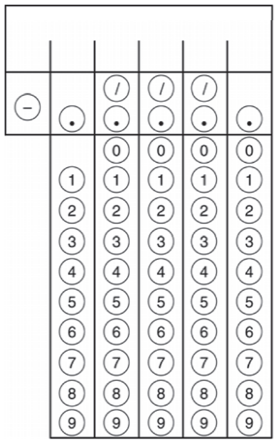
AP Biology Math Review

1) You may use an APPROVED calculator and formula sheet.
2) You will solve each problem and grid in the answer.

Tips for using grid sheet:

- Grid LEFT to right
- Use the formula sheet
- Don't round until the end
- Look at HOW the answer should be given: "Round to nearest…"



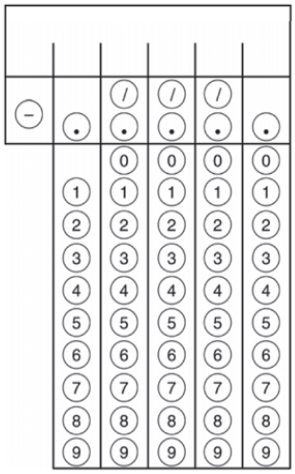
Example: .123

The 1 is in the **tenths** place
The 2 is in the **hundreds** place
The 3 is in the **thousandths** place

Q1: Chi Square

A hetero red eyed female was crossed with a red eyed male. The results are shown below. Red eyes are sex-linked dominant to white, determine **the chi square value.** Round to the nearest hundredth.

Phenotype	# flies observed
Red Eyes	134
White Eyes	66



Chi Square Strategy:

a. Given = observed
b. Calculate the expected, usually do a Punnett square to figure this out how many phenotypes
c. Plug in $X^2 = \frac{(o-e)^2}{e} + \frac{(o-e)^2}{e}$

Q1: Chi Square Answer
Observed = 134 red eyes, 66 white eyes

Expected

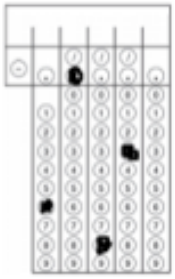
	X^R	X^r
X^R	$X^R X^R$	$X^R X^r$
Y	X^R Y	X^r Y

3:1 ratio

134+ 66=200

150 red

50 white



Chi-Square

$$X^2 = \frac{(o-e)^2}{e}_{\text{red}} + \frac{(o-e)^2}{e}_{\text{white}}$$

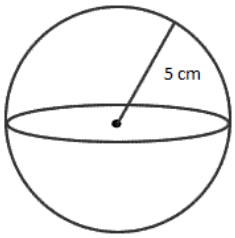
$$X^2 = \frac{(134-150)^2}{150} + \frac{(66-50)^2}{50}$$

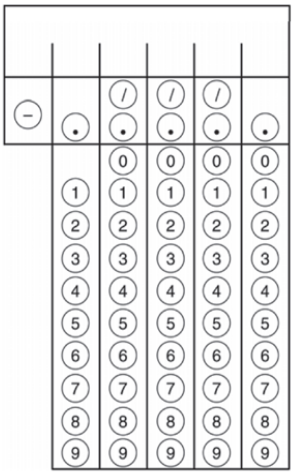
$$X^2 = 1.70666 + 5.12$$

$$X^2 = 6.83$$

Q2: Surface Area and Volume

What is the SA/V for this cell? Round your answer to the nearest hundredths.





