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QUESTION 1

Musical instruments generate vibrations in the air that are perceived as musical tones. In many kinds of drums, these vibrations are created by a standing waves in a vibrating membrane. In a timpani drum, membrane vibration is coupled to the vibration of an enclosed volume of air. There may also be a second membrane whose vibration is coupled to that of the first by the enclosed air space, as in a snare drum. An idealized circular membrane will vibrate at normal mode frequencies given by Equation 1 where T is the membrane tension, r is the membrane radius, σ is the mass per unit area of the membrane, and f_{rel} is the relative frequency shown under each mode in Figure 1. The pitch of drums can be tuned by adjusting the membrane tension.

$$f_{mm} = \frac{2.40 \times f_{rel}}{2\pi r} \sqrt{\frac{T}{\sigma}}$$

Equation 1

The modes are designated by two numbers, m and n . m indicates the number of diameter nodes, and n indicates the number of circular nodes. Several modes of vibration are shown in Figure 1.

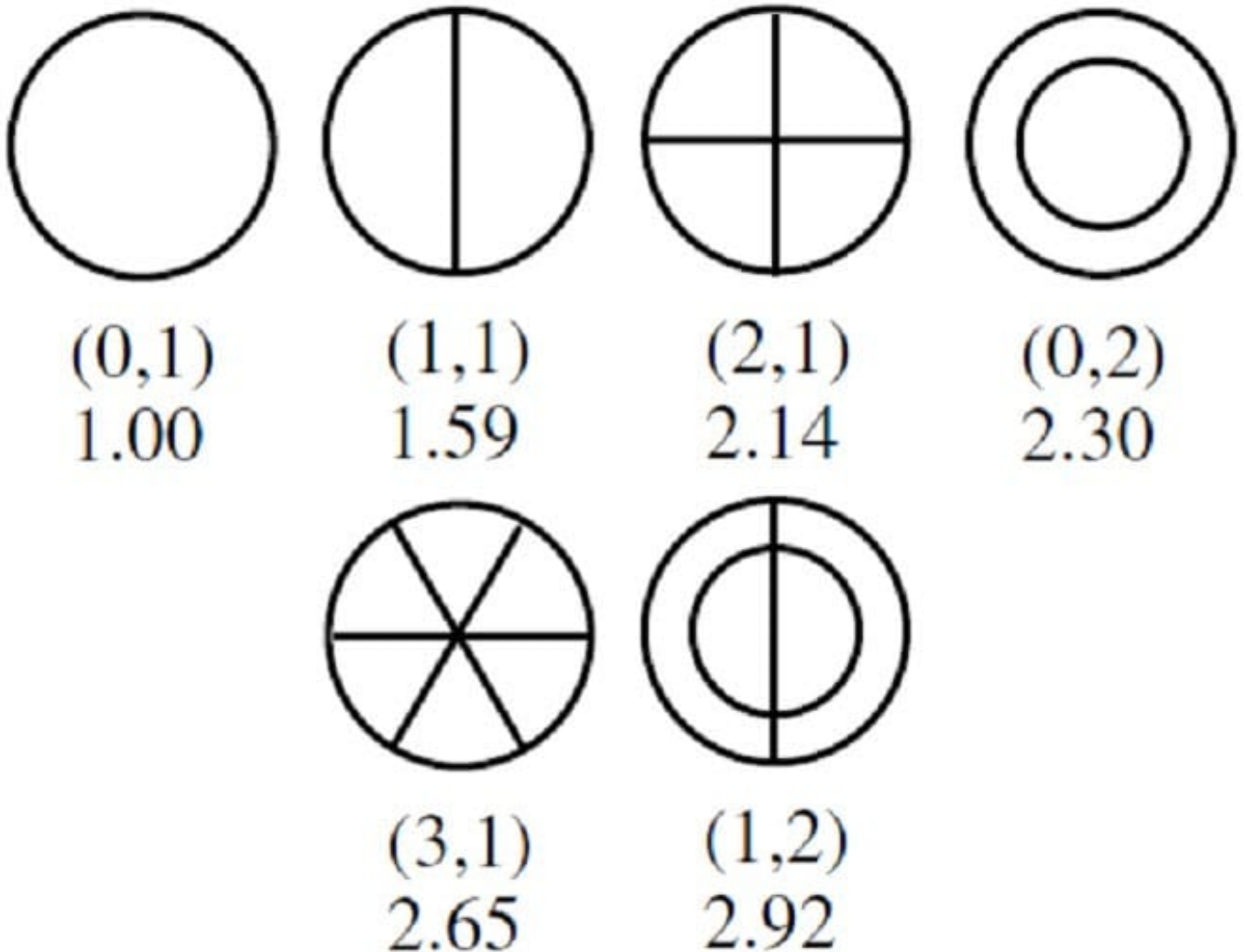




Figure 1

Which of the following combinations of modal frequencies would generate the highest beat frequency?

- A. (0,1) and (2,1)
- B. (0,1) and (0,2)
- C. (1,1) and (3,1)
- D. (2,1) and (1,2)

Correct Answer: B

Sounds that differ in their frequency produce "beats" of high amplitude by interference at a frequency equal to the difference between their frequencies. The greater the difference in frequencies between the two sounds, the greater will be the frequency of the beats produced. Musicians may use beats to help tune instruments. When an instrument is tuned to a known frequency, the beats will slow down, then disappear when the frequencies are equal.

$$\text{Freq}_{\text{beats}} = \text{Freq}_1 - \text{Freq}_2$$

The relative frequencies given in Figure 1 are directly proportional to the actual frequency of vibration, so we can compare them directly. Among the choices, the greatest difference is between the (0,1) and (0,2) modes.

QUESTION 2

Family violence, such as domestic violence, child abuse, and elder abuse, are serious and pervasive problems in the United States. On an annual basis, the National Crime Survey has found domestic violence results in 21000 hospitalizations, 99800 days of hospitalization, 28700 emergency department visits, and 39900 visits to physicians.

