1. The set $S = \{a, b, c, d\}$ is a sample space for a particular experiment. The following events are defined on this experiment:

$$E_1 = \{a\}, \quad E_2 = \{a, b\}, \quad E_3 = \{a, b, d\}, \quad E_4 = \{b, c\}.$$

If $\Pr[E_1] = .1, \Pr[E_2] = .4$, and $\Pr[E_3] = .8$, what is $\Pr[E_4]$?

| | | | | |
|---|---|---|---|---|
| A: .2 | B: .3 | C: .5 | D: .7 | E: cannot be determined |

2. A student is selected at random from a particular class and his or her mark (out of 50) on the final exam is looked up in the professor's marks file. (Only integer grades were awarded on the exam.)

Let $S_1$ be the set of all students in the class,
let $S_2$ be the set of all student numbers of students enrolled in the class, and
let $S_3$ be a subset of the integers from 0 to 50, containing only those which were marks received by students on the final exam.

Which of these sets could be used as an *equiprobable* sample space for this experiment?

| | | | | |
|---|---|---|---|---|
| A: $S_1$ only | B: $S_2$ only | C: $S_3$ only | D: $S_1$ and $S_2$, but not $S_3$. | E: $S_1$, $S_2$ and $S_3$. |

3. A single poker hand of 5 cards is dealt from a standard deck. What is the probability that this hand contains 3 of a kind (i.e. exactly 3 cards of the same denomination, e.g. exactly 3 tens or exactly 3 aces)?

| | | | | |
|---|---|---|---|---|
| A: $\frac{\binom{5}{3}\binom{5}{2}}{\binom{5}{5}}$ | B: $\frac{\binom{13}{1}\binom{4}{3}\binom{39}{2}}{\binom{52}{3\ 2\ 47}}$ | C: $\frac{\binom{13}{1}\binom{4}{3}\binom{48}{2}}{\binom{52}{5}}$ | D: $\frac{\binom{13}{1}\binom{4}{3}\binom{12}{1}\binom{4}{2}}{\binom{52}{5}}$ | E: $\frac{\binom{52}{1}\binom{3}{2}\binom{48}{2}}{\binom{52}{5}}$ |

4. A subcommittee of 4 people is selected at random from a committee of 10 people. If Julie and Frances are 2 people on the committee, what is the probability that Julie is chosen for the subcommittee and Frances isn't?

| | | | | |
|---|---|---|---|---|
| A: $\frac{6}{10}$ | B: $\frac{4}{10}$ | C: $\frac{1}{3}$ | D: $\frac{4}{15}$ | E: $\frac{2}{15}$ |

5. Laura, Mitch, Norm and Penny arrange themselves randomly around a card table. What is the probability that Mitch and Penny are sitting beside one another?

| | | | | |
|---|---|---|---|---|
| A: $\frac{1}{6}$ | B: $\frac{1}{4}$ | C: $\frac{1}{3}$ | D: $\frac{1}{2}$ | E: $\frac{2}{3}$ |

6. Let $A$ and $B$ be 2 events defined on a sample space $S$. If $\Pr[A] = .3$, $\Pr[B] = .6$ and $\Pr[A \cap B] = .2$, what is $\Pr[A|B]$?

| | | | | |
|---|---|---|---|---|
| A: .02 | B: .06 | C: .2 | D: $\frac{1}{3}$ | E: $\frac{2}{3}$ |

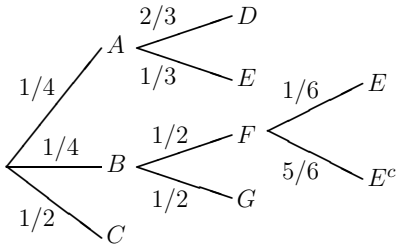
7. Let $A$ and $B$ be 2 events defined on a sample space $S$. If $\Pr[A] = .3$ and $\Pr[B] = .6$, and it is known that $A$ and $B$ are mutually exclusive events, what is $\Pr[A|B]$?