Q2: Surface Area and Volume Answer

$SA = 4\pi r^2$

$= 4(3.14)5^2$

$= 314$

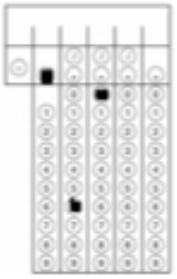
Volume of a sphere $= 4/3\ \pi\ r^3$

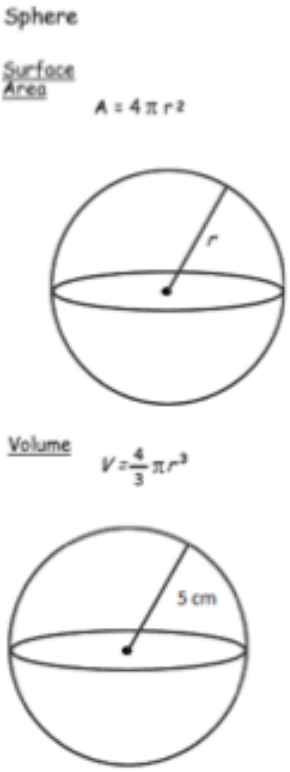
$= 4/3\ (3.14)5^3$

$= 523.33$

$SA/V = 314/523.33$

$= .60$

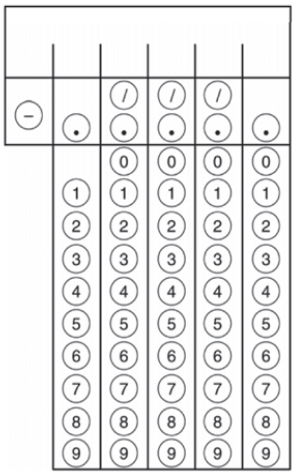




Q3: Water Potential and Solution Potential

- Solute potential= –iCRT
- *i* = The number of particles the molecule will make in water; for NaCl this would be 2; for sucrose or glucose, this number is 1
- *C* = Molar concentration (from your experimental data)
- *R* = Pressure constant = 0.0831 liter bar/mole K
- *T* = Temperature in degrees Kelvin = 273 + °C of solution

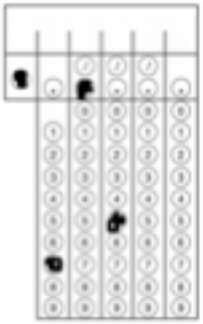
The molar concentration of a sugar solution in an open beaker has been determined to be 0.3M. Calculate the solute potential at 27 degrees Celsius. Round your answer to the nearest tenths.



Q3: Water Potential and Solution Potential Answer

Solute potential= –iCRT
-i= 1
C= 0.3
R = Pressure constant = 0.0831
T= 27 +273=300K

Solute concentration= -7.5

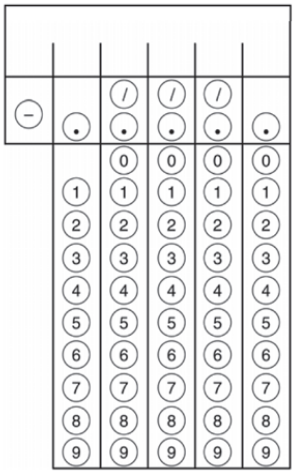


Q4: Hardy Weinberg $p^2 + 2pq + q^2 = 1$

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

Hardy Weinberg Strategy:

a. figure out what you are given: allele (p or q) or genotypes (p^2, 2pq, q^2)
b. figure out what you are solving for (allele frequency, number in population)
c. manipulate formulas to go from given to solving for
d. always give answers in decimals



Q4: Hardy Weinberg Answer

Homozygous Recessive=q^2=24/87= .2758

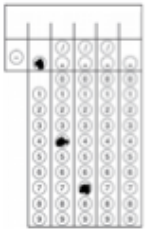
q^2= .2758

$\sqrt{}$

q=.5252

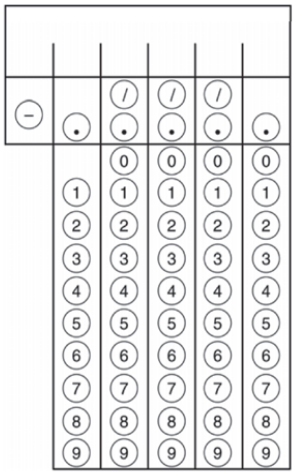
p+q=1

p=.47



Q5: Rate

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 hundreds.

