

***I A Exploration***

BABY

**Due August 16, 2024 (test grade)**

IB Math A&I Summer Compulsory Assignment

|  |  |
| --- | --- |
| **Official (IB)**  **Project**  **Description** | The project (IA) is internally assessed by the teacher and externally moderated by the IB using assessment criteria that relate to the objectives for mathematics. Each project is assessed against five criteria. The final mark for each project is the sum of the scores for each criterion. The project should not normally exceed 2,000 words, excluding diagrams, graphs, appendices and bibliography. However, it is the *quality* of the mathematics and the processes used and described that is important, rather than the number of words written. The maximum possible final mark is 20. |
| **Scoring** | The IA is 20% of IB’s score for the Math Studies course (Paper 1 and Paper 2 are each 40%).  The three weeks of testing at the end of the year are an arduous time of the year. Earning maximum points on your IA project is an excellent way to alleviate pressure at the end of the year on these high-stakes exams while improving your overall grade. |
| **Data** | Doing a quickie regression between two variables found in existing data is hackneyed and derivative. This project is meant to be a showcase of your interest and ability, not an afterthought. Scoring on such projects has a hard time achieving full marks.  Collecting your own original data is highly encouraged and shows a strong commitment to the intent of the project. I will happily assist you with providing subjects to fill out your surveys and volunteers to help you compile your data if needed. Surveys may *not* be completed as an online answer-if-you-want-to questionnaire (this creates systemic errors in your data). |
| **IA Logistics**  **& Timing** | The majority of work for the IA should be completed at home, while up to 25 hours will be spent in class assessing and refining the project. While other interim deadlines will be set together, the following deadlines are non-negotiable and each will be a test grade (grade reduced if late):   * + **8/16/24** this assignment, your final topic, 1 page of data or survey, and grading of 2 IAs due   + **11/22/24** rough draft of paper due   + **1/31/25** final draft of paper due   The IB curriculum is very challenging with many additional papers and activities overlapping this one. Though it is not required to finish your IA over the Summer, I strongly urge you to devote several hours to understanding the project, understanding the requirements and the rubric, benchmarking other IAs, and researching a topic that will hold your interest and motivate you to complete a high-level exploration with Maths. |
| **This**  **Assignment** | Complete and turn in the **bolded** items:   * Read the attached IB rubric, checklist, and titles and complete additional research to understand the requirements. **Create a list of questions you still have about the project.** * Grade the **2 past IAs** using the full criteria (rubric) and IB Math IA checklist (make comments on the papers, show where criteria have been met, etc.) * Complete the **IA Getting Started Questionnaire** to assist you with picking a topic * Complete the **IA Topic Evaluation Page** about your topic to determine if there will be enough different types of math you can perform to maximize your grade * Topic, and survey or 1 page of data (including citation/source) |

<page left blank to make others print back to back…>

|  |  |
| --- | --- |
| **Criterion A: Presentation** | |
| 🞏 0 | does not reach the standard below. |
| 🞏 1 | some coherence or some organization. |
| 🞏 2 | some coherence and shows some organization. |
| 🞏 3 | is coherent and well organized. |
| 🞏 4 | is coherent, well organized, and concise. |

**Criterion B: Math communication**

Total Points:

**coherent** - logically developed, easy to follow and meets its aim. This refers to the overall structure or framework, including introduction, body, conclusion and how well the different parts link to each other.

**well-organized** - includes an introduction, describes the aim of and has a conclusion. Relevant graphs, tables and diagrams should accompany the work in the appropriate place and not be attached as appendices to the document. Appendices should be used to include information on large data sets, additional graphs, diagrams and tables.

There must be evidence of personal engagement demonstrated in the student’s work. It is not sufficient that a teacher comments that a student was highly engaged. Textbook style explorations or reproduction of readily available mathematics without the candidate’s own perspective are unlikely to achieve the higher levels.

