1. Observational studies in Britain have showed that children who grew up with better self-control during childhood ended up being less likely to smoke and less likely to experience unemployment later in life (better life outcomes).

   (i)    These studies are correlational, so we do not know if self-control is really causing these better life outcomes.

   (ii)   We could begin to establish the causation by looking at life outcomes of subjects in randomised controlled experiments which try to improve self-control of young people in the treatment group.

   Which of the above statements is/are true?

   (a) (i) only.
   (b) (ii) only.
   (c) Both (i) and (ii).
   (d) Neither (i) nor (ii).

2. From the above example, what can we say about the direction of the association?

   (a) Childhood self-control has a negative association with smoking only.
   (b) Childhood self-control has a negative association with both smoking and unemployment.
   (c) Childhood self-control has a positive association with unemployment only.
   (d) Observational studies do not give us enough information to establish association.

3. To investigate whether controlling mothers tend to have obese children, an observational study was conducted and it was found that controlling behaviour in mothers is positively associated with obesity in their children: rate(obese child | controlling mom) = 71% while rate(obese child | non-controlling mom) = 39%. It was suspected that the health status of the father plays a role in the phenomenon, so the sample was 'sliced' according to whether the fathers were obese or not:

| | Non-controlling Mother | | | Controlling Mother | | |
|---|---|---|---|---|---|---|
| | Number | Obese | Rate (%) | Number | Obese | Rate (%) |
| Obese father | 87 | 78 | 90% | 270 | 234 | 87% |
| Non-obese father | 263 | 60 | 23% | 80 | 16 | 20% |
| Overall | 350 | 138 | 39% | 350 | 250 | 71% |

Which of the following statements is/are true:

(i) Obesity in the father is a confounder, this is an example of Simpson's paradox.

(ii) Obesity in children is positively associated with controlling mothers when the father is obese.

(a) (i) only.
(b) (ii) only.
(c) Both (i) and (ii).
(d) Neither (i) nor (ii).

4. There are 3 families X, Y, Z. The families have 2 children each. Family X has 1 boy and 1 girl. Family Y has 2 girls. Family Z has 2 boys. 1 child is randomly selected among the 6 children. If the selected child is a boy, the probability that he is from family X is _____.

(a) 0
(b) 1/6
(c) 1/3
(d) 1/2

**Questions 5 and 6** are based on the following information about the success rates of students and professionals in turning up for their scheduled appointments. They receive only one of the prompts - either text or email – before their scheduled appointments. There was a success rate of 30% among students who were prompted through text messages, but only 10% when they were reminded through emails. Professionals on the other hand, stuck to the appointments 40% of the time when reminded through texts and 80% when through emails.

5. From the information given above, which of the following must be true?
   (i)   Overall success rate for those prompted through text message is between 30% and 40%
   (ii)  Overall success rate for those prompted through text message is 35%

   (a) (i) only.
   (b) (ii) only.
   (c) Both (i) and (ii).
   (d) Neither (i) nor (ii).

6. Let X be the overall success rate for students and Y the overall success rate for professionals. Which of the following is true?

   (a) X < Y
   (b) X = Y
   (c) X > Y
   (d) The relationship between X and Y cannot be determined from the information above

7. In a certain year, it is known that the prevalence of diabetes among Singapore residents is 10%. And the prevalence of diabetes among old (age 60 and above) Singapore residents is 30%. It was suggested that sex is a possible confounder in the observed association between age and diabetes among Singapore residents. After further analysis, the researchers concluded that sex is not a confounder. Which of the following statements is/are true?

   (i)    rate(Diabetes|Male)= rate(Diabetes|Female)
   (ii)   rate(Male|Diabetes)= rate(Female|Diabetes)
   (iii)  rate(Diabetes|Female)=10%

   (a) (i) only.
   (b) (ii) only.
   (c) (i) and (ii) only.
   (d) (i) and (iii) only.
   (e) (i), (ii) and (ii).


8. In an effort to see if Brand A of cola tastes better than Brand B, a blind taste test was conducted on 100 sworn fans of Brand A. The result was 50 people indicated they preferred Brand A, while the other 50 indicated they preferred Brand B. Does this give good evidence Brand B tastes better than Brand A?

   (a) Yes, this is a randomised controlled experiment.
   (b) Yes, because the subjects were blinded.
   (c) Yes, because 50% sworn fans of Brand A preferred Brand B
   (d) No, because there is no control group.
   (e) No, because the sample size of 100 is too small.

**Questions 9 and 10** refer to the following scenario. NUS has opened two classes, A and B, for GER1000 and each class has 100 students. In class A, every student scores 1 point higher in the final than in the midterm. In class B, every student scores 1 point lower in the final than in the midterm.

9. Which of the following statements is/are true?
   (i) The correlation coefficient between the final score and the midterm score in class A is 1.
   (ii) The correlation coefficient between the final score and the midterm score in class B is -1.

   (a) (i) only.
   (b) (ii) only.
   (c) Both (i) and (ii).
   (d) Neither (i) nor (ii).