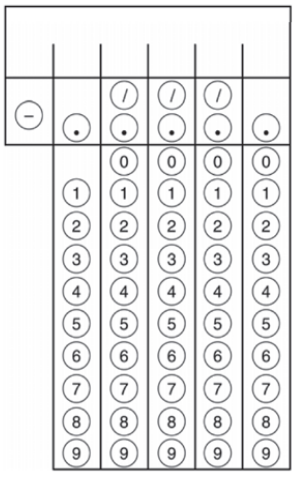


Time (mins)	Amount of O_2 produced (mL)
1	2.3
2	3.6
3	4.2
4	5.5
5	5.9

Q6: Laws of Probability

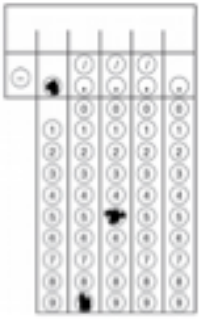
Calculate the probability of tossing three coins simultaneously and obtaining three heads. Express in fraction form.

Q6: Laws of Probability



Q5: Rate Answer

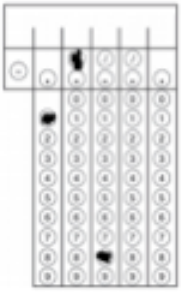
- Rise/run= rate= 5.5-3.6/4-2
- Rise/run= rate=1.9/2
- Rise/run= rate= .95



Q6: Laws of Probability Answer

- Probability of a heads is ½
- Probability of heads AND a heads AND a heads

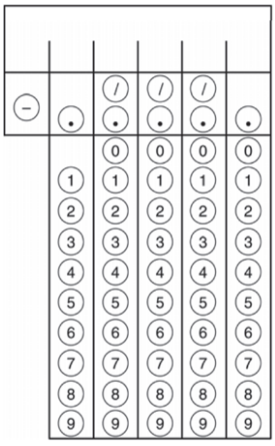
½ X ½ X ½=1/8



Q7: Population Growth

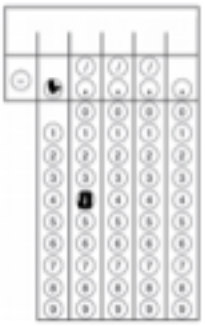
N—total number in pop r—rate of growth

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.



Q7: Population Growth Answer

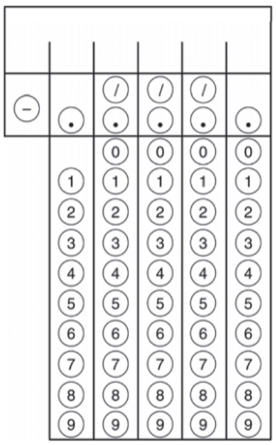
- N=2000
- r_{max}=1000-200=800
- 800/2000= 0.4



Q8: Net Productivity

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.

Q8: Net Productivity



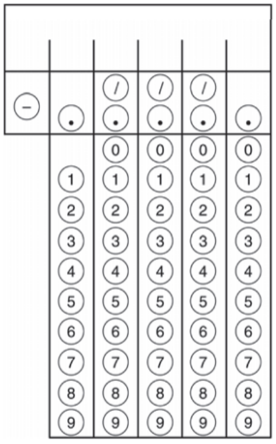
Q9: Q_{10}

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

$$Q_{10} = \left(\frac{k_2}{k_1}\right)^{\frac{10}{t_2 - t_1}}$$

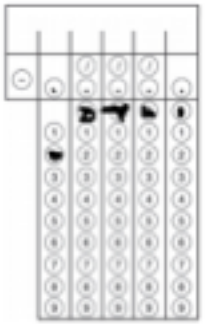
Temperature (C)	Respiration Rate (Min)
16	16
21	22

