Name: _____ Period: _____ Date: _____

Simulating Global Warming

In this activity you will use a deck of cards to simulate the "random" changes in temperature from year to year. By stacking the deck a bit, you can produce global warming in your simulation with a relatively small change to the cards. This is similar to the way a relatively small change in CO_2 levels produces warmer temperatures in the real world.

Background: the carbon cycle

Much like water, carbon in our environment goes through a cycle as it moves around the world. We call it the **carbon cycle**. Carbon dioxide in the atmosphere can be taken in by plants during photosynthesis. This removes or "**sequesters**" the CO_2 from the air. The ocean can also sequester CO_2 because CO_2 can be dissolved into water. (That's how soft drinks get their fizz – it's dissolved gas that slowly bubbles out.) Heated water releases some of its dissolved CO_2. And, when organisms digest their food, they produce CO_2 that is breathed out into the atmosphere. Anytime we burn fossil fuels like coal, gasoline, or natural gas, we release even more back into the air.

The release and sequestration of carbon will naturally find a balance point. But human activities have been putting more and more CO_2 into the atmosphere, which throws off the balance. This leads to an increase in the strength of the **greenhouse effect** and results in higher global average temperatures.

Part 1: Balanced climate

- Shuffle your deck of cards. Then, deal out 30 cards to simulate the changes in temperature over a timespan of 30 years.
- Each red card represents an increase in temperature from the previous year. Black cards represent a decrease. Use the table to the right to determine the AMOUNT of change.
- Your starting temperature is **14°C**. This is Earth's current average.
- Using the first data table (on page 2), go through your 30 cards one-by-one and record the temperature of your simulated climate for each year.

Card	Value
Ace	0.1°C
2-10	0.2-1.0°C
Jack	1.5°C
Queen	2.0°C
King	2.5°C
Red=Increase Black=Decrease	

Part 2: Unbalanced climate

- For both black suits, remove the face cards. Put all six of these cards back in the deck box. Taking out these black cards represents an upset in the balance of the carbon cycle. The climate is now more likely to warm up than cool down.
- Repeat the steps of part 1 with your modified deck and fill in the second table.

Part 3: Highly unbalanced climate

- Remove six more black cards: the 8, 9, and 10 from both black suits.
- Repeat the simulation and fill in the third table.

Part 3: Analyzing the results

- On pages 3-4, graph the results of your three climate simulations.
- Then answer the questions!

Tables

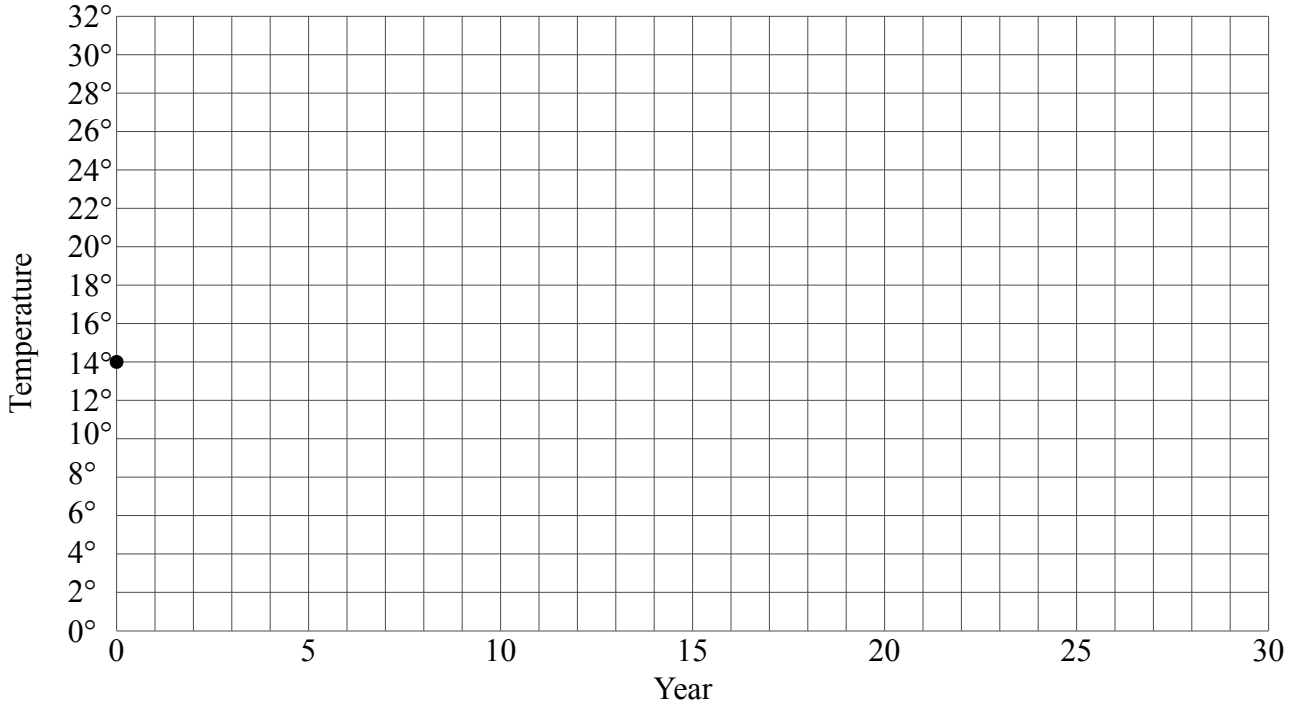
Balanced		
Year	Change	Temp
0	n/a	14.0
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		

