answer key

AP BIOLOGY QUANTITATIVE SKILLS

WORKSHEET #1: BASIC STATISTICAL TESTS

Mode = value that occurs most frequently
Median = middle value
Mean = average
Range = dispersion of data points (value obtained by subtracting the smallest observation from the greatest observation)

$\bar{x}$ = sample mean
n = size of sample
s = sample standard deviation
o = observed results
e = expected results

standard dev → SD = $\sqrt{\frac{\Sigma(x_i - \bar{x})^2}{n-1}}$ ← sum of all; datapt; sample size

$SE_{\bar{x}} = \frac{s}{\sqrt{n}}$ ← stand. dev

$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$ ← crazy formula for using an average.

standard deviation **standard mean error** **mean**

Example problem:

One of the lab groups collected the following data for the heights (in cm) of their Wisconsin Fast Plants:

5.4 7.2 4.9 9.3 7.2 8.1 8.5 5.4 7.8 10.2

Find the mode, median, mean, and range. Show your work where necessary.

Mode(s): 5.4 & 7.2 Median: 7.5 Mean: 7.4 Range: 5.3

Find the standard deviation by filling in the following table.

Heights (x)	Mean ($\bar{x}$)	$x - \bar{x}$ (Value − mean)	$(x-\bar{x})^2$ (this value from Column 3 squared)
5.4	7.4	2.0	4.00
7.2		0.2	0.04
4.9		2.5	6.25
9.3		1.9	3.61
7.2		0.2	0.04
8.1		0.7	0.49
8.5		1.1	1.21
5.4		2.0	4.00
7.8		0.4	0.16
10.2		2.8	7.84
			27.64 = $\Sigma(x-\bar{x})^2$ ← of all values

Summation ↓

* this is a very large dataset. I doubt on the AP exam it will be as large.

Standard deviation:

Interpret the standard deviation in the context of the problem.

$SD = \sqrt{\frac{\Sigma(x_1 - \bar{x})^2}{n-1}}$ $\sqrt{\frac{27.64}{(10-1)}} = \sqrt{3.07} = 1.75$

What is the standard mean error? Calculate it for this data set.

$SE_{\bar{x}} = \frac{\text{Standard dev.}}{\sqrt{n}}$ $\frac{27.64}{\sqrt{10}} =$

n = sample size.

SAMPLE QUESTIONS SUITABLE FOR GRID-IN RESPONSES.

1. In snapdragons (Antirrhinum), the phenotype for flower color is governed by two alleles – red (R) and white (W). Heterozygous individuals have pink flowers. Two pink individuals are crossed to produce 465 offspring. Calculate how many of these offspring are expected to have the red phenotype. Round your response to the nearest whole number.

2. The molar concentration of a sugar solution in an open beaker has been determined to be 0.3M. Calculate the solute potential at 27 degrees Celsius. Round your answer to the nearest tenths.

3. The net annual primary productivity of a particular wetland ecosystem is found to be 8000 kcal/m^2. If respiration by the aquatic producers is 12,000 kcal/m^2 per year, what is the gross annual primary productivity for this ecosystem in kcal/m^2 per year? Round to the nearest whole number.

4. Data taken to determine the effect of temperature on the rate of respiration in a goldfish is given in the table to the right. Calculate Q_{10} for this data. Round to the nearest whole number.

Temp (°C)	Respiration rate (per min)
16	16
21	22

5. Joe has a 2 g/L solution. He dilutes it and creates 3 L of a 1 g/L solution. How much of the original solution did he dilute (in L)? Round to the nearest tenths.

6. What is the hydrogen ion concentration of a solution of pH 8? Round to the nearest whole number.

7. What is the SA/V for this cell if r = 3μm? Round your answer to the nearest hundredth.

8. A census of birds nesting on a Galapagos Island revealed that 24 of them show a rare recessive condition that affected beak formation. The other 63 birds in this population show no beak defect. If this population is in HW equilibrium, what is the frequency of the dominant allele? Give your answer to the nearest hundredth

9. There are 2000 mice living in a field. If 1000 mice are born each month and 200 mice die each month, what is the per capita growth rate of mice over a month? Round to the nearest tenths.

10. Hydrogen peroxide is broken down to water and oxygen by the enzyme catalase. The 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 hundreds

Time (min)	O_2 produced (mL)
1	2.3
2	3.6
3	4.2
4	5.5
5	5.9

11. The following data were collected on the behavior of preschoolers. Some were spanked, some were given time-outs and some were given no discipline. Five years later teachers were asked to keep track of the behavior issues of these children. Find the chi-square.

