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# Welcome to Saturday Sessions!

## AP Biology

AP Biology students are penguins because they are dressed for success!

You are now an AP Bio Penguin!

# Favorite Resources

## AP Bio Penguins

- @apbiopenguins (Instagram, Twitter, YouTube & TikTok)
- Website: apbiopenguins.weebly.com
- AP Biology Review Guide
- TONS of Review PowerPoints

## Additional Resources

- Podcast: @theapsoluterecap
- YouTube: Bozeman Biology
- Review Book: Barron's (7th Edition)
- TikTok: @mrssloanbiology or @a_biology_teacher

# Exam Options

## Paper Administration

- May 14th @ 8am Local
- Traditional Exam: 60 MC/2 Long + 4 Short FRQ

## Digital Administration

- May 27th @ 12pm Eastern

  OR
- June 11th @ 12pm Eastern
- Traditional Exam: 60 MC/2 Long + 4 Short FRQ
- Students will not be asked to draw or graph as part of their response (#2 or #5)

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Tips from Marco

Pace Yourself
Present Practice
Persevere
Penguin

# Science Practice 5

## Statistical Tests and Data Analysis:

- Perform statistical tests and mathematical calculations to analyze and interpret data.
- 5.A: Perform mathematical calculations, including
  - a. Mathematical equations in the curriculum.
  - b. Means.
  - c. Rates.
  - d. Ratios.
  - e. Percentages.
- 5.C Perform chi-square hypothesis testing.

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# Formula Sheet Equations

## Mean

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

Treatment of tomato plants with a growth hormone yielded the following weights of tomatoes: 104 g, 82 g, 121 g, 96 g, 108 g, 73 g. What is the average weight of a tomato after treatment?

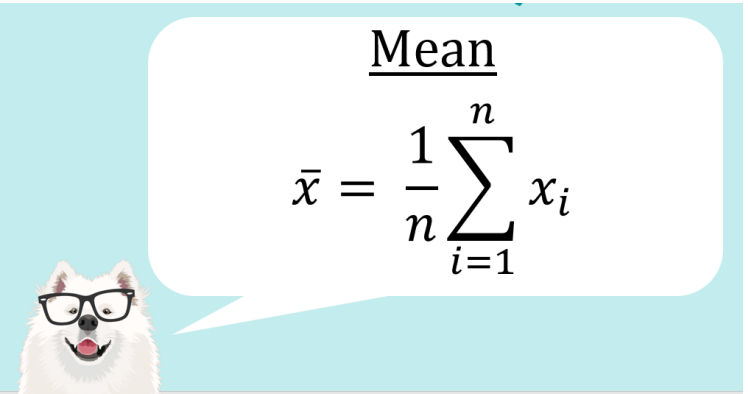
$n = 6$

$$\bar{x} = \frac{1}{6}\sum_{i=1}^{6} x_i$$

$$\bar{x} = \frac{1}{6}(104 + 82 + 121 + 96 + 108 + 73)$$

$$\bar{x} = \frac{1}{6}(584)$$

$$\bar{x} = 97.3$$



Treatment of tomato plants with a growth hormone yielded the following weights of tomatoes: 104 g, 82 g, 121 g, 96 g, 108 g, 73 g. What is the average weight of a tomato after treatment?

## Mean

Button: "STAT"
Select Edit -> 1:Edit
Button: "ENTER"
Under L1, enter the values
Quit back to main screen by: Button "2nd" then "MODE"
Button: "STAT"
Select Calc -> 1: 1-Var Stats
Button: "ENTER"
Button: "ENTER"

The mean is the $\bar{x}$

**Mean**

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

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Formula Sheet Equations

# Standard Deviation

$$s = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n - 1}}$$

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# Standard Deviation

Treatment of tomato plants with a growth hormone yielded the following weights of tomatoes: 104 g, 82 g, 121 g, 96 g, 108 g, 73 g. What is the average weight of a tomato after treatment?

