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Mechanical Aptitude Test

Study Guide

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Mechanical Aptitude

1.

A man orders a cup of coffee at a restaurant. If he wants the coffee to be kept hot as long as possible, should he order a regular glass cup or a paper cup to go?

If there is no difference, choose option 3.


1. A paper cup to go
2. A regular glass
3. No difference

Explanation:

The correct answer is 1.

The "to go" cup is made of paper, which is an isolator. Thus, it will keep the liquid hot longer than the glass cup, which is open on top.

2.

Campers are trying to start a fire using only the sunlight and a magnifying glass. When they are holding the magnifying glass 15 inches away from the wood, it starts to smoke. How close to the wood should they hold the magnifying glass in order to create a fire?
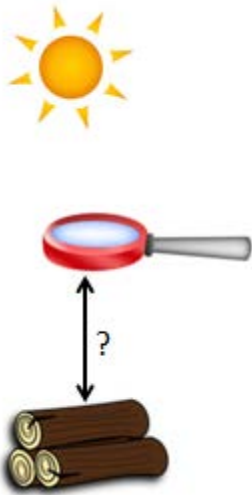
1. 10 inches away
2. 30 inches away
3. Remain at 15 inches
4. It is impossible to start a fire using this method

Explanation:

The correct answer is 3.

A magnifying glass is a convex lens that produces a magnified image of an object. A convex lens converts light as follows: when parallel rays of light from the sun hit the glass, they converge to a single point called 'the focal point' of the magnifying glass. This process forms concentrated heat that when applied onto a flammable substance can (eventually) ignite fire.

The smoke indicates that 15 inches away is where the 'focal point' of the magnifying glass is located. Thus, the wood must remain there in order to successfully start a fire.

3.

A child playing with a stone on a string makes the motion of a circle around him. If the string suddenly tears, in which direction will the stone fly?
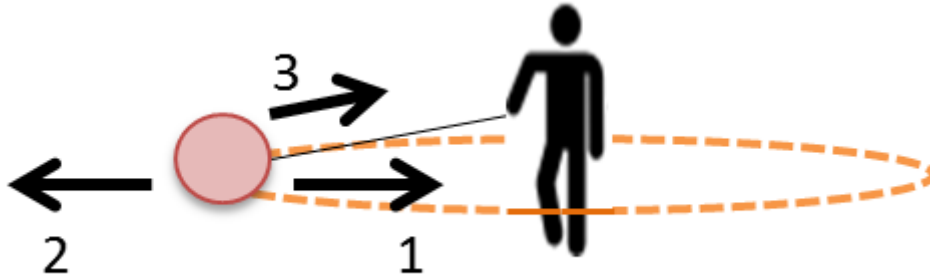
1. Center of the circle
2. In the opposite direction of the center of the circle
3. Perpendicular to the direction of the circle's radius

Explanation:
The correct answer is 3.

The centrifugal force is directed in the opposite direction of the center of the circle around which the stone spins. The tension of the string pushes the stone inwards, maintaining the rotation. In each moment the stone changes its speed, but its direction is always perpendicular to the direction of the circle's radius.
Thus, the stone will fly in the direction of answer 3.

4.
In an imaginary scenario, a hockey puck is sliding on an infinite plane of ice. The friction between the puck and the ice is zero, as well as the friction between the puck and the air. What will affect the time required for the hockey puck to come to a full stop?

1. The puck's weight
2. Gravity
3. The puck's initial velocity
4. Nothing, it will never stop

Explanation:
The correct answer is 4.

With no friction, the puck is sliding with no forces applied onto it apart from its weight. Since the direction of weight is downwards, it will not affect the velocity which is perpendicular to it (the ice is a horizontal plane). With no other forces applied onto the puck, it will never stop; this is due to the puck's inertia (its resistance to a change in its motion). According to inertia, without a decelerating force the puck will slide forever.

5.

At what distance from the left weight does the fulcrum have to be placed to balance the following lever if the distance between the weights is 15 cm?
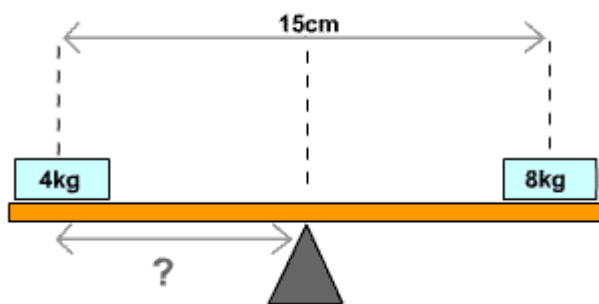
1. 3 cm
2. 5 cm
3. 7 cm
4. 10 cm

Explanation:
The correct answer is 4.

The lever is also a class 1 in which the fulcrum is between the load and the effort. It is given in the question that the distance between the two masses is 15 cm. In order to solve the question, the distance between the mass weighing 4 kg and the fulcrum will be marked as the variable d and the distance between the mass weighing 8 kg and the fulcrum as 15 cm - d. The answer is calculated by substituting the values given in the question in the below equation:

$M_1 \times L_1 = M_2 \times L_2$

4 kg × d = 8 kg × (15 cm - d)
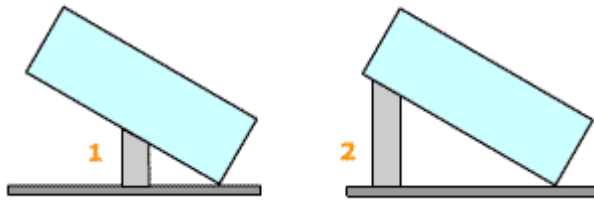
4d = 120 - 8d

Therefore: d = 10 cm

Therefore, 10 cm is the correct answer.

6.

On which pole does the weight press harder? Please select answer option '3' if the weight pressed is equal on both sides.

1. Pole 1
2. Pole 2
3. The weight pressed is equal on both sides.

Explanation:
The answer is 1.

The rectangle pivots about the point of contact with the floor. The further the pole is away from the pivot point, the less force it needs to apply to achieve the same torque (the torque needed to keep the rectangle static). Thus, Pole 2, the pole that is further away from the point of contact with the floor applies less force on the rectangle. This is essentially the Law of the Lever.

By Newton's 3rd Law, the rectangle applies less force on Pole 2 as well. Therefore, on pole 1 the weight is pressed harder.

7.

Two identical triangles are placed inside a water tank as shown in the diagram below. The triangles are fixed in position. On which triangle will a greater force be exerted?
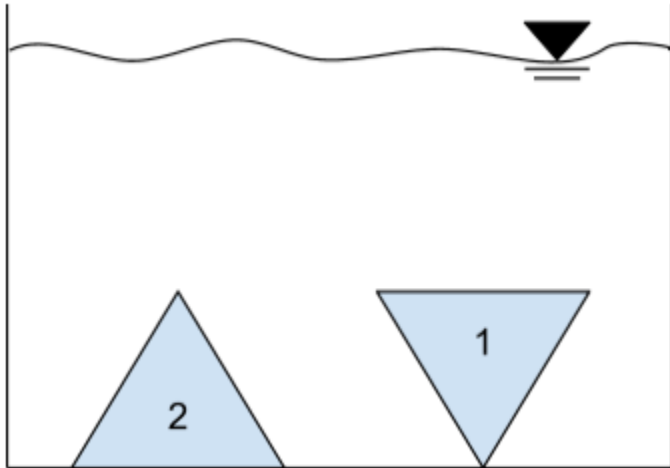
1. Triangle 1
2. Triangle 2
3. Equal on both
4. Cannot say

Explanation:

The answer is 2.

When the triangles are immersed in water a hydrostatic pressure acts upon them. We know that hydrostatic pressure increases with depth (the deeper an object is immersed, the larger the body of water pressing on it is). In other words, the pressure exerted on the base of the tank is greater than the pressure exerted at the midpoint of the tank.

Force is defined by the equation: $F = P*A$

From the equation we can see that under constant pressure, an increase in area will be followed by an increase in force.

We can see from the diagram that the triangles are positioned differently in direction but at the same height (depth). In order to calculate the forces on each triangle we need to sum the pressure exerted on each area. Since the triangles are identical, their total area is the same; but

triangle 2's area is relatively lower (deeper) than the area of triangle 1. Therefore, more force will act on triangle 2.

8.

A sealed tight cylinder is completely filled with gas. When the piston moves from position A to position B, the pressure in the gas part of the cylinder...
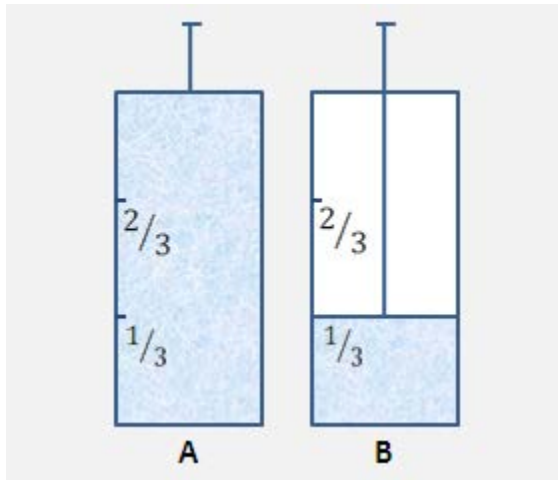
1. is tripled
2. is doubled
3. remains the same
4. is halved
5. decreases by a third

Explanation:
The answer is 1.

While gas quantity remained the same, its volume was reduced threefold (1/3 the volume of the cylinder).
If quantity is constant, pressure is inversely proportional to volume.
Therefore, the pressure will be tripled.

9.

The diagram shows two fixed cogwheels which can only rotate around their own axis. A rack is inserted between the two cogwheels and is moved in the direction shown by the arrow.

What are the directions of movement and velocities of revolution of the cogwheels?
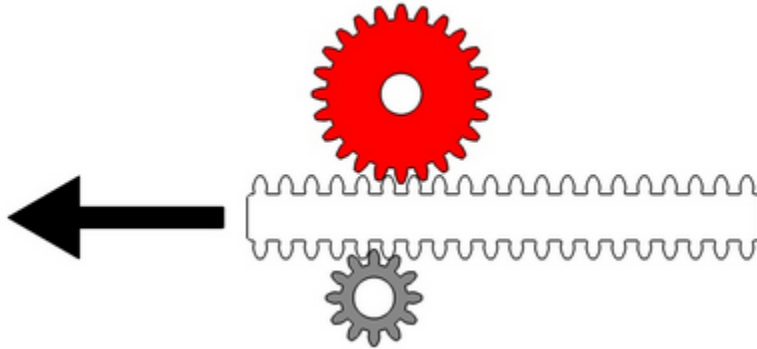
1. Same direction, same velocities
2. Same direction, different velocities
3. Different directions, same velocities
4. Different directions, different velocities
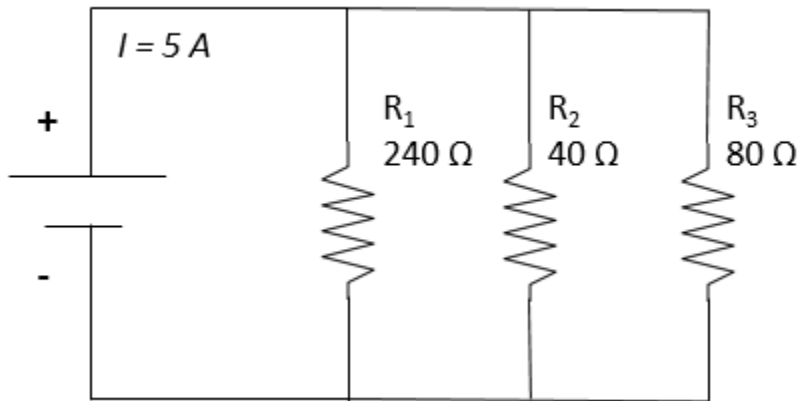
Explanation:

The correct answer is 4.

When contact is made between the rack (toothed belt) and the cogwheels a conversion from a linear velocity to an angular velocity occurs. Thus, the location of the point of contact is critical.

We can see from the diagram that the point of contact between the red cogwheel and the rack is in the lower part of the red cogwheel, a position in which the linear velocity induces an angular velocity in a clockwise direction.

In contrast, the point of contact between the grey cogwheel and the rack is in the upper part of the grey cogwheel, a position in which the linear velocity induces an angular velocity in a counter clockwise direction. It follows that the cogwheels rotate in opposite directions.

The thumb rule: "fewer teeth, faster velocity" which is based on the concept of gear ratio and enables us to conclude without unnecessary calculations that the grey cogwheel rotates much faster than the red cogwheel since it has fewer teeth.

10.

Base your answer to the following questions on the figure below:

The total resistance of the circuit is:

1. 360 Ω
2. 1/24 Ω
3. 24 Ω
4. 240 Ω

Explanation:
The correct answer is 3.

The formula to calculate the total resistance (RT) in a circuit where N resistors are connected in parallel is:

$1/R_T = 1/R_1 + 1/R_2 + 1/R_3 \ldots + 1/R_N$

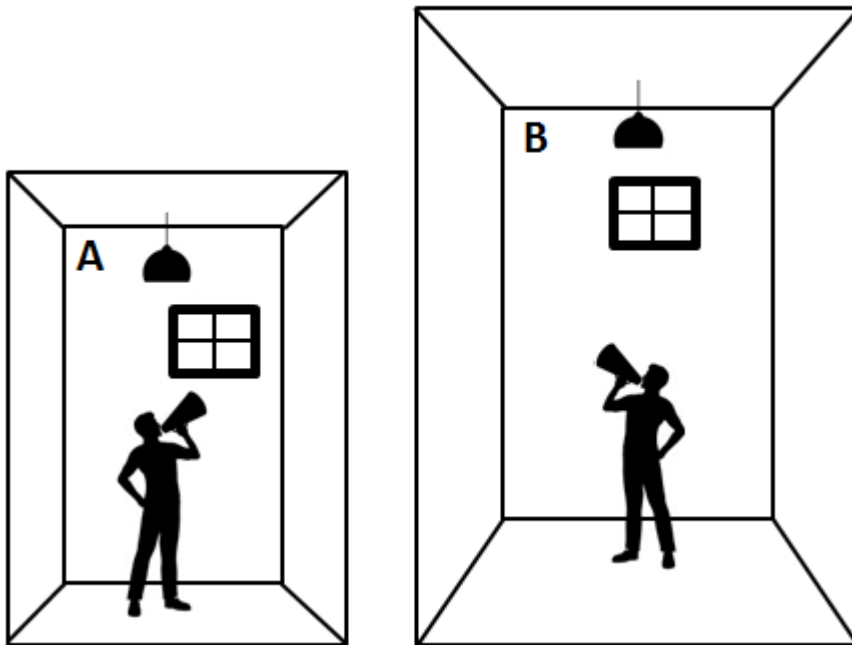If we substitute the values from the figure we get:

$1/R_T = 1/240 + 1/40 + 1/80$

The common denominator is 240:

$1/R_T = 1/240 + 6/240 + 3/240 = (1+6+3)/240 = 10/240 = 1/24$

This is the reciprocal value for R_T ($1/R_T$), thus - R_T is 24 Ω.

11.
The following two singers are singing at the same intensity but standing in different sized rooms. In which room would the echo from the singing be louder?

1. Room A
2. Room B

Explanation:
The correct answer is 2.

An echo is formed when sound waves are hitting large objects such as walls, and returned in different intensities. In room B the walls of the rooms are larger, and thus will produce a louder echo.

12.
Which of the following components restricts the electric current flow to a single direction?
1. Condenser
2. Diode
3. Resistor
4. Transducer
5. Switch

Explanation:
The correct answer is 2.

A diode is an electrical component with an asymmetric conductance - it allows the current to flow in one direction only.

A condenser is a device that condenses gas (such as steam) to liquid (such as water); A resistor is a component that resists to the movement of charge, and slows it down; A transducer is a device that transforms a certain type of energy to a different type of energy; and a switch is a device that allows a convenient opening and closing of electric circuits.

Spatial Reasoning

13.
The following cube has six **different** facets. Which of the four possible options represents the same cube shown from a different perspective?
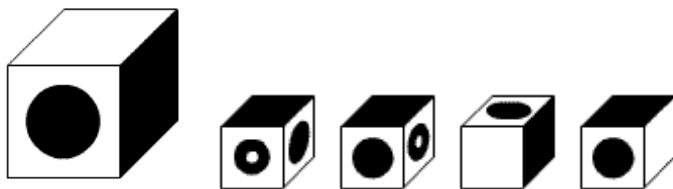
Explanation:
The correct answer is -

We were told the cube has six different facets. Therefore, each facet is unique- even the white one. Therefore, when you see a white facet in the answers, you should regard it as representing the one shown in the question.

- The first option on the left can be eliminated because the facet facing the front should be white.
- The second option is correct and reveals the bottom facet of the cube that was hidden in the main diagram.
- The third option can be eliminated because the white facet should be at the back of the cube rather than in front.

- The fourth option on the right can be eliminated because the white facet should be on the left side rather than on the right.

14.

The following diagram depicts boxes piled in a stack. Each box is of similar size and must be placed either on the ground or on another box.

One of the boxes is marked by a red X. A box touches another box if they have at least one adjacent face or edge (not including vertices).

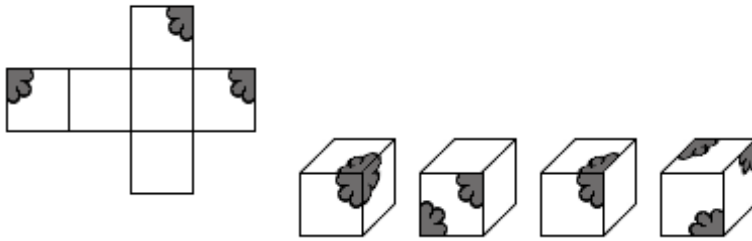How many other boxes touch the marked box?
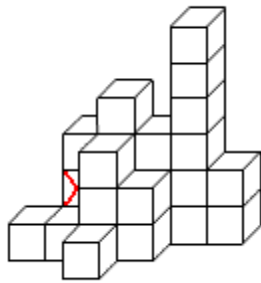
1. 6
2. 7
3. 4
4. 5
5. 8

Explanation:

The correct answer is 2 (7 touching spots).

Faces: top, bottom, right --> 3
Edges: top-right, bottom-right, bottom-front, front-right --> 4

15.

Which of the four possible options represent the cube in its folded form?

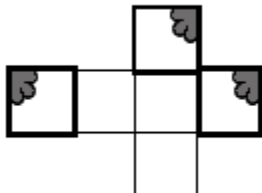Explanation:

The correct answer is option 1.
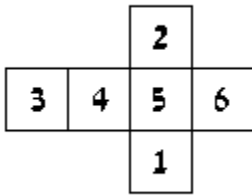
Option 1 – The main diagram consists of three blank facets and 3 facets with a 'floral' pattern. The facets seen in option 1 represent facets 6, 3, and 2 (front, top, and right, respectively). This is the correct answer.

Option 2 – In the front facet in the cube two parts of a flower are presented. When observing the main diagram, it is clear that such a facet does not exist. This option is incorrect.

Option 3 – This option can be easily ruled out, since the top and front facets are represented by facets 3 and 6. Therefore, just like in option 1, the right facet should be represented by facet 2. This option is incorrect.

Option 4 – The only option for all three facets with the flower part to be seen are if they combine to create a flower (like in option 1). This option is incorrect.

16.

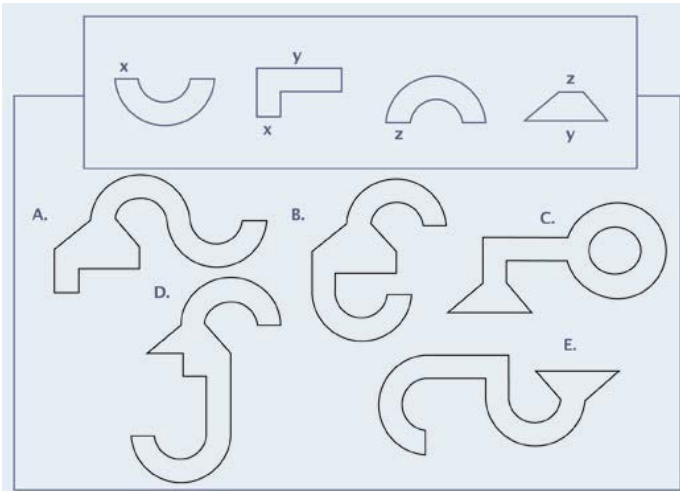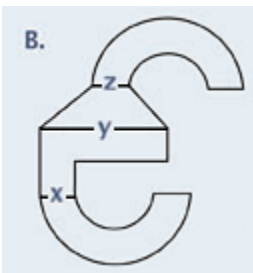Choose the mirror image of the shape.
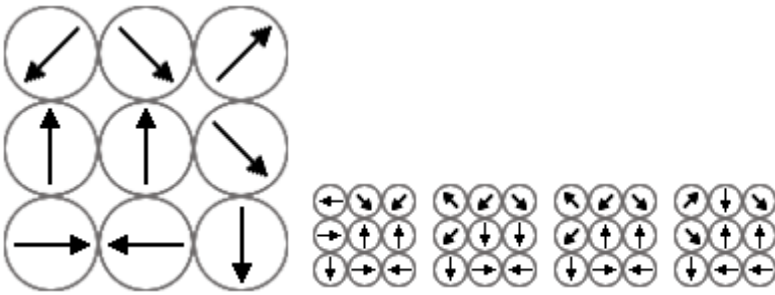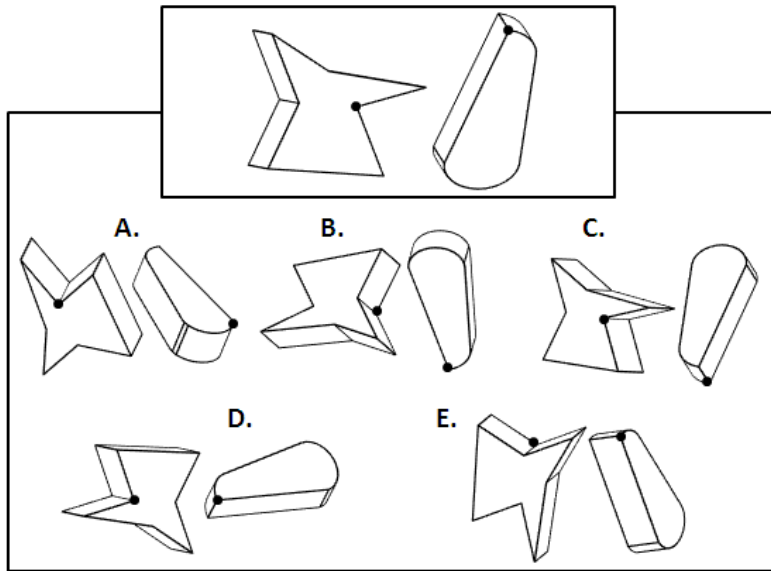
Explanation:

The correct shape is

17.

The letters near the sides of each shape point out where exactly should the different shapes be joined together. Which of the following options shows the joint shape?
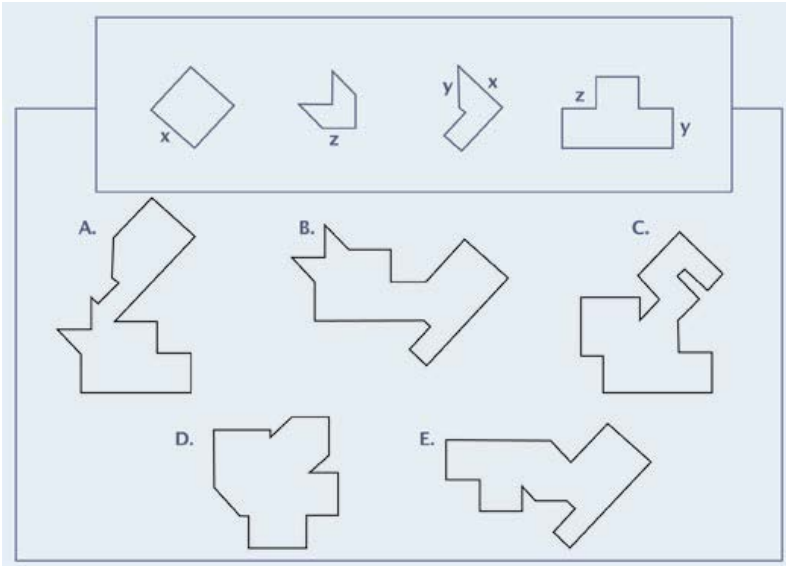

Explanation:

B.

18.

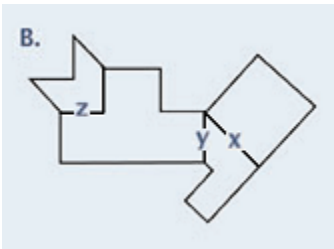Explanation:

The correct answer is D.

Notice that it is much easier to mentally rotate the right object. If one begins with eliminating all options in which the right object has the wrong vertex marked, the solution becomes easier in general.

19.

The letters near the sides of each shape point out where exactly should the different shapes be joined together. Which of the following options shows the joint shape?
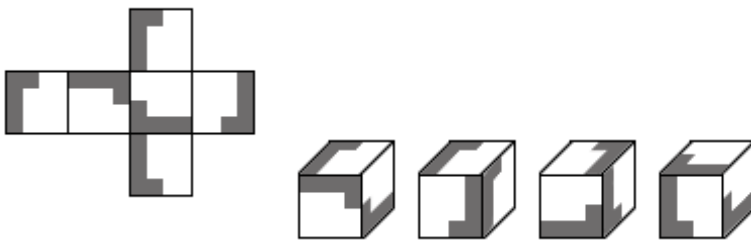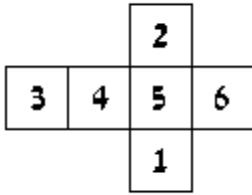
Explanation:

20.

Which of the four possible options represent the cube in its folded form?

Explanation:

The correct answer is option 4.

Option 1 – If the facet in the front represents facet number 4 then the facet on the right represents facet number 5, yet the top facet should represent facet number 2 but it doesn't. This option is incorrect.

Option 2 – If the facet in the front represents facet number 6 then the facet on the right represents facet number 3, yet the top facet should represent facet number 2 but it doesn't. This option is incorrect.

Option 3 – The front facet represents facet number 1, therefore the top facet represents facet number 6, but the L should be facing the opposite direction. This option is incorrect.

Option 4 – The facets seen in the diagram represent facets 1, 5, and 6. This is the correct option.