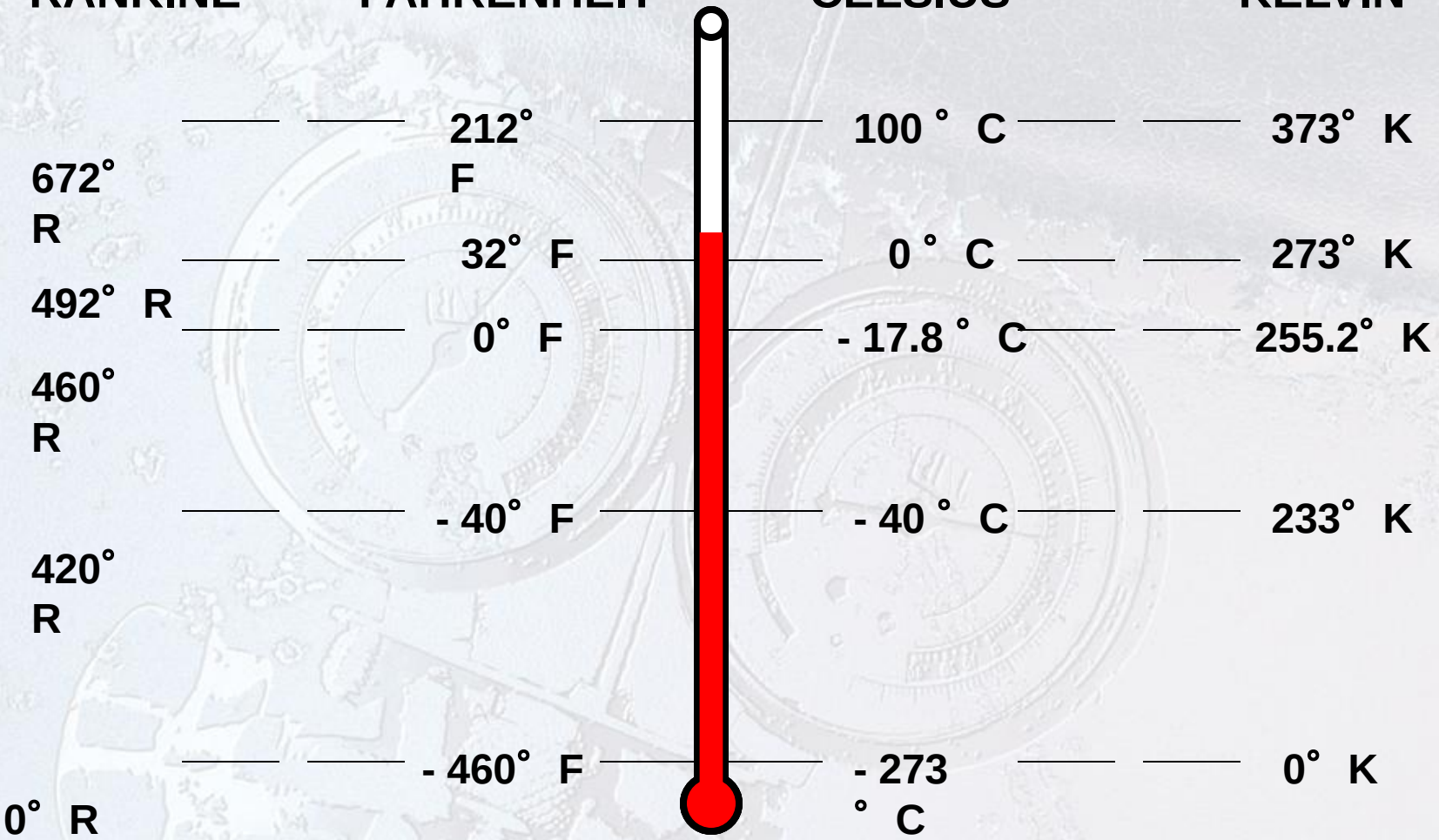
TEMPERATURE

- The ***level of heat*** or ***heat intensity***
- Measured with thermometers
- English system – Fahrenheit (°F)
- Metric system – Celsius (°C)
- Fahrenheit Absolute scale – Rankine (°R)
- Celsius Absolute scale - Kelvin (°K)
- Absolute zero – Temperature at which all molecular movement stops (-460°F)



