Probability

Question1

Let $P = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$ be a matrix. Three elements of this matrix P are selected at random. A is the event of having the three elements whose sum is odd. B is the event of selecting the three elements which are in a row or column. Then, $P(A) + P\left(\frac{A}{B}\right) =$

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Options:

A.

$\frac{221}{420}$

B.

$\frac{17}{21}$

C.

$\frac{21}{20}$

D.

$\frac{3}{2}$

Answer: B

Solution:

Given, matrix $P = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$

Odd elements $= \{1, 3, 5, 7, 9\}$

Total = 5

Even elements $= \{2, 4, 6, 8\}$

Total =4

Case I 3 odd numbers numbers of ways $= {}^5C_3 = 10$

Case II 1 odd and 2 even numbers of ways $= {}^5C_1 \times {}^4C_2$

$= 5 \times 6 = 30$

Total favourable cases for A

$= 10 + 30 = 40$

And total ways for selecting 3 elements from 9 elements $= {}^9C_3 = 84$

$\therefore \quad P(A) = \frac{40}{84}$

Selecting 3 elements in a row or column.

3 rows $\times 1$ way $= 3$ ways

3 column $\times 1$ way $= 3$ ways

total $= 6$ ways

Now, Row 1 : $1 + 2 + 3 = 6$ (even)

Row 2 : $4 + 5 + 6 = 15$ (odd)

Row 3 : $7 + 8 + 9 = 24$ (even)

Column I : $1 + 4 + 7 = 12$ (even)

Column II : $2 + 5 + 8 = 15$ (odd)

Column III : $3 + 6 + 9 = 18$ (even)

$$\therefore P(A \cap B) = \frac{2}{84}$$
$$P(B) = \frac{6}{84}$$

$$\therefore \quad P\left(\frac{A}{B}\right) = \frac{P(A \cap B)}{P(B)} = \frac{\frac{2}{84}}{\frac{6}{84}} = \frac{1}{3}$$

$$\therefore P(A)+P\left(\frac{A}{B}\right)=\frac{40}{84}+\frac{1}{3}$$
$$=\frac{40+28}{84}$$
$$=\frac{68}{84}=\frac{17}{21}$$

Question2

A, B_1, B_2, B_3 are the events in a random experiment. If $P(B_1)=0.25, P(B_2)=0.30, P(B_3)=0.45, P\left(\frac{A}{B_1}\right)=0.05$, $P\left(\frac{A}{B_2}\right)=0.04, P\left(\frac{A}{B_3}\right)=0.03$, then $P\left(\frac{B_2}{A}\right)=$

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Options:

A.

$\frac{6}{19}$

B.

$\frac{8}{19}$

C.

$\frac{12}{19}$

D.

$\frac{5}{19}$

Answer: A

Solution:

Given, $P(B_1) = 0.25, P(B_2) = 0.30,$
$P(B_3) = 0.45, P\left(\frac{A}{B_1}\right) = 0.05$
$P\left(\frac{A}{B_2}\right) = 0.04, P\left(\frac{A}{B_3}\right) = 0.03$
$\therefore P\left(\frac{B_2}{A}\right) = \frac{P\left(\frac{A}{B_2}\right)P(B_2)}{P\left(\frac{A}{B_2}\right)P(B_2)+P\left(\frac{A}{B_3}\right)P(B_3)}$
$+P\left(\frac{A}{B_1}\right)P(B_1)$
$= \frac{0.04 \times 0.30}{0.04 \times 0.30 + 0.03 \times 0.45 + 0.05 \times 0.25}$
$= \frac{0.012}{0.012 + 0.0135 + 0.0125}$
$= \frac{0.012}{0.038} = \frac{6}{19}$

Question3

A, B are the events in a random experiment.

If $P(A) = \frac{1}{2}, P(B) = \frac{1}{3}, P(A \cap B) = \frac{1}{4}$, then $P\left(\frac{A^c}{B^c}\right) + P\left(\frac{A}{B}\right) =$

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Options:

A.

1

B.

$\frac{4}{5}$

C.

$\frac{11}{8}$

D.

$\frac{7}{3}$

Answer: C

Solution:

Given, $P(A)=\frac{1}{2}, P(B)=\frac{1}{3}$,

$$P(A\cap B)=\frac{1}{4}$$

$$\therefore \quad P\left(\frac{A}{B}\right)=\frac{P(A\cap B)}{P(B)}=\frac{\frac{1}{4}}{\frac{1}{3}}=\frac{3}{4}$$

$$P\left(\frac{A'}{B'}\right)=\frac{P\left(A'\cap B'\right)}{P\left(B'\right)}$$

$$=\frac{P\left((A\cup B)'\right)}{P\left(B'\right)}$$

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

$$=\frac{1}{2}+\frac{1}{3}-\frac{1}{4}$$

$$=\frac{6+4-3}{12}=\frac{7}{12}$$

$$\therefore P\left((A\cup B)'=1-\frac{7}{12}=\frac{5}{12}\right.$$

And $P\left(B'\right)=\frac{2}{3}$

$$\therefore P\left(\frac{A'}{B'}\right)=\frac{\frac{5}{12}}{\frac{2}{3}}=\frac{5}{12}\times\frac{3}{2}=\frac{5}{8}$$

$$\therefore P\left(\frac{A'}{B'}\right)+P\left(\frac{A}{B}\right)=\frac{5}{8}+\frac{3}{4}=\frac{11}{8}$$

Question4

Two persons A and B play a game by throwing two dice. If the sum of the numbers appeared on the two dice is even, A will get $\frac{1}{2}$ point and B will get $\frac{1}{2}$ point.

If the sum is odd, A will get one point and B will get no point. The arithmetic mean of the random variable of the number of points of A is

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Options:

A.

$1/2$

B.

$1/4$

C.

1 .

D.