	# misbehaviors
no discipline	40
time-outs	34
spanking	26

WORKSHEET #2: CHI-SQUARE AND PUNNETT SQUARE

Formulas:

Chi Square $\chi^2 = \Sigma\left(\frac{(o-e)^2}{e}\right)$ o = observed individuals with observed genotype

e = expected individuals with observed genotype

Degrees of freedom equals the number of distinct possible outcomes minus one

	Degrees of Freedom							
p	1	2	3	4	5	6	7	8
0.05	3.84	5.99	7.82	9.49	11.07	12.59	14.07	15.51
0.01	6.64	9.32	11.34	13.28	15.09	16.81	18.48	20.09

Example problem:

Wisconsin Fast Plants have two very distinctive visible traits (stems and leaves). Each plant will either have a purple (P) or green (p) stem and also have either have green (G) or yellow (g) leaves. Suppose that we cross a dihybrid heterozygous plant with another plant that is homozygous purple stem and heterozygous for the leaf trait. Make a Punnett square to figure out the expected ratios for the phenotypes of the offspring.

	Pp	Gg
P	PP Pp	GG Gg
P	PP Pp	Gg gg

Using your understanding of genetics, what might be one reason why the class got these results?

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observed: 234 purple stem & green leaves

42 purple stem & yellow leaves

total: 276 plants

btw. organisms should not be 1/2.

expected from Q#1

276 x 75% = 207

276 x 25% = 69

$\frac{12}{16}$ plants should be purple stem & green leaf = 75%

$\frac{4}{16}$ plants should be purple stem & yellow leaf = 25%

$$\frac{(O-E)^2}{E} + \frac{(O-E)^2}{E}$$

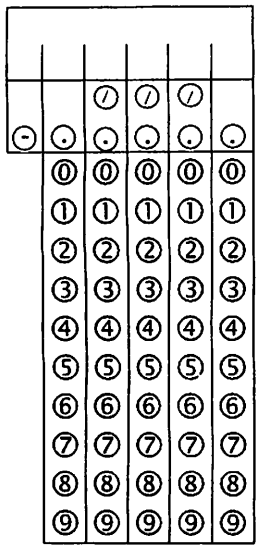
makes this + value = abs value

$$\frac{(234-207)^2}{234} + \frac{(42-69)^2}{69}$$

$3.52 + 10.57$ X^2 value = 14.09

go back to top of last page...

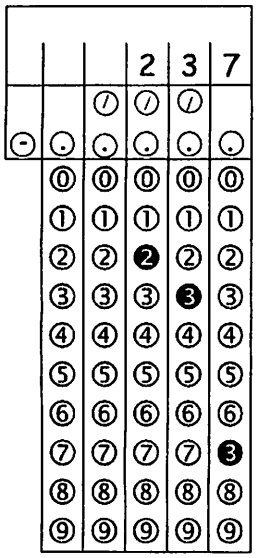
WORKSHEET #15: GRID-IN PRACTICE

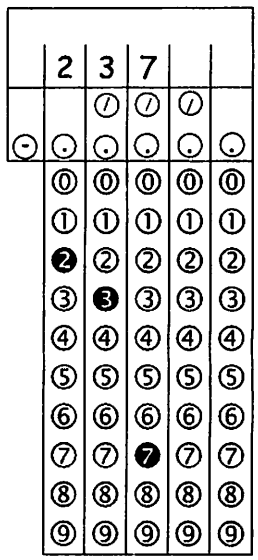


You will have questions that use a grid-in. in general, these questions should be fairly straight forward. Here are a few examples.

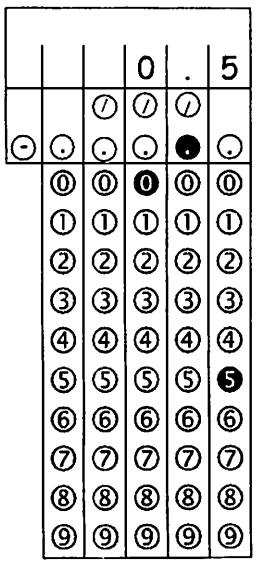
There are 252 deer in a population. There is no net immigration or emigration. If 47 deer die and 32 deer are born in one month, what is the population size at the end of the month? Round to the nearest whole number.

