AP Precalculus FRQ #4 Practice

- You are welcome to edit, print, or post the contents of this document to your heart's content. Teachers, you can include these problems on classwork, homework, assessments, optional extra practice, or wherever else they may be helpful. However, I ask that you do not remove my name from the footer. Instead, just add your own name to take credit for any improvements you make (e.g. "Written by QED-Math, edited by Ms. Joy" or "Written by QED-Math, fixed by Mr. Rose").
- At the end of this document there are not only answers, there are solutions with work shown. Keep that in mind as you decide how best to use these problems.
- Teachers, do not assign these blindly. Try problems before assigning them to verify they are aligned with the level of difficulty and problem types you aim to practice.

In case it helps you find a specific type of problem you wish to practice, the following table summarizes all twenty-nine practice problems in this document. In addition, note:

- Every problem other than the one titled "Descendants" contains a "rewriting trig expressions in an equivalent form" question.
- In almost every problem, the verb in part A is "solve" and the verb in part B is "rewrite." The exceptions to this are "Descendants" and "Finding Neverland" which contain "rewrite" problems in part A and "solve" problems in part B. Nearly all resources released by College Board ask "solve" followed by "rewrite", but the sample FRQ 4 given in the CED asks "rewrite" then "solve".

	Exponential Equation	**Log Equation**	**Trig Equation**	**Inverse Trig Equation**	**Rewrite Log**	**Rewrite Exponential**	**Strategies for Rewriting Trig**	**Part C**
Amadeus	A	A	C	C	B		Sine Double Angle + Quotient	Inverse Trig Eqn Becomes Trig Eqn
Beauty and the Beast	A	C		A	B		Common Denominator + Pythagorean Identity	Log Equation Becomes Quadratic Equation
Big Fish		A	C	A		B	Cosine Double Angle + Quotient	Trig Equation with argument more complicated than just x
Casablanca	A		A	C	B		Factor GCF + Pythagorean Identity	Inverse Trig Equation
Descendants			B, C	B	A	A		Pythagorean Identity Yields a "Quadratic Form" Trig Equation

	Exponential Equation	Log Equation	Trig Equation	Inverse Trig Equation	Rewrite Log	Rewrite Exponential	Strategies for Rewriting Trig	Part C
Elf	A	A	C	C	B		Common Denominator + Pythagorean Identity + Quotient Identity	Inverse Trig Eqn Becomes Multiple Angle Trig Eqn
Finding Neverland	B	B	C	C	A		Quotient Identity + Reciprocal Identity	Inverse Trig Eqn Becomes Trig Eqn
Forrest Gump	C		A	A	B		Pythagorean Identity + Quotient Identity	Exponential Equation Yields a Quartic Polynomial in a “Quadratic Form”
Ghostbusters		A	C	A		B	Pythagorean Identity + Quotient Identity	Trig Equation in a “Quadratic Form”
Hamnet	A	A		C	B		Common Denominator + Pythagorean Identity + Quotient	Inverse Trig Equation
Inside Out	C	A		A	B		Quotient Identity + Reciprocal Identity + Pythagorean Identity	Exponential Equation in a “Quadratic Form”
Jurassic Park		A	C	A		B	Cosine Double Angle + Reciprocal Identity	Multiple Angle Trig Equation
Kung Fu Panda	A	A	C	C	B		Factor GCF + Pythagorean Identity + Quotient Identity + Sine Double Angle	Inverse Trig Eqn Becomes Trig Eqn with Multiple Angle
The Lion King	C		A	A	B		Cosine Double Angle	Exponential Equation Yields a Quartic Polynomial in a “Quadratic Form”
The Martian		A	A, C	C		B	Pythagorean Identity + Reciprocal Identity + Quotient Identity	Inverse Trig Eqn Becomes Trig Eqn with Multiple Angle
Night at the Museum	A		C	A	B		Pythagorean Identiy + Sine Double Angle + Quotient Identity	Multiple Angle Trig Eqn + Remember Plus or Minus

	Exponential Equation	Log Equation	Trig Equation	Inverse Trig Equation	Rewrite Log	Rewrite Exponential	Strategies for Rewriting Trig	Part C
O Brother, Where Art Thou?	A, C	A			B		Reciprocal Identity + Quotient Identity + Pythagorean Identity	Exponential Equation in "Quadratic Form"
The Princess Bride	A	A	C		B		Pythagorean Identity + Reciprocal Identity + Quotient Identity	Trig Equation with Multiple Angle
A Quiet Place	A, C	A			B		Common Denominator + Pythagorean Identity + Quotient Identity + Reciprocal Identity	Exponential Equation in "Quadratic Form"
Ratatouille	A	C		A	B		Sine Double Angle + Quotient Identity	Log Equation that Becomes Quadratic
Star Wars		A	C	A		B	Pythagorean Identity + Quotient Identity	Multiple Angle Trig Eqn + Remember Plus or Minus
Toy Story		A, C		A		B	Pythagorean Identity + Quotient Identity + Reciprocal Identity	Log Equation that Becomes Quadratic
Up	C	A	A			B	Sine Double Angle + Quotient Identity + Reciprocal Identity	Exponential Equation that Becomes Quadratic
Venom		A	A, C			B	Pythagorean Identity + More Pythagorean Identity + Reciprocal Identity + Quotient Identity	Multiple Angle Trig Equation
West Side Story		C	A	A	B		Sine Double Angle + Quotient Identity + Pythagorean Identity	Log Equation that Becomes Quadratic
What's Up Doc?	C	A	A		B		Cosine Double Angle + Sine Double Angle + Quotient Identity	Exponential Equation in a "Quadratic Form"

	Exponential Equation	Log Equation	Trig Equation	Inverse Trig Equation	Rewrite Log	Rewrite Exponential	Strategies for Rewriting Trig	Part C
X-Men	A	C	A		B		Sine Double Angle + Quotient Identity + Pythagorean Identity	Log Equations
Young Frankenstein	A	A	C		B		Pythagorean Identity + Common Denominator + Reciprocal Identity	Trig Equation in a “Quadratic Form”
Zootopia		A	C	A		B	Pythagorean Identity + Sine Angle Addition + Reciprocal Identity	Multiple Angle Trig Equation

FRQ 4 Practice – Amadeus

Directions:

- Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number. Angle measures for trigonometric functions are assumed to be in radians.
- Solutions to equations must be real numbers. Determine the exact value of any expression that can be obtained without a calculator. For example, $\log_2 8$, $\cos\left(\frac{\pi}{2}\right)$, and $\sin^{-1}(1)$ can be evaluated without a calculator.
- Unless otherwise specified, combine terms using algebraic methods and rules for exponents and logarithms, where applicable. For example, $2x + 3x$, $5^2 \cdot 5^3$, $\frac{x^5}{x^2}$, and $\ln 3 + \ln 5$ should be rewritten in equivalent forms.
- For each part of the question, show the work that leads to your answers.

A. The functions g and h are given by

$$g(x) = 6\log_2 x$$
$$h(x) = 3^{2x-1}$$

(i) Solve $g(x) = 18$ for all values of x in the domain of g.

(ii) Solve $h(x) = 10$ for values of x in the domain of h.

B. The functions j and k are given by

$$j(x) = 3\log_4 x - \log_4(2x)$$
$$k(x) = \frac{\sin(2x)}{(\sin x \cot x)^2}$$

(i) Rewrite $j(x)$ as a single logarithm base 4 without negative exponents in any part of the expression. Your result should be of the form $\log_4$(expression).

(ii) Rewrite $k(x)$ as an expression in which $\tan x$ appear exactly once and no other trigonometric functions are involved.

C. The function m is given by

$$m(x) = \arctan(2\sin x)$$

Find all values in the domain of m that yield an output value of $-\frac{\pi}{3}$.

FRQ 4 Practice – Beauty and the Beast

Directions:

- Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number. Angle measures for trigonometric functions are assumed to be in radians.
- Solutions to equations must be real numbers. Determine the exact value of any expression that can be obtained without a calculator. For example, $\log_2 8$, $\cos\left(\frac{\pi}{2}\right)$, and $\sin^{-1}(1)$ can be evaluated without a calculator.
- Unless otherwise specified, combine terms using algebraic methods and rules for exponents and logarithms, where applicable. For example, $2x + 3x$, $5^2 \cdot 5^3$, $\frac{x^5}{x^2}$, and $\ln 3 + \ln 5$ should be rewritten in equivalent forms.
- For each part of the question, show the work that leads to your answers.

A. The functions g and h are given by

$$g(x) = e^{x-2}$$

$$h(x) = 12\arcsin(x+1)$$

(i) Solve $g(x) = 4$ for values of x in the domain of g.

(ii) Solve $h(x) = -2\pi$ for values of x in the domain of h.

B. The functions j and k are given by

$$j(x) = \log_5 x + 3\log_5 2$$

$$k(x) = 3\sec x - \frac{3\tan^2 x}{\sec x}$$

(i) Rewrite $j(x)$ as a single logarithm base 5 without negative exponents in any part of the expression. Your result should be of the form $\log_5$(expression).

(ii) Rewrite $k(x)$ as an expression in which $\sec x$ appears exactly once and no other trigonometric functions are involved.

C. The function m is given by

$$m(x) = \log_2 x + \log_2(x+2)$$

Find all input values in the domain of m that yield an output value of 3.

FRQ 4 Practice – Big Fish

Directions:

- Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number. Angle measures for trigonometric functions are assumed to be in radians.
- Solutions to equations must be real numbers. Determine the exact value of any expression that can be obtained without a calculator. For example, $\log_2 8$, $\cos\left(\frac{\pi}{2}\right)$, and $\sin^{-1}(1)$ can be evaluated without a calculator.
- Unless otherwise specified, combine terms using algebraic methods and rules for exponents and logarithms, where applicable. For example, $2x + 3x$, $5^2 \cdot 5^3$, $\frac{x^5}{x^2}$, and $\ln 3 + \ln 5$ should be rewritten in equivalent forms.
- For each part of the question, show the work that leads to your answers.

A. The functions g and h are given by

$$g(x) = \log_2(4x)$$

$$h(x) = 2\arctan x$$

(i) Solve $g(x) = 5$ for all values of x in the domain of g.

(ii) Solve $h(x) = \frac{\pi}{3}$ for all values of x in the domain of h.

B. The functions j and k are given by

$$j(x) = \frac{3 \cdot 9^{x+1}}{81^{3x}}$$

$$k(x) = \frac{\cos^2 x}{\cos(2x) - \cos^2 x}$$

(i) Rewrite $j(x)$ as an expression of the form $9^{(ax+b)}$, where a and b are constants.

(ii) Rewrite $k(x)$ as a single term involving $\cot x$ with no other trigonometric functions involved.

C. The function m is given by

$$m(x) = \sqrt{2}\cos\left(x - \frac{\pi}{4}\right)$$

Find all input values in the domain of m that yield an output value of 1.

FRQ 4 Practice – Casablanca

Directions:

- Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number. Angle measures for trigonometric functions are assumed to be in radians.
- Solutions to equations must be real numbers. Determine the exact value of any expression that can be obtained without a calculator. For example, $\log_2 8$, $\cos\left(\frac{\pi}{2}\right)$, and $\sin^{-1}(1)$ can be evaluated without a calculator.
- Unless otherwise specified, combine terms using algebraic methods and rules for exponents and logarithms, where applicable. For example, $2x + 3x$, $5^2 \cdot 5^3$, $\frac{x^5}{x^2}$, and $\ln 3 + \ln 5$ should be rewritten in equivalent forms.
- For each part of the question, show the work that leads to your answers.

A. The functions g and h are given by

$$g(x) = 9^{2x}$$

$$h(x) = 3\tan^2 x$$

(i) Solve $g(x) = \frac{1}{9}$ for all values of x in the domain of g.

(ii) Solve $h(x) = 1$ for values of x in the interval $\left[0, \frac{\pi}{2}\right)$.

B. The functions j and k are given by

$$j(x) = \log_3(x-3) + \log_3 2 - 3\log_3 x$$

$$k(x) = \frac{\sin^2 x}{\cos^4 x - \cos^2 x}$$

(i) Rewrite $j(x)$ as a single logarithm base 3 without negative exponents in any part of the expression. Your result should be of the form $\log_3$(expression)

(ii) Rewrite $k(x)$ as an expression in which a power of $\cos x$ appears exactly once and no other trigonometric functions are involved.

C. The function m is given by

$$m(x) = 2\arcsin(3x)$$

Find all values in the domain of m that yield an output value of $\arctan(-\sqrt{3})$.

