Section VII

PERCEPTUAL ABILITY

CHAPTER SIXTY-THREE

Perceptual Ability Strategies

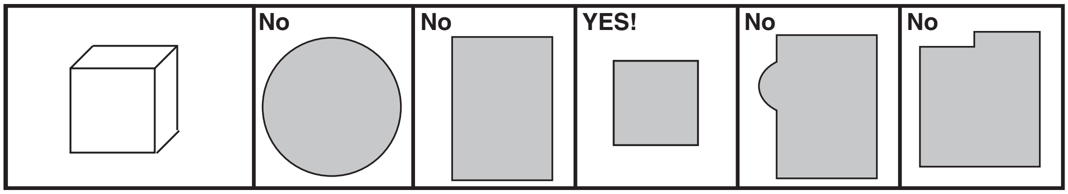
The Perceptual Ability Test (PAT) is the second section of the DAT and tests your spatial visualization skills, including your ability to interpret two-dimensional (2D) representations of three-dimensional (3D) objects. These skills will be very useful to you as a dentist since you will need to construct mental images of teeth from X-rays, deal with casts and fillings, and otherwise work with 2D and 3D objects.

The PAT contains a total of 90 questions that you must complete within 60 minutes. The 90 questions are divided into six categories consisting of 15 questions each: **Keyholes (apertures)**, **Top-Front-End (view recognition)**, **Angle Ranking**, **Hole Punching (paper folding)**, **Cube Counting**, and **Pattern Folding (3D form development)**. All the questions for a given subsection appear together, and the subsections always appear in the same order.

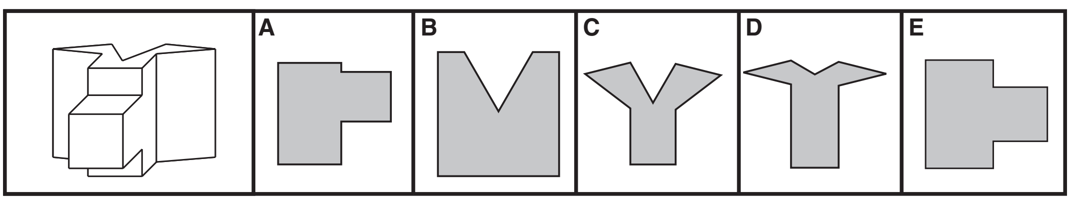
Some question types are more time-consuming than others, so pace yourself accordingly rather than only considering the average amount of time per question for the entire section. Angle Ranking and Hole Punching questions tend to be the fastest because they only involve 2D images and should take you approximately 20 seconds each. Keyhole and Top-Front-End questions require understanding of how 2D images correspond with 3D shapes and will likely take closer to 50 seconds each. Pattern Folding questions also require 2D-to-3D manipulation and tend to be some of the most challenging, so they may take up to 60 seconds each. Finally, the Cube Counting section is unique because it contains several questions associated with one figure, so it is easier to think about it as taking two minutes per figure (which corresponds to about 40 seconds per question). You may find certain subsections to be easier or more challenging for you personally, but these guidelines are a good place to start, and you can modify them based on your personal needs.

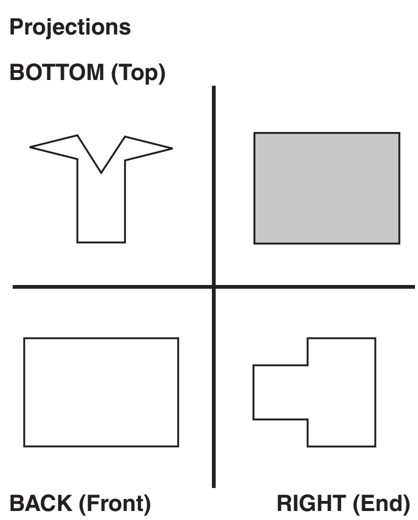
KEYHOLES

For each Keyhole question you are presented with a 3D object and must determine which of the five openings in the answer choices would allow the object to pass through with a perfect fit. The object can pass through the opening in any orientation, but it cannot be rotated *while* it is passing through. The external outline of the object is the exact size and shape of the opening without being too big or small or having extra protrusions. In the example below, the cube *could* fit through any of the apertures, but the only correct answer is the square projection of the cube that is an exact fit.



