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How to Solve Cubes and Dice **Problems - Part 2**

Our last article dealt with constructing deconstructed cubes, and finding out what is on each side of a cube. If you haven't yet read Part 1 of How to Solve Cubes and Dice Problems, do so at once:

How to Solve Cubes and Dice Problems - Part 1

Now, we can easily solve questions based on those topics, and are able to visualize the sides of a cube, for each question. Let us look at more types of Cubes and Dice problems. Let us first get started on questions dealing with painted faces of a cube.

Painted Faces of a Cube

We are often given a cube consisting of many smaller cubes (like a Rubik's cube), with one or more of the faces painted, and asked how many of the smaller cubes will have painted faces. The following question will give you a clearer idea of what to expect.

E.g. 1. A solid cube of side of length 4 inches has been painted red, green and blue on opposite pairs of faces of the cube. It has been cut into one-inch cubes. How many cubes have only two faces painted?

- 1. 8
- 2. 16
- 3. 24
- 4. 32

Explanation: The figure will look like this -







These questions may seem very lengthy and hard to visualize, but they can be simplified using some easy tips. The first step should always be to draw a rough figure of the cube specified in the question, if it hasn't been provided.

Once you have the diagram, it should be easy to see how many of the smaller cubes are painted or not. Here's how you can count the number of small cubes, with 1 face painted, 2 faces painted and 3 faces painted, respectively.

	3 faces painted	All corner cubes (4)			
	2 faces painted	All edge cubes			
	1 face painted	All face cubes, minus edge cubes			
Corner Cubes - Small cubes that share a corner with the bigger cube. Edge Cubes - Small cubes that share an edge with the big cube.					

IMPORTANT TIP! *

In the problem above, let us first take a look at two sides of the cube. The one inch cubes having two coloured faces can be counted as below,

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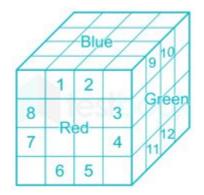












We want to be careful not to recount the same cube twice or thrice. If we count 8 cubes with two faces painted on the red face, then we can count only 4 of the same on the green side. There is another set of red and green sides on the back side. So we can easily say that there are 12 more cubes present on the back side. However, if we look at the two blue side, all the cubes painted on two sides have already been counted in the remaining four sides. Therefore, the total number of cubes having two faces coloured are 24. Hence the, answer is 24.

<u>General Arrangement of a Dice</u>

Some questions rely on your prior knowledge of the faces of a dice. We know that every conventional dice has six faces, with the numbers 1 through 6 painted on each face of the dice. Questions like the one below, often require a knowledge of which number is opposite to, and adjacent to which other number.

E.g. 2. Four regular dice are thrown on the ground. The total of numbers on the top faces of these four dice is 13 as the top faces showed 4, 3, 1 and 5 respectively. What is the total of the faces touching the ground?

- 1. 12
- 2. 13
- 3. 15
- 4. Cannot be determined

Explanation:

In the above question, we have been asked to find the sum of the numbers on four faces of different dice. For this, we need to know the numbers on those faces.

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Use the following table for future reference.

Face of a die	Opposite face	<u>Adjacent</u> <u>faces</u>
1	6	2,3,4,5
2	5	1,3,4,6
3	4	1,2,5,6
4	3	1,2,5,6
5	2	1,3,4,6
6	1	2,3,4,5

All conventional dice have the same configuration as shown above. An important thing to remember is that the opposite faces of a die always add up to 7, so when in doubt, use that.

TIP!



Now, the above question is easy to solve. Since the top faces are 4, 3, 1, and 5 respectively, the sides facing the ground will be opposite sides, i.e. 3, 4, 6 and 2, respectively.

∴ Sum= 3+4+6+2=15.

Cubes and Numbers

Cubes and numbers encompass a vast variety of questions that can be asked in the topic of Cubes and Dice. Dice can be rolled, one or two at a time, asking you to predict the sum, difference or calculate the possibility of getting a certain number. In order to solve these kind of questions, some important things to be kept in mind are -

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<u>Туре</u>	Range of numbers	<u>Number of</u> possibilities
One at a time	This gives us numbers between 1 to 6	6
Two dice rolled together (sum).	This gives us numbers between 2-12	36
Two dice rolled together (difference).	This gives us a number between 0 to 5.	36
More than two dice rolled together.	Depending on number of dice.	Depending on number of dice.

When a single die is rolled, the no. of possibilities is 6.

When two dice are rolled together, the no. of possibilities is 6*6=36

When three dice are rolled together, the no. of possibilities is 6*6*6=216. ...and so on.

Let us take a look at some of the types of questions can be asked in this category-

E.g. 3. A dice is numbered from 1 to 6 in different ways. If 1 is adjacent to 2, 4 and 6, then which of the following statements is necessarily true?

