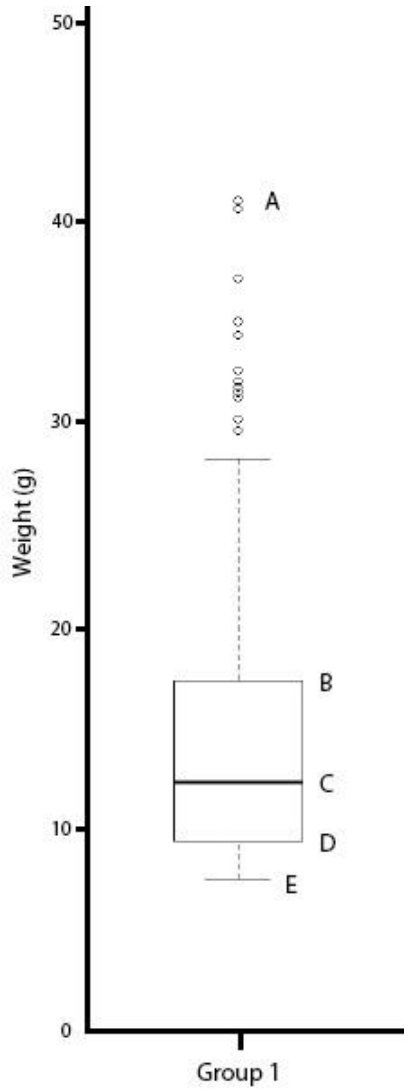
Level 1: remembering.

Frequently used task words: define, list, label, name.

Can the student recall or remember the information?



Q

A researcher constructed a boxplot (*left*) for the weights of week-old chickens.

Name the parts of the box plot labelled A-E.

i

This question just asks you to label the parts.

It doesn't ask you to draw a new diagram or explain anything about what the parts are for or what they mean.

A simple answer is all that is required to get good marks.

A

A – maximum

B – 3rd quartile or Q3

C – median

D – 1st quartile or Q1

E - minimum

Level 2: understanding.

Frequently used task words: describe, explain, identify & example.

Can the student explain ideas or concepts?

Q

a) Define the mean and the median.

b) Give an example of a situation when the median should be used instead of the mean.

This question is checking whether you understand what the mean and median is and when it is appropriate to use them in a statistical analysis.

It's not enough for you to just know the name of the item – you also need to know what it means and how to use it.

A

a) The **median** represents the middle value of a data set. Half the values are higher than the median, and half are lower.

The **mean** is the average of the data set.

b) The median should be used when data are not symmetrically distributed or includes outliers.

The median is often used in the analysis of experimental data sets because the median is less affected by outliers and skewed data.

Level 3: applying.

Frequently used task words: apply, illustrate, solve, use & demonstrate.

Can the student use information in a new way?

A study investigated the growth of poplar trees under various conditions. One of the treatment groups involved a combination of fertiliser and irrigation. The observed heights (m) of these 20 trees were:

1.9, 2.9, 3.2, 3.6, 3.9, 4.1, 4.1, 4.6, 4.8, 5.2, 5.4, 5.5, 5.5, 5.5, 6.1, 6.3, 6.5, 6.8, 6.9, 6.9

a) Create a box plot and the relevant summary statistics.

b) Describe the distribution of this data.

This is a classic application problem where you have to perform some calculations, show your working, and display the data on a box plot.

It relies on you knowing what the process entails, explaining what you are doing, and applying your understanding to a problem. For these problems it is important to show your working - even if you get the final plot wrong you can often get marks for the working.

The question asks for you to provide a description of the data. This should be quite brief – it's not asking you to perform and analysis.

a)

Find the summary statistics needed for the box plot.

1.9, 2.9, 3.2, 3.6, 3.9 | 4.1, 4.1, 4.6, 4.8, 5.2 | 5.4, 5.5, 5.5, 5.5, 6.1 | 6.3, 6.5, 6.8, 6.9, 6.9

