THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF MATHEMATICS AND COMPUTER SCIENCE

ENTRANCE EXAMINATIONS – 2016

MA003 – ENGINEERING MATHEMATICS

For candidates applying for Applied Physics/Radio Therapy, Mathematics & Computer Science, Electrical Engineering, Mechanical Engineering, Civil Engineering, Mining Engineering, and Mineral Processing Engineering.

TIME ALLOWED: 2 HOURS

INFORMATION FOR CANDIDATES

1. Print and sign your name below, and tick a box to indicate the type of course for which you are applying.
2. All answers must be written in this booklet.
3. Show your workings where required.
4. Do not use red ink or pencil to write this exam.
5. **Calculators are allowed in the examination room.**

Surname: _____ First name: _____
Signature: _____ Date: _____ Venue: _____

Tick the type of course for which you are applying.
[ ]   Applied Physics/Radio Therapy
[ ]   Mathematics & Computer Science
[ ]   Electrical Engineering
[ ]   Mechanical Engineering
[ ]   Civil Engineering
[ ]   Mining Engineering
[ ]   Mineral Processing Engineering

SECTION A: Short Answer Questions

Write the correct answer in the spaces provided on the far right for each question. Each part is worth 2 marks.

1. Find the value for n when $\left(2\dfrac{2}{5}\right)^{\frac{1}{n}} = 10$.   **Ans:** $n = \log\left(\dfrac{12}{5}\right) = 0.3802$

2. Solve $\dfrac{x-4}{3} - \dfrac{2x-3}{5} = 2$.   **Ans:** $x = -41$

3. Completely factorize $3x^2 + 8x + 5$.   **Ans:** $(3x+5)(x+1)$

4. Solve the equation $x - 10 + \dfrac{9}{x} = 0$.   **Ans:** $x = 1$ or $x = 9$

5. Transpose the formula $v = \dfrac{2R}{R-r}$ to make R the subject. **Ans:** $R = \dfrac{rv}{v-2}$

6. Simplify $\dfrac{2\sqrt{5}+1}{3\sqrt{5}-2\sqrt{2}}$.   **Ans:** $\dfrac{10\sqrt{10}+5\sqrt{2}}{10}$ or $\dfrac{5\left(2\sqrt{10}+\sqrt{2}\right)}{10} = \dfrac{2\sqrt{10}+\sqrt{2}}{2}$

7. Transpose $Q = \dfrac{w(H-h)}{T-\sqrt{t}}$ for t.   **Ans:** $t = \left(\dfrac{QT - w(H-h)}{Q}\right)^2$

8. Calculate for $\sqrt{\dfrac{p}{q}}$ when $p = 64^{\frac{2}{3}}$ and $q = 3^{-2}$.   **Ans:** 12

9. If $2^{x+1} = 4^x$, find the value for x.   **Ans:** $x = 1$

10. Solve the equation $\log x^4 - \log 100 = 1$ for x.   **Ans:** $x = 5.6234$

SECTION B: Multiple Choice Questions

Circle the correct choice for each question. Each part is worth 2 marks.

1. A television set is offered for sale at K360. A customer is offered a discount of 5% for cash purchase. How much will the customer pay on the discount price?
   A. K18   **B. K342**   C. K378   D. K345

2. Solve for x for the equation $\dfrac{5x}{6} - \dfrac{3x}{4} = \dfrac{1}{2}$.
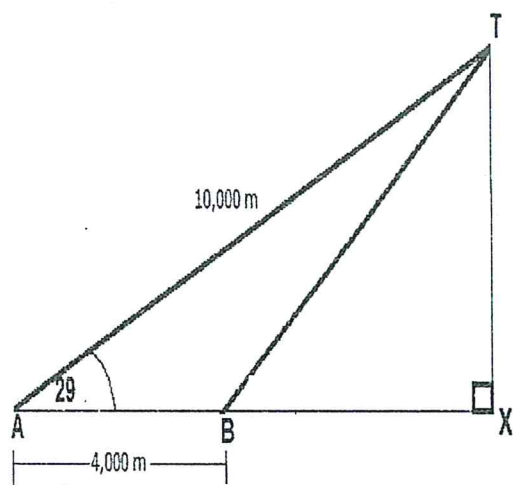   A. -8   B. -2   C. -1   **D. 6**