$3/4$

Answer: D

Solution:

Total outcomes when two dice are thrown $= 36$

Even sum : happen when sum

$= 2, 4, 6, 8, 10, 12$

Odd sum : happens when sum

$= 3, 5, 7, 9, 11$

Sum	Combination	Even
2	$(1,1)$	1
4	$(1,3),(2,2),(3,1)$	3
6	$(1,5),(2,4),(3,3),(4,2),(5,1)$	5
8	$(2,6),(3,5),(4,4),(5,3),(6,2)$	5
10	$(4,6),(5,5),(6,4)$	3
12	$(6,6)$	1

$\therefore$ Even sum $= 18$ outcomes

Odd sum $= 36 - 18 = 18$ outcomes

Sum is even, A gets $= \frac{1}{2}$, point with probability

$= \frac{18}{36} = \frac{1}{2}$

Sum is odd, A gets $= \frac{1}{2}$, point with probability

$= \frac{18}{36} = \frac{1}{2}$

Expected value $E(X) = \frac{1}{2} \times \frac{1}{2} + 1 \times \frac{1}{2}$

$= \frac{1}{4} + \frac{1}{2} = \frac{3}{4}$

Question5

A typist claims that he prepares a typed page with typo errors of 1 per 10 pages. In a typing assignment of 40 pages, if the probability that the typo errors are at most 2 is p, then $e^2 p =$

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Options:

A.

5

B.

13

C.

$13e^{-2}$

D.

$5e^{-2}$

Answer: C

Solution:

Step 1: Finding the average number of errors

The typist makes 1 mistake for every 10 pages. For 40 pages, expected errors = $\frac{40}{10} = 4$.

Step 2: Setting up the Poisson distribution

We use the Poisson formula to find the chance of getting up to 2 errors when the average (λ) is 4.

$P(X = k) = \frac{e^{-4} 4^k}{k!}$

Step 3: Find probability of at most 2 errors

We need to calculate $P(X \leq 2) = P(X = 0) + P(X = 1) + P(X = 2)$:

$P(X = 0) = \frac{e^{-4} \cdot 4^0}{0!} = e^{-4}$
$P(X = 1) = \frac{e^{-4} \cdot 4^1}{1!} = 4e^{-4}$

$P(X = 2) = \frac{e^{-4} \cdot 4^2}{2!} = 8e^{-4}$

Add them up:
$p = e^{-4} + 4e^{-4} + 8e^{-4} = 13e^{-4}$

Step 4: Multiply by e^2 as asked in the question

$e^2 p = 13e^{-4} \times e^2 = 13e^{-2}$

Question6

If three smallest squares are chosen at-random on a chess board, then the probability of getting them in such a way that they are all together in a row or in a column is

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Options:

A.

$\frac{73}{5208}$

B.

$\frac{1}{434}$

C.

$\frac{96}{217}$

D.

$\frac{479}{504}$

Answer: B

Solution:

Total number of ways to choose any 3 distinct squares $= {}^{64}C_3$

$\Rightarrow \quad \frac{64!}{3!61!} = \frac{64 \times 63 \times 62}{6} = 41664$

Since, each row has 8 squares.

In each row, the number of ways to choose 3 adjacent squares $= 8 - 3 + 1 = 6$

So, total for 8 rows $= 8 \times 6 = 48$

Similarly, total for 8 columns $= 8 \times 6 = 48$

$\therefore$ Total favourable outcomes

$\Rightarrow \quad 48 + 48 = 96$

Hence, required probability

$\Rightarrow \quad \frac{96}{41664} = \frac{1}{434}$

Question7

If three cards are drawn randomly from a pack of 52 playing cards then the probability of getting exactly, one spade card, exactly one king and exactly one card having a prime number is

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Options:

A.

$\frac{72}{221}$

B.

$\frac{72}{5525}$

C.

$\frac{16}{425}$

D.

$\frac{144}{5525}$

Answer: B

Solution:

Number of spade cards $= 13$, number of kings $= 4$

Prime numbered cards are $2, 3, 5$ and 7

So, total primes cards $= 4$ suits $\times 4$

numbers

$\Rightarrow 16$ cards

But, a single card can be both a king and a spade or a prime and a spade.

So, the number of favourable outcomes.

Case I Spade that is not a king or prime $= 13 - 1 - 4 = 8$

Case II King that is not a spade or prime = 3

Case III Prime card that is not a spade or king $= 16 - 4 = 12$

So, total favourable cases

$\Rightarrow \quad 8 \times 3 \times 12 = 288$

and total number of ways to choose 3 cards from 52 cards $= {}^{52}C_3$

$= \frac{52!}{3!49!} = \frac{52 \times 51 \times 50}{6} = 22100$

Thus, required probability

$= \frac{288}{22100} = \frac{72}{5525}$

Question8

Urn A contains 6 white and 2 black balls; run B contains 5 white and 3 black balls and urn C contains 4 white and 4 black balls. if an urn is chosen at random and a ball is drawn at random from it, then the probability that the ball drawn is white is

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Options:

A.

$\frac{3}{8}$

B.

$\frac{5}{8}$

C.

$\frac{1}{2}$

D.

$\frac{3}{4}$

Answer: B

Solution:

Since, there are three Urn.

So, $P(\text{Urn } A)=\frac{1}{3}=P(\text{Urn } B)=P(\text{Urn } C)$

Now, probability of drawing a white ball from each Urn

Urn A 6 white balls, 2 black balls.

Total = 8 balls

$P(\text{ White/Urn A})=\frac{6}{8}=\frac{3}{4}$

Urn B 5 white balls, 3 black balls

Total = 8 balls

$P(\text{ White/Urn B })=\frac{5}{8}$

Urn C 4 white balls, 4 black balls

Total $=8$ balls

$P(\text{ White / Urn C})=\frac{4}{8}=\frac{1}{2}$

So, the total probability of drawing a white ball is

$P(\text{ White })=P(\text{ White / Urn A})\cdot P(\text{ Urn A})$

$+P(\text{ White / Urn B})\cdot P(\text{ Urn B})$

$+P(\text{ White / Urn C})\cdot P(\text{ Urn C})$

$$
\begin{aligned}
& =\frac{1}{3}\times\frac{3}{4}+\frac{1}{3}\times\frac{5}{8}+\frac{1}{3}\times\frac{1}{2} \\
& =\frac{1}{4}+\frac{5}{24}+\frac{1}{6} \\
& =\frac{6+5+4}{24}=\frac{15}{24}=\frac{5}{8}
\end{aligned}
$$

Question9

The numbers $2, 3, 5, 7, 11, 13$ are written on six distinct paper chits. If 3 of them are chosen at random, then the probability that the sum of the numbers on the obtained chits is divisible by 3 , is

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Options:

A. $\frac{7}{20}$

B. $\frac{6}{20}$

C. $\frac{5}{20}$

D. $\frac{1}{5}$

Answer: A

Solution:

We have the Numbers $2, 3, 5, 7, 11$ and 13.

