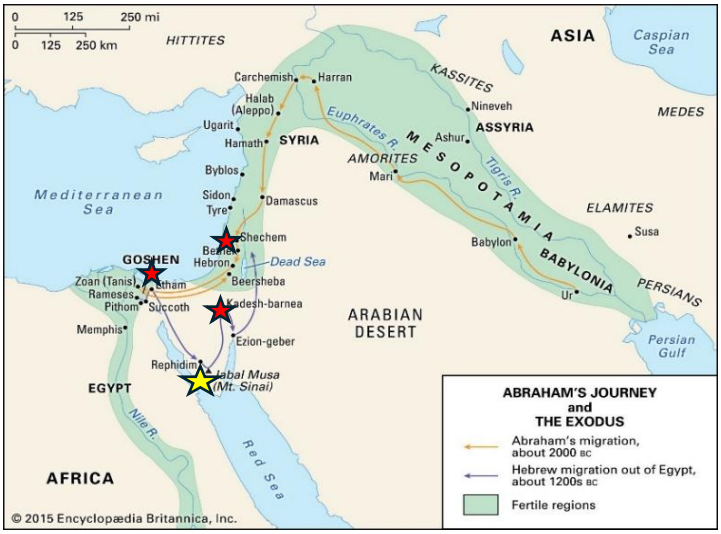
FIRE POWER

INTRODUCTION:

Hebrews 11:24-25 *By faith Moses, when he had grown up, refused to be known as the son of Pharaoh's daughter. He chose to be mistreated along with the people of God rather than to enjoy the fleeting pleasures of sin.*



What if…
God's plans for you are far different than what you might choose? Would it be easy to change? Would you follow Him no matter what the cost?

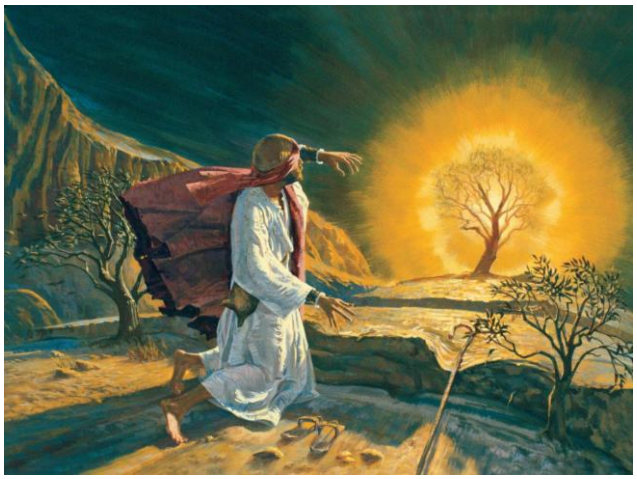
At the "burning bush" on Mt. Sinai (yellow star), God called Moses to free His people from Egypt where they were held as slaves. During the Exodus from Egypt, God used a "pillar of fire" to give light so they may travel by night demonstrating His presence to the Hebrew nation. After the miraculous Exodus from Egypt, again at Mt. Sinai amidst "smoke and lightning," God delivered the ten commandments to Moses and the Israelites.

God directed Moses to write the first five books of the Old Testament from "The Beginning…" (Genesis) to the "Blessings of the Tribes" (Deuteronomy). Near the end of Moses' life, God called Moses to go to Mount Nebo to see all the lands of Canaan, the land He promised to Abraham. God's desired the Israelites to be back in their homeland. It seems to be the one constant that still affects the world and defines who believes God's Word and who does not. For us, it's difficult to overestimate the impact of one man's life. His choice to leave a "cush" position in Egypt and become "like a slave" made all the difference for the Hebrew nation. Even though Moses was far from perfect, unable to enter the promised land himself, his obedience, his life, and his actions changed the world.

DEUTERONOMY 32:49-50 *Go up into the Abarim Range to Mount Nebo in Moab, across from Jericho, and view Canaan, the land I am giving the Israelites as their own possession.* [50] *There on the mountain that you have climbed, you will die*.

DEVOTIONS: EXODUS 3

EXODUS 3:5-6 [5] *"Do not come any closer," God said. "Take off your sandals, for the place where you are standing is holy ground."* [6] *Then he said, "I am the God of your father,*[a] *the God of Abraham, the God of Isaac and the God of Jacob."*



A burning bush that isn't consumed by fire or a pillar of fire that needs no fuel in the desert – both are supernatural fires unknown to anyone of us who've tried to start a campfire. God's presence and the Holy Spirit's actions are awe inspiring. An all-consuming fire demands respect. As God told Abram, *"Take off your sandals, for the place where you are standing is holy ground."*

God called Moses to free his people from Egypt. Rebellion within the tribes, against Moses and God, resulted in 40 years of wandering in the desert – the regions of the Sinai Peninsula and Arabian Desert – before they were able to enter the promised lands again. The nation was forced to rely on God alone for their food (manna and quail) and water. When the rebellious generation passed away, Joshua led the Israelites into the promised land. Moses' last days were spent observing the land of Canaan from Mt. Nebo.

