

SECTION A [10 MARKS]

Answer **all** questions

Question I

For each question, there are **FOUR** responses: A, B, C and D. Choose the corresponding letter of your response and **CIRCLE** it. If you change your answer, cross out the previous response clearly and circle your new answer. **NO** score will be awarded, if you circle more than **ONE** letter.

[10]

1. A committee sets up a scholarship fund. The fund will award Nu 20,000 annually forever at an interest rate of 5%. Find the present value of an annuity.

A Nu 100,000
B Nu 400,000
C Nu 420,000
D Nu 1,000,000

2. Given the matrix $A = \begin{bmatrix} 2 & -3 \\ 5 & 7 \end{bmatrix}$, determine the product of A and its multiplicative inverse.

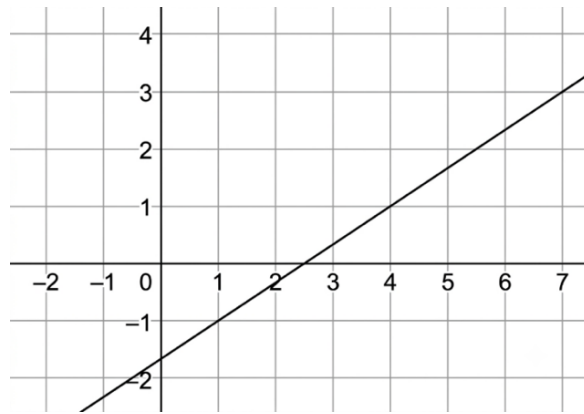
A $\frac{1}{29} \begin{bmatrix} 7 & -3 \\ -5 & 2 \end{bmatrix}$

B $\frac{1}{29} \begin{bmatrix} 7 & 5 \\ 3 & 2 \end{bmatrix}$

C $\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$

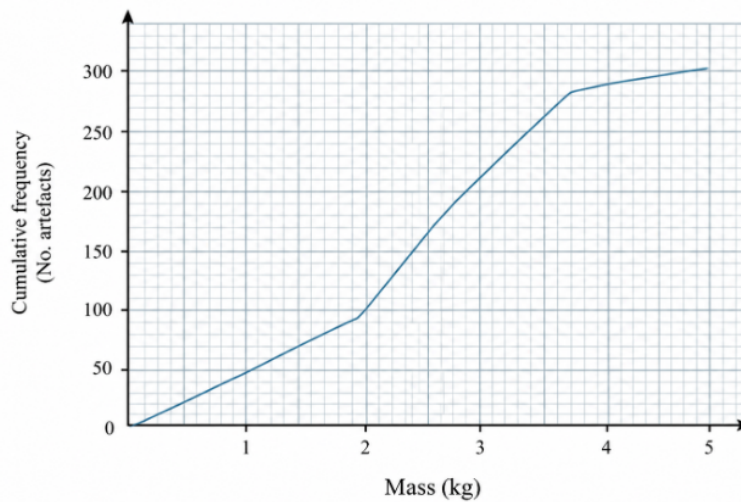
D $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$

3. The graph shows the line of regression line y on x . If the correlation between x and y is $\frac{\sqrt{3}}{3}$, then the regression coefficient of x on y is



- A $-\frac{2}{9}$
- B $-\frac{1}{2}$
- C $\frac{2}{9}$
- D $\frac{1}{2}$

4. The given graph displays the distribution of masses of 300 museum artifacts.



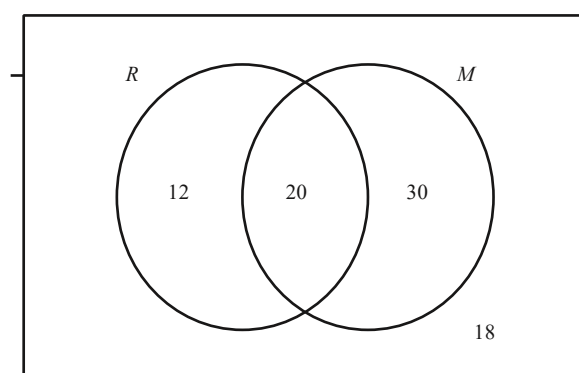
Find the median mass of the artifacts.

