PREDICTING SALMON HATCH

Students collect and chart data on temperature and predict development milestones based on their findings.

GRADES
3rd - 5th

COMMON CORE - MATH
Problem solving
Data representation and interpretation

NEXT GENERATION
LS1.B

TIME
Introduction: 25 mins.
Interpreting: 10 mins. each

LEARNING OBJECTIVES

- To gain experience in solving problems involving measurement and time intervals.
- To gain experience in gathering, representing, and interpreting data.
- To understand temperature as one environmental factor contributing to species development.

PREPARATION

1. Ask hatchery staff (or whoever delivers your eggs) to give you total ATUs on the day your eggs left the hatchery, **either in Fahrenheit or centigrade, as you choose**.
2. Copy enough "Predictions" forms (6 per sheet) for your class and cut them apart.
3. Make one copy of the "Recording Accumulated Thermal Units" table (either Fahrenheit or centigrade), add the start date, and post near the tank.
4. Make one copy of the "Depicting Accumulated Thermal Units" graph (either Fahrenheit or centigrade), add study dates at tick marks along the X axis, and post near the tank. (See teacher example.) If you like, shade in ranges for your species/temperature system, per teacher example.
   NOTE: Bold vertical lines on the graph are weeks; light vertical lines are days.
5. Make one copy of the "About Accumulated Thermal Units" (either Fahrenheit or centigrade) explanation sheet for each student.
6. Make a copy of calendar pages for the study period, starting with the month your eggs will arrive and ending 4-6 weeks later, or find an image of the time period you need online.

WHAT TO DO

1. Tell students what they will be doing and go over the "About" sheet with them.
2. Write the ATU number from the hatchery on the board and show calendar pages on your overhead projector.
3. Give each student a "Predictions" slip and tell students to apply what they just learned about ATUs to predict when eggs will begin hatching and when alevin will begin swimming freely as fry. Collect to check later when fish reach these milestones.
4. Take students to the tank and go over the "Recording" table and "Depicting" graph posted there.
5. Walk your students through recording one day's worth of data on both the table and graph.
6. Help students decide what time of day to take temperature readings and how they will consistently estimate ATUs for weekends/holidays.
7. When eggs begin to hatch, check contest entries to see whose estimates came closest.
8. Ask students the following or similar questions:
   - What do we know so far about the influence of temperature on species development?
   - What is a simple way to state this cause-and-effect relationship?
   - Based on evidence to date, what could we say about when fish will begin swimming freely?
9. When fish begin swimming freely, check contest entries to see whose estimates came closest.
10. Ask students the following or similar questions to complete the lesson:
    - Do we know anything more now about the influence of temperature on species development?
    - How would you relate what we have seen in the tank with salmon development in the wild?
    - Would we know as much if we had not recorded the data in chart form?

PREDICTIONS BASED ON ATUs

I predict eggs will begin hatching on

_____

I predict alevin will begin swimming freely on

_____

Name

_____

PREDICTIONS BASED ON ATUs

I predict eggs will begin hatching on

_____

I predict alevin will begin swimming freely on

_____

Name

_____

PREDICTIONS BASED ON ATUs

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PREDICTIONS BASED ON ATUs

I predict eggs will begin hatching on

_____

I predict alevin will begin swimming freely on

_____

Name

_____

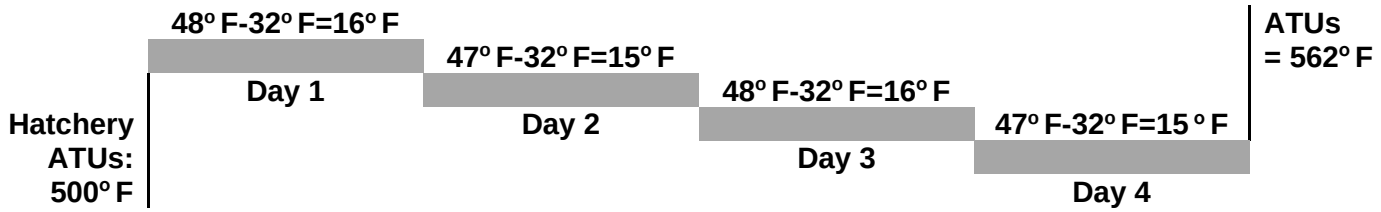
ABOUT ACCUMULATED THERMAL UNITS - FAHRENHEIT

Temperature affects everything from the rate at which salmon eggs develop to the amount of feed that fry require and the amount of dissolved oxygen that water will hold. Accumulated thermal units (ATUs) are a way to track the effect of temperature in order to predict when eggs will hatch and when alevin will start swimming freely as fry.

What is an ATU

ATU is the number of degrees ("increment") that each day's tank water temperature is over freezing, added to the ATUs as of the previous day. In Fahrenheit, the increment over freezing is tank water temperature minus 32° F.