3. 18 books are to be bought for a library. Some cost K6 each and the remaining cost K7.50 each. If K120 is to be spent, how many of each type of books can be bought?
   A. 8 at K7.50 and 10 at K6   **B. 10 at K6 and 8 at K7.5 0**

   C. 5 at K7.50 and 9 at K6   D. 9 at K6 and 5 at K7.50

4. 4 times a certain number plus 9 is equal to 3 times the number plus 20, Find the number.

   A. 9   B. 10   **C. 11**   D. 12

5. Find two numbers x and y such that their sum is 24 and their difference is 6.
   A. 15 and 9   B. 10 and 8   C. 11 and 6   D. 14 and 5

6. Two angles are complementary. One angle is $23°$. What is the size of the other angle?
   A. $60°$ B. $68°$ C. $67°$ D. $17°$

7. How many degrees are there in $1\frac{1}{2}$ right angle?

   A. $140°$ **B. $135°$**   C. $75°$ D. $1.5°$

8. An isosceles triangle has a base of 3.4 cm and other sides are each 4.2 cm. Find its altitude.
   A. 13.81 cm   B. 2.92 cm   **C. 3.84 cm**   D. 4.51 cm

9. The mean of the numbers 12, 24 and y is the same as the mean of the numbers 9, 12, 18 and 21. What is the value of y.
   A. 9   B. 15   C. 18   D. 24

10. The marks of the 10 students in a test are 8, 4, 5, 10, 9, 8, 6, 5, 8, 3. What is the modal mark?
    A. 10   B. 8.5   **C. 8**   D. 6.9

Question	1	2	3	4	5	6	7	8	9	10
Answer	B	D	B	C	A	C	B	C	A	C

SECTION C: Workings required

Show workings for each question and write your final answer in the spaces provided on the far right for each question. Each part is worth 3 marks.

1. The figure below represents two plotting stations, A and B which is 4,000 m apart. T is a stationary target in the same vertical plane as A and B. It is recorded that when the distance of the target from the station A is 10,000 m, the angle of elevation is $29°$.

Calculate;

(a) The vertical height of the target, TX.   **Ans: 4,848.10m**

$$Sin(29) = \frac{TX}{10,000} \Rightarrow TX = 10,000 \times Sin(29) = 4,848.10$$

(b) The distance AX.   **Ans: 8,746.20m**

$$Cos(29) = \frac{AX}{10,000} \Rightarrow AX = 10,000 \times Cos(29) = 8,746.20$$

(c) The angle of elevation of the target T from B.   **Ans: 45.61^0**

$$BX = AX - 4,000 = 8,746.20 - 4,000 = 4,746.20$$

$$\therefore Tan(B) = \frac{XT}{BX} = \frac{8,746.20}{4,746.20} \Rightarrow B = Tan^{-1}\left(\frac{8,746.20}{4,746.20}\right) = 45.61$$

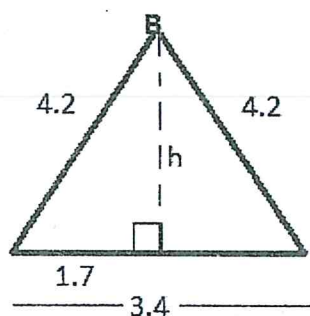(d) The distance TB.   **Ans: 6,784.58m**

$$(BT)^2 = (TX)^2 + (BX)^2 = (4,848.10)^2 + (4,746.20)^2$$
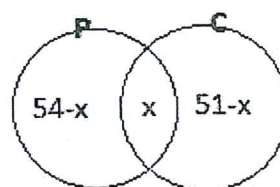$$\therefore BT = 6,784.58$$

