IB Math IA Sample

TOPIC:
OPTIMISING THE DESIGN OF
A WINE GLASS

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Internal Assessment

Mathematics

Research Question:

Optimising the design of a wine glass

Introduction

Wine—a veritable millennia-old elixir with a suitably storied past, that reaches back some 9000 years from now—has since evolved into an international cultural movement. And the shochu as it is from China, has been greatly journeying for years and also it became a symbol of the party time, refinery and of pure friendship. Since, this beverage remains appealing to taste pushes people all over the world around comprehensively keeps developing importance on what vessel wine is drunk serving. Through this mathematical expedition, we expound on the way of optimizing the design of a wine glass that appreciates wine being not only from but also having its own form and function which is so much oriented to the specialized aspects of appreciating its composition as wine.

In terms of human development, the factors of culture and history are more encompassing than intoxicating properties when regarding wine. Instead, it has made itself an intricate part of civilization. From the depth of old rituals to the modern culminations of feasts, wine is an eternal companion that testifies to the all-embracing progression and palettes of civilizations. There is an inextricable link between the vessel and its content which goes beyond a simple visual delight because it joins science, art, education to unity. There is a general name for the design of a wine glass which refers to shape, diameter and thickness it has been shown to be an essential factor contributing in increasing sensory enjoyment when consuming wine.

The main question posed in the current study to explore is how best the design of the wine glass should be optimized. The theme refers to a search of the possibility for using mathematical concepts organizationally cleansing factors in composition glass that cause pleasure from wine consumption. Through this addressing, we establish the need to reveal mathematical complications that guide design tradeoffs of a wine glass hence in their process elevating one's spirit from mere 'appreciation of ice cream.

To contextualize this inquiry, it is also to be noted how the physicality of a wine glass is not simply by chance; rather, they are carefully calibrated to enrich bouquet, taste, and visual enjoyment experience within each glass. Curves, vessel heights, and thickness of the glass all play in part to how wine interacts with air via myriads of sensory mechanisms such that its excellence may be enjoyed.

As the idea of mathematically determining mathematical patterns and relationships that determine the ideal form of a wine glass, this exploration strives to figure out an optimal design geometry. From a systematic perusal, we hope to determine how mathematical ideas implemented in geometry, fluidity dynamics, and ergonomics can be integrated into the creation of a wine glass that both regenerates tradition as well as elevates the multiplex enjoyment of downing water that is dressed in nature's fresh elegance. Therefore, we undertake a voyage of mathematical tenacity intertwined with the lavishness of oenology, shaping an artistic adventure for all senses in each sip.

Mathematical Background

In the field of wine glass mathematics as explored in terms of ways through which one can optimize on a design that works best, there are some fundamental concepts and theories. Among the major some focus areas are that of geometry since it enumerate geometric tools for analyzing complex shapes and curvatures characteristic of wines forming a glass physical structure. Furthermore, the field of fluid dynamics must be taken into consideration, which would allow one to analyse how wine moves in response to a glass [, affecting its aroma, taste, or sensory quality all together]. Ergonomics is an important part of understanding the human factor in opening perspective that minimizes a glass's discomfort use and appearance.

When it comes to the frame of this research, mathematical instruments that are used can be geometric modes, polynomial equations, and computational modeling. These tools make it possible to convert natural physical dimensions and shapes into mathematical equations, which translates to the possibility of analyzing the wine-glass design in a systematic quantitative way.

Methods

The approach adopted by this study originates in the collection of a picture, representing a figure of wine glass to serve as the observed visual basis for further mathematical modeling. Using dynamic geometry software GeoGebra, the photo is imported and an ordinate coordinate system with the base of glass at Point L origin (0, 0) to set up.

The description of the behavior captured in the video must be systematic in terms of capturing all cues at the places which were previously mentioned where specific changes turning glass from one form to another occurred. For this reason, 19 key points are identified and plotted on the object. These points in their turn serve as reference anchor for the subsequent modeling mathematical aspects. Later, the fit poly-function tool in GeoGebra is used; this way, 10 functions are produced to resemble the package of curved lines that characterise a wine glass.