Q9: Q_{10}



Q8: Net Productivity Answer

- NPP=GPP-R
- 8,000 = GPP – 12,000
- 8,000+ 12,000= GPP
- 20,000=GPP

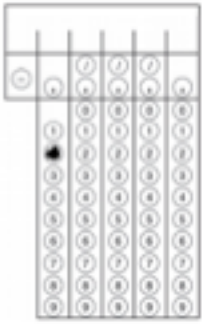


Q9: Q_{10} Answer

$Q_{10} = (22/16)^{10/(21-16)}$

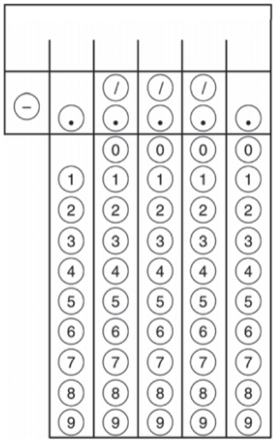
$Q_{10} = (1.375)^{2}$

$Q_{10} = 2$



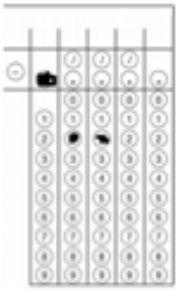
Q10: Standard Deviation

Grasshoppers in Madagascar show variation in their back-leg length. Given the following data, determine the standard deviation for this data. Round the answer to the nearest hundredth.
Length(cm): 2.0, 2.2, 2.2, 2.1, 2.0, 2.4 and 2.5



Q10: Standard Deviation Answer

- Average = 2.0 + 2.2 +2.2+2.1+2.0 +2.4 +2.5/7=2.2
- Deviation = -.2+ 0+ 0+-.1+-.2+.2+.3
- Deviation Squared = .04+0+0+.01+.04 +.04+.09=
- Sum of the Deviations Squared = 0.22

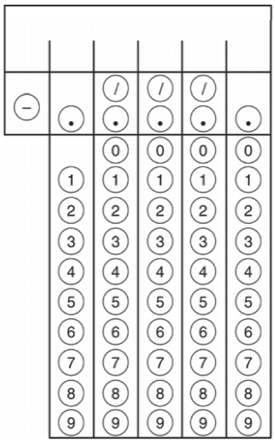


Q11: Dilution

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? Round to the nearest tenths.

$C_1V_1 = C_2V_2$

Q11: Dilution

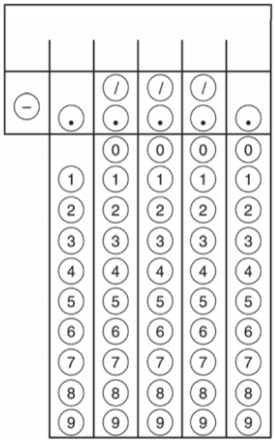


Q12: pH log

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

pH = - log [H+]

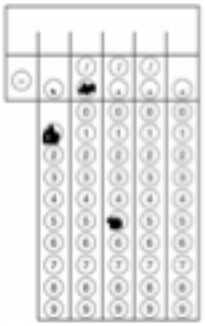
Q12: pH log



Q11: Dilution Answer

We are looking for V_1:

$$C_1V_1 = C_2V_2$$
$$2V_1 = 1(3)$$
$$V_1 = 1.5$$



Q12: pH log Answer

- [H+] if pH = 8.0
- $[H+] = 10^{-pH}$
  $[H+] = 10^{-8.0}$
- $1 \div 10^{8} = 0.00000001$

AP Biology Math Review – Part II

Q13:
Initial mass of pumpkin cores was measured in grams. What is the **average** initial mass for the pumpkin cores? 29.15, 28.45, 30.92, 29.25, 32.09, 31.67.
Round to nearest hundredths.

