# DEPARTMENT OF MATHEMATICS

# S6 MATHEMATICS TEST 1 2026

# TIME: 2 HOURS 20 MINUTES

**Answer all the four (4) items.**

## ITEM 1:

(a) A wave is represented by $P(\theta) = 8\cos\theta - 15\sin\theta$.

(i) Express $P(\theta) = 8\cos\theta - 15\sin\theta$ in the form $R\cos(\theta + \alpha)$ where $\alpha$ is an acute angle.

(ii) Find the maximum and minimum values of $\frac{3}{5 - (8\cos\theta - 15\sin\theta)}$, giving the values of $\theta$ between $0^0$ and $360^0$ for which the maximum and minimum values occur.

(b) Juma, a young researcher in a telecommunication company found a tower $BAO$ which stood with its base $O$ on a horizontal plane, where, $BA = c$ and $AO = b$. A point $P$ was situated on the horizontal plane at a distance $x$ from $O$, and the angle $APB = \theta$. Help Juma to prove that $\tan\theta = \frac{cx}{x^2 + b^2 + bc}$.

## ITEM 2:

Two boxes P and Q contain coloured marbles. Box P contains 7 blue and 3 red marbles. Box Q contains 3 blue marbles and 4 red marbles. A box is picked randomly and from it, two marbles are drawn, one at a time, without replacement.

(a) Given that X is the random variable, 'the number of blue marbles picked',

(i) find the probability distribution of X,

(ii) calculate the expected number and standard deviation of X.

(b) Given that T is the event, 'the second marble drawn is red'

(i) Calculate $P(T)$.

(ii) Determine the probability that in 8 such trials, T appears exactly 3 times.

**ITEM 3:**

An engineer modelled an arch to be constructed on a building, by the function $f(x) = \dfrac{3x^3 + 7x^2 - 3x + 2}{x(x-1)(x+2)}$.

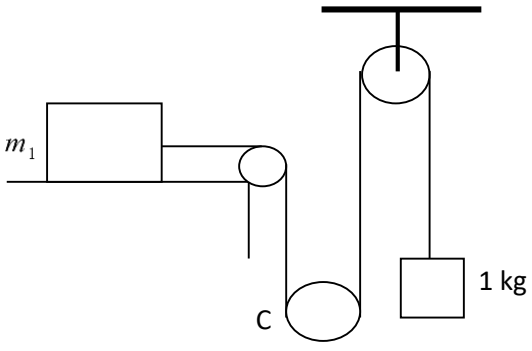
(a) Help the engineer to express $f(x)$ in partial fractions.

(b) Calculate the value of $\int_2^4 f(x)dx$, correct to 4 significant figures.

**ITEM 4:**

(a) Mr Mujuni's car developed a mechanical problem while he was on his way to village. He ordered for a car carrier of mass 1500 kg to tow his car of mass 900 kg to the garage for repair. The road surface is assumed to be inclined at angle $\theta$, where $\sin\theta = \dfrac{1}{10}$. The engine of the car exerts a forward force of 2.4 kN and the resistance to motion of the car and carrier is 200N. Find the acceleration produced and the tension in the tow bar.

(b) A block of mass $m_1$ kg is at rest on a smooth horizontal platform. It is attached to a light inextensible string. The string, after passing over a small fixed pulley at the edge of the platform, passes under a small moveable pulley C of mass $m_2$ kg. The string then passes over a smooth fixed pulley and supports a mass of 1 kg.




The system is released from rest.

(i) Show that the tension in the string is $T = \dfrac{3m_1m_2g}{4m_1 + m_2 + m_1m_2}$.

(ii) The pulley C will remain at rest if $\dfrac{2}{m_2} - \dfrac{1}{m_1} = k$. Find the value of *k*.

END