CAVE CLIMATE COMPARISON ACTIVITY
BETWEEN THE SURFACE AND THE CAVERN

Created by Ray Bowers
For the Virtual Center for the Environment (VCE)
A part of the Institute of Natural Resources Analysis and Management (INRAM)

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TEACHER INFORMATION

ABSTRACT: The students will compare the climate from the Carlsbad, NM airport to the climate within Carlsbad Cavern, NM by graphing climate data from the Western Regional Climate Center and Carlsbad National Park. The temperature and relative humidity hourly data will be graphed to see how these climate factors changed on June1, 2003. The average temperature, relative humidity, and precipitation from the surface will be compared to the temperature and relative humidity within Carlsbad Cavern each month from October 2002 through September 2003.

GRADE LEVEL (S): 7--12

OBJECTIVES: Students will:

- Develop a graph format, and graph the data about the temperature, relative humidity, and precipitation at Carlsbad airport, and the temperature and relative humidity in Carlsbad Caverns
- Compare the climate at the airport to the climate in the cavern on an hourly basis for one day, and the monthly averages for one year.
- Hypothesize about the affect of cave climate on cave organisms.

NATIONAL STANDARDS:

Unifying Concepts and Processes
- Evidence, models, and explanation (5-12)
- Change, consistency, and measurement (5-12)

Science as Inquiry – Development of:
- Abilities necessary to do scientific inquiry (5-12)
- Understandings about scientific inquiry (5-12)

Life Science – Development of an understanding of:
- Matter, energy, and organization in living systems (9-12)

Earth and Space Science – Development of an understanding of:
- Structure of the earth system (5-8)
- Energy in the earth system (9-12)

NEW MEXICO STANDARDS:

Strand I: Scientific Thinking and Practice

Standard I: Understand the processes of scientific investigations and use inquiry and scientific ways of observing, experimenting, predicting, and validating to think critically.

5-8 Benchmark I:	Use scientific methods to develop questions, design and conduct experiments using appropriate technologies, analyze and evaluate results, make predictions, and communicate findings.
9-12 Benchmark I:	Use accepted scientific methods to collect, analyze, and interpret data and observations and to design and conduct scientific investigations and communicate results.
5-8 Benchmark II:	Understand the processes of scientific investigation and how scientific inquiry results in scientific knowledge.
9-12 Benchmark II:	Understand that scientific processes produce scientific knowledge that is continually evaluated, validated, revised, or rejected.
5-8 Benchmark III:	Use mathematical ideas, tools, and techniques to understand scientific knowledge.
9-12 Benchmark III:	Use mathematical concepts, principles, and expressions to analyze data, develop models, understand patterns and relationships, evaluate findings, and draw conclusions.

Strand II: Content of Science

Standard II (Life Science): Understand the properties, structures, and processes of living things and the interdependence of living things and their environments.

5-8 Benchmark I:	Explain the diverse structures and functions of living things and the complex relationships between living things and their environments.
9-12 Benchmark I:	Understand how the survival of species depends on biodiversity and on complex interactions, including the cycling of matter and the flow of energy.

Standard III (Earth and Space Science): Understand the structure of Earth, the solar system, and the universe, the interconnections among them, and the processes and interactions of Earth's systems.

5-8 Benchmark II:	Describe the structure of Earth and its atmosphere and explain how energy, matter, and forces shape Earth's systems.
9-12 Benchmark II:	Examine the scientific theories of the origin, structure, energy, and evolution of Earth and its atmosphere, and their interconnections.

MATERIALS:

- Hourly and Monthly data charts
- Colored pencils
- Graph paper

BACKGROUND: In Caves the temperature and relative humidity generally becomes more constant as the distance from the entrance increases due to the layers of rock providing insulation and the low air circulation within the cave. The Cave Data was collected at Devils Hill approximately 875 ft from the entrance to Carlsbad Cavern. If a cave has water moving into it, the relative humidity can increase to saturation and above. Relative humidity is measured as a percentage of moisture in the air compared to how much moisture the air could actually hold; the higher the temperature the more moisture the air can hold. With humidity at the saturation point in moist caves, animals that have lived on land must deal with a situation that has been compared to living in freshwater. Now there is no need to conserve water, but there is a need to remove water without losing body salts.