3 Number are chosen

$\therefore \quad n(s) = {}^6C_3 + 20$

$E =$ sum of number is divisible by 3

$E = \{(2, 37)(2, 3, 13)(3, 5, 7)(3, 5, 13)$

$(3, 11, 13)\}(3, 7, 11)(2, 5, 11)$

$n(E) = 7$

$P(E) = \frac{7}{20}$

Question10

If two dice are rolled, then the probability of getting a multiple of 3 as the sum of the numbers appeared on the top faces of the dice, if it is known that their sum is an odd number, is

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Options:

A. $\frac{1}{6}$

B. $\frac{11}{36}$

C. $\frac{1}{3}$

D. $\frac{7}{18}$

Answer: C

Solution:

To determine the probability of getting a multiple of 3 as the sum of the numbers on the top faces of two dice, given that their sum is an odd number, we define the following:

Let A be the event that the sum is a multiple of 3.

Let B be the event that the sum is an odd number.

First, we calculate the total probabilities:

The probability of event A, $P(A)$, is the number of favorable outcomes divided by the total outcomes, i.e., $\frac{12}{36}$.

The probability of event B, $P(B)$, is similarly $\frac{18}{36}$.

Next, we need to determine the probability of both events occurring simultaneously, $P(A \cap B)$.

The probability $P(A \cap B) = \frac{6}{36}$, which represents the outcomes where the sum is both a multiple of 3 and an odd number.

Finally, we calculate the conditional probability of A given B, denoted as $P(A|B)$:

$$P(A|B) = \frac{P(A \cap B)}{P(B)} = \frac{\frac{6}{36}}{\frac{18}{36}} = \frac{6}{18} = \frac{1}{3}$$

Therefore, the probability of getting a multiple of 3 as the sum, given that the sum is an odd number, is $\frac{1}{3}$.

Question11

If a random variable X has the following probability distribution, then its variance is

X = x	1	3	5	2
P(X = x)	$3K^2$	K	K^2	2K

Options:

A. $\frac{9}{4}$

B. $\frac{25}{8}$

C. $\frac{27}{16}$

D. $\frac{15}{16}$

Answer: D

Solution:

$\Sigma p_i = 1$

$4k^2 + 3k = 1$

$4k^2 + 4k - k - 1 = 0$

$4k(k+1) - 1(k+1) = 0$

$(k+1)(4k-1) = 0$

$k = \frac{1}{4}$

X_i	1	3	5	2	
P_i	$\frac{3}{16}$	$\frac{4}{16}$	$\frac{1}{16}$	$\frac{8}{16}$	
$X_i P_i$	$\frac{3}{16}$	$\frac{12}{16}$	$\frac{5}{16}$	$\frac{16}{16}$	$\frac{36}{16} = \bar{X}$
$X_i - \bar{X}$	$\frac{20}{16}$	$-\frac{12}{16}$	$-\frac{14}{16}$	$\frac{4}{16}$	
$\left(X_i - \bar{X}\right)^2$	$\frac{400}{16^2}$	$\frac{144}{16^2}$	$\frac{1936}{16^2}$	$\frac{16}{16^2}$	
$P_i\left(X_i - \bar{X}\right)^2$	$\frac{1200}{16^3}$	$\frac{576}{16^3}$	$\frac{1936}{16^3}$	$\frac{128}{16^3}$	$\frac{3840}{16^3} = \frac{15}{16}$

$\text{Var}(X) = \frac{15}{16}$

Question12

The mean and variance of a binomial variate X are $\frac{16}{5}$ and $\frac{48}{25}$ respectively. IfP $(X > 1) = 1 - K\left(\frac{3}{5}\right)^7$, then $5K =$

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Options:

A. 19

B. 3

C. 2

D. 11

Answer: A

Solution:

$\text{Mean} = np = \frac{16}{5}$

$\text{Variance} = npq = \frac{48}{25}$

$q = \frac{48}{25} \times \frac{5}{16} = \frac{3}{5}$

$p = \frac{2}{5}$

$$n \times \frac{2}{5} = \frac{16}{5}$$

$$n = 8$$

$P(x > 1) = 1 - P(x = 0) - P(x = 1)$

$$=1-{}^8C_0\left(\frac{3}{5}\right)^8-{}^8C_1\left(\frac{2}{5}\right)\left(\frac{3}{5}\right)^7$$

$$=1-\left(\frac{3}{5}\right)^7\left\{\frac{3}{5}+\frac{16}{5}\right\}$$

$$=1-\left(\frac{3}{5}\right)^7\left(\frac{19}{5}\right)$$

$$\because \quad k=\frac{19}{5}$$

$$5k=19$$

Question13

If three numbers are randomly selected from the set $\{1, 2, 3, \ldots\ldots 50\}$, then the probability that they are in arithmetic progression is

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Options:

A. $\frac{3}{50}$

B. $\frac{3}{98}$

C. $\frac{3}{49}$

D. $\frac{3}{25}$

Answer: B

Solution:

When selecting three numbers from the set $\{1, 2, 3, \ldots, 50\}$, we want to find the probability that they form an arithmetic progression (AP).

First, determine the total number of ways to choose three numbers from the set:

${}^{50}C_3 = \frac{50\times49\times48}{6}$

For the numbers a, b, and c to be in AP, $2b = a + c$, which implies that $a + c$ must be even. Therefore, a and c must both be even or both be odd.

The set $\{1, 2, 3, \ldots, 50\}$ consists of 25 odd numbers and 25 even numbers.