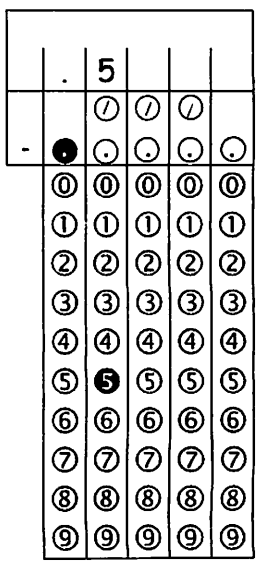
Solution: 252-47+32=237 All answers below are correct

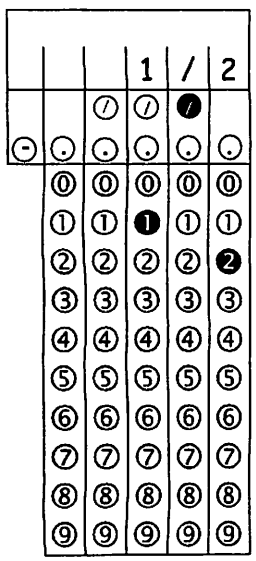




Correct ways to write one-half include:







WORKSHEET #3: HARDY-WEINBERG A

Formulas:

$p^2 + 2pq + q^2 = 1$ p = frequency of the dominant allele in a population
$p + q = 1$ q = frequency of the recessive allele in a population

For people, being right handed (R) is the dominant trait over being left handed (r). Suppose there is a sample of 20 people that reveals the following genotypes:

(RR)	(Rr)	(RR)	(Rr)	(rr)	(Rr)	(RR)	(RR)	(Rr)	(RR)
(Rr)	(rr)	(Rr)	(Rr)	(RR)	(RR)	(Rr)	(RR)	(rr)	(Rr)

What percentage of the people are right handed? Left handed?

RR = 8/20 Rr = 9/20 rr 3/20 > left = 15% = .15 freq.

Find p and q and interpret each in the context of the problem. each person has two copies

right handed = 17/20 = 85% = .85 freq | $p = \frac{25}{40} = .625$ freq $q = \frac{15}{40} = .375$ freq.

Now suppose that we took another sample of 10 people. This time we only know their phenotypes.

(Right) (Left) (Right) (Right) (Right) (Right) (Right) (Right) (Left) (Right)

What percentage of the people are right handed? Left handed?

right handed = 8/10 80% .8 freq. (p^2) left handed = 2/10 20% .2 freq (q^2)

Can you find p and q exactly? Why?

based solely on phenotype you can not tell p & q freq b/c it is impossible to tell homo. dom vs hetero

Estimate p and q and interpret each in the context of the problem.

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

$p + q = 1$

Estimate how many of the right handed people are homozygous and how many are heterozygous.

if p = .55 & q = .45

$p^2 = .30$ 2pq $q^2 = .20$

30% of 10 = 3 people right homo. dom.

2(.55)(.45) = .495 = 50% of 10 = 10 right hetero

if $q^2 = .2$ then

$q = \sqrt{.2} = .45$ ∴

$p = .55$.

WORKSHEET #4: HARDY-WEINBERG B

Formulas:

$p^2 + 2pq + q^2 = 1$ p = frequency of the dominant allele in a population
$p + q = 1$ q = frequency of the recessive allele in a population

Example problem:

Cannot distinguish p^2 vs. $2pq$ based on right hand phenotype however

In 1988 the Garces Memorial High School student body was made up of 90% right handed students. Being right handed (R) is the dominant trait over being left handed (r).

What is p and q for the population of 1990 GMHS High School students. Interpret each.

Left handed = 10% (q^2) $q^2 = .10 \therefore \sqrt{q^2} = .316 \therefore p = .684$ b/c $p+q=1$

$q = .316$ $p = .684$

Find the percent of the student body in 1990 that are homozygous right handed, heterozygous right handed, and left handed.

$q^2 = 10\%$ = Left handed (homozygous recessive)

$p^2 = (.684)^2 = .47 \rightarrow 47\%$ right handed (homozygous dominant)

$2pq = 2(.316)(.684) \rightarrow .43 \rightarrow 43\%$ right handed (heterozy)

Fast forward to today at Garces. We took a random sample of 100 students today and found that 18 of them were left handed.

What are the new p and q values? How do they compare with the values from 1990?

$\frac{18}{100}$ left handed = .18 freq $q^2 \rightarrow \sqrt{q^2} \rightarrow q = .42$ ↙ increases

$\therefore p = .58$ ↖ decreases

There are many reasons why this apparent change could have occurred. Come up the five you will be expected to know and give an example for each: (Hint: Why did I choose 1988, the year I graduated?)

- immigration / emigration
- large population / small pop.
- genetic drift
- random mutation
- sexual selection → lefty's are hot.

WORKSHEET #5: POPULATIONS A

Rate	Population Growth	Exponential Growth	Logistic Growth
dY/dt	dN/dt = B – D	$\frac{dN}{dt} = r_{max} N$	$\frac{dN}{dt} = r_{max} N\left(\frac{K-N}{K}\right)$

dY = amount of change B = birth rate D = death rate N = population size
K = carrying capacity r_{max} = maximum per capita growth rate of population

Notes

$$\frac{dN}{dt} = \frac{\Delta N}{\Delta t} = \frac{change\ in\ population\ size}{change\ in\ time} = \text{population growth rate}$$

Example 1:

There are 300 falcons living in a certain forest at the beginning of 2013. Suppose that every year there are 50 falcons born and 30 falcons that die.