FRQ 4 Practice – Descendants

Directions:

- Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number. Angle measures for trigonometric functions are assumed to be in radians.
- Solutions to equations must be real numbers. Determine the exact value of any expression that can be obtained without a calculator. For example, $\log_2 8$, $\cos\left(\frac{\pi}{2}\right)$, and $\sin^{-1}(1)$ can be evaluated without a calculator.
- Unless otherwise specified, combine terms using algebraic methods and rules for exponents and logarithms, where applicable. For example, $2x + 3x$, $5^2 \cdot 5^3$, $\frac{x^5}{x^2}$, and $\ln 3 + \ln 5$ should be rewritten in equivalent forms.
- For each part of the question, show the work that leads to your answers.

A. The functions g and h are given by

$$g(x) = e^{2x-1} \cdot e^x$$
$$h(x) = 2\ln x + \ln 5$$

(i) Rewrite $g(x)$ as an expression of the form $e^{(\text{expression})}$.

(ii) Rewrite $h(x)$ as a single natural logarithm without negative exponents in any part of the expression. Your result should be of the form $\ln(\text{expression})$.

B. The functions j and k are given by

$$j(x) = \arcsin(3x) + \pi$$
$$k(x) = \tan^2 x$$

(i) Solve $j(x) = \frac{\pi}{2}$ for values of x in the domain of j.

(ii) Solve $k(x) = \frac{1}{3}$ for values of x in the interval $[0, 2\pi)$

C. The function m is given by

$$m(x) = \sin^2 x - \cos^2 x + 9\sin x$$

Find all input values in the domain of m that yield an output value of 4.

FRQ 4 Practice – Elf

Directions:

- Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number. Angle measures for trigonometric functions are assumed to be in radians.
- Solutions to equations must be real numbers. Determine the exact value of any expression that can be obtained without a calculator. For example, $\log_2 8$, $\cos\left(\frac{\pi}{2}\right)$, and $\sin^{-1}(1)$ can be evaluated without a calculator.
- Unless otherwise specified, combine terms using algebraic methods and rules for exponents and logarithms, where applicable. For example, $2x + 3x$, $5^2 \cdot 5^3$, $\frac{x^5}{x^2}$, and $\ln 3 + \ln 5$ should be rewritten in equivalent forms.
- For each part of the question, show the work that leads to your answers.

A. The functions g and h are given by

$$g(x) = 3^x$$
$$h(x) = \log_2(x - 5)$$

(i) Solve $g(x) = \frac{1}{9}$ for values of x in the domain of g.

(ii) Solve $h(x) = 4$ for values of x in the domain of h.

B. The functions j and k are given by

$$j(x) = \ln x - 4\ln 2$$
$$k(x) = \left(\sin x + \frac{\cos^2 x}{\sin x}\right)\tan x$$

(i) Rewrite $j(x)$ as a single natural logarithm without negative exponents in any part of the expression. Your result should be of the form $\ln(\text{expression})$.

(ii) Rewrite $k(x)$ as an expression in which $\cos x$ appears once and no other trigonometric functions are involved.

C. The function m is given by

$$m(x) = 4\arctan(\sin(2x))$$

Find all input values in the domain of m that yield an output value of $\arccos(-1)$.

FRQ 4 Practice – Finding Neverland

Directions:

- Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number. Angle measures for trigonometric functions are assumed to be in radians.
- Solutions to equations must be real numbers. Determine the exact value of any expression that can be obtained without a calculator. For example, $\log_2 8$, $\cos\left(\frac{\pi}{2}\right)$, and $\sin^{-1}(1)$ can be evaluated without a calculator.
- Unless otherwise specified, combine terms using algebraic methods and rules for exponents and logarithms, where applicable. For example, $2x + 3x$, $5^2 \cdot 5^3$, $\frac{x^5}{x^2}$, and $\ln 3 + \ln 5$ should be rewritten in equivalent forms.
- For each part of the question, show the work that leads to your answers.

A. The functions g and h are given by

$$g(x) = \frac{\tan x}{\sin x}$$

$$h(x) = 4\ln x - \ln 3$$

(i) Rewrite $g(x)$ in terms of $\sec x$ and no other trigonometric function.

(ii) Rewrite $h(x)$ as a single natural logarithm without negative exponents in any part of the expression. Your result should be of the form $\ln$(expression).

B. The functions j and k are given by

$$j(x) = \frac{2^x \cdot 4^{2x}}{16^{x+1}}$$

$$k(x) = \log_4(3x - 1) - \log_4(x + 1)$$

(i) Solve $j(x) = \sqrt{2}$ for values of x in the domain of j.

(ii) Solve $k(x) = 1$ for values of x in the domain of k.

C. The function m is given by

$$m(x) = \sin^{-1}\left(\frac{\sqrt{3}}{2}\tan x\right)$$

Find all input values in the domain of m that yield an output value of $\frac{\pi}{6}$.

FRQ 4 Practice – Forrest Gump

Directions:

- Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number. Angle measures for trigonometric functions are assumed to be in radians.
- Solutions to equations must be real numbers. Determine the exact value of any expression that can be obtained without a calculator. For example, $\log_2 8$, $\cos\left(\frac{\pi}{2}\right)$, and $\sin^{-1}(1)$ can be evaluated without a calculator.
- Unless otherwise specified, combine terms using algebraic methods and rules for exponents and logarithms, where applicable. For example, $2x + 3x$, $5^2 \cdot 5^3$, $\frac{x^5}{x^2}$, and $\ln 3 + \ln 5$ should be rewritten in equivalent forms.
- For each part of the question, show the work that leads to your answers.

A. The functions g and h are given by

$$g(x) = \tan^{-1}\left(3x - \sqrt{3}\right)$$
$$h(x) = \sqrt{2}\cos x$$

(i) Solve $g(x) = \frac{\pi}{3}$ for all values of x in the domain of g.

(ii) Solve $h(x) = 1$ for values of x in the interval $\left[0, \frac{\pi}{2}\right)$.

B. The functions j and k are given by

$$j(x) = \log_2 x + 6\log_4 x$$
$$k(x) = \left(\frac{\cos x}{\cos^2 x - 1}\right)\sin x$$

(i) Rewrite $j(x)$ as a single logarithm base 8 without negative exponents in any part of the expression. Your result should be of the form $\log_8$(expression).

(ii) Rewrite $k(x)$ as a single term involving $\cot x$ and no other trigonometric function.

C. The function m is given by

$$m(x) = 9^{(x^4 + x^2)}$$

Find all input values in the domain of m that yield an output value of 81.

FRQ 4 Practice – Ghostbusters

Directions:

- Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number. Angle measures for trigonometric functions are assumed to be in radians.
- Solutions to equations must be real numbers. Determine the exact value of any expression that can be obtained without a calculator. For example, $\log_2 8$, $\cos\left(\frac{\pi}{2}\right)$, and $\sin^{-1}(1)$ can be evaluated without a calculator.
- Unless otherwise specified, combine terms using algebraic methods and rules for exponents and logarithms, where applicable. For example, $2x + 3x$, $5^2 \cdot 5^3$, $\frac{x^5}{x^2}$, and $\ln 3 + \ln 5$ should be rewritten in equivalent forms.
- For each part of the question, show the work that leads to your answers.

A. The functions g and h are given by

$$g(x) = \cos^{-1}(4x)$$
$$h(x) = \log_2\left(\frac{x}{6}\right)$$

(i) Solve $g(x) = \frac{\pi}{6}$ for values of x in the domain of g.

(ii) Solve $h(x) = 3$ for values of x in the domain of h.

B. The functions j and k are given by

$$j(x) = \frac{10^{2x+1}}{5}$$
$$k(x) = \frac{\cot x\,(\sec^2 x - 1)}{\sin x}$$

(i) Rewrite $j(x)$ as an expression of the form $a(b)^x$ where a and b are constants.

(ii) Rewrite $k(x)$ as an expression in which $\cos x$ appears exactly once and no other trigonometric functions are involved.

C. The function m is given by

$$m(x) = 2\sin^2 x - \sin x - 1$$

Find all values in the domain of m that yield an output value of -1.

FRQ 4 Practice – Hamnet

Directions:

- Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number. Angle measures for trigonometric functions are assumed to be in radians.
- Solutions to equations must be real numbers. Determine the exact value of any expression that can be obtained without a calculator. For example, $\log_2 8$, $\cos\left(\frac{\pi}{2}\right)$, and $\sin^{-1}(1)$ can be evaluated without a calculator.
- Unless otherwise specified, combine terms using algebraic methods and rules for exponents and logarithms, where applicable. For example, $2x + 3x$, $5^2 \cdot 5^3$, $\frac{x^5}{x^2}$, and $\ln 3 + \ln 5$ should be rewritten in equivalent forms.
- For each part of the question, show the work that leads to your answers.

A. The functions g and h are given by

$$g(x) = \log_3(2x + 1) - 2$$

$$h(x) = \frac{(3^x)^2}{9}$$

(i) Solve $g(x) = 1$ for all values of x in the domain of g.

(ii) Solve $h(x) = \frac{1}{27}$ for all values of x in the domain of h.

B. The functions j and k are given by

$$j(x) = \sin x - \csc x$$

$$k(x) = 3\log(x + 2) - 2\log(3x) - \log(x^2)$$

(i) Rewrite $j(x)$ as a product involving $\cot x$ and $\cos x$ and no other trigonometric functions.

(ii) Rewrite $k(x)$ as a single logarithm base 10 without negative exponents in any part of the expression. Your result should be of the form $\log(\text{expression})$.

C. The function m is given by

$$m(x) = 3\arcsin\left(\sqrt{2}x\right)$$

Find all values in the domain of m that yield an output value of $\arccos\left(-\frac{\sqrt{2}}{2}\right)$.

FRQ 4 Practice – Inside Out

Directions:

- Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number. Angle measures for trigonometric functions are assumed to be in radians.
- Solutions to equations must be real numbers. Determine the exact value of any expression that can be obtained without a calculator. For example, $\log_2 8$, $\cos\left(\frac{\pi}{2}\right)$, and $\sin^{-1}(1)$ can be evaluated without a calculator.
- Unless otherwise specified, combine terms using algebraic methods and rules for exponents and logarithms, where applicable. For example, $2x + 3x$, $5^2 \cdot 5^3$, $\frac{x^5}{x^2}$, and $\ln 3 + \ln 5$ should be rewritten in equivalent forms.
- For each part of the question, show the work that leads to your answers.

A. The functions g and h are given by

$$g(x) = \log_5(3x + 1)$$
$$h(x) = \arccos(3x)$$

(i) Solve $g(x) = 2$ for all values of x in the domain of g.

(ii) Solve $h(x) = \frac{\pi}{3}$ for values of x in the domain of h.

B. The functions j and k are given by

$$j(x) = \log_4(15x) - 2\log_4 3$$
$$k(x) = \tan^2 x - \sin^4 x \sec^2 x$$

(i) Rewrite $j(x)$ as a single logarithm base 4 without negative exponents in any part of the expression. Your result should be of the form $\log_4$(expression).

(ii) Rewrite $k(x)$ as a power of $\sin x$ with no other trigonometric function involved.

C. The function m is given by

$$m(x) = 3^{2x} - 4 \cdot 3^x - 5$$

Find all input values in the domain of m that yield an output value of 0.

FRQ 4 Practice – Jurassic Park

Directions:

- Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number. Angle measures for trigonometric functions are assumed to be in radians.
- Solutions to equations must be real numbers. Determine the exact value of any expression that can be obtained without a calculator. For example, $\log_2 8$, $\cos\left(\frac{\pi}{2}\right)$, and $\sin^{-1}(1)$ can be evaluated without a calculator.
- Unless otherwise specified, combine terms using algebraic methods and rules for exponents and logarithms, where applicable. For example, $2x + 3x$, $5^2 \cdot 5^3$, $\frac{x^5}{x^2}$, and $\ln 3 + \ln 5$ should be rewritten in equivalent forms.
- For each part of the question, show the work that leads to your answers.

A. The functions g and h are given by

$$g(x) = 6\arctan x$$

$$h(x) = \log_2 x - \log_2 5$$

(i) Solve $g(x) = 2\pi$ for values of x in the domain of g.

(ii) Solve $h(x) = 3$ for values of x in the domain of h.

B. The functions j and k are given by

$$j(x) = \frac{3^x \cdot 3^{5x}}{9}$$

$$k(x) = (\cos(2x) - 1) \cdot \csc x$$

(i) Rewrite $j(x)$ as an expression of the form $9^{(\text{expression})}$.