The number of ways to choose two even numbers is:

${}^{25}C_2 = \frac{25\times24}{2}$

Similarly, the number of ways to choose two odd numbers is also:

${}^{25}C_2 = \frac{25\times24}{2}$

Thus, the total number of favorable cases (either two evens or two odds) is:

$2 \times {}^{25}C_2 = 2 \times \frac{25\times24}{2}$

Therefore, the probability that the selected numbers are in arithmetic progression is:

$\text{Probability} = \frac{2\times\frac{25\times24}{2}}{\frac{50\times49\times48}{6}} = \frac{3}{98}$

Question14

The probability that exactly 3 heads appear in six tosses of an unbiased coin, given that first three tosses resulted in 2 or more heads is

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Options:

A. $\frac{3}{16}$

B. $\frac{5}{16}$

C. $\frac{1}{4}$

D. $\frac{9}{16}$

Answer: B

Solution:

p represent the probability of getting head in a toss of a fair coin, so

$p = \frac{1}{2}$

$q = \frac{1}{2}$

$\Rightarrow p(X = r) = {}^6C_r \left(\frac{1}{2}\right)^r \left(\frac{1}{2}\right)^{6-r}$

Probability of getting 3 head $r = 3$

$\Rightarrow \quad p(X = 3) = {}^6C_3 \left(\frac{1}{2}\right)^3 \left(\frac{1}{2}\right)^3 = \frac{5}{16}$

Question15

A student has to write the words ABILITY, PROBABILITY, FACILITY, MOBILITY. He wrote one word and erased all the letters in it except two consecutive letters. If 'LI' is left after erasing then the probability that the boy wrote the word PROBABILITY is

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Options:

A. $\frac{21}{116}$

B. $\frac{72}{116}$

C. $\frac{3}{5}$

D. $\frac{2}{3}$

Answer: A

Solution:

To solve the problem, we need to determine the probability that the word written by the student was "PROBABILITY," given that the letters "LI" were left after erasing the rest.

Definitions

Event B: "LI" is the sequence of letters left.

Event A: The student wrote "PROBABILITY."

We need to find $P(A|B)$, which represents the probability of event A given event B.

Calculations

Probability of Event $A \cap B$:

Event $A \cap B$ happens when the student writes "PROBABILITY" and "LI" is the part remaining after erasing. In "PROBABILITY," "LI" can appear in exactly one position. Hence, the probability of choosing "PROBABILITY" and having "LI" is:

$$P(A \cap B) = \frac{1}{4} \times \frac{1}{10}$$

$\frac{1}{4}$ represents the probability of choosing "PROBABILITY" from the four words.

$\frac{1}{10}$ represents the probability of choosing "LI" from the 10 possible pairs of consecutive letters in "PROBABILITY."

Similar Probability Calculations for Other Words:

For "ABILITY": "LI" can be one of 6 pairs.

$$P(\text{ABILITY}) = \frac{1}{4} \times \frac{1}{6}$$

For "FACILITY": "LI" can be one of 7 pairs.

$$P(\text{FACILITY}) = \frac{1}{4} \times \frac{1}{7}$$

For "MOBILITY": "LI" can be one of 7 pairs.

$$P(\text{MOBILITY}) = \frac{1}{4} \times \frac{1}{7}$$

Probability of Event B:

$$P(B) = P(\text{PROBABILITY} \cap B) + P(\text{ABILITY} \cap B) + P(\text{FACILITY} \cap B) + P(\text{MOBILITY} \cap B)$$

Conditional Probability $P(A|B)$:

$$P(A|B) = \frac{P(A \cap B)}{P(B)} = \frac{\frac{1}{4} \times \frac{1}{10}}{\frac{1}{4} \times \frac{1}{10} + \frac{1}{4} \times \frac{1}{6} + \frac{1}{4} \times \frac{1}{7} + \frac{1}{4} \times \frac{1}{7}}$$

Final Calculation:

The probability is simplified to:

$$\boxed{\frac{21}{116}}$$

Question16

Two cards are drawn at random one after the other with replacement from a pack of playing cards. If X is the random variable denoting the number of ace cards drawn, then the mean of

the probability distribution of X is

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Options:

A. 2

B. $\frac{2}{13}$

C. 1

D. $\frac{1}{13}$

Answer: B

Solution:

In a standard deck of 52 cards, there are 4 aces. Therefore, the probability of drawing an ace on a single trial is given by:

$\text{Probability} = \frac{4}{52} = \frac{1}{13}$

When drawing two cards with replacement, the situation can be modeled using a binomial distribution where the number of trials is 2 and the probability of success (drawing an ace) is $\frac{1}{13}$.

The mean (or expected value) of a binomial distribution is calculated as:

$\text{Mean} = \text{Number of trials} \times \text{Probability of success} = 2 \times \frac{1}{13} = \frac{2}{13}$

Therefore, the mean of the probability distribution of X, where X denotes the number of aces drawn, is $\frac{2}{13}$.

Question17

If two dice are thrown, then the probability of getting co-prime numbers on the dice is

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Options:

A. $\frac{23}{36}$

B. $\frac{13}{36}$

C. $\frac{5}{6}$

D. $\frac{1}{6}$

Answer: A

Solution:

Total number of outcomes when 2 dice are thrown $= 36$

Number of co-prime numbers on each die are

$(1,1),(1,2),(1,3),(1,4),(1,5),(1,6),$

$(5,3),(5,4),(5,6),(6,1),(6,5)$

Number of favourable outcomes $= 23$

$\therefore$ Required probability $= \frac{23}{36}$

Question18

If two cards are drawn at random simultaneously from a well shuffled pack of 52 playing cards, then the probability of getting a cards having a composite number and a card having a number which is a multiple of 3 is

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Options:

A. $\frac{94}{663}$

B. $\frac{62}{663}$

C. $\frac{102}{663}$

D. $\frac{64}{663}$

Answer: C

Solution:

Total number of outcomes

$= {}^{52}C_2 = 1326$

Let $A = \{4, 8, 10\}, B = \{6, 9\}$ and $C = \{3\}$ $A' =$ Cards which have the number either 4 or 8 or 10

$B' =$ Cards which have the number either 6 or 9

$C' =$ Cards which have the number 3

Now,

$n(A') = 3 \times 4 = 12$

$n(B') = 2 \times 4 = 8$

$n(C') = 1 \times 4 = 4$

Favourable cases

Case I 0 cards from A', 1 cards from B' and 1 card from C'.

