Clarifications, Corrections, and Guidance for the AP Precalculus Course and Exam Description, Effective Fall 2023

Unit 1

EKs 1.1.A.3 and 1.1.A.4 (Guidance)

Definitions of “increasing over an interval” and “decreasing over an interval” are provided in EK 1.1.A.3 and EK 1.1.A.4. Precalculus does not include the analytical tools necessary to wrestle with the behavior at endpoints of intervals where functions reach relative extrema. Therefore, the elementary definitions in EK 1.1.A.3 and EK 1.1.A.4 are most useful for precalculus students to develop the conceptual understandings of increasing and decreasing.

Student understanding of intervals of increase and decrease is extended in calculus. There is extensive debate on how to best teach this topic due to the analysis issues the topic invokes. As a result, discriminating between open intervals and closed intervals as it relates to intervals of increase and decrease is <u>not</u> assessed on the AP Precalculus exam. <u>Note</u>: This does not impact this topic in the *AP Calculus AB and BC Course and Exam Description* nor assessment of this topic on the AP Calculus AB and Calculus BC exams.

EKs 1.1.A.3 and 1.1.A.4 (Clarification)

In the AP Precalculus course, increasing and decreasing are defined as “strictly” increasing and decreasing.

EK 1.3.A.3 (Clarification)

This EK refers to a function *f* .“The average rate of change **of a function *f*** over the closed interval...”

EK 1.4.A.1 (Correction)

The EK should say “*a_i* is a real number for each *i* from **0 to *n***” rather than “1 to *n*.”

EK 1.4.A.2 (Clarification)

To clarify global (absolute) maxima and minima, the last two sentences, “Of all local maxima, the greatest is called the *global*, or *absolute*, maximum. Likewise, the least of all local minima is called the global, or absolute, minimum” would be better stated as “**If any of the local maxima is greater than any other function value, then that local maximum is a global, or absolute, maximum. Similarly, if any of the local minima is less than any other function value, then that local minimum is a global, or absolute, minimum.**”

Unit 2

EK 2.1.B.3 (Clarification)

This EK applies only to positive-valued geometric sequences.

EK 2.2.A.3 (Correction)

This EK should end with "**by a constant ratio**" rather than "by a constant proportion."

EK 2.2.A.4 (Clarification)

For better consistency between EKs, this can be written as "***f*(*x*) = *y_i**(*b*)^(*x*-*x_i*) based on a known ratio *b***."

EKs 2.2.A.3, 2.2.A.4, and 2.2.B.1 (Clarification)

For exponential functions, the trivial cases where the common ratio is 1 or 0 result in linear functions. Therefore, **the ratio must not equal 1 or 0** to be exponential and not simultaneously linear.

EK 2.3.A.4 (Correction)

The purpose of this EK is to help students see that values in a data set might need to be transformed by an additive transformation in order to recognize that the data can be modeled by transformations of an exponential function. For example, consider the points (1, 7), (2, 9), (3, 13), and (4, 21). These data can be modeled by transformations of an exponential function because subtracting 5 from each *y*-value results in (1, 2), (2, 4), (3, 8), and (4,16) and these *y*-values are proportional over equal-length input-value intervals. Therefore, this EK is better stated as follows: "If the output values of the function *f* are not proportional over equal-length input-value intervals, but the output values of an additive transformation of *f* are proportional over equal-length input-value intervals, then *f* can be modeled by an additive transformation of an exponential function."

EKs 2.5.B.3, 2.14.A.6, and 3.7.A.5 (Clarification)

These EKs mention that models can be used to predict dependent variables. Applying Skill 1.A to models in general also allows for the prediction of **values of the independent variable**.

EK 2.6.B.1 and 2.6.B.2 (Guidance)

A **residual** of a regression is the actual value of the dependent variable minus the value predicted by the function regression model. The **error** in the model is sometimes seen as the value of the dependent variable predicted by the function regression model minus the actual value, and sometimes seen as the absolute value of this difference. As a result, the sign of the residual is valid content for the AP Exam, but the sign of the error will not be assessed on the AP Exam. Because residuals of a regression provide information about errors in a model, either residuals or errors can be used to answer questions about having an underestimate or an overestimate in a modeling context.

EK 2.7.A.4 (Correction)

In sentence 3 of the EK, it should say "**identity** function" rather than "identify function."

EKs 2.13.B.1 and 2.13.B.2 (Clarification)

For better consistency between EKs, the expressions in parentheses can be written as ***x* plus *h*** rather than *x* minus *h*.

EK 2.15.A.2 (Clarification)

If for large input values of a bivariate data set the logarithms of the output values trend linear, then transformations of an exponential function can be used to model the data set.

Unit 3

EK 3.2.A.2 (Clarification)

For consistency with other sources, "**subtended**" should describe the angle rather than the arc.

EKs 3.2.A.3, 3.2.A.4, 3.2.A.5, and 3.3.A.2 (Guidance)

It is important to **attend to the signs** of the values based on the Quadrant in the *xy*-plane in which the terminal ray lies.

EK 3.4.A.2 and 3.4.A.4 (Clarification)

For consistency, EK 3.4.A.2 and EK 3.4.A.4 can be written using "**displacement**" rather than "distance," as used in EK 3.4.A.1 and EK 3.4.A.3.

EK 3.6.A.1 (Clarification)

For precision, this EK should also say ***b* is not equal to 0**.

EK 3.13.A.1 (Clarification)

The EK indicates a geometric interpretation of the **absolute value of *r***. The line "theta equals (some angle measure)" coincides with the terminal ray of an angle in standard position. For points on that line, positive values of *r* are measured in the direction of that terminal ray. Negative values of *r* are measured in the opposite direction, as with all other number lines. Consequently, values of *r* may be thought of as signed radius values.

EK 3.14.A.1 (Clarification)

Because output values can be nonpositive, "**output values are radii"** may be an oversimplification of the output values of the function. The output values are signed values corresponding to changing radii or simply signed radii.

EK 3.14.A.3 (Clarification)

The positive *x*-axis is commonly called the "**polar axis**" in the polar coordinate system. It should be noted that in the polar coordinate system, changes in output values could correspond to no change in distance from the origin. This is like in the rectangular coordinate system where changes in output values from *y* equals negative 2 to *y* equals 2 results in no change in distance from the *x*-axis.

EKs 3.15.A.1 and 3.15.A.2 (Clarification)

To add precision, this is more appropriately the distance between **the point with polar coordinates (*f*(theta), theta)** and the origin.

EK 3.15.A.4 (Clarification)

Radius values are technically **signed** radius values.