FAHRENHEIT TO CELSIUS CONVERSIONS

$^{\circ}C = (5/9)\ (^{\circ}F - 32)$

EXAMPLE: CONVERT 212°F TO CELSIUS

$^{\circ}C = (5/9)\ (212 - 32)$

$^{\circ}C = (5/9)\ (180)$

$^{\circ}C = 5 \times 20$

$^{\circ}C = 100$

CELSIUS TO FAHRENHEIT CONVERSION

°F = (9/5)°C + 32

EXAMPLE: CONVERT 10°C TO FAHRENHEIT

°F = (9/5)(10) + 32

°F = (9 x 2) + 32

°F = 18 + 32

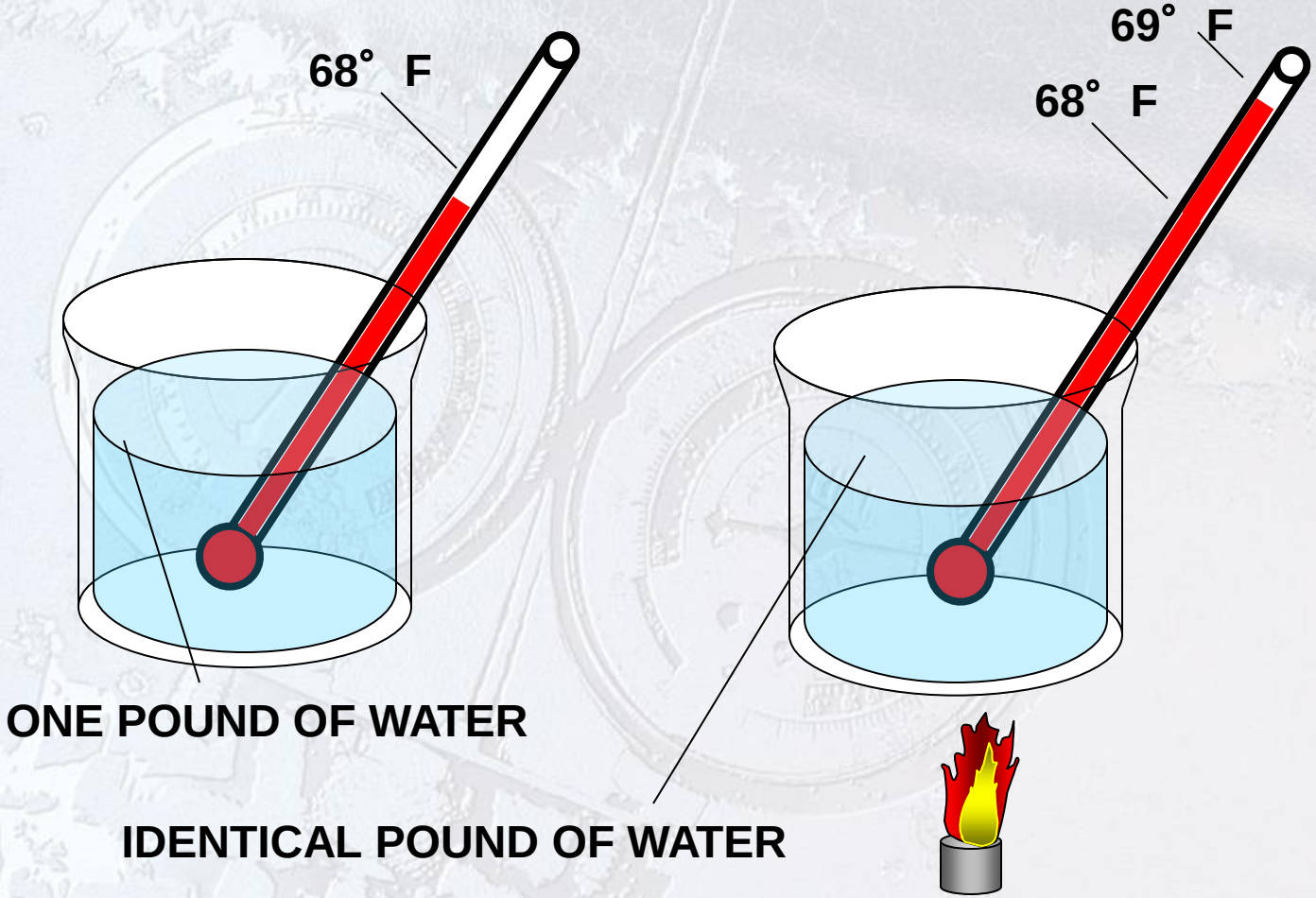
°F = 50

INTRODUCTION TO HEAT

- Heat is the ***motion of molecules***
- Heat *cannot* be created or destroyed
- Heat *can* be measured and accounted for
- Heat *can* be transferred from one substance to another
- Heat travels from a warmer substance to a cooler substance
- Quantity of heat in a substance is measured in British Thermal Units, BTUs

THE **BRITISH THERMAL UNIT** IS THE AMOUNT OF HEAT ENERGY THAT IS REQUIRED TO RAISE THE TEMPERATURE OF 1 POUND OF WATER 1 DEGREE FAHRENHEIT

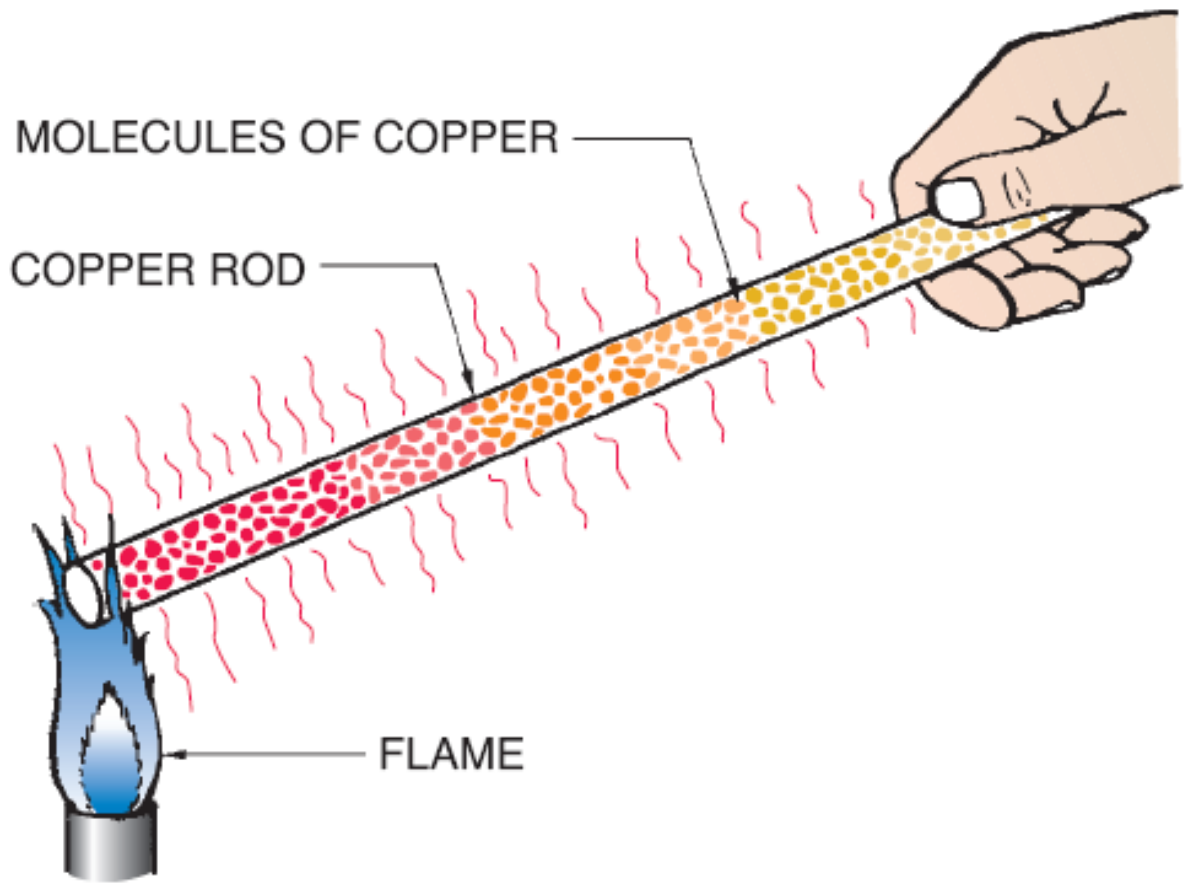
ONE BTU OF HEAT ENERGY HAS BEEN ADDED TO ONE POUND OF WATER



CONDUCTION

- Heat energy travels from one molecule to molecule within a substance
- Heat energy travels from one substance to another
- Heat does not conduct at the same rate in all materials
- Example of conduction:

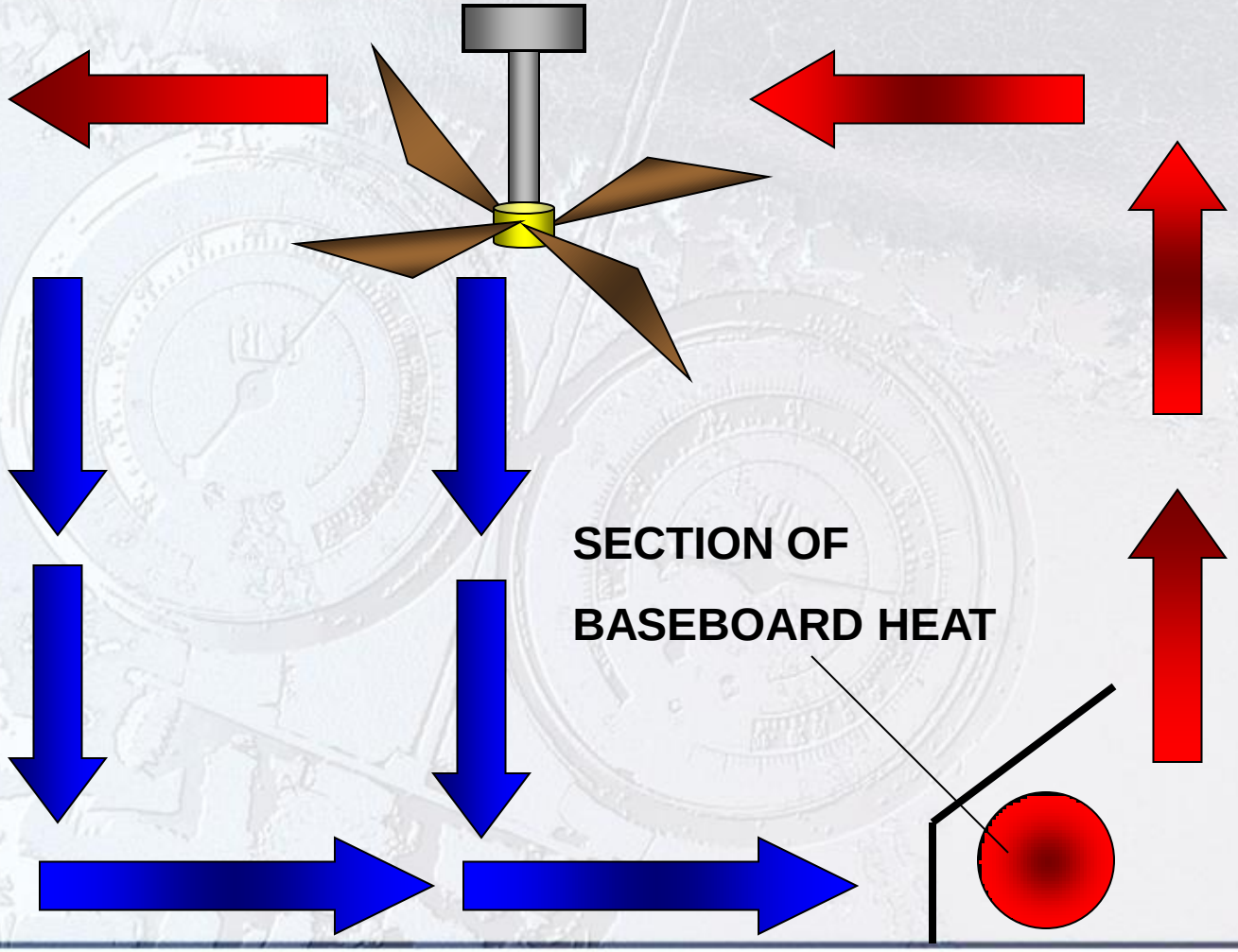
Heat will travel through a copper rod when placed near fire



CONVECTION

- Heat transfers through a fluid from one substance to another
- Natural convection utilizes natural fluid flow, such as the rising of warm air and the falling of cooler air
- Forced convection uses fans or pumps to move fluids from one point to another
- Example of convection:

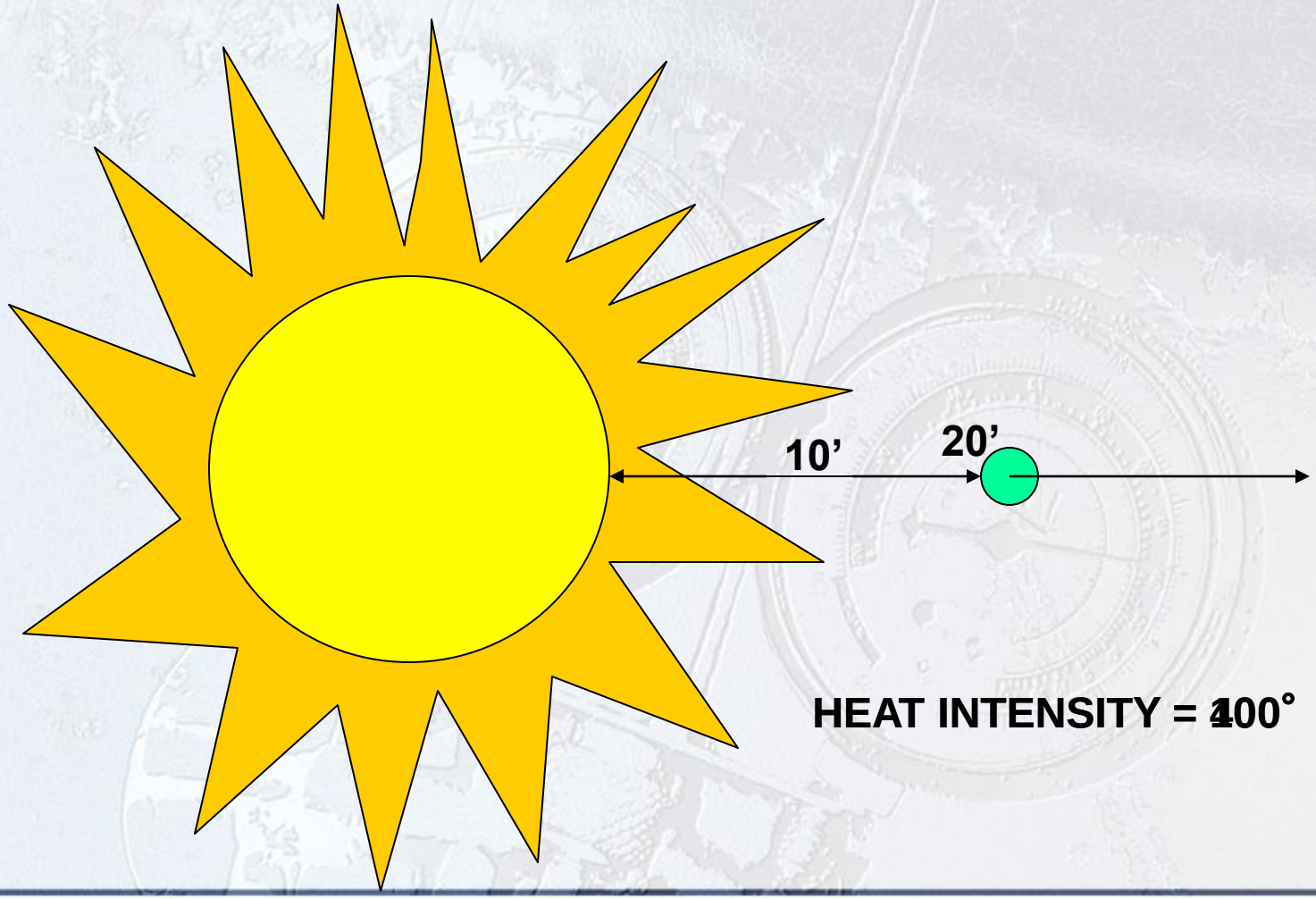
Baseboard Heating



RADIATION

- Radiant heat passes through air, heating the first solid object the heat comes in contact with
- These heated objects, in turn, heat the surrounding area
- Radiant heat can travel through a vacuum
- Radiant heat can travel through space without heating it
- Example of radiation:

An electric heater that glows red



HEAT INTENSITY = 400° F

SENSIBLE HEAT

- Heat transfer that results in a change in temperature of a substance
- Sensible heat transfers can be measured with a thermometer
- Example of a sensible heat transfer:

  Changing the temperature of a sample of water from 68° F to 69° F

LATENT HEAT

- Also referred to as ***hidden heat***
- Latent heat transfers result in a change of state of a substance with no change in temperature
- Latent heat transfers cannot be measured with a thermometer
- Example of a latent heat transfer:

Changing 1 pound of ice at 32˚ F to

1 pound of water at 32˚ F

SPECIFIC HEAT

- Defined as the number of btus required to raise the temperature of 1 pound of a substance 1 degree Fahrenheit
- Specific heat of water is 1.00
- Specific heat of ice is approximately 0.50
- Specific heat of steam is approximately 0.50
- Specific heat of air is approximately 0.24

SPECIFIC HEAT FORMULA

Q = Weight x Specific Heat x Temperature Difference

Where Q = Quantity of heat needed for the temperature change

Example: 1000 pounds of steel must be heated from 0° F to 70° F.

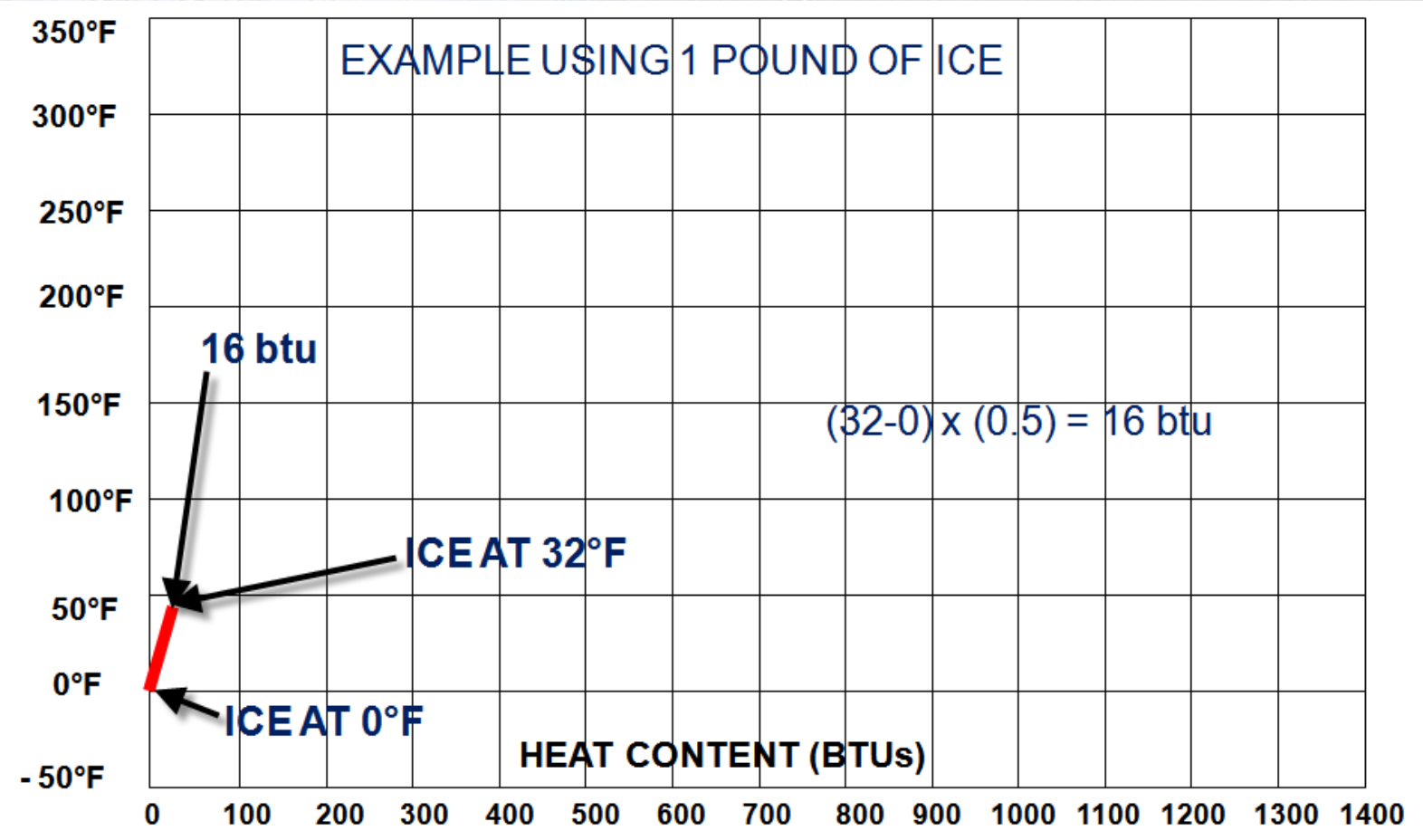
How much heat is required to accomplish this?