Note that none of the features present within an object, such as overlapping shapes, appear in the answer choices; instead, the focus is merely on the outline alone. Because of this, the correct opening generally corresponds with one of three **projections** (reductions of 3D images to flat, 2D images) that can be drawn for the object: the top-bottom projection, the front-back projection, or the side projection. One way to visualize these projections is to think of what shadow would be created if you were to shine a bright light on the object from one direction. Regardless of how you visualize the projections, the most efficient way to arrive at the correct answer is to determine the three main projections of the object and pick the choice that matches one of these. The following example illustrates this technique:





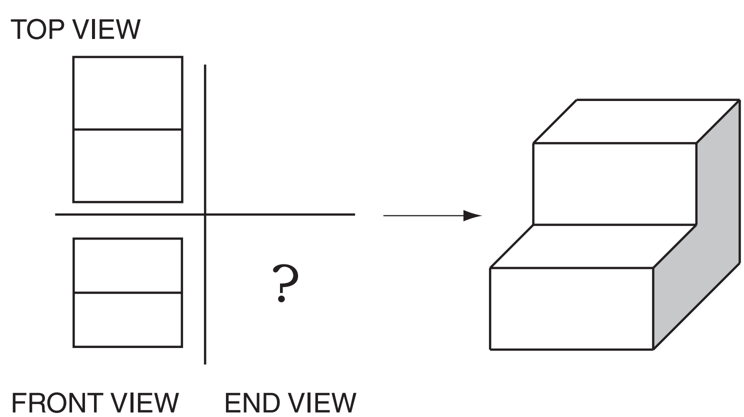
The correct choice is therefore (E). Note how choice (D) is a distractor designed to trap test takers who go for the obvious features of the object without paying attention to the finer aspects; this is a common PAT trap.

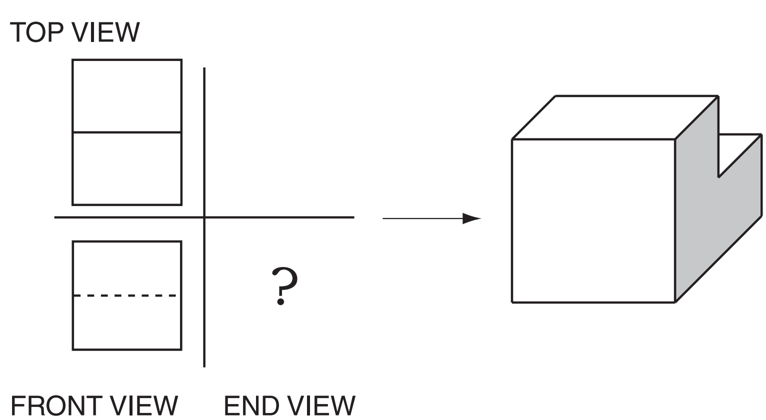
If you have difficulty visualizing the correct projection, try to imagine what would happen if you were to flatten the object against the wall relative to the top/bottom, front/back, or left/right sides. Whichever way you crush the original object, the part that remains will represent a correct aperture for the problem. A good example of this occurs when crushing a soft drink can. If you crush it from top to bottom, you are left with a circular disc. If you crush it from left to right or from front to back, though, you are instead left with a rectangular piece. Therefore, if your original object is a circular cylinder, the correct projection would be either a rectangle or a circle.

With practice, focusing on the three main projections will allow you to spend no more than the recommended 12.5 minutes on the 15 questions in the Keyholes subsection, which equates to 50 seconds per question.

