General Certificate of Education
Advanced Level Examination
June 2011

Human Biology HBI6X/TN

Unit 6X A2 Externally Marked Practical Assignment

Teachers' Notes Confidential

A copy should be given immediately to the teacher(s) responsible for GCE Human Biology

Open on receipt

Teachers' Notes

CONFIDENTIAL

These notes should be read in conjunction with *Instructions for the Administration of the Externally Marked Practical Assignment* for GCE Human Biology published on the AQA website.

Meeting energy requirements of the body

Food is the body's source of energy. Candidates will investigate the energy content of a food substance, in this case, runner bean seeds. The choice of runner bean seeds in both Tasks avoids the risk of nut allergies and the need to use a fume cupboard. In Task 1, candidates will use a simple method of calorimetry to examine some aspects of the method. In Task 2, they will use the same technique to investigate whether there is a relationship between the mass and energy content of the food substance.

Task 1: Measuring the energy content of a food substance

Materials

In addition to access to general laboratory equipment, each candidate needs

- 1 runner bean seed
- 1 boiling tube
- 25 cm^3 measuring cylinder
- distilled water
- clamp and stand
- thermometer capable of reading between 15 and 60 ºC
- mounted needle
- access to a balance
- Bunsen burner
- heat-resistant mat
- method of lighting Bunsen burner.

Managing the investigation

Candidates will require access to a balance and Bunsen burner. If there is a limited supply, the centre should control the use of the apparatus and communication between candidates. Candidates must read off the seed mass for themselves.

This investigation was successfully trialled using packets of runner bean seeds obtained from a retail outlet, such as Wilkinson's, and from garden centres. The seeds can take 1 to 2 minutes to start burning and often need to be relighted a few times. A temperature increase in the water in the boiling tube is clearly found. It is possible to hold the seed on a mounted needle by slowly and carefully pushing the needle into the seed. Not all of the seed will burn and it might be helpful to provide weighing boats or crucibles if the centre has them, or simply a piece of filter paper to weigh the remains.

The task must be trialled before use.

Candidates **must not** be given information about an EMPA assessment until one week before Task 1. One week before Task 1 candidates should be given the following information:

The investigation will be about measuring the energy content of foods, metabolism and factors that affect basal metabolic rate.

There **must** be no further discussion and candidates **must not** be given any further resources to prepare for the assessment.

In this investigation, teachers must not give candidates the following information

- whether they should attempt to relight the seed or not
- what data to record
- how to prevent the Bunsen burner from affecting their results.

Task 2: Investigating the relationship between the mass of a food substance and the energy content of the food substance

Materials

In addition to access to general laboratory equipment, each candidate needs

- 10 runner bean seeds
- 5 boiling tubes (candidates will need to wash and reuse, or 10 if there are sufficient supplies available)
- 25 cm^3 measuring cylinder
- 250 cm^3 distilled water
- clamp and stand
- glass rod
- thermometer capable of reading between 15 and 60 ºC
- rack for boiling tubes
- mounted needle
- access to a balance capable of measuring to 0.01 g
- Bunsen burner
- heat-resistant mat
- method of lighting Bunsen burner
- marker pen.

Managing the investigation

Candidates will again use a simple calorimeter to determine the energy content of runner bean seeds. One reason for the choice of runner bean seeds is that they vary in size and therefore in mass. It will help if candidates are provided with a variety of sizes of seeds. Only a visual assessment of size is required. Broad bean seeds could be used as an alternative to runner bean seeds. This does not affect any questions in the Written Test.

In trials with both types of seed, some seeds took 1 to 2 minutes to light with a blue Bunsen flame. Most continued to burn for about 20 to 30 seconds and a temperature increase greater than 10 °C was recorded. It is appreciated that the simple calorimeter does not provide a measure of all the energy within the seed but, for this investigation, it does not matter. A relationship will be evident and statistical analysis of the data will still be possible. 10 seeds are provided so that the candidate will have 10 sets of data available for statistical analysis.

Candidates will again require access to a balance and a Bunsen burner. If there is a limited supply, the centre should control the use of the apparatus and communication between candidates.

The task must be trialled before use.

In this investigation, teachers must not give candidates the following information

- what data to record.