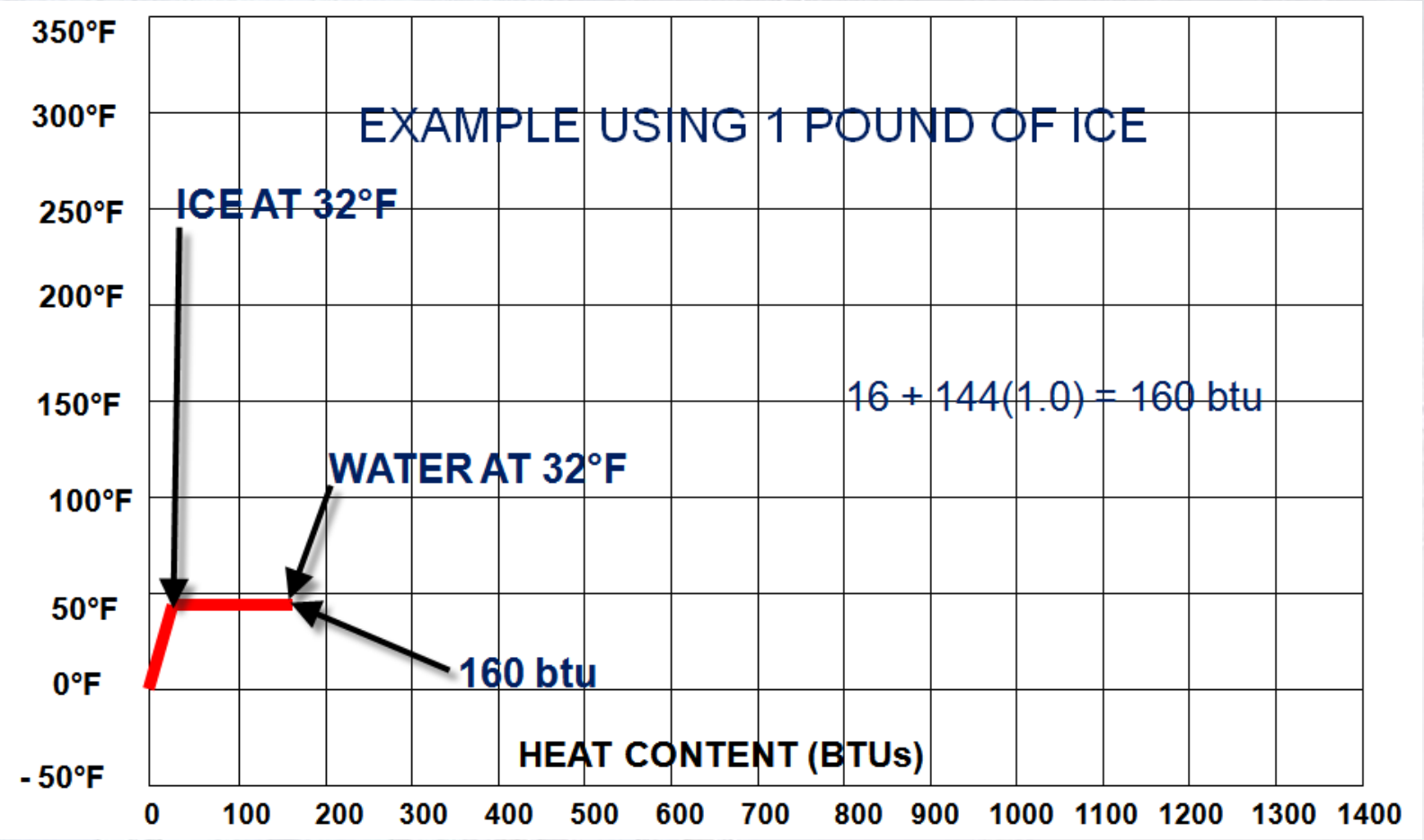
The specific heat of steel is 0.116 btu/lb