**Significant:** The student demonstrates authentic personal engagement in the exploration on a few occasions and it is evident that these drive the exploration forward and help the reader to better understand the writer’s intentions.

**Outstanding:** The student demonstrates authentic personal engagement in the exploration in numerous instances and they are of a high quality. It is evident that these drive the exploration forward in a creative way. It leaves the impression that the student has developed, through their approach, a complete understanding of the context of the exploration topic and the reader better understands the writer’s intentions.

* used appropriate mathematical language (**notation, symbols, terminology**). Calculator and computer notation is acceptable only if it is software generated. Otherwise it is expected that students use appropriate mathematical notation in their work
* defined **key terms** and variables, where required
* used **multiple forms of mathematical representation**, such as formulae, diagrams, tables, charts, graphs and models, where appropriate
* used a **deductive method** and set out proofs logically where appropriate

Examples of level 1 can include graphs not being labelled, consistent use of computer notation with no other forms of correct mathematical communication.

Level 4 can be achieved by using only one form of mathematical representation as long as this is appropriate to the topic being explored. For level 4, any *minor* errors that do not impair clear communication should not be penalized.

|  |  |
| --- | --- |
| 🞏 0 | does not reach the standard below. |
| 🞏 1 | some relevant mathematical communication which is partially appropriate. |
| 🞏 2 | some relevant appropriate mathematical communication. |
| 🞏 3 | communication is relevant, appropriate and is mostly consistent. |
| 🞏 4 | communication is relevant, appropriate and consistent throughout. |

## Criterion C: Personal engagement

|  |  |
| --- | --- |
| 🞏 0 | does not reach standard below |
| 🞏 1 | some personal engagement. |
| 🞏 2 | significant personal engagement. |
| 🞏 3 | outstanding personal engagement. |

## Criterion D: Reflection

Simply describing results represents **limited reflection**. Further consideration is required to achieve the higher levels.

Some ways of showing **meaningful reflection** are: linking to the aims of the exploration, commenting on what they have learned, considering some limitation or comparing different mathematical approaches.

**Critical reflection** is reflection that is crucial, deciding or deeply insightful. It will often develop the exploration by addressing the mathematical results and their impact on the student’s understanding of the topic. Some ways of showing critical reflection are: considering what next, discussing implications of results, discussing strengths and weaknesses of approaches, and considering different perspectives.

**Substantial evidence** means that the critical reflection is present throughout the exploration. If it appears at the end of the exploration it must be of high quality and demonstrate how it developed the exploration in order to achieve 3

|  |  |
| --- | --- |
| 🞏 0 | does not reach the standard below. |
| 🞏 1 | evidence of limited reflection. |
| 🞏 2 | evidence of meaningful reflection. |
| 🞏 3 | substantial evidence of critical reflection. |

## Criterion E: Use of mathematics

**Relevant** refers to mathematics that supports the development of the exploration towards the completion of its aim. Overly complicated mathematics where simple mathematics would suffice is not relevant.

Students are expected to produce work that is **commensurate with the level** of the course, which means it should not be completely based on mathematics listed in the prior learning. The mathematics explored should either be part of the syllabus, or at a similar level.

A key word in the descriptor is **demonstrated**. The command term demonstrate means “to make clear by reasoning or evidence, illustrating with examples or practical application”. Obtaining the correct answer is not sufficient to demonstrate understanding (even some understanding) in order to achieve level 2 or higher.

For knowledge and understanding to be **thorough** it must be demonstrated throughout.

The mathematics can be regarded as **correct** even if there are occasional minor errors as long as they do not detract from the flow of the mathematics or lead to an unreasonable outcome.

Students are encouraged to use technology to obtain results where appropriate, but **understanding must be demonstrated** in order for the student to achieve higher than level 1, for example merely substituting values into a formula does not necessarily demonstrate understanding of the results.

