Dept of Mathematics and Statistics
King Fahd University of Petroleum & Minerals

AS389: Actuarial Science Problem Lab II
Major 1, Term 261
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DATE: Oct. 11, 2025
DURATION: 100 MINUTES

Name: _____ **ID:** _____

Instructions

1. Please turn off your cell phones and place them under your chair. Any student caught with mobile phones on during the exam will be considered under the cheating rules of the University.

2. If you need to leave the room, please do so quietly so not to disturb others taking the test. No two person can leave the room at the same time. No extra exam time will be provided for the time spent outside the room.

3. Only materials provided by the instructor can be present on the table during the exam.

4. Do not spend too much time on any one question. If a question seems too difficult, leave it and go on.

5. Use the blank portions of each page for your work. Extra blank pages can be provided if necessary.

6. While every attempt is made to avoid defective questions, sometimes they do occur. In the rare event that you believe a question is defective, the instructor cannot give you any guidance beyond these instructions.

7. Mobile calculators, I-pad, or communicable devices are disallowed. Use regular scientific calculators, financial calculators, or SOA-approved calculators only.

The test is 100 minutes, GOOD LUCK, and you may begin now!

Work Space

Questions

1. A class contains 8 boys and 7 girls. The teacher selects 3 of the children at random and without replacement. Calculate the probability that number of boys selected exceeds the number of girls selected.

A) $\frac{512}{3375}$ **B)** $\frac{28}{65}$ **C)** $\frac{8}{15}$ **D)** $\frac{1856}{3375}$ **E)** $\frac{36}{65}$

2. There are 97 men and 3 women in an organization. A committee of 5 people is chosen at random, and one of these 5 is randomly designated as chairperson. What is the probability that the committee includes all 3 women and has one of the women as chairperson?

A) $\frac{3(4!97!)}{2(100!)}$ **B)** $\frac{5!97!}{2(100!)}$ **C)** $\frac{3(5!97!)}{2(100!)}$ **D)** $\frac{3!5!97!}{100!}$ **E)** $\frac{3^3 97^2}{100^5}$

3. A box contains 4 red balls and 6 white balls. A sample of size 3 is drawn without replacement from the box. What is the probability of obtaining 1 red ball and 2 white balls, given that at least 2 of the balls in the sample are white?

A) $\frac{1}{2}$ **B)** $\frac{2}{3}$ **C)** $\frac{3}{4}$ **D)** $\frac{9}{11}$ **E)** $\frac{54}{55}$

4. When sent a questionnaire, 50% of the recipients respond immediately. Of those who do not respond immediately, 40% respond when sent a follow-up letter. If the questionnaire is sent to 4 persons and a follow-up letter is sent to any of the 4 who do not respond immediately, what is the probability that at least 3 never respond?

A) $(.3)^4+4(.3)^3(.7)$ **B)** $4(.3)^3(.7)$ **C)** $(.1)^4+4(.1)^3(.9)$ **D)** $.4(.3)(.7)^3+(.7)^4$ **E)** $(.9)^4+4(.9)^3(.1)$

5. A survey of 100 TV watchers revealed that over the last year:

i) 34 watched CBS.
ii) 15 watched NBC.
iii) 10 watched ABC.
iv) 7 watched CBS and NBC.
v) 6 watched CBS and ABC.
vi) 5 watched NBC and ABC.
vii) 4 watched CBS, NBC, and ABC.
viii) 18 watched HGTV and of these, none watched CBS, NBC, or ABC.

Calculate how many of the 100 TV watchers did not watch any of the four channels (CBS, NBC, ABC or HGTV).

A) 1 B) 37 C) 45 D) 55 E) 82

6. $\lim_{N\to\infty} \frac{5^N}{N!} =$

A) 0 **B)** $\frac{1}{2}$ **C)** $5\ln 5$ **D)** $+\infty$ **E) None of A,B,C,D**

7. An auto insurance company has 10,000 policyholders. Each policyholder is classified as (i) young or old; (ii) male or female; and (iii) married or single. Of these policyholders, 3000 are young, 4600 are male, and 7000 are married. The policyholders can also be classified as 1320 young males, 3010 married males, and 1400 young married persons. Finally, 600 of the policyholders are young married males. How many of the company's policyholders are young, female, and single?