Case II 0 cards from A', 2 cards from B' and 0 cards from C'

Case III 1 cards from A', 1 card from B' and 0 cards from C'

Case IV 1 cards from A', 0 cards from B' and 1 card from C'

Total number of cases

$= {}^{12}C_0 \times {}^{8}C_1 \times {}^{4}C_1 + {}^{12}C_0 \times {}^{8}C_2 \times {}^{4}C_0$

$+ {}^{12}C_1 \times {}^{8}C_1 \times {}^{4}C_0 + {}^{12}C_1 \times {}^{8}C_0 \times {}^{4}C_1$

$= 1 \times 8 \times 4 + 1 \times 28 \times 1 + 12 \times 8 \times 1 + 12 \times 1 \times 4$

$= 32 + 28 + 96 + 48 = 204$

$\therefore$ Required probability $= \frac{204}{1326} = \frac{102}{663}$

Question19

Bag P contains 3 white, 2 red, 5 blue balls and bag Q contains 2 white, 3 red, 5 blue balls. A ball is chosen at random from P and is placed in Q. If a ball is chosen from bag Q at random, then the probability that it is a red ball is

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Options:

A. $\frac{9}{50}$

B. $\frac{13}{45}$

C. $\frac{16}{55}$

D. $\frac{12}{35}$

Answer: C

Solution:

Bag P contains 3 white, 2 red, and 5 blue balls, while bag Q contains 2 white, 3 red, and 5 blue balls. We are interested in finding the probability of drawing a red ball from bag Q after transferring one ball from bag P to bag Q.

First, define E_1, E_2, and E_3 as the events of drawing a white, red, and blue ball from bag P, respectively. The probabilities are calculated as follows:

$P(E_1) = \frac{3}{10}$ (probability of drawing a white ball from P)

$P(E_2) = \frac{2}{10}$ (probability of drawing a red ball from P)

$P(E_3) = \frac{5}{10}$ (probability of drawing a blue ball from P)

Now, consider the composition of bag Q after transferring one ball from bag P:

If E_1 occurs (a white ball is transferred), bag Q will have 3 white balls, 3 red balls, and 5 blue balls. The probability of drawing a red ball from Q becomes $\frac{3}{11}$.

If E_2 occurs (a red ball is transferred), bag Q will have 2 white balls, 4 red balls, and 5 blue balls. The probability of drawing a red ball from Q becomes $\frac{4}{11}$.

If E_3 occurs (a blue ball is transferred), bag Q will have 2 white balls, 3 red balls, and 6 blue balls. The probability of drawing a red ball from Q becomes $\frac{3}{11}$.

The overall probability $P(E)$ of drawing a red ball from bag Q is computed using the law of total probability:

$P(E) = P(E_1) \cdot \frac{3}{11} + P(E_2) \cdot \frac{4}{11} + P(E_3) \cdot \frac{3}{11}$

Substitute the values:

$P(E) = \left(\frac{3}{10} \times \frac{3}{11}\right) + \left(\frac{2}{10} \times \frac{4}{11}\right) + \left(\frac{5}{10} \times \frac{3}{11}\right)$

$P(E) = \frac{9}{110} + \frac{8}{110} + \frac{15}{110} = \frac{32}{110} = \frac{16}{55}$

The probability that a ball chosen from bag Q is red after transfer is $\frac{16}{55}$.

Question20

If the probability distribution of a random variable X is as follow, then the variance of X is

$X = x$	2	3	5	9
$P(X = x)$	k	$2k$	$3k^2$	k

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Options:

A. $\frac{61}{4}$

B. $\frac{7}{2}$

C. 12

D. 3

Answer: D

Solution:

$$K + 2K + 3K^2 + K^2 = 1$$

$$3K + 4K^2 = 1 \Rightarrow 4K^2 + 3K - 1 = 0$$

$$4K^2 + 4K - K - 1 = 0$$

$$(4K - 1)(K + 1) = 0$$

$$K = \frac{1}{4}(K \neq -1)$$

$$\text{Mean } (E(X)) = 2K + 6K + 15K^2 + 9K^2$$

$$= 8K + 24K^2$$

$$= 2 + 24 \times \frac{1}{16} = 2 + \frac{3}{2} = \frac{7}{2}$$

$$E\left(X^2\right) = 4K + 18K + 75K^2 + 81K^2$$

$$= 22K + 156K^2$$

$$= \frac{22}{4} + 156 \times \frac{1}{16} = \frac{22}{4} + \frac{39}{4} = \frac{61}{4}$$

Variance $= E\left(X^2\right) - (E(X))^2$

$$= \frac{61}{4} - \frac{49}{4} = \frac{12}{4} = 3$$

Question21

Among the 5 married couples, if the names of 5 men are matched with the names of their wives randomly, then the probability that no man is matched with name of his wife is

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Options:

A. $\frac{9}{20}$

B. $\frac{1}{5}$

C. $\frac{11}{30}$

D. $\frac{17}{60}$

Answer: C

Solution:

The given problem is same as the probability of de-arrangement of $n!$ objects.

$\therefore$ Required probability

$$= \frac{5!\left[1 - 1! + \frac{1}{2!} - \frac{1}{3!} + \frac{1}{4!} - \frac{1}{5!}\right]}{5!}$$

$$= 1 - 1 + \frac{1}{2} - \frac{1}{6} + \frac{1}{24} - \frac{1}{120}$$

$$= \frac{60 - 20 + 5 - 1}{120} = \frac{44}{120} = \frac{11}{30}$$

Question22

If 3 dice are thrown, the probability of getting 10 as the sum of the three numbers that appeared on the top faces of the dice is

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Options:

A. $\frac{1}{9}$

B. $\frac{7}{72}$

C. $\frac{5}{36}$

D. $\frac{1}{8}$

Answer: D

Solution:

Total possible outcomes,

$n(S) = 6 \times 6 \times 6 = 216$

Triplets	Favourable cases
(6,3,1)	3!=6
(6,2,2)	$\frac{3!}{2!} = 3$
(5,1,4)	3!=6
(5,2,3)	3!=6
(4,4,2)	$\frac{3!}{2!} = 3$
(4,3,3)	$\frac{3!}{2!} = 3$
	Total = 27

$\therefore$ Required probability $= \frac{27}{216} = \frac{1}{8}$

Question23

Three similar urns A, B, C contain 2 red and 3 white balls; 3 red and 2 white balls; 1 red and 4 white balls respectively. If a ball selected at random from one of the urns is found to be red, then the probability that it is drawn from urn C is

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Options:

A. $\frac{1}{6}$

B. $\frac{1}{3}$

C. $\frac{1}{2}$

D. $\frac{2}{9}$

Answer: A

Solution:

2R 3R 1R
3W 2W 4W
A B C

$$P(A)=P(B)=P(C)=\frac{1}{3}$$

$$P(R/A)=\frac{2}{5} \Rightarrow P(R/B)=\frac{3}{5}$$

$$P(R/C)=1/5$$

$$P(C/R)=\frac{P(C)\times P(R/C)}{P(A)\times P(R/A)+P(B)\times P(R/B)}$$

$$=\frac{\frac{1}{3}\times\frac{1}{5}}{\frac{1}{3}\times\frac{2}{5}+\frac{1}{3}\times\frac{3}{5}+\frac{1}{3}\times\frac{1}{5}}$$

$$=\frac{1}{2+3+1}=\frac{1}{6}$$

Question24

If a random variable X has the following probability distribution, then the mean of X is

$X = x_1$	1	2	3	5
$p(X = x_i)$	$2k^2$	k	k	k^2

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Options:

A. $\frac{26}{9}$

B. $\frac{22}{9}$

C. $\frac{24}{9}$

D. $\frac{28}{9}$

Answer: B

Solution:

Given,

X=x_i	1	2	3	5
p(X = x_i)	$2k^2$	k	k	k^2

We know that $\sum p(x_i) = 1$

$$\therefore \quad 2k^2 + k + k + k^2 = 1$$

$$\Rightarrow \quad 3k^2 + 2k - 1 = 0$$

$$\Rightarrow \quad 3k^2 + 3k - k - 1 = 0$$

$$\Rightarrow \quad 3k(k+1) - 1(k+1) = 0$$

$$\Rightarrow \quad -(3k-1)(k+1) = 0$$

$$\Rightarrow \quad k = \frac{1}{3}$$

[$\because$ probability cannot be negative]

Mean of $X=\sum x_i p\left(x_i\right)$

$$=(1)\left(2 k^2\right)+2(k)+3(k)+5\left(k^2\right)$$

$$=7 k^2+5 k$$

$$=7\left(\frac{1}{3}\right)^2+5\left(\frac{1}{3}\right)=\frac{7}{9}+\frac{5}{3}=\frac{22}{9}$$

Question25

A fair coin is tossed a fixed number of times. If the probability of getting 5 heads is equal to the probability of getting 4 heads, then the probability of getting 6 heads is

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Options:

A.

$\frac{7}{64}$

B.

$\frac{9}{32}$

C

$\frac{21}{128}$

D.

$\frac{35}{256}$

Answer: C

Solution:

Let the coin be tossed n times.

It is a binomial distribution problem Here, $p = P(H) = \frac{1}{2}, q = P(T) = \frac{1}{2}$

According to the question,

$^nC_5 p^5 q^{n-5} = {}^nC_4 p^4 q^{n-4}$

$$\Rightarrow {}^nC_5 \left(\frac{1}{2}\right)^5 \left(\frac{1}{2}\right)^{n-5} = {}^nC_4 \left(\frac{1}{2}\right)^4 \left(\frac{1}{2}\right)^{n-4}$$

$$\Rightarrow {}^nC_5 = {}^nC_4 \Rightarrow n = 5 + 4 = 9$$

$$\therefore \text{ Required probability } = {}^9C_6 \left(\frac{1}{2}\right)^6 \left(\frac{1}{2}\right)^{9-6}$$

$$= \frac{9 \times 8 \times 7}{3!} \left(\frac{1}{2}\right)^9 = \frac{21}{128}$$

Question26

When 2 dice are thrown, it is observed that the sum of the numbers appeared on the top faces of both the dice is a prime number. Then, the probability of having a multiple of 3 among the pair of numbers thus obtained is

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Options:

A. $\frac{8}{15}$

B. $\frac{11}{36}$

C. $\frac{5}{9}$

D. $\frac{5}{12}$

Answer: A

Solution:

Possible outcomes are

$(1,1),(1,2),(1,4),(1,6),(2,1),(2,3),(2,5),(3,2),(3,4),(4,1),(4,3),(5,2),(5,6),(6,1),(6,5)$

$\therefore$ Desired outcomes are $(1,6),(2,3),(3,2),(3,4),(4,3),(5,6),(6,1),(6,5)$

$\therefore$ Required probability $=\frac{8}{15}$

Question27

If 2 cards are drawn at random from a well shuffled pack of 52 playing cards from the same suit, then the probability of getting a face card and a card having a prime number is

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Options:

A. $\frac{8}{13}$

B. $\frac{2}{13}$

C. $\frac{8}{221}$

D. $\frac{32}{221}$

Answer: B

Solution:

Since, we can choose any face card (3 options) and any prime card (4 options) in a suit

$\Rightarrow 3 \times 4=12$ favourable combination in one suit.

$\because$ This situation can happen in any of the 4 suits

$\Rightarrow 12 \times 4=48$ overall favourable combination and when drawing 2 cards from the same suit, then total possible ways

$= {}^{13}c_2 = 78$

Since, there are 4 suits, then total ways $= 78 \times 4$

Hence, required probability $= \frac{48}{78 \times 4} = \frac{2}{13}$

Question28

A dealer gets refrigerators from 3 different manufacturing companies C_1, C_2 and C_3.25% of his stock is from C_1, 35% from C_2 and 40% from C_3. The percentages of receiving defective refrigerators from C_1, C_2 and C_3 are $3\%2\%, 1\%$ respectively. If a refrigerator sold at random is found to be defective by a customer, then the probability that it is from C_2 is

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Options:

A. $\frac{29}{37}$

B. $\frac{8}{37}$

C. $\frac{14}{37}$

D. $\frac{15}{37}$

Answer: C

Solution:

Let E_1, E_2 and E_3 denote the stock from C_1, C_2 and C_3 respectively. Let A be event that refrigerator sold at random is found to be defective by a customer.

$$P(E_1) = \frac{25}{100}, P(E_2) = \frac{35}{100}, P(E_3) = \frac{40}{100}$$

$$P\left(\frac{A}{E_1}\right) = \frac{3}{100}, P\left(\frac{A}{E_2}\right) = \frac{2}{100} \Rightarrow P\left(\frac{A}{E_3}\right) = \frac{1}{100}$$

Using Baye's theorem, we get

$$A\left(\Sigma_2/A\right)=\frac{Y\left(E_2\right)\cdot P\left(A/E_2\right)}{\Sigma P\left(E_i\right)\cdot P\left(A/E_i\right)}=\frac{\frac{35}{100}\cdot\frac{2}{100}}{\frac{25}{100}\cdot\frac{3}{100}+\frac{35}{100}\cdot\frac{2}{100}+\frac{40}{100}\cdot\frac{1}{100}}$$

$$=\frac{70}{5(15+14+8)}=\frac{14}{37}$$

Question29

If the probability that a student selected at random from a particular college is good at mathematics is 0.6 , then the probability of having two students who are good at Mathematics in a group of 8 students of that college standing in front of the college, is