At that time the Israelites were ruled by judges (chosen leaders from among the 12 tribes of Israel), who from time to time banded together with other tribes to fight enemies or to work together. Three to four centuries later, the Hebrew nation cried out for a king though they were warned of the dangers. From their cries, King Saul, then King David, and finally King Solomon reigned over a United Kingdom of Israel.

HEBREWS 1:29 ***29*** *By faith the people passed through the Red Sea as on dry land; but when the Egyptians tried to do so, they were drowned.*

VOCABULARY:

SUB-CATAGORIES OF KINETIC ENERGY:

Thermal energy is the energy in a system responsible for temperature, often molecular or atomic-level kinetic energy.

Radiant energy is energy transferred by electromagnetic photons or waves, often an invisible form of kinetic energy measured by an increase in temperature.

TEMPERATURE – the average kinetic energy of particles in a substance (chemistry) or in an object (physics). The speed/motion of atoms is key.

JOULES (J): A quantity of energy needed to do work over a distance equal to 1 N x 1 m or 1 $kg{\cdot}m^2/s^2$. Whereas a calorie is the heat energy needed to raise the temperature of 1 cc or mL of water 1 degree Celsius; a joule is based on a force over a distance.
A joule equals ~$1/4^{th}$ or .24 calories; 4.184 Joules = 1 calorie. A Joule (1 kgm^2/s^2) the capacity of 1 **Newton** (force) **for 1 meter distance** (**Nm)**.

WORK – the transfer of energy to or from an object via application of force, **Work = Force (F) x (d) Distance (aka s → for displacement). W = Fd measured in Nm or Joules.**

TIME – is an irreversible continuum measured by clocks or other instruments (hourglass). It's a fundamental concept of physics linked to change. SI units are seconds, minutes, hrs.

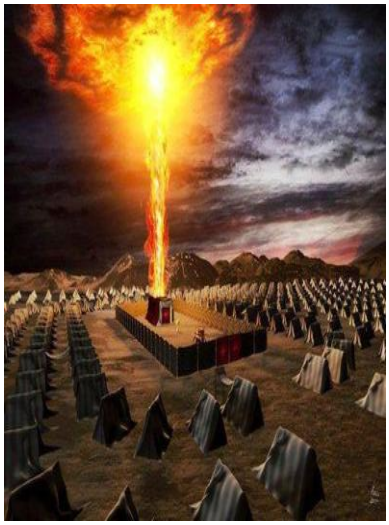
POWER – energy or work converted/change over a unit of time, usually given as represents a rate of change in energy Power = Work/time shown as **P = W/t** or the change in Energy/time shown as → **ΔE/t**.

WATTS – a unit of power equal to Joules/sec used to describe electrical circuits and equipment. Watts, horsepower, and BTU/hr are all power references. A 15 watt bulb will use 1/3 the energy of a 45 watt bulb in the same amount of time.

MAGNETITE (72%), HEMATITE (70%), LIMONITE (60%), SIDERITE (50%) – these minerals are iron oxides, percentage of iron shown. Magnetite streaks are black-gray; Hematite streaks are red-brown; Limonite streaks are yellow-brown; Siderite streaks yellow-white. Only magnetite shows strong magnetism (Fe_3O_4) properties. Iron meteorites may be up to 95% iron and were the source of the earliest hammered iron tools; however, only about 5% of meteorites are considered iron meteorites.

THEME: FIRE POWER

Hebrews 12:29 *For our God is a consuming fire.*

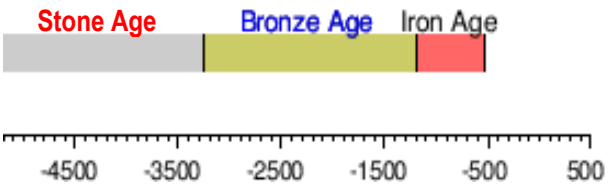


In the Bible, fire often symbolizes the Spirit of God, His presence, power and judgment. God gave us the ability to create and use fire, to produce heat and energy when needed; however, our human form is far from "powerful." God is infinitely powerful. We are weak in terms of power. Without calories, we die. Without water or oxygen, we die. Without warmth, we die. These are "needs" that do not come from within us, whereas God's power resides in Him and Him alone. With His power, He created and commands all things.