A) 280 B) 423 C) 486 D) 880 E) 896

8. The probability that a visit to a primary care physician's (PCP) office results in neither lab work nor referral to a specialist is 35%. Of those coming to a PCP's office, 30% are referred to specialists and 40% require lab work. Determine the probability that a visit to a PCP's office results in both lab work and referral to a specialist.

A) 0.05 B) 0.12 C) 0.18 D) 0.25 E) 0.35

9. You are given $P[A \cup B] = 0.7$ and $P[A \cup B'] = 0.9$. Determine $P[A]$.

A) 0.2 B) 0.3 C) 0.4 D) 0.6 E) 0.8

10. A survey of a group's viewing habits over the last year revealed the following information:

(i) 28% watched gymnastics

(ii) 29% watched baseball

(iii) 19% watched soccer

(iv) 14% watched gymnastics and baseball

(v) 12% watched baseball and soccer

(vi) 10% watched gymnastics and soccer

(vii) 8% watched all three sports.

Calculate the percentage of the group that watched none of the three sports during the last year.

A) 24 B) 36 C) 41 D) 52 E) 60

11. A ball is drawn at random from a box containing 10 balls numbered sequentially from 1 to 10. Let X be the number of the ball selected, let R be the event that X is an even number, let S be the event that $X \geq 6$, and let T be the event that $X \leq 4$. Which of the pairs (R, S), (R, T), and (S, T) are independent?

A) (R, S) **only** **B)** (R, T) **only** **C)** (S, T) **only** **D)** (R, S) **and** (R, T) **only** **E)** (R, S)**,** (R, T) **and** (S, T)

12. A health study tracked a group of persons for five years. At the beginning of the study, 20% were classified as heavy smokers, 30% as light smokers, and 50% as nonsmokers. Results of the study showed that light smokers were twice as likely as nonsmokers to die during the five-year study, but only half as likely as heavy smokers. A randomly selected participant from the study died over the five-year period. Calculate the probability that the participant was a heavy smoker.

A) 0.20 **B) 0.25** **C) 0.35** **D) 0.42** **E) 0.57**

13. If E_1, E_2 and E_3 are events such that $P[E_1|E_2] = P[E_2|E_3] = P[E_3|E_1] = p$, $P[E_1 \cap E_2] = P[E_1 \cap E_3] = P[E_2 \cap E_3] = r$, and $P[E_1 \cap E_2 \cap E_3] = s$, find the probability that at least one of the three events occurs.

A) $1 - \frac{r^3}{p^3}$ **B)** $\frac{3p}{r} - r + s$ **C)** $\frac{3r}{p} - 3r + s$ **D)** $\frac{3p}{r} - 6r + s$ **E)** $\frac{3r}{p} - r + s$

14. A public health researcher examines the medical records of a group of 937 men who died in 1999 and discovers that 210 of the men died from causes related to heart disease. Moreover, 312 of the 937 men had at least one parent who suffered from heart disease, and, of these 312 men, 102 died from causes related to heart disease. Determine the probability that a man randomly selected from this group died of causes related to heart disease, given that neither of his parents suffered from heart disease.

A) 0.115 B) 0.173 C) 0.224 D) 0.327 E) 0.514

15. Two life insurance policies, each with a death benefit of 10,000 and a one-time premium of 500, are sold to a couple, one for each person. The policies will expire at the end of the tenth year. The probability that only the wife will survive at least ten years is 0.025, the probability that only the husband will survive at least ten years is 0.01, and the probability that both of them will survive at least ten years is 0.96. What is the expected excess of premiums over claims, given that the husband survives at least ten years?

A) 350 B) 385 C) 397 D) 870 E) 897

16. X_1 and X_2 are two independent random variables, but they have the same density function $f(x) = \begin{cases} 2x & \text{for } 0 < x < 1 \\ 0, & \text{elsewhere} \end{cases}$. Find the probability that the maximum of X_1 and X_2 is at least .5.

A) .92 B) .94 C) .96 D) .98 E) 1.00

17. For two random variables, the "distance" between two distributions is defined to be the maximum, $\max_{allx} |F_1(x) - F_2(x)|$ over the range for which F_1 and F_2 are defined, where $F(x)$ is the cumulative distribution function. Find the distance between the following two distributions: (i) uniform on the interval $[0, 1]$, (ii) pdf is $f(x) = \frac{1}{(x+1)^2}$ for $0 < x < \infty$.

