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ANGLICAN COLLEGE

Assessment Notification

Year 12 Task 2

Subject: **Mathematics Extension 1**

Task title	**Mathematical Investigation**		
Date issued	**Thursday, 3 April 2025**	Weighting	**20 %**
Due date	**Thursday, 1 May 2025**	Total marks	**25**

Outcomes:

ME12-1 applies techniques involving proof or calculus to model and solve problems.

ME12-2 applies concepts and techniques involving vectors and projectiles to solve problems.

ME12-4 uses calculus in the solution of applied problems, including differential equations and volumes of solids of revolution.

ME12-5 applies appropriate statistical processes to present, analyse and interpret data.

ME12-6 chooses and uses appropriate technology to solve problems in a range of contexts.

ME12-7 evaluates and justifies conclusions, communicating a position clearly in appropriate mathematical forms.

Context:

Mathematical modelling and investigations can be powerful tools that can be used to describe many situations in our world and solve problems. Mathematics can be used in many different fields including in Science, journalism, economics, sport, medicine ….etc. The purpose of this assignment is to explore the mathematics involved in projectile motion and LEGO patterning

Description of the task:

This is a mathematical investigation exploring real world problems associated with projectile motion and LEGO patterns. The task will assess students' knowledge and understanding of calculus, vectors, binomial probability and graphing. It will also assess students' skills in using technology, solving problems, modelling, constructing arguments, justifying, providing reasoning, proving and evaluating. There will also be a 30 minute validation test. This will validate the skills required to complete the at-home component.

Marking criteria:

Student's assignment submissions will be marked according to the included marking criteria, syllabus outcomes and details provided within the task.

Your assignment should include:

- reasoned explanations
- full working for any calculations
- justification of conclusions
- evidence of the use of appropriate technology. This can be in the form of digital files submitted with the report or relevant screenshots of your work.

Feedback provided:

Individual feedback, according to the assignment's marking guidelines and syllabus outcomes will be provided on Edumate as part of On-time Reporting.

Submission details:

Students are to submit an electronic copy of the task on CANVAS by the same period of the validation test on the due date. **The validation test will be in period 0** (7:30am before school).

Important information:

- It must be all your own work.
- You must include all relevant working out calculations, tables and graphs.
- The writing and drawings must be clear, neat and legible.

Faculty Leader approval:

Students are reminded of the rules and requirements relating to completion, submission and absences for assessment tasks.	 **Faculty Leader approval**

Part A: All Sports Golf!
(10 marks)

Watch *Dude Perfect* play their All Sports Golf Battle! They use different balls, at different speeds, at different heights to end up in the 'golf' hole.

The Task:

You will conduct calculations based on one of their scenarios. You will be allocated a ball, a height, a speed and a range to investigate.

Imagine you are standing with your _____ ball.

You are at the top of a cliff edge that is of a _____ m tall.

You hit the ball at a speed of _____ m/s.

The hole below, where you need to hit your ball into, is _____ m from the base of the cliff.

You are hitting your ball at an angle α.

Assumptions:

- Acceleration due to gravity (downwards) is 9.8 m/s.
- There is no air resistance or other forces involved.
- The height stated above includes the height where you are hitting the ball above the ground.
- That the land is horizontal to the base of the cliff.
- The ball doesn't roll or bounce etc. – it lands directly in the hole.

Complete the following:

(a) Include a labeled neat sketch showing the starting situation with all the initial information. **(1 mark)**
(b) Find expressions for both the velocity and position vectors. **(2 marks)**
(c) Calculate when the projectile (the ball) hits the target (the hole). **(1 mark)**
(d) Calculate the angle(s) required to launch the projectile to hit the target. **(2 marks)**
(e) Determine the maximum height of the ball above the ground. **(1 mark)**
(f) Write the cartesian equation for the flight of the ball. **(1 mark)**
(g) Include a labelled graph showing the (theoretical) flight of the ball/projectile using graphing technology. **(1 mark)**
(h) Calculate the angle of projection that produces the longest distance the ball can travel horizontally before hitting the ground. **(1 mark)**

Notes:

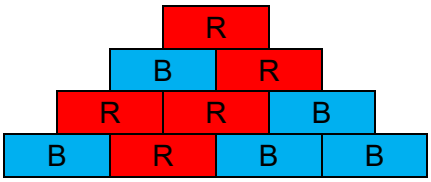
1. To receive full marks, ALL necessary algebraic, vector and calculus methods and ALL working out must be included.
2. It is recommended that you study projectile motion using vector methods as shown in chapter 13.3 of your textbook. You may also find assistance from ATOMI and other research.

Part B: Statistical Analysis – Binomial Investigations (10 marks)

A LEGO tower is to be constructed using only red and blue bricks. The bricks are each selected at random. In the source of bricks available, the probability of selecting a blue brick is ____ .

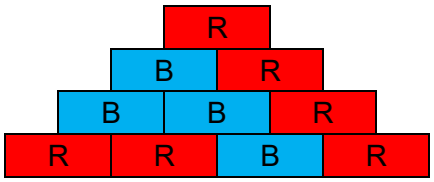
The tower can be built to any height. The first four rows of the tower could look like this:

Example 1



← Row 1→
← Row 2 →
← Row 3 →
← Row 4 →

Example 2



Predicting the Pattern of the LEGO Tower — Marks

1. Investigate towers up to 6 rows high. Calculate the probability that in each row there are no blue bricks, exactly one blue brick, exactly two blue bricks or exactly three blue bricks. Show your working out and summarise your findings in a table similar to the model shown below. **1**

Number of blue bricks	0	1	2	3
Row 1				
Row 2				
Row 3				
…				
Row 6				

2. What pattern in the probabilities of exactly 0, 1, 2 or 3 blue bricks do you observe? **1**

3. Consider building the tower to a height of n rows. Write generalised rules for exactly 0, 1, 2 or 3 blue bricks for the nth row. **1**

4. (i) Create a spreadsheet using formulas to calculate the probability of various numbers of blue bricks in rows of different lengths up to Row 15. Label the columns with the number of blue bricks and the rows with the number of bricks in the row as in the table given above. Submit the spreadsheet. **1**

   (ii) Investigate two different values for the probability that the brick is blue. State the results and describe the effect of altering the probability of a cell being coloured blue have on the patterns or rules you have discovered? **2**

5. Research the term 'Galton Board' on the internet. For the LEGO towers created above, if a red brick represents a ball falling to the left, and blue brick represents a ball falling to the right, **explain** how the towers can be used to represent the probabilities of balls falling down a Galton Board. **1**

6. (i) Watch The Wall – She's So incredibly Lucky!.

(ii) Consider the simplified situation in which at each level of the wall, the ball can only fall one cell to the left or the right on the next level down. Both of these options have equal probability. **3**

There are 7 cells at the top of the wall and 15 at the base. The number of cells in each row increases from 7 to 15 and thereafter, the wall is rectangular (from rows 15 to 20). There are 20 rows in total.

In the last row of the wall the cells contain the value to be 'won'. These are, in order from left to right: $1, $50 000, $100, $100 000, $10, $200 000, $1, $300 000, $1, $400 000, $10, $500 000, $100, $1 000 000 and $1.

Explore the probability that a person will 'win' $1 000 000 on the first ball they drop from a cell of their choice. Explain your strategy, providing all relevant reasoning and working. You should submit a spreadsheet as part of your answer and all working out, explanations, conclusions and justifications.

Part C: Validation Test
(5 marks)

Students will be asked to complete similar styled questions as work at home. It will be 30 minutes under test conditions.