On this test:
Each page is a question. The answer choices are in another packet. The questions are not “traditionally” phrased. There will be NO disputes based on incorrect interpretations of questions.
I like tangent lines!
That guy likes tangent lines too much!
Yeah

Say! What tangent line are you thinking about?

Wrong! You didn't give a point.

Tell us everything!
You'll tell The Boss!
I'm not saying!

And so they traveled all day and all night to get to the secret ranch of The Boss.

Now you're in for it!

Once again, what point?!

He knew the point. But he wasn't about to just tell anyone what it was.

Instead, the tables are turned!

You already know the function. Now I'll say the line is tangent at $x = 1$

But others heard too, and now they all knew the tangent line!
At the offices of the Daily Planet

Hello, sir. What do you need?

Kent! Do you know of Superman?

His logo is able to be graphed with a crazy inequality.

Oh really? What is it?

Kent! Do you know of Superman?

His logo is able to be graphed with a crazy inequality.

Oh really? What is it?

It's

\[ \min(x, y) = \begin{cases} x, & x < y \\ y, & x \geq y \end{cases} \]

Wow! A lot of min functions.

Are you off to investigate min functions?

Yes!

Later, as Superman...

\[ f(x) = \min(x^{23}, Ax^2 - A + 1) \]

That's not differentiable everywhere!

It is for the right choice of \( A \)!

What is \( A \)?
In the land of functions, where each function is represented by a black box, the Wizard reigns supreme.

Billy has been summoned by the Wizard. But why?

\[ \int H(a)Z(a)\,dM \]

I have summoned you, Billy, to unlock the secrets of the land of functions. I know \( H(a) = a^5 \), \( Z(a) = 7a^4 - 3 \), and \( M(a) = 1/a^2 \). I am interested in integrating the product of \( H(a) \) and \( Z(a) \) with respect to \( M(a) \).

Do you know what that is?

You have discovered the secret power of the functions. Now for your full potential, you will need to solve the integral.

I can do that!
Motivated by the tragic loss of his parents, Bruce Wayne gets to work...

I must harness...

... the most powerful equation I can!

The equation came to him!

To use it, Wayne needs to become the paragon of intellect...

And the model of physical strength!

I have almost finished my work...

The only piece left is to find the area of the region bounded by $y = \sqrt{1 - (|x| - 2) - 1^2}$ and the $x$-axis.

Can you help out Bruce Wayne?

Once I have unlocked the secrets of this equation...

He can become the night!
The Human Torch approaches

He is, of course, on fire.

That’s not normal

But what *is* normal is the line normal to $y = 20e^{2x}$ ...

... at $x = \ln 3$

I shall melt this

Wow that really is melting quickly!

Find the slope of this line!

FIRE!
Each of the eight members rolls a fair 10-sided die, and they win if they roll a 10 (10 appears on only one face). The Flash has been to the future and he knows he wins. But, he does not know when he wins. If the Flash is fourth to go, what is the expected number of times he rolls until he wins?
I must leave and return home now. Farewell to you!

The astronaut had done all he could do.

But we still need help!

I know. But I've taught you all I can right now.

They could learn no more math.

We are still so bad at Calculus!

You need practice.

A bargain was made…

Try this integral:

\[ \int_{0}^{\infty} \frac{\ln(x)}{2022x^2 + x + 2022} \, dx \]

And then?

Then I will return and teach you more.

Excellent!

But he never heard from them again. The integral was too much for them.

He often wonders if he taught them enough. Can you do better?
I'm stretchy!

Please explain to me how stretchy you are.

Well, I can be modeled with a polar spiral
\[ r(\theta) = \frac{a}{2\pi} \theta + b. \]

I've seen this before. Don't try anything.

My maximum length will be an arc length

I will make myself too thick to model!

You are only cylindrical with a radius of 30 cm!
Not big enough!

Well, then I will throw this tree at you.

My arms are \(2\pi\) cm thick.

Then how long are you stretched?

Well I wrapped around 10 times so I will solve...

TAKE THAT!
You'll never capture me!

Yikes!
I am The Flash from the future! I have traveled to learn from you, the first Flash. I have a Calculus question I cannot answer. Can you help?

Sure, what is the question?

If I am traveling at a rate of 1,000 m/s along the x-axis, what is the rate of change of the distance to the curve \( y = \sqrt{x} \) when I am at the point \( \left(\frac{17}{4}, 0\right) \)?

I can’t figure out how to move along the x-axis and translate that into the distance to the curve! Any ideas?

Of course! You will need to...

... set up the appropriate distance equation and use the information provided, along with implicit differentiation in order to find the appropriate rates of change.

To go further, I will need to put on my Calculus gear. I have to be able to move as fast as you in order to be able to teach you what you need.

Normally, I charge very high rates for Calculus tutoring. Perhaps I will make an exception for myself, however!

Tutoring is so expensive!
Captain America is being defrosted after found frozen in the artic...  
This is taking forever!  

During that time, Cap had only warmed 10° C  
Ugh  

At what temperature... ...did he start? -20° C.

It’s Newtonian!  
\[
\frac{dT}{dt} = k(T - T_0)
\]

Cool!

What is the temperature in here?  
Really hot, 40° C.

Then when will Cap reach 37° C?
\[ \int_0^\infty \frac{(1 + \frac{1}{x})^{2022x} - (1 + \frac{2022}{x})^x}{x} \, dx \]

I need you to solve the integral in the yellow box above!

Consider a more general form for the numerator.