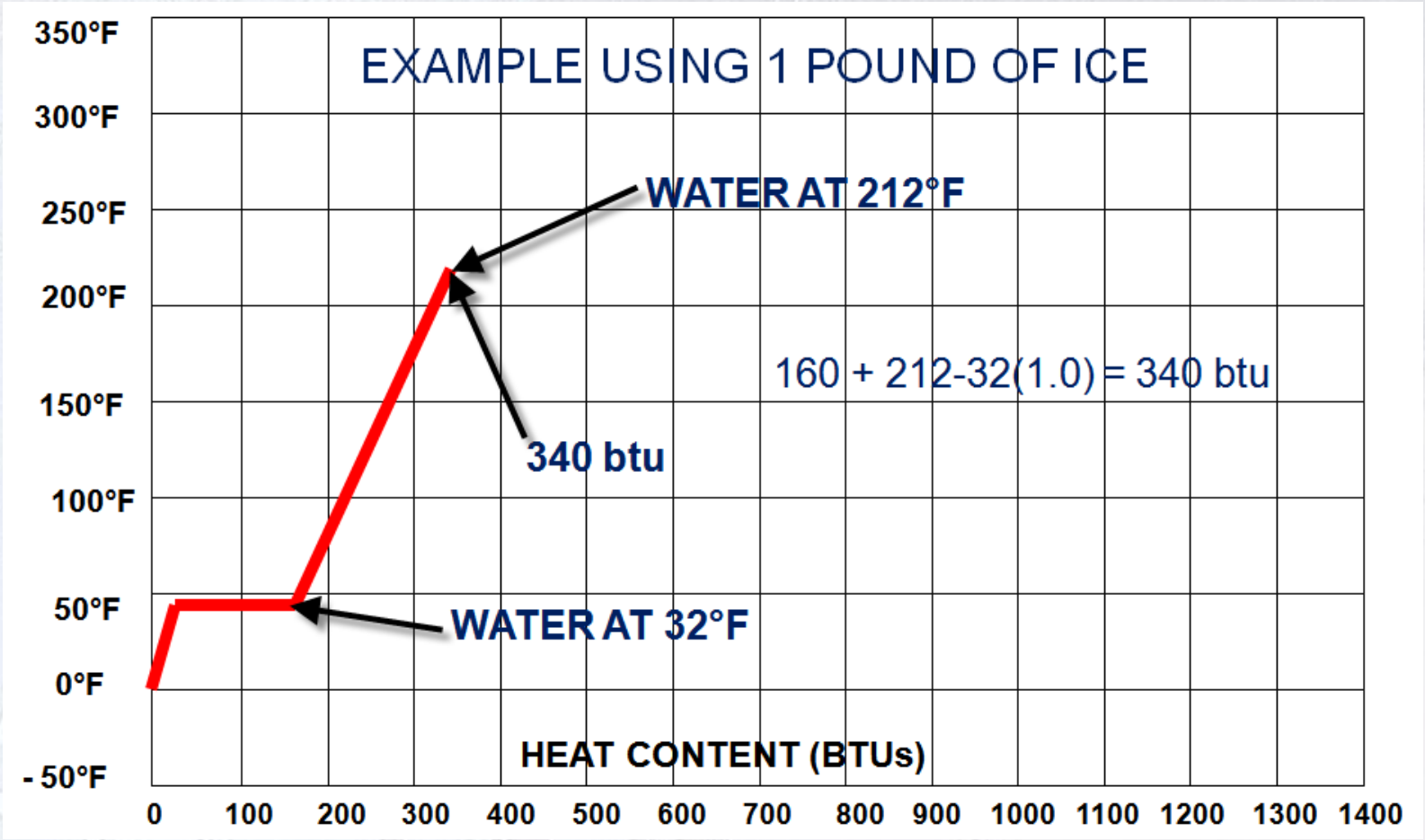
Substituting in the above formula gives us

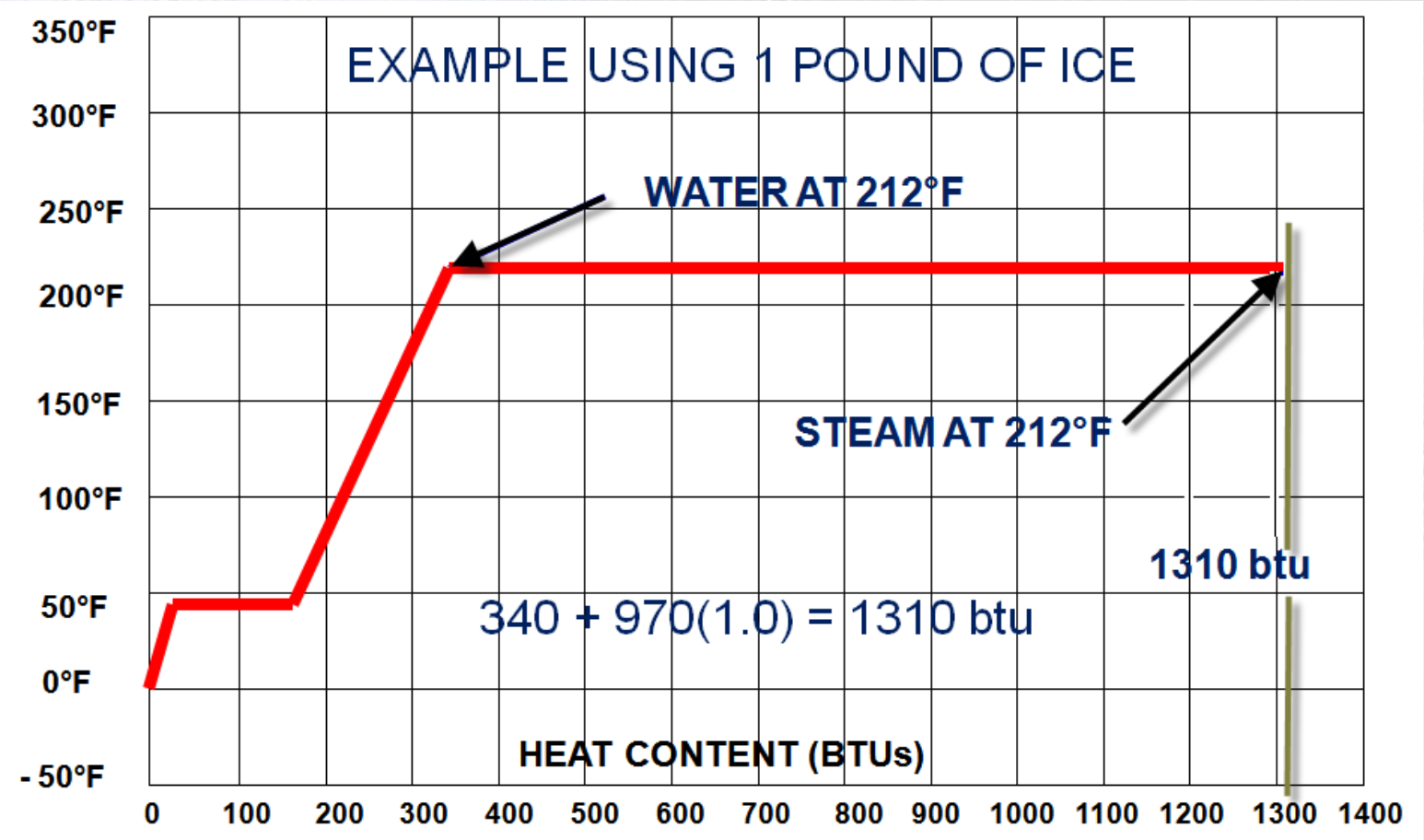
Q = 1000 pounds x 0.116 btu/lb x (70° F - 0° F)