For instance, if the first day of incubation occurred when the water was 48°F, the calculation would be 48°F - 32°F = 16°F. Here's an example of what ATUs would be after four days, starting at 500°F when eggs left the hatchery and assuming tank water temperature stays at 47°F or 48°F:



Hatcheries use ATU measurements to predict date of hatch and date when alevins will start swimming freely (or "button up") to become fry. In a creek or river, additional environmental factors such as oxygen level and water flow also influence the speed of development. In a controlled environment, however, tank water temperature is usually the only variable.

How to measure ATU

1. Take the temperature at approximately the same time each day and, if using a thermometer, from the same part of the tank. This discipline will guard against readings not representative of the whole tank and differences that can occur over a 24-hour period. You may also read temperature as displayed on the chiller.
2. If using a thermometer not mounted in the tank, leave the thermometer submerged until the column of mercury (if using this type) has stabilized. If possible, keep the bulb submerged as you read the temperature OR read the temperature the instant you remove the bulb from the water so that it's not affected by air temperature.
3. Enter the temperature reading on the ATU chart and subtract 32° F.
4. Add the new daily ATU to the ATU total from the day before.

What does the reading indicate?

During incubation, tracking temperature may not be exciting. It becomes more interesting, however, as the days pass and ATUs begin to near the total at which hatching and swimming freely might occur. The following chart shows ATU readings at which three Pacific salmon species can be expected to reach these stages. Unusually warm or cold water (say from a brief equipment problem) might cause your experience to vary, but under normal conditions, these numbers are reliable.

SPECIES	STAGE	ATUs in °F
CHINOOK SALMON	To start hatching	860-980
	To start swimming freely	1620-1800
CHUM SALMON	To start hatching	850-950
	To start swimming freely	1620-1800
COHO SALMON	To start hatching	720-900
	To start swimming freely	1260-1450

RECORDING ACCUMULATED THERMAL UNITS IN FAHRENHEIT

S	M	T	W	T	F	S
Date ________ Temp. today _______ - 32^{0} F ATU today _________ ATU to date ________	Date ________ Temp. today _______ - 32^{0} F ATU today _________ ATU to date ________	Date ________ Temp. today _______ - 32^{0} F ATU today _________ ATU to date ________	Date ________ Temp. today _______ - 32^{0} F ATU today _________ ATU to date ________	Date ________ Temp. today _______ - 32^{0} F ATU today _________ ATU to date ________	Date ________ Temp. today _______ - 32^{0} F ATU today _________ ATU to date ________	Date ________ Temp. today _______ - 32^{0} F ATU today _________ ATU to date ________
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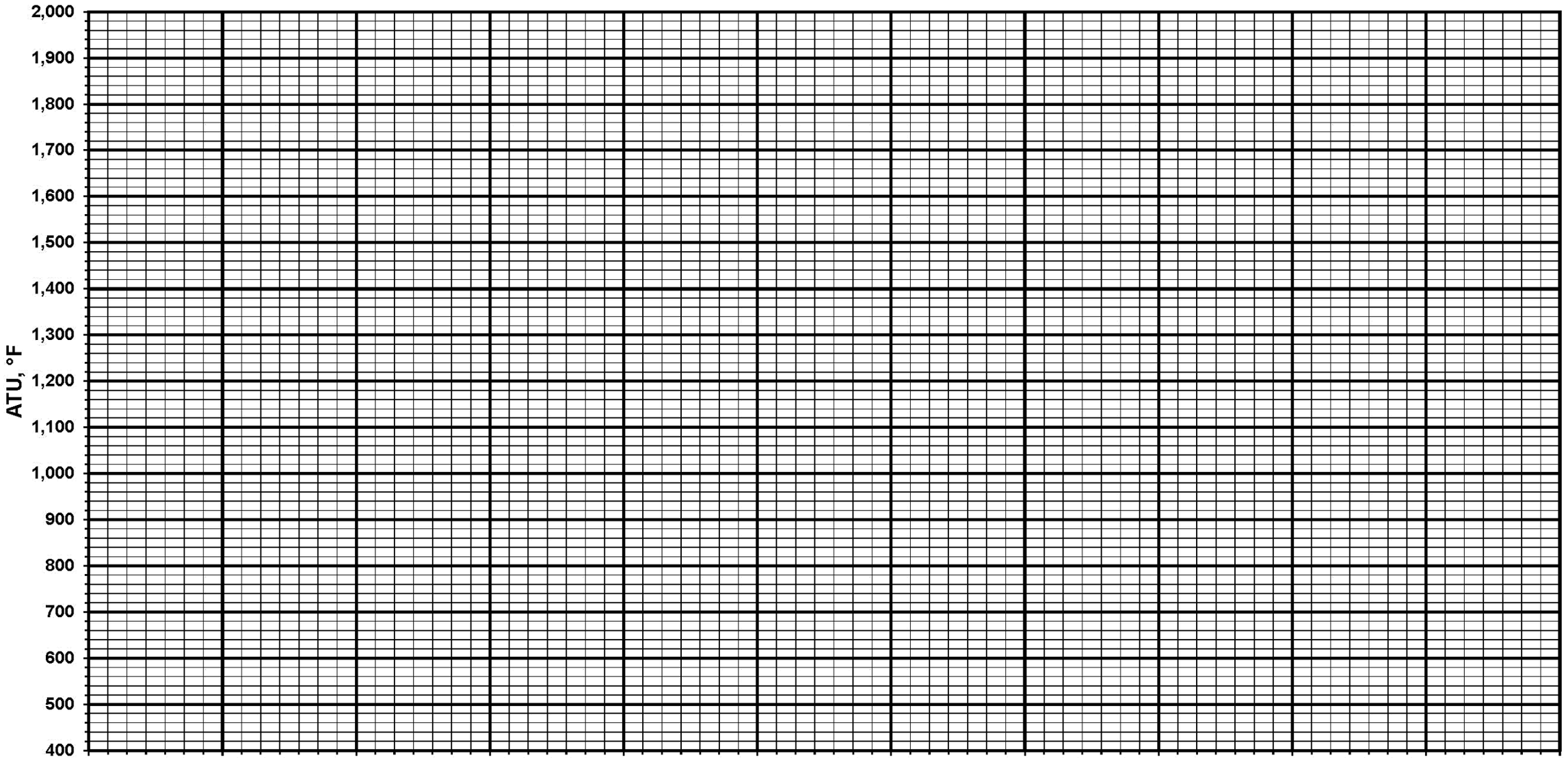
DEPICTING ACCUMULATED THERMAL UNITS IN FAHRENHEIT