What does \( \frac{1}{b} \frac{d}{da} [f(ab)] \) equal?
An inverted conical tank is leaking water. Its height is 200 m & its base has a 50 m radius. Water leaks out at a rate of \( \pi \) m\(^3\)/min. It began full. How fast is the height of the... water changing when the tank... is half full?
Evaluate:

\[
\lim_{{n \to \infty}} \sum_{{k=1}}^{{n}} \frac{n}{{k^2 + n^2}}
\]
A region in the Cartesian plane is bounded by $\frac{1}{(x+1)^2} \ldots$

And the coordinate axes!

Call it $R$. Region $R$ is in Quadrant 1 and has finite area.

Region $R$ is on fire.

Huh!

The only way to get the fire under control is...

But we have no functions!

To divide $R$ in half!

By area, I mean!

Behold! I am Black Panther!

I bring you a function that divides region $R$ in half.

It is $w(x) = b^{-x}$

Kabam! It is working! But...

I also need to kick you!

Do you know what $b$ is?
I'm giving up because I can't solve...

\[ \int_0^\infty \frac{x \, dx}{e^x - 1} \]

I know it has something to do with series...
Not even with the Mystical Arts can Wanda invert $f(x) = 12x^5 - 3x^3 + 5x^2 + 8$.

But she does not need to. She just need to know...
C3-PO, translate all further English into Wookie!*

https://www.wookietranslator.com/
Let $D(x) = L(R(x))$ and $M(x) = L(x)R(x)$

Find $D'(1) + M'(2)$
I need to find \( \int_{0}^{22} f(x) \, dx \)

Can anybody help me?

I know \( f(x) \) is odd. How is that helpful?

It may be... Perhaps...

With other facts, the answer will appear to us!

What else?

Hmmm...

We can see \( \int_{-12}^{0} f(x) \, dx = 6 \)

\( \int_{0}^{22} f(x) \, dx = 6 \)

I can't believe that...

Would be enough to answer...

Right?

Right! Also:

\( \int_{-12}^{6} f(x) \, dx = 10 \)

That...

That should be enough!

Why?

In mathematics, we can find the solution indirectly!

b

You don't know \( f(x) \)

nonsense.

We don't need it
A mouse is climbing up a rope tied to the top of a tree 45 meters tall.

The end of the rope is attached to the mouse's tail such that the weight of rope the mouse has already...

That doesn't seem fun.

It was not.

climbed is entirely born by the mouse.

The mouse has a weight of 4 N, and the rope has a linear density of 2 N/m.

How much work (in N·m) does the mouse do when climbing from the bottom of the rope to the top?

Okay

That doesn't seem fun.

It was not.

climbed is entirely born by the mouse.

The mouse has a weight of 4 N, and the rope has a linear density of 2 N/m.

How much work (in N·m) does the mouse do when climbing from the bottom of the rope to the top?
Thanos... Do this

starts with 22g of Thorium. In one...

Question!

What is its half-life?

hour he has...

5 g left.
This tests my limits!

Your limit just like...

Easy

Hmmph!

I forgot that Bruce is a...

Hahahaha!

...scientist.
I am not!

You No Get Limit

Brrak-Koom!

It's true
What is the limit?
I bring a challenge!

Evaluate:

\[
\frac{d^2e^{2022}}{dx^2} \left[ x^4 e^{x^2} \right]_{x=0}
\]
Find \(\frac{dy}{dx}\) at the point \((3, 1)\) if
\[y^4 x^3 + x^2 - 14y = 22\]
Such is the boundless depths of the multiverse, which allows me, Thor, to be a frog: Throg!
I wonder what the value is of

$$\int_{3/22}^{8/22} \frac{\sqrt{1 + 22x}}{x} \, dx$$

is? I bet if I use a clever...

...substitution I can figure it out!
Ms. Marvel’s hand grows!

Treat it as a sphere, growing...

...3 cm³/s...

When r=7

How fast is the radius r changing?
Some of the questions have been ~shockingly~ hard!

Let's try something nicer:

$$\int_0^2 20\sqrt{2x} \, dx =$$
<SNIFF> It smells like $\sqrt{22}$.

We need to approximate that using differentials.

How?

25 is the closest perfect square. Use that.

Calculus?

I do!

Uh-oh Fire!

My math is for cards!

Yes, of course.

Don't you know how?
Find the number of absolutely convergent series minus the number of conditionally convergent series.

\[\sum_{n=1}^{\infty} \frac{(-1)^n n^2}{n^2 + 2022}\]

What’s a neat series? \[\sum_{n=1}^{\infty} \frac{\cos(n)}{n}\]

\[\sum_{n=1}^{\infty} \frac{(-22)^n}{n!}\]

Exp-citing!

\[\sum_{n=1}^{\infty} \frac{n!}{n^n}\]

Hint: What’s the purity of that silver?

\[\sum_{n=1}^{\infty} 2021^{n-(-1)^n}\]

Ratio won’t work!

\[\sum_{n=1}^{\infty} \left(\frac{1}{9}\right)^n (3n)! / (n!)^3\]

Exp-citing!

Given this:

\[}\sum_{n=1}^{\infty} \frac{1}{n \tan(\theta)}\]

2022

2023

\[\sum_{n=1}^{\infty} \frac{(-1)^n n^{2022}}{2022^n}\]

Nice use of year

\[\sum_{n=1}^{\infty} \frac{1}{n - 1000}\]

There is no series. Only Ant.

\[\sum_{n=2}^{\infty} \frac{(-1)^n}{n \ln(n)}!\]

\[\sum_{u \to \infty, T=p}^{2023} \frac{u}{u(1-\epsilon)} \sum_{\epsilon=0}^{\infty}\]
THE END.