$n = 6$

$$s = \sqrt{\frac{(104-97.3)^2+(82-97.3)^2+(121-97.3)^2+(96-97.3)^2+(108-97.3)^2+(73-97.3)^2}{5}}$$

$$s = \sqrt{\frac{\sum(x_i-97.3)^2}{6-1}}$$

$$s = \sqrt{\frac{(6.7)^2+(-15.3)^2+(23.7)^2+(-1.3)^2+(10.7)^2+(-24.3)^2}{5}}$$

$$s = \sqrt{\frac{44.89+234.09+561.69+1.69+114.49+590.49}{5}}$$

$$s = \sqrt{\frac{1547.34}{5}} \qquad s = \sqrt{309.468} \qquad s = 17.59$$

Standard Deviation

$$s = \sqrt{\frac{\sum(x_i-\bar{x})^2}{n-1}}$$

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# TI-Calc Tricks

Treatment of tomato plants with a growth hormone yielded the following weights of tomatoes: 104 g, 82 g, 121 g, 96 g, 108 g, 73 g. What is the average weight of a tomato after treatment?

## Standard Deviation

Button: "STAT"
Select Edit -> 1:Edit
Button: "ENTER"
Under L1, enter the values
Quit back to main screen by: Button "2nd" then "MODE"
Button: "STAT"
Select Calc -> 1: 1-Var Stats
Button: "ENTER"
Button: "ENTER"

The standard deviation is the Sx

**Standard Deviation**

$$s = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n-1}}$$

# Standard Error of Mean

$$SE_{\bar{x}} = \frac{s}{\sqrt{n}}$$

# Standard Error of Mean

Treatment of tomato plants with a growth hormone yielded the following weights of tomatoes: 104 g, 82 g, 121 g, 96 g, 108 g, 73 g. What is the average weight of a tomato after treatment?

$n = 6$

$s = 17.59$

$$SE_{\bar{x}} = \frac{17.59}{\sqrt{6}}$$

$$SE_{\bar{x}} = \frac{17.59}{2.449}$$

$$SE_{\bar{x}} = 7.18$$

**Standard Error of Mean**

$$SE_{\bar{x}} = \frac{s}{\sqrt{n}}$$

# Chi Square

$$x^2 = \sum \frac{(o-e)^2}{e}$$

In a certain species of flowering plant, the purple allele P is dominant to the yellow allele p.

A student performed a cross between a purple-flowered plant and a yellow-flowered plant. When planted, the 156 seeds that were produced from the cross matured into 92 plants with purple flowers and 64 plants with yellow flowers.

Calculate the chi-squared value for the null hypothesis that the purple-flowered parent was heterozygous for the flower-color gene. Give your answer to the nearest tenth.

Purple (P) > yellow (p)

Pp x pp = 92 purple flowers and 64 yellow flowers, 156 total

$$x^2 = \sum \frac{(o-e)^2}{e}$$

| | Purple | Yellow |
|---|---|---|
| o = observed | o = 92 | o = 64 |
| e = expected | e = 78 | e = 78 |

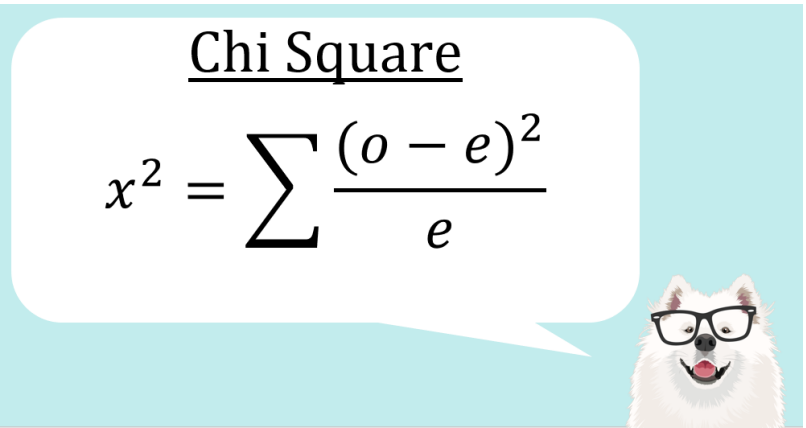
$$x^2 = \frac{(92-78)^2}{78} + \frac{(64-78)^2}{78}$$

$$x^2 = \frac{(14)^2}{78} + \frac{(-14)^2}{78}$$

$$x^2 = \frac{196}{78} + \frac{196}{78}$$

$$x^2 = 2.51 + 2.51$$

$$x^2 = 5.02 = 5.0$$



$X^2 = 5.0$

## Chi-Square Table

| *p* value | Degrees of Freedom | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 0.05 | 3.84 | 5.99 | 7.81 | 9.49 | 11.07 | 12.59 | 14.07 | 15.51 |
| 0.01 | 6.63 | 9.21 | 11.34 | 13.28 | 15.09 | 16.81 | 18.48 | 20.09 |