(ii) Rewrite $k(x)$ as an expression in which a multiple of $\sin x$ appears exactly once and no other trigonometric functions are involved.

C. The function m is given by

$$m(x) = 6\sin(2x)$$

Find all input values in the domain of m that yield an output value of 3.

FRQ 4 Practice – Kung Fu Panda

Directions:

- Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number. Angle measures for trigonometric functions are assumed to be in radians.
- Solutions to equations must be real numbers. Determine the exact value of any expression that can be obtained without a calculator. For example, $\log_2 8$, $\cos\left(\frac{\pi}{2}\right)$, and $\sin^{-1}(1)$ can be evaluated without a calculator.
- Unless otherwise specified, combine terms using algebraic methods and rules for exponents and logarithms, where applicable. For example, $2x + 3x$, $5^2 \cdot 5^3$, $\frac{x^5}{x^2}$, and $\ln 3 + \ln 5$ should be rewritten in equivalent forms.
- For each part of the question, show the work that leads to your answers.

A. The functions g and h are given by

$$g(x) = e^{2x}$$
$$h(x) = 3\log_5(x-1)$$

(i) Solve $g(x) = 5$ for all values of x in the domain of g.

(ii) Solve $h(x) = 6$ for values of x in the domain of h.

B. The functions j and k are given by

$$j(x) = 3\log_2 x + 2\log_2 5$$
$$k(x) = \tan x - \sin^2 x \tan x$$

(i) Rewrite $j(x)$ as a single logarithm base 2 without negative exponents in any part of the expression. Your result should be of the form $\log_2(\text{expression})$.

(ii) Rewrite $k(x)$ as a multiple of $\sin(2x)$. That is to say, rewrite $k(x)$ in the form $b\sin(2x)$ where b is an integer to be determined.

C. The function m is given by

$$m(x) = \tan^{-1}(\cos(3x))$$

Find all values in the domain of m that yield an output value of $\frac{\pi}{4}$.

FRQ 4 Practice – The Lion King

Directions:

- Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number. Angle measures for trigonometric functions are assumed to be in radians.
- Solutions to equations must be real numbers. Determine the exact value of any expression that can be obtained without a calculator. For example, $\log_2 8$, $\cos\left(\frac{\pi}{2}\right)$, and $\sin^{-1}(1)$ can be evaluated without a calculator.
- Unless otherwise specified, combine terms using algebraic methods and rules for exponents and logarithms, where applicable. For example, $2x + 3x$, $5^2 \cdot 5^3$, $\frac{x^5}{x^2}$, and $\ln 3 + \ln 5$ should be rewritten in equivalent forms.
- For each part of the question, show the work that leads to your answers.

A. The functions g and h are given by

$$g(x) = 2\cos x$$

$$h(x) = 4\arctan(x + 8)$$

(i) Solve $g(x) = \sqrt{2}$ for values of x in the interval $\left[0, \frac{\pi}{2}\right)$.

(ii) Solve $h(x) = -\pi$ for values of x in the domain of h.

B. The functions j and k are given by

$$j(x) = 3\log_2 x - \log_2 5$$

$$k(x) = \frac{\cos(2x)}{\sin^2 x}$$

(i) Rewrite $j(x)$ as a single logarithm base 2 without negative exponents in any part of the expression. Your result should be of the form $\log_2$(expression).

(ii) Rewrite $k(x)$ as an expression in which a power of $\csc x$ is the only trigonometric function involved.

C. The function m is given by

$$m(x) = 2^{x^4 - 3x^2}$$

Find all input values in the domain of m that yield an output value of 16.

FRQ 4 Practice – The Martian

Directions:

- Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number. Angle measures for trigonometric functions are assumed to be in radians.
- Solutions to equations must be real numbers. Determine the exact value of any expression that can be obtained without a calculator. For example, $\log_2 8$, $\cos\left(\frac{\pi}{2}\right)$, and $\sin^{-1}(1)$ can be evaluated without a calculator.
- Unless otherwise specified, combine terms using algebraic methods and rules for exponents and logarithms, where applicable. For example, $2x + 3x$, $5^2 \cdot 5^3$, $\frac{x^5}{x^2}$, and $\ln 3 + \ln 5$ should be rewritten in equivalent forms.
- For each part of the question, show the work that leads to your answers.

A. The functions g and h are given by

$$g(x) = \sqrt{3}\tan x$$
$$h(x) = \log_3(x-1) - \log_3 2$$

(i) Solve $g(x) = 1$ for values of x in the interval $\left[0, \frac{\pi}{2}\right)$.

(ii) Solve $h(x) = 2$ for all values of x in the domain of h.

B. The functions j and k are given by

$$j(x) = \frac{9}{3^{3x}}$$
$$k(x) = \frac{\csc x}{\sin x}(\sec^2 x - 1)$$

(i) Rewrite $j(x)$ as an expression of the form $3^{(\text{expression})}$.

(ii) Rewrite $k(x)$ as an expression in which $\cos x$ is raised to a power and no other trigonometric functions are involved.

C. The function m is given by

$$m(x) = \arcsin(\cos(2x))$$

Find all values in the domain of m that yield an output value of 0.

FRQ 4 Practice – Night at the Museum

Directions:

- Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number. Angle measures for trigonometric functions are assumed to be in radians.
- Solutions to equations must be real numbers. Determine the exact value of any expression that can be obtained without a calculator. For example, $\log_2 8$, $\cos\left(\frac{\pi}{2}\right)$, and $\sin^{-1}(1)$ can be evaluated without a calculator.
- Unless otherwise specified, combine terms using algebraic methods and rules for exponents and logarithms, where applicable. For example, $2x + 3x$, $5^2 \cdot 5^3$, $\frac{x^5}{x^2}$, and $\ln 3 + \ln 5$ should be rewritten in equivalent forms.
- For each part of the question, show the work that leads to your answers.

A. The functions g and h are given by

$$g(x) = \left(\frac{1}{5}\right)^{4x}$$

$$h(x) = \arccos(x + 3)$$

(i) Solve $g(x) = \sqrt{5}$ for all values of x in the domain of g.

(ii) Solve $h(x) = \frac{\pi}{2}$ for all values of x in the domain of h.

B. The functions j and k are given by

$$j(x) = 4\ln(x + 1) - \ln x - 3\ln 2$$

$$k(x) = \frac{8(1 - \sin^2 x)}{\sin(2x)}$$

(i) Rewrite $j(x)$ as a single natural logarithm without negative exponents in any part of the expression. Your result should be of the form $\ln$(expression).

(ii) Rewrite $k(x)$ as an expression in which $\cot x$ appears exactly once and no other trigonometric functions are involved.

C. The function m is given by

$$m(x) = \cos^2(2x)$$

Find all input values for m in the interval $\left[0, \frac{\pi}{2}\right)$ that yield an output value of $\frac{1}{2}$.

FRQ 4 Practice – O Brother, Where Art Thou?

Directions:

- Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number. Angle measures for trigonometric functions are assumed to be in radians.
- Solutions to equations must be real numbers. Determine the exact value of any expression that can be obtained without a calculator. For example, $\log_2 8$, $\cos\left(\frac{\pi}{2}\right)$, and $\sin^{-1}(1)$ can be evaluated without a calculator.
- Unless otherwise specified, combine terms using algebraic methods and rules for exponents and logarithms, where applicable. For example, $2x + 3x$, $5^2 \cdot 5^3$, $\frac{x^5}{x^2}$, and $\ln 3 + \ln 5$ should be rewritten in equivalent forms.
- For each part of the question, show the work that leads to your answers.

A. The functions g and h are given by

$$g(x) = e^{2x}$$
$$h(x) = 3\ln x$$

(i) Solve $g(x) = 6$ for values of x in the domain of g.

(ii) Solve $h(x) = 12$ for values of x in the domain of h.

B. The functions j and k are given by

$$j(x) = \ln(x+3) - 2\ln(x) + 3\ln 2$$
$$k(x) = (1 - \cos^2 x)\frac{\sec x \tan x}{\sin x}$$

(i) Rewrite $j(x)$ as a single natural logarithm without negative exponents in any part of the expression. Your result should be of the form $\ln(\text{something})$.

(ii) Rewrite $k(x)$ as an expression in which $\tan x$ is raised to a power and no other trigonometric functions are involved.

C. The function m is given by

$$m(x) = (5^x)^2 - 9 \cdot 5^x$$

Find all input values in the domain of m that yield an output of 10.

FRQ 4 Practice – The Princess Bride

Directions:

- Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number. Angle measures for trigonometric functions are assumed to be in radians.
- Solutions to equations must be real numbers. Determine the exact value of any expression that can be obtained without a calculator. For example, $\log_2 8$, $\cos\left(\frac{\pi}{2}\right)$, and $\sin^{-1}(1)$ can be evaluated without a calculator.
- Unless otherwise specified, combine terms using algebraic methods and rules for exponents and logarithms, where applicable. For example, $2x + 3x$, $5^2 \cdot 5^3$, $\frac{x^5}{x^2}$, and $\ln 3 + \ln 5$ should be rewritten in equivalent forms.
- For each part of the question, show the work that leads to your answers.

A. The functions g and h are given by

$$g(x) = 8(4)^x$$

$$h(x) = \log_4(x - 1)$$

(i) Solve $g(x) = 2$ for values of x in the domain of g.

(ii) Solve $h(x) = \frac{1}{2}$ for values of x in the domain of h.

B. The functions j and k are given by

$$j(x) = \ln(x - 2) - 3\ln(x + 1) - \ln(x^2)$$

$$k(x) = \frac{\sec x \csc x + \sec^2 x}{1 + \tan^2 x}$$

(i) Rewrite $j(x)$ as a single natural logarithm without negative exponents in any part of the expression. Your result should be of the form $\ln(\text{expression})$.

(ii) Rewrite $k(x)$ as an expression in which $\cot x$ appears exactly once and no other trigonometric functions are involved.

C. The function m is given by

$$m(x) = \cos(4x) + 1$$

Find all input values for m in the interval $\left[0, \frac{\pi}{2}\right]$ that yield an output value of 1.

FRQ 4 Practice – A Quiet Place

Directions:

- Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number. Angle measures for trigonometric functions are assumed to be in radians.
- Solutions to equations must be real numbers. Determine the exact value of any expression that can be obtained without a calculator. For example, $\log_2 8$, $\cos\left(\frac{\pi}{2}\right)$, and $\sin^{-1}(1)$ can be evaluated without a calculator.
- Unless otherwise specified, combine terms using algebraic methods and rules for exponents and logarithms, where applicable. For example, $2x + 3x$, $5^2 \cdot 5^3$, $\frac{x^5}{x^2}$, and $\ln 3 + \ln 5$ should be rewritten in equivalent forms.
- For each part of the question, show the work that leads to your answers.

A. The functions g and h are given by

$$g(x) = 4^{x+1}$$
$$h(x) = \log_3(2x)$$

(i) Solve $g(x) = \frac{1}{64}$ for values of x in the domain of g.

(ii) Solve $h(x) = 2$ for values of x in the domain of h.

B. The functions j and k are given by

$$j(x) = \log_{10}(7x^3) + \log_{10}(3x^2) - 4\log_{10} x$$
$$k(x) = \frac{\cot^2 x}{\csc x} + \sin x$$

(i) Rewrite $j(x)$ as a single logarithm base 10 without negative exponents in any part of the expression. Our result should be of the form $\log_{10}$(expression).

(ii) Rewrite $k(x)$ as a single term involving $\sin x$ and no other trigonometric function.

C. The function m is given by

$$m(x) = e^{2x} - 7e^x + 12$$

Find all input values in the domain of m that yield an output value of 6.

FRQ 4 Practice – Ratatouille

Directions:

- Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number. Angle measures for trigonometric functions are assumed to be in radians.
- Solutions to equations must be real numbers. Determine the exact value of any expression that can be obtained without a calculator. For example, $\log_2 8$, $\cos\left(\frac{\pi}{2}\right)$, and $\sin^{-1}(1)$ can be evaluated without a calculator.
- Unless otherwise specified, combine terms using algebraic methods and rules for exponents and logarithms, where applicable. For example, $2x + 3x$, $5^2 \cdot 5^3$, $\frac{x^5}{x^2}$, and $\ln 3 + \ln 5$ should be rewritten in equivalent forms.
- For each part of the question, show the work that leads to your answers.