A) 0 B) $\frac{1}{4}$ **C)** $\frac{1}{2}$ **D)** $\frac{3}{4}$ **E) 1**

18. A family health insurance policy pays the total of the first three claims in a year. If there is one claim during the year, the amount claimed is uniformly distributed between 100 and 500. If there are two claims in the year, the total amount claimed is uniformly distributed between 200 and 1000, and if there are three claims in the year, the total amount claimed is uniformly distributed between 500 and 2000. The probabilities of 0, 1, 2 and 3 claims in the year are .5, .3, .1, .1 respectively. Find the probability that the insurer pays at least 500 in total claims for the year.

A) .10 B) .12 C) .14 D) .16 E) .18

19. Question 19 and 20 relate to the following information. Smith begins a new job at a salary of 100,000. Smith expects to receive a 5% raise every year until he retires.

Suppose that Smith works for 35 years. Determine the total salary earned over Smith's career (nearest million).

A) 5 B) 6 C) 7 D) 8 E) 9

20. At the end of each year, Smith's employer deposits 3% of Smith's salary (for the year just finished) into a fund earning 4% per year compounded each year. Find the value of the fund just after the final deposit at the end of Smith's 35th year of employment (nearest 10,000).

A) 450,000 B) 460,000 C) 470,000 D) 480,000 E) 490,000

Answer Key

1. E

2. A

3. C

4. A

5. B

6. A

7. D

8. A

9. D

10. D

11. B

12. D

13. C

14. B

15. E

16. B

17. C

18. D

19. E

20. C

Solutions

1. Solution: Total children = 15 (8 boys, 7 girls). Select 3 without replacement. We want the number of boys selected to exceed the number of girls selected. Possible cases: 2 boys and 1 girl, or 3 boys and 0 girls.

$$P(\text{2 boys, 1 girl}) = \frac{\binom{8}{2}\binom{7}{1}}{\binom{15}{3}} = \frac{28 \times 7}{455} = \frac{196}{455}$$

$$P(\text{3 boys, 0 girls}) = \frac{\binom{8}{3}\binom{7}{0}}{\binom{15}{3}} = \frac{56 \times 1}{455} = \frac{56}{455}$$

$$P(\text{boys} > \text{girls}) = \frac{196 + 56}{455} = \frac{252}{455} = \frac{36}{65}$$

Answer: **E)** $\frac{36}{65}$

2. Solution: Total people = 100. We need a committee of 5 that includes all 3 women, and one of the women is the chairperson.

Number of ways to choose the committee: - Choose all 3 women: $\binom{3}{3} = 1$ - Choose 2 men from 97: $\binom{97}{2} = \frac{97 \times 96}{2} = 4656$

Number of ways to choose a chairperson from the 3 women: 3 ways.

Total favorable outcomes: $4656 \times 3 = 13968$

Total ways to choose 5 people from 100 and designate a chairperson:

$$\binom{100}{5} \times 5 = \frac{100!}{5! \cdot 95!} \times 5$$

Probability:

$$P = \frac{3 \times \binom{97}{2}}{\binom{100}{5} \times 5} = \frac{3 \times \frac{97!}{2! \cdot 95!}}{\frac{100!}{5! \cdot 95!} \times 5} = \frac{3 \times \frac{97!}{2}}{\frac{100!}{120} \times 5} = \frac{3 \times 97! \times 120}{2 \times 100! \times 5}$$

$$= \frac{3 \times 97! \times 120}{10 \times 100!} = \frac{36 \times 97!}{100!} = \frac{3(4! \times 97!)}{2(100!)}$$

Answer: **A)** $\frac{3(4!97!)}{2(100!)}$

3. Solution: Box has 4 red and 6 white balls. Sample size 3 without replacement. We want P(1 red, 2 white — at least 2 white).

$$P[R, 2W \mid \text{at least } 2W] = \frac{P[R, 2W]}{P[\text{at least } 2W]} = \frac{\binom{4}{1}\binom{6}{2}}{\binom{4}{1}\binom{6}{2} + \binom{4}{0}\binom{6}{3}}$$

$$= \frac{4 \times 15}{4 \times 15 + 1 \times 20} = \frac{60}{60 + 20} = \frac{60}{80} = \frac{3}{4}$$

Answer: **C)** $\frac{3}{4}$

4. Solution: Let p = probability a person never responds. - Respond immediately: 0.5 - Do not respond immediately: 0.5 - Of those, 40% respond to follow-up: $0.5 \times 0.4 = 0.2$ - Never respond: $0.5 \times 0.6 = 0.3$

So $p = 0.3$ (never respond), $q = 0.7$ (respond eventually).