$X^2 = 5.0 >$ Table value $= 3.84$

Reject the null hypothesis (the purple plant was not heterozygous)

# Laws of Probability

If A and B are mutually exclusive, then:

$$P(A \text{ or } B) = P(A) + P(B)$$

If A and B are independent, then:

$$P(A \text{ and } B) = P(A) \times P(B)$$

# Laws of Probability

In pea plants, smooth seeds are dominant to wrinkled, and purple flowers are dominant to white. In a dihybrid cross, what is the phenotypic ratio?

| | S | s |
|---|---|---|
| S | SS | Ss |
| s | Ss | ss |

| | P | p |
|---|---|---|
| P | PP | Pp |
| p | Pp | pp |

Smooth: ¼ + ½ = ¾
wrinkled: ¼

Purple: ¼ + ½ = ¾
white: ¼

## Laws of Probability

If A and B are mutually exclusive, then:
$P(A \text{ or } B) = P(A) + P(B)$

If A and B are independent, then:
$P(A \text{ and } B) = P(A) \times P(B)$

In pea plants, smooth seeds are dominant to wrinkled, and purple flowers are dominant to white. In a dihybrid cross, what is the phenotypic ratio?

Smooth: ¾
Wrinkled: ¼
Purple: ¾
White: ¼

## Laws of Probability

If A and B are mutually exclusive, then:
$P(A \text{ or } B) = P(A) + P(B)$

If A and B are independent, then:
$P(A \text{ and } B) = P(A) \times P(B)$

Smooth & Purple: ¾ x ¾ = 9/16

Smooth & White: ¾ x ¼ = 3/16

Wrinkled & Purple: ¼ x ¾ = 3/16

Wrinkled & White: ¼ x ¼ = 1/16

# Hardy Weinberg

$$p^2 + 2pq + q^2 = 1$$

$$p + q = 1$$

# Identification of variables in equation:

p = frequency of allele 1 (dominant)

q = frequency of allele 2 (recessive)

$p^2$ = frequency of homozygous allele 1 (homozygous dominant)

2pq = frequency of allele 1/allele 2 (heterozygous)

$q^2$ = frequency of homozygous allele 2 (homozygous recessive)

Hardy Weinberg

$$p^2 + 2pq + q^2 = 1$$

$$p + q = 1$$

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# Hardy-Weinberg

In a population of penguins, the fluffy feathers (F) is dominant to smooth feathers (f). If 15% of the population shows smooth feathers, what percentage of the population, to the nearest tenth, is heterozygous of fluffy feathers.

| $p$ | $q$ | $p^2$ | $2pq$ | $q^2$ |
|---|---|---|---|---|
| 0.61 | 0.39 | 0.37 | 0.48 | 0.15 |

**Hardy Weinberg**

$$p^2 + 2pq + q^2 = 1$$

$$p + q = 1$$

Heterozygous = 0.5

# Hardy Weinberg

$$p = \frac{2(AA) + 1(Aa)}{total}$$

$$q = \frac{2(aa) + 1(Aa)}{total}$$

# Hardy-Weinberg

A cruise ship is stranded on a desert island. There are 400 individuals aboard. There are 200 individuals with sickle cell trait (carriers), 150 unaffected individuals, and 50 individuals with sickle cell disease (homozygous recessive).

$$p^2 = \frac{150}{400} = 0.375$$

$$2pq = \frac{200}{400} = 0.5$$

$$q^2 = \frac{50}{400} = 0.125$$

**Hardy Weinberg**

$$p = \frac{2(AA) + 1(Aa)}{total}$$

$$q = \frac{(2aa) + 1(Aa)}{total}$$

$$p = \frac{2(AA) + 1(Aa)}{total}$$

$$p = \frac{2(150) + 1(200)}{400\ x\ 2}$$

$$p = \frac{300 + 200}{800}$$

$$p = \frac{500}{800} = 0.625$$

$$q = \frac{2(aa) + 1(Aa)}{total}$$

$$q = \frac{2(50) + 1(200)}{400\ x\ 2}$$

$$q = \frac{100 + 200}{800}$$

$$q = \frac{300}{800} = 0.375$$

# Teacher ShoutOuts

Mrs. Mason
Ms. Taylor
Ms. Nolte
Dr. Tatum
Ms. Carroll
Mrs. Phillips
Mrs. Rhinehart
Mrs. Halsell
Mrs. Brewer
Mrs. Mundy
Mrs. Jensen (Steele Canyon HS)
Mr. Roach (BBP)
Mr. Shields(UHS)
Mrs. Mills