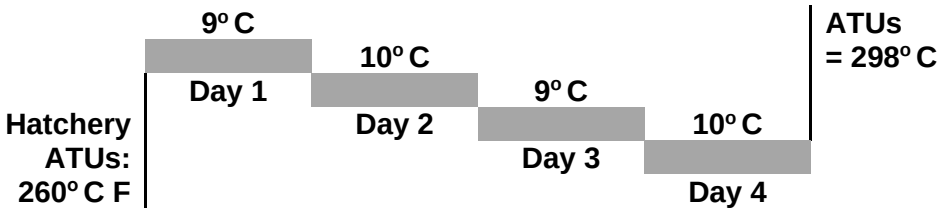
ABOUT ACCUMULATED THERMAL UNITS - CENTIGRADE

Temperature affects everything from the rate at which salmon eggs develop to the amount of feed that fry require and the amount of dissolved oxygen that water will hold. Accumulated thermal units (ATUs) are a way to track the effect of temperature in order to predict when eggs will hatch and when alevin will start swimming freely as fry.

What is an ATU

ATU is the number of degrees ("increment") that each day's tank water temperature is over freezing, added to the ATUs as of the previous day. In centigrade, the increment over freezing is tank water temperature minus 0.

For instance, if the first day of incubation occurred when the water was 9° C, the increment would be 9° C. Here's an example of what ATUs would be after four days, starting at 260° C when eggs left the hatchery and assuming tank water temperature stays at 9° C or 10° C:



Hatcheries use ATU measurements to predict date of hatch and date when alevins will start swimming freely (or "button up") to become fry. In a creek or river, additional environmental factors such as oxygen level and water flow also influence the speed of development. In a controlled environment, however, tank water temperature is usually the only variable.

How to measure ATU

1. Take the temperature at approximately the same time each day and, if using a thermometer, from the same part of the tank. This discipline will guard against readings not representative of the whole tank and differences that can occur over a 24-hour period. You may also read temperature as displayed on the chiller.
2. If using a thermometer not mounted in the tank, leave the thermometer submerged until the column of mercury (if using this type) has stabilized. If possible, keep the bulb submerged as you read the temperature OR read the temperature the instant you remove the bulb from the water so that it's not affected by air temperature.
3. Enter the temperature reading on the ATU chart.
4. Add the new daily ATU to the ATU total from the day before.

What does the reading indicate?

During incubation, tracking temperature may not be exciting. It becomes more interesting, however, as the days pass and ATUs begin to near the total at which hatching and swimming freely might occur. The following chart shows ATU readings at which three Pacific salmon species can be expected to reach these stages. Unusually warm or cold water (say from a brief equipment problem) might cause your experience to vary, but under normal conditions, these numbers are reliable.