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use
Total Task 1

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Human Biology HBI6X/PM1

Unit 6X A2 Externally Marked Practical Assignment
Task Sheet 1

To be completed before Task Sheet 2

For submission by 15 May 2011

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

Measuring the energy content of a food substance

Introduction

When a food substance burns, heat energy is released. If this energy is transferred to water, the change in temperature of the water can be used as a measure of the energy content of the food substance. In Task 1, you will investigate a simple method for obtaining a measure of the energy content of a runner bean seed.

Task 1

Materials

You are provided with

- runner bean seed
- boiling tube
- 25 cm^3 measuring cylinder
- distilled water
- clamp and stand
- thermometer
- mounted needle
- access to a balance
- Bunsen burner
- heat-resistant mat
- method of lighting Bunsen burner.

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

Outline method

Read these instructions carefully before you start your investigation.

Be aware that it can take 1 to 2 minutes for a seed to start burning. You might also need to relight your seed.

1. Use the measuring cylinder to put 25 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° and facing away from you and anyone else.
3. Record the temperature of the water in the boiling tube.
4. Weigh the runner bean seed and record its mass.
5. Carefully use a mounted needle to hold the seed.
6. Light the Bunsen burner and use it to set fire to the seed.
7. 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.
8. If the seed stops burning, see if it will relight and continue heating the water.
9. When the seed finally stops burning, record the temperature of the water.
10. Weigh the remains of the seed and record its mass.

You will need to decide for yourself

- when the seed is alight
- when the seed has finished burning
- how to prevent your Bunsen burner from affecting your results.

Recording your results

Record your results in the table.

Initial mass of seed / g	
Initial temperature of water / °C	
Final temperature of water / °C	
Final mass of seed / g	

Questions on Task 1

Answer **all** questions in the spaces provided.

1 The method you used only allows some of the seed's energy content to be measured. The unburned remains of the seed is one piece of evidence for this. Give **one** other piece of evidence from your experiment that also shows why only some of the seed's energy content can be measured.

2 Describe how you could monitor the temperature of the water in the boiling tube while the seed burns.

3 Another student, who followed the same method, recorded a temperature increase of $8\,^{o}C$. Without changing any of the apparatus, how could you modify the method to make sure that a temperature increase of at least $10\,^{o}C$ was always obtained?

4 As the seed burns, the organic matter it contains releases its energy. Most of the organic matter in the seed is starch.

4 (a) Describe how you could show that the seed contains starch.

4 (b) Use your results to calculate the proportion of the seed that did not burn. Show your working.

5 What additional measurement would you have had to take during your investigation to calculate the rate of combustion of the seed? Explain your answer.

6 The energy content of food substances is expressed in units of $kJ\,g^{-1}$. Explain why it is important to express the energy content in this way.

END OF TASK 1

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use
Total Task 2

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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°C.

