Faculty of Science, Technology, Engineering and Mathematics
MU123 Discovering mathematics

MU123

EMA 2020J

Covers the whole module **Cut-off date 25 May 2021**

Submission instructions

There are some important differences in the procedure for preparing and submitting this end-of-module assessment (EMA) compared to that for submitting TMAs.

Before beginning this assignment, you must read the EMA page on the MU123 website for all instructions relating to the EMA.

Your score out of 5 for good mathematical communication (GMC) will be recorded against Question 7. You do not have to submit any work for Question 7.

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Question 1 – 2 marks

Think back over your experience of studying MU123. Think about what has gone well, or what has not gone so well.

(a) Describe one change that you have made, or plan to make, to your studying. I have learnt to model equations, functions, and data. This helped me in visualizing the problems and becoming familiar with the real meaning of the concepts. [1]

(b) Describe how you hope that the change will make your studying more effective. *If you think that no changes are necessary, then explain why.* [1]

In the future, I am planning that I'll use more real life applications to visualize the concepts. I believe this will help me to understand better.

Question 2 – 16 marks

During a prolonged stay indoors, Ambarine is concerned about how much time she spends on social media. She downloads an app which records how long she spends on two social media apps. Table 1 shows the results for the first 20 days.

Table 1 Time spent (in minutes) each day on two social media apps over a period of 20 days

Facebook	WhatsApp
90	45
62	37
58	16
45	26
35	28
72	41
85	28
58	32
58	28
76	34
58	27
72	91
64	22
52	64
43	27
40	26
38	7
46	28
50	17
60	35

(a) (i) Enter the data into two new lists in Dataplotter. Copy and complete the table below. Round values, where necessary, to one decimal place. *The mean, rounded to one decimal place, is given for you as a check that you have entered the data correctly.* [1]

—	Facebook	WhatsApp
Min	35	7
Median	58	28
Max	90	91
Mean	58.1	33.0
SD	14.9	17.6
IQ range	20.3	9.5
Range	55	84

(ii) Use the two measures of location to say which social media app, on average, Ambarine spent more time on. Explain your reasoning. [2]

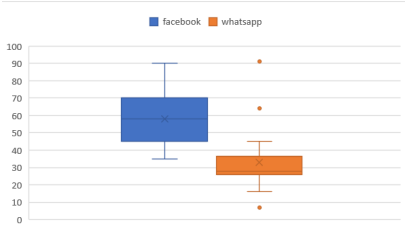
Ambarine stays more time on average at Facebook than at whatsapp. The average time at Facebook is 58.1 while on Whatsapp is 32.95

(iii) Use all three measures of spread to say which social media app has the greater variability in the amount of time Ambarine spent on it. Explain your reasoning. [2]

the greatest variability of time is on Whatsapp because it has a range of 84 compared to a 55 for facebook. We obtained this data through comparing the Max and Min value to calculate the range

(b) (i) Create boxplots for these two datasets (either drawn by hand or as output from Dataplotter). Include all the relevant information required for drawing boxplots as set out in Subsection 1.2 of Unit 11.

The summary values can be displayed on the boxplots themselves or in a table to the side of the chart, as they appear in Dataplotter.



(ii) Use the boxplot for the WhatsApp data to say whether the data are symmetric or skewed. If the data are skewed, then state whether they are skewed to the left or skewed to the right. What does this tell you about how the data are spread in the dataset for WhatsApp? [2]

the data is positively (right) skewed, this tell us that most data falls to the right near the 28

(iii) Ambarine tries to summarise what the boxplot for Facebook is telling her. Are the following statements true or false? In each case justify your answer.

(1) On about one-quarter of the days she spent more than 58 minutes on Facebook. [2]

False, because the median is on 58 minutes. so it's on about half of the days she spent more than 58 minutes

(2) On about three-quarters of the days she spent less than 68 minutes on Facebook. [2]

