Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use Total Task 2

General Certificate of Education
Advanced Level Examination
June 2013

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 2013

For this paper you must have:
- Task 1
- a ruler with millimetre measurements
- a calculator.

Investigating the effect of an antiseptic on the rate of respiration in yeast

Task 2

In this investigation, you will use five different concentrations of the antiseptic you used in Task 1. You will compare the effects of these concentrations of antiseptic on the rate of respiration in yeast.

Materials

You are provided with:

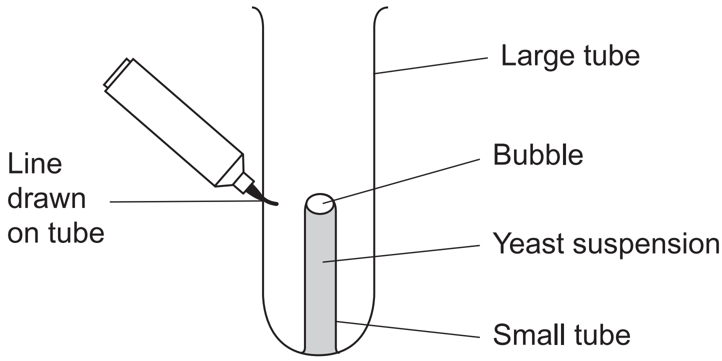
- yeast suspension in a solution of glucose
- 5 concentrations of antiseptic solution
- distilled water
- 6 large tubes
- 6 small tubes in a small beaker
- plastic pipettes
- thermometer
- boiling-tube rack
- timer
- marker pen
- 250 cm^3 beaker to use as a water bath
- access to hot and cold water
- a ruler with millimetre measurements.

You may ask for any other apparatus you require.

Outline method

Read these instructions carefully before you start your investigation.

1. Set up a water bath at 35 ºC. Maintain the water at 35 ºC throughout the experiment by adding warm water to the beaker if the temperature drops.
2. Label the large tubes **A**, **B**, **C**, **D**, **E** and **F**.
3. Add 10 drops of 100% antiseptic to **one** of the small tubes.
4. Use a plastic pipette to fill up completely the small tube with yeast suspension.
5. Set up the apparatus as you did in Task 1 using this small tube and large tube **A**. Your equipment should be set up as shown in the diagram below.



6. Draw a line on tube **A** to show the level of the bottom of the bubble in the smaller tube.
7. Put tube **A** into the water bath and leave for 10 minutes.
8. Take tube **A** out of the water bath and draw a line on tube **A** to show the new level of the bottom of the bubble.
9. Record the distance between the lines on tube **A**.
10. Repeat steps 3 to 9 using the other tubes and other concentrations of antiseptic. Carry out the 6th trial using distilled water.

You will need to decide for yourself:

- how many repeats to carry out.

Turn over for question 5

Turn over ▶

Recording your data

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

(4 marks)

Analysing your data

6 Analyse your data with a suitable statistical test. You may use a calculator and the AQA Students' Statistics Sheet that has been provided.

You are provided with a sheet of graph paper. You may use this if you wish.

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

6 (a) State your null hypothesis.

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(1 mark)

6 (b) Give your choice of statistical test.

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(1 mark)

6 (c) Give a reason for your choice of statistical test.

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(1 mark)

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

(1 mark)

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

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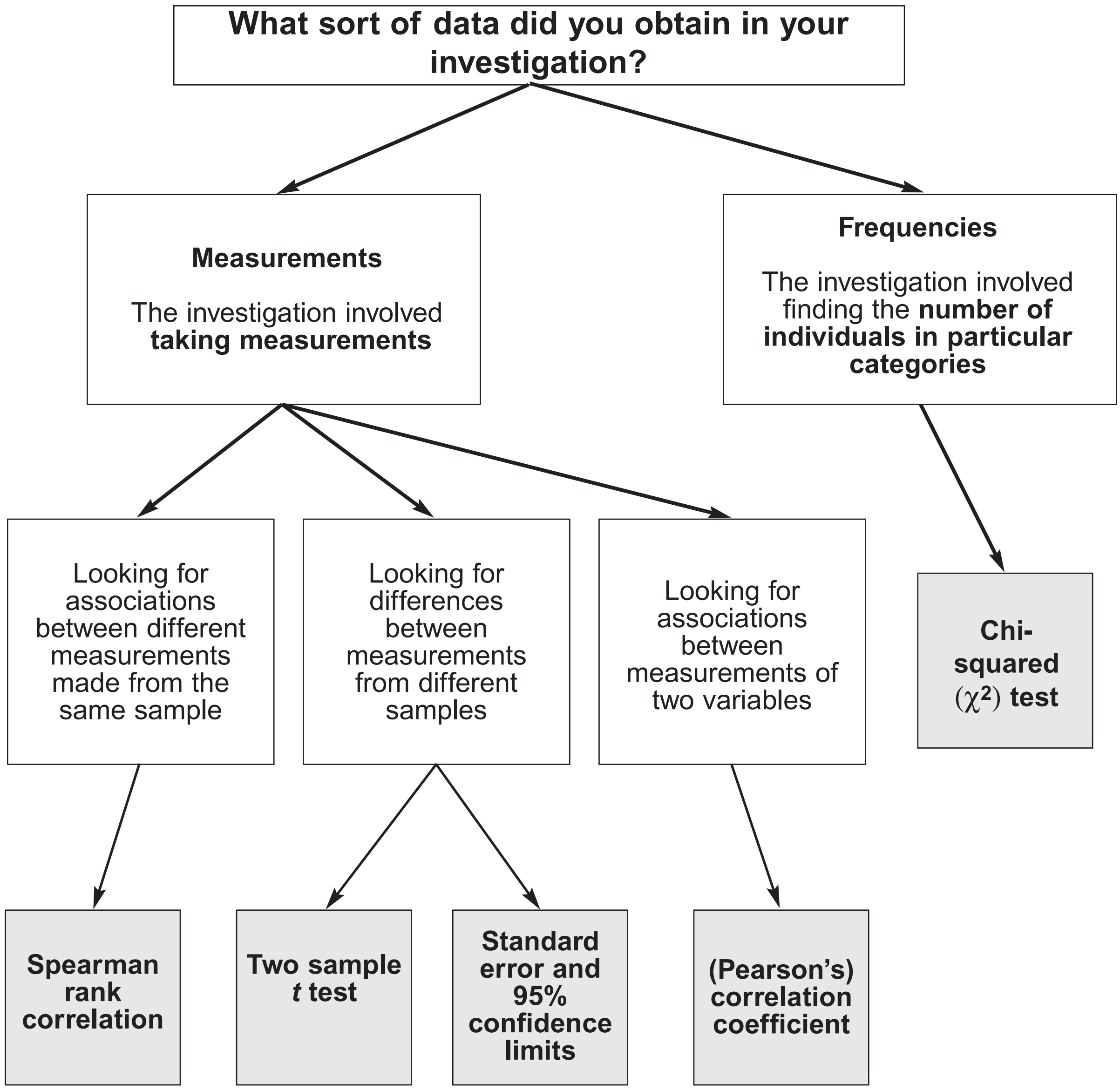
(2 marks)

10

END OF TASK 2

You may use this graph paper if you wish.

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

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

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 = $(n_1 + n_2) - 2$

Turn over ▶

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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