Remove face cards		
Year	Change	Temp
0	n/a	14.0
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		

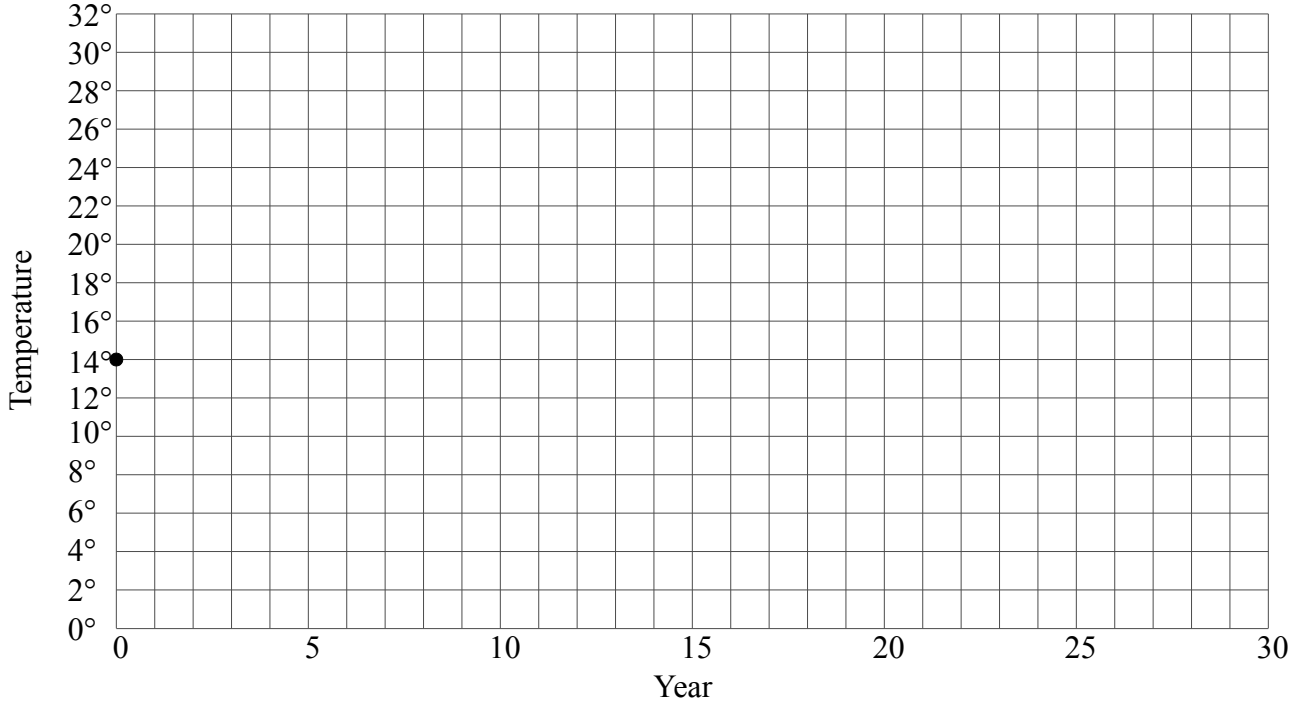
Remove 8-10 also		
Year	Change	Temp
0	n/a	14.0
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		