PROCEDURES:

1. The hourly and monthly data is provided to show the variation during a day in June as well as the variation over a year. Both of these graphs could be done or just one.
2. The hourly and monthly graphing procedures will be similar.
3. It would be useful if the temperatures and humidities could be graphed on the same sheet of graph paper.
4. Look at the high and low temperature and humidity readings to determine the range for the scales.
5. Graph the data for temperature and relative humidity for each month or hour. Use a different color of pencil for each temperature and humidity set. It might be useful to use similar colors for the temperatures and humidities; for example dark red of airport temperatures and pink for cave temperatures. Make a color key to identify which color represents each temperature and humidity set.

CONCLUSIONS: Allow the students to draw conclusions from the graphs. They could include the relationship between temperature and humidity at the airport as well as comparing the airport to the cave conditions. How is the temperature related to the humidity on June 1, 2003? Is there enough

data to say this is always true? How could this be checked? How is the monthly average temperature compare to the monthly humidity? How does the average monthly precipitation affect the humidity at the airport and in the cave? These conclusions could be followed with a discussion about how cave organisms might adapt to the cave climate of constant temperatures and humidities as well as the very high humidities found in caves. Would they need to hibernate during the winter? Would they need a way to keep cool? Would they need to conserve water?

References:

Culver, David C. 1982. Cave Life, Evolution and Ecology. Cambridge, Mass. Harvard University Press

Mohr, Charles E. and Thomas L. Poulson. 1966. The Life of the Cave. New York: McGraw-Hill Book Company

National Research Council. 1996, National Science Education Standards. Washington D.C.: National Academy Press

New Mexico Department of Education. 2003. New Mexico Science Content Standards, Benchmarks, and Performance Standards. http://164.64.166.11/cilt/standards/science/index.html

Poulson,Thomas L and William B. White. 1969. The Cave Environment. Science. Volume 165, Number 3897

Monthly Temperature and Relative Humidity
in Carlsbad Caverns, NM and
Monthly Temperature, Relative Humidity and Precipitation

at Carlsbad Airport, NM
October, 2002 through September, 2003

Carlsbad Caverns (1.) **Carlsbad Airport (** 2.)

Month	Temperature	Humidity		Temperature	Humidity	Precipitation
	^{o}F	%		^{o}F	%	In.
Oct	55	104		57	67	2.50
Nov	52	104		48	53	0.23
Dec	51	103		43	60	0.50
Jan	51	104		38	67	0.00
Feb	51	104		46	67	1.18
Mar	51	104		58	39	0.22
Apr	53	104		67	23	0.00
May	54	104		72	35	1.73
Jun	55	104		79	44	0.14
Jul	55	104		83	43	0.78
Aug	55	104		82	45	0.29
Sep	55	104		74	51	0.53

1. .From Carlsbad National Park's data table at Devils Hill in Carlsbad Caverns

2. Modified from: http://weather.nmsu.edu/cgishl/cns/rstat.pl?station=kcnm&type=hourly&smonth=6&sday=01&syear=03&emonth=06&eday=02&eyear=03
3. From the National Weather Service: http://www.srh.noaa.gov/maf/HTML/climate.html

On 01 June, 2003

	In Carlsbad Caverns, NM (1.)			At Carlsbad Airport, NM (2.)	
Time (Hrs)	Temp (^{o} F)	Humidity %		Temp (^{o} F)	Humidity %
00	54	104		75	54
01	54	104		73	53
02	54	104		70	64
03	54	104		70	64
04	54	104		66	73
05	54	104		66	73
06	54	104		68	73
07	54	104		72	60
08	54	104		77	54
09	54	104		81	48
10	54	104		82	45
11	54	104		90	36
12	54	104		91	30
13	54	104		97	22
14	54	104		97	22
15	54	104		99	20
16	54	104		99	21
17	54	104		100	18
18	54	104		99	21
19	54	104		84	29
20	54	104		79	39
21	54	104		79	39
22	54	104		75	44
23	54	104		73	50