The mathematics only needs to be what is required to support the development of the exploration. This could be a few small elements of mathematics or even a single topic (or sub-topic) from the syllabus. It is better to do a few things well than a lot of things not so well. If the mathematics used is relevant to the topic being explored, commensurate with the level of the course and understood by the student, then it can achieve a high level in this criterion.

|  |  |
| --- | --- |
| 🞏 0 | does not reach the standard below |
| 🞏 1 | Some relevant mathematics is used. |
| 🞏 2 | Some relevant mathematics is used. Limited understanding is demonstrated. |
| 🞏 3 | Relevant mathematics commensurate with the level of the course is used. Limited understanding is demonstrated. |
| 🞏 4 | Relevant mathematics commensurate with the level of the course is used. The mathematics explored is partially correct. Some knowledge and understanding are demonstrated. |
| 🞏 5 | Relevant mathematics commensurate with the level of the course is used. The mathematics explored is mostly correct. Good knowledge and understanding are demonstrated. |
| 🞏 6 | Relevant mathematics commensurate with the level of the course is used. The mathematics explored is correct. Thorough knowledge and understanding are demonstrated. |

|  |
| --- |
| **IB Math IA Checklist** |

1. Presentation

Introduction

* + meaningful title
  + clear statement of task explicitly stated, describes *what* is being researched and how
  + clear description of the plan, how task will be performed (including how to obtain data and how to analyze it)
  + includes thoughts and predictions of what the answer to the research question will be
  + optimum background information on the topic
  + discussion of why student wanted to research this topic

Information/measurement

* + data relevant to the research question
  + data sufficient in quantity
  + data sufficient in quality - not too simple
  + data produced by student (survey in appendix) or from a reputable source (fully cited)
  + raw data in appendix
  + raw data organized into a form appropriate for analysis (ex., a table) & grouped in an appropriate way as needed

1. Math Communication
   * paper is easy to read - logical order and flow, neat, headings, labels, non-wrapping tables, large tables in appendix
   * bibliography/footnotes included as appropriate
   * all mathematical terminology & notation appropriate and correct
   * correct graphs/charts/tables/diagrams included with conclusions alongside / immediately preceding/following
   * calculator / spreadsheet notation is NOT used ( √, ^2, \*, sum, X2 )
   * correct units of measurement
   * the = sign is in the right places
   * all variables have been defined
2. Personal Engagement
   * evidence of *authentic* engagement throughout the entire paper
   * author gives details about what they learned about the data and about Maths
   * compelling arc and denouement to the learning & engagement process
3. Reflection
   * included at least two meaningful conclusions based on mathematical processes
   * discussion of how to interpret the results of mathematical processes
   * conclusions and interpretations *consistent* with the mathematical process
   * conclusions relate back to original research question
   * discussion of interpretations and conclusions is “comprehensive”
   * addressed whether mathematical processes were appropriate & applicable in this context
   * commented on limitations to the mathematical processes used
   * commented on the reasonableness of conclusions/interpretations
   * included limitations of conclusions/interpretations
   * if more information/measurements were needed, did they explain why
   * mentioned possible project extensions
4. Use of Mathematics
   * maths used are relevant and meaningful for the type of data collected
   * maths used are “sophisticated” and not simplistic (ex, finding correlation, line of best fit, Chi-Square Test, calculus)
   * *all* necessary work shown & completed *by hand* (first by hand, multiples with technology ok)
   * understanding of maths used is ***demonstrated*** (not just plugging in values)
   * any discernable errors are minor in nature (arithmetic errors are minor, wrong hypothesis test conclusions are not)
   * math is *relevant* – extra unnecessary or over-complicated maths are not allowed (ex if r is low, can’t fit the model anyway)
   * math is sufficient in quantity – there should be at least 4 *different* simple analyses performed (graph, calculation, etc.) and 2 different advanced analyses performed (hypothesis test, modeling, etc.)