God vested us with creativity, ingenuity, a desire for justice and spiritual communion, but He did not endow men with an innate power source. Our heart is the closest thing to a "power" source, a pump with a *life expectancy*. Perhaps this is why hearts are referred to in the scriptures (and in life) as the source of our desires, rather than our minds. Without a heart, we'd be unable to power our thoughts or do anything about them.

TIMELINE/Introduction (History): The Beginning of the Iron Age

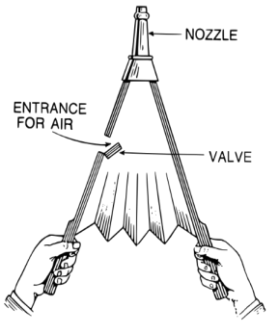
1500-1000 BC Hot Oven Metallurgy, Smelting, Iron and Magnetism.



The **Iron Age** has various start times for different cultures; however, it is generally accepted as spanning 1200 – 500 BC. The end of Moses' lifetime (around 1200 BC) coincides with the beginning of the Iron Age. The Iron Age spans the time of the Judges through the time of the Israelite Kings (last to reign, King Zedekiah) when Neo-Babylonian conquerors took the Southern Kingdom captive in 586 BC.

Exploration was the first step into the **Bronze Age** as they searched for gold, copper, silver, tin, lead, and other metals primarily in veins or mine shafts. Once laborers were fully engaged in **digging mines**, as well as canals, ditches, and drainage pathways (underground sewers date back 5000 years), more rocks were recognized as a source of metal ore. Labor intensive quarry-type mines, using **axes**, **shovels**, **wheeled carts**, and many man hours, powered the transition into the **Iron Age** as did new inventions and better smelters. Beasts of burden (ox, buffalo/cattle, donkeys/mules, horses, elephants) hauled the loads.

The Northern and Southern Kingdoms of Israel were engaged in mining along with many other kingdoms. However, extracting iron from oxide or silicate ore required new inventions. Man had to find ways to increase oven temperatures, vent gases properly (both in and out of the oven), and recombine minerals to extract iron. Once mastered, however, higher temperature ore separation was possible.

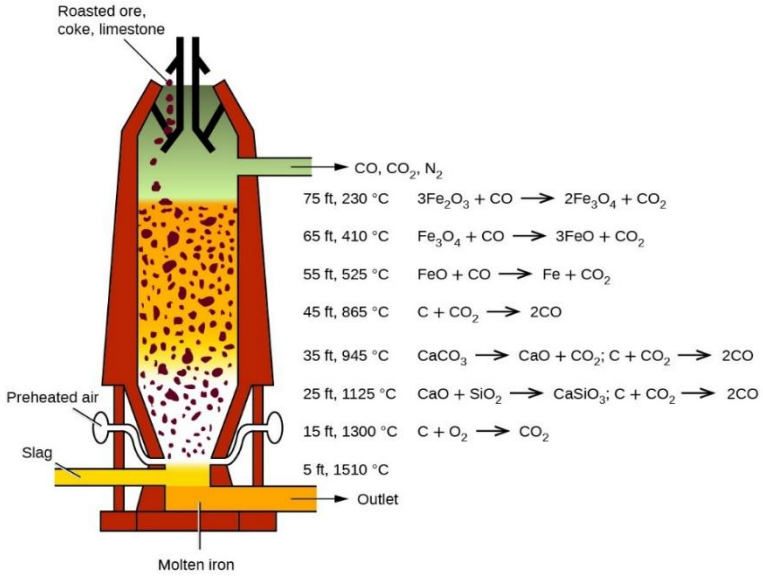


Unless you are God, **FIRE POWER** needs oxygen fuel. Bellows were invented to increase the available oxygen around 1800 BC by the Babylonians and Hittites. To increase air flow, they used skins over pots or containers to push air. Balloon and fan-like bellows created a means to narrow and direct the flow (similar to a **nozzle**). Much later a freely-moving, air-pressure **valve** would be used to trap air using air pressure and flow directions. Bellows were feet or hand pumps, such as the one illustrated here; however, later waterwheel and windmill-powered bellows were invented. Wind-powered bellows only worked when the wind blew. A much later invention (1800's AD) would be needed to store wind or waterwheel energy.

Finally, the additional power to smelt iron came from a concentrated energy source and a little "chemical magic." The key to both was carbon in the form of charcoal (now coke is used) and limestone. Coal increases the rate of burning energy (i.e. power). Limestone, a calcium carbonate, releases CO and CO_2 gas at high temperatures providing the "chemical magic." Carbon monoxide bonds with oxygen, silica, and oxide impurities to produce: iron, carbon monoxide/dioxide gases, and a calcium silicate slag (wollastonite).

Published 2024-2025

SMELTER DIAGRAM



The process of turning preheated rock/ore into molten cast iron.