# Formula Sheet Equations

## Rate

$$\frac{dy}{dt}$$

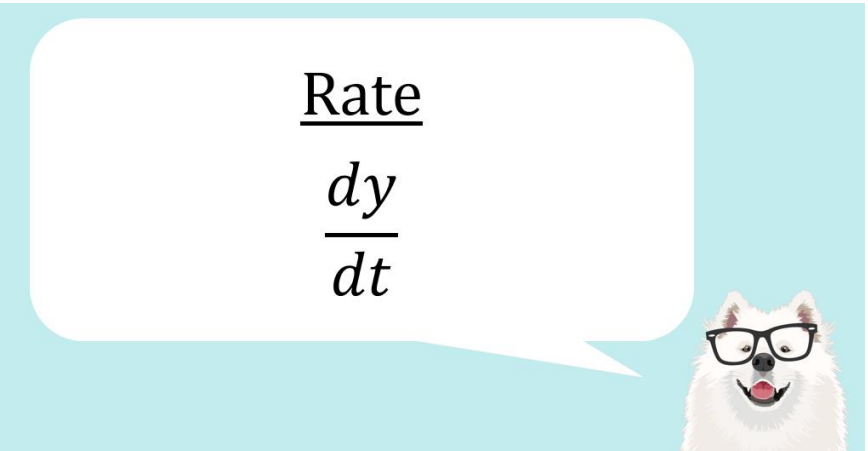
| Time (min) | Amount of $O_2$ produced (mL) |
|---|---|
| 1 | 2.5 |
| 2 | 3.1 |
| 3 | 4.3 |
| 4 | 5.7 |
| 5 | 5.9 |

Hydrogen peroxide is broken down to water and oxygen by the enzyme catalase. The following data were taken over 5 minutes. What is the rate of enzymatic reaction in mL/min from 2 to 4 minutes? Round to the nearest hundredth.

$$\frac{dy}{dt} = \frac{(y_2 - y_1)}{(x_2 - x_1)}$$

$$\frac{dy}{dt} = \frac{(5.7 - 3.1)}{(4 - 2)}$$

$$\frac{dy}{dt} = \frac{(2.6)}{(2)} = 1.3$$



# Population Growth

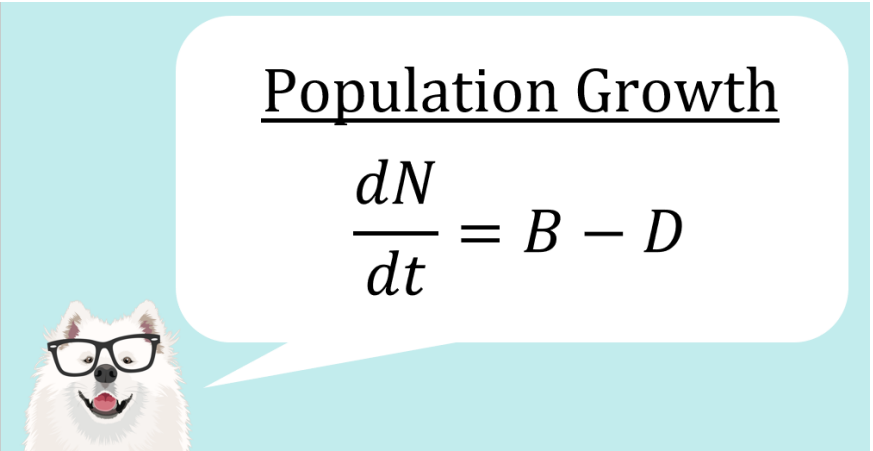
$$\frac{dN}{dt} = B - D$$

# Population Growth

In 2020, a population of penguins had 40 births and 20 deaths. Determine the population growth in 2020.

B = birth rate
D = death rate

$$\frac{dN}{dt} = 40 - 20$$




$$\frac{dN}{dt} = 20$$

# Exponential Growth

$$\frac{dN}{dt} = r_{max}N$$

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# Exponential Growth

A population of 500 penguins has found a new resource. If the maximum rate of increase is 0.25 per individual per year, determine the exponential growth rate to the nearest penguin.

