Warm Up

AP Exam Review Question

Preface. Our water in Eugene is of fairly high quality according to regular testing. However, you may have heard of the drinking water contamination in Flint, Michigan, in 2014 while you were in elementary or middle school. Thousands of people found out that they had been exposed to lead contamination from their own drinking water. Unfortunately, other similar sites in Michigan have popped up since then. From a recent July 10, 2018 News story from www.mlive.com/news/index.ssf/page/michigans_water_crisis_pfas.html:

> Per- and polyfluoroalkyl substances, known collectively as PFAS or PFCs, are contaminating water supplies and the environment across both peninsulas of Michigan. Sometimes called "forever chemicals" because of their durability, PFAS are the latest industrial wonder compounds to become global pollutants. Under the umbrella acronym PFAS, individual chemicals like PFOS, PFOA, PFHxS, PFNA and many others are generating escalating concern in Michigan and beyond as testing finds them in ever more locations.
>
> To date, more than 30 sites in 15 communities across Michigan have confirmed PFAS contamination in the soil, groundwater or surface water.

In one of those communities lives two of the contributing authors of our textbook. Today's lesson is related to their situation. You can get started on that with the next handout.

Should Rockford switch to bottled water? 9.1 Day 2

The Wolverine Worldwide (a shoe company in Rockford) improperly disposed of chemicals (PFAS), which have leaked into the ground water. The state's drinking water limit of 70 parts per trillion (ppt) is considered safe, while anything above 70 ppt is considered dangerous. Officials believes the water in Rockford may be unsafe. They take a random sample of 200 households in Rockford. They find the average lead level of the sample is 70.5 ppt.

1. State appropriate hypotheses for performing a significance test using words and symbols.

2. After conducting a significance test, a P-value of 0.045 is found. Interpret this value.

3. Based on the P-value, should Rockford keep the current water or switch to bottled water? Explain.

4. Let's suppose this decision is wrong. What would be a consequence of this error?

5. Given the water is safe, how often will this error occur?

Continue on to the back side.

6. Now suppose the P-value was 0.14. Should the town keep the current water or switch to bottled water?

7. Let's suppose this decision is wrong. What would be a consequence of this error?

8. Are the consequences in question #4 or question #7 more serious? Explain.

Type 1 and Type 2 Errors

When we draw conclusions from a significance test we hope our conclusion will be correct. But sometimes it will be wrong. There are two types of errors we can make.

Important ideas:

		Truth about the population	
		H_0 true	H_a true
Conclusion based on sample	Reject H_0	Type I error	Correct conclusion
	Fail to reject H_0	Correct conclusion	Type II error

If H_0 is true:

- Our conclusion is correct if we <u>don't</u> find convincing evidence that H_a is true.
- We make a type I error if we find convincing evidence that H_a is true.

If H_0 is false:

- Our conclusion is correct if we find convincing evidence that H_a is true.
- We make a type II error if we <u>don't</u> find convincing evidence that H_a is true.

Check Your Understanding

The manager of a fast-food restaurant wants to reduce the proportion of drivethru customers who have to wait longer than 2 minutes to receive their food after placing an order. Based on store records, the proportion of customers who had to wait longer than 2 minutes was $p = 0.63$. To reduce this proportion, the manager assigns an additional employee to drive-thru orders. During the next month, the manager collects a random sample of 250 drive-thru times and finds that $\hat{p} = \frac{144}{250} = 0.576$. The manager then performs a test of the following hypotheses at the $\alpha = 0.10$ significance level:

$$H_0: p = 0.63$$
$$H_a: p < 0.63$$

where p = the true proportion of drive-thru customers who have to wait longer than 2 minutes to receive their food.

1. Describe a Type I error and a Type II error in this setting.

2. Which type of error is more serious in this case? Justify your answer.

3. Based on your answer to Question 2, do you agree with the company's choice of $\alpha = 0.10$? Why or why not?

4. The *P*-value of the manager's test is 0.0385. Interpret the *P*-value.