**Internal Assessment Titles**

*Here is a list of titles of previous IAs. Just because a title is listed below does not mean that the IA received high marks. You do not (and should not) necessarily choose to do a topic similar to one that you see below. This list is just to give you an idea of the type of project that other students have done.*

* Motor Vehicle Crash Fatalities by State between 1999 and 2007.
* Is there a Correlation between State Population and the Number of Facebook Users in each State, and is the Number of Facebook Users Distributes Uniformly in each US Region?
* Is there a Relationship between the Average Number of Passing Yards per Play from an NFL Quarterback to a College Quarterback?
* In Football, is there a Correlation between Completed Passes and Touchdowns Thrown?
* The Correlation between Height of NBA Players and their Shooting Percentage.
* The Correlation between the Year and the Average Annual Income.
* The Effect of Video Game Production on Console Sales
* Par as a Reasonable Target Score for the Average Miniature Golf Player
* Determining Whether or not there is a Relationship between Gross Domestic Income of a Movie and the Gross International, Income of a Movie
* Is there an Association between Median Age at the Time of First Marriage in Women and Men?
* Is there a Correlation between the Number of Engines and Maximum Speed of a Second World War Aircraft?
* The Effects of Water Temperature on Wave Height
* Which Animal Yields More Attacks on Humans in the State of Florida: the American Alligator (Alligator mississippiensis) or Sharks in General?
* In the 2008 regular season, did the age of the Wide Receiver in the National Football League (NFL) affect how many touchdowns he scored?
* Is there a relationship between the continents and the number of medals they received in the 2008 Summer Olympics?
* Is there a correlation between NBA player’s average minutes played per game and their average points scored per game?
* Is there a relationship between the number of births and infant deaths in the United States?
* Correlation between an NFL Quarterback’s NFL Experience and his Passer Rating
* Take Me to the Movies: Correlation between Number of Films Produced and Cinema Attendance in 2003
* Effects of Car Weight on Lap Time
* Is there a correlation between wind speed and wave height?
* Can a higher MPAA rating destroy a movie’s box office potential?
* Is there a relationship between the number of visitors to each state in 1998 and 2003?
* Is there a correlation between the year and the amount of money made by the highest grossing film?
* Is there a correlation between the number of immigrants and languages in Europe?
* Does the age of a hair cure company determine the number of products currently offered?
* The Correlation between Movie Gross and Initial Budget
* Does the amount of time a dolphin is kept in captivity affect its lifespan?
* Is gender and yearly earned salary independent or dependent of each other of high school graduates?
* The Correlation between the Percent of Children (under 18) below the Poverty Level and Teen Birth Rate
* Is there a correlation between the number of post secondary degrees awarded by state and the number of popular votes for John Kerry in the 2004 U.S. presidential election by state?
* The Correlation between obesity and the Prevalence of Fast Food Restaurants
* Shopping Mall Number and Gross Income
* Mortality Rates from Heart Disease in Men and Women from 1950 until 2000
* The Correlation between the Amount of Air Pollutants and the Prevalence of Asthma
* Is there a correlation between race and the age of death?
* Is there a relationship between the amounts of burglaries in the United States from the year 1967 to 2007?
* Does weight determine how strong a girl is?
* Is there a correlation between the amount of shots on goal and the amount of goals that are scored?
* The Correlation between Rank on the Best Education Index and the Percent of People with Health Care Coverage
* PBA Rank vs. Number of Perfect Games
* The Relationship between a Movie’s Gross Income and the Type of Movie
* Correlation between Births and Infant Deaths
* Number of Years Suffering on the ASP World Tour vs. Number of Points Earned in the 2008 Season
* Does the weight of a car positively affect its Nurbuging Nordschleife Lap Time?
* Is there a relationship between batting average and on base percentage?
* Weight and Totals at the 2008 Boys Weightlifting State Meet
* Is there a correlation between the live births and the year in the United States?
* Does the region where people skydive affect the type of fatalities?
* Is there a correlation between Cold War progression and increased military spending annually?
* Is there a correlation between the number of restaurants and the obesity rate in each state?
* Correlation between a Person’s Height and their Shoe Size