SPECIES	STAGE	ATUs in °C
CHINOOK SALMON	To start hatching	460-530
	To start swimming freely	880-980
CHUM SALMON	To start hatching	450-510
	To start swimming freely	880-980
COHO SALMON	To start hatching	380-480
	To start swimming freely	680-790

RECORDING ACCUMULATED THERMAL UNITS IN CENTIGRADE

S	M	T	W	T	F	S
Date ________ Temp. today _______ ATU today ________ ATU to date ________	Date ________ Temp. today _______ ATU today ________ ATU to date ________	Date ________ Temp. today _______ ATU today ________ ATU to date ________	Date ________ Temp. today _______ ATU today ________ ATU to date ________	Date ________ Temp. today _______ ATU today ________ ATU to date ________	Date ________ Temp. today _______ ATU today ________ ATU to date ________	Date ________ Temp. today _______ ATU today ________ ATU to date ________
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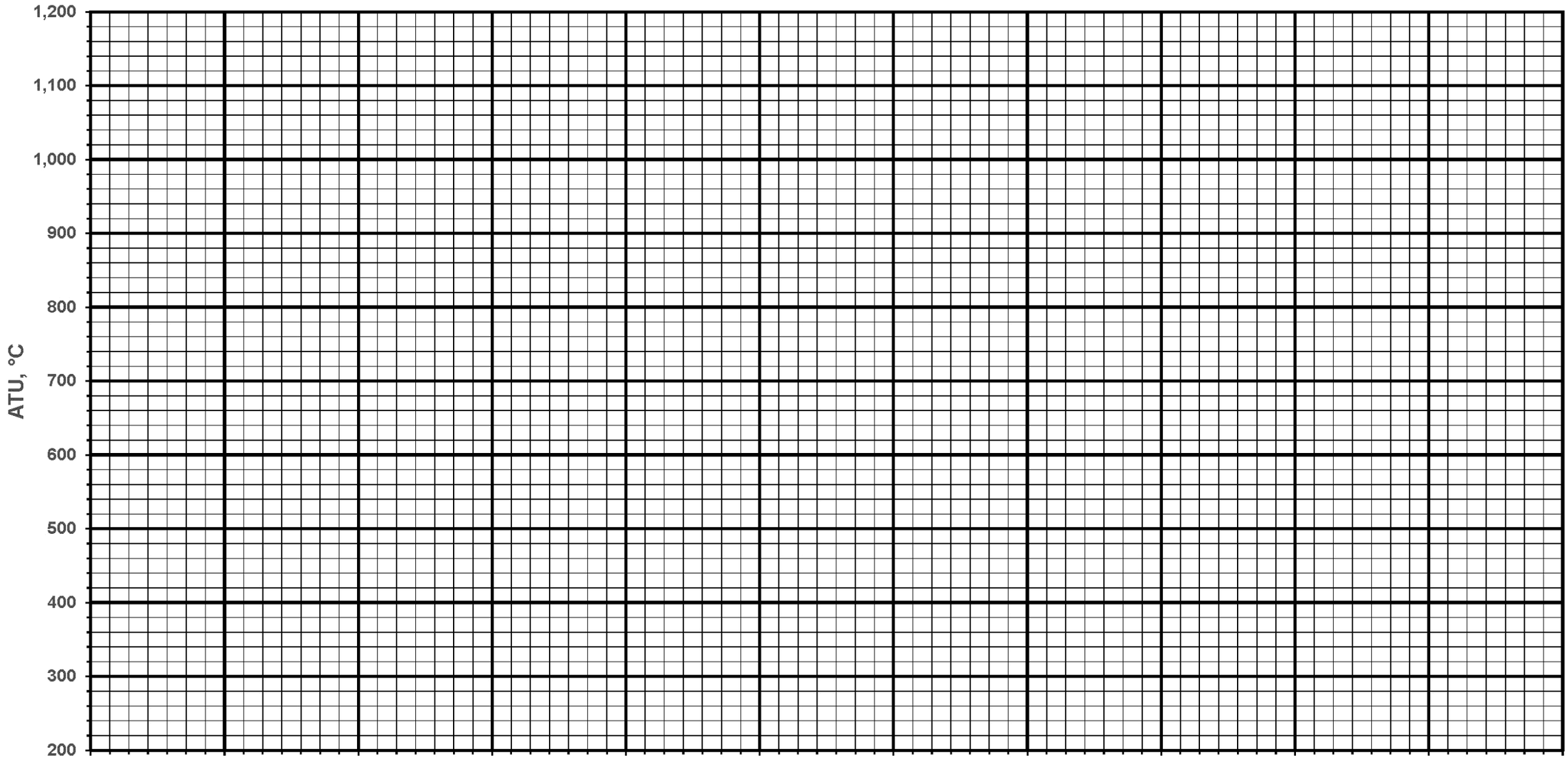
DEPICTING ACCUMULATED THERMAL UNITS IN CENTIGRADE



DEPICTING ACCUMULATED THERMAL UNITS - TEACHER EXAMPLE