A. The functions g and h are given by

$$g(x) = e^{x-5}$$
$$h(x) = \arccos(2x)$$

(i) Solve $g(x) = \frac{1}{e^{10}}$ for values of x in the domain of g.

(ii) Solve $h(x) = \frac{3\pi}{4}$ for values of x in the domain of h.

B. The functions j and k are given by

$$j(x) = 4\log_2(2x) - \log_2 6$$
$$k(x) = \frac{\sin^2 x}{\sin(2x)}$$

(i) Rewrite $j(x)$ as a single logarithm base 2 without negative exponents in any part of the expression. Your result should be of the form $\log_2$(expression).

(ii) Rewrite $k(x)$ as an expression in which $\tan x$ appears exactly once and no other trigonometric functions are involved.

C. The function m is given by

$$m(x) = \log_3(x^2) - \log_3(x - 2)$$

Find all input values in the domain of m that yield an output value of 2.

FRQ 4 Practice – Star Wars

Directions:

- Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number. Angle measures for trigonometric functions are assumed to be in radians.
- Solutions to equations must be real numbers. Determine the exact value of any expression that can be obtained without a calculator. For example, $\log_2 8$, $\cos\left(\frac{\pi}{2}\right)$, and $\sin^{-1}(1)$ can be evaluated without a calculator.
- Unless otherwise specified, combine terms using algebraic methods and rules for exponents and logarithms, where applicable. For example, $2x + 3x$, $5^2 \cdot 5^3$, $\frac{x^5}{x^2}$, and $\ln 3 + \ln 5$ should be rewritten in equivalent forms.
- For each part of the question, show the work that leads to your answers.

A. The functions g and h are given by

$$g(x) = \arctan(3x + 2)$$
$$h(x) = \log_2(x - 7)$$

(i) Solve $g(x) = \frac{\pi}{4}$ for all values of x in the domain of g.

(ii) Solve $h(x) = 3$ for values of x in the domain of h.

B. The functions j and k are given by

$$j(x) = \frac{5^{x+1}}{25^x}$$
$$k(x) = \frac{\sin x}{(1 - \sin^2 x)(\tan x)}$$

(i) Rewrite $j(x)$ as an expression of the form $5^{(\text{expression})}$.

(ii) Rewrite $k(x)$ as a single term involving $\cos x$.

C. The function m is given by

$$m(x) = \sin^2(4x)$$

Find all input values for m in the interval $\left[0, \frac{\pi}{2}\right]$ that yield an output value of 1.

FRQ 4 Practice – Toy Story

Directions:

- Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number. Angle measures for trigonometric functions are assumed to be in radians.
- Solutions to equations must be real numbers. Determine the exact value of any expression that can be obtained without a calculator. For example, $\log_2 8$, $\cos\left(\frac{\pi}{2}\right)$, and $\sin^{-1}(1)$ can be evaluated without a calculator.
- Unless otherwise specified, combine terms using algebraic methods and rules for exponents and logarithms, where applicable. For example, $2x + 3x$, $5^2 \cdot 5^3$, $\frac{x^5}{x^2}$, and $\ln 3 + \ln 5$ should be rewritten in equivalent forms.
- For each part of the question, show the work that leads to your answers.

A. The functions g and h are given by

$$g(x) = 5\log_2 x$$
$$h(x) = 3\arctan(x)$$

(i) Solve $g(x) = -15$ for values of x in the domain of g.

(ii) Solve $h(x) = -\pi$ for values of x in the domain of h.

B. The functions j and k are given by

$$j(x) = \frac{4^{2x}}{2^{x+1}}$$
$$k(x) = \frac{\cot^2 x + 1}{\cot x \csc x}$$

(i) Rewrite $j(x)$ as an expression of the form $2^{(\text{expression})}$.

(ii) Rewrite $k(x)$ as a single term involving $\cos x$.

C. The function m is given by

$$m(x) = \log_2(3x + 4) - 2\log_2 x$$

Find all input values in the domain of m that yield an output value of 0.

FRQ 4 Practice – Up

Directions:

- Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number. Angle measures for trigonometric functions are assumed to be in radians.
- Solutions to equations must be real numbers. Determine the exact value of any expression that can be obtained without a calculator. For example, $\log_2 8$, $\cos\left(\frac{\pi}{2}\right)$, and $\sin^{-1}(1)$ can be evaluated without a calculator.
- Unless otherwise specified, combine terms using algebraic methods and rules for exponents and logarithms, where applicable. For example, $2x + 3x$, $5^2 \cdot 5^3$, $\frac{x^5}{x^2}$, and $\ln 3 + \ln 5$ should be rewritten in equivalent forms.
- For each part of the question, show the work that leads to your answers.

A. The functions g and h are given by

$$g(x) = \cos^2 x$$

$$h(x) = \ln x - 2\ln 3$$

(i) Solve $g(x) = \frac{1}{2}$ for values of x in the interval $\left[0, \frac{\pi}{2}\right)$.

(ii) Solve $h(x) = 1$ for all values of x in the domain of h.

B. The functions j and k are given by

$$j(x) = 4^{2x-1} \cdot \left(\frac{1}{2}\right)^x$$

$$k(x) = \frac{\tan x}{\sin(2x)}$$

(i) Rewrite $j(x)$ as an expression of the form $2^{\text{(expression)}}$.

(ii) Rewrite $k(x)$ as an expression involving $sec\, x$ and no other trigonometric function.

C. The function m is given by

$$m(x) = 3^{6x^2+7x+1}$$

Find all input values in the domain of m that yield an output value of $\frac{1}{3}$.

FRQ 4 Practice – Venom

Directions:

- Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number. Angle measures for trigonometric functions are assumed to be in radians.
- Solutions to equations must be real numbers. Determine the exact value of any expression that can be obtained without a calculator. For example, $\log_2 8$, $\cos\left(\frac{\pi}{2}\right)$, and $\sin^{-1}(1)$ can be evaluated without a calculator.
- Unless otherwise specified, combine terms using algebraic methods and rules for exponents and logarithms, where applicable. For example, $2x + 3x$, $5^2 \cdot 5^3$, $\frac{x^5}{x^2}$, and $\ln 3 + \ln 5$ should be rewritten in equivalent forms.
- For each part of the question, show the work that leads to your answers.

A. The functions g and h are given by

$$g(x) = \tan x$$
$$h(x) = \ln(5x)$$

(i) Solve $g(x) = 1$ for values of x in the interval $[0,2\pi)$.

(ii) Solve $h(x) = 2$ for values of x in the domain of h.

B. The functions j and k are given by

$$j(x) = \frac{\sec^2 x - 1}{\cos^2 x - 1}$$
$$k(x) = \frac{25}{\sqrt{5^x}}$$

(i) Rewrite $j(x)$ as an expression involving $\sec x$ raised to an integer power with no other terms.

(ii) Rewrite $k(x)$ as an expression of the form 5^{ax+b}, where a and b are constants.

C. The function m is given by

$$m(x) = 2\cos(2x)$$

Find all values in the domain of m that yield an output value of $\sqrt{3}$.

FRQ 4 Practice – West Side Story

Directions:

- Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number. Angle measures for trigonometric functions are assumed to be in radians.
- Solutions to equations must be real numbers. Determine the exact value of any expression that can be obtained without a calculator. For example, $\log_2 8$, $\cos\left(\frac{\pi}{2}\right)$, and $\sin^{-1}(1)$ can be evaluated without a calculator.
- Unless otherwise specified, combine terms using algebraic methods and rules for exponents and logarithms, where applicable. For example, $2x + 3x$, $5^2 \cdot 5^3$, $\frac{x^5}{x^2}$, and $\ln 3 + \ln 5$ should be rewritten in equivalent forms.
- For each part of the question, show the work that leads to your answers.

A. The functions g and h are given by

$$g(x) = \frac{\arcsin(4x)}{2}$$

$$h(x) = \tan^2 x$$

(i) Solve $g(x) = \frac{\pi}{4}$ for all values of x in the domain of g.

(ii) Solve $h(x) = 3$ for values of x in the interval $\left[0, \frac{\pi}{2}\right)$.

B. The functions j and k are given by

$$j(x) = \ln(4x) - 4\ln(x)$$

$$k(x) = 1 - \frac{1}{2}\sin(2x)\tan x$$

(i) Rewrite $j(x)$ as a single natural logarithm without negative exponents in any part of the expression. Your result should be of the form $\ln$(expression).

(ii) Rewrite $k(x)$ as an expression involving a power of $\cos x$ involving no other trigonometric expression.

C. The function m is given by

$$m(x) = \log_2(x - 2) + \log_2(x + 4)$$

Find all input values in the domain of m that yield an output value of 4.

FRQ 4 Practice – What's Up Doc?

Directions:

- Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number. Angle measures for trigonometric functions are assumed to be in radians.
- Solutions to equations must be real numbers. Determine the exact value of any expression that can be obtained without a calculator. For example, $\log_2 8$, $\cos\left(\frac{\pi}{2}\right)$, and $\sin^{-1}(1)$ can be evaluated without a calculator.
- Unless otherwise specified, combine terms using algebraic methods and rules for exponents and logarithms, where applicable. For example, $2x + 3x$, $5^2 \cdot 5^3$, $\frac{x^5}{x^2}$, and $\ln 3 + \ln 5$ should be rewritten in equivalent forms.
- For each part of the question, show the work that leads to your answers.

A. The functions g and h are given by

$$g(x) = 2\log_4(x+1)$$

$$h(x) = 2\sin^2 x$$

(i) Solve $g(x) = 3$ for all values of x in the domain of g.

(ii) Solve $h(x) = 1$ for values of x in the interval $\left[0, \frac{\pi}{2}\right)$.

B. The functions j and k are given by

$$j(x) = \frac{1 - \cos(2x)}{2\sin(2x)}$$

$$k(x) = 3\log_6 x - \log_6(4x)$$

(i) Rewrite $j(x)$ in terms of $\tan\theta$ and no other trigonometric function.

(ii) Rewrite $k(x)$ as a single logarithm base 6 without negative exponents in any part of the expression. Your result should be of the form $\log_6(\text{expression})$.

C. The function m is given by

$$m(x) = \left(\frac{1}{2}\right)^{2x} + 3\left(\frac{1}{2}\right)^{x}$$

Find all values in the domain of m that yield an output value of 4.

FRQ 4 Practice – X-Men

Directions:

- Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number. Angle measures for trigonometric functions are assumed to be in radians.
- Solutions to equations must be real numbers. Determine the exact value of any expression that can be obtained without a calculator. For example, $\log_2 8$, $\cos\left(\frac{\pi}{2}\right)$, and $\sin^{-1}(1)$ can be evaluated without a calculator.
- Unless otherwise specified, combine terms using algebraic methods and rules for exponents and logarithms, where applicable. For example, $2x + 3x$, $5^2 \cdot 5^3$, $\frac{x^5}{x^2}$, and $\ln 3 + \ln 5$ should be rewritten in equivalent forms.
- For each part of the question, show the work that leads to your answers.

A. The functions g and h are given by

$$g(x) = \sec x$$
$$h(x) = 3(2)^{x-4}$$

(i) Solve $g(x) = 2$ for values of x in the interval $\left[0, \frac{\pi}{2}\right)$.

(ii) Solve $h(x) = 15$ for values of x in the domain of h.

B. The functions j and k are given by

$$j(x) = \log_5 x + 3\log_5 2$$
$$k(x) = 2 - \sin(2x)\tan(x)$$

(i) Rewrite $j(x)$ as a single logarithm base 5 without negative exponents in any part of the expression. Your result should be of the form $\log_5$(expression).

(ii) Rewrite $k(x)$ as an expression involving a multiple of a power of $\cos(x)$ and no other trigonometric function. In other words, rewrite $k(x)$ as an expression of the form of the form $a(\cos x)^b$, where a and b are constants.

C. The function m is given by

$$m(x) = 2\log_2(x+3) - \log_2(x+5)$$

Find all input values in the domain of m that yield an output value of 0.

FRQ 4 Practice – Young Frankenstein

Directions:

- Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number. Angle measures for trigonometric functions are assumed to be in radians.
- Solutions to equations must be real numbers. Determine the exact value of any expression that can be obtained without a calculator. For example, $\log_2 8$, $\cos\left(\frac{\pi}{2}\right)$, and $\sin^{-1}(1)$ can be evaluated without a calculator.
- Unless otherwise specified, combine terms using algebraic methods and rules for exponents and logarithms, where applicable. For example, $2x + 3x$, $5^2 \cdot 5^3$, $\frac{x^5}{x^2}$, and $\ln 3 + \ln 5$ should be rewritten in equivalent forms.
- For each part of the question, show the work that leads to your answers.