- A 2.0 kg
- B 2.4 kg
- C 4.0 kg
- D 5.0 kg

5. Find the value of x , if $\log_{10}(x+3) - \log_{10}(x) = 1$.

- A -3
- B $\frac{3}{10}$
- C $\frac{1}{3}$
- D 3

6. The Venn Diagram shows the numbers of students who read books (R) and watch movies (M). Find the probability that a student reads books but does not watch movies.



- A 0.15
- B 0.23
- C 0.25
- D 0.38

7. At the end of each year, a business owner deposits Nu 200,000 in a bank offering 6% compound interest per annum. Find the total amount accumulated after 10 years.

- A Nu 2,000,000
- B Nu 2,636,160
- C Nu 2,800,000
- D Nu 3,581,695

8. A bag contains 5 red balls and 3 black balls. Two balls are drawn one after another without replacement. Find the probability that both balls drawn are red.
- A $\frac{5}{14}$
- B $\frac{25}{64}$
- C $\frac{4}{7}$
- D $\frac{5}{8}$
9. A school will form a committee of 4 students from a group of 5 boys and 3 girls. The committee will include at most 2 girls. In how many ways can the committee be formed?
- A 15
- B 30
- C 55
- D 65
10. A family earns Nu 18,000 per month from farming and dairy activities. Their monthly expenses are Nu 6,500 for food and groceries, Nu 4,000 for loan repayment, Nu 1,200 for utilities, and Nu 1,800 for transportation. Based on this information, what type of cash flow does the family experience?
- A Balanced cash flow
- B Break-even situation
- C Surplus
- D Deficit

SECTION B (60 MARKS)

Answer **all** questions

Question II

Given the matrix

$$A = \begin{bmatrix} 2 & 1 \\ 3 & 2 \end{bmatrix},$$

1. Find A^{-1} . **[2]**

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2. Hence, solve the system of linear equations. **[3]**

$$2x + y = 5$$

$$3x + 2y = 8$$

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3. Consider the system of equations

$$\begin{bmatrix} 2 & 1 \\ 3 & k \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 5 \\ 8 \end{bmatrix}$$

where k is a constant.

Find the value of k for which the system has no solution. Justify your answer using the matrix method.

[2]

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Question III

1. A customer buys a laptop by making a down payment of Nu 8000 and agreeing to pay Nu 1500 at the end of every three-month period for 5 years. The interest rate charged is 8% per annum compounding quarterly. Find the cash price of the car and interest charged.

[4]

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2.

- a. Suppose the customer misses the first 4 payments. How much should he pay at the time of the 5th payment to bring his loan up to date?

[2]

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- b. If at the end of 3rd year (after making 12th payment), he wants to finish his liability by single payment, how much should he pay?

[2]

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Question IV

Tashi is a civil servant in Thimphu. He earns a monthly salary of Nu 55 000 and also receives monthly rental income of Nu 8 000 from a property.

1. Tashi deposits Nu 5 000 at the end of each month into a savings account that pays 6% per annum compounded monthly. Find the total amount in the account after 3 years. [2]

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2. After allowable deductions, Tashi's net taxable income for the year is Nu 636 000. Using the Personal Income Tax (PIT) slabs below (Income Tax Act of Bhutan, 2025), calculate the total tax payable for the year. [2]

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3. His annual contributions are
- PF: 10% of his salary
 - GIS: Nu 400 per month
 - Life insurance premium: Nu 18,000 per year
 - Education fee for his child (private school): Nu 120,000 per year

Calculate:

- a. Total allowable deductions **[1]**

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- b. Net taxable income **[1]**

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- c. Total tax payable **[1]**

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Question V

Students applying for colleges under the Royal University of Bhutan (RUB) are required to sit for an entrance examination. Those who are admitted then take a progress test three months after the course has begun. Table 5.1 shows the entrance test scores x and the progress test scores y for a random sample of 8 students.

Table 5.1

x	61	80	74	60	83	92	71	67
y	53	77	61	70	81	54	63	85

1. Find the correlation coefficient using the rank method.

[3]

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2. Draw a double box-and-whisker plot, using the same scales for both.

[4]

	
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Question VI

1. The six numbers 1, 1, 2, 3, 5, 5 are to be arranged in a row. Find the number of distinct arrangements possible.

[2]

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The faces of a fair blue die are marked 1,1,2,3,5,5.