Q14: $\chi^2 = \sum \frac{(o-e)^2}{e}$

In pea plants, smooth seeds are dominant to wrinkled, and purple flowers are dominant to white. In a dihybrid cross where a 9:3:3:1 ratio is expected, the following data was collected:

Smooth and Purple = 223
Smooth and White = 84
Wrinkled and Purple = 89
Wrinkled and White = 33

Determine the **chi-square value.** Round to nearest hundredths.

Q15: $\chi^2 = \sum \frac{(o-e)^2}{e}$

Two Wisconsin fast plants are crossed. One has the recessive dwarf trait, but the normal pigment anthocyanin, while the other has the recessive anthocyaninless trait, but is on normal height. Their offspring consist of:

89 plants of normal height and pigment
93 anthocyaninless plants and normal height
96 dwarf plants and normal pigment
94 anthocyaninless, dwarf plants

A student proposes that the parent plants' genotype must have been **ddAa** for the dwarf parent and **Ddaa** for the anthocyaninless parent. Calculate the **chi square value** that would be used to confirm this hypothesis. Round to nearest hundredths.

Q16: p2 + 2pq + q2 = 1, p + q = 1

If 250 people out of a population of 1,000 are born with sickle-cell anemia, **how many** people in the population will be more resistant to malaria because they are heterozygous for the sickle-cell gene?

Q17: p2 + 2pq + q2 = 1, p + q = 1

In a population of 250 peas, 16% of the peas are homozygous recessive wrinkled and the rest are smooth. What is the frequency of the dominant allele for smooth peas?

Q18: p2 + 2pq + q2 = 1, p + q = 1

In a population that is Hardy-Weinberg equilibrium, the frequency of the homozygous recessive genotype is 0.09.

a. What is the p and q value for this population?
b. What is the frequency of individuals homozygous for the dominant trait?
c. What is the frequency of individuals that show the dominant trait?

Q19: *SA = l x w, V = l x w x h*

Four blocks of phenolphthalein agar are placed in a vinegar solution. The pH indicator solution changes to pink when in contact with an acidic solution.

Block A: 2 cm x 4 cm x 4 cm
Block B: 2 cm x 8 cm x 4 cm
Block C: 1 cm x 8 cm x 8 cm
Block D: 1 cm x 1 cm x 64 cm

a. Which block would the vinegar solution penetrate most thoroughly into after ten minutes?
b. Which block would have the greatest volume of pink phenolphthalein at the end of ten minutes?

Justify your answer mathematically and relate your predicted results to the **surface area** of your blocks.

Q20: total water potential = pressure potential + solute potential

$\psi_{total} = \psi_p + \psi_s$

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**? Round to nearest hundredths.

Q21: growth rate = dN/dt = rN, r = b-d; dN/dt = $r_{max}N(1 -(N/K))$

A hypothetical population has a carrying capacity of 1,500 individuals and r_{max} is 1.0.

a. Fill out the following table:

Population size	**Population growth rate**
1,600	
1,750	
2,000	

b. What is happening to this population? Why?

Q22: pH = -log [H+]

According to the Acid Rain Monitoring Project at the University of Mass, the pH measured at King Phillip Brook on April 10, 2012, was near 5, which the pH measured at Robbins Pond on that same date was near 9. Determine to the nearest whole number how many times greater the **hydrogen ion concentration** was at King Phillip Brook.

Q23: growth rate = dN/dt = rN, r = b-d; dN/dt = (b-d)N

In 2009, the US had a population of about 307 million people. If there were 14 births and 8 deaths per 1000 people, what was the country's net **population growth** that year (ignore immigration and emigration)? Round to nearest thousandths.

