.

(4 marks)

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

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

You should

(a) state your null hypothesis

(1 mark)

(b) give your choice of statistical test

(1 mark)

(c) give reasons for your choice of statistical test

(1 mark)

Do not write outside the box

(d) carry out the test and calculate the test statistic. Show your working.

(1 mark)

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

(2 marks)

END OF TASK 2

10

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You may use this if you wish.

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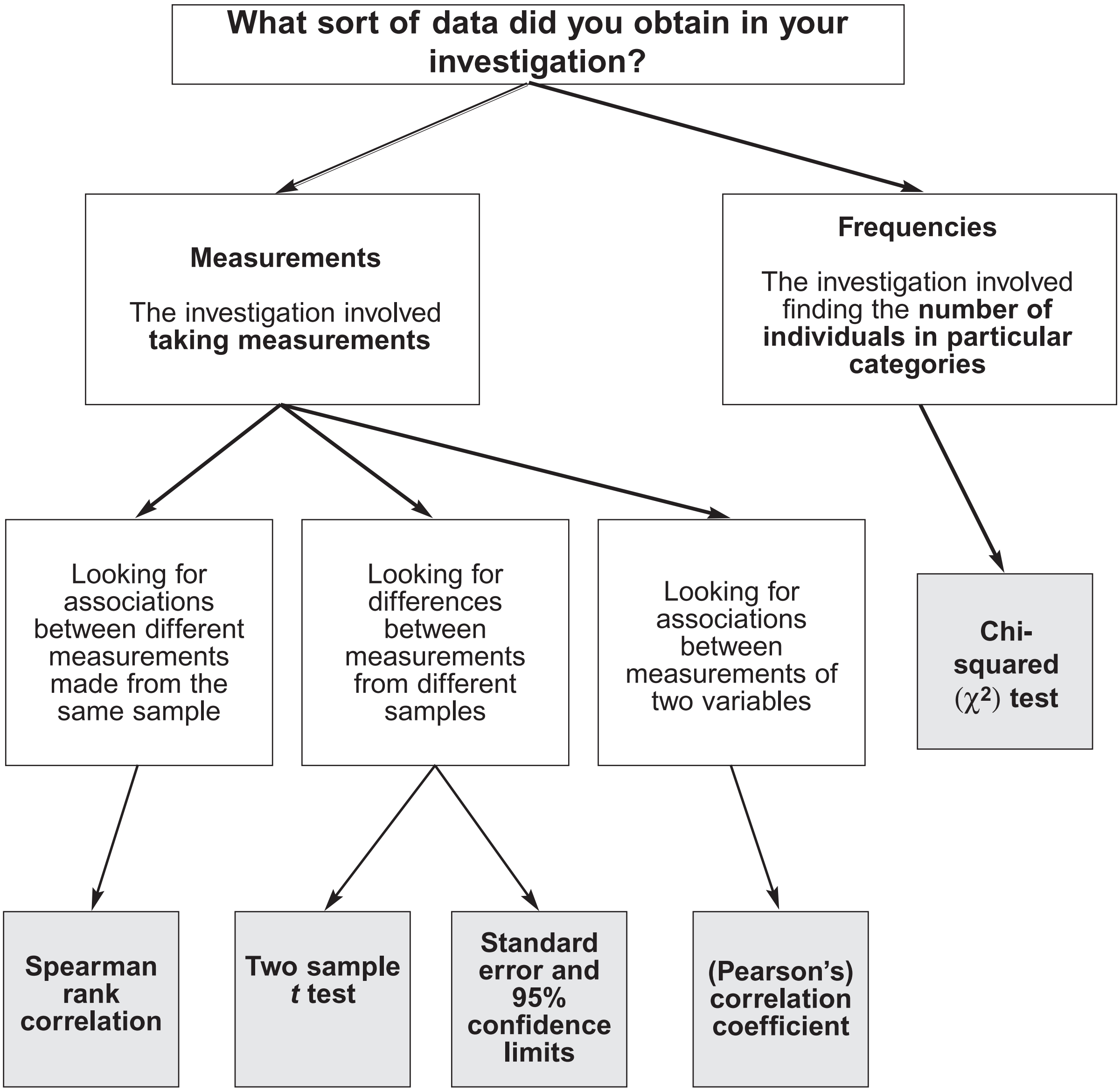
Students’ Statistics Sheet



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 = $n - 2$

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 data points 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 are calculated using the following formula

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

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-squared (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

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