TOP-FRONT-END

Top-Front-End questions are closely related to Keyhole problems. You are presented with two projections of an object and are expected to determine the third. However, Top-Front-End projections are not mere outlines but also contain lines that represent where the visible and hidden edges of each figure would appear. Hidden edges of the object that *cannot* be seen when viewing it straight on are represented by dotted lines, whereas visible edges that *can* be seen when viewing it straight on are represented by solid lines. The following scenario illustrates this convention:



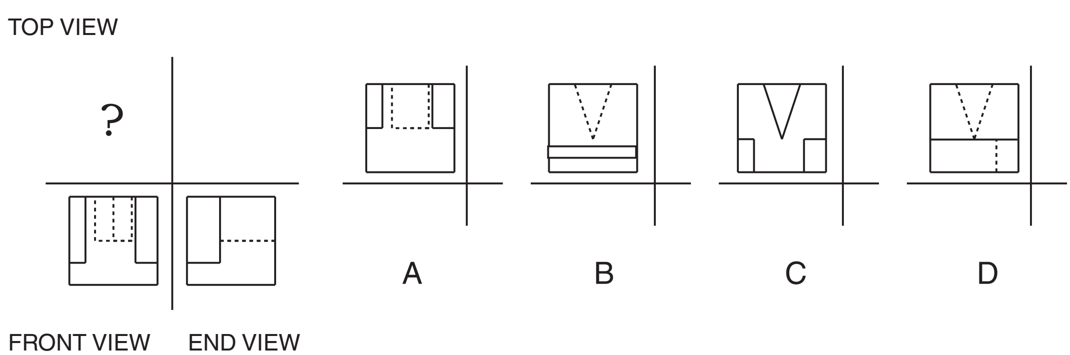


The top views of both of the above objects are the same. They show that the object possesses some kind of step, but it's not clear which half is higher from the top view alone. This information is conveyed in the front views. In the first case, since the front view contains a solid line, the lower step must be in front. In the second case, however, the higher step is in front, hiding the lower step from view. Hence, a dotted or dashed line is used to indicate the presence of the step; it is something that is present in the shape but not visible when looking from the direction indicated.

The actual 3D objects being represented in each case are similar, but their orientations are different. This is important because the end view is always lateral from the right. Hence, in the first case, the end view is an L-shape pointing from right to left, while in the second case, the L-shape points from left to right. In short, unlike in Keyhole problems, orientation *does* matter here.

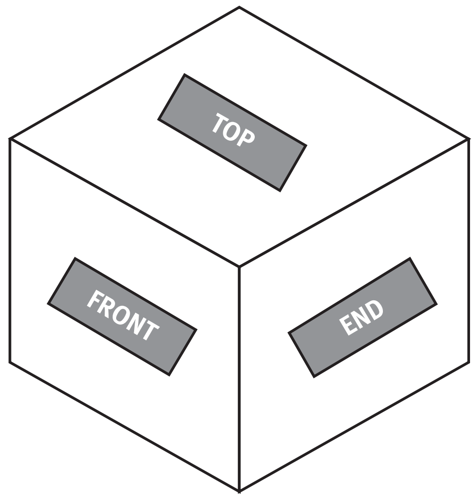
Note that on the DAT you will *not* be given the 3D objects shown to the right of each figure; instead, you are expected to be able to construct those kinds of images mentally.

The correct interpretation of solid and dashed lines can be very helpful in more challenging problems. Sometimes it can be very difficult to construct a full 3D image of the object from the two projections given; in these situations, it may be much easier to focus on some finer features and determine whether solid or dotted lines will be present in certain regions. The following example illustrates this point:



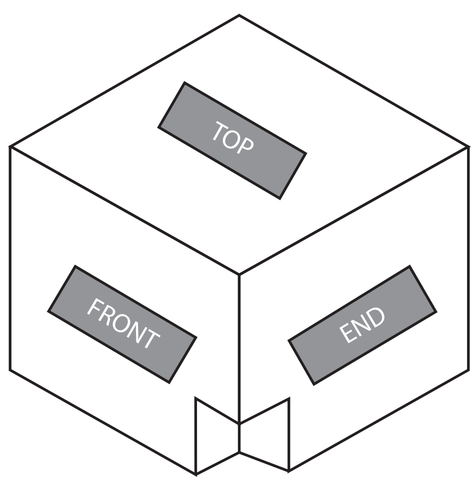
In this question, you are asked to select the correct top view. The 3D appearance of the object is not immediately obvious from the two given projections. However, in the front view, you can see a substructure represented by dotted lines. The dotted lines show that the substructure is present but not visible from the front view. However, since the substructure is connected to the top of the object, you *can* expect to see it in solid lines in the top view. Only choice (C), which shows a horizontally centered, visible structure, fits that prediction.