A. The functions g and h are given by

$$g(x) = 2(9)^x$$

$$h(x) = \log_2(5x)$$

(i) Solve $g(x) = 6$ for all values of x in the domain of g.

(ii) Solve $h(x) = 4$ for all values of x in the domain of h.

B. The functions j and k are given by

$$j(x) = \log_2(x+3) - 5\log_2(x) + 1$$

$$k(x) = \frac{(\csc x - \sin x)(\sec^2 x)}{\csc^2 x}$$

(i) Rewrite $j(x)$ as a single logarithm base 2 without negative exponents in any part of the expression. Your result should be of the form $\log_2$(expression).

(ii) Rewrite $k(x)$ as an expression in which $\csc(x)$ appears once and no other trigonometric functions are involved.

C. The function m is given by

$$m(x) = 2\sin^2 x + 3\sin x$$

Find all values in the domain of m that yield an output value of 2.

FRQ 4 Practice – Zootopia

Directions:

- Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number. Angle measures for trigonometric functions are assumed to be in radians.
- Solutions to equations must be real numbers. Determine the exact value of any expression that can be obtained without a calculator. For example, $\log_2 8$, $\cos\left(\frac{\pi}{2}\right)$, and $\sin^{-1}(1)$ can be evaluated without a calculator.
- Unless otherwise specified, combine terms using algebraic methods and rules for exponents and logarithms, where applicable. For example, $2x + 3x$, $5^2 \cdot 5^3$, $\frac{x^5}{x^2}$, and $\ln 3 + \ln 5$ should be rewritten in equivalent forms.
- For each part of the question, show the work that leads to your answers.

A. The functions g and h are given by

$$g(x) = \arctan(5x)$$

$$h(x) = \log_3(x^2)$$

(i) Solve $g(x) = \frac{\pi}{3}$ for values of x in the domain of g.

(ii) Solve $h(x) = 0$ for values of x in the domain of h.

B. The functions j and k are given by

$$j(x) = \frac{\tan^2 x - \sec^2 x}{\sin(\pi - x)}$$

$$k(x) = 15(3)^{2x-1}$$

(i) Rewrite $j(x)$ as an expression in which $\csc x$ appears exactly once and no other trigonometric functions are involved.

(ii) Rewrite $k(x)$ as an expression of the form $a(b)^x$, where a and b are constants.

C. The function m is given by

$$m(x) = 2\sin(4x) + 3$$

Find all input values in the domain of m that yield an output value of 1.

Solutions to FRQ 4 Practice – Amadeus

A.

(i) $6\log_2 x = 18$
$\log_2 x = 3$
$2^{\log_2 x} = 2^3$
$\boldsymbol{x = 8}$

(ii) $3^{2x-1} = 10$
$\log_3(3^{2x-1}) = \log_3(10)$
$2x - 1 = \log_3 10$
$2x = 1 + \log_3 10$
$\boldsymbol{x = \frac{1+\log_3 10}{2}}$

B.

(i) $j(x) = \log_4(x^3) - \log_4(2x) = \log_4\left(\frac{x^3}{2x}\right) = \boldsymbol{\log_4\left(\frac{x^2}{2}\right)}$ **for $\boldsymbol{x > 0}$**

(ii) $k(x) = \frac{2\sin x\cos x}{\left(\sin x\cdot\frac{\cos x}{\sin x}\right)^2} = \frac{2\sin x\cos x}{\cos^2 x} = 2\frac{\sin x}{\cos x} = \boldsymbol{2\tan x}$ **for $\boldsymbol{x \neq k\pi}$**

C. $\arctan(2\,sin\,x) = -\frac{\pi}{3}$

$\tan(\arctan(2\,sin\,x)) = \tan\left(-\frac{\pi}{3}\right)$

$2\sin x = -\sqrt{3}$

$\sin x = -\frac{\sqrt{3}}{2}$

$\boldsymbol{x = \frac{4\pi}{3} + 2\pi k}$ **or $\boldsymbol{x = \frac{5\pi}{3} + 2\pi k}$ for any integer value of $\boldsymbol{k}$.**

Solutions to FRQ 4 Practice – Beauty and the Beast

A.

(i) $e^{x-2} = 4$
$\ln(e^{x-2}) = \ln(4)$
$x - 2 = \ln 4$
$\boldsymbol{x = 2 + \ln 4}$

(ii) $12\arcsin(x+1) = -2\pi$
$\arcsin(x+1) = -\frac{\pi}{6}$
$\sin(arcsin(x+1)) = \sin\left(-\frac{\pi}{6}\right)$
$x + 1 = -\frac{1}{2}$
$\boldsymbol{x = -\frac{3}{2}}$

B.

(i) $j(x) = \log_5 x + \log_5(2^3) = \boldsymbol{\log_5(8x)}$

(ii) $k(x) = \frac{3\sec^2 x}{\sec x} - \frac{3\tan^2 x}{\sec x} = \frac{3\sec^2 x - 3\tan^2 x}{\sec x} = \frac{3(\sec^2 x - \tan^2 x)}{\sec x} = \frac{3(1)}{\sec x} = \boldsymbol{\frac{3}{\sec x}}$

C. $\log_2 x + \log_2(x+2) = 3$
$\log_2(x^2 + 2x) = 3$
$2^{\log_2(x^2+2x)} = 2^3$
$x^2 + 2x = 8$
$x^2 + 2x - 8 = 0$
$(x+4)(x-2) = 0$
$x = -4$ is not in the domain of $m(x)$, so the only solution is
$\boldsymbol{x = 2}$

Solutions to FRQ 4 Practice – Big Fish

A.

(i) $\log_2(4x) = 5$

$2^{\log_2(4x)} = 2^5$

$4x = 32$

$\boldsymbol{x = 8}$

(ii) $2\arctan x = \frac{\pi}{3}$

$\arctan x = \frac{\pi}{6}$

$\tan(\arctan x) = \tan\left(\frac{\pi}{6}\right)$

$\boldsymbol{x = \frac{\sqrt{3}}{3}}$

B.

(i) $j(x) = \frac{3 \cdot 9^{x+1}}{81^{3x}} = \frac{9^{\frac{1}{2}} \cdot 9^{x+1}}{(9^2)^{3x}} = \frac{9^{x+\frac{3}{2}}}{9^{6x}} = \boldsymbol{9^{-5x+\frac{3}{2}}}$

(ii) $k(x) = \frac{\cos^2 x}{\cos(2x) - \cos^2 x} = \frac{\cos^2 x}{2\cos^2 x - 1 - \cos^2 x} = \frac{\cos^2 x}{\cos^2 x - 1} = \frac{\cos^2 x}{-\sin^2 x} = \boldsymbol{-\cot^2 x}$

C. $\sqrt{2}\cos\left(x - \frac{\pi}{4}\right) = 1$

$\cos\left(x - \frac{\pi}{4}\right) = \frac{1}{\sqrt{2}}$

$x - \frac{\pi}{4} = -\frac{\pi}{4} + 2\pi k$ or $x - \frac{\pi}{4} = \frac{\pi}{4} + 2\pi k$

$\boldsymbol{x = 2\pi k}$ or $\boldsymbol{x = \frac{\pi}{2} + 2\pi k}$ where $\boldsymbol{k}$ is any integer

Solutions to FRQ 4 Practice – Casablanca

A.

(i) $9^{2x} = \frac{1}{9}$

$\log_9(9^{2x}) = \log_9\left(\frac{1}{9}\right)$

$2x = -1$

$\boldsymbol{x = -\frac{1}{2}}$

(ii) $3\tan^2 x = 1$

$\tan^2 x = \frac{1}{3}$

$\tan x = \pm\frac{1}{\sqrt{3}}$

(we may ignore the case where $\tan x = -\frac{1}{\sqrt{3}}$ as $\tan x$ must be positive for x in the first quadrant)

$\boldsymbol{x = \frac{\pi}{6}}$

B.

(i) $j(x) = \log_3(x-3) + \log_3 2 - \log_3(x^3) = \log_3\left(\frac{(x-3)(2)}{x^3}\right) = \boldsymbol{\log_3\left(\frac{2(x-3)}{x^3}\right)}$ **for $\boldsymbol{x > 3}$**

(ii) $k(x) = \frac{\sin^2 x}{\cos^2 x(\cos^2 x - 1)} = \frac{\sin^2 x}{(\cos^2 x)(-\sin^2 x)} = \boldsymbol{-\frac{1}{\cos^2 x}}$ **for $\boldsymbol{x \neq k\pi}$**

C. $2\arcsin(3x) = \arctan(-\sqrt{3})$

$2\arcsin(3x) = -\frac{\pi}{3}$

$\arcsin(3x) = -\frac{\pi}{6}$

$\sin(\arcsin(3x)) = \sin\left(-\frac{\pi}{6}\right)$

$3x = -\frac{1}{2}$

$\boldsymbol{x = -\frac{1}{6}}$

Solutions to FRQ 4 Practice – Descendants

A.

(i) $g(x) = e^{2x-1} \cdot e^x = e^{2x-1+x} = \boldsymbol{e^{3x-1}}$

(ii) $h(x) = \ln(x^2) + \ln 5 = \mathbf{\ln(5x^2)}$ **for** $\boldsymbol{x > 0}$

B.

(i) $\arcsin(3x) + \pi = \frac{\pi}{2}$

$\arcsin(3x) = -\frac{\pi}{2}$

$\sin(\arcsin(3x)) = \sin\left(-\frac{\pi}{2}\right)$

$3x = -1$

$\boldsymbol{x = -\frac{1}{3}}$

(ii) $\tan^2 x = \frac{1}{3}$

$\tan x = \frac{1}{\sqrt{3}}$ or $\tan x = -\frac{1}{\sqrt{3}}$

$\boldsymbol{x = \frac{\pi}{6} + \pi k}$ **or** $\boldsymbol{x = \frac{5\pi}{6} + \pi k}$ **for any integer value of** $\boldsymbol{k}$

C. $\sin^2 x - \cos^2 x + 9\sin x = 4$

$\sin^2 x - (1 - \sin^2 x) + 9\sin x = 4$

$2\sin^2 x + 9\sin x - 5 = 0$

$(2\sin x - 1)(\sin x + 5) = 0$

$\sin x = \frac{1}{2}$ (we do not need to investigate the possibility that $\sin x = -5$ as -5 is beyond the range of $\sin x$)

$\boldsymbol{x = \frac{\pi}{6} + 2\pi k}$ **or** $\boldsymbol{x = \frac{5\pi}{6} + 2\pi k}$ **for** $\boldsymbol{k} \in \mathbb{Z}$

Solutions to FRQ 4 Practice – Elf

A.

(i) $3^x = \frac{1}{9}$

$\log_3(3^x) = \log_3\left(\frac{1}{9}\right)$

$\boldsymbol{x = -2}$

(ii) $\log_2(x-5) = 4$

$2^{\log_2(x-5)} = 2^4$

$x - 5 = 16$

$\boldsymbol{x = 21}$

B.

(i) $j(x) = \ln x - \ln(2^4) = \mathbf{\ln}\left(\boldsymbol{\frac{x}{16}}\right)$

(ii) $k(x) = \left(\frac{\sin^2 x}{\sin x} + \frac{\cos^2 x}{\sin x}\right)\tan x = \left(\frac{\sin^2 x + \cos^2 x}{\sin x}\right)\tan x = \left(\frac{1}{\sin x}\right)\tan x = \frac{1}{\sin x} \cdot \frac{\sin x}{\cos x} = \boldsymbol{\frac{1}{\cos x}}$ **for** $\boldsymbol{x \neq k\pi}$

C. $4\arctan(\sin(2x)) = \arccos(-1)$

$4\arctan(\sin(2x)) = \pi$

$\arctan(\sin(2x)) = \frac{\pi}{4}$

$\tan(\arctan(\mathit{sin}(2x))) = \tan\left(\frac{\pi}{4}\right)$

$\sin(2x) = 1$

$2x = \frac{\pi}{2} + 2\pi k, k \in \mathbb{Z}$

$\boldsymbol{x = \frac{\pi}{4} + \pi k, k} \in \mathbb{Z}$

Solutions to FRQ 4 Practice – Finding Neverland

A.