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Options:

A. $\frac{2^6\times3^2\times7}{5^8}$

B. $\frac{2^6\times3^2\times7}{5^6}$

C. $\frac{2^8\times3^2\times7}{5^6}$

D. $\frac{2^8\times3^2\times7}{5^8}$

Answer: D

Solution:

To determine the probability of having exactly two students who are good at Mathematics in a group of 8 students. We use Binomial probability formula,

$p(X=k)={}^nC_kp^k(1-p)^{n-k}$

Here, $n=8,k=2,p=0.6=\frac{6}{10}$

Then, required probability

$$= P(X=2) = {}^8C_2 \times \left(\frac{6}{10}\right)^2 \times \left(\frac{4}{10}\right)^6$$

$$= 28 \times \frac{3^2}{5^2} \times \frac{2^6}{5^6} = \frac{7 \times 3^2 \times 2^8}{5^8}$$

Question30

If on an average 4 customers visit a shop in an hour, then the probability that more than 2 customers visit the shop in a specific hour is

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Options:

A. $\frac{e^4-13}{e^4}$

B. $\frac{4}{e^4}$

C. $\frac{8}{e^4}$

D. $\frac{e^4-21}{e^4}$

Answer: A

Solution:

To solve this problem, we use poisson distribution.

The Poisson probability formula is $P(X=k) = \frac{\lambda^k e^{-\lambda}}{k!}$ Here,

$\lambda =$ average number of events $= 4$

$K =$ number of events (customer)

So, probability that more than 2 customers visit the shop in a specific hour $= P(X>2)$

$$= 1 - P(X \leq 2) = 1 - [P(X=0) + P(X=1) + P(X=2)]$$

$$= 1 - \left[\frac{4^0 e^{-4}}{0!} + \frac{4^1 e^{-4}}{1!} + \frac{4^2 e^{-4}}{2!}\right] = 1 - \left[e^{-4} + 4e^{-4} + 8e^{-4}\right]$$

$$= 1 - 13e^{-4} = 1 - \frac{13}{e^4} = \frac{e^4 - 13}{e^4}$$

Question31

If A and B are two events of a random experiment such that $P(A \cup B) = P(A \cap B)$, then which one amongst the following four options is not true?

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Options:

A. A and B are equally likely

B. $P\left(A \cap B'\right) = 0$

C. $P\left(A' \cap B\right) = 0$

D. $P(A) + P(B) = 1$

Answer: D

Solution:

Given, $P(A \cup B) = P(A \cap B)$

We know,

$P(A \cup B) = P(A) + P(B) - P(A \cap B)$
$\Rightarrow P(A) + P(B) = 2P(A \cap B) \neq 1$

Hence, option (d) is not true.

Question32

If a group of six students including two particular students A and B stand in a row, then the probability of getting an arrangement in which A and B are separated by exactly one student in between them is

Options:

A. $2/15$

B. $4/15$

C. $6/15$

D. $8/15$

Answer: B

Solution:

Let us consider, A, B, C, where C is between A and B. Now choice for C is ${}^4C_1$ and A, B interchange their placer in 2 ways.

Now, A, B, C and other 3 students stand in a row in $4!$ ways.

So, total number of ways to stand in a row such that two A, B and separated by one students in between them is

$4 \times 2 \times 4!$

Total number of ways to stand without restriction $= 6!$

$$\begin{aligned} \text{Probability } &= \frac{4 \times 2 \times 4!}{6!} = \frac{4 \times 2 \times 4!}{6 \times 5 \times 4!} \\ &= \frac{8}{30} = \frac{4}{15} \end{aligned}$$

Question33

A, B, C, D cut a pack of 52 well shuffled playing cards successively in the same order. If the person who cuts a spade first, wins the game and the game continues until this happens, then the probability that A wins the game is

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Options:

A. $\frac{74}{175}$

B. $\frac{44}{175}$

C. $\frac{54}{175}$

D. $\frac{64}{175}$

Answer: D

Solution:

Let ' E ' be the event of any one cutting a spade in one out first, and ' S ' be the sample space.

Then, $n(E)={ }^{13} C_1$ and $n(S)={ }^{52} C_1$

Now, $p(E)=\frac{n(E)}{n(S)}=\frac{{ }^{13} C_1}{{ }^{52} C_1}=\frac{13}{52}=\frac{1}{4}$

$\therefore \quad q=1-p=1-\frac{1}{4}=\frac{3}{4}$

Now, probability of A wins the game is

$$
\begin{aligned}
& =P+q^4 P+q^8 P+\ldots \infty \\
& =\frac{P}{1-q^4}=\frac{1 / 4}{1-\left(\frac{3}{4}\right)^4}=\frac{64}{256-81}=\frac{64}{175}
\end{aligned}
$$

Question34

Two bad eggs are mixed accidentally with 10 good ones. If three eggs are drawn at random from this lot in succession without replacement, then the variance of the probability distribution of the number of bad eggs drawn is

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Options:

A. $17/44$

B. $15/44$

C. 13/44

D. 8/44

Answer: B

Solution:

Since, Their are total two bad eggs. So, while drawing 3 eggs we can draw 0 bad eggs, or 1 bad eggs or 2 bad eggs.

Let ' x ' be the random variable denoting number of bad eggs that can be drawn in each draw.

Thus, $P(x=0)$

$=\frac{{}^2C_0\times{}^{10}C_3}{{}^{12}C_3}=\frac{120}{220}=\frac{6}{11}$

Similarly, $P(x=1)=\frac{{}^2C_1\times{}^{10}C_2}{{}^{12}C_3}=\frac{9}{22}$

and $P(x=2)=\frac{{}^2C_2\times{}^{10}C_1}{{}^{12}C_3}=\frac{1}{22}$

Now,

x	P_i	xP_i	x^2P_i
0	6/11	0	0
1	9/22	9/22	9/22
2	1/22	1/11	2/11

$$\therefore \mu=\sum_{i=0,1,2} xP_i=0+\frac{9}{22}+\frac{1}{11}=\frac{11}{22}=\frac{1}{2}$$

$$\sigma^2=\sum x^2P_i-\mu^2$$
$$=\frac{9}{22}+\frac{2}{11}-\frac{1}{4}=\frac{18+8-11}{44}=\frac{15}{44}$$

Thus, variance is $\frac{15}{44}$.