Q13 Answer:

average initial mass = total mass/total number = 181.53/6 = 30.26 grams

Q14 Answer:

Observed	Expected (9:3:3:1)
Smooth and Purple = 223	(9/16) 429 = 241
Smooth and White = 84	(3/16) 429 = 81
Wrinkled and Purple = 89	(3/16) 429 = 81
Wrinkled and White = 33	(1/16) 429 = 27
Total = 429	Total = 429

$$\chi^2 = \sum \frac{(o-e)^2}{e} = \frac{(241-223)^2}{241} + \frac{(81-84)^2}{81} + \frac{(81-89)^2}{81} + \frac{(27-33)^2}{27}$$

$$= 1.34 + 0.11 + 0.79 + 1.33 = \mathbf{3.57}$$

Q15 Answer:

ddAa x Ddaa = 1:1:1:1

Observed	Expected (1:1:1:1)
plants of normal height and pigment = 89	(1/4) 372 = 93
anthocyaninless plants and normal height = 93	(1/4) 372 = 93
dwarf plants and normal pigment = 96	(1/4) 372 = 93
anthocyaninless, dwarf plants = 94	(1/4) 372 = 93
Total = 372	Total = 372

$$\chi^2 = \sum \frac{(o-e)^2}{e} = \frac{(93-89)^2}{93} + \frac{(93-93)^2}{93} + \frac{(93-96)^2}{93} + \frac{(93-94)^2}{93}$$

$$= 0.17 + 0 + 0.10 + .01 = \mathbf{0.28}$$

Q16 Answer:

$250/1000 = 0.25 = aa = q^2$
$q = 0.5$, $p = 1 - q = 0.5$
$2pq = 0.5$; **heterozygous = 0.5 x 1000 = 500**

Q17 Answer:

16% = 0.16 = ss = q^2
q = 0.4, p = 1 - q = **0.6**

Q18 Answer:

a) q = 0.3, p = 0.7 b) p^2 = 0.49 c) 2pq = 0.91
0.09 = q^2
a. q = 0.3, p = 1 - q = 0.7
b. p^2 = 0.49
c. $p^2 + 2pq = 1 - q^2 = 0.91$

Q19 Answer:

Four blocks of phenolphthalein agar are placed in a vinegar solution. The pH indicator solution changes to pink when in contact with an acidic solution.

	Surface area	Volume	SA/V
Block A: 2 cm x 4 cm x 4 cm	64	**32**	2
Block B: 2 cm x 8 cm x 4 cm	112	64	1.75
Block C: 1 cm x 8 cm x 8 cm	160	64	2.5
Block D: 1 cm x 1 cm x 64 cm	258	64	**4.03**

c. Which block would the vinegar solution penetrate most thoroughly into after ten minutes? **D, greater SA/V = faster diffusion**
d. Which block would have the greatest volume of pink phenolphthalein at the end of ten minutes? **A, smallest volume = more diffused inside**

Q20 Answer:

$\psi_{total} = \psi_p + \psi_s$

water potential $\psi_{total} = \psi_p + \psi_s$ = -0.6 MPa + -1.0 MPa = **-1.6 MPa**

Q21 Answer:

logistic growth rate = dN/dt = rN, r = b-d; dN/dt = $r_{max}N(1 -(N/K))$

population number (N)
birth (b)
death (d)
carrying capacity (K)
rate (r)

at N = 1600: dN/dT = 1.0 x 1600 (1 - (1600/1500)) = 1600(1 - 1.06) = - 96

at N = 1750: dN/dT = 1.0 x 1750 (1 - (1750/1500)) = 1750(1 – 1.17) = - 298

at N = 2000: dN/dT = 1.0 x 2000 (1 - (2000/1500)) = 2000 (1 – 1.33) = - 660

Population size	Population growth rate
1,600	-96
1,750	- 298
2,000	- 660

shrinking because over carrying capacity

Q22 Answer:

pH 5: [H+] = 1 x 10^{-5}
pH 9: [H+] = 1 x 10^{-9}
$\frac{1 \times 10^{-9}}{1 \times 10^{-5}}$ = **10000**

Q23 Answer:
logistic growth rate = dN/dt = rN, r = b-d; dN/dt = (b-d)N

N = 307 million
b = 14/1000
d = 8/1000

dN/dt = (b-d)N = (14/1000 – 8/1000) 307 million = **1.842 million**