- 1. 2 is opposite to 6
- 2. 1 is adjacent to 3
- 3. 3 is adjacent to 5
- 4. 3 is opposite to 5

Answer: 3 is adjacent to 5. **Explanation**:











Consider 1 to be on top. Then since 2, 4 and 6 are adjacent to 1, we can say that they will lie on three of the four lateral sides of the cube. This means that the fourth lateral side and the bottom will have 3 and 5 (not necessarily in that order). Now let us look at the options.

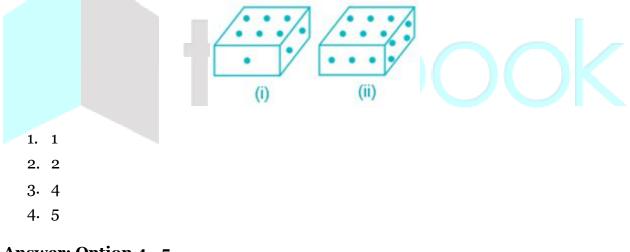
Option $1 \Rightarrow 2$ and 6 are both on lateral sides, but whether they lie on opposite faces or no is not known. So this statement is not necessarily true.

Option $2 \Rightarrow 1$ is on top, whereas 3 can be either on a lateral side or on the bottom. So we cannot say that 1 is adjacent to 3 in all cases.

Option $3 \Rightarrow$ Two cases arise. Either 3 is on a lateral side, and 5 is at the bottom, or 3 is at the bottom and 5 is on a lateral side. In both cases, 3 and 5 will be adjacent to each other. So this statement is necessarily true.

Option $4 \Rightarrow$ We have proven above that 3 will necessarily be adjacent to 5, so it cannot be opposite to 5. So this statement is false.

E.g. 4. Two positions of a block are shown below: When six is at the bottom, what number will be at the top?



Answer: Option 4 - 5 <u>Hint</u>:

The top side is 6. The four lateral sides are 1, 2, 3, 4 from the two figures. Clearly, if 6 goes to the bottom, then the side at the top will be the only one we haven't seen yet -5.

E.g. 5. Observe the dots on a dice (one to six dots) in the following figures. How many dots are contained on the face opposite to that containing four dots?

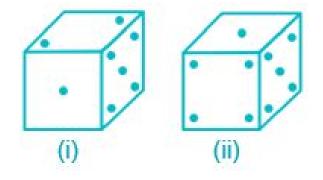












- 1. 2
- 2. 3
- 3. 6
- 4. Cannot be determined

Ans: Option 1

Solution:

Cube in position (ii) is obtained by rotating the cube in position (i) in such a way that the side with one dot goes on top, while keeping the side with 5 dots on the right in the same position (S2). So side with two dots goes to S3. And side with 4 dots is in S1. Since the side opposite to S1 is S3, the side opposite the one with 4 dots has 2 dots.

<u>Now Try It Yourself</u>

Some Cubes and Dice Problems

Q1. All surfaces of a cube are coloured. If a number of smaller cubes are taken out from it, each side 1/4 the size of the original cube's side. Find the number of cubes with only one side painted.

- 1. 60
- 2. 32
- 3. 24
- 4. 16

Q2. If the difference between the no. of dots on any of the adjacent faces is 3, find out the figure which is correct?

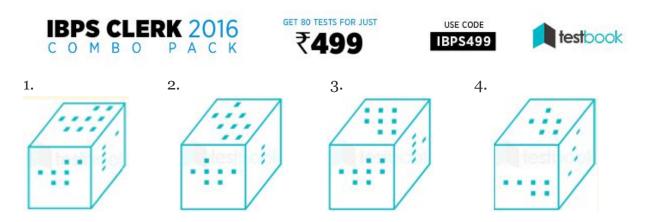
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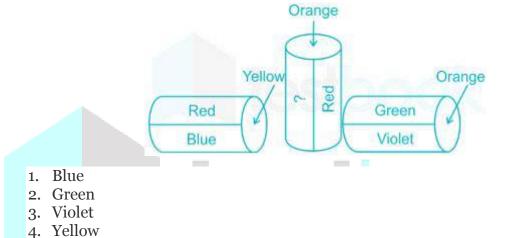
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Q3. A cylinder is painted in 6 colours – Green, Blue, Yellow, Violet, Red and Orange. Three positions are shown below:



Q4. A cube is cut in two equal parts along a plane parallel to one of its faces. One piece is then colored red on the two larger faces and green on remaining. While the other is colored green on two smaller adjacent faces and red on the remaining. Each is then cut into 32 cubes of same size and mixed up.

What is the number of cubes with at least one green face on each?

- 1. 36
- 2. 32
- 3. 38
- 4. 48
- 5. 40

Answers & Solutions

Q1. Ans: Option 3 – 24 Solution: 8 | P a g e

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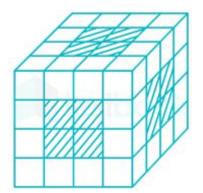






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The original (coloured) cube is divided into 64 smaller cubes as shown in the figure. The four central cubes on each face of the larger cube, have only one side painted. Since, there are six faces, therefore total number of such cubes = $4 \times 6 = 24$.