We want P(at least 3 never respond) = P(3 never) + P(4 never):

$$P(\text{3 never}) = \binom{4}{3}(0.3)^3(0.7) = 4(0.3)^3(0.7)$$

$$P(\text{4 never}) = (0.3)^4$$

$$P(\text{at least 3 never}) = (0.3)^4 + 4(0.3)^3(0.7)$$

Answer: **A)** $(.3)^4 + 4(.3)^3(.7)$

5. Solution: Use inclusion-exclusion for CBS, NBC, ABC:

$$|C \cup N \cup A| = 34 + 15 + 10 - (7 + 6 + 5) + 4 = 59 - 18 + 4 = 45$$

HGTV watchers: 18, and none watched CBS, NBC, or ABC.

Total watching at least one of the 4 channels: $45 + 18 = 63$

Not watching any: $100 - 63 = 37$

Answer: **B) 37**

6. Solution: Consider the series $\sum_{N=0}^{\infty} \frac{5^N}{N!} = e^5$, which converges. Therefore, the terms $\frac{5^N}{N!} \to 0$ as $N \to \infty$.

Answer: **A) 0**

7. Solution: We use the given information to find the number of young, female, and single policyholders.

Let Y = young, F = female, S = single.

Given: - Total = 10,000 - Young = 3,000 - Male = 4,600 - Married = 7,000 - Young males = 1,320 - Married males = 3,010 - Young married = 1,400 - Young married males = 600

We want $N(Y \cap F \cap S)$:

$$N(Y \cap F \cap S) = N(Y \cap F) - N(Y \cap F \cap M)$$

$N(Y \cap F) = N(Y) - N(Y \cap M) = 3000 - 1320 = 1680$

$N(Y \cap F \cap M) = N(Y \cap M) - N(Y \cap M \cap S)$

We need $N(Y \cap M \cap S) = N(Y \cap M) - N(Y \cap M \cap \text{Married})$

$N(Y \cap M \cap \text{Married}) = 600$ (given)

$N(Y \cap M \cap S) = 1320 - 600 = 720$

$N(Y \cap F \cap \text{Married}) = N(Y \cap \text{Married}) - N(Y \cap M \cap \text{Married}) = 1400 - 600 = 800$

$N(Y \cap F \cap S) = N(Y \cap F) - N(Y \cap F \cap \text{Married}) = 1680 - 800 = 880$

Answer: **D) 880**

8. Solution: Let L = lab work, R = referral. Given: $P(L^c \cap R^c) = 0.35$, $P(R) = 0.30$, $P(L) = 0.40$.

We want $P(L \cap R)$.

$P(L \cup R) = 1 - P(L^c \cap R^c) = 1 - 0.35 = 0.65$

$P(L \cup R) = P(L) + P(R) - P(L \cap R) = 0.40 + 0.30 - P(L \cap R) = 0.65$

$P(L \cap R) = 0.70 - 0.65 = 0.05$

Answer: **A) 0.05**

9. Solution: Given $P(A \cup B) = 0.7$ and $P(A \cup B') = 0.9$.

$P(A \cup B') = P(A) + P(B') - P(A \cap B') = P(A) + (1 - P(B)) - (P(A) - P(A \cap B)) = 1 - P(B) + P(A \cap B)$

$P(A \cup B) = P(A) + P(B) - P(A \cap B) = 0.7$

Adding the two equations:

$$P(A \cup B) + P(A \cup B') = 0.7 + 0.9 = 1.6$$

But $P(A \cup B) + P(A \cup B') = P(A) + P(B) - P(A \cap B) + 1 - P(B) + P(A \cap B) = P(A) + 1$

So $P(A) + 1 = 1.6 \Rightarrow P(A) = 0.6$

Answer: **D) 0.6**

10. Solution: Let G = gymnastics, B = baseball, S = soccer.

Given: - $P(G) = 0.28$, $P(B) = 0.29$, $P(S) = 0.19$ - $P(G \cap B) = 0.14$, $P(B \cap S) = 0.12$, $P(G \cap S) = 0.10$ - $P(G \cap B \cap S) = 0.08$