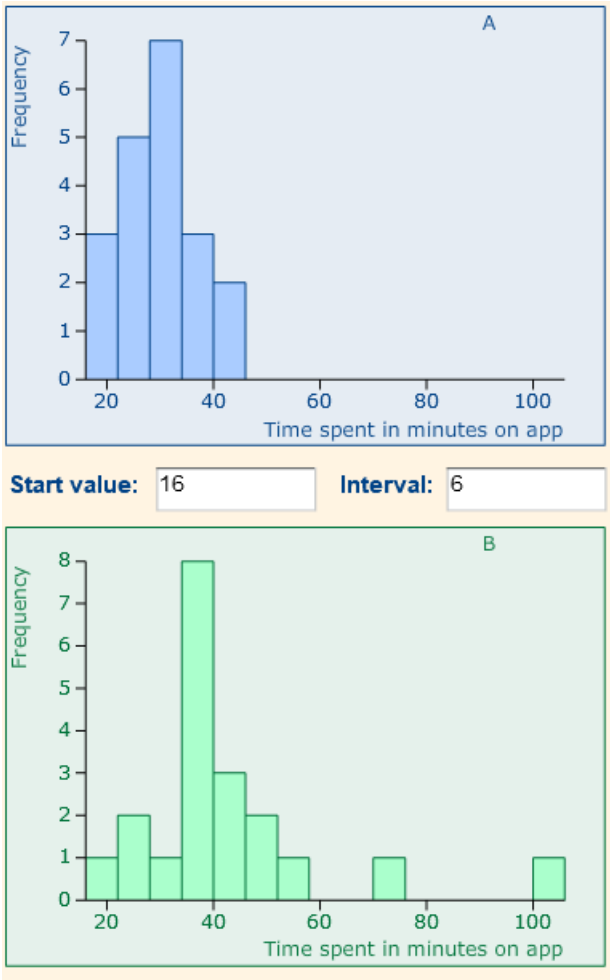
True, because the quarter of days on the pox-plots is higher than 68 minutes. Thus, there are 15 days (three-quarters) of the days she spent less than 68 minutes on Facebook

(c) Ambarine also looks at the amount of time her son is on the same apps on the same days. The summary data is in the table below.

Table 2 Time spent (in minutes) on social media apps by Ambarine's son over the same period of 20 days

	Facebook	WhatsApp
Min	18	16
Median	29	37
Max	45	100
Mean	29.2	42
SD	7.4	17.6
IQ range	11	10
Range	27	84

Ambarine creates histograms for her son's data, shown in Figure 1, but forgets to label them. Which histogram represents the Facebook data? Explain your answer. [2]



The first graph represents the Facebook
data because the max value for Facebook data is 45 which corresponds to the histogram. Moreover, the mean of the Facebook data which represents the avg. values is equal to 29.2 which corresponds with data in fig 1 also as the mean of the graph is in the same region

Figure 1

Question 3 – 18 marks

Throughout this question, use algebra to work out your answers. You may use a graph to check that your answers are correct, but it is not sufficient to read your results from a graph.

(a) A straight line passes through the points $\left(\frac{5}{2}, 2\right)$ and $\left(-\frac{3}{2}, 1\right)$.

(i) Calculate the gradient of the line. (2-1)/ (5/2 - (-3/2) = 1/4 = 0.25 [1]

(ii) Find the equation of the line. y= 0.25x + C => 2 = 5/2 * 0.25 + C => C = 11/8 [1] Y=0.25x + (11/8)

(iii) Find the x-intercept of the line. 0= 0.25x + (11/8) => -11/8 = 0.25x => x= -11/2 [1] (-11/2,0)

(b) Does the point $(4, 3)$ lie on the line that you found in part (a)(ii)? Explain your answer. [2]

No it doesn't lie on the line because when X = 4 the Y of the line = 19/8

(c) Find the coordinates of the point where the lines with the following equations intersect:

$$11x + 4y = 2,$$
$$-2x + 2y = 1.$$

11x + 4y = 2
-4x + 4y = 2
---------- (Minus)
15x = 0
x = 0

at x = 0
4y = 2
y = 0.5

The two lines intersect at (0,0.5)

[3]

(d) Before putting up a tree swing, a computer programmer models the trajectory his child would follow if the planned tree swing broke at a certain point. He shows the trajectory can be modelled by the equation

$$y = -0.33x^2 + 0.84x + 6 \qquad (0 \leq x \leq 6),$$

where x is the horizontal distance from the point at which the swing breaks, and y is the vertical height of the child from the ground (both measured in metres).

(i) Find the y-intercept of the parabola

$$y = -0.33x^2 + 0.84x + 6.$$

at X = 0 the Y-intercept occur
Then, y = 6
Y-intercept point is (0,6)

What does this represent in the situation being modelled? [2]

(ii) (1) By substituting $x = 3$ into the equation of the parabola, find the coordinates of the point where the line $x = 3$ meets the parabola. -0.33*9+0.84*3+6 = 5.55 They meet at point (3,5.55) [2]

(2) There is a 2.5-metre high slide in the path of the child's trajectory at a horizontal distance of 3 metres from the start of the trajectory. Using your answer to part (d)(ii)(1), explain whether the child would clear the slide. [1]

The child won't clear the slide because at t=3, the min. height he

(iii) (1) Calculate the x-intercepts of the parabola. [4] Using the quadratic formula a=-0.33 b=0.84 c=6. roots

(2) Assuming the ground is flat, give the horizontal distance between the start of the child's trajectory and the point where they would land. [1]

They will land when y is equal to zero. Thus, they will land at the x-intercept point.