Currently there is little consensus about the definitions of intimate violence. Even the terms employed are varied; for example, domestic violence, conjugal violence, intimate abuse, and partner abuse. Similarly, there are a range of causal explanations, and these are contingent upon the theoretical perspective employed. There is also controversy whether the term "violence," "abuse," or "aggression" should be used. Finally, within the terms adopted, there is no consensus about the victim-perpetrator relationship. For example, do the terms refer to a married co-habiting couple? Two heterosexual individuals who do not reside together but are dating? All this has implications for research, practice, and policy.

The National Violence Against Women Survey was one of the largest studies sponsored by the National Institute of Justice and the Centers for Disease Control and Prevention. It systematically analyzed crime against women in the United States. A total of 8000 men and 8000 women in the United States were interviewed on the phone using a closed-ended survey. Table 1 displays the breakdown of figures when examining life time victimization by racial groups.

Table 1 Percentage of people victimized by an intimate partner in lifetime, by victim gender, type of victimization, and victim race



| | Persons Victimized in Lifetime (%) | | | | |
|--|------------------------------------|------------------|------------------------|-------------------------------|------------|
| Victim Gender/Type of Victimization | White | African-American | Asian Pacific Islander | American Indian/Alaska Native | Mixed Race |
| Women | n = 6452 | n = 780 | n = 133 | n = 88 | n = 397 |
| Rape | 7.7 | 7.4 | 3.8 | 15.9 | 8.1 |
| Physical assault | 21.3 | 26.3 | 12.8 | 30.7 | 27.0 |
| Stalking | 4.7 | 4.2 | - | 10.2 | 6.3 |
| Total victimized | 24.8 | 29.1 | 15.0 | 37.5 | 30.2 |
| Men | n = 6424 | n = 659 | n = 165 | n = 105 | n = 406 |
| Rape | 0.2 | 0.9 | - | - | - |
| Physical assault | 7.2 | 10.8 | - | 11.4 | 8.6 |
| Stalking | 0.6 | 1.1 | - | - | 1.2 |
| Total victimized | 7.5 | 12.0 | 3.0 | 12.4 | 9.1 |
| - Estimates not calculated on fewer than five victims. | | | | | |

Source: Adapted from P Tjaden and N. Thoennes, "Consequences of Intimate Partner Violence: Findings from the National Violence Against Women Survey."