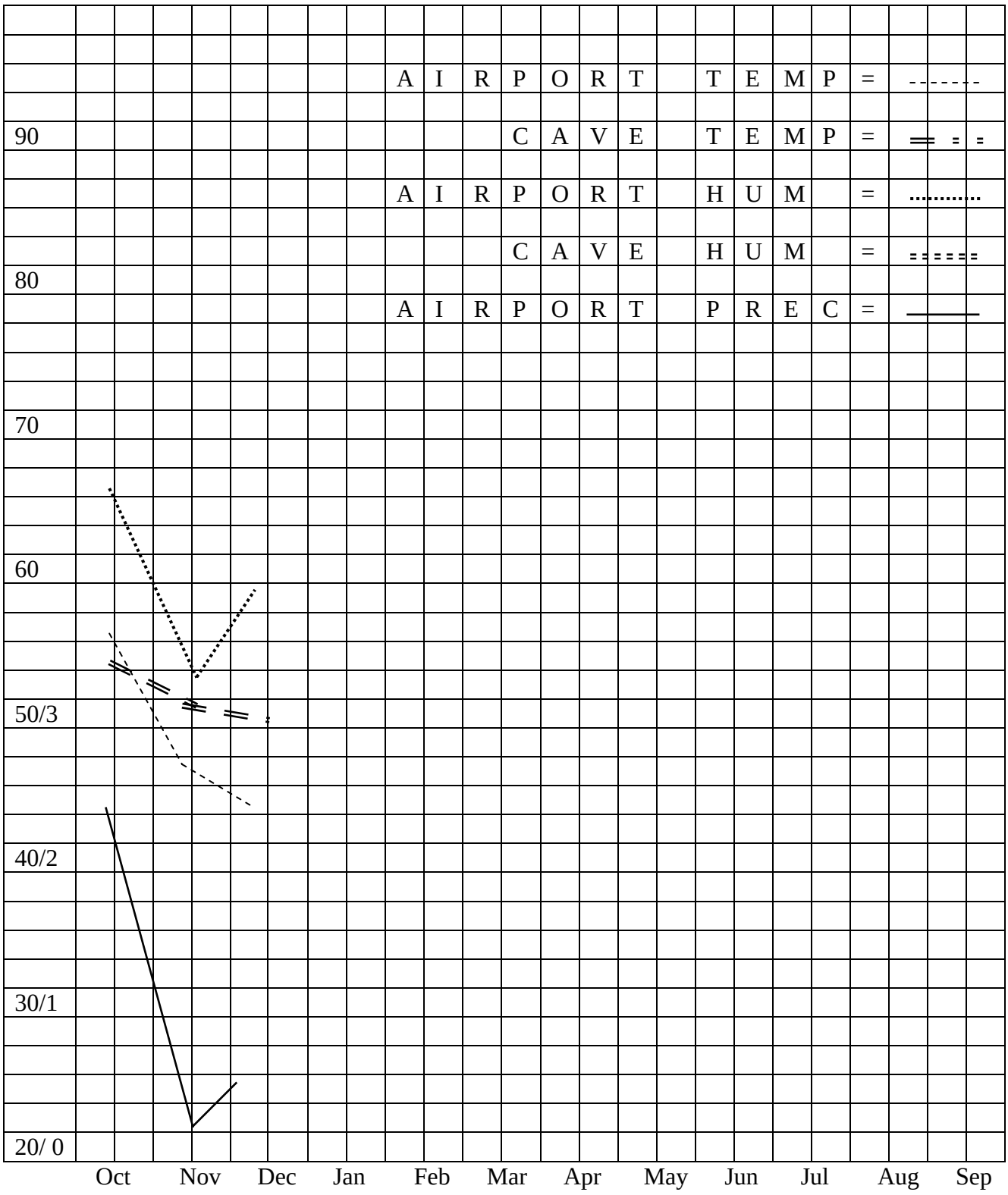
1. From Carlsbad National Park's data table at Devils Hill in Carlsbad Caverns
2. Modified from: http://weather.nmsu.edu/cgi shl/cns/rstat.pl?station=kcnm&type=hourly&smonth=06&sday=01&syear=03 month=06&eday=02&eyear=03