Even with a strong grasp of how Top-Front-End questions work, you may still find them to be challenging, especially when confronted with elaborate shapes. In those cases, Kaplan's **event-counting** strategy can make the questions much more manageable. The fundamental concept behind the strategy is that, although the three views may at first seem completely separate, they all share edges with one another. For example, the right edge of the front view must necessarily be the same as the left edge of the end view because both represent the exact same corner of the overall figure. This is easiest to visualize if your original shape is a cube:



Looking at the figure this way, you also can see that the top of the front view matches the bottom of the top view, and the right of the top view matches the top of the end view. This may sound confusing at first, but all you really need to know is that edges from each view correspond with edges from another.

The reason why this is important is that anything that happens along the edge in one view also must be happening along the corresponding edge in another view—because it is the same edge. For example, consider the cube above but with a notch removed from the corner:



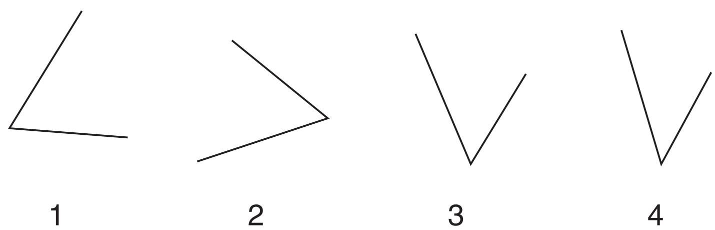
In this situation, the notch is visible from the right edge of the front view and also the left edge of the end view. If the end view was the missing view, you would know that the correct answer must have that corresponding notch. In fact, you can simplify that even further by merely realizing that "something" (some "event") happened along that edge in the front view, so that "event" must have happened along the corresponding edge in the end view, too. By counting the number of events that occur along one edge and finding the answer choice(s) that also have the same number of events along the corresponding edge in the missing view, you will be able to quickly eliminate wrong answer choices, sometimes even narrowing down to the correct answer based on counting alone.

Armed with this strategy, expect to spend 12.5 minutes on the Top-Front-End section, which equates to 50 seconds per question.

ANGLE RANKING

For each Angle Ranking question, you are given four angles labeled 1–4 that you must rank in increasing order from smallest to largest interior angle.

Some angles may be so close in size (such as a difference of only two degrees) that assigning the order of them unambiguously is almost impossible. However, you will be able to use the answer choices to help you eliminate based on the other angles and possibly find the correct answer without needing to identify the full ranking first. This strategy is illustrated in the following example:



A. 3-2-1-4
B. 3-2-4-1
C. 4-3-1-2
D. 4-3-2-1

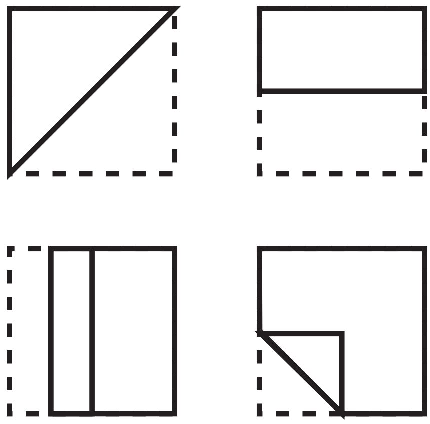
It is difficult to ascertain which angle is larger, 2 or 3. However, if you can see that 4 is the smallest angle, you can eliminate (A) and (B), and then seeing that 1 is the largest angle will confirm that (A) is incorrect and also eliminate (C). This leaves only choice (D) as the correct answer and doesn't require determining whether 2 or 3 is smaller.

Although not necessarily easier than the other PAT questions, the Angle Ranking questions don't require 3D manipulation and can be completed very quickly. Spending no more than five minutes on the 15 Angle Ranking questions at the rate of 20 seconds per question will allow you to spend longer on the more time-consuming subsections.