Question 4 – 20 marks

You should use algebra in all parts of this question, showing your working clearly.

(a) Solve the following equations, giving your answers as integers or fractions in their simplest form.

(i) $6x + 2 = -5x - 9$ [2]

11x = -11, x=-11/11 = -1

(ii) $10 - 3(\frac{1}{2} - 4x) = \frac{1}{3}x + 9$ [4]

10 - (3/2) + 12x = (1/3)x + 9 >>> 8.5 - 9 = - 12x + (1/3)x >>> -0.5 = (-35/3)x >>> x = (3/70)

(iii) $\dfrac{-4x}{x-6} + \dfrac{3}{x+5} = -4$ [5]

-4x * (x+5) / (x-6) * (x+5) + 3 / (x-6) * (x+5) = -4

(b) Solve the equation $2x^2 + 23x - 39 = 0$ by factorisation. [3]

(2x-3) * (x+13) = 0
1/ 2x-3 = 0 >>> x = 3/2
2/ x+13 = 0 >>> x = -13
the solutions are 3/2 and -13

(c) A student was asked to rearrange the formula

$$a - \frac{2}{3}b = 7b - 3c\left(\frac{4b}{3} - 3\right)$$

to make b the subject, where $23 - 12c \neq 0$. The student's **incorrect** attempt is shown below.

1. $a - \frac{2}{3}b = 7b - 3c\left(\frac{4b}{3} - 3\right)$
2. $3a - 2b = 21b - 9c(4b - 9)$
3. $3a - 2b = 21b - 36bc - 81c$
4. $3a + 81c = 21b + 2b - 36bc$
5. $3a + 81c = 23b - 36bc$
6. $3a + 81c = b(23 - 36c)$
7. $b = \dfrac{3a + 81c}{23 - 36c}$

a - (2/3)b = 7b - 3c ((4b/3) - 3)
3a - 2b = 21b - 9c ((4b/3) - 3)
3a - 2b = 21b - 12bc + 27c
3a - 27c = 21b + 2b - 12bc
3a - 27c = 23b - 12 bc
3a - 27c = b (23 - 12 c)
b = (3a - 27c) / (23 - 12c)

(i) Write out a correct rearrangement of the formula. [4]

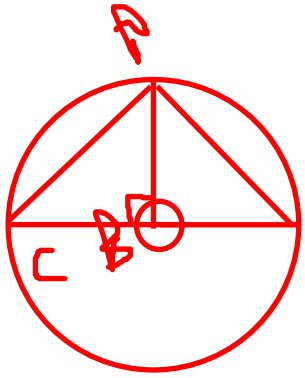
(ii) Identify and explain, as if directly to the student, two of the three mistakes made by the student. [2]

- In step 2, you tried to multiply both sides by 3. when multiplying an equation you should multiply each term in it. Thus the term -3c((4b/3) - 3) * 3 is equal to -9c((4b/3) - 3) the mistake that you made is multiplying the coefficient and the bracket also, and this is incorrect because it's one term. Your multiplication is equal to multiplying by 6 not 3

Question 5 – 20 marks

Throughout this question, take care to explain your reasoning carefully. You should round your answers, where necessary, to two significant figures.

A mathematical exhibition is being constructed. The backdrop consists of a circle with two congruent right-angled triangles either side of it. The circle has diameter 1.8 metres, which includes a circular rim which is 10 centimetres wide. The remaining area is covered with magnetic vinyl. Each triangle, ABC, has $\angle ABC = 90°$ with side lengths (measured in metres) $AB = 1.8$ and $BC = 3.8$.



(a) Find the circumference of the circle. 2*3.14*r = 5.7 meters [1]

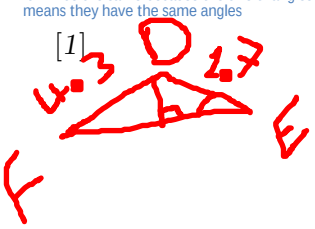
(b) Find the area of the magnetic vinyl on the circle. 3.14*0.9^2 - 3.14*0.05^2 = 2.5 cubic meters [1]

(c) Find the length of the hypotenuse of the triangle ABC. (3.8^2+1.8^2)^(1/2) = 4.2 meters [2]

(d) Find all the internal angles of the triangle ABC. A = 65, B =25, C = 90 [2]

(e) Inside each triangle ABC is a piece of magnetic vinyl which is a scaled-down similar triangle to ABC. In the smaller vinyl triangle, the side corresponding to BC is 20 centimetres shorter. What is the reduction scale factor? scale factor = length of reduced side / length of original side = 3.6/3.8 = 18/19 (reduction scale factor) approximately equal to 0.95 [1]

(f) Is the angle corresponding to BAC on the smaller vinyl triangle greater than, less than, or the same as angle BAC? Explain your answer. It will be the same because the two triangles are similar which means they have the same angles [1]



(g) An interactive exhibit with a programmable robot is to be included in the exhibition. The robot operates within a triangular enclosure DEF. With all lengths measured in metres, $DE = 2.7$, $DF = 4.3$ and $\angle EDF = 120°$.