(i) $g(x) = \frac{\sin x/\cos x}{\sin x} = \frac{1}{\cos x} = \mathbf{sec}\,\boldsymbol{x}$ **for** $\boldsymbol{x \neq k\pi}$

(ii) $h(x) = \ln(x^4) - \ln 3 = \mathbf{ln}\left(\frac{\boldsymbol{x^4}}{\mathbf{3}}\right)$ **for** $\boldsymbol{x > 0}$

B.

(i) $\frac{2^x \cdot 4^{2x}}{16^{x+1}} = \sqrt{2}$

$\frac{2^x \cdot (2^2)^{2x}}{(2^4)^{x+1}} = 2^{\frac{1}{2}}$

$\frac{2^x \cdot 2^{4x}}{2^{4x+4}} = 2^{\frac{1}{2}}$

$2^{x-4} = 2^{\frac{1}{2}}$

$x - 4 = \frac{1}{2}$

$\boldsymbol{x = \frac{9}{2}}$

(ii) $\log_4(3x-1) - \log_4(x+1) = 1$

$\log_4\left(\frac{3x-1}{x+1}\right) = 1$

$4^{\log_4\left(\frac{3x-1}{x+1}\right)} = 4^1$

$\frac{3x-1}{x+1} = 4$

$3x - 1 = 4x + 4$

$\boldsymbol{x = -5}$

C. $\sin^{-1}\left(\frac{\sqrt{3}}{2}\tan x\right) = \frac{\pi}{6}$

$\sin\left(\sin^{-1}\left(\frac{\sqrt{3}}{2}\tan x\right)\right) = \sin\left(\frac{\pi}{6}\right)$

$\frac{\sqrt{3}}{2}\tan x = \frac{1}{2}$

$\tan x = \frac{1}{\sqrt{3}} = \frac{\sqrt{3}}{3}$

$\boldsymbol{x = \frac{\pi}{6} + 2\pi k}$ **or** $\boldsymbol{x = \frac{7\pi}{6} + 2\pi k}$ **for any integer** $\boldsymbol{k}$

(note: this may optionally be written more concisely as $\boldsymbol{x = \frac{\pi}{6} + \pi k}$ **for any integer** $\boldsymbol{k}$)

Solutions to FRQ 4 Practice – Forrest Gump

A.

(i) $\tan^{-1}(3x - \sqrt{3}) = \frac{\pi}{3}$

$\tan(\tan^{-1}(3x - \sqrt{3})) = \tan\left(\frac{\pi}{3}\right)$

$3x - \sqrt{3} = \sqrt{3}$

$3x = 2\sqrt{3}$

$\boldsymbol{x = \frac{2\sqrt{3}}{3}}$

(ii) $\sqrt{2}\cos x = 1$

$\cos x = \frac{1}{\sqrt{2}}$

$\boldsymbol{x = \frac{\pi}{4}}$

B.

(i) $j(x) = \frac{\log_8 x}{\log_8 2} + 6 \cdot \frac{\log_8 x}{\log_8 4} = \frac{\log_8 x}{\frac{1}{3}} + 6 \cdot \frac{\log_8 x}{\frac{2}{3}} = 3\log_8 x + 9\log_8 x = 12\log_8 x = \mathbf{log_8}(\boldsymbol{x^{12}})$ **for** $\boldsymbol{x > 0}$

(ii) $k(x) = \left(\frac{\cos x}{-\sin^2 x}\right)\sin x = -\frac{\cos x}{\sin x} = -\mathbf{cot}\,\boldsymbol{x}$

C. $9^{(x^4+x^2)} = 81$

$\log_9(9^{(x^4+x^2)}) = \log_9(9^2)$

$x^4 + x^2 = 2$

Substituting $A = x^2$ yields the quadratic $A^2 + A = 2$

$A^2 + A - 2 = 0$

$(A+2)(A-1) = 0$

$A = -2$ or $A = 1$

$x^2 = -2$ (impossible) or $x^2 = 1$

$\boldsymbol{x = -1}$ **or** $\boldsymbol{x = 1}$

Solutions to FRQ 4 Practice – Ghostbusters

A.

(i) $\cos^{-1}(4x) = \frac{\pi}{6}$

$\cos(\cos^{-1}(4x)) = \cos\left(\frac{\pi}{6}\right)$

$4x = \frac{\sqrt{3}}{2}$

$\boldsymbol{x = \frac{\sqrt{3}}{8}}$

(ii) $\log_2\left(\frac{x}{6}\right) = 3$

$2^{\log_2\left(\frac{x}{6}\right)} = 2^3$

$\frac{x}{6} = 8$

$\boldsymbol{x = 48}$

B.

(i) $j(x) = \frac{10^{2x+1}}{5} = \frac{1}{5} \cdot (10)^{2x} \cdot (10)^1 = 2 \cdot (10)^{2x} = 2(10^2)^x = \boldsymbol{2(100)^x}$

(ii) $k(x) = \frac{\cot x(\sec^2 x - 1)}{\sin x} = \frac{\cot x(\tan^2 x)}{\sin x} = \frac{\tan x}{\sin x} = \frac{\sin x/\cos x}{\sin x} = \boldsymbol{\frac{1}{\cos x}}$ **for $\boldsymbol{x \neq \pi k}$**

C. $2\sin^2 x - \sin x - 1 = -1$

$2\sin^2 x - \sin x = 0$

$(\sin x)(2\sin x - 1) = 0$

$\sin x = 0$ or $\sin x = \frac{1}{2}$

$\boldsymbol{x = 2\pi k}$ **or** $\boldsymbol{x = \pi + 2\pi k}$ **or** $\boldsymbol{x = \frac{\pi}{6} + 2\pi k}$ **or** $\boldsymbol{x = \frac{5\pi}{6} + 2\pi k}$ **where** $\boldsymbol{k} \in \mathbb{Z}$

(note: this may optionally be written more concisely as $\boldsymbol{x = \pi k}$ **or** $\boldsymbol{x = \frac{\pi}{6} + 2\pi k}$ **or** $\boldsymbol{x = \frac{5\pi}{6} + 2\pi k}$ **where** $\boldsymbol{k} \in \mathbb{Z}$)

Solutions to FRQ 4 Practice – Hamnet

A.

(i) $\log_3(2x + 1) - 2 = 1$

$\log_3(2x + 1) = 3$

$3^{\log_3(2x+1)} = 3^3$

$2x + 1 = 27$

$\boldsymbol{x = 13}$

(ii) $\frac{(3^x)^2}{9} = \frac{1}{27}$

$\frac{3^{2x}}{3^2} = 3^{-3}$

$3^{2x-2} = 3^{-3}$

$2x - 2 = -3$

$\boldsymbol{x = -\frac{1}{2}}$

B.

(i) $j(x) = \sin x - \csc x = \sin x - \frac{1}{\sin x} = \frac{\sin^2 x}{\sin x} - \frac{1}{\sin x} = \frac{\sin^2 x - 1}{\sin x} = \frac{-\cos^2 x}{\sin x} = -\cos x \cdot \frac{\cos x}{\sin x} = \boldsymbol{-\cos x \cot x}$

(ii) $k(x) = \log((x + 2)^3) - \log((3x)^2) - \log(x^2) = \log\left(\frac{(x+2)^3}{(3x)^2 x^2}\right) = \boldsymbol{\log\left(\frac{(x+2)^3}{9x^4}\right)}$ **for $\boldsymbol{x > 0}$**

C. $3\arcsin(\sqrt{2}x) = \arccos\left(-\frac{\sqrt{2}}{2}\right)$

$3\arcsin(\sqrt{2}x) = \frac{3\pi}{4}$

$\arcsin(\sqrt{2}x) = \frac{\pi}{4}$

$\sin(\arcsin(\sqrt{2}x)) = \sin\left(\frac{\pi}{4}\right)$

$\sqrt{2}x = \frac{\sqrt{2}}{2}$

$\boldsymbol{x = \frac{1}{2}}$

Solutions to FRQ 4 Practice – Inside Out

A.

(i) $\log_5(3x+1) = 2$

$5^{\log_5(3x+1)} = 5^2$

$3x + 1 = 25$

$\boldsymbol{x = 8}$

(ii) $\arccos(3x) = \frac{\pi}{3}$

$\cos(arccos(3x)) = \cos\left(\frac{\pi}{3}\right)$

$3x = \frac{1}{2}$

$\boldsymbol{x = \frac{1}{6}}$

B.

(i) $j(x) = \log_4(15x) - \log_4(3^2) = \log_4\left(\frac{15x}{9}\right) = \boldsymbol{\log_4\left(\frac{5x}{3}\right)}$

(ii) $k(x) = \frac{\sin^2 x}{\cos^2 x} - \frac{\sin^4 x}{1} \cdot \frac{1}{\cos^2 x} = \frac{\sin^2 x - \sin^4 x}{\cos^2 x} = \frac{(\sin^2 x)(1-\sin^2 x)}{\cos^2 x} = \frac{(\sin^2 x)(\cos^2 x)}{\cos^2 x} = \boldsymbol{\sin^2 x}$ **for** $\boldsymbol{x \neq \frac{\pi}{2} + \pi k}$

C. $3^{2x} - 4 \cdot 3^x - 5 = 0$

$(3^x)^2 - 4(3^x) - 5 = 0$

$(3^x - 5)(3^x + 1) = 0$

$3^x = 5$ or $3^x = -1$ (impossible)

$\boldsymbol{x = \log_3 5}$

Solutions to FRQ 4 Practice – Jurassic Park

A.

(i) $6 \arctan x = 2\pi$

$\arctan x = \frac{\pi}{3}$

$\tan(arctan\, x) = \tan\left(\frac{\pi}{3}\right)$

$\boldsymbol{x = \sqrt{3}}$

(ii) $\log_2 x - \log_2 5 = 3$

$\log_2\left(\frac{x}{5}\right) = 3$

$2^{\log_2\left(\frac{x}{5}\right)} = 2^3$

$\frac{x}{5} = 8$

$\boldsymbol{x = 40}$

B.

(i) $j(x) = \frac{3^x . 3^{5x}}{9} = \frac{3^{6x}}{9} = \frac{(3^2)^{3x}}{9} = \frac{9^{3x}}{9^1} = \boldsymbol{9^{3x-1}}$

(ii) $k(x) = (\cos(2x) - 1) \cdot \csc x = (1 - 2\sin^2 x - 1) \cdot \frac{1}{\sin x} = (-2\sin^2 x) \cdot \frac{1}{\sin x} = \boldsymbol{-2\sin x}$ **for** $\boldsymbol{x \neq \pi k}$

C. $6\sin(2x) = 3$

$\sin(2x) = \frac{1}{2}$

$2x = \frac{\pi}{6} + 2\pi k$ or $2x = \frac{5\pi}{6} + 2\pi k$

$\boldsymbol{x = \frac{\pi}{12} + \pi k}$ **or** $\boldsymbol{x = \frac{5\pi}{12} + \pi k}$ **where** $\boldsymbol{k}$ **is any integer**

Solutions to FRQ 4 Practice – Kung Fu Panda

A.

(i) $e^{2x} = 5$

$\ln(e^{2x}) = \ln(5)$

$2x = \ln 5$

$\boldsymbol{x = \frac{1}{2}\ln 5}$

(ii) $3\log_5(x-1) = 6$

$\log_5(x-1) = 2$

$5^{\log_5(x-1)} = 5^2$

$x - 1 = 25$

$\boldsymbol{x = 26}$

B.

(i) $j(x) = \log_2(x^3) + \log_2(5^2) = \log_2(25x^3)$

(ii) $k(x) = (\tan x)(1-\sin^2 x) = (\tan x)(\cos^2 x) = \frac{\sin x}{\cos x}\cdot\cos^2 x = \sin x\cos x = \frac{1}{2}(2\sin x\cos x) = \boldsymbol{\frac{1}{2}\sin(2x)}$ **for** $\boldsymbol{x \neq \frac{\pi}{2} + \pi k}$

C. $\tan^{-1}(\cos(3x)) = \frac{\pi}{4}$

$\tan(\tan^{-1}(\cos(3x))) = \tan\left(\frac{\pi}{4}\right)$

$\cos(3x) = 1$

$3x = 2\pi k$

$\boldsymbol{x = \frac{2\pi k}{3}}$ **where** $\boldsymbol{k} \in \mathbb{Z}$

Solutions to FRQ 4 Practice – The Lion King

A.

(i) $2\cos x = \sqrt{2}$

$\cos x = \frac{\sqrt{2}}{2}$

$\boldsymbol{x = \frac{\pi}{4}}$

(ii) $4\arctan(x+8) = -\pi$

$\arctan(x+8) = -\frac{\pi}{4}$

$\tan(arctan(x+8)) = \tan\left(-\frac{\pi}{4}\right)$

$x + 8 = -1$

$\boldsymbol{x = -9}$

B.