$r_{max}$ = maximum per capita growth rate of population
N = population size

**Exponential Growth**

$$\frac{dN}{dt} = r_{max}N$$

$$\frac{dN}{dt} = 0.25(500)$$

$$\frac{dN}{dt} = 125$$

# Logistic Growth

$$\frac{dN}{dt} = r_{max} N \left( \frac{K - N}{K} \right)$$

# Logistic Growth

A population of penguins has a carrying capacity of 650 individuals. If the maximum rate of increase is 0.25 per individual per year and a population size of 500, determine the logistic growth rate to the nearest penguin.

$r_{max}$ = maximum per capita growth rate of population
N = population size
K = carrying capacity

**Logistic Growth**

$$\frac{dN}{dt} = r_{max}N\left(\frac{K-N}{K}\right)$$

$$\frac{dN}{dt} = 0.25(500)\left(\frac{650-500}{650}\right)$$

$$\frac{dN}{dt} = 125\left(\frac{150}{650}\right)$$

$$\frac{dN}{dt} = 125(0.231) \quad = 28.85 = 29$$

# Simpson's Diversity Index

$$1 - \sum \left(\frac{n}{N}\right)^2$$

# Simpson's Diversity Index

In a community of penguins, there are three different types of penguins shown in the table below. Determine the Shannon diversity index of the community.

n = total organisms of a particular species
N = total number of organisms of all species

| Penguin Species | Number of Individuals |
|---|---|
| Adele | 6 |
| Gentoo | 8 |
| Little | 13 |

**Simpson's Diversity Index**

$$1 - \sum \left(\frac{n}{N}\right)^2$$

$$1 - \left[\left(\frac{6}{27}\right)^2 + \left(\frac{8}{27}\right)^2 + \left(\frac{13}{27}\right)^2\right]$$

$$1 - [(0.222)^2 + (0.296)^2 + (0.481)^2]$$

$$1 - [0.369] = 0.631$$

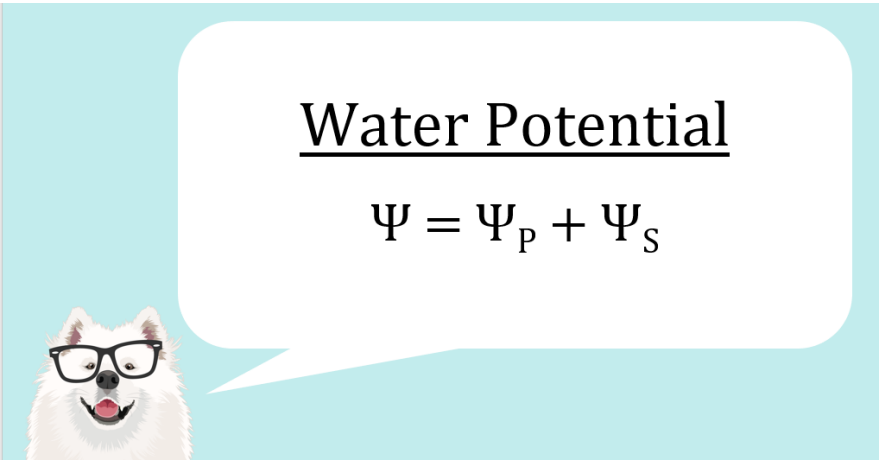
# Water Potential

$$\Psi = \Psi_P + \Psi_S$$

# Water Potential

Scientists are trying to determine under what conditions a plant can survive. They collect the following data and would like to know the water potential of the plant cell. The solute potential is -0.6 MPa and the pressure potential is -1.0 MPa. What is the water potential.

$\Psi_S$ = solute potential  $\Psi_P$ = pressure potential




$$\Psi = \text{-1.0 MPa} + \text{-0.6 MPa}$$

$$\Psi = \text{-1.6 MPa}$$

# Solute Potential

$$\Psi_S = -iCRT$$

# Identification of variables in equation:

i = ionization constant
(1.0 for sucrose)

C = molar concentration

R = pressure constant
(R = 0.0831 liter bars/mole K)

T = temperature in Kelvin
(°C + 273)

Solute Potential

$\Psi_S = -iCRT$

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# Solute Potential

Potato cores were placed in solutions of varying concentrations and were found to neither gain nor lose mass in a sucrose solution of 0.32M. Use this information to calculate the solute potential of the potato cores. The temperature of the solution is 22°C.

$$\Psi_S = -1.0(0.32\ M)(0.0831\ \text{liter bars/mole K})(295\ K)$$

$$\Psi_S = -7.84\ \text{bars}$$

**Solute Potential**

$$\Psi_S = -iCRT$$

i = 1.0 C = 0.32 M T = 22°C

R = 0.0831 liter bars/mole K

T = (22°C + 273) = 295 K

# pH

$$pH = -\log[H^+]$$

Compare the number of $H^+$ ions in a solution with a pH of 4 to a solution with a pH of 8. If appropriate, include a negative sign in your answer.

