

First Fundamental Theorem of Calculus

Evaluate each definite integral exactly. Show an antiderivative and upper minus lower.

1. $\int_1^2 6 \cdot x^5 + 4 \cdot x^4 - 5 \cdot x^3 + 6 \cdot x^2 + 2 \cdot x + 3 \, dx$

2. $\int_{-1}^{-2} 5 \cdot x^3 + 3 \cdot x^2 - 4 \cdot x - 6 \, dx$

3. $\int_0^{-3} x^4 + 4 \cdot x^3 + 4 \cdot x^2 + x + 5 \, dx$

4. $\int_{-5}^{-4} 3 - 5 \cdot x^{-1} + 3 \cdot x^{-2} \, dx$

5. $\int_{\frac{5}{18}\pi}^{\frac{-1}{12}\pi} 3 \cdot \sin(3 \cdot x) \, dx$

6. $\int_{-1}^1 -4 \cdot e^{2 \cdot x} \, dx$

7. $\int_1^0 -6 \cdot x^3 + 3 \cdot x \, dx$

8. $\int_{-1}^2 6 \cdot (4)^{3 \cdot x} \, dx$

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Evaluate each definite integral exactly. Show an antiderivative and upper minus lower.

9. $\int_1^{-1} -x^5 - 2x^4 - 4x^3 + x \, dx$

10. $\int_1^3 6x^4 + 3x^3 - 4x^2 + x + 6 \, dx$

11. $\int_{-\frac{5}{3}\pi}^{\frac{5}{4}\pi} 5 \cdot \cos(x) \, dx$

12. $\int_5^1 5x^2 + 2x - 5x^{-4} \, dx$

13. $\int_1^5 6x^{-1} - 3x^{-4} \, dx$

14. $\int_{-1}^{-2} -4 \cdot e^{2x} \, dx$

15. $\int_2^3 -x^3 + x^2 \, dx$

16. $\int_{\frac{-1}{12}\pi}^{\frac{-7}{18}\pi} 5 \cdot \sin(3x) \, dx$

First Fundamental Theorem of Calculus

Worked Answer Key

Evaluate each definite integral exactly. Show an antiderivative and upper minus lower.
Use radians for trigonometric integrals. Reciprocal-power sums stay on an interval that does not cross zero.

1. $\int_1^2 6 \cdot x^5 + 4 \cdot x^4 - 5 \cdot x^3 + 6 \cdot x^2 + 2 \cdot x + 3 \, dx$

$$F(x) = x^6 + \frac{4}{5} \cdot x^5 - \frac{5}{4} \cdot x^4 + 2 \cdot x^3 + x^2 + 3 \cdot x$$

$$F(\text{upper}) = \frac{478}{5}$$

$$F(\text{lower}) = \frac{131}{20}$$

$$\text{Substitute: } \frac{478}{5} - \left(\frac{131}{20} \right)$$

$$\text{Result} = \frac{1781}{20}$$

2. $\int_{-1}^{-2} 5 \cdot x^3 + 3 \cdot x^2 - 4 \cdot x - 6 \, dx$

$$F(x) = \frac{5}{4} \cdot x^4 + x^3 - 2 \cdot x^2 - 6 \cdot x$$

$$F(\text{upper}) = 16$$

$$F(\text{lower}) = \frac{17}{4}$$

$$\text{Substitute: } 16 - \left(\frac{17}{4} \right)$$

$$\text{Result} = \frac{47}{4}$$

3. $\int_0^{-3} x^4 + 4 \cdot x^3 + 4 \cdot x^2 + x + 5 \, dx$

$$F(x) = \frac{1}{5} \cdot x^5 + x^4 + \frac{4}{3} \cdot x^3 + \frac{1}{2} \cdot x^2 + 5 \cdot x$$