Q2. Ans: 3 Solution:

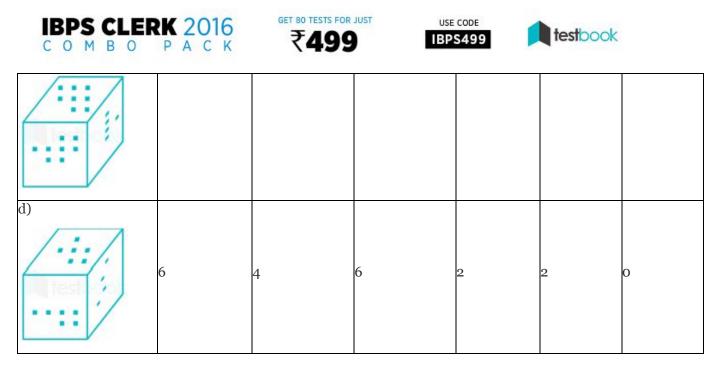
In the cube given, there can be three differences possible. One is between top side and right side. One is between top and front side. And, one is between front and right side.

Option	Dots in Top side (1)	Dots in Right side (2)	Dots in Front side (3)	(1) - (2)	(3) - (2)	(1) - (3)
a)	9	5	7	4	2	2
b)	9	3	7	6	4	2
c)	8	5	8	3	3	0









We can see that option 3 is the only option where difference between adjacent sides' dots is 3.

Q3. Ans: 1. Blue

Solution: End faces of cylinder are of orange and yellow color. From first figure we see that Yellow is on the right side of 'Red and Blue' and in second figure Yellow is on right so Orange must be on left side of 'Red and blue'.



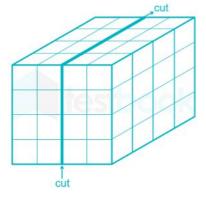




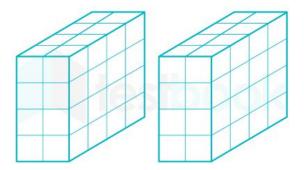


Q4. Ans: Option 3 – 38

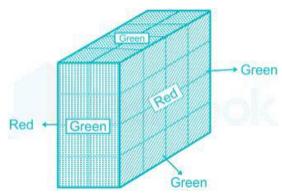
Solution: Stage I: One big Cube.



Stage II: After cutting two equal parts, we have two equal rectangles.

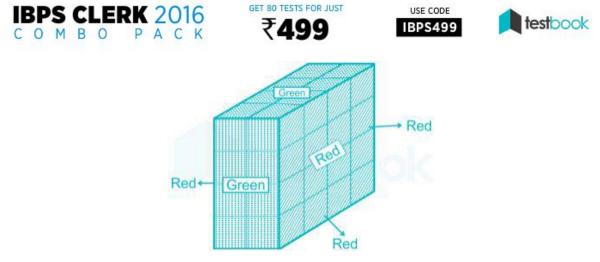


Stage III: One piece is colored red on larger faces & green on 4 smaller faces \Rightarrow 2 Large faces = Red; 4 small face = Green.

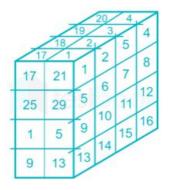


Stage IV: the other is colored green on two smaller adjacent faces and red on the remaining \Rightarrow 2 small faces = green, 2 small faces = red, 2 large faces = red.





Stage V: Cutting 1st rectangle into 32 equal pieces:



Face Color Composition	Cube No. from figure	Total
Red = 1 face Green = 2 face None = 3 face	1, 4, 13, 16, 17, 20, 29, 32	8
Red =1 face Green = 1 face None = 4 face	2, 3, 5, 8, 9, 12, 14, 15, 18, 19, 21, 24, 25, 28, 30, 31	16
Red = 1 face None = 5 faces	6, 7, 10, 11, 22, 23, 26, 27	8

Stage VI: : Cutting 2^{nd} rectangle into 32 equal pieces:

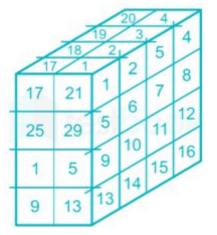












Face Color Composition	Cube No. from figure	Total	
Red = 1 face Green = 2 face None = 3 face	1, 17	2	
Red = 3 face None = 3 face	16, 32	2	
Red = 1 face Green = 1 face None = 4 faces	2, 3, 5, 9, 18, 19, 21, 25	8	K
Red = 2 face Green = 1 face None = 3 face	4, 13, 20, 29	4	
Red = 2 face None = 4 face	8, 12, 14, 15, 24, 28, 30, 31	8	
Red = 1 face none = 5 face	6, 7, 10, 11, 22, 23, 26, 27	8	

At least 1 green face means 1 or more than 1 green faces.

1. 1st Rectangle \Rightarrow 2 green faces + 1 green face = 8 + 16 = 24

2. 2^{nd} Rectangle \Rightarrow 2 green faces + 1 green face = 2 + 8 + 4 = 14

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Total such cube with at least 1 green face = 24 + 14 = 38