10. Consider the three correlation coefficients between midterm and final in class A, class B, and class A and B combined together. Which of the following statements is/are true?
    (i) The correlation coefficient of class A and B combined is smaller than the correlation coefficient of class A.
    (ii) The correlation coefficient of class A and B combined is larger than the correlation coefficient of class B.

   (a) (i) only.
   (b) (ii) only.
   (c) Both (i) and (ii).
   (d) Neither (i) nor (ii).

11. A college has 60 male and 60 female students taking a quantitative reasoning module in a particular semester. The following table depicts the distribution of sex (male vs. female) and grades (S vs. U) among these students.

| | S (Satisfactory) | U (Unsatisfactory) | Row Total |
|---|---|---|---|
| Male | | | 60 |
| Female | | | 60 |
| Column Total | | | 120 |

Suppose that rate(S|Female) was 0.5, and the odds ratio for S grade between male students to female students was also 0.5. What is the rate(Male|S)?

(a) 0.2
(b) 0.3
(c) 0.4
(d) 0.5

**Questions 12 to 16** refer to the following scenario. Oak, an NUS student, is interested in studying the satisfaction level of exchange students in the school. Unfortunately, he does not have access to the class list but is allowed to survey the seven residences on campus.

12. Assuming all exchange students have to board with campus residences, what can be said of this sampling frame?
    (i)     As the sampling frame is larger than the target population, the sample is biased.
    (ii)    As the sampling frame is larger than the target population, it is costly to implement.

    (a) (i) only.
    (b) (ii) only.
    (c) Both (i) and (ii).
    (d) Neither (i) nor (ii).

13. As Oak dislikes walking, he decides to interview all residents of one randomly selected block of every residence only. If the residents are not in, he will return at least twice. What sort of sampling scheme is this?

   (a) Volunteer sampling
   (b) Convenience sampling
   (c) Simple random sampling
   (d) Cluster Sampling
   (e) Quota sampling

14. Suppose of all the blocks chosen, there are 1057 students, of whom 279 are exchange students. Oak managed to meet and interview 143 of these exchange students. There are 2036 exchange students across the whole of NUS for the current year. Which of the following comments is/are valid?
   (i)     The response rate of 51% might be a source of bias.
   (ii)    The sampling plan employed is not a probability sampling plan.

   (a) (i) only.
   (b) (ii) only.
   (c) Both (i) and (ii).
   (d) Neither (i) nor (ii).

15. In the following year, Oak injures his leg before he can implement his survey, preventing him from conducting door to door interviews. He decides instead to send the survey to the whole NUS student population via email. 5% of email recipients eventually responded. To whom can the results of his survey be generalised?

   (a) All exchange students.
   (b) All NUS students.
   (c) All respondents of the survey.

16. Before sending out his survey via email, Oak is acquainted with the "Exchange Students in NUS - AY2017/18" Facebook group and decides to disseminate his survey via this channel instead. Out of 1378 members in the group, 1184 are exchange students while the rest are local NUS students. 496 members responded to the survey, of whom responses from 27 local students were excluded. Which of the following statements is/are true?

(i)     Not all exchange students join the Facebook group, so the sample is biased.

(ii)    The Facebook group is infiltrated by local students who will eventually be excluded, so the sample is biased.

(a) (i) only.
(b) (ii) only.
(c) Both (i) and (ii).
(d) Neither (i) nor (ii).


17. In a uniform wire with electrical current flowing at steady state, three ammeters (an ammeter is a device used to measure electrical current in a wire) calibrated using the same procedure, and possessing the same standard deviation for successive measurements of the same object, should measure the same current reading. Which of the following statements is true?

(a) Random error of the average of readings from the three ammeters is likely to be larger than that of a single ammeter reading.

(b) Random error of the average of readings from the three ammeters is likely to be smaller than that of a single ammeter reading.

(c) Neither options (a) nor (b) is necessarily true in this situation.

18. The Gemological Institute of America rates the colour of diamonds submitted to its laboratory on a scale from D (colourless) to Z (light yellow, light brown or light gray). The cut of a diamond is rated on a scale ranging from 'Excellent' to 'Poor'. It also reports the weight of diamonds in units of carats, with 1 carat = 200 milligrams. Which of these variables is/are ordinal in nature?

    (i)    Colour
    (ii)   Cut
    (iii)  Weight

    (a) (i) only.
    (b) (ii) only.
    (c) (iii) only.
    (d) (i) and (ii) only.
    (e) (i), (ii) and (iii).

19. Martin takes an uncalibrated thermocouple and repeatedly measures the temperature of a melting block of ice at sea-level, with pressure of 1atm (the freezing point of water is 0 degrees Celsius at 1atm pressure), and gets the following results in degrees Celsius: 2.000, 2.001, 1.999, 2.001, 2.001. Assuming he only requires temperature readings to a precision of 2 decimal places, which of the following statements is/are true?