SAMPLES

Monthly Averages

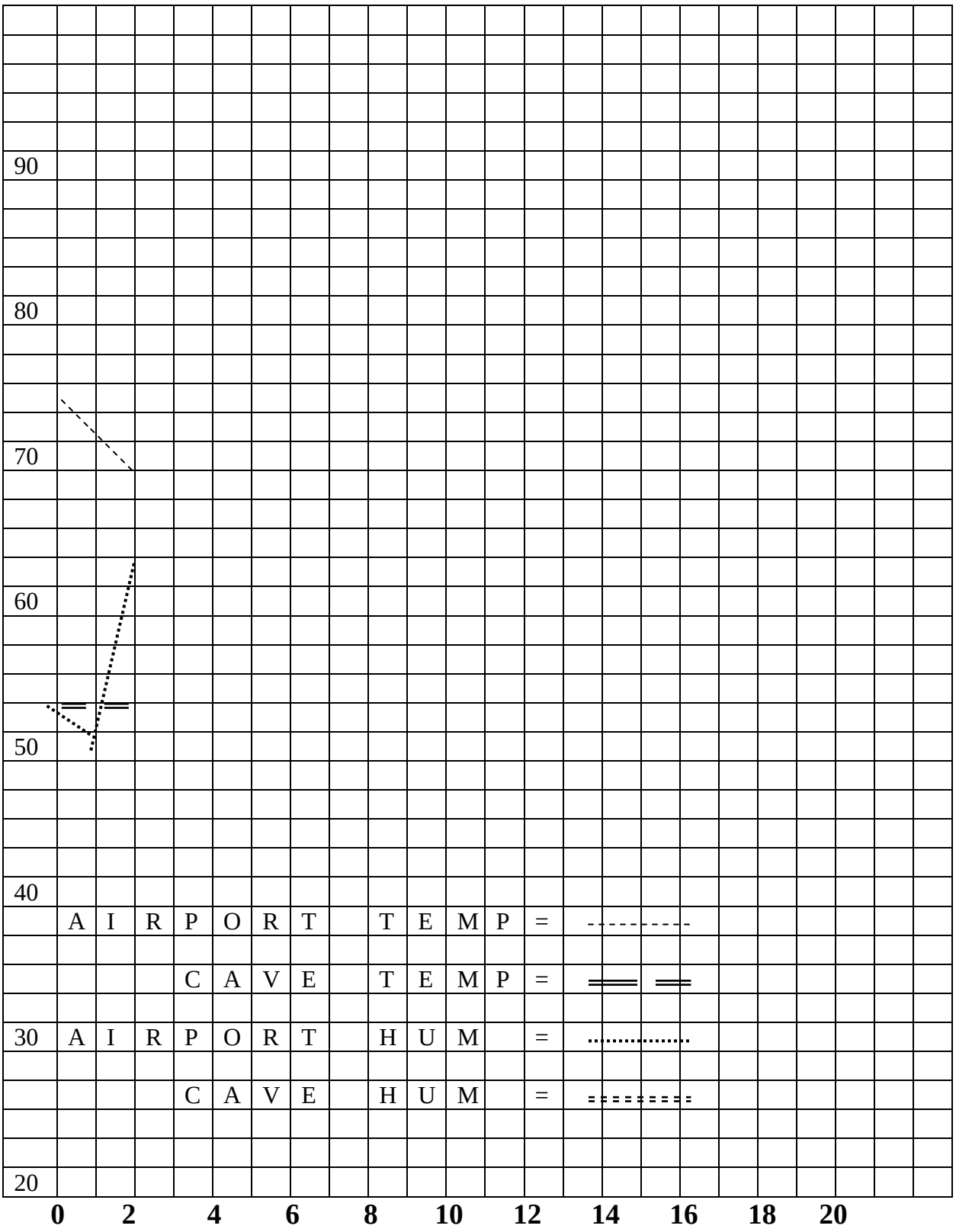
Temp ^{o}F &
Hum % / Precp in

100																								



Hourly Readings
1 June, 2003

Temp ^{o}F /
Hum %


90
80
70
60
50
40
30
20
AIRPORT TEMP =
CAVE TEMP =
AIRPORT HUM =
CAVE HUM =
0 2 4 6 8 10 12 14 16 18 20

STUDENT CAVE CLIMATE COMPARISON ACTIVITY

CAVE CLIMATE COMPARISON ACTIVITY

Student Name_____

QUESTION: How do temperature and humidity compare?
How does the cave environment compare to the surface environment?

MATERIALS:

1. Hourly and Monthly data charts
2. Colored pencils
3. Graph paper

METHODS:

1. Graph the data for temperature and relative humidity for each month or hour. Use a different color of pencil for each temperature and humidity set. It might be useful to use similar colors for the temperatures and humidities; for example dark red of airport temperatures and pink for cave temperatures. Make a color key to identify which color represents each temperature and humidity set.

CONCLUSIONS: Continue conclusions on the back if needed

Monthly Temperature and Relative Humidity
in Carlsbad Caverns, NM and
Monthly Temperature, Relative Humidity and Precipitation
at Carlsbad Airport, NM
October, 2002 through September, 2003

Carlsbad Caverns (1.) **Carlsbad Airport (** 2.)

Month	Temperature	Humidity		Temperature	Humidity	Precipitation
	^{o}F	%		^{o}F	%	In.
Oct	55	104		57	67	67
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Dec	51	103		43	60	60
