

AP Review # 19

3. (12 points, suggested time 25 minutes)

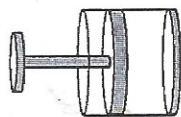
Students are watching a science program about the North Pole. The narrator says that cold air sinking near the North Pole causes high air pressure. Based on the narrator's statement, a student makes the following claim: "Since cold air near the North Pole is at high pressure, temperature and pressure must be inversely related."

(a) Do you agree or disagree with the student's claim about the relationship between pressure and temperature? Justify your answer.

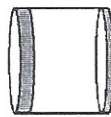
$PV = nRT$

I disagree with the student because pressure and temperature are directly related. As the temperature increases, the particles move faster and more energetically which then exerts more pressure.

After hearing the student's hypothesis, you want to design an experiment to investigate the relationship between temperature and pressure for a fixed amount of gas. The following equipment is available.



Cylinder with Movable Piston



Cylinder with Fixed Lid

A cylinder with a movable piston, shown above on the left

A cylinder with a fixed lid, shown above on the right

Note: The two cylinders have gaskets through which measurement instruments can be inserted without gas escaping.

A pressure sensor

A source of mixed ice and water

A basin that is large enough to hold

A meterstick

either cylinder with a lot of extra room

A thermometer

A source of hot water

A stopwatch

(b) Put a check in the blank next to each of the items above that you would need for your investigation. Outline the experimental procedure you would use to gather the necessary data. Make sure the outline contains sufficient detail so that another student could follow your procedure.

- 1) Place the cylinder in the large bin
- 2) Attach the pressure gauge and thermometer
- 3) Surround the cylinder with hot water. Allow to reach equilibrium
- 4) Record pressure with pressure gauge + temperature with thermometer
- 5) Repeat several times as the water cools

(i) gas law  
 (i) volume constant  
 or  
 (i)  $P \uparrow$  as  $T \downarrow$   
 dense sinks  
 (i) not closed system

(i) cylinder  
 (i) equipment mentioned  
 no extras  
 (i) measure T  
 (i) change T + measure P

The table below shows data from a different experiment in which the volume, temperature, and pressure of a sample of gas are varied.

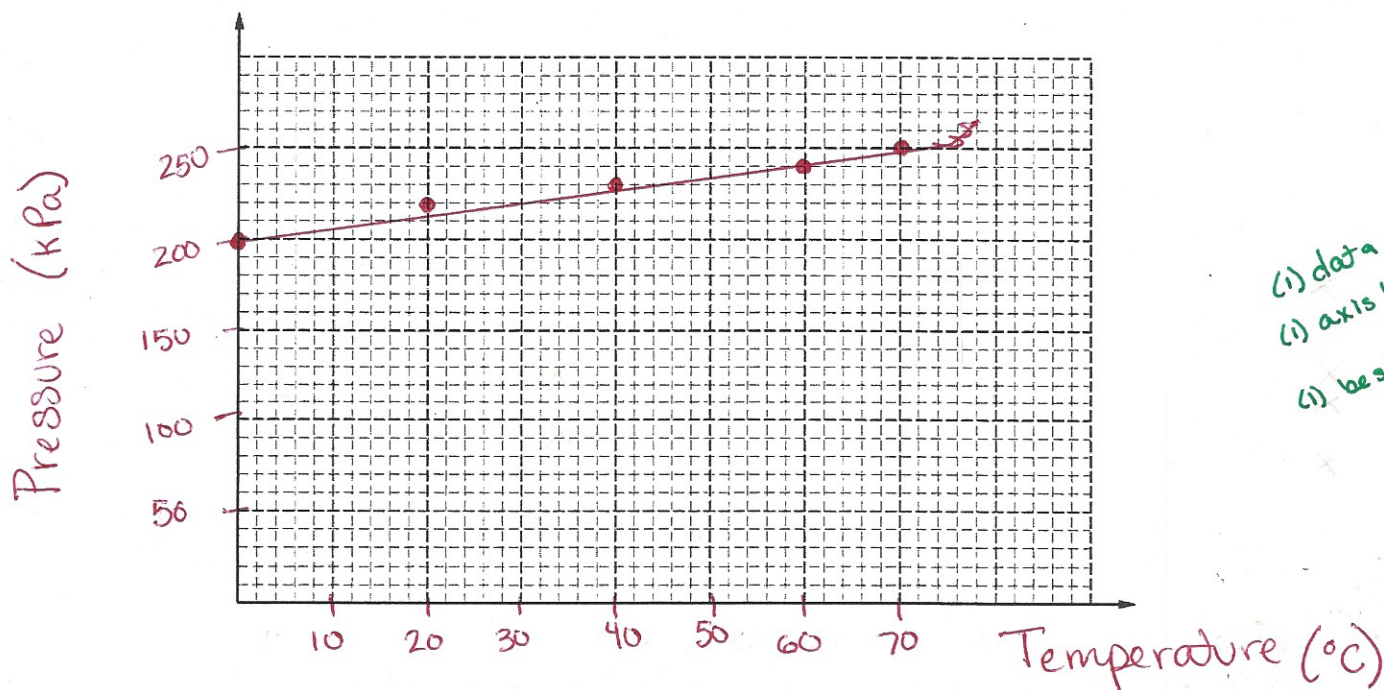
Trial Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Volume (cm <sup>3</sup> )	10.0	5.0	4.0	3.0	5.0	4.0	10.0	5.0	3.0	4.0	5.0	10.0	3.0	5.0
Pressure (kPa)	100	200	250	330	220	270	110	230	380	290	240	120	420	250
Temperature (°C)	0	0	0	0	20	20	20	40	40	40	60	60	70	70

- (c) What subset of the experimental trials would be most useful in creating a graph to determine the relationship between temperature and pressure for a fixed amount of gas? Explain why the trials you selected are most useful.

(i) same V + explain  
(ii) V = 5 cm<sup>3</sup> + explain

Trials 2, 5, 8, 11, and 14 are the best ones to use. They all have the same volume, allowing the relationship between pressure + temperature to be observed. Those trials also allow for the most data points to be used.

- (d) Plot the subset of data chosen in part (c) on the axes below. Be sure to label the axes appropriately. Draw a curve or line that best represents the relationship between the variables.



- (e) What can be concluded from your curve or line about the relationship between temperature and pressure?

(i)

They have a linear relationship. As the temperature increases, the pressure increases.