$4 = -\log[H^+]$ $\quad$ $8 = -\log[H^+]$

$10^{-4} = 10^{\log[H+]}$ $\quad$ $10^{-8} = 10^{\log[H+]}$

$10^{-4} = [H+]$ $\quad$ $10^{-8} = [H+]$

pH of 4 has 10,000 more $H^+$ ions

**pH**

$$pH = -\log[H^+]$$

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Formula Sheet Equations

# Surface Area & Volume

$$SA = 4\pi r^2$$

$$V = \frac{4}{3}\pi r^3$$

## Sphere

# Identification of variables in equation:

SA = surface area

V = volume

r = radius

l = length

h = height

w = width

s = length of one side of a cube

Determine the surface area-to-volume ratio for a sphere with radius 2cm.

$r = 2$ cm

$$SA = 4\pi 2^2 \qquad V = \frac{4}{3}\pi 2^3$$

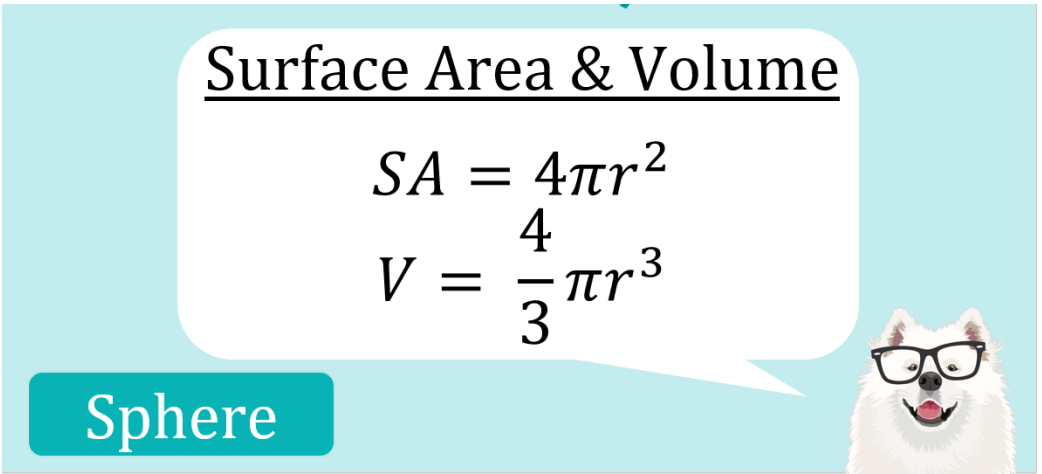
$$SA = 4\pi 4 \qquad V = \frac{4}{3}\pi 8$$

$$SA = 16\pi \qquad V = \frac{32}{3}\pi$$

$$\frac{SA}{V} = \frac{16\pi}{\frac{32}{3}\pi} = \frac{16\pi}{1} \times \frac{3}{32\pi} = \frac{3}{2}$$

1

2



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Formula Sheet Equations

# Surface Area & Volume

$$SA = 2lh + 2lw + 2wh$$

$$V = lwh$$

## Rectangular Solid

Determine the surface area-to-volume ratio for a rectangular solid with length of 2 cm, height of 3 cm, and width of 4 cm.