Which of the following methodological procedures would NOT help to assure that the findings in Table 1 allow drawing valid and reliable conclusions about differences in victimization incidence across race groups?

- A. Verify whether the population in the US shows or does not show the same proportion of races as that found for the study illustrated in Table 1.
- B. Create equal sample sizes and test whether group differences are significant, like through ANOVA.
- C. Verify whether the samples per condition are or are not fairly equivalent in term of demographic characteristics, such



as age, place of residence, and employment status.

D. Verify whether race groups are or are not strongly and significantly correlated to the number of victimization incidents.

Correct Answer: D

D is correct. Correlations are association tests that can be applied only when there are at least ordinal variables under study. The study illustrated in Table 1 includes one at least ordinal variable: amount of victimization incidents. This is a quantitative variable. However, race groups are a nominal variable. Thus, correlations could not be applied to help to assure that valid and reliable conclusions about race group differences in victimization incidence can be drawn. A. This is incorrect. Verifying whether the population in the US shows or does not show the same proportion of races as that found for the study illustrated in Table 1 would help to understand whether the race groups are representative of the population. Representativeness is critical for drawing valid conclusions about differences in victimization incidence; it helps to understand whether findings can be generalized to the overall population. B. This is incorrect. The race-group sample sizes in the study illustrated in Table 1 are fairly dissimilar. Tests such as ANOVA, that test whether group differences are significant, require the fulfillment of a series of conditions, one of which being the similarity of sample sizes per condition. Thus, if groups of equal sizes were formed from the study data, researchers could test statistically whether differences in incidence of victimization across race groups were or not significant. C. This is incorrect. Verifying whether the samples per condition are or not fairly equivalent in term of demographic characteristics, such as age, place of residence, and employment status, would provide an idea of whether the groups are "matched". Matched samples are those which are fairly similar in terms of demographic traits. This procedure helps to minimize the odds of the presence of confounding variables, and as such contributes to the validity of conclusions.

QUESTION 3

The polymerase chain reaction (PCR) is a powerful biological tool that allows the rapid amplification of any fragment of DNA without purification. In PCR, DNA primers are made to flank the specific DNA sequence to be amplified. These primers are then extended to the end of the DNA molecule with the use of a heat-resistant DNA polymerase. The newly synthesized DNA strand is then used as the template to undergo another round of replication.

The 1st step in PCR is the melting of the target DNA into 2 single strands by heating the reaction mixture to approximately 94 °C, and then rapidly cooling the mixture to allow annealing of the DNA primers to their specific locations. Once the primer has annealed, the temperature is elevated to 72 °C to allow optimal activity of the DNA polymerase. The polymerase will continue to add nucleotides until the entire complementary strand of the template is completed at which point the cycle is repeated (Figure 1)