The faces of a fair red die are marked 2,3,3,4,4,4.

The two dice are thrown and the scores recorded.

B is the score on the blue die.

R is the score on the red die.

2. The two dice are thrown and the scores recorded. Find the probability that the sum $B + R$ is greater than or equal to 8.

[2]

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3. The events X and Y are defined as follows:

X : the score on the blue die is 5.

Y : the sum of $B + R$ is greater than or equal to 8

a. Determine whether events X and Y are independent. Use suitable calculations to prove this mathematically.

[3]

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b. Determine whether events X and Y are mutually exclusive. Explain your reasoning.

[1]

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Question VII

A teacher wants to investigate the relationship between the number of hours students spend revising (x) and their percentage scores in a final examination (y). A random sample of 6 students gave the following calculation summary.

$$\sum x = 48, \quad \sum y = 390, \quad \sum x^2 = 426, \quad \sum y^2 = 26098, \quad \sum xy = 3296.$$

1. Calculate Karl Pearson's correlation coefficient between x and y . Give your answer correct to 3 significant figures.

[2]

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2.

- a. Find the equation of the regression line of y on x . Give your answer in the form $y = mx + c$.

[3]

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- b. Using the regression line, estimate the examination score for a student who revises for 8 hours.

[1]

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3. Comment on the reliability of your answer to part (2)(b), based on the value of the correlation coefficient.

[1]

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Question VIII

A librarian has 8 different novels and 5 different magazines. She wants to arrange some of them on a shelf and later select some at random for a reading competition.

1. The librarian arranges **all 8 novels** in a row on a shelf.
- a. Find the number of different possible arrangements.

[1]

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- b. Find the number of different arrangements if the 3 shortest novels must be placed at the left-hand end of the row (in any order).

[2]

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- c. Find the number of different arrangements if the 2 longest novels are not next to each other.

[1]

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2. She selects 3 books at random without replacement.

- a. Find the probability that all 3 selected items are novels.

[1]

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- b. Given that at least one novel is selected, find the probability that exactly two novels are selected.

[3]

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Question IX

1. Solve the equation

$$3^{2x-1} = 50$$

giving your answer correct to 3 significant figures.

[2]

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2. Show that the equation

$$3^{4x} - 7 \cdot 3^{2x} + 10 = 0$$

can be written as a quadratic equation in $y = 3^{2x}$ and hence solve it.

[4]

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3. Hence, or otherwise, solve $3^{4x} - 7 \cdot 3^{2x} + 10 = 0$, giving your answers correct to 3 significant figures where appropriate.

[2]

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FORMULAE

Class XI

Strand A: Numbers and Operations

$$C_{ij} = (-1)^{i+j} M_{ij}$$

$$A A^{-1} = A^{-1} A = I$$

$$A^{-1} = \frac{1}{\det A} \cdot \text{adj} A$$

Strand D: Data Management and Probability

$$\bar{x} = \frac{\sum_{i=1}^n x_i}{n}, \quad \bar{x} = \frac{\sum_{i=1}^n f_i x_i}{\sum_{i=1}^n f_i}$$

$$\bar{x} = A + \frac{\sum f d}{\sum f}, \text{ where } d_i = x_i - A$$

$$\bar{x}_w = \frac{\sum_{i=1}^n w_i x_i}{\sum_{i=1}^n w_i}, \quad \bar{x} = \frac{n_1 \bar{x}_1 + n_2 \bar{x}_2}{n_1 + n_2}$$

$$\text{Median } (M_d) = \text{Size of } \frac{n+1}{2} \text{th item}$$

$$M_d = l + \frac{i}{f} \left(\frac{n}{2} - c \right)$$

$$\text{Interquartile range} = Q_3 - Q_1$$

$$Q_1 = \frac{n}{4}, \quad Q_1 = \frac{n+1}{4} \text{th item}, \quad Q_1 = l + \frac{i}{f} \left(\frac{n}{4} - c \right)$$

$$Q_3 = \frac{3n}{4}, \quad Q_3 = \frac{3(n+1)}{4} \text{th item}, \quad Q_3 = l + \frac{i}{f} \left(\frac{3n}{4} - c \right)$$