HOLE PUNCHING

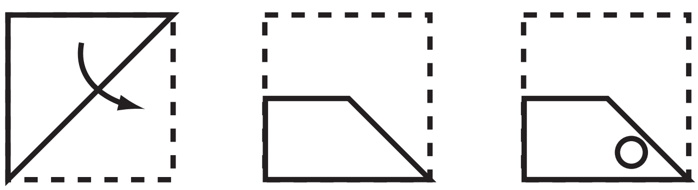
For each Hole Punching question, a square piece of paper is folded one, two, or three times, and then one or more holes are punched at specific locations. You are then asked to unfold the paper mentally and determine the final locations of the hole(s).

The paper is always folded toward the front (out of the screen and toward you) to allow you to see the final positions of paper. The edges of the paper in the new position are represented by solid lines, and the original locations where the paper used to be are represented by dashed lines. The folds are not arbitrary; in fact, there are only four possible types of first folds, as follows:

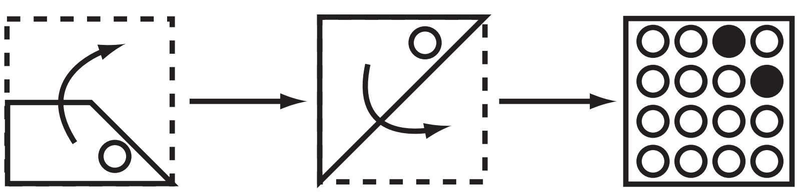


However, note that each of these four first folds can occur on any edge; for example, the corner fold shown in the bottom right can be on any of the four corners, not just the bottom-left corner.

After the first fold, the paper may be folded one or more additional times. Since these occur after the first fold, a wide range of combinations exist, but all the folds still follow the same basic patterns. In the following example, you can see the paper folded diagonally in the first fold and then folded halfway down before a hole is punched.

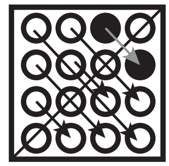


Mentally unfolding the paper gives the following:

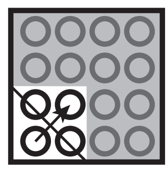


In the answer choices, punched holes are indicated by filled circles on a grid of 16 possible positions. These 16 positions represent the only possible final holes, and no partial holes will appear in the correct answer. Here, the correct answer includes two punched holes.

A helpful strategy for Hole Punching questions is to eliminate answer choices by looking at the symmetry of the first fold. Because the unfolding step will be the opposite of that initial fold, any position with a hole on one side of the line of symmetry created by the first fold will be mirrored by another position with the same hole.



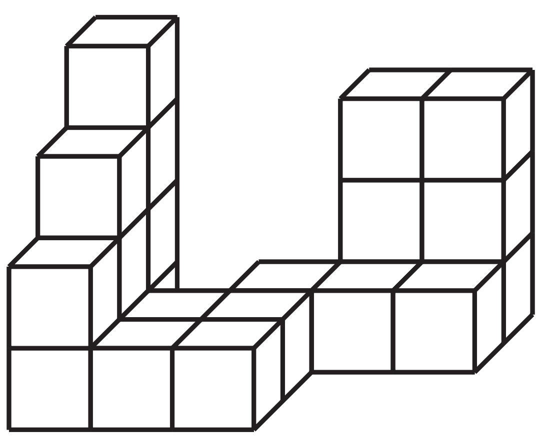
Any answer choice that does *not* have the corresponding line of symmetry can be eliminated immediately regardless of any other factors. Note that, if the first fold does not bisect the paper into two equal parts, you should only look at the overlapping portion of the paper and can ignore any other sections. For example, if the first fold is a corner fold, the line of symmetry will be diagonal across that quadrant (one-fourth) of the paper, and the other three-fourths can be ignored when evaluating the paper's symmetry:



Similar to Angle Ranking, spend only five minutes on the Hole Punching section, which means taking an average of 20 seconds on each question. This is a very short amount of time, so spend time practicing completing these questions both quickly and accurately.

