AP Statistics – 6.3N Activity (Revised 2020 to use Z scores)	Name:
Goal: Understand Normal Model as an Approximation to the Binomial Model	Date:

I. Example: Teens and Debit Cards

In a survey of 506 teenagers ages 14-18, subjects were asked a variety of questions about personal finance. One question asked teens if they had a debit card. Suppose that exactly 10% of teens ages 14-18 have debit cards.

(a) Show that the distribution of X is approximately binomial.

Let X = the number of teens in a random sample of size 506 that have a debit card.

B DEBIT OR NO DEBIT CARD

I Sampling without replacement. SINCE THERE ARE MILLIONS OF TEENS AND WE HAVE A SAMPLE OF 506, THE 10% CONDITION HAS BEEN MET.

N FIXED TRIALS $n = 506$

S FIXED Probability $p = 10\%$

This is a binomial distribution → $B(506, .1)$ (n, p)

(b) Check the conditions for using a Normal approximation in this setting.

To use the Normal distribution you must check BOTH np and $n(1-p)$ must be Greater or EQUAL TO 10.

Check:

$np \geq 10$

$506(.1) \geq 10$

$50.6 \geq 10$ ✓

$n(1-p) \geq 10$

$506(.9) \geq 10$

$455.4 \geq 10$ ✓

(c) Use a Normal distribution to estimate the probability that 40 or fewer teens in the sample have debit cards.

USING A NORMAL APPROXIMATION:

(a+b) Conditions met $n = 506$ $p = .1$

On Green Sheet:

$\mu_X = np = 506(.1) = 50.6$

$\sigma_X = \sqrt{np(1-p)} = \sqrt{506(.1)(.9)} = 6.75$

STATE DISTRIBUTION → $N(50.6, 6.75)$

$P(X \leq 40) =$

$P\left(Z \leq \frac{40 - 50.6}{6.75}\right) =$

$P(Z \leq -1.57) =$

.058 ← Normal cdf

THERE is APPROXIMATELY, A 6 % Chance that 40 OR FEWER TEENS will have a debit card.

EXACT PROBABILITY WITH BINOMIAL DISTRIB:

$B(506, .1)$

$P(X \leq 40) = .063$ ← Binomcdf

Remember

① BINOMIAL DISTRIB GRAPH WITH $p = .1$ IS SKewed RIGHT

THEREFORE IT WILL HAVE A LARGER AREA

② As "n" ↑, the distrib. approaches a Normal distrib

II. Notes –see definitions on page 395

The Normal Distribution can be used as an approximation for the binomial distribution

- If... the number of successes and failures are at least 10. *(np ≥10 and n(1-p) ≥10)*
- In English that means – when the number of trials is large, this method can be used.

$$\mu = np$$
$$\sigma = \sqrt{np(1-p)}$$

$$P(x \geq 4000) = P\left(z \geq \frac{x-\mu}{\sigma}\right)$$

MUST

~~Optional to calculate~~ z-score,

but you MUST CLEARLY sketch normal graph.

In the above model, *replace the inequality with less than, etc., whatever is appropriate for the problem you are solving. Additionally, replace the 4000 for your problem.*

Steps:

Step 1: Define the Random Variable and check binomial conditions

Step 2: Check the normal conditions np ≥10 and n(1-p) ≥10

**** You must show BOTH calculations to indicate you verified the normal condition.**

Step 3: Calculate the mean and standard deviation with the formulas above (green sheet); and state the normal model N(μ,σ)

Step 4: Sketch the normal graph (identify area for probability, mean and x-value); and calculate the probability of interest

Step 5: State your conclusion, in the context of the problem.