* Is there a correlation between a baseball player’s weight and his total number of home runs in a season?
* The Relationship between the Number of Fouls Committed and the Number of Yellow Cards Received
* Is there a correlation between total grand slam wins and grand slam winning percentages?
* The Relationship between the Horsepower rating and MSRP of Automobiles
* Is there a correlation between QB passing yards in the NFL and salary?
* The Correlation between the Oil Consumption of a State and the Total Energy Consumption of a State
* The Correlation between Number of Hospitals and Number of Births
* Is there a correlation between third grade FCAT Reading and Mathematics scores?
* Is there a positive correlation between the gross incomes in 50 Disney Movies and the movie budget?
* The United States’ Grounds vs. Coffee Grounds: Is there a correlation between the Land Area of Each State in the United States and the Number of Starbucks Stores in Each State?
* Is there a linear correlation between Total Amount of Cerebral Grey Matter and Intelligence Quotient?
* Is there an increase between high school students carrying weapons in 2003 and 2005?
* Is there a relationship between age of African children and the percentage that are orphaned?
* Does the number of refugees affect the gross state product?
* Is there a correlation between Army and Navy recruits in individual states/territories in 2004?
* The Correlation between the Height of a Male Tennis Player in the ATP and the Speed of their Serve
* The Relationship between Ethnicity and Cause of Death
* Is there a correlation between the amount of dentists and the number of Starbucks per state?
* Is there a correlation between the maximum height and the maximum speed of roller coasters?
* The Correlation between Physical Exercises and the Death Rate from Heart Disease
* Comparison between the Manufacturer’s Suggested Retail Price of Pick-up Trucks and Sport Utility Vehicles and Fuel Economy
* The Relationship between Gender and the Level of Physical Activity
* Is the income per capita evenly distributed among each of the United States?
* Tebow or Bradford? Who is the better Quarterback?
* Is there a correlation between the annual salary of secondary school teachers and the annual average salary of the state that teacher is from?
* Is there a higher death rate from brain and other nervous system cancer of males than females in the United States?
* Is there a correlation between land area of each state in the United States and the Cost of Military in each state?
* Is there a correlation between the weight of a male lifter and his total?
* Is there a correlation between the percentage of state’s population that has a high school diploma or greater and the voter turnout rate of the state?
* Is there a correlation between the number of people who smoke and the number of people who have asthma in the US?
* Is there a correlation between the seating capacity of a performing arts center and the population of a city?
* Is there a relationship between the ages of jazz vocalists when they signed their first recording label and their gender?
* Is there a correlation between the total number of miles led in races and the driver’s final position in the standings in NASCAR?
* Is there a relationship between the amounts of money budgeted for a film and the amount of money it grossed?
* Is there a correlation between the heart rate of jazz musician and the tempo of the song being performed?
* Do certain factors affect the amount of money a movie will receive during its showing in the theaters?
* Is the type of tender used in a transaction dependent or independent on the location of the register?
* Is there a correlation between flexibility and weight of high school cheerleaders?
* Is there a correlation between the number of cars sold and the average price of gasoline?
* Is there a correlation between estimated total sales of shopping malls within a given state and population?
* Does the month of a year influence the type of work done on the internet?
* Does the month of a year influence the type of work done on the internet?
* Is there a correlation between median SAT score of the freshman class and yearly tuition cost?
* Is there a correlation between the number of NASCAR Championships won and the manufacturer that earned them?
* Is there a correlation between one’s gender and the amount of raffle tickets he or she is willing to purchase?
* Is there a relationship between religious views and political party affluence?
* Is a person’s Body Mass Index (BMI) dependent of the hours of video games they play?
* Is there a relationship between gender and instrument choice?
* Is there a correlation between freshman retention rate and population of Southeastern Colleges?
* Is there a correlation between a state’s population and the number of Starbucks in that state?