DIfference between and of minute difference, plot points to as , will move traveling to the last plotted point. This transfer does not only provide for a clearer visualization, but also opens the possibility of thresholds being placed and parameters fine-tuning within DESMOS. These processes represent a mathematical image in DESMOS which is to become the complete model of wine glass design.

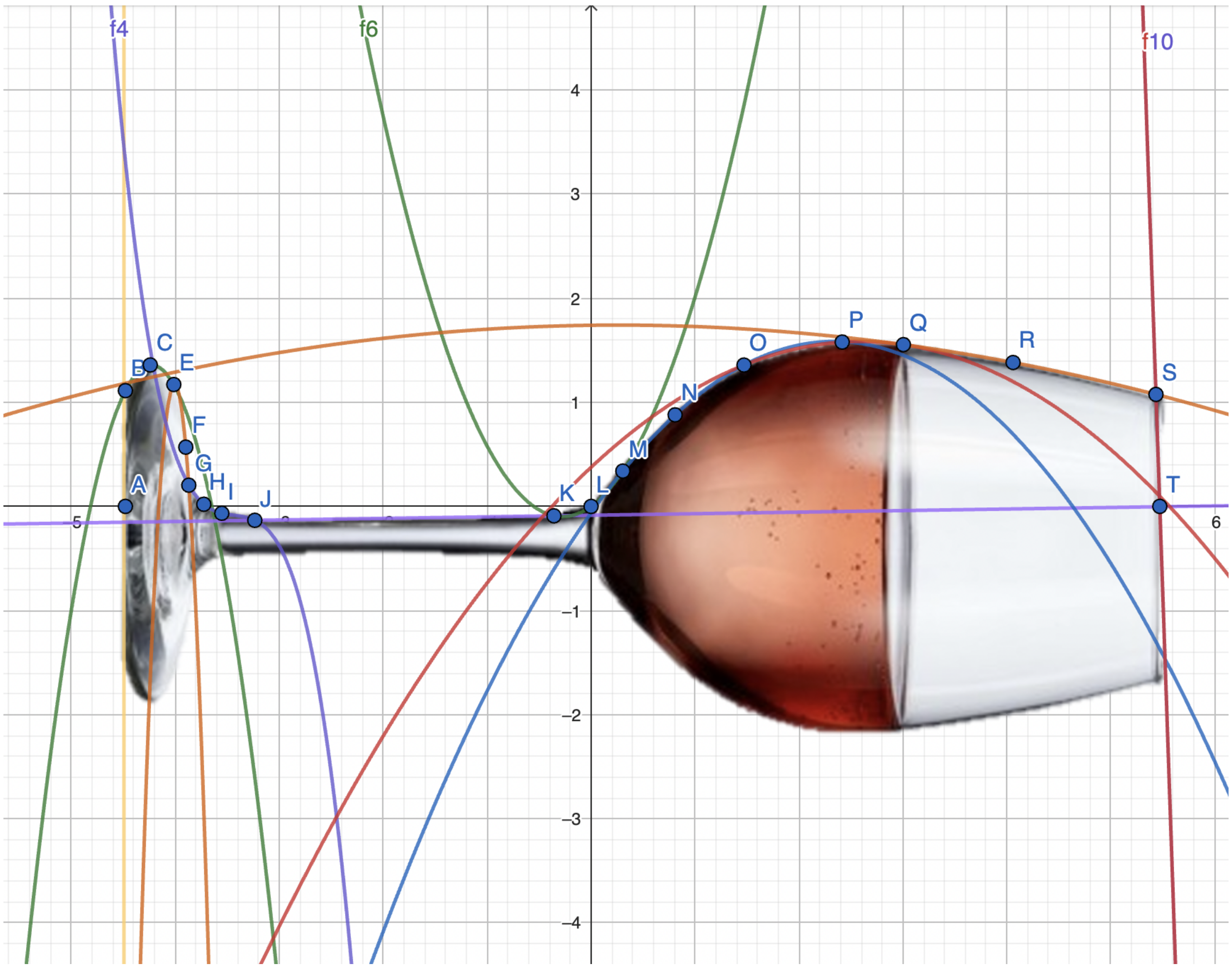
The selection of GeoGebra and DESMOS is based on their ability to support different mathematical solutions for solving complex kharasim problems as compared to previously used apps. GeoGebra helps one to start plotting points and creating functions from his photograph that he has imported. DESMOS is then followed by the more sophisticated rendering to allow a better graphical representation that creates an idealized structural aesthetics.