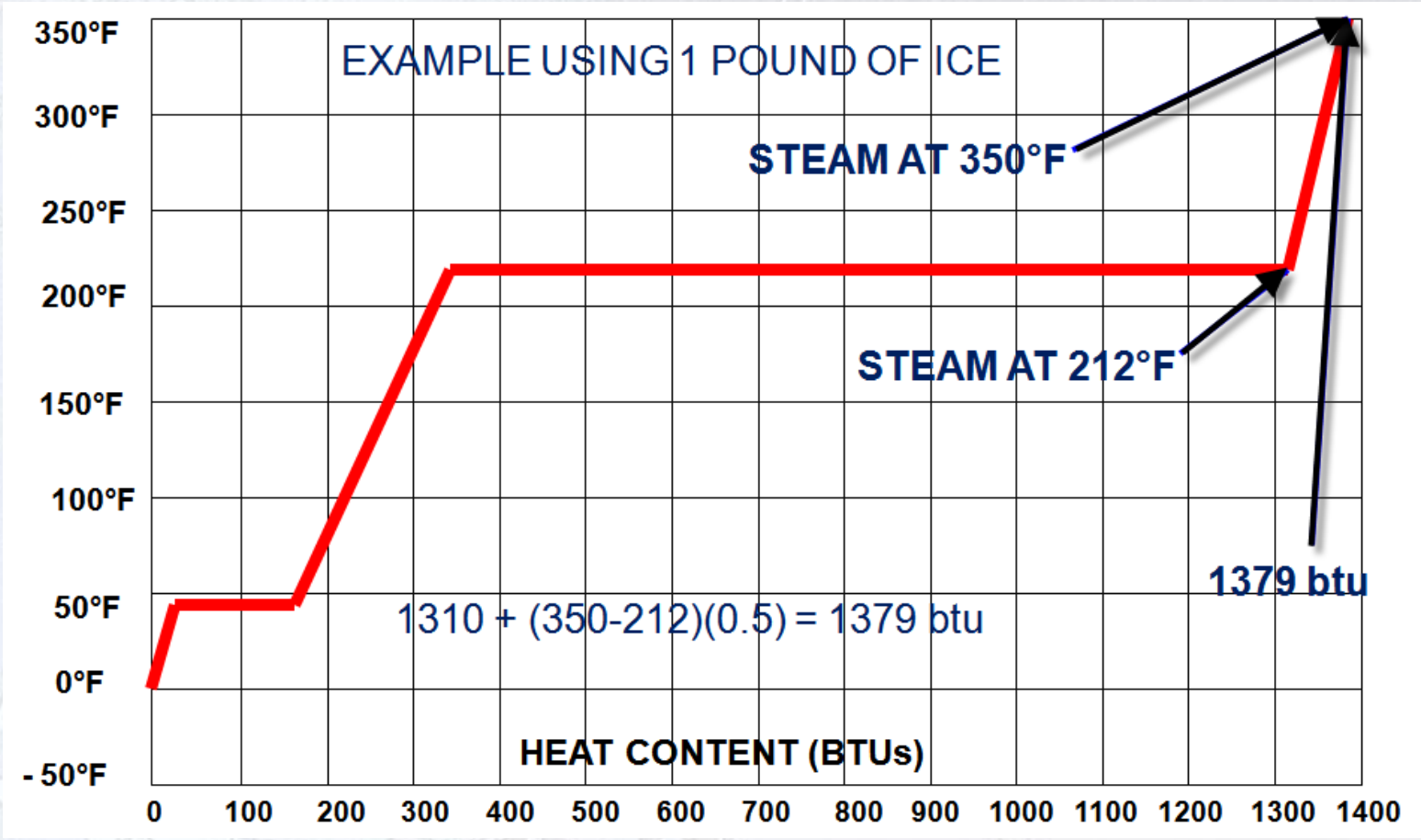
Q = 1,000 x 0.116 x 70 = 8,120 btu











SUMMARY OF ICE EXAMPLE

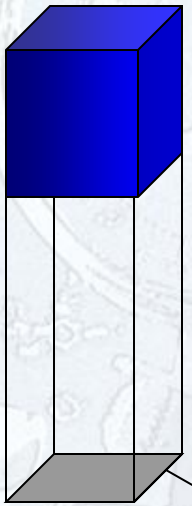
Ice at 0° F to Ice at 32° F	(32 – 0) (0.5)	= 16 btu
Ice at 32° F to Water at 32° F		= 144 btu
Water at 32° F to Water at 212° F	(212 – 32) (1.0)	= 180 btu
Water at 212° F to Steam at 212° F		= 970 btu
Steam at 212° F to Steam at 350° F	(350-212)(0.5)	= 69 btu
	TOTAL HEAT TRANSFER	= 1,379 btu

PRESSURE

- Defined as the force per unit area
- Often expressed in pounds per square inch
- Example: If a 100-pound weight rests on a surface of 1 square inch, the pressure is 100 psi
- Example: If a 100-pound weight rests on a surface of 100 square inches, the pressure is only 1 psi

