2023 Calculus Bee
Thursday, May 4, 2023

1st Place	Duc Toan Nguyen
2nd Place	Brandon Isensee
3rd Place	Nathaniel Smith

(1) Evaluate and simplify the derivative of

$$\frac{\sin(x) + \frac{2023}{\cos(x)}}{\cos(x) + \frac{2023}{\sin(x)}}.$$

(2) Compute $\lim_{r \to \frac{\pi}{2}} \frac{\sin r}{r}$.

(3) Jabba the Hutt wants to build a hut that is 45 qwtzls wide, 32 qwtzls long, and 15 qwtzls high. What should the dimensions of the hut be?

(4) Help Spock find the slope of the tangent line to $y = (\ln 3 \arcsin 3)x - e^6 \sin(43.2\pi)$ when $x = 11$.

(5) For what positive value of m is the area of the finite region bounded by $y = x^2$ and $y = mx$ equal to 2023?

(6) Evaluate

$$\sum_{n=1}^{\infty} \frac{1}{n(n+1)(n+2)}.$$

(7) Compute Yoda requires!

$$\int_0^1 e^{x^2}\, du.$$

du or du not - there is no ϕ!

(8) Find a degree 3 polynomial
$p(x) = x^3 + ax^2 + bx + c$
satisfying both of the following:

- the graph of p has a local maximum at the point $(-3, 10)$;
- the graph of p has a point of inflection when $x = -5/3$.

(9) Suppose that $p(x)$ and $q(x)$ are
polynomials that are zero when $x = 0$.

Simplify

$$\int_0^{2023} \left(p(x)\, q''(x) + p'(x)\, q'(x)\right)\, dx.$$

(10) In order to pilot the Millennium Falcon through Tannhäser Gate, Rick Deckard needs to evaluate

$$\int_0^4 \sin^2(13 \arctan x) + \cos^2(13 \arctan x)\, dx.$$

(11) Simplify

$$\frac{d}{dx}\left(2023x + \int_0^{\int_0^x u\ du} \cos\left(t^2\right)\ dt\right).$$