2. An isosceles triangle has a base of 3.4 cm and the length of other sides is each 4.2 cm each. Calculate its smallest angle.   **Ans: 47.76⁰**

$$Sin(y) = \frac{1.7}{4.2} \Rightarrow y = \sin^{-1}\left(\frac{1.7}{4.2}\right) = 23.88$$

$\therefore$ Smallest angle at **B** is $2 \times 23.88 = 47.76$

3. In a group of 90 students, 54 take Physics and 51 take Chemistry. 9 take neither. How many students take both subjects?   **Ans: x = 24**

$n(P) = 54$

$n(C) = 51$

$n(P \cup C) = 90 - 9 = 81.$ Therefore using the vann diagram on right, we solve that;

$n(P \cup C) = 54 - x + x + 51 - x$

$81 = 105 - x \Rightarrow x = 24$

4. The flow of water from a tap is measured as 60 litres in 5 minutes.

(a) Work out the rate of the flow of water.   **Ans: 12 litres per minute**

$$\text{Rate} = \frac{60 litres}{5 \min utes} = 12l/\min$$

(b) Find the volume of water that flow in 7 minutes.   **Ans: 84 litres**

$12 \times 7 = 84$

(c) How long will it take to fill a tank with a capacity of 90 litres?   **Ans: 7.5 minutes**

$$12 : 1 = 90 : x \Rightarrow \frac{12}{1} = \frac{90}{x}$$

$$\Rightarrow 12x = 90 \Rightarrow x = \frac{90}{12} = 7.5$$

5. For what value of x is the gradient of the tangent to the curve $y = \dfrac{x^3}{3} + \dfrac{x^2}{2} - 33x + 7$ equal to 3?

Ans: x = 5.5   or   x = −6.5

$$y = \frac{x^3}{3} + \frac{x^2}{2} - 33x + 7 \Rightarrow y = 2x^3 + 3x^2 - 198x + 42 \Rightarrow \therefore \frac{dy}{dx} = 6x^2 + 6x - 198$$
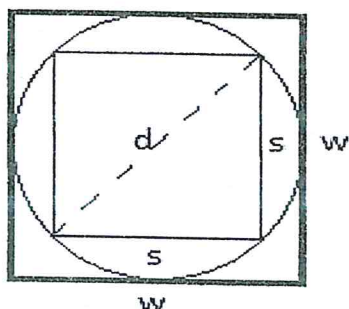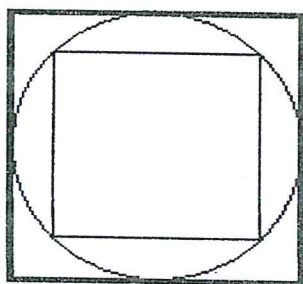
$Since \ \dfrac{dy}{dx} = 3$, we have $3 = 6x^2 + 6x - 198 \Rightarrow 6x^2 + 6x - 201 = 0$

Using quadratic formula $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a} \Rightarrow x = \dfrac{-6 \pm \sqrt{6^2 - 4(6)(-201)}}{2(6)}$

$x = 5.5$ or $x = -6.5$

6. In the diagram below, the area of a smaller square is $10 \, \text{cm}^2$. Find the area of the larger square.

Ans: 20cm^2

Area of smaller square : $A = s \times s \Rightarrow 10 = s^2 \Rightarrow s = \sqrt{10}$

$d^2 = s^2 \times s^2 \Rightarrow d^2 = 10 + 10 \Rightarrow d^2 = 20 \Rightarrow d = \sqrt{20}$

$\therefore$ Since d = diameter of the circle $= \sqrt{20} = w$

Area of larger square : $A = w \times w = \sqrt{20} \times \sqrt{20} = 20$

7. If $x + y = 5$ and $2x - y = 7$, what is the value of x which satisfies both these equations?

Ans: x = 4

$x + y = 5 \qquad \Rightarrow 2x + 2y = 10$

$2x - y = 7 \qquad \Rightarrow 2x - y = 7$

$\qquad\qquad\qquad\qquad 3y = 3 \Rightarrow y = 1$

$\therefore x + y = 5 \Rightarrow x + 1 = 5 \Rightarrow x = 4$