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Creative Project 1
Practice Exam: Unit 1

1. Bruce Banner was working on a new drug. He makes 13 pills and needs to know the amount of iron in each. If the chemical equation begins with .359 g of Fe_2O_3 , which has a molecular mass of 159.69 g, what is the average mass of iron in each pill?

19.3 mg or .0193 g

2. Dr. Henry McCoy (aka Beast) is hard at work in the lab trying to isolate the mutation responsible for mutants' powers. Unfortunately, the scale he is using was damaged during the Brotherhood's latest attack, so it is .03 g off.

a) What type of error is this?

Systemic error

While preparing a solution, Dr. McCoy adds $1.5 \pm .03$ g of NaCl to 100 mL of water.

b) What is the molarity of this solution? What is the absolute and percent relative error associated with this molarity?

*$1.5 \text{ g NaCl} * (1 \text{ mol} / 58.44 \text{ g}) / .1 \text{ L} = .257 \text{ M molarity}$*

*$.03 \text{ g NaCl} * (1 \text{ mol} / 58.44 \text{ g}) / .1 \text{ L} = .005 \text{ M absolute error}$*

*$.005 \text{ M} / .257 \text{ M} * 100 = 1.95\% \text{ percent relative error}$*

3. The average height of a super villain is 6'3", with a standard deviation of 2.5".

a) Doctor Doom is 6'7". How many standard deviations away from the mean is this? Does this value lie within 95.5% of the area under a Gaussian curve?

$6'7'' - 6'3'' = 4''$

$4'' / 2.5'' = 1.6 \text{ standard deviations away}$

This value does lie within 95.5% of the area under the Gaussian curve as it is within 2 standard deviations

b) Magneto is 6'2". How many standard deviations away from the mean is this? Does this value lie within 68.3% of the Gaussian curve?

$6'2'' - 6'3'' = -1''$

$-1'' / 2.5'' = .04 \text{ standard deviations away}$

This value does lie within 68.3% of the area under the Gaussian curve as it is within a standard deviation of the mean

c) Galactus is 28'3". How many standard deviations away from the mean is this? Does this value lie within 99.7% of the Gaussian curve?

$28'3'' - 6'3'' = 22'$

$22' / 2.5'' = 8.8$

No, because this value is more than 3 standard deviations away

4. Reed Richards and a team of S.H.E.I.L.D. scientists are using different methods to determine the concentration of adamantium in some samples obtained from a raid on a HYDRA base. SHIELD wants to use the cheapest, but still accurate, method.

Table 1

Sample number	Method 1-Richards ($\mu\text{L}/\text{mL}$)	Method 2-SHEILD scientists ($\mu\text{L}/\text{mL}$)	Difference ($x_i - x_j$)
1	20.5	20.3	.2
2	19.3	16.9	2.4
3	17.0	18.6	-1.5
4	18.9	19.6	0.7
5	20.1	19.9	.2
Average	19.2	19.1	0.12
Standard Deviation	1.32	1.36	1.46

- a) How could SHIELD determine whether or not the two methods produce different results?

They could use the student t-test, specifically case 3, which is a paired t-test for comparing individual differences

- b) Calculate the t value for this data

$$t_{\text{calculated}} = .1839$$

- c) The t_{table} value for a 95% confidence interval and 4 degrees of freedom is 2.776. Based on this, and your answer to part b, do these methods generate statistically different results?

No, as the t calc is less than the t table.

- d) The method used by Dr. Richards costs \$20 to analyze one sample, but it takes 24 hours to get results. The method used by SHIELD scientists costs \$30 to analyze one sample, but it only takes 12 hours to get results back. Which method should SHIELD use, and explain your reasoning.

There isn't really a wrong answer for this one; it's just a chance to use your critical thinking skills.

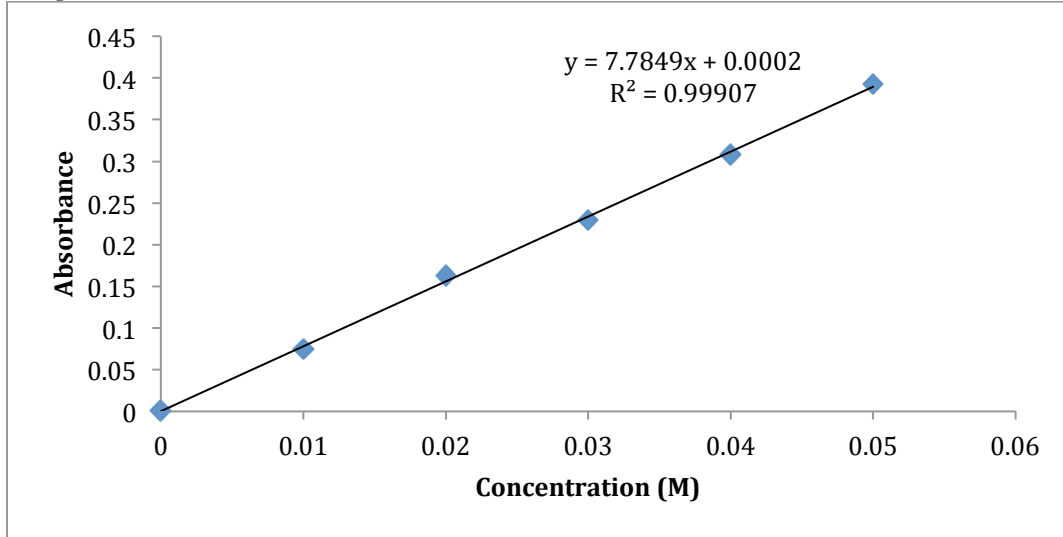
Dr. Richards' method is cheaper, which makes it a better choice financially, however, the SHEILD scientists' method gets results back in half the time, and is not that much more expensive. If there were time constraints it might be better to use that method.

5. Peter Parker is working in the lab and trying to identify the concentration of a solution. Peter has worked with this solution before and he knows that the matrix does not affect the absorbance of the solution.

- a) What method should he use, a calibration curve, standard addition, or an internal standard and why.

A calibration curve would be a reasonable choice for this situation, as there is not interference from the matrix and the exact composition of the solution is known.

Graph 1



- b) Peter analyzes a sample of an unknown concentration and finds it to have an absorbance of .205. What is the concentration of this sample?
.026 M

6. Norman Osborn is working on creating a new goblin serum so that he can defeat Spider-Man once and for all. It's important for him to make sure that the instruments are all functioning properly, as an improperly mixed serum could have disastrous effects. Every 10 samples, Osborn runs a method blank. What is this an example of?

Calibration check

7. Before creating Captain America, Dr. Abraham Erskine created some ineffective serum, as the concentration was too high. Out of the four doses they were 4%, 4.5%, 4.2% and 4.3% over what they should be. This outcome was very ____ but not very ____.

Precise, accurate.

8. Dr. Hank Pym is researching the long-term effects of using Pym particles. He initially developed use objectives and specifications, after which he conducted his experiment. What part of the quality assurance process comes next?

Assessment

9. Tony Stark was working with a solution he created based on the element vibranium. During his experiment he took a calibration curve. Tony's result for r^2 was .689, does that seem reasonable? Why or why not?

No, because the r^2 value should be greater than or equal to .995