|  |
| --- |
| **IA Getting Started Questionnaire Name** |

List 3 activities you’d like to have time to do

What extra-curricular activity(ies) do you enjoy

What do you do to *really* unwind & relax

If you could wave a magic wand and fix one thing about the world, what would it be

What is your current college major

What would you really like to do for a living

What does your family do on vacation

Where would you like to go on vacation and why

What relationship between variables and history of a topic have you wanted to investigate mathematically

What topic that have you always wanted to perform a survey on

What would have to be done to your AP Stats Past-Present-Future project to turn it into your IA

List 3 possible topics you’ve thought of after answering the previous questions. If you’re still stuck, find 3 IAs you like, skim them & try to find some inspiration and spark. List what Math you would explore with these topics (consult the IA Topic Evaluation page).

* <https://ibpublishing.ibo.org/live-exist/rest/app/tsm.xql?doc=d_5_matsl_tsm_1205_1_e&part=2&chapter=2>
* <https://ibmathsresources.com/maths-ia-maths-exploration-topics/>
* <https://www.lanternaeducation.com/ib-blog/50-ib-maths-ia-topic-ideas/>

Topic 1 and MATH TOPICS

Topic 2 and MATH TOPICS

Topic 3 and MATH TOPICS

|  |
| --- |
| **IB IA Topic Evaluation Name** |

What is your IA Topic / Title?

Describe a little detail about your IA.

Does the topic seem reasonable & sufficient for the IA Criteria? What grade do you predict?

Are your data source(s) sufficient & robust? (Attach a copy of 1 page of data or survey draft)

Which Number & Algebra topics do you plan to explore?

* scientific notation
* estimation & error
* arithmetic & geometric sequence & series
* compound interest
* annual depreciation
* amortization and annuities

Which Functions & Modelling topics do you plan to explore?

* lines
* graph of a function
* domain/range
* identifying extrema
* intercepts, zeros, asymptotes
* modelling (linear, quadratic, etc.)
* modelling exponential functions
* Modelling logarithmic functions

Which display & summarization methods will you use? (pick from ***one*** column)

|  |  |  |  |
| --- | --- | --- | --- |
| 1 Categorical Variable | 2 Categorical Variables | 1 Quantitative Variable | 2 Quantitative Variables |
| * frequency table | * 2-way frequency table | * mean, standard deviation | * mean, standard deviation |
| * bar graph | * stacked bar graph | * median IQR | * dotplot / histogram |
|  | * side-by-side bar graph | * dotplot / histogram | * stem & leaf plot |
|  |  | * stem & leaf plot | * X-Y scatterplot |

Which Statistical Analysis method will you use? (pick from ***one*** column)

|  |  |  |  |
| --- | --- | --- | --- |
| 1 Categorical Variable | 2 Categorical Variables | 1 Quantitative Variable | 2 Quantitative Variables |
| * Chi-Square test | * Chi-Square test | * Hypothesis test | * Calculate correlation |
| of Goodness of Fit | of Independence | comparing… | * Calculate line of best fit |
|  |  |  | * Hypothesis test of |

Which other Probability & Statistical topics do you plan to explore?

* sampling
* Venn/tree diagrams
* combined events
* conditional probability
* discrete random variables and expected value
* normal distributions
* binomial distributions
* Type I & Type II errors

Which Geometry & Trigonometry topics do you plan to explore?

* distances and midpoints
* volume and surface area of solids
* angle between 2 lines or line and a plane angles of elevation/depression
* equations of perpendicular bisectors Voronoi diagrams
* modelling periodic & sinusoidal functions

Which Calculus topics do you plan to explore?

* increasing/decreasing functions (easy Calculus check)
* calculus of polynomials
* tangents / normal (perpendicular) (calculating instantaneous rate of change)
* first derivative test
* optimization
* integration
* antiderivatives
* definite integrals
* indefinite integrals

What’s the next step & what might you need?