Use inclusion-exclusion:

$$P(G \cup B \cup S) = 0.28 + 0.29 + 0.19 - (0.14 + 0.12 + 0.10) + 0.08 = 0.76 - 0.36 + 0.08 = 0.48$$

$$P(\text{none}) = 1 - 0.48 = 0.52 = 52\%$$

Answer: **D) 52**

11. Solution: $X \in \{1, 2, \ldots, 10\}$.

$R = \{2, 4, 6, 8, 10\}$, $P(R) = 0.5$ $S = \{6, 7, 8, 9, 10\}$, $P(S) = 0.5$ $T = \{1, 2, 3, 4\}$, $P(T) = 0.4$

Test (R, S): $R \cap S = \{6, 8, 10\}$, $P(R \cap S) = 0.3$. $P(R)P(S) = 0.5 \times 0.5 = 0.25$. Not independent.

Test (R, T): $R \cap T = \{2, 4\}$, $P(R \cap T) = 0.2$. $P(R)P(T) = 0.5 \times 0.4 = 0.2$. Independent.

Test (S, T): $S \cap T = \emptyset$, $P(S \cap T) = 0$. $P(S)P(T) = 0.5 \times 0.4 = 0.2$. Not independent.

Only (R, T) is independent.

Answer: **B)** (R, T) **only**

12. Solution: Let D = dies. Let $P(D|N) = k$. Then: - $P(D|L) = 2k$ - $P(D|H) = 4k$

Given: $P(N) = 0.5$, $P(L) = 0.3$, $P(H) = 0.2$

$$P(D \cap N) = 0.5k, \quad P(D \cap L) = 0.6k, \quad P(D \cap H) = 0.8k$$

$$P(D) = 0.5k + 0.6k + 0.8k = 1.9k$$

$$P(H|D) = \frac{P(H \cap D)}{P(D)} = \frac{0.8k}{1.9k} = \frac{8}{19} \approx 0.42$$

Answer: **D) 0.42**

13. Solution: From $P(E_1|E_2) = \frac{P(E_1 \cap E_2)}{P(E_2)} = p$, we get $P(E_2) = \frac{r}{p}$.

Similarly, $P(E_1) = \frac{r}{p}$ and $P(E_3) = \frac{r}{p}$.

$$P(E_1 \cup E_2 \cup E_3) = P(E_1) + P(E_2) + P(E_3) - P(E_1 \cap E_2) - P(E_1 \cap E_3) - P(E_2 \cap E_3) + P(E_1 \cap E_2 \cap E_3)$$

$$= \frac{3r}{p} - 3r + s$$

Answer: **C)** $\frac{3r}{p} - 3r + s$

14. Solution: Total = 937. Heart disease deaths $(DH) = 210$. Parent with heart disease $(PH) = 312$. $DH \cap PH = 102$.

$PH' = 937 - 312 = 625$ $DH \cap PH' = 210 - 102 = 108$

$$P(DH|PH') = \frac{108}{625} = 0.1728 \approx 0.173$$

Answer: **B) 0.173**

15. Solution: Let W = wife survives 10 years, H = husband survives 10 years.

Given: $P[W \cap H'] = .025$, $P[W' \cap H] = .01$, $P[W \cap H] = .96$.

$P[H] = P[W \cap H] + P[W' \cap H] = .96 + .01 = .97$.

Given the husband survives at least 10 years, the probability that the wife survives at least 10 years is:

$$P[W|H] = \frac{P[W \cap H]}{P[H]} = \frac{.96}{.97}$$

The probability that the wife does not survive at least 10 years:

$$P[W'|H] = \frac{P[W' \cap H]}{P[H]} = \frac{.01}{.97}$$

Given that the husband survives 10 years, the claim will either be 0 if the wife survives 10 years, and 10,000 if the wife does not survive 10 years.