$$F(\text{upper}) = \frac{-141}{10}$$

$$F(\text{lower}) = 0$$

$$\text{Substitute: } \frac{-141}{10} - (0)$$

$$\text{Result} = \frac{-141}{10}$$

4. $\int_{-5}^{-4} 3 - 5 \cdot x^{-1} + 3 \cdot x^{-2} \, dx$

$$F(x) = 3 \cdot x - 3 \cdot x^{-1} - 5 \cdot \ln(|x|)$$

$$F(\text{upper}) = -\frac{45}{4} - 10 \cdot \ln(2)$$

$$F(\text{lower}) = -\frac{72}{5} - 5 \cdot \ln(5)$$

$$\text{Substitute: } -\frac{45}{4} - 10 \cdot \ln(2) - \left(-\frac{72}{5} - 5 \cdot \ln(5) \right)$$

$$\text{Result} = \frac{63}{20} - 10 \cdot \ln(2) + 5 \cdot \ln(5)$$

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$$5. \int_{\frac{5}{18}\pi}^{\frac{-1}{12}\pi} 3 \cdot \sin(3 \cdot x) dx$$

$$F(x) = -1 \cdot \cos(3 \cdot x)$$

$$F(\text{upper}) = \frac{-1}{2} \cdot \sqrt{2}$$

$$F(\text{lower}) = \frac{1}{2} \cdot \sqrt{3}$$

$$\text{Substitute: } \frac{-1}{2} \cdot \sqrt{2} - \left(\frac{1}{2} \cdot \sqrt{3} \right)$$

$$\text{Result} = -\frac{1}{2} \cdot \sqrt{2} - \frac{1}{2} \cdot \sqrt{3}$$

$$6. \int_{-1}^1 -4 \cdot e^{2 \cdot x} dx$$

$$F(x) = -2 \cdot e^{2 \cdot x}$$

$$F(\text{upper}) = -2 \cdot e^2$$

$$F(\text{lower}) = -2 \cdot e^{-2}$$

$$\text{Substitute: } -2 \cdot e^2 - \left(-2 \cdot e^{-2} \right)$$

$$\text{Result} = 2 \cdot e^{-2} - 2 \cdot e^2$$

$$7. \int_1^0 -6 \cdot x^3 + 3 \cdot x dx$$

$$F(x) = -\frac{3}{2} \cdot x^4 + \frac{3}{2} \cdot x^2$$

$$F(\text{upper}) = 0$$

$$F(\text{lower}) = 0$$

$$\text{Substitute: } 0 - \left(0 \right)$$

$$\text{Result} = 0$$

$$8. \int_{-1}^2 6 \cdot (4)^{3 \cdot x} dx$$

$$F(x) = \frac{(2)^{6 \cdot x}}{\ln(2)}$$

$$F(\text{upper}) = \frac{4096}{\ln(2)}$$

$$F(\text{lower}) = \frac{\frac{1}{64}}{\ln(2)}$$

$$\text{Substitute: } \frac{4096}{\ln(2)} - \left(\frac{\frac{1}{64}}{\ln(2)} \right)$$

$$\text{Result} = \frac{\frac{262143}{64}}{\ln(2)}$$

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9. $\int_1^{-1} -x^5 - 2 \cdot x^4 - 4 \cdot x^3 + x \, dx$

$$F(x) = -\frac{1}{6} \cdot x^6 - \frac{2}{5} \cdot x^5 - x^4 + \frac{1}{2} \cdot x^2$$

$$F(\text{upper}) = \frac{-4}{15}$$

$$F(\text{lower}) = \frac{-16}{15}$$

$$\text{Substitute: } \frac{-4}{15} - \left(\frac{-16}{15} \right)$$

$$\text{Result} = \frac{4}{5}$$

10. $\int_1^3 6 \cdot x^4 + 3 \cdot x^3 - 4 \cdot x^2 + x + 6 \, dx$

$$F(x) = \frac{6}{5} \cdot x^5 + \frac{3}{4} \cdot x^4 - \frac{4}{3} \cdot x^3 + \frac{1}{2} \cdot x^2 + 6 \cdot x$$