CUBE COUNTING

In this part of the PAT, you will be presented with several stacks of cubes. Each stack is constructed by cementing together identical cubes. You are asked to imagine that the stack as a whole is painted on all sides except for the bottom (on which the stack rests). You are then asked to determine how many individual cubes have a particular number of sides painted with each figure accompanied by several questions. The following example makes the directions more concrete:



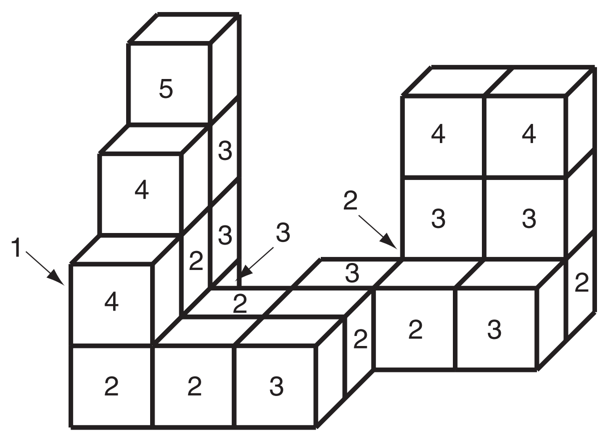
In the figure, how many cubes have two of their exposed sides painted?

- **A.** 5 cubes
- **B.** 6 cubes
- **C.** 7 cubes
- **D.** 8 cubes
- **E.** 9 cubes

In the figure, how many cubes have three of their exposed sides painted?

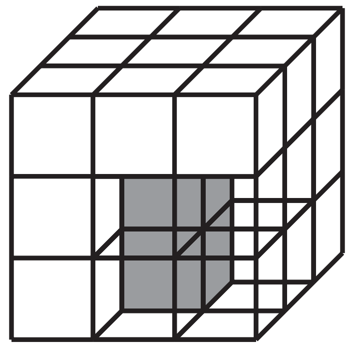
- **A.** 5 cubes
- **B.** 6 cubes
- **C.** 7 cubes
- **D.** 8 cubes
- **E.** 9 cubes

For this figure, the total number of sides painted for each cube in this stack is as follows:



As the diagram illustrates, you cannot neglect cubes that are not clearly visible, but you also can't imagine cubes are present when they are not; requiring you to do so would make the questions unfair. The general rule devised by the test makers is that the only hidden cubes are the ones necessary to support other cubes. In this diagram, you should infer the presence of a hidden cube with one side painted on the left because without such a cube the four-sided and two-sided cubes on top of it would not be supported.

Sometimes cubes can be totally hidden within the stack and have no sides painted, as shown below:



The most useful strategy for this section is to make a **tally** of all the cubes that make up the figure before even starting the corresponding questions. To do so, make a table on your note board with a left column of 0–5. Then, methodically go over the stack and make a tally mark next to the correct number of sides painted for each cube in the figure. After you have constructed the table, count the total number of cubes in the figure and compare it to your total number of tally marks to ensure you did not omit any cubes when tallying.

Besides allowing you to verify that you did not miss any cubes when counting, this strategy also saves you a significant amount of time per figure. Rather than approaching each question separately by repeatedly searching the figure for each type of cube being asked about, you instead are able to obtain all the answers right away and use those to very quickly select the correct choice for each question based on your tally and move right on to the next figure.

The tally table for the example shown above would look something like this:

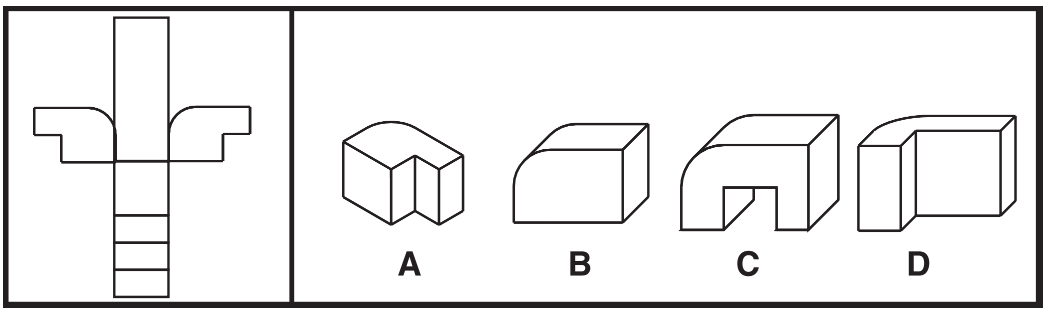
0 side	
1 side	I
2 sides	~~IIII~~ III
3 sides	~~IIII~~ III
4 sides	IIII
5 sides	I