(i) $j(x) = \log_2(x^3) - \log_2 5 = \boldsymbol{\log_2\left(\frac{x^3}{5}\right)}$

(ii) $k(x) = \frac{\cos(2x)}{\sin^2 x} = \frac{1-2\sin^2 x}{\sin^2 x} = \frac{1}{\sin^2 x} - \frac{2\sin^2 x}{\sin^2 x} = \boldsymbol{\csc^2 x - 2}$

C. $2^{x^4-3x^2} = 16$

$2^{x^4-3x^2} = 2^4$

$\log_2\left(2^{x^4-3x^2}\right) = \log_2(2^4)$

$x^4 - 3x^2 = 4$

Substituting $A = x^2$ yields the quadratic $A^2 - 3A = 4$

$A^2 - 3A - 4 = 0$

$(A-4)(A+1) = 0$

$A = 4$ or $A = -1$

$x^2 = 4$ or $x^2 = -1$ (impossible)

$\boldsymbol{x = -2}$ **or** $\boldsymbol{x = 2}$

Solutions to FRQ 4 Practice – The Martian

A.

(i) $\sqrt{3}\tan x = 1$

$\tan x = \frac{1}{\sqrt{3}}$

$\boldsymbol{x = \frac{\pi}{6}}$

(ii) $\log_3(x-1) - \log_3 2 = 2$

$\log_3\left(\frac{x-1}{2}\right) = 2$

$3^{\log_3\left(\frac{x-1}{2}\right)} = 3^2$

$\frac{x-1}{2} = 9$

$\boldsymbol{x = 19}$

B.

(i) $j(x) = \frac{9}{3^{3x}} = \frac{3^2}{3^{3x}} = \boldsymbol{3^{2-3x}}$

(ii) $k(x) = \frac{\csc x}{\sin x}(\sec^2 x - 1) = \frac{\csc x}{\sin x}(\tan^2 x) = \frac{1}{\sin^2 x}\left(\frac{\sin^2 x}{\cos^2 x}\right) = \frac{1}{\cos^2 x} = (\boldsymbol{\cos x})^{-2}$ **for** $\boldsymbol{x \neq k\pi}$

C. $\arcsin(\cos(2x)) = 0$

$\sin(\arcsin(\cos(2x))) = \sin(0)$

$\cos(2x) = 0$

$2x = \frac{\pi}{2} + 2\pi k$ or $2x = \frac{3\pi}{2} + 2\pi k$

$\boldsymbol{x = \frac{\pi}{4} + \pi k}$ **or** $\boldsymbol{x = \frac{3\pi}{4} + \pi k}$ **for any integer value of** $\boldsymbol{k}$

(note: this may optionally be written more concisely as $\boldsymbol{x = \frac{\pi}{4} + \frac{\pi}{2}k}$ for any integer value of k)

Solutions to FRQ 4 Practice – Night at the Museum

A.

(i) $\left(\frac{1}{5}\right)^{4x} = \sqrt{5}$

$5^{-4x} = 5^{\frac{1}{2}}$

$-4x = \frac{1}{2}$

$\boldsymbol{x = -\frac{1}{8}}$

(ii) $\arccos(x+3) = \frac{\pi}{2}$

$\cos(\arccos(x+3)) = \cos\left(\frac{\pi}{2}\right)$

$x + 3 = 0$

$\boldsymbol{x = -3}$

B.

(i) $j(x) = 4\ln(x+1) - \ln x - 3\ln 2 = \ln((x+1)^4) - \ln x - \ln(2^3) = \boldsymbol{\ln\left(\frac{(x+1)^4}{8x}\right)}$

(ii) $k(x) = \frac{8(1-\sin^2 x)}{\sin(2x)} = \frac{8\cos^2 x}{2\sin x\cos x} = \frac{4\cos x}{\sin x} = \boldsymbol{4\cot x}$ **for** $\boldsymbol{x \neq \frac{\pi}{2}k}$

C. $\cos^2(2x) = \frac{1}{2}$

$\cos(2x) = \frac{1}{\sqrt{2}}$ or $\cos(2x) = -\frac{1}{\sqrt{2}}$

$2x = \frac{\pi}{4} + \frac{\pi}{2}k$

$x = \frac{\pi}{8} + \frac{\pi}{4}k$ where $k \in \mathbb{Z}$

$\boldsymbol{x = \frac{\pi}{8}}$ **or** $\boldsymbol{x = \frac{3\pi}{8}}$

Solutions to FRQ 4 Practice – O Brother, Where Art Thou?

A.

(i) $e^{2x} = 6$
$\ln(e^{2x}) = \ln(6)$
$2x = \ln 6$
$\boldsymbol{x = \frac{1}{2}\ln 6}$

(ii) $3\ln x = 12$
$\ln x = 4$
$e^{\ln x} = e^4$
$\boldsymbol{x = e^4}$

B.

(i) $j(x) = \ln(x+3) - \ln(x^2) + \ln(2^3) = \mathbf{ln}\left(\frac{8(x+3)}{x^2}\right)$

(ii) $k(x) = (\sin^2 x)\frac{\sec x \tan x}{\sin x} = (\sin^2 x)(\sec x)(\tan x)\left(\frac{1}{\sin x}\right) = (\sin^2 x)\left(\frac{1}{\cos x}\right)\left(\frac{\sin x}{\cos x}\right)\left(\frac{1}{\sin x}\right) = \frac{\sin^2 x}{\cos^2 x} = \boldsymbol{\tan^2 x}$ **for** $\boldsymbol{x \neq k\pi}$

C. $(5^x)^2 - 9 \cdot 5^x = 10$
$(5^x)^2 - 9 \cdot 5^x - 10 = 0$
$(5^x - 10)(5^x + 1) = 0$
$5^x = 10$ or $5^x = -1$ (impossible)
$\boldsymbol{x = \log_5 10}$

Solutions to FRQ 4 Practice – The Princess Bride

A.

(i) $8(4)^x = 2$
$4^x = \frac{1}{4}$
$\log_4(4^x) = \log_4\left(\frac{1}{4}\right)$
$\boldsymbol{x = -1}$

(ii) $\log_4(x-1) = \frac{1}{2}$
$4^{\log_4(x-1)} = 4^{\frac{1}{2}}$
$x - 1 = 2$
$\boldsymbol{x = 3}$

B.

(i) $j(x) = \ln(x-2) - \ln((x+1)^3) - \ln(x^2) = \mathbf{ln}\left(\frac{(x-2)}{x^2(x+1)^3}\right)$ **for** $\boldsymbol{x > 2}$

(ii) $k(x) = \frac{\sec x \csc x + \sec^2 x}{\sec^2 x} = \frac{\sec x \csc x}{\sec^2 x} + \frac{\sec^2 x}{\sec^2 x} = \frac{\csc x}{\sec x} + 1 = \frac{\cos x}{\sin x} + 1 = \boldsymbol{\cot x + 1}$ **for** $\boldsymbol{x \neq \frac{\pi}{2} + \pi k}$

C. $\cos(4x) + 1 = 1$
$\cos(4x) = 0$
$4x = \frac{\pi}{2} + \pi k$
$x = \frac{\pi}{8} + \frac{\pi}{4}k$
$\boldsymbol{x = \frac{\pi}{8}}$ **or** $\boldsymbol{x = \frac{3\pi}{8}}$

Solutions to FRQ 4 Practice – A Quiet Place

A.

(i) $4^{x+1} = \frac{1}{64}$

$4^{x+1} = 4^{-3}$

$\log_4(4^{x+1}) = \log_4(4^{-3})$

$x + 1 = -3$

$\boldsymbol{x = -4}$

(ii) $\log_3(2x) = 2$

$3^{\log_3(2x)} = 3^2$

$2x = 9$

$\boldsymbol{x = \frac{9}{2}}$

B.

(i) $j(x) = \log_{10}(7x^3) + \log_{10}(3x^2) - \log_{10}(x^4) = \log_{10}\left(\frac{(7x^3)(3x^2)}{x^4}\right) = \boldsymbol{\log_{10}(21x)}$

(ii) $k(x) = \frac{\cot^2 x}{\csc x} + \sin x = \cot^2 x \cdot \sin x + \sin x = (\sin x)(\cot^2 x + 1) = (\sin x)(\csc^2 x) = \frac{\sin x}{\sin^2 x} = \boldsymbol{\frac{1}{\sin x}}$

C. $e^{2x} - 7e^x + 12 = 6$

$(e^x)^2 - 7e^x + 6 = 0$

$(e^x - 6)(e^x - 1) = 0$

$e^x = 6$ or $e^x = 1$

$x = \ln 6$ or $x = 0$

Solutions to FRQ 4 Practice – Ratatouille

A.

(i) $e^{x-5} = \frac{1}{e^{10}}$

$\ln(e^{x-5}) = \ln\left(\frac{1}{e^{10}}\right)$

$x - 5 = -10$

$\boldsymbol{x = -5}$

(ii) $\arccos(2x) = \frac{3\pi}{4}$

$\cos(\arccos(2x)) = \cos\left(\frac{3\pi}{4}\right)$

$2x = -\frac{\sqrt{2}}{2}$

$\boldsymbol{x = -\frac{\sqrt{2}}{4}}$

B.

(i) $j(x) = \log_2((2x)^4) - \log_2 6 = \log_2\left(\frac{16x^4}{6}\right) = \boldsymbol{\log_2\left(\frac{8x^4}{3}\right)}$

(ii) $k(x) = \frac{\sin^2 x}{2\sin x\cos x} = \frac{\sin x}{2\cos x} = \boldsymbol{\frac{1}{2}\tan x}$ **for** $\boldsymbol{x \neq \pi k}$

C. $\log_3(x^2) - \log_3(x-2) = 2$

$\log_3\left(\frac{x^2}{x-2}\right) = 2$

$3^{\log_3\left(\frac{x^2}{x-2}\right)} = 3^2$

$\frac{x^2}{x-2} = 9$

$x^2 = 9x - 18$

$x^2 - 9x + 18 = 0$

$(x-3)(x-6) = 0$

$\boldsymbol{x = 3}$ **and** $\boldsymbol{x = 6}$

Solutions to FRQ 4 Practice – Star Wars

A.

(i) $\arctan(3x+2) = \frac{\pi}{4}$

$\tan(\arctan(3x+2)) = \tan\left(\frac{\pi}{4}\right)$

$3x + 2 = 1$

$3x = -1$

$\boldsymbol{x = -\frac{1}{3}}$

(ii) $\log_2(x-7) = 3$

$2^{\log_2(x-7)} = 2^3$

$x - 7 = 8$

$\boldsymbol{x = 15}$

B.

(i) $j(x) = \frac{5^{x+1}}{(5^2)^x} = \frac{5^{x+1}}{5^{2x}} = 5^{x+1-2x} = \boldsymbol{5^{-x+1}}$

(ii) $k(x) = \frac{\sin x}{(1-\sin^2 x)(\tan x)} = \frac{\sin x}{(\cos^2 x)\left(\frac{\sin x}{\cos x}\right)} = \frac{\sin x}{\cos x \sin x} = \boldsymbol{\frac{1}{\cos x}}$ **for** $\boldsymbol{x \neq k\pi}$

C. $\sin^2(4x) = 1$

$\sin(4x) = -1$ or $\sin(4x) = 1$

$4x = \frac{3\pi}{2} + 2\pi k$ or $4x = \frac{\pi}{2} + 2\pi k$ for $k \in \mathbb{Z}$

$4x = \frac{\pi}{2} + \pi k$

$\boldsymbol{x = \frac{\pi}{8} + \frac{\pi}{4}k}$ **for** $\boldsymbol{k} \in \mathbb{Z}$

Solutions to FRQ 4 Practice – Toy Story

A.

(i) $5\log_2 x = -15$

$\log_2 x = -3$

$2^{\log_2 x} = 2^{-3}$

$\boldsymbol{x = \frac{1}{8}}$

(ii) $3\arctan(x) = -\pi$

$\arctan(x) = -\frac{\pi}{3}$

$\tan(arctan(x)) = \tan\left(-\frac{\pi}{3}\right)$

$\boldsymbol{x = -\sqrt{3}}$

B.