$$\text{Quartile deviation} = \frac{Q_3 - Q_1}{2}$$

$$\sigma = \sqrt{\frac{\sum x^2}{n} - \left(\frac{\sum x}{n} \right)^2}$$

$$\sigma = \sqrt{\frac{\sum (x - M)^2}{n}} = \sqrt{\frac{\sum (d_x)^2}{n}}$$

$$\sigma = \sqrt{\frac{\sum f (x - M)^2}{\sum f}} = \sqrt{\frac{\sum f (d_x)^2}{\sum f}}$$

$$P(E) = \frac{n(A)}{n(S)}$$

$$P(\bar{A}) = 1 - P(A)$$

$$P(A) + P(\bar{A}) = 1$$

Class XII

Strand A: Numbers and Operations

$$C_{ij} = (-1)^{i+j} M_{ij}$$

$$A A^{-1} = A^{-1} A = I$$

$$A^{-1} = \frac{1}{\det A} \cdot \text{adj} A$$

$$a^m \times a^n = a^{m+n}$$

$$a^m \div a^n = a^{m-n}$$

$$(a^m)^n = a^{m \times n}$$

$$(ab)^n = a^n b^n$$

$$\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$$

$$a^{\frac{1}{n}} = \sqrt[n]{a}, \left(a^{\frac{1}{n}}\right)^n = a$$

$$a^{\frac{m}{n}} = \left(a^{\frac{1}{n}}\right)^m$$

$$\text{If } a^x = a^y, \text{ then } x = y$$

$$a^x = y \Leftrightarrow \log_a y = x$$

$$\log_a mn = \log_a m + \log_a n$$

$$\log_a \left(\frac{m}{n}\right) = \log_a m - \log_a n$$

$$\log_a m^n = n \log_a m$$

$$\log_a \left(\frac{1}{n}\right) = -\log_a n$$

$$\log_a (m^p) = p \log_a m$$

$$A = \frac{a}{i}(1+i) \left[(1+i)^n - 1 \right]$$

$$A = \frac{a}{i} \left[(1+i)^n - 1 \right]$$

$$P = \frac{a}{i}(1+i) \left[1 - (1+i)^{-n} \right]$$

$$P = \frac{a}{i} \left[1 - (1+i)^{-n} \right]$$

$$\text{Present worth}(P) = \frac{A}{1+ni}$$

Strand D: Data Management & Probability

$${}^n P_r = \frac{n!}{(n-r)!}$$

$${}^n C_r = \frac{n!}{r!(n-r)!}$$

$$\bar{X} = \frac{\sum fx}{\sum f} \text{ or } \bar{X} = \frac{\sum x}{n}$$

$$r = \frac{n \sum xy - \sum x \sum y}{\sqrt{n \sum x^2 - (\sum x)^2} \sqrt{n \sum y^2 - (\sum y)^2}}$$

$$r = \frac{\sum (x - \bar{x})(y - \bar{y})}{n \sigma_x \sigma_y}$$

$$r = 1 - \frac{6 \sum d^2}{n(n^2 - 1)},$$

$$\text{Correction factor} = \frac{1}{12}(m^3 - m)$$

$$r = \pm \sqrt{b_{xy} \cdot b_{yx}}$$

$$b_{yx} = r \frac{\sigma_y}{\sigma_x} = \frac{n \sum xy - \sum x \sum y}{n \sum x^2 - (\sum x)^2}$$

$$b_{xy} = r \frac{\sigma_x}{\sigma_y} = \frac{n \sum xy - \sum x \sum y}{n \sum y^2 - (\sum y)^2}$$

$$y - \bar{y} = \frac{\text{cov}(x, y)}{\sigma_x^2} (x - \bar{x}) = r \frac{\sigma_y}{\sigma_x} (x - \bar{x})$$

$$x - \bar{x} = \frac{\text{cov}(x, y)}{\sigma_y^2} (y - \bar{y}) = r \frac{\sigma_x}{\sigma_y} (y - \bar{y})$$

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

$$P(A) + P(\bar{A}) = 1$$

$$P(B / A) = \frac{P(A \cap B)}{P(A)}$$

$$P(A / B) = \frac{P(A \cap B)}{P(B)}$$