What is the population growth rate (include units)? Interpret the value.

$\frac{dn}{dt}$ = $\frac{\text{change in pop size}}{\text{change time}}$ = B - D = 50 - 30 = $20 \frac{\text{falcons}}{1 \text{ yr.}}$

What is the per capita growth rate of the falcons over a year? Interpret the value.

$\frac{dN}{dt} = r_{max} N$ ← pop size

$\frac{20 \text{ falcons}}{1 \text{ yr}} = r_{max} 300 = \frac{20}{300} = r_{max} = 0.067$

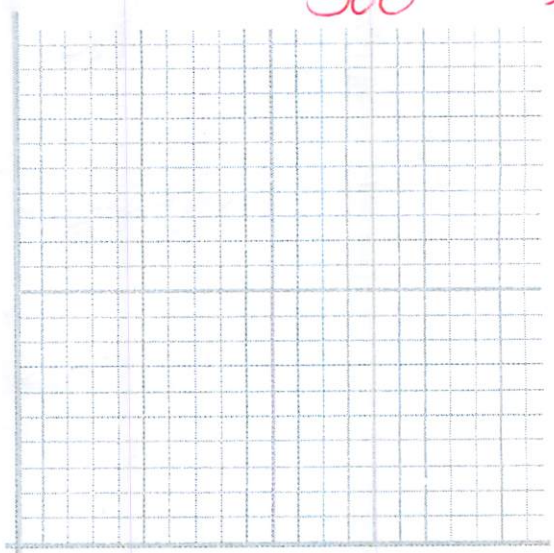
c. Fill in the table and construct a graph.

start value

Year	Population
2013	300
2014	320
2015	341.4
2016	364.3
2017	388.7
2018	415

Year	Population
2019	442.8
2020	472.5
2021	504
2022	537.8
2023	573.8
2024	612.2

(*) see next pg for calc.



Find the average rate of change for the falcon population from 2013 to 2018 (include units). Interpret the value.

f - i = 415 - 300 = $\frac{115 \text{ new falcons}}{5 \text{ years}}$ = $\frac{23 \text{ falcons}}{1 \text{ year}}$.

2013 = 300 x 0.067 = 20 add organism

2014 320 x .067 = 21.4 add. organism

2015 = 341.4 x .067 = 22.8 add org.

2016 = 364.3 x .067 = 24.4 add org.

2017 388.7 x .067 = 26.04 add

414.7

2018 = 415 x .067 = 27.8 add

2019 = 442.8 x .067 = 29.7 add

2020 = 472.5 x .067 = 31.7 add

2021 = 504 x .067 = 33.8 add

2022 = 537.8 x .067 = add 36

2023 = 573.8

2023 = 573.8 x .067 = add 38.4.

+ 38.4

2024 = 612.2

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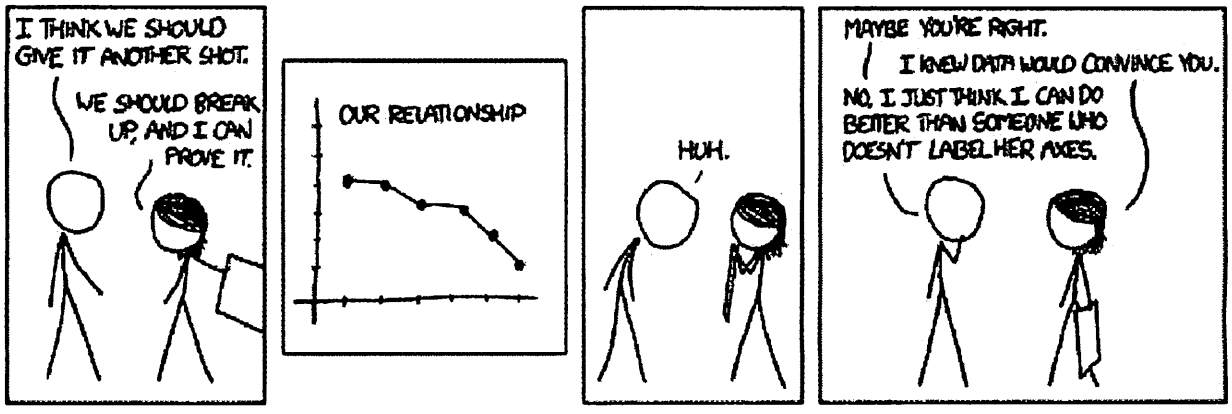


