M140

TMA 04   2020J

Covers Units 10 and 11   **Cut-off date   28 April 2021**

Please read the Assessment Guide on the module website before beginning work on this TMA. You can submit your TMA either by post or electronically using the University's online TMA/EMA service.

This TMA is marked out of 50. Your overall score for this TMA will be the sum of your marks for each question. Note, however, that because the University requires TMAs to be marked out of 100, the mark returned to you by the University will actually be out of 100 (i.e. twice the total of marks on your TMA script).

The marks allocated to each part of each question are indicated in brackets in the margin.

Guidance about how to answer TMA questions is given in Subsection 7.2 of Unit 1.

Note that the Minitab files that you require for this assignment should be downloaded from the 'Assessment' area on the module website.

Please note that you should round you answers to an appropriate level of accuracy.

If you have a disability that makes it difficult for you to attempt any of these questions, then please contact your Student Support Team or your tutor for advice.

You should be able to answer Questions 1 and 2 after you have studied Unit 10. You will need to use Minitab to answer parts (b) and (e) of Question 1.

You should be able to answer Questions 3 to 5 after you have studied Unit 11. You will need to use Minitab to answer Question 5.

Question 1 (Unit 10)   –   24 marks

This question concerns the analysis of the mustard seedlings experiment that you were asked to carry out in Unit 10. You will need to use Minitab to answer parts (b) and (e).

(a) In one or two sentences, describe how your experiment went; for example, mention any difficulties that you faced along the way. Then present a table of your results, similar in layout to Table 3 of Unit 10 (Subsection 3.4). Indicate clearly the units in which you made your measurements (for example, millimetres) and the measurements that correspond to seedlings whose stems were cut during their growth. Then proceed to part (b) of the question.

If, however, you were unable to collect data of your own, then state this and explain why. Instead of presenting results in a table, draw stemplots for each of the two samples of data given in Table 1, including only measurements from seedlings whose stems were cut during growth. Also, give the main reason for producing such stemplots in the context of a *t*-test, and comment on the shape of the stemplots relative to this reason.

Table 1   Lengths of roots (in mm) obtained in
a mustard seedlings experiment

Seedlings grown in light					Seedlings grown in dark				
24	**30**	**21**	29	18	**27**	×	**18**	×	×
42	×	**22**	**17**	**27**	**24**	×	**29**	**31**	**31**
×	32	×	28	**24**	**26**	32	**27**	40	**23**
22	**25**	×	**32**	×	29	35	**25**	×	41

In Table 1, measurements given in bold were obtained from seedlings whose stems were cut during their growth. A cross indicates a seed which did not germinate.   [*6*]

To answer the remainder of this question, you should use your own data if you have them. Otherwise, use the data from Table 1.

(b) Run Minitab and type your data into columns headed `Light`, for lengths of roots of seedlings grown in light, and `Dark`, for lengths of roots of seedlings grown in the dark, for all the seedlings whose stems you cut. In your answer, provide a list of the data as it appears in your Minitab worksheet. (You should also save a copy of your worksheet in order to be able to work on it again at another time.)

Use Minitab to calculate the values of the sample variances of the two columns of data. Include a copy of the relevant Minitab output in your answer.   [*3*]

(c) Using the information you obtained in part (b), check whether it is reasonable to assume that the two samples come from populations whose distributions have a common variance. [3]

(d) To investigate whether light affects root growth (when stems have been cut during growth), a t-test is to be performed on the measurements that you made. Defining and using appropriate notation, state the null and alternative hypotheses of this test. [2]

(e) Use Minitab to perform the appropriate t-test on your data. (You should assume that the assumption of a common population variance is reasonable, regardless of the outcome of your investigation in part (c).) Include a copy of the relevant Minitab output in your answer.

What is the result of the t-test? Carefully report your conclusions concerning the question of whether light affects root growth of mustard seedlings. [6]

(f) A reservation about your conclusions in part (e), given the way in which the experiment was designed and carried out, might be that cutting the stems could have different effects in the light and in the dark. Give two other valid reservations. [4]

Question 2 (Unit 10) – 9 marks

You should not use Minitab to answer this question, but do the calculations 'by hand' (using a calculator), showing your working.

A manufacturer claims that a model of mobile phone has a battery life of 1020 minutes (i.e. 17 hours). In order to test this claim, 20 mobile phones of that model were fully charged and then used to perform a range of tasks. One task involved browsing the web continuously until the phones shut down. The length of time for each phone to shut down was recorded in minutes.

The results are summarised in Table 2.