(i) Find the length EF. using cos law, EF = (4.3^2 + 2.7^2 - (2*4.3*2.7* cos120))^(1/2) = 6.1 meters [4]

(ii) Find $\angle DEF$. using sin law, 4.3/ sin DEF = 6.1 / sin 120 >>> sin DEF = 37 [4]

(iii) Find the area of triangle DEF. A = 0.5*EF* DE*sin 37 = 0.5*6.1*2.7*sin37 = 5.0 meter squared [4]

Question 6 – 19 marks

In this question, where necessary, you should round answers appropriately.

(a) A researcher claims that the average six-year-old child has a vocabulary of around 5000 words and subsequently acquires 3000 words per year until they are 12 years old.

The size of the average child's vocabulary over this period can be modelled by the equation

$$v = 3000(t - 6) + 5000 \qquad (6 \leq t \leq 12),$$

where v is the size of the vocabulary in number of words and t is age in years.

(i) Find the vocabulary size of a nine-year-old according to this model. [1]

v= 3000 (9-6)+ 5000
v = 3000 * 3 + 5000
v = 14000 vocabs

(ii) Explain what is meant by the inequality '$(6 \leq t \leq 12)$' that follows the equation. [1]

Means that the domain of the function is [6,12] that means that function works from t = 6 to t = 12

(iii) Using algebra, calculate the age at which the vocabulary size is 20 000 words. [3]

20000 = 3000 (t-6) +5000 >>> 15000 = 3000t - 18000 >>> 33000 = 3000t >>> t = 11 years

(iv) Write down the gradient of the straight line represented by the equation

$$v = 3000(t - 6) + 5000.$$

v = 3000t - 18000 +5000
y = 3000t - 13000
as the gradient is the slope of the function. Then, the gradient is the t coefficient and equal to 3000

What does this measure in the practical situation being modelled? [2]

means that with every 1 year increase the vocub number increases by 3000

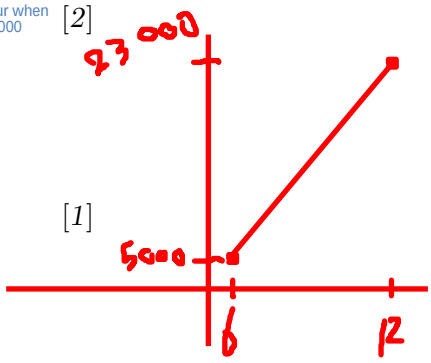
(v) Explain why the vertical v-intercept is not 5000. [2]

because of the -6, the v-intercept occur when x = 0. at x = 0, v= 3000*-6 +5000 = -13000
then the v-intercept is -13000

(vi) Either using Graphplotter or by hand, sketch the graph of

$$v = 3000(t - 6) + 5000,$$

putting v on the vertical axis and covering the time interval $6 \leq t \leq 12$. [1]



(b) A mother with an interest in language development records the number of words that her child can say, up to the age of 36 months. She claims the size of her child's vocabulary can be modelled by an exponential model with equation $v = 0.27 \times (1.26)^t$, where v is the size of the vocabulary in number of words and t is age in months.

(i) Calculate the size of vocabulary for a child aged 18 months and a child aged 30 months, according to this model. [3]

v(18) = 0.27 * 1.26^18 = 17 words, v(30) = 0.27*1.26^30 = 227 words

(ii) Write down the scale factor and use this to find the percentage increase in the vocabulary each month. [2]

scale factor is 1.26^t and the function increases by 26% each month.

(iii) Use the method shown in Subsection 5.2 of Unit 13 to find the age at which a child will have a vocabulary of 500 words. [4]

500 = 0.27 * 1.26^t
500/0.27 = 1.26^t
ln (500/0.27) = t ln(1.26)
t = ln(500/0.27) / ln(1.26) months >>> approximately equals 32 months

Question 7 – 5 marks

A score out of 5 marks for good mathematical communication over the entire EMA will be recorded under Question 7.