Mathematical Modeling

The mathematical model is generated from the design of 10 functions that together characterize the complication in hues and phases of a glass of wine. These functions were obtained by using the fit poly-function tool based on GeoGebra, a polymer that uses a polynomial equation to provide closer approximation to the appearance qualities of glass.

The mathematical model is however close to the real result only as a rough approximation, since it is based on available photo only. Hypotheses include the reliability of the photo image, equal thickness and equi-smoothness of glass surfaces not got into view interference. Moreover, the fit poly-function tool assumes about the glass curves that they are comprised of a polynomial form and some deviations from this may take place.

Results



The image shows a graphical representation of a wine glass overlaid on a Cartesian coordinate system. The wine glass is filled with red wine, and it's partially transparent allowing the underlying grid and curves to be visible. Multiple colored curves intersect and surround the wine glass, representing mathematical functions or equations used in modeling the shape of the glass. There are 19 labeled points (A-T excluding D) on the wine glass which likely represent key data points or vertices used in creating the mathematical model. The coordinate grid is marked, aiding in understanding the position and scale of each element within this graphical representation.

Here are the coordinates:

A = (-4.481957351213282, 0.339101448533872)

B = (-4.4801573123282, 1.112161923383)

C = (-4.2406016689373, 1.3584146554972)

E = (-4.0144247648474, 1.1707359478482)

F = (-3.8989301755249, 0.569201624603)

G = (-3.8700556281943, 0.2034687622724)

H = (-3.7256882951412, 0.0206023291785)

I = (-3.5524464075575, -0.0660186128134)

J = (-3.2348362869206, -0.1333904655849)

K = (-3.572522078341, -0.0903448064724)

L = (0, 0)

M = (0.3035575411025, 0.03391244752457)

N = (0.808450128258, 0.08790287151199)

O = (1.471059871945, 0.13575802004633)

P = (2.4158922969744, 0.17584501167752)

Q = (3.00487804736, 1.553990149627)

R = (4.0604164184096, 1.38213210322755)

S = (5.4344478199076, 1.0753755296196)

T = (5.4712594726263, 0)

The mathematical modeling of the wine glass design involved the use of polynomial functions to approximate the shape of the glass. The model was built using key points identified on the wine glass, and polynomial functions were fitted to these points using the FitPoly function in GeoGebra.

The results of the mathematical modeling are represented by four polynomial functions, labeled as f1(x), f2(x), f3(x), f4(x), f5(x), f6(x) f7(x), f8(x), f9(x), and f10(x). Each function corresponds to a specific segment of the wine glass, and the coefficients of these functions were calculated for precise curve fitting.

Here are the functions and their interpretations:

1. **f1(x) = FitPoly{(A,B)}**

   This function represents a linear trend in the data set {(A,B)}.

   f1(x)=34783113438824.39+x×155833820018490.38

2. **f2(x) = FitPoly{(B,C,E)}**

   This function represents a parabolic trend in the data set {(B,C,E)}. The negative coefficient of the (x^2) term indicates a concave down parabola.

   f2(x)=−3.9887983766157x2–33.75423722043x–70.0639962135755

3. **f3(x) = FitPoly{(E,F,G)}**

   This function represents another parabolic trend in the data set {(E,F,G)}. The negative coefficient of both terms suggests a downward shift on both axes.