Table 2 Summary statistics for the battery life (in minutes) of a model of mobile phone

Task	Sample size	Mean	Standard deviation
Web browsing	20	986	49

(a) What is the most appropriate version of the t-test if you want to test the null hypothesis that the underlying population mean battery life for this model of phone is what the manufacturer claims it to be when the phone is used in this way? Justify your choice. [2]

(b) What are the number of degrees of freedom and the 5% critical value for the most appropriate t-test applied to these data? [2]

(c) Hence calculate a 95% confidence interval for the population mean battery life for this model of mobile phone, as measured during this task. [3]

(d) Based on your calculated 95% confidence interval, is it plausible that the underlying population mean battery life is 1020 minutes as claimed by the manufacturer? Justify your answer. [2]

Question 3 (Unit 11) – 5 marks

Rheumatoid arthritis is a common, chronic condition that causes symptoms such as joint pain and restricted movement of the joints. Drugs do not cure rheumatoid arthritis, but they may reduce the symptoms. A medical research team wishes to compare the efficacy of two treatments (drug X and drug Y) that are currently available. It is known that these two treatments will alleviate symptoms only whilst the drug is being taken.

Consider the two designs below in turn. Explain how each of the two designs could be implemented in this context and state which you would recommend, justifying your choice. Your answer should discuss any pros and cons for each type of trial.

- A group-comparative design
- A crossover design   [5]

Question 4 (Unit 11) – 6 marks

Several surveys of graduate employers have been conducted to investigate the question 'what skills do graduate employers look for?'. These core skills are seen as 'transferable skills' or 'employability skills' and graduates are expected to provide examples demonstrating their competencies in these areas when applying to graduate schemes. Ten skills were identified with the five key core skills given in Table 3.

Table 3   Five core skills that graduate employers look for

A	Ability to apply subject knowledge and concepts
B	Good communication skills (oral and written)
C	Time management and organisation
D	Information gathering; interpretation and evaluation
E	Adaptability

A university department wanted to investigate whether extra online coaching in these skills was needed to support their students, or whether these skills were already well developed through modules taught by the department.

A study was conducted to see whether extra coaching was needed to develop these core skills. In the study, 22 pairs of students were selected from the department's year 3 students at the start of the year. The students were matched for modules studied, age and number of years of work experience. The 44 students were each initially asked to supply evidence to show how they met the five core skills given in Table 3. The evidence of each individual was then scored on a scale between 0 and 100.

After this was done, one student selected at random from each pair received an extra set of interactive tutorial sessions during their study. The other students were not given extra material and had only their normal study resources to work from. At the end of the academic year all 44 students were asked to resubmit their evidence about how they met the skills listed in Table 3. The resubmitted evidence was then scored using the same scale as before, and the change in the score for each student was recorded. The resulting data are to be analysed using a hypothesis test.

(a) From the hypothesis tests listed at the start of Subsection 4.4 of Unit 11, give the name of the most appropriate test for analysing these data, together with two reasons for your answer. [3]

(b) Choose three of the core skills listed in Table 3. For each of them, give a specific example of how your skills have improved thanks to M140. [3]

Question 5 (Unit 11) – 6 marks

You will need to use Minitab to answer this question.

A clinical trial is being designed to compare drug X against a placebo in the treatment of a disease. The researchers want to collect more information from the patients on drug X and so have decided to use a $2 : 1$ random allocation to drug X rather than a $1 : 1$ random allocation. A $2 : 1$ random allocation means that, for each patient, there is a 67% chance of being allocated drug X and a 33% chance of being allocated placebo. The trial is planning to recruit 200 patients.

In order to assign the 200 patients to a treatment group, you will need to allocate patients at random so that approximately 67% of them receive drug X (group 1) and the rest are allocated to the placebo group (group 0). Run Minitab.

(a) How many patients would you expect to allocate to the treatment group? [1]

(b) Set the seed of Minitab's random number generator to the value **723**. Why do you think that you have been asked to do this? [1]

(c) Use the appropriate facilities of Minitab to assign each of the 200 patients to placebo (group 0) or drug X (group 1) at random, with probability 0.67 that a patient will be in the drug X group.

    (i) State what method you used to allocate patients to groups. E.g. 'I used the method described in Computer Activity X'. [1]

    (ii) How many patients are randomised to receive drug X (group 1)? [1]

    (iii) Using worksheet row numbers as patient ID numbers, list the first ten IDs of the patients who will be assigned to drug X. [1]

(d) Comment on the outcome of the allocation of patients to the treatment group that you obtained in part (c) compared with the number you expected in part (a). [1]