1. Gases released
2. FeO is an iron oxide
3. Carbon monoxide or dioxide are released
4. $CaCO_3$ limestone
5. SiO_2 quartz
6. CO_2 gas released
7. Preheated blasts of air are added (bellows).
8. Slag $CaSiO_3$
9. Molten Iron

EQUIPPED/Science Principle: **Power and Temperature**

Power equals a rate of change in energy over time. The greater the ability to use energy, the greater the power. Note that time (t) is in the denominator (divide by time).

Power is "work" per a unit of time; that is, how fast work is done. **Horsepower** and **Watts** are units of power that represent the ability or speed which work can be done. These units also indicate the rate a tank of gas or an electrical current will be used. **Time is of essence**. Did it take a day, an hour, a minute, or a second to reach the top of the stairs?

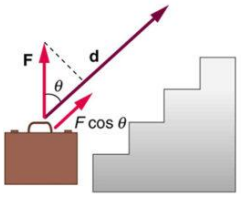
Power

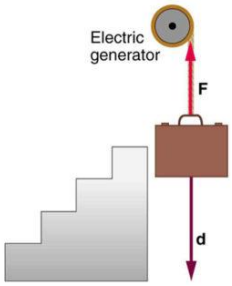
Power is the rate at which energy is transferred or the rate at which work is done.

$$P = \frac{W}{t}$$

$$P = \frac{\Delta E}{t}$$

P = power (Watt)
W = work done (J)
ΔE = energy transferred (J)
t = time (s)





Since heat is a form of energy, power relates to the transfer or change in temperature. Power determines the rate at which temperatures will change. A more powerful "heat gun" will change temperatures quicker. A more powerful generator (greater watts or horsepower) will lift a larger load and/or lift it faster. When you want to do greater or harder work, you'll want increased power.

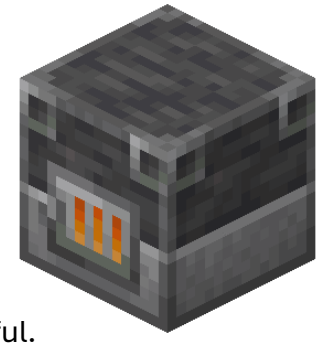
Temperature is a gauge of energy in motion – the greater the temperature, the greater the change in the kinetic energy of atoms. A thermometer is used to measure temperatures. Physics primarily uses the Kelvin Scale, with similar units to Celsius, but Kelvin (K) starts

with absolute 0 as its starting point whereas Celsius uses the freezing point of water as its zero-starting point (absolute 0 = -273.15 Celsius). In the 1700's, Daniel G. Fahrenheit devised a scale with units based on an approximate body temperature at 100 degrees and 0 equal to the freezing point of brine, 1/3 water, 1/3 ice, and 1/3 ammonium chloride. Although we commonly use Fahrenheit, its base points are flawed and more complex than Celsius or Kelvin.

When temperatures change, work is done "inside a substance" by altering electron bonds, increasing the speed of atom vibrations, or changing the state of matter. The four states of matter – solid, liquid, gas, plasma – are determined by the amount of heat energy the molecules possess. Temperature is a measure of this energy. Higher temperatures cause solids to flow and become liquids. At even higher temps, electron bonds reconfigure into faster-moving gases. Gas expands, so vents are essential to prevent explosions in ovens.

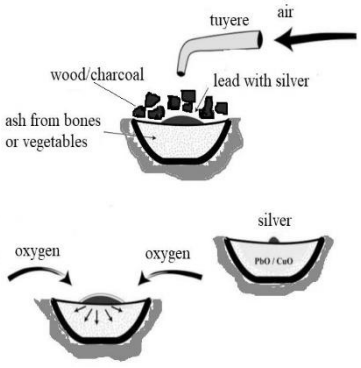
GEAR-UP/Practical Illustration: **METALLURGY**

Power provides the ability to change the rate energy is transferred or delivered to a system. Additional power was needed to increase **temperatures** for metallurgy.



A forge is used to heat metals and prepare them to be shaped. Metals like gold, silver, copper, and tin were extracted mechanically, without the need to melt the metal. Forge temperatures were adequate to soften metals but were inadequate to melt iron or remove the silicate impurities. Metals are defined by ductility (ability to be drawn or stretched without breaking), malleability (ability to press or hammer into a sheet without cracking), and reflectivity or metallic luster. These properties were coveted and useful.

Although a forge consumes energy faster (870-1370 °C) than an earthen oven (600-700 °C), melting metals requires a smelter oven (1000-2400 °C). Heat is essential to break electron bonds or alter the state of matter. All elements, minerals, and compounds have their unique melt temperatures, but iron – the 2nd most prolific metallic mineