Heat, Pressure, Repair

Use evidence from gas tests to predict how a protective film behaves.

P.7.5B "Students will demonstrate an understanding about the effects of temperature and pressure on physical state, molecular motion, and molecular interactions..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the changes made to the air or film, and circle what happened as a result. Number the three air tests so you can use their evidence in your answers.

What Happens Beneath the Film?

1. Two science teams tested air to learn what happens when conditions change. Team A sealed air in a syringe, then pushed the plunger while keeping the air at about the same temperature. The trapped air took up less space, but its mass stayed the same. A sensor showed that its pressure rose. Team B warmed a sealed, flexible balloon without adding air. The balloon grew larger while the air inside kept the same mass. In each test, the amount of air stayed constant, so changes in space also changed its density.

2. Why did the results differ? In the warmed balloon, faster moving air molecules pushed against its rubber walls, which stretched outward. With more room, the same air became less dense. In the syringe, the molecules had less room to travel, so they hit the walls more often even though their average speed stayed about the same. A third team heated air inside a sealed metal can that could not expand. Its air could not spread out, so its pressure rose while its volume and density stayed the same.

3. These ideas matter when engineers design a self-healing protective film. Some films contain polymer chains with links that can break and reconnect. If a scratch brings broken surfaces close together, warming the film can help the chains move and meet, allowing some links to form again. Cooling usually slows their motion and may slow repair. Engineers also test films over tiny air pockets: heating trapped air can raise pressure if the pocket cannot expand. A film that stretches might let the pocket grow instead. Both outcomes could change how well the film protects a surface.

2 ANSWER WITH EVIDENCE

Use the passage

1. If Team A pushes the plunger farther at the same temperature, what do you predict will happen to the air's pressure and density? Will its molecules move faster on average?

2. Why did the air in Team B's balloon become less dense when it was warmed?

3. The third team's can held the same amount of air before and after heating. Why did its pressure rise while its density stayed the same?

4. How might warming help a scratched film repair itself but cause a problem in an air pocket that cannot expand?

3 YOUR TURN

Your own words

A helmet pad has a protective film over a rigid, sealed air pocket. In 4 to 5 sentences, propose a test using two equally scratched pads, warming only one, and predict what happens to each scratch and pocket. Use molecular motion and pressure or volume to explain your predictions.

ANSWER KEY

Heat, Pressure, Repair

PART 1 · READ AND MARK

Underline the changes made to the air or film, and circle what happened as a result. Number the three air tests so you can use their evidence in your answers. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	If Team A pushes the plunger farther at the same temperature, what do you predict will happen to the air's pressure and density? Will its molecules move faster on average?	**Pressure and density will rise as the same air takes up less space. At about the same temperature, its molecules will not move faster on average.**
2	Why did the air in Team B's balloon become less dense when it was warmed?	**The air molecules moved faster and pushed the flexible balloon outward. The same mass of air then took up more space.**
3	The third team's can held the same amount of air before and after heating. Why did its pressure rise while its density stayed the same?	**Heating made the molecules move faster and strike the can's walls harder and more often, raising pressure. The rigid can kept the air's volume the same, so its density did not change.**
4	How might warming help a scratched film repair itself but cause a problem in an air pocket that cannot expand?	**Warming can help polymer chains move, meet, and reconnect across the scratch. It can also raise the pressure of trapped air in a pocket that cannot expand.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I would make equal scratches in two identical pads and warm only one for the same test period. In the warmed pad, polymer chains move faster, so the scratch may repair sooner than the scratch in the unheated pad. Air molecules in the warmed pad's rigid pocket also move faster, so its pressure rises while its volume stays the same. I would compare the scratches and measure the pressure in each pocket at the end.

Accept predictions that connect warming to faster molecular motion and distinguish a flexible space that expands from a rigid space where pressure rises. Film repair is a possibility, not a guaranteed result.