$l = 2$ cm

$h = 3$ cm

$w = 4$ cm

$$SA = 2(2)(3) + 2(2)(4) + 2(4)(3)$$

$$SA = 12 + 16 + 24$$

$$SA = 52$$

$$V = (2)(4)(3)$$

$$V = 24$$

$$\frac{SA}{V} = \frac{52}{24} = \frac{13}{6} = 2.17$$

Surface Area & Volume

$$SA = 2lh + 2lw + 2wh$$

$$V = lwh$$

Rectangular Solid

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Formula Sheet Equations

# Surface Area & Volume

$$SA = 2\pi rh + 2\pi r^2$$

$$V = \pi r^2 h$$

## Cylinder

# Determine the surface area-to-volume ratio for a cylinder with radius of 2 cm and height of 3 cm

$r = 2$ cm

$h = 3$ cm

$$SA = 2\pi(2)(3) + 2\pi 2^2$$

$$SA = 2\pi 6 + 2\pi 4$$

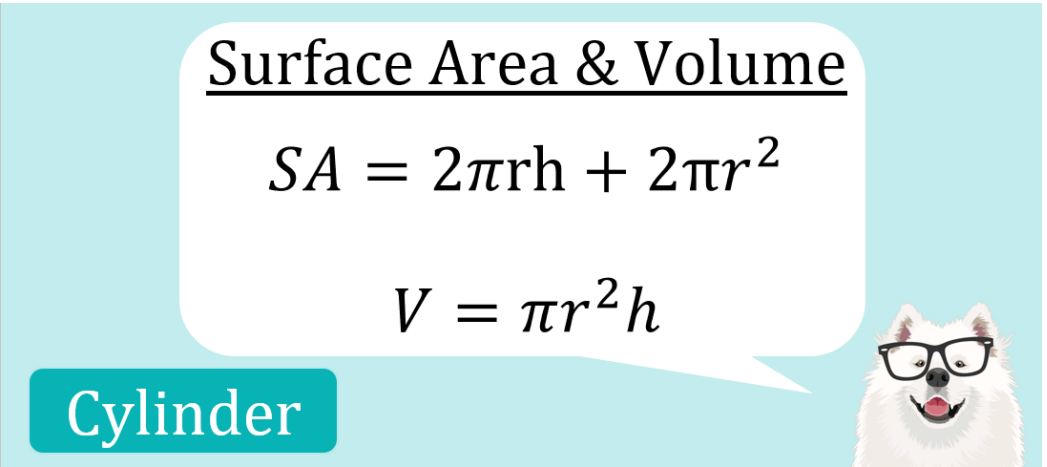
$$SA = 12\pi + 8\pi = 20\pi$$

$$V = \pi 2^2 3$$

$$V = \pi(4)3$$

$$V = 12\pi$$

$$\frac{SA}{V} = \frac{20\cancel{\pi}}{12\cancel{\pi}} = \frac{5}{3}$$



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Formula Sheet Equations

# Surface Area & Volume

$$SA = 6s^2$$

$$V = s^3$$

## Cube

Determine the surface area-to-volume ratio for a cube with side length of 2 cm

$s = 2$ cm

$SA = 6(2)^2$

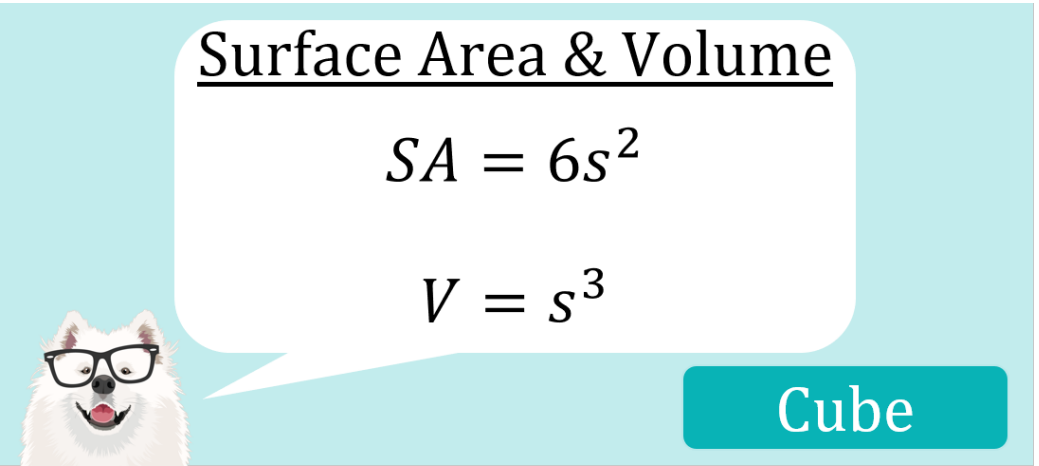
$SA = 6(4)$

$SA = 24$

$V = (2)^3$

$V = 8$

$$\frac{SA}{V} = \frac{24}{8} = 3$$



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Party on Penguin

# Unit 8 Q&A
# @apbiopenguins
# 5/2 @ 8pm ET