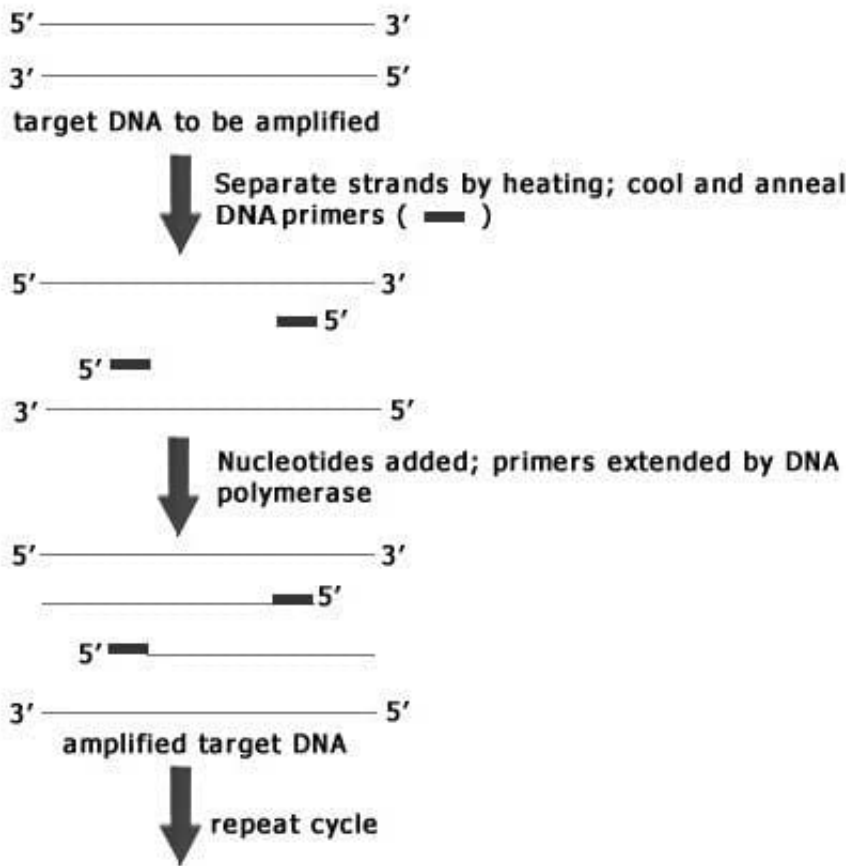


Figure 1

One of the uses of PCR is sex determination, which requires amplification of intron 1 of the amelogenin gene. This gene found on the X-Y homologous chromosomes has a 184 base pair deletion on the Y homologue. Therefore, by amplifying intron 1 females can be distinguished from males by the fact that males will have 2 different sizes of the amplified DNA while females will only have 1 unique fragment size.

Which of the following statements could be used to correctly describe the overall polymerase chain reaction?

- A. It is an anabolic reaction that breaks down new DNA strands.
- B. It is an anabolic reaction that synthesizes new DNA strands.
- C. It is a catabolic reaction that breaks down new DNA strands.
- D. It is a catabolic reaction that synthesizes new DNA strands.

Correct Answer: B

This question requires knowledge of the definition of anabolism and catabolism. A catabolic reaction involves the breakdown of macromolecules, whereas an anabolic reaction involves the synthesis of macromolecules from individual building blocks. PCR entails the synthesis (amplification) of a new DNA strand using a DNA template and free nucleotides, therefore, it is an anabolic reaction that synthesizes new DNA strands.

QUESTION 4



In a fit of passion, the spectator of a political debate exclaims that "welfare recipients are all lazy." The spectator's thought process is an example of:

- A. prejudice.
- B. discrimination.
- C. ethnocentrism.
- D. conflict theory.

Correct Answer: A

Prejudice consists of inflexible and irrational attitudes held by one group about another. Discrimination is the prejudicial treatment of an individual based on their actual or perceived membership in a certain group or category, "in a way that is

worse than the way people are usually treated." While the outburst could be considered discriminatory, the thought process underlying the outburst would be described as prejudice. Ethnocentrism refers to evaluation of others' cultures based

on one's own cultural norms and values. Conflict theory refers to perspectives in sociology that emphasize the social, political, or material inequality of social groups, allowing for macro-level analysis.

a) ?correct.

b) ?incorrect. The question is about the thought process and not the action or behavior. c) ?incorrect. The outburst is not an evaluation of another's ethnic culture. d) ?incorrect. While conflict theory perspectives do often pit social classes

against each other, this sociological perspective does not describe the thought process at work here.

QUESTION 5

If a wire carrying a current flowing into the screen is placed in a magnetic field pointing left, in which direction will the Lorentz force act on the charge carriers?

- A. to the left
- B. to the right
- C. upward
- D. out of the screen

Correct Answer: C

The right hand rule can be used to find the direction of the Lorentz force.