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

Energy content in joules = mass of water × increase in temperature × 4.2

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

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

(b) give your choice of statistical test

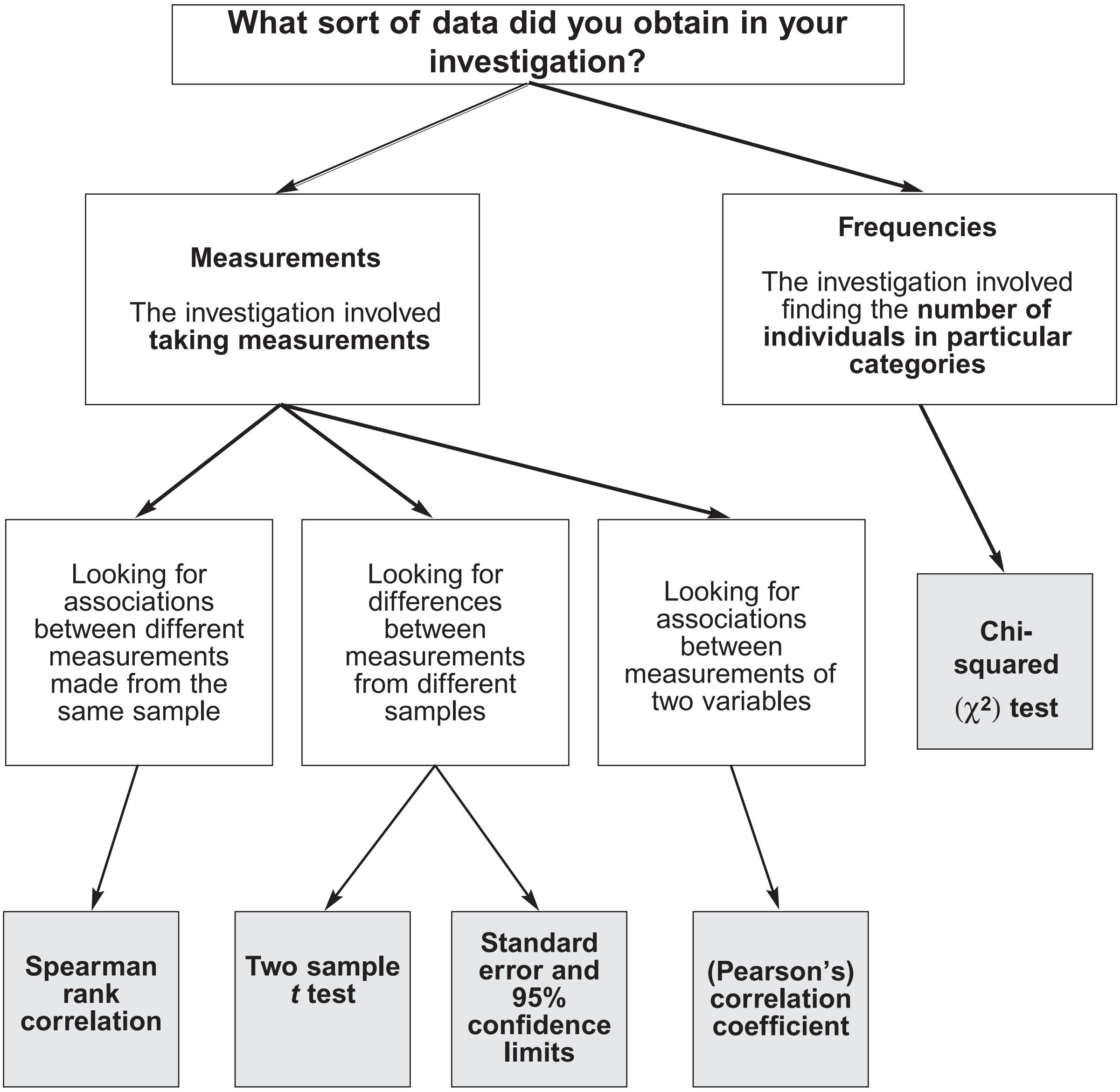
(c) give reasons for your choice of statistical test

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

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

END OF TASK 2

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 = $(n_1 + n_2) - 2$

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 = $\bar{x} \pm 2 \times \frac{\text{SD}}{\sqrt{n}}$ **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-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

Centre Number						Candidate Number				
Surname						Other Names				
Notice to Candidate. The work you submit for assessment must be your own. If you copy from someone else or allow another candidate to copy from you, or if you cheat in any other way, you may be disqualified.										
Candidate Declaration. I have read and understood the Notice to Candidate and can confirm that I have produced the attached work without assistance other than that which is acceptable under the scheme of assessment.										
Candidate Signature						Date				

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Total EMPA mark	
Examiner's Initials	
Section	Mark
Task 1	
Task 2	
Section A	
Section B	
TOTAL EMPA MARK	

General Certificate of Education
Advanced Level Examination
June 2011

Human Biology HBI6X

Unit 6X A2 Externally Marked Practical Assignment

For submission by 15 May 2011

For this paper you must have:	Time allowed
• your Task Sheet 2, your results and your calculations • a ruler with millimetre measurements • a calculator.	• 1 hour 15 minutes

Instructions:	Information
• Use black ink or black ball-point pen. • Fill in the boxes at the top of this page. • Answer **all** questions. • You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages. • Do all rough work in this book. Cross through any work you do not want to be marked.	• The marks for questions are shown in brackets. • The maximum mark for this paper is 30. • You will be marked on your ability to: – use good English – organise information clearly – use scientific terminology accurately.

Details of additional assistance (if any). Did the candidate receive any help or information in the production of this work? If you answer yes, give the details below or on a separate page.

Yes ☐ No ☐

Teacher Declaration:

I confirm that the candidate has met the requirements of the practical skills verification (PSV) in accordance with the instructions and criteria in section 3.8 of the specification.