    (i)    This method of measuring temperature is reliable.
    (ii)   This method of measuring temperature is biased.

    (a) (i) only.
    (b) (ii) only.
    (c) Both (i) and (ii).
    (d) Neither (i) nor (ii).

20. COSC (Contrôle Officiel Suisse des Chronomètres) is the institute responsible for certifying the accuracy of wristwatches in Switzerland. A mechanical wristwatch is certified to be a "chronometer" if it satisfies the criteria set out in ISO 3159:2015, two of which are:

    (i)   An average daily deviation of between -4 to +6 seconds per day when tested over a span of 15 days in 5 different positions. Measurements are compared with a time base established by two independent atomic clocks synchronized on GPS time, which are assumed to be accurate.

    (ii)  The absolute value of the greatest of the five daily deviations with regard to the five positions of the watch during the first ten days of the tests must also not exceed 5 seconds per day.

    Criteria (i) and (ii) refer to the _____ when measuring the length of a fixed time period of 24 hours with the watch.

    (a) bias
    (b) reliability
    (c) bias and reliability, respectively
    (d) reliability and bias, respectively

21. Consider the following survey questions to gather pet owners' views on whether their dogs should be vaccinated:

    (i)   Do you think dogs should be required to be vaccinated?
    (ii)  Should concerned dog owners vaccinate their pets?
    Which survey question is more likely to elicit a "Yes"?

    (a) (i).
    (b) (ii).

In the following two questions, two fair six-sided dice are rolled once each. The dice are labelled Die-1 and Die-2. The faces of each die are labelled 1 to 6. The outcome of each die is the face it lands on. Assume the outcomes of the two dice are independent.

22. P(sum of the outcomes of the two dice = 2) is equal to:

   (a) P(Die-1 lands on 1) * P(Die-2 lands on 1)
   (b) P(Die-1 lands on 1) + P(Die-2 lands on 1)
   (c) P(Die-2 lands on 1)
   (d) None of the above

23. P(sum of the outcomes of the two dice = 3) is equal to:

   (a) P(one of the dice lands on 1) + P(one of the dice lands on 2)
   (b) P(one of the dice lands on 1) * P(one of the dice lands on 2)
   (c) P(one of the dice lands on 1 and one of the dice lands on 2)
   (d) None of the above

24. Jane suspects that sleep duration is associated with a child's mathematical ability. She conducts a study to test her hypothesis. What should be her null hypothesis?

   (a) There is insufficient evidence to conclude sleep duration is associated with a child's mathematical ability.
   (b) Sleep duration is not associated with a child's mathematical ability.
   (c) Sleep duration is associated with a child's mathematical ability.
   (d) There is sufficient evidence to conclude sleep duration is associated with a child's mathematical ability.

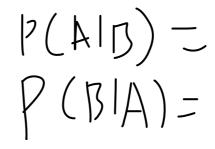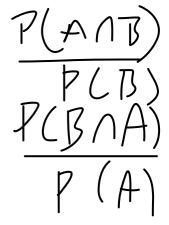25. Consider two events A and B with $P(A) \neq 0$ and $P(B) \neq 0$. If $P(A \mid B) = P(B \mid A)$, then

   (a) P(A) = P(B)
   (b) P(A and B) $\neq$ 0
   (c) 1 - P(B) = P(A)
   (d) None of the above

$$P(A \mid B) = \frac{P(A \cap B)}{P(B)}$$

$$P(B \mid A) = \frac{P(B \cap A)}{P(A)}$$
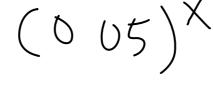
26. Allen is recently interested in buying stock X. He observes that within one day the stock price increases by 10% with probability of 40% and decreases by 10% with probability of 60%. Today's stock price is $10. Which of the following statements is/are correct?
    (i) The expected stock price in two days is higher than today's stock price.
    (ii) The stock price in two days will be higher than today's stock price.


    (a) (i) only.
    (b) (ii) only.
    (c) Both (i) and (ii).
    (d) Neither (i) nor (ii).


27. Among all the people in country A, 40% have blue eyes and 38% are left-handed. Among the people who do not have blue eyes, 30% are left-handed. If a person was picked at random from the people who have blue eyes, the probability that he/she is right-handed is _____.

    (a) 50%
    (b) 60%
    (c) 62%
    (d) 70%


28. To test whether a coin is fair, Jane tossed it X times and observed that all outcomes were heads. If the p-value is greater than 0.05, what are possible values of X?
    (i) 4
    (ii) 5
    (iii) 6

    $(0.05)^X$

    (a) (i) only
    (b) (i) and (ii) only.
    (c) (i), (ii) and (iii).
    (d) None of the above, X must be greater than 7.

Answer Key

1. C
2. B
3. A
4. C
5. A
6. A
7. D
8. D
9. A
10. A
11. C
12. B
13. D
14. A
15. C
16. A
17. B
18. D
19. C
20. C
21. B
22. A
23. C
24. B
25. D
26. D
27. A
28. A