(i) $j(x) = \frac{4^{2x}}{2^{x+1}} = \frac{(2^2)^{2x}}{2^{x+1}} = \frac{2^{4x}}{2^{x+1}} = 2^{4x-(x+1)} = \boldsymbol{2^{3x-1}}$

(ii) $k(x) = \frac{\csc^2 x}{\cot x \csc x} = \frac{\csc x}{\cot x} = \frac{1/\sin x}{\cos x/\sin x} = \boldsymbol{\frac{1}{\cos x}}$ **for** $\boldsymbol{x \neq k\pi}$

C. $\log_2(3x+4) - 2\log_2 x = 0$

$\log_2\left(\frac{3x+4}{x^2}\right) = 0$

$2^{\log_2\left(\frac{3x+4}{x^2}\right)} = 2^0$

$\frac{3x+4}{x^2} = 1$

$3x + 4 = x^2$

$0 = x^2 - 3x - 4$

$0 = (x-4)(x+1)$

$x = 4$ or $x = -1$ (not in the domain of m)

$\boldsymbol{x = 4}$

Solutions to FRQ 4 Practice – Up

A.

(i) $\cos^2 x = \frac{1}{2}$

$\cos x = \frac{1}{\sqrt{2}}$ or $\cos x = -\frac{1}{\sqrt{2}}$

We may disregard the latter possibility since $\cos x$ is positive for values of x in the interval $\left[0, \frac{\pi}{2}\right)$.

$\boldsymbol{x = \frac{\pi}{4}}$

(ii) $\ln x - 2\ln 3 = 1$

$\ln\left(\frac{x}{3^2}\right) = 1$

$e^{\ln\left(\frac{x}{9}\right)} = e^1$

$\frac{x}{9} = e$

$\boldsymbol{x = 9e}$

B.

(i) $j(x) = 4^{2x-1} \cdot \left(\frac{1}{2}\right)^x = (2^2)^{2x-1} \cdot (2^{-1})^x = 2^{4x-2} \cdot 2^{-x} = \mathbf{2^{3x-2}}$

(ii) $k(x) = \frac{\tan x}{\sin(2x)} = \frac{\tan x}{2\sin x \cos x} = \frac{\sin x}{2\sin x \cos^2 x} = \frac{1}{2\cos^2 x} = \boldsymbol{\frac{1}{2}\sec^2 x}$ **for** $\boldsymbol{x \neq k\pi}$

C. $3^{6x^2+7x+1} = \frac{1}{3}$

$\log_3\left(3^{6x^2+7x+1}\right) = \log_3\left(\frac{1}{3}\right)$

$6x^2 + 7x + 1 = -1$

$6x^2 + 7x + 2 = 0$

$(3x+2)(2x+1) = 0$

$\boldsymbol{x = -\frac{2}{3}}$ **or** $\boldsymbol{x = -\frac{1}{2}}$

Solutions to FRQ 4 Practice – Venom

A.

(i) $\tan x = 1$

$\boldsymbol{x = \frac{\pi}{4}}$ **or** $\boldsymbol{x = \frac{5\pi}{4}}$

(ii) $\ln(5x) = 2$

$e^{\ln(5x)} = e^2$

$5x = e^2$

$x = \frac{1}{5}e^2$

B.

(i) $j(x) = \frac{\sec^2 x - 1}{\cos^2 x - 1} = \frac{\tan^2 x}{-\sin^2 x} = -\frac{\sin^2 x / \cos^2 x}{\sin^2 x} = -\frac{1}{\cos^2 x} = \boldsymbol{-\sec^2 x}$ **for** $\boldsymbol{x \neq \pi k}$

(ii) $k(x) = \frac{25}{\sqrt{5^x}} = \frac{5^2}{5^{\frac{x}{2}}} = 5^{2-\frac{x}{2}} = \mathbf{5^{-\frac{1}{2}x+2}}$

C. $2\cos(2x) = \sqrt{3}$

$\cos(2x) = \frac{\sqrt{3}}{2}$

$2x = \frac{\pi}{6} + 2\pi k$ or $2x = \frac{11\pi}{6} + 2\pi k$

$\boldsymbol{x = \frac{\pi}{12} + \pi k}$ **or** $\boldsymbol{x = \frac{11\pi}{12} + \pi k}$ **for any integer value of** $\boldsymbol{k}$

Solutions to FRQ 4 Practice – West Side Story

A.

(i) $\frac{\arcsin(4x)}{2} = \frac{\pi}{4}$

$\arcsin(4x) = \frac{\pi}{2}$

$\sin(\arcsin(4x)) = \sin\left(\frac{\pi}{2}\right)$

$4x = 1$

$\boldsymbol{x = \frac{1}{4}}$

(ii) $\tan^2 x = 3$

$\tan x = \sqrt{3}$ or $\tan x = -\sqrt{3}$

$\boldsymbol{x = \frac{\pi}{3}}$

B.

(i) $j(x) = \ln(4x) - \ln(x^4) = \ln\left(\frac{4x}{x^4}\right) = \mathbf{ln}\left(\frac{\mathbf{4}}{\boldsymbol{x^3}}\right)$

(ii) $k(x) = 1 - \frac{1}{2}\sin(2x)\tan x = 1 - \frac{1}{2}(2\sin x\cos x)\left(\frac{\sin x}{\cos x}\right) = 1 - \sin^2 x =$ $\boldsymbol{\cos^2 x}$ **for** $\boldsymbol{x \neq \frac{\pi}{2} + \pi k}$

C. $\log_2(x-2) + \log_2(x+4) = 4$

$\log_2\big((x-2)(x+4)\big) = 4$

$2^{\log_2((x-2)(x+4))} = 2^4$

$(x-2)(x+4) = 16$

$x^2 + 2x - 8 = 16$

$x^2 + 2x - 24 = 0$

$(x+6)(x-4) = 0$

$x = -6$ (not in the domain of m) or $x = 4$

$\boldsymbol{x = 4}$

Solutions to FRQ 4 Practice – What's Up Doc?

A.

(i) $2\log_4(x+1) = 3$

$\log_4(x+1) = \frac{3}{2}$

$4^{\log_4(x+1)} = 4^{\frac{3}{2}}$

$x + 1 = 8$

$\boldsymbol{x = 7}$

(ii) $2\sin^2 x = 1$

$\sin^2 x = \frac{1}{2}$

$\sin x = \frac{1}{\sqrt{2}}$ or $\sin x = -\frac{1}{\sqrt{2}}$

$\boldsymbol{x = \frac{\pi}{4}}$

B.

(i) $j(x) = \frac{1-\cos(2x)}{2\sin(2x)} = \frac{1-(1-2\sin^2 x)}{2(2\sin x\cos x)} = \frac{2\sin^2 x}{4\sin x\cos x} = \frac{\sin x}{2\cos x} = \boldsymbol{\frac{1}{2}\tan x}$ **for** $\boldsymbol{x \neq \pi k}$

(ii) $k(x) = \log_6(x^3) - \log_6(4x) = \log_6\left(\frac{x^3}{4x}\right) = \boldsymbol{\log_6\left(\frac{x^2}{4}\right)}$ **for** $\boldsymbol{x > 0}$

C. $\left(\frac{1}{2}\right)^{2x} + 3\left(\frac{1}{2}\right)^x = 4$

$\left(\left(\frac{1}{2}\right)^x\right)^2 + 3\left(\frac{1}{2}\right)^x - 4 = 0$

Let $A = \left(\frac{1}{2}\right)^x$

$A^2 + 3A - 4 = 0$

$(A+4)(A-1) = 0$

$A = -4$ or $A = 1$

$\left(\frac{1}{2}\right)^x = -4$ (impossible) or $\left(\frac{1}{2}\right)^x = 1$

$\boldsymbol{x = 0}$

Solutions to FRQ 4 Practice – X-Men

A.

(i) $\sec x = 2$

$\cos x = \frac{1}{2}$

$\boldsymbol{x = \frac{\pi}{3}}$

(ii) $3(2)^{x-4} = 15$

$2^{x-4} = 5$

$\log_2(2^{x-4}) = \log_2(5)$

$x - 4 = \log_2 5$

$\boldsymbol{x = 4 + \log_2 5}$

B.

(i) $j(x) = \log_5 x + \log_5(2^3) = \boldsymbol{\log_5(8x)}$

(ii) $k(x) = 2 - (2\sin x\cos x)\left(\frac{\sin x}{\cos x}\right) = 2 - 2\sin^2 x = 2(1 - \sin^2 x) = \boldsymbol{2\cos^2 x}$ **for** $\boldsymbol{x \neq \frac{\pi}{2} + \pi k}$

C. $2\log_2(x+3) - \log_2(x+5) = 0$

$\log_2\left(\frac{(x+3)^2}{x+5}\right) = 0$

$2^{\log_2\left(\frac{(x+3)^2}{x+5}\right)} = 2^0$

$\frac{(x+3)^2}{x+5} = 1$

$(x+3)^2 = x + 5$

$x^2 + 6x + 9 = x + 5$

$x^2 + 5x + 4 = 0$

$(x+1)(x+4) = 0$

$x = -1$ or $x = -4$ (not in the domain of m)

$\boldsymbol{x = -1}$

Solutions to FRQ 4 Practice – Young Frankenstein

A.

(i) $2(9)^x = 6$

$9^x = 3$

$\log_9(9^x) = \log_9(3)$

$\boldsymbol{x = \frac{1}{2}}$

(ii) $\log_2(5x) = 4$

$2^{\log_2(5x)} = 2^4$

$5x = 16$

$x = \frac{16}{5}$

B.

(i) $j(x) = \log_2(x+3) - \log_2(x^5) + \log_2 2 = \boldsymbol{\log_2\left(\frac{(2)(x+3)}{x^5}\right)}$ **for** $\boldsymbol{x > 0}$

(ii) $k(x) = \frac{\left(\frac{1}{\sin x} - \sin x\right)(\sec^2 x)}{\csc^2 x} = \frac{\left(\frac{1}{\sin x} - \frac{\sin^2 x}{\sin x}\right)(\sec^2 x)}{\csc^2 x} = \frac{\left(\frac{1-\sin^2 x}{\sin x}\right)(\sec^2 x)}{\csc^2 x} = \frac{\left(\frac{1-\sin^2 x}{\sin x}\right)(\sec^2 x)}{\csc^2 x} = \frac{\left(\frac{\cos^2 x}{\sin x}\right)(\sec^2 x)}{\csc^2 x} = \frac{\cos^2 x\sec^2 x}{\sin x\csc^2 x} = \frac{1}{\sin x} =$ $\boldsymbol{\csc x}$ **for** $\boldsymbol{x \neq \frac{\pi}{2} + \pi k.}$

C. $2\sin^2 x + 3\sin x = 2$

$2\sin^2 x + 3\sin x - 2 = 0$

$(2\sin x - 1)(\sin x + 2) = 0$

$\sin x = \frac{1}{2}$ or $\sin x = -2$ (impossible)

$\boldsymbol{x = \frac{\pi}{6} + 2\pi k}$ **or** $\boldsymbol{x = \frac{5\pi}{6} + 2\pi k}$ **for any integer value of** $\boldsymbol{k}$

Solutions to FRQ 4 Practice – Zootopia

A.

(i) $\arctan(5x) = \frac{\pi}{3}$

$\tan(\arctan(5x)) = \tan\left(\frac{\pi}{3}\right)$

$5x = \sqrt{3}$

$\boldsymbol{x = \frac{\sqrt{3}}{5}}$

(ii) $\log_3(x^2) = 0$

$3^{\log_3(x^2)} = 3^0$

$x^2 = 1$

$x = 1$ or $x = -1$

B.

(i) $j(x) = \frac{\tan^2 x - \sec^2 x}{\sin(\pi - x)} = \frac{-1}{\sin(\pi)\cos(x) - \cos(\pi)\sin(x)} = \frac{-1}{(0)(\cos x) - (-1)(\sin x)} = \frac{-1}{\sin x} = \boldsymbol{-\csc x}$ **for** $\boldsymbol{x \neq \frac{\pi}{2} + \pi k}$

(ii) $k(x) = 15(3)^{2x-1} = 15 \cdot (3)^{2x} \cdot (3)^{-1} = 15 \cdot \frac{1}{3} \cdot (3)^{2x} = 5(3^2)^x = \boldsymbol{5(9)^x}$

C. $2\sin(4x) + 3 = 1$

$\sin(4x) = -1$

$4x = \frac{3\pi}{2} + 2\pi k$

$\boldsymbol{x = \frac{3\pi}{8} + \frac{\pi}{2}k}$ **for integer values of** $\boldsymbol{k}$