Practical Skills Verification	**Yes** ☐

Signature of teacher .... Date

Section A

These questions relate to your investigation into the relationship between energy content and mass of a food substance.

Use your Task Sheet 2, your results and your statistical calculation to answer them.

Answer **all** questions in the spaces provided.

9 Using a graduated pipette instead of a measuring cylinder would improve the method. Explain why.

10 You were told to have the boiling tube facing away from you and have the tube at an angle of about 45°.

10 (a) Why were you told to have the tube facing away from you?

10 (b) What was the advantage of having the tube at an angle of about 45^{o}?

11 When the seed was burning, only some of the heat released was transferred into the water.

11 (a) Give **two** reasons why only some of the heat was transferred into the water.

11 (b) Does the efficiency of the transfer of heat to water affect the accuracy **or** the reliability of your results? Explain your answer.

12 A student carried out a similar investigation to yours with runner bean seeds and with pea seeds. She measured the mass of each seed and calculated the energy transferred from the burning seed into water. Her results are shown in the table.

Runner bean seed		**Pea seed**	
Mass of seed / g	**Energy transferred / J**	**Mass of seed / g**	**Energy transferred / J**
1.24	4.3	0.28	1.2
1.37	5.0	0.19	1.0
0.98	3.9	0.31	1.8
1.53	5.8	0.22	1.1
1.06	4.1	0.35	2.1

What is the mean energy transferred from the pea seeds in $J\,g^{-1}$? Show your working.

13 The student wanted to draw a graph of her results. What type of graph should she use to show the relationship between the mass of a seed and the energy transferred? Explain your answer.

14 She calculated the mean mass of the runner bean seeds and the mean mass of the pea seeds. She then used a *t* test to decide whether the difference between the means was significant.

14 (a) Give the null hypothesis for her *t* test.

14 (b) Explain how she should use a table of *t* values to decide if the difference between the two means is significant or not.

15 When seeds are eaten, some of their energy is lost in faeces. Explain **one** reason why.

Resource Sheet

Introduction

The basal metabolic rate (BMR) is the number of joules the body uses per kilogram of body mass per hour when at rest.

Resource A

BMR falls with age. The loss of a small amount of muscle each year is thought to be one reason for the fall.

Some researchers investigated two hypotheses to explain the fall in BMR with age.

Hypothesis 1 – Level of exercise

A person who exercises frequently has a higher BMR.

Hypothesis 2 – Level of energy intake

A person who eats more has a higher BMR.

Resource B

Researchers measured the BMR of groups of men. The groups were as follows.

- Young inactive
- Young active
- Old inactive
- Old active

Their results are shown in the table.

Group of men	Mean BMR / $J\,kg^{-1}\,h^{-1}$
Young inactive	302
Young active	323
Old inactive	268
Old active	285

Resource C

'Energy flux' describes the rate of flow of energy through the body. It depends on BMR, the level of exercise and energy intake. This is shown in the table.

Type of energy flux	Level of exercise	Energy intake
High	High	High
Low	Low	Low

Weight loss when dieting depends on energy flux. Losing weight by reducing energy intake can only continue for a certain time. If energy intake is reduced by too much for too long, then muscle tissue is lost. As a result, BMR decreases and so does the rate of weight loss.

Section B

Use the information in the **Resource Sheet** to answer the questions.

Answer **all** questions in the spaces provided.

Use **Resource A** to answer Questions **16** and **17.**

16 If muscle tissue is lost, BMR falls. Explain why

17 (a) Use **Hypothesis 1** to suggest why older men tend to have a lower BMR than younger men.

17 (b) Use **Hypothesis 2** to suggest why older men tend to have a lower BMR than younger men.

Use **Resource B** to answer Questions **18** and **19**.

18 Two of the young active men, born on the same day, had the same body masses but different BMRs. Suggest and explain **two** reasons for the difference in their BMR.

19 The researchers extended their study to include men and women. They expressed their results in the same units. Explain why.

Use **Resource C** to answer Question **20**.

20 Complete the table for someone who is trying to lose weight.

Type of energy flux	Level of exercise	Energy intake

Use **Resources A, B** and **C** to answer Question **21**.

21 Many doctors believe that keeping body weight at a suitable level is one way to enjoy a long life. Use all the resources to evaluate this belief.

END OF QUESTIONS