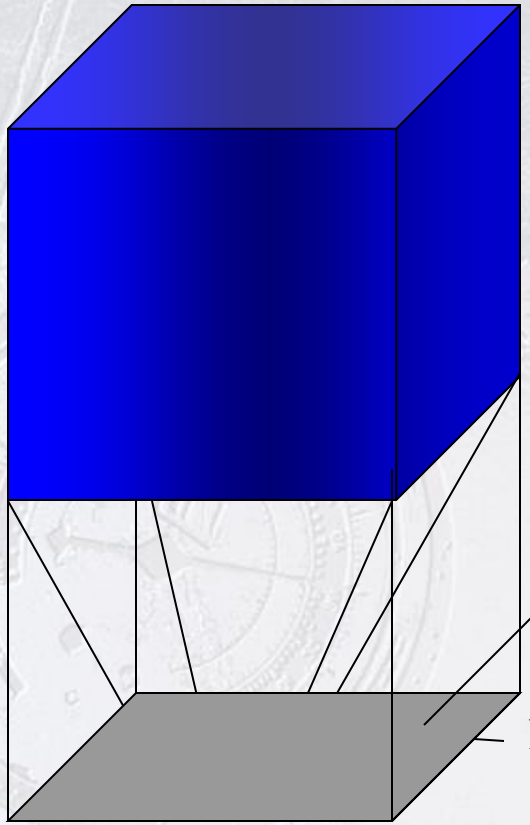
100 pound block

1 cubic inch block with a weight of 1 pound



Pressure = 1 psi

1 square inch



100 square inches

1 square inch

Pressure = 100 psi

Pressure = 1 psi

ATMOSPHERIC PRESSURE

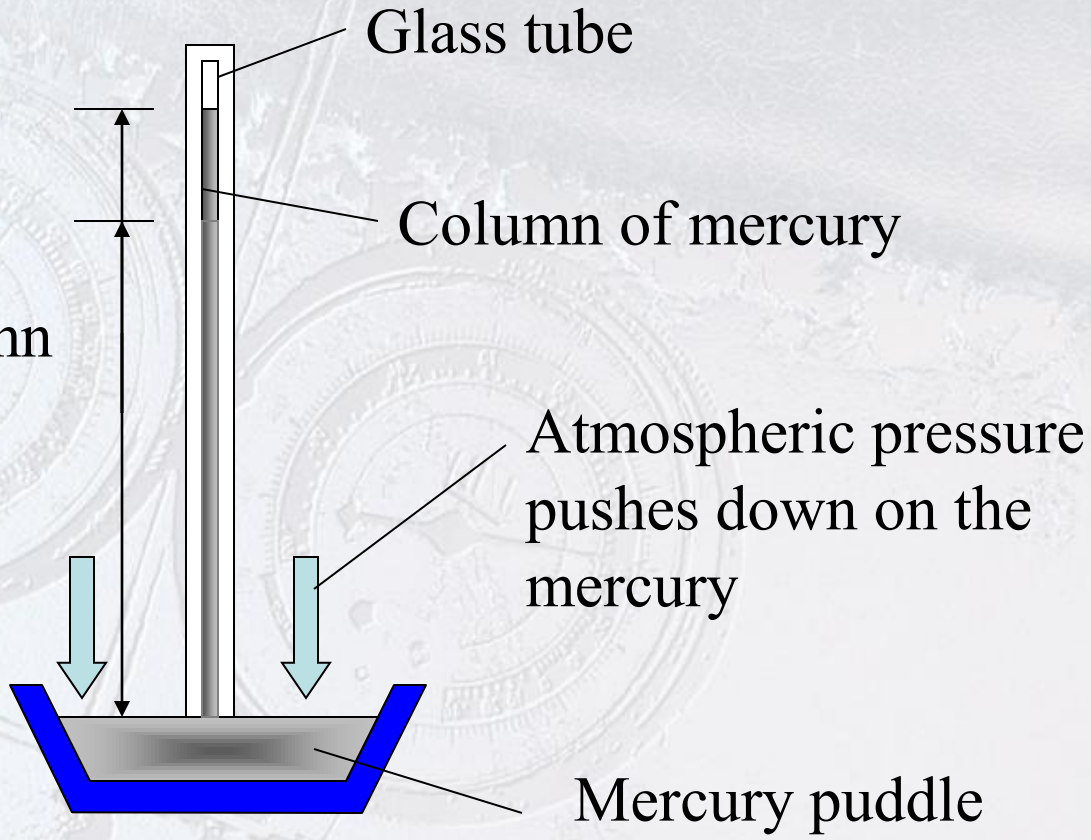
- The atmosphere we live in has weight
- The atmosphere exerts a pressure of 14.696 psi at sea level (often rounded off to 15 psi)
- 14.696 psi at sea level is known as the **standard condition**
- Measured with a barometer

THE BAROMETER

- Used to measure atmospheric pressure
- Constructed as a 36” glass tube
- Tube is sealed at one end and filled with mercury
- The tube is inverted and placed mercury
- As atmospheric pressure drops, so does the level of mercury in the tube
- At atmospheric pressure, the height of the mercury will be 29.92”

As atmospheric pressure drops, so does the level of mercury in the tube

Height of mercury column is 29.92” at standard condition



INCHES OF MERCURY AND PSI

- The column of mercury is 29.2” at atmospheric condition of 14.696 psi
- One psi is equal to approximately 2” Hg
- Example: If the barometer reads 20”Hg, then the atmospheric pressure is approximately equal to 10 psi
- Absolute pressures are measured in pounds per square inch absolute, psia

PRESSURE GAGES

- Bourden tube – measures pressure in a closed system
- Used to measure the pressures in an air conditioning or refrigeration system
- Gages read 0 psi when opened to the atmosphere
- Gage pressures are measured in pounds per square inch gage, psig

PRESSURE CONVERSIONS

- To convert gage pressure to absolute pressure, we add 15 (14.696) psi to the gage reading
- To convert absolute pressure to gage pressure, we subtract 15 (14.696) from the absolute pressure
- Example: 0 psig = 15 psia
- Example: 70 psig = 85 psia