Graphs

Graph 1: Balanced climate

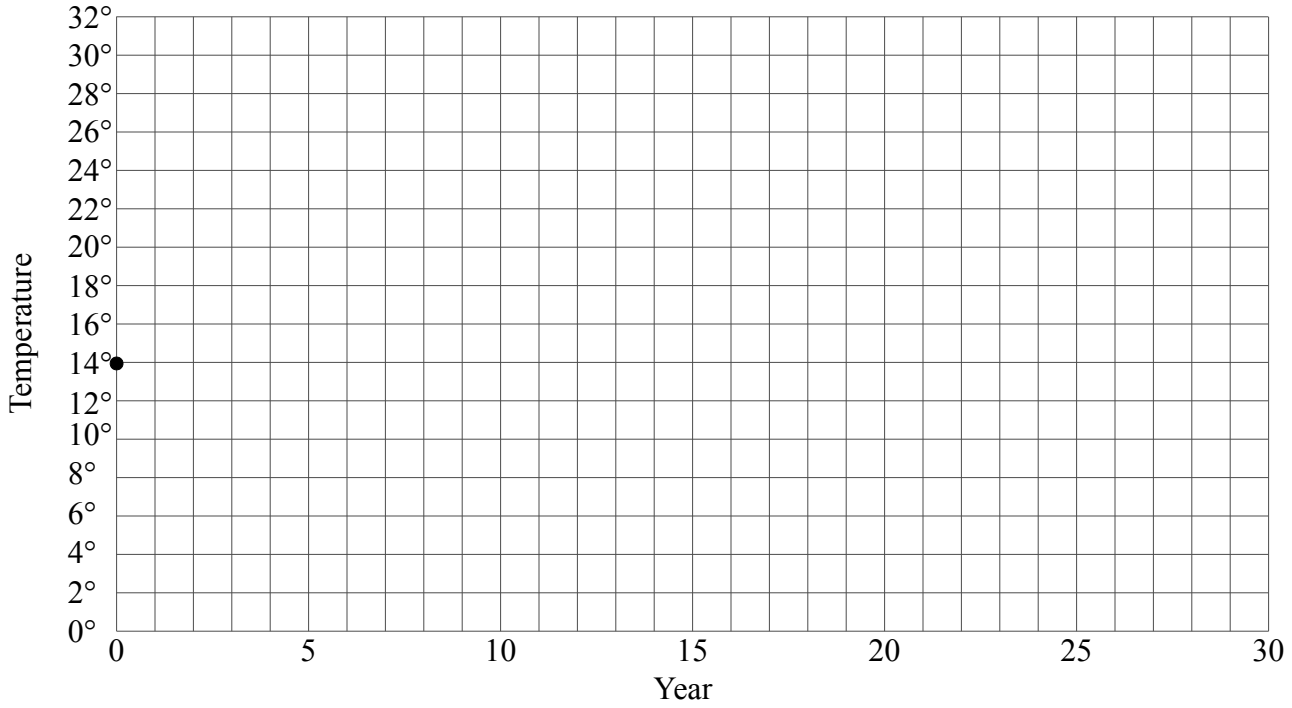


Graph 2: Some warming



Graphs, cont

Graph 3: Lots of warming



Questions

1) Make a best-fit line on each of your three graphs. <u>The line must start at 14°</u>, but can be at whatever angle you need.
2) On each of your graphs, how many years have a temperature ABOVE that starting temp?
   A) Graph 1: _____ years above starting temperature
   B) Graph 2: _____ years above starting temperature
   C) Graph 3: _____ years above starting temperature
3) Do any of your graphs show a warming or cooling trend in temperature? Which one(s)?

4) Can you tell from any one year's temperature whether the climate is getting warmer? Why or why not?

5) Natural processes release 210 billion tons of CO_2 each year, and humans are releasing 9 billion more. The oceans and plants on Earth can absorb about 215 billion tons per year. How much CO_2 is accumulating in the atmosphere each year as a result?

6) Suppose we wanted to cut CO_2 accumulation in half. What amount could we still release to meet that goal?