WORKSHEET #6: POPULATIONS B

Bakersfield had a population of 347,500 in the year 2010. The infrastructure of the city allows for a carrying capacity of 450,000 people. r_{max} = .9 for Bakersfield.

a. Is the current population above or below the carrying capacity? Will the population increase or decrease in the next year?

below → therefore should increase

b. What will be the population growth rate for 2010 (include units)?

used this eq bc it carry capacity

$\frac{dN}{dt} = r_{max} N\left(\frac{K-N}{N}\right)$ $(.9)(347,500)\left(\frac{450,000-347,500}{450,000}\right) =$ 71,238 individuals / 1 yr.

c. What will be the population size at the start of 2014.

d. Fill in the following table:

* see next page for work

Year	Population size at start of year	Population growth rate (new people added)
2010	347,500	71238
2011	418,738	26181
2012	444,919	4521
2013	449,440	503
2014	449,943	51

e. What happened to the population size over the years?

increased

f. What happened to the population growth rate over the years?

rate decreased b/c reaching carrying capacity limit

g. f. Explain your answer from part (e) using what you know about carrying capacity.

as population reaches K, limited resources limits growth rate

h. g. Explain your answer from part (e) using the formula: $\frac{dN}{dt} = r_{max} N\left(\frac{K-N}{K}\right)$

as N approaches K → becomes equal to zero

2010 = 347,500 + 71,238 new add. orgn

2011 = 418,138 + 26,181 $\quad .9(418,138)\left(\frac{450,000-418,138}{450,000}\right)$

$= 26,181$ new add organisms

2012 = 444,919 + 4,521

$.9(444,919)\left(\frac{450,000-444,919}{450,000}\right)$

$= 4,521$ new add organisms

2013 = 449,440 + 503

$= .9(449,440)\left(\frac{450,000-449,440}{450,000}\right)$

$= 503$ new add organisms

2014 = 449,943 + 51

$= .9(449,943)\left(\frac{450,000-449,943}{450,000}\right)$

51 add new organisms

STATISTICAL ANALYSIS AND PROBABILITY

Standard Error	Mean
$SE_{\bar{x}} = \frac{s}{\sqrt{n}}$	$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$
Standard Deviation	**Chi-Square**
$s = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n-1}}$	$\chi^2 = \sum \frac{(o-e)^2}{e}$

s = sample standard deviation (i.e., the sample based estimate of the standard deviation of the population)

$\bar{x}$ = mean

n = size of the sample

o = observed individuals with observed genotype

e = expected individuals with observed genotype

Degrees of freedom equals the number of distinct possible outcomes minus one.

CHI-SQUARE TABLE

	Degrees of Freedom							
p	1	2	3	4	5	6	7	8
0.05	3.84	5.99	7.82	9.49	11.07	12.59	14.07	15.51
0.01	6.64	9.32	11.34	13.28	15.09	16.81	18.48	20.09

LAWS OF PROBABILITY

If A and B are mutually exclusive, then P (A or B) = P(A) + P(B)

If A and B are independent, then P (A and B) = P(A) x P(B)

HARDY-WEINBERG EQUATIONS

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

$p + q = 1$

p = frequency of the dominant allele in a population

q = frequency of the recessive allele in a population

METRIC PREFIXES

Factor	Prefix	Symbol
10^9	giga	G
10^6	mega	M
10^3	kilo	k
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p

Mode = value that occurs most frequently in a data set

Median = middle value that separates the greater and lesser halves of a data set

Mean = sum of all data points divided by number of data points

Range = value obtained by subtracting the smallest observation (sample minimum) from the greatest (sample maximum)

WORKSHEET #7: TEMPERATURE COEFFICIENT

$$Q_{10} = \left(\frac{k_2}{k_1}\right)^{\frac{10}{T_2 - T_1}}$$

T_2=higher temperature
T_1 = lower temperature
k_2= reaction rate at T_2
k_1=reaction rate at T_1
Q_{10}=factor by which the reaction rate increases when the temperature increases by 10°C

$$R2 = R1 \times Q_{10}$$

The rate of metabolism of a certain animal at 10°C, is 27 μL O_2 $g^{-1}h^{-1}$.