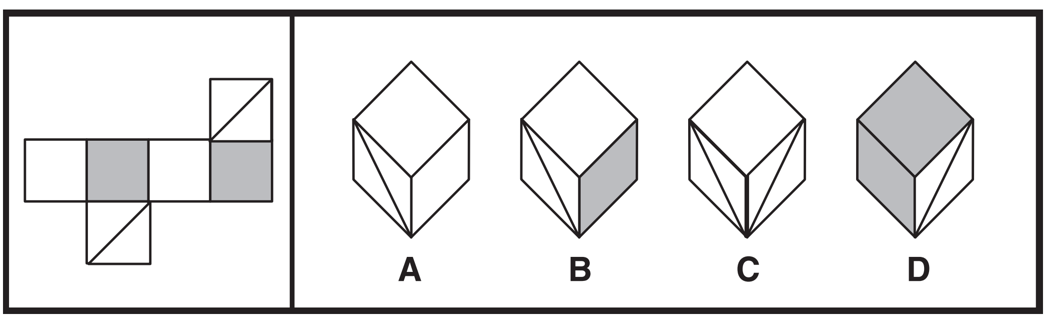
The entire figure has 22 cubes, and this does in fact correspond with the 22 tallies in the table.

On Test Day, the Cube Counting section will have 15 questions corresponding to five different figures with 2–4 questions each. A good goal is to spend two minutes on each figure (including time spent answering its approximately three questions) for a total of ten minutes for the entire subsection.

PATTERN FOLDING

For Pattern Folding questions, a flat pattern is presented, and you are asked to select the 3D figure it would become when folded. Some questions require you to identify the structure only, as in the first example below, while others also present shading and patterns that you must identify, as in the second example below:





In figures that have **unique shapes**, an effective strategy is to eliminate any answer choices that do not contain the unique shape in the original pattern. For the first question above, the flat pattern shows a two-step shape with a rounded back. Choices (B) and (C) do not make the correct stair-step system, and choice (D) has the wrong proportions for the shape. Only choice (A) has the correct, unique shape, so (A) must be correct, regardless of how the rest of the figure comes together.

For figures that instead have **unique shading** as the predominant feature, the strategy is to instead focus on that shading pattern. For the second question above, the figure shows an alternating shaded-unshaded pattern. Again, elimination of answer choices is a very powerful technique here. You can eliminate choice (A) because it shows two unshaded faces together and (D) because it shows two shaded faces together, and you know the pattern should instead alternate. This leaves answer choices (B) and (C) as options.

Although identifying unique shapes and shading often allows you to eliminate down to the correct answer, sometimes more than one choice will be left, as with the second question above. In that case, the final piece to look at is a **key landmark** or point of interest in the figure. This builds on what you already identified with unique shape and shading but adds in evaluating the relationships among key pieces. For the second figure above, you already narrowed the correct answer down to either (B) or (C). Both answer choices feature the square with a diagonal line through it, so use the corresponding square toward the bottom and left of the original pattern as your key landmark. The square is attached to a shaded square, which is part of the alternating shaded-unshaded pattern you already identified. That means all the squares that intersect your key landmark must follow that pattern as well. Therefore, (C) can be eliminated, and (B) is the correct answer.

The important takeaway for all of these strategies is to evaluate a point of interest and focus in on that rather than attempting to visualize the folding and positioning of the entire figure, which is a much more difficult task. By focusing in, you break the pattern into more reasonable pieces that tend to be much less overwhelming but that will still allow you to narrow down to the correct answer.

Because Pattern Folding questions are some of the most challenging ones in the PAT, you can spend up to 15 minutes on this subsection at the rate of 60 seconds per question.