   f3(x)=−51.66187179652561x2–414.027061736126x–828.3473729707379

4. **f4(x) = FitPoly{(G,H,I,J)}**

This is a cubic polynomial representing trends in dataset {(G,H,I,J)}, with all coefficients being negative indicating complex behavior with multiple turning points.

f4(x)=−2.8767549813503x3–29.6567536988975x2–102.0352942857x–117.2454377990784

5. **f5(x) = FitPoly{(J,K)}**

   This is a linear equation.

   f5(x)=0.0149585947792x–0.0850006868507

6. **f7(x) = -0.30101685547x² + 1.4084957364813x – 0.062983401951**

   This function represents a parabolic trend in the data set (M,N,O). The negative coefficient of the (x^2) term indicates a concave down parabola.

   f7(x)=−0.30101685547x2+1.4084957364813x–0.062983401951

7. **f8(x) = -0.179573295081x² + 0.931759206094x + 0.375506647913**

   This function represents another parabolic trend in the data set (O,P,Q). The positive constant term suggests an upward shift of the parabola on the y-axis.

   f8(x)=−0.179573295081x2+0.931759206094x+0.375506647913

8. **f9(x) = -0.0248700843912x² + 0.0129170667922x + 1.739654155175**

   This function represents a wider and flatter parabola in the data set (Q,R,S), indicated by a smaller coefficient for the (x^2) term.

   f9(x)=−0.0248700843912x2+0.0129170667922x+1.739654155175

9. **f10(x) = -29.21242188816x + 159.828739740695**

   This function represents a linear fit for the data set (S,T), showing a direct variation between variables with a negative slope indicating an inverse relationship.

   f10(x)=−29.21242188816x+159.828739740695

These functions collectively form a mathematical model of the wine glass. It’s important to note that these functions are approximations and assume that the curves of the glass can be represented by polynomial functions. Deviations from this assumption may occur.

A	**(-4.481957351213282, 0.339101448533872)**	**f1(x) = 34783113438824.39 + x * 155833820018490.38**

B	(-4.4801573123282, 1.112161923383)	f2(x) = $-3.9887983766157x^2 - 33.75423722043x - 70.0639962135755$
C	(-4.2406016689373, 1.3584146554972)	f2(x) = $-3.9887983766157x^2 - 33.75423722043x - 70.0639962135755$
E	(-4.0144247648474, 1.1707359478482)	f2(x) = $-3.9887983766157x^2 - 33.75423722043x - 70.0639962135755$
F	(-3.8989301755249, 0.569201624603)	f3(x) = $-51.66187179652561x^2 - 414.027061736126x - 828.3473729707379$
G	(-3.8700556281943, 0.2034687622724)	f3(x) = $-51.66187179652561x^2 - 414.027061736126x - 828.3473729707379$
H	(-3.7256882951412, 0.0206023291785)	f3(x) = $-51.66187179652561x^2 - 414.027061736126x - 828.3473729707379$
I	(-3.5524464075575, -0.0660186128134)	f4(x) = $-2.8767549813503x^3 - 29.6567536988975x^2 - 102.0352942857x - 117.2454377990784$
J	(-3.2348362869206, -0.1333904655849)	f4(x) = $-2.8767549813503x^3 - 29.6567536988975x^2 - 102.0352942857x - 117.2454377990784$

K	(-3.572522078341, -0.0903448064724)	$f4(x) = -2.8767549813503x^3 - 29.6567536988975x^2 - 102.0352942857x - 117.2454377990784$
L	(0, 0)	-
M	(0.3035575411025, 0.03391244752457)	$f7(x) = -0.30101685547x^2 + 1.4084957364813x – 0.062983401951$
N	(0.808450128258, 0.08790287151199)	$f8(x) = -0.179573295081x^2 + 0.931759206094x + 0.375506647913$
O	(1.471059871945, 0.13575802004633)	$f9(x) = -0.0248700843912x^2 + 0.0129170667922x + 1.739654155175$
P	(2.4158922969744, 0.17584501167752)	$f10(x) = -29.21242188816x + 159.828739740695$
Q	(3.00487804736, 1.553990149627)	-
R	(4.0604164184096, 1.38213210322755)	-
S	(5.4344478199076, 1.0753755296196)	$f10(x) = -29.21242188816x + 159.828739740695$
T	(5.4712594726263, 0)	$f10(x) = -29.21242188816x + 159.828739740695$