1. What are its rates of metabolism at 20, 30, and 40 °C if the Q_{10} is 2? If it is 2.5?

* see next page

Temperature °C	Rate2 if Q_{10} = 2
20	54
30	108
40	216

Temperature °C	Rate2 if Q_{10} = 2.5
20	67.5
30	169
40	422

2. Graph the two tables above showing the effect of Temp on reaction rate

Temperature (°C)	Rate of Metabolism (μLO_2 $g^{-1}h^{-1}$.)	Q_{10}
15	10	$= \left(\frac{K2}{K1}\right)^{\frac{10}{T2-T1}} = \left(\frac{13.42}{10}\right)^{\frac{10}{5}} = 1.80$
20	13.42	$= \left(\frac{21.22}{13.42}\right) = 1.58$
30	21.22	$\left(\frac{10}{21.22}\right)^{\frac{10}{15-30}} = 1.65$

have to relate back to 15

The table above reports the rates of metabolism of a species at a series of ambient temperatures:

3. Calculate the Q_{10} values for each temperature interval
4. Within which temperature interval (15-20 or 20-30) is the rate of metabolism most sensitive to temperature change?

10-15

5. For this species, would a Q_{10} calculated for 15 to 30 °C be as useful as several for smaller temperature ranges? Calculate that Q_{10} as part of your answer.

The reaction rate for a certain process at 14 °C is 15 units/time. What would be the reaction rate at 20 °C if the Q_{10} = 1?

$$1 = \left(\frac{X}{15}\right)^{\frac{10}{6}}$$

WORKSHEET #8: DILUTIONS

$C_1V_1 = C_2V_2$ aka. $M_1V_1=M_2V_2$

1M $AgNO_3$= 1 mol $AgNO_3$/L

C_1 = original concentration of the solution, before it gets watered down or diluted.
C_2 = final concentration of the solution, after dilution.
V_1 = volume about to be diluted
V_2 = final volume after dilution

For all dilution problems $C_1 > C_2$, and $V_1 < V_2$. It makes sense because to dilute, we add water.

Joe has a 2 g/L solution. He dilutes it and creates 3 L of a 1 g/L solution. How much of the original solution did he use?

$(2\frac{g}{L})(x) = (3L)(\frac{1g}{1L})$ $x = 1.5$ liters

What is the molarity of a solution with 360 g glucose in 500 mL of distilled water?

$\frac{M}{1L} = \frac{mols}{liter}$ ← can't use grams so can't use liters

$500mL(\frac{10^{-3}L}{1mL}) = .5$ Liters

360 grams $C_6H_{12}O_6(\frac{1mol}{180grams}) = 2$ mols glucose

gfm = 180.

$\frac{M}{1L} = \frac{2mols}{.5L} = 4M$

Since Joe did such a good time before, the teacher asked Joe to make a set of solutions. For the lab the students need 2-L of each NaCl stock solution at 1.0M, 0.75M, 0.50M, and 0.25M. If the molar mass of NaCl is 58.45 g/mol, what are the directions for ***each*** of the solutions. Be specific and show your calculations.

$\frac{1M}{1L} = \frac{mols}{2L} = 2mols(\frac{58.45g}{1mol}) = 117$ grams

gfm = 58.5 grams, 116.9 gram

$\frac{.75M}{1L} = \frac{mols}{2L} = 1.5mols(\frac{58.45g}{1mol}) = 87.675$ grams

$\frac{.5M}{1L} = \frac{mols}{2L} = 1mol$ (58.45 grams)

$\frac{.25M}{1L} = \frac{X}{2L} = .5mols(\frac{58.45}{1mol})$

29.225 grams

WORKSHEET #9: SA:V

Surface area to Volume and Water Potential Review

Cells throughout the world have variable shapes and sizes. Because of this, and because structure is designed around function, certain shapes are optimal for certain processes.

Analyze the following cells (units not to scale), and determine the following...

$V_{sphere} = 4/3\ \pi\ r^3$
$V_{rectangle} = l\ w\ h$
$A_{sphere} = 4\ \pi\ r^2$
$A_{rectangle} = \Sigma$ (SA for each side)

Cell 1 (spherical) where the diameter is 6 mm

Cell 2 (flat and rectangular) where the height is 0.5mm, length is 4mm, width is 2mm

Cell 3 (cube) where side length is 6 mm

this : that.

Cell	Surface area	Volume	Surface area to Volume Ratio
Cell 1	113.1	37.7	3:1
Cell 2	22	4	5.5:1
Cell 3	216	216	1:1

A) What is the surface area to volume ratio of each cell? Complete the table above.

B) Conclusion: Compare the ratios and explain why one cell would be more efficient than another.

greater SA to volume ratio

C) If the volume of two cells are identical, but one is a sphere and the other a cube, what are their respective surface areas? Use an arithmetical example.

D) Are you made of lots of large cells or lots of small cells? Why? How do you grow in height?

E) Provide 5 specific examples of ways organisms use SA:V ratio to survive.