| | | | | |
|---|---|---|---|---|
| A: 0 | B: .18 | C: .3 | D: .6 | E: 1 |

8. Consider the following game: First, a coin is tossed. If the coin comes up heads, the player wins \$1 and the game is over. If the coin comes up tails, a fair die is rolled. If a 1 or a 2 is rolled, the player wins \$1 and the game is over. If a 3 or a 4 is rolled, the player flips another coin and wins \$3 times the number of heads tossed. If the die roll was a 5 or a 6, then the player draws a single card from a standard deck. If the card is a diamond, the player wins \$10. Otherwise, the player wins \$1. What is the probability that someone who plays this game once wins \$10?

| | | | | |
|---|---|---|---|---|
| A: $\frac{1}{24}$ | B: $\frac{1}{12}$ | C: $\frac{1}{10}$ | D: $\frac{1}{6}$ | E: $\frac{1}{4}$ |

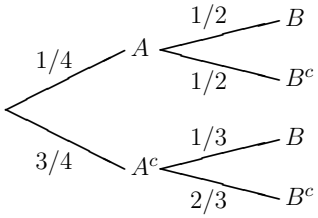
9. Consider the stochastic process modelled by the probability tree below. What is $\Pr[E \cup F]$?




| | | | | |
|---|---|---|---|---|
| A: $\frac{1}{48}$ | B: $\frac{5}{48}$ | C: $\frac{9}{48}$ | D: $\frac{10}{48}$ | E: $\frac{11}{48}$ |

Use the following information for questions 10 through 12:

Consider the stochastic process modelled by the probability tree shown here.




10. What is $\Pr[B|A]$?

| | | | | |
|---|---|---|---|---|
| A: $\frac{1}{8}$ | B: $\frac{1}{4}$ | C: $\frac{1}{3}$ | D: $\frac{3}{8}$ | E: $\frac{1}{2}$ |

11. What is $\Pr[B \cap A^c]$?

| | | | | |
|---|---|---|---|---|
| A: $\frac{1}{8}$ | B: $\frac{1}{4}$ | C: $\frac{1}{3}$ | D: $\frac{3}{8}$ | E: $\frac{1}{2}$ |

12. What is $\Pr[A|B]$?

| | | | | |
|---|---|---|---|---|
| A: $\frac{1}{8}$ | B: $\frac{1}{4}$ | C: $\frac{1}{3}$ | D: $\frac{3}{8}$ | E: $\frac{1}{2}$ |

13. A widget produced by a particular process has probability .1 of being defective. A test can be performed which has 99% accuracy. That is, if a defective widget is tested, the test will identify the widget as defective 99% of the time. And if a non-defective widget is tested, there is a 99% chance that the test will indicate that the widget is not defective. One widget is selected at random and is tested. If the test says that the widget is not defective, what is the probability that this widget actually is defective?

| | | | | |
|---|---|---|---|---|
| A: .1 | B: .01 | C: .001 | D: $\frac{.009}{.108}$ | E: $\frac{.001}{.892}$ |

14. A fair coin is tossed 4 times. What is the probability that heads will come up on the fourth toss, if it is known that heads has come up on **all** of the first 3 tosses?

| | | | | |
|---|---|---|---|---|
| A: 0 | B: $\frac{1}{2}$ | C: $\left(\frac{1}{2}\right)^3$ | D: $\left(\frac{1}{2}\right)^4$ | E: $\binom{4}{3}\left(\frac{1}{2}\right)^3\left(\frac{1}{2}\right)$ |

15. A coin is tossed 10 times. What is the probability that heads comes up exactly 5 times?

| | | | | |
|---|---|---|---|---|
| A: $\frac{1}{2}$ | B: $\left(\frac{1}{2}\right)^5$ | C: $\frac{5!}{2^{10}}$ | D: $\binom{10}{5}\left(\frac{1}{2}\right)^{10}$ | E: $\binom{10}{5}\left(\frac{1}{2}\right)^5$ |