Question35

A student is given 6 questions in an examination with true or false type of answers. If he writes 4 or more correct answers, he passes in the examination. The probability that he passes in the examination is

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Options:

A. $5/32$

B. $7/32$

C. $11/32$

D. $3/32$

Answer: C

Solution:

$n=6$

$P=$ Probability of a question marked with correct answer $=1/2$

$$q=\frac{1}{2}$$

$$\begin{aligned} P(X \geq 4) &= {}^6C_4\left(\frac{1}{2}\right)^6+{}^6C_5\left(\frac{1}{2}\right)^6+{}^6C_6\left(\frac{1}{2}\right)^6 \\ &= \frac{1}{64}(15+6+1)=\frac{22}{64}=\frac{11}{32} \end{aligned}$$

Question36

If $P(X=x)=c\left(\frac{2}{3}\right)^x ; x=1,2,3,4, \ldots$ is a probability distribution function of a random variable X, then the value of c is

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Options:

A. $1/4$

B. $1/3$

C. $1/2$

D. $1/6$

Answer: C

Solution:

To find the value of the constant c, we need to ensure that the probability distribution function sums to 1. This means:

Write the sum of the probability mass function:

$$\sum_{x=1}^{\infty} c\left(\frac{2}{3}\right)^{x} = 1.$$

Factor out the constant c:

$$c\sum_{x=1}^{\infty} \left(\frac{2}{3}\right)^{x} = 1.$$

Recognize that the series

$$\sum_{x=1}^{\infty} \left(\frac{2}{3}\right)^{x}$$

is a geometric series with first term

$$a = \left(\frac{2}{3}\right)$$

and common ratio

$$r = \frac{2}{3}.$$

The sum of a geometric series starting at $x = 1$ is given by:

$$\sum_{x=1}^{\infty} a\, r^{x-1} = \frac{a}{1-r}.$$

However, since our first term is already $\left(\frac{2}{3}\right)^{1}$, we have:

$$\sum_{x=1}^{\infty} \left(\frac{2}{3}\right)^{x} = \frac{\frac{2}{3}}{1-\frac{2}{3}}.$$

Simplify the series sum:

$$\frac{\frac{2}{3}}{1-\frac{2}{3}} = \frac{\frac{2}{3}}{\frac{1}{3}} = 2.$$

Substitute back into the equation:

$$c \cdot 2 = 1.$$

Solve for c:

$$c = \frac{1}{2}.$$

Thus, the value of c is $\frac{1}{2}$, which corresponds to Option C.

Question37

In a non-leap year, the probability of getting 53 Sundays or 53 Tuesdays or 53 Thursdays is

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Options:

A. $\frac{1}{7}$

B. $\frac{2}{7}$

C. $\frac{3}{7}$

D. $\frac{4}{7}$

Answer: C

Solution:

In a non-leap year, we need to determine the probability of having either 53 Sundays, 53 Tuesdays, or 53 Thursdays.

Calculation

A non-leap year consists of 365 days.

Since each week contains 7 days, a year typically has $\frac{365}{7} = 52$ full weeks with 1 extra day.

The extra day determines whether one of the days of the week occurs 53 times. The extra day can be any day of the week:

Sample Space (S): {Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, Saturday}

Thus, the probability sample space $n(S)$ is 7.

Event A: {Sunday, Tuesday, Thursday}

Since Sunday, Tuesday, and Thursday can each be this extra day, we have:

Number of favorable outcomes $n(A) = 3$ (Sunday, Tuesday, Thursday)

Using the probability formula, the probability of Event A is:

$P(A) = \frac{n(A)}{n(S)} = \frac{3}{7}$

Thus, the probability of having either 53 Sundays, 53 Tuesdays, or 53 Thursdays in a non-leap year is $\frac{3}{7}$.

Question38

The equation of the parabola with $x + 2y = 1$ as directrix and $(1, 0)$ as focus is

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Options:

A.

$4x^2 - 4xy + y^2 - 8x + 4y + 4 = 0$

B.

$4x^2 - 4xy + y^2 - 4x + 4y + 4 = 0$

C.

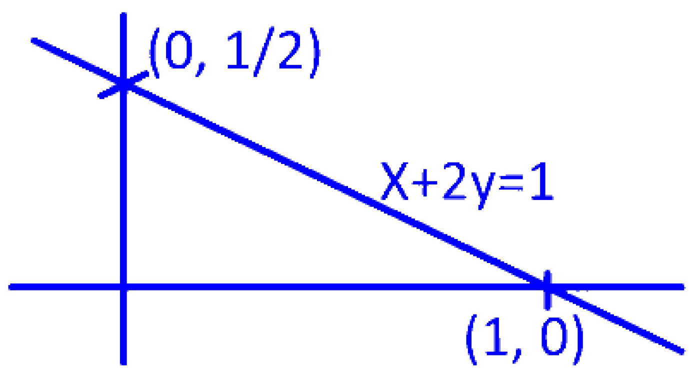
$4x^2 - 4xy + y^2 + 8x + 4y + 4 = 0$

D.

$x^2 - 4xy + y^2 - 8x + 4y + 4 = 0$

Answer: A

Solution:



Question39

If A and B are two events in a random experiment such that $P(A) + P(B) = 2P(A \cap B)$, then

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Options:

A. $P(A) + P(B) = 1$

B. $P(A) = P(B)$

C. $P(A) + P(B) > 1$

D. $P(A) = 0, P(B) = 1$

Answer: B

Solution:

Given the problem statement that $P(A) + P(B) = 2P(A \cap B)$, we can deduce several points based on probability theory.

First, recall the formula for the probability of the union of two events:

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

From the given condition, substitute the information provided:

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

This simplifies to:

$P(A \cap B) = P(A \cup B)$

This equation implies that the probability of the intersection of events A and B is equal to the probability of their union. For this statement to hold true, there are specific conditions that must be satisfied:

The events A and B are such that the probability of their overlap (intersection) is the entire probability of the union, meaning that the events are not just overlapping — they are covering the entire probability space available to them for their union. This can only happen under specific circumstances, which include:

Both events might be equivalent, which implies $P(A) = P(B)$. This means both events have the same probability and overlap completely.

Thus, from the given condition, $P(A) = P(B)$ is a valid conclusion.