Minimum = 1.9 m
Maximum = 6.9 m

Median = $\frac{5.2+5.4}{2}$ = 5.3 m

A

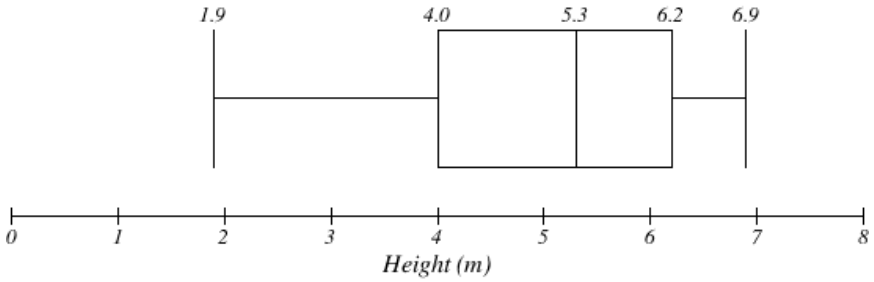
Q1 = $\frac{3.9+4.1}{2}$ = 4.0 m

Q3 = $\frac{6.1+6.3}{2}$ = 6.2 m

IQR = 6.2 m - 4.0 m = 2.2 m

1.5 x IQR = 3.3 m – no outliers identified.

Draw the box plot, ensuring the axis is labelled.



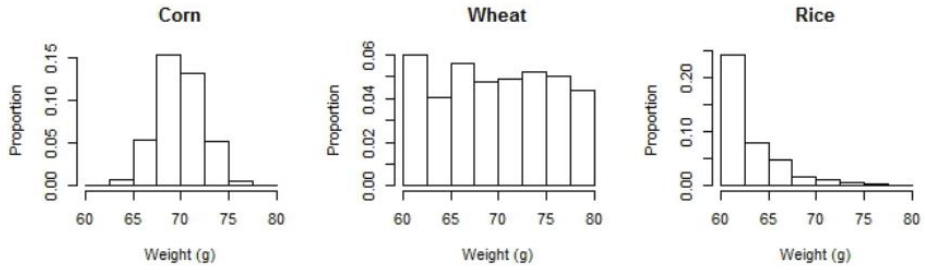
Level 4: analysing.

Frequently used task words: analyse, compare, contrast, examine.

Can the student distinguish between different parts?

A poultry researcher conducted a study to investigate the effects of three types of diets (corn, wheat, and rice) on the weight gain in week-old chicks. The collected data are summarised in the histograms below.

a) Compare and contrast these three distributions in terms of centre, spread and shape.
b) Suppose the ideal weight for week-old chicks is between 70 to 75 grams. Which diet would you recommend, and why?



This question is asking you to compare and contrast the 3 histograms (i.e. mention the similarities or differences) - specifically referring to the centre, spread and shape. It is essential that you refer to all aspects.

For part B, you need to make a judgment based on the data presented in the graphs. This is testing your ability to interpret the data.

It's important to look closely at the scale on the axes when analysing graphs. In this case, the scales vary considerably and should be taken into account when estimating the proportions.

A

a) Corn and wheat have similar centres while rice is lower. Although the total range is similar for all three, wheat has a uniform distribution and thus a greater spread than the others. Rice is skewed to the right while corn and wheat are symmetric.

b) The group of chicks being a fed a corn diet have the highest proportion of individuals in the 70-75 g range. Therefore, the corn diet should be recommended.

Level 5: evaluating.

Frequently used task words: justify, defend, argue, evaluate, assess

Can the student justify a stand or decision?

The output from three power tests for a t-test are given below. This examined sample sizes (n) of 2, 20, and 200. (In the output 'delta' is the true difference in means, 'sd' is the standard deviation and these are both kept constant at 1 for these power calculations).

Look at the output and suggest which sample size you would use. Justify your answer.

```
Two-sample t test power calculation

              n = 2
          delta = 1
             sd = 1
      sig.level = 0.05
          power = 0.09131778
    alternative = two.sided

NOTE: n is number in *each* group

 power.t.test(n = 20, delta = 1)


Two-sample t test power calculation

              n = 20
          delta = 1
             sd = 1
      sig.level = 0.05
          power = 0.8689528
    alternative = two.sided

NOTE: n is number in *each* group

 power.t.test(n = 200, delta = 1)

     Two-sample t test power calculation

              n = 200
          delta = 1
             sd = 1
      sig.level = 0.05
          power = 1
    alternative = two.sided

NOTE: n is number in *each* group
```

This question is asking you to analyse the output of the three power tests and state which sample size should be used for the experiment. You should justify your answer by providing more details on what should be considered when determining the sample size for an experiment.

A

The second sample (n=20) is a suitable option.

The first sample (n=2) has a power below 80%, making it unreliable.

Samples 2 and 3 (n=20 & n=200) both have a power above 80%, however, sample 3 (n=200) has a much larger sample size, which may increase experimental costs unnecessarily.