Jan	51	104		38	67	67
Feb	51	104		46	67	67
Mar	51	104		58	39	39
Apr	53	104		67	23	23
May	54	104		72	35	35
Jun	55	104		79	44	44
Jul	55	104		83	43	43
Aug	55	104		82	45	45
Sep	55	104		74	51	51

1. .From Carlsbad National Park's data table at Devils Hill in Carlsbad Caverns

3. Modified from: http://weather.nmsu.edu/cgishl/cns/rstat.pl?station=kcnm&type=hourly&smonth=6&sday=01&syear=03&emonth=06&eday=02&eyear=03
4. From the Westrern Regional Climate Center: http://www.wrcc.dri.edu/cgibin/cliMAIN.pl?nmcfaa

Hourly Temperature and Relative Humidity
At Carlsbad Airport and in Carlsbad Caverns, NM
On 01 June, 2003

In Carlsbad Caverns, NM (1.) At Carlsbad Airport, NM (2.)

Time (Hrs)	Temp (^{o} F)	Humidity %		Temp (^{o} F)	Humidity %
00	54	104		75	54
01	54	104		73	53
02	54	104		70	64
03	54	104		70	64
04	54	104		66	73
05	54	104		66	73
06	54	104		68	73
07	54	104		72	60
08	54	104		77	54
09	54	104		81	48
10	54	104		82	45
11	54	104		90	36
12	54	104		91	30
13	54	104		97	22
14	54	104		97	22
15	54	104		99	20
16	54	104		99	21
17	54	104		100	18
18	54	104		99	21
19	54	104		84	29
20	54	104		79	39
21	54	104		79	39
22	54	104		75	44
23	54	104		73	50

4. 1. From Carlsbad National Park's data table at Devils Hill in Carlsbad Caverns
Modified from: http://weather.nmsu.edu/cgi
shl/cns/rstat.pl?station=kcnm&type=hourly&smonth=06&sday=01&syear=03
month=06&eday=02&eyear=03

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