#1
SA: $4\pi r^2$
$4\pi 6^2$
V: $\frac{4}{3}\pi 6^3$

WORKSHEET #10: WATER POTENTIAL

$\Psi = \Psi_P + \Psi_S$ Ψ_P= pressure potential; Ψ_S = solute potential

$\Psi_S = -iCRT$ i = ionization constant; C = molar concentration; R = 0.0831; T=Temp (K)

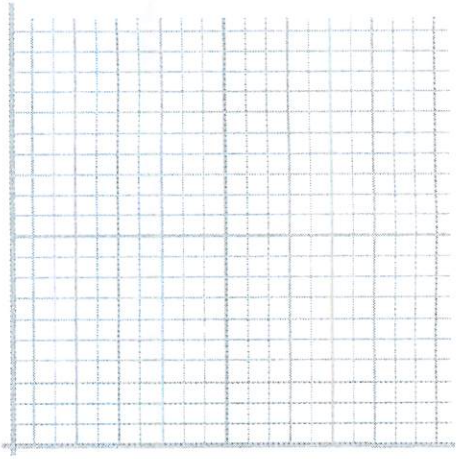
The water potential will be equal to the solute potential of a solution in an open container

i is 1.0 for sucrose because sucrose does not ionize in water

Water potential in potato cells was determined in the following manner. The initial masses of six groups of potato cores were measured. The potato cores were placed in sucrose solutions of various molarities. The masses of the cores were measured again after 24 hours. Percent changes in mass were calculated. The results are shown below

Molarity of Sucrose in Beaker	Percent Change in Mass
0.0 M	18.0
0.2	5.0
0.4	-8.0
0.6	-16.0
0.8	-23.5
1.0	-24.0

Graph these data. From your graph, label where the cells were hypotonic and hypertonic. Determine the apparent molar concentration (osmolarity) of the potato core cells.



Looking at the water potential equation,

Pressure potential is always (positive/negative), while solute potential is always (positive/negative).

When Solution potential goes down (gets more negative), water potential (increases/decreases)

When Pressure potential goes down (gets smaller), water potential (increases/decreases)

When would the pressure in a cell rise? (Under what conditions?)

when Ψ_P or Ψ_S goes up

$\Psi_S = -iCRT$ Salt ionize/dissocied into 3 ≡ decrease value

What would happen to the solute potential when Concentration is increased (justify with equation)? WHY?

decrease $\Psi_S = -iCRT$ ↑ value makes more ⊖

What would happen to the solute potential when the dissolved substance is glucose vs. salt (justify with equation)? WHY?

decrease

Why is water potential important for plants? What are they lacking?

turgidity b/c no heart to pump & maintain pressure

What would happen to the solute potential when Temperature is increased (justify with equation)? WHY?

decrease $\Psi_S = -iCRT$ ↑ temp, molec value more ⊖

Predict what would happen to animal cells placed in 0.0M and 1.0M concentration solution

0M = lyse / shrivel

1M = turgid / plasmolysis

WORKSHEET #11: GIBBS FREE ENERGY BASICS

$\Delta G = \Delta H - T\,\Delta S$

plug into formula

What is Entropy (ΔS) = a measurement of randomness/order

When ΔS is positive this means there is more random/less order

When ΔS is negative this means there is less random/more order

What is ΔH? = a measurement of enthalpy/heat

When ΔH is positive this means the reaction is endothermic

When ΔH is negative this means the reaction is exothermic

What is Gibbs Free energy? = a measurement of free energy to do work

When ΔG is positive this means the reaction will happen only if energy is added.

When ΔG is negative this means the reaction will happen spontaneously.

ΔG (Joules)	ΔH (Joules)	T (Kelvin)	ΔS (J/K)
-500	1000	300	5
-400	1100	300	5
-300	1200	300	5
-200	1300	300	5
-100	1400	300	5
0	1500	300	5
100	1600	300	5
200	1700	300	5
300	1800	300	5
400	1900	300	5

What happens to ΔG when ΔH goes up ? WHY?

↑ ΔH, ↑ ΔS

↑ more energy required → reduce spontaneity

What happens to ΔG when ΔH goes down ? WHY?

↓ ΔH, ↓ ΔG

↓ energy required, ↑ spontaneity

ΔG	ΔH	T	ΔS
200	1700	300	5
150	1700	310	5
100	1700	320	5
50	1700	330	5
0	1700	340	5
-50	1700	350	5
-100	1700	360	5
-150	1700	370	5
-200	1700	380	5
-250	1700	390	5

What happens to ΔG when T goes up ? WHY?

↑ temp, ↓ ΔG ↑ spontaneous blc particles have ↑ temp

What happens to ΔG when T goes down ? WHY?

ΔG	ΔH	T	ΔS
	7500	300	5
	7500	300	10
	7500	300	15
	7500	300	20
	7500	300	25
	7500	300	30
	7500	300	35
	7500	300	40
	7500	300	45
	7500	300	50

What happens to ΔG when ΔS goes up ? WHY?