Expected claim given husband survives:

$$(0) \cdot P[W|H] + (10,000) \cdot P[W'|H] = 10,000 \cdot \frac{.01}{.97} = 103.09$$

Total premium = 1,000. Excess premium over expected claim:

$$1000 - 103.09 = 896.91 \approx 897$$

Answer: **E) 897**

16. Solution: $f(x) = 2x$ for $0 < x < 1$. CDF: $F(x) = x^2$.

For $M = \max(X_1, X_2)$: $F_M(m) = P(M \leq m) = P(X_1 \leq m)P(X_2 \leq m) = (m^2)(m^2) = m^4$.

$P(M \geq 0.5) = 1 - P(M < 0.5) = 1 - F_M(0.5) = 1 - (0.5)^4 = 1 - 0.0625 = 0.9375 \approx 0.94$

Answer: **B) .94**

17. Solution: (i) Uniform on $[0, 1]$: $F_1(x) = x$ for $0 \leq x \leq 1$, and $F_1(x) = 1$ for $x > 1$.

(ii) $f(x) = \frac{1}{(x+1)^2}$ for $x > 0$. CDF: $F_2(x) = \int_0^x \frac{1}{(t+1)^2} dt = 1 - \frac{1}{x+1}$ for $x > 0$.

For $0 \leq x \leq 1$: $|F_1(x) - F_2(x)| = |x + \frac{1}{x+1} - 1|$, which is maximized at either $x = 0, 1$ or a critical point.

$|F_1(0) - F_2(0)| = 0$, $|F_1(1) - F_2(1)| = \frac{1}{2}$.

For $x > 1$: $|F_1(x) - F_2(x)| = |1 + \frac{1}{x+1} - 1| = \frac{1}{x+1}$, which decreases.

The distance between the two distributions is $\frac{1}{2}$.

Answer: **C)** $\frac{1}{2}$

18. Solution: Let N = number of claims. $P(N = 0) = 0.5$, $P(N = 1) = 0.3$, $P(N = 2) = 0.1$, $P(N = 3) = 0.1$.

If $N = 0$: payment = 0. $P(\text{pay} \geq 500) = 0$.

If $N = 1$: uniform on $[100, 500]$. $P(\text{pay} \geq 500) = 0$.

If $N = 2$: uniform on $[200, 1000]$. $P(\text{pay} \geq 500) = \frac{1000-500}{1000-200} = \frac{500}{800} = 0.625$.

If $N = 3$: uniform on $[500, 2000]$. $P(\text{pay} \geq 500) = 1$.

Total: $0.5(0) + 0.3(0) + 0.1(0.625) + 0.1(1) = 0.0625 + 0.1 = 0.1625$

Answer: **D) .16**

19. Solution: Salary: 100,000 in year 1, growing at 5% per year.

Year k salary: $100,000 \times (1.05)^{k-1}$

Total over 35 years:

$$S = 100,000 \sum_{k=0}^{34} (1.05)^k = 100,000 \times \frac{(1.05)^{35} - 1}{1.05 - 1}$$

$(1.05)^{35} \approx 5.516, \quad S = 100,000 \times \dfrac{5.516 - 1}{0.05} = 100,000 \times \dfrac{4.516}{0.05} = 100,000 \times 90.32 = 9,032,000$

Nearest million: 9

Answer: **E) 9**

20. Solution: The value at end of 35 years of deposits is:

$$100,000(.03)(1.04)^{34} + 100,000(.03)(1.05)(1.04)^{33} + 100,000(.03)(1.05)^2(1.04)^{32} + \cdots + 100,000(.03)(1.05)^{34}$$

$$= 100,000(.03)\left[(1.04)^{34} + (1.05)(1.04)^{33} + (1.05)^2(1.04)^{32} + \cdots + (1.05)^{34}\right]$$

This represents accumulation of 1st yr. deposit, 2nd year deposit, 3rd year deposit, ..., 34th year deposit, and 35th year deposit. If we factor out $(1.04)^{34}$ the sum becomes:

$$100,000(.03)(1.04)^{34}\left[1 + \frac{1.05}{1.04} + \left(\frac{1.05}{1.04}\right)^2 + \cdots + \left(\frac{1.05}{1.04}\right)^{33} + \left(\frac{1.05}{1.04}\right)^{34}\right]$$

$$= 100,000(.03)(1.04)^{34}\left[\frac{\left(\frac{1.05}{1.04}\right)^{35} - 1}{\frac{1.05}{1.04} - 1}\right] = 470,978$$

Nearest 10,000: 470,000

Answer: **C) 470,000**