16. A die is rolled 5 times. What is the probability that one 2, two 3's and two 6's are rolled?

| |
|---|
| A: $\left(\frac{1}{6}\right)^1\left(\frac{1}{6}\right)^2\left(\frac{1}{6}\right)^2\left(\frac{1}{2}\right)^0$ |
| B: $\binom{5}{1}\left(\frac{1}{6}\right)^1\left(\frac{5}{6}\right)^4 + \binom{5}{2}\left(\frac{1}{6}\right)^2\left(\frac{5}{6}\right)^3 + \binom{5}{2}\left(\frac{1}{6}\right)^2\left(\frac{5}{6}\right)^3$ |
| C: $\left[\binom{5}{1}\left(\frac{1}{6}\right)^1\left(\frac{5}{6}\right)^4\right] \times \left[\binom{5}{2}\left(\frac{1}{6}\right)^2\left(\frac{5}{6}\right)^3\right] \times \left[\binom{5}{2}\left(\frac{1}{6}\right)^2\left(\frac{5}{6}\right)^3\right]$ |
| D: $\frac{5!}{2!\,2!}\left(\frac{1}{6}\right)^5$ |
| E: None of these |

Use the following information for questions 17, 18 and 19.

A single card is drawn from a well-shuffled deck. This experiment is repeated 5 times. (The card is replaced and the deck is shuffled between repetitions of the experiment.)

17. What is the probability that exactly one heart is drawn?

| | | | | |
|---|---|---|---|---|
| A: $\frac{1}{5}$ | B: $\frac{\binom{13}{1}\binom{39}{4}}{\binom{52}{5}}$ | C: $\binom{5}{1}\left(\frac{1}{4}\right)\left(\frac{3}{4}\right)^4$ | D: $5 \times \left(\frac{1}{4}\right)^5$ | E: $\binom{5}{0}\left(\frac{1}{4}\right)^0\left(\frac{3}{4}\right)^5 + \binom{5}{1}\left(\frac{1}{4}\right)^1\left(\frac{3}{4}\right)^4$ |

18. What is the probability that at least one club is drawn?

| | | | | |
|---|---|---|---|---|
| A: $\left(\frac{1}{4}\right)^1 + \left(\frac{1}{4}\right)^2 + \left(\frac{1}{4}\right)^3 + \left(\frac{1}{4}\right)^4 + \left(\frac{1}{4}\right)^5$ | B: $1 - \left(\frac{1}{4}\right)^0$ | C: $1 - \left(\frac{3}{4}\right)^5$ | D: $1 - \binom{5}{1}\left(\frac{1}{4}\right)\left(\frac{3}{4}\right)^4$ | E: $\left(\frac{3}{4}\right)^5$ |

19. What is the probability that exactly 2 spades and exactly one diamond are drawn?

| | | |
|---|---|---|
| A: $\binom{5}{2\ 1\ 2}\left(\frac{1}{4}\right)^2\left(\frac{1}{4}\right)^1\left(\frac{1}{2}\right)^2$ | B: $\binom{5}{2}\left(\frac{1}{4}\right)^2\left(\frac{3}{4}\right)^3 + \binom{5}{1}\left(\frac{1}{4}\right)^1\left(\frac{3}{4}\right)^4$ | C: $\binom{5}{2}\left(\frac{1}{4}\right)^2 \times \binom{3}{1}\left(\frac{1}{4}\right)^1$ |
| D: $\binom{5}{2}\binom{5}{1}\left(\frac{1}{4}\right)^3\left(\frac{3}{4}\right)^2$ | E: $\binom{5}{2\ 1\ 1}\left(\frac{1}{4}\right)^5$ | |

20. What is the smallest number of times you would need to toss a fair coin in order to be sure of having probability at least .9 of tossing at least one head?

| | | | | |
|---|---|---|---|---|
| A: 2 | B: 3 | C: 4 | D: 10 | E: cannot be determined |