↑ ΔS, ↓ ΔG blc more disorder in system = more spontaneous

What happens to ΔG when ΔS goes down ? WHY?

↓ ΔS, ↑ ΔG blc less disorder, less spontaneous

Complete the sentences below.

As the reaction requires less and less energy, its spontaneity will (increase, decrease).

As randomness increases, the free energy will (increase, decrease) because _____

_____

Skip

WORKSHEET #13: PRIMARY PRODUCTIVITY

$$\frac{mg\,O_2}{L} x \frac{0.698mL}{mg} = \frac{mL\,O_2}{L} \qquad \frac{mL\,O_2}{L} x \frac{0.536\,mg\,C\ fixed}{mL\,O_2} = \frac{mg\,C\ fixed}{L}$$

One can determine Primary Productivity by measuring dissolved oxygen in the water (as it is hard to measure it in the air)

1 ml of O_2 = 0.536 mg of Carbon assimilated
mg O_2/L x 0.698 = ml O_2/L; ml O_2/L x 0.536 = mg carbon fixed/L

$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$$

Fill in the table and Graph Net and Gross Productivity vs. % of light

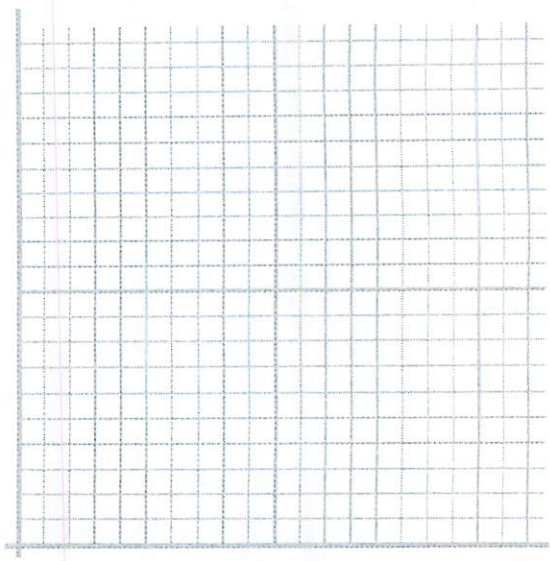
% light	DO_2 (mg O_2/L)	Gross PP = DO_2-dark (mg O_2/L)	Net PP = DO_2 -initial (mg O_2/L)	Gross carbon fixed in mg C/L Gross PP x 0.698 x 0.536
Initial	8.4	—	—	—
Dark	6.2	—	—	—
100%	10.2			
65%	9.7			
25%	9.0			
10%	8.5			
2%	7.1			

Using your data table, what seems to be the trend as the % of light decreases? WHY?

Using your data table, what seems to be the trend as the % of light increases? WHY?

Where would you say this organism is using as much energy as they are making? WHY?

Using your table and graph, explain why most of the time there are bigger plants on land than in the sea? Explain this in terms of evolution.



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WORKSHEET #14: PH AND METRIC SYSTEM

$pH = -\log[H^+]$ $pOH = -\log[OH^-]$ $pH + pOH = 14$ recall $[H^+]$ is really $[H_3O^+]$

Which is more acidic? $[H^+]$ 1.0×10^{-8} or 1.0×10^{-12}

Which is more basic? $[H^+]$ 1.0×10^{-6} or 1.0×10^{-3}

$pH = -\log(H^+)$
$1.5 = -\log(H^+)$

The pH of stomach acid is about 1.5. what is the $[H^+]$?

Blood has a pH of about 7.40. What is the $[H^+]$?

[H+]	Scientific notation	pH	Metric prefix
1 000 000		—	
1 000		—	
100		—	
10		—	
1		—	
0.1			
0.01			
0.001			
0.000 001			
0.000 000 001			
0.005			
0.05			
0.000 026			

Write answers in scientific notation: (NO CALCULATORS)

lie. we can use graphing calculators

$4.00 \times 10^5 \times 2.00 \times 10^3$

$4.00 \times 10^{-5} \times 2.00 \times 10^{-3}$

$4.00 \times 10^5 \times 2.00 \times 10^{-3}$

$4.00 \times 10^{-5} \times 2.00 \times 10^3$

$8.00 \times 10^7 / 2.00 \times 10^3$

$8.00 \times 10^7 / 2.00 \times 10^{-3}$

$8.00 \times 10^{-7} / 2.00 \times 10^3$

$8.00 \times 10^{-7} / 2.00 \times 10^{-3}$

When you divide in scientific notation, you need to _____ the exponents.

When you multiply in scientific notation you need to _____ the exponents.