$$F(\text{upper}) = \frac{6777}{20}$$

$$F(\text{lower}) = \frac{427}{60}$$

$$\text{Substitute: } \frac{6777}{20} - \left(\frac{427}{60} \right)$$

$$\text{Result} = \frac{4976}{15}$$

11. $\int_{\frac{-5}{3}\pi}^{\frac{5}{4}\pi} 5 \cdot \cos(x) \, dx$

$$F(x) = 5 \cdot \sin(x)$$

$$F(\text{upper}) = \frac{-5}{2} \cdot \sqrt{2}$$

$$F(\text{lower}) = \frac{5}{2} \cdot \sqrt{3}$$

$$\text{Substitute: } \frac{-5}{2} \cdot \sqrt{2} - \left(\frac{5}{2} \cdot \sqrt{3} \right)$$

$$\text{Result} = -\frac{5}{2} \cdot \sqrt{2} - \frac{5}{2} \cdot \sqrt{3}$$

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12. $\int_5^1 5 \cdot x^2 + 2 \cdot x - 5 \cdot x^{-4} \, dx$

$$F(x) = \frac{5}{3} \cdot x^3 + x^2 + \frac{5}{3} \cdot x^{-3}$$

$$F(\text{upper}) = \frac{13}{3}$$

$$F(\text{lower}) = \frac{17501}{75}$$

$$\text{Substitute: } \frac{13}{3} - \left(\frac{17501}{75} \right)$$

$$\text{Result} = \frac{-17176}{75}$$

13. $\int_1^5 6 \cdot x^{-1} - 3 \cdot x^{-4} \, dx$

$$F(x) = x^{-3} + 6 \cdot \ln(|x|)$$

$$F(\text{upper}) = \frac{1}{125} + 6 \cdot \ln(5)$$

$$F(\text{lower}) = 1$$

$$\text{Substitute: } \frac{1}{125} + 6 \cdot \ln(5) - (1)$$

$$\text{Result} = -\frac{124}{125} + 6 \cdot \ln(5)$$

14. $\int_{-1}^{-2} -4 \cdot e^{2 \cdot x} \, dx$

$$F(x) = -2 \cdot e^{2 \cdot x}$$

$$F(\text{upper}) = -2 \cdot e^{-4}$$

$$F(\text{lower}) = -2 \cdot e^{-2}$$

$$\text{Substitute: } -2 \cdot e^{-4} - (-2 \cdot e^{-2})$$

$$\text{Result} = -2 \cdot e^{-4} + 2 \cdot e^{-2}$$

15. $\int_2^3 -x^3 + x^2 \, dx$

$$F(x) = -\frac{1}{4} \cdot x^4 + \frac{1}{3} \cdot x^3$$

$$F(\text{upper}) = \frac{-45}{4}$$

$$F(\text{lower}) = \frac{-4}{3}$$

$$\text{Substitute: } \frac{-45}{4} - \left(\frac{-4}{3} \right)$$

$$\text{Result} = \frac{-119}{12}$$

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16. $\int_{\frac{-1}{12}\pi}^{\frac{-7}{18}\pi} 5 \cdot \sin(3 \cdot x) dx$

$$F(x) = \frac{-5}{3} \cdot \cos(3 \cdot x)$$
$$F(\text{upper}) = \frac{5}{6} \cdot \sqrt{3}$$
$$F(\text{lower}) = \frac{-5}{6} \cdot \sqrt{2}$$
$$\text{Substitute: } \frac{5}{6} \cdot \sqrt{3} - \left(\frac{-5}{6} \cdot \sqrt{2} \right)$$
$$\text{Result} = \frac{5}{6} \cdot \sqrt{2} + \frac{5}{6} \cdot \sqrt{3}$$