Discussion

Mathematical modelling the glass wine optimize design is a result are several polynomial functions, and it has represented different parts of the wineglass. These functions offer a numberbased clarification regarding the form and curvature of the glass, thus illustrating how mathematical principles can be implemented in order to improve wine enjoyment.

Linear Trends (f1(x), f5(x)): The linear curves given by function f1(x) and f5(x) help to point out the fact that various corners of the wineglass are easy. These sections are most likely identified as the stalk and more simplistically features with linear relationship between the x coordinates and Y coordinates demonstrated to be adequate for approximation.

Parabolic Trends (f2(x), f3(x), f7(x), f8(x), f9(x)): This is demonstrated by the dominance of parabolic functions in modeling, which indicates the high prevalence of smooth curvature among sections presented. These parabolic tendencies correspond to a form that was expected of the bowl of a glass, where curvilinear is dominant in terms of increasing aesthetic and utilitarian qualities.

Cubic Polynomial Trend (f4(x)): The polynomial trend of the cubic is highly observed as a signified complex nature that may take capturing subtle in details in the curvature glass with four turning point. This typifies the delicate art of glass design involved in twinning an ideal wine glass shape.

Linear Fit (f10(x)): By visualizing the linear fit, as shown by function f10(x), one can observe an opposite correlation of variables presented on the graph indicating that maybe there is a tapering trend reaching toward the glass' rim.

Limitations

The models assume that the curves can be considered appropriate in shaping the wine glass with wireless loop antennas. However, deviations from this can exist in the real-world case, where for instance defects or peculiarities which could appear on the design of glass might not be fully represented through those chosen functions.

The high level of precision required to achieve accuracy in the models is mainly determined by the degree of correctness achieved in collection of data from wine glass photographs. All deviations, inaccuracies, and defects negating the photo's ability to produce a faithful mathematical image may also affect the fidelity of mathematical representation.

While a proposed constant piece of the nature of polynomial capacity gives just sensible movement, picking this one facilitates the significantly intricate geometry of wine glass. The mathematical shapes and transitions presented by the selected functions may be included in some actual field glasses that are complex and certainly do not cover them all.

Unexpected Outcomes and Explanations

The important feature of some polynomial functions, such as f1(x), may include the extreme coefficients that could also represent sensitivity of the solutions to outliers or anomalies in data. This might be because of certain unique characteristics in the glass pattern, which are markedly different from the trends that can be seen in this data set.

The dominance concave downwards parabola in such type of functions f2(x),f3(x) ,f7(x) and, f8 (x) fit accordingly that what is to be expected from a bowl of the wine glass. Yet unforeseen differences may occur due to inconsistencies in glass thickness, refractive indexes associated with curvature complexities or the general fact that polynomial functions cannot cope flawlessly as they are only functional approximations.

Conclusion

The mathematical building into optimizing the design of a wine glass has shown significant results that help enriching our knowledge on understanding the nature, and purpose behind deciding what form a wine glass should have. Polynomial functions from the modeling process present a quantified measure of curvature for this glass; where segment A exhibits linear trends, whereas sets B and C demonstrate sections where parabolic trends persist. These findings have implications to the improvement of wine drinking, but their impact blends between artistic and use.

The outcomes correspond with the concept of widespread application envisioned in the original question focusing on how scientific principles can influence modifications to improve design features for a wine glass. The multiple functions shown by the above depiction indicate the subtle play of curves and shapes in a wine glass that enables in gaining valuable avenues for further application of design principles. In conclusion, often confined by its limitations and unpredicted outcomes, these explorations provided a basis that supports the future optimization to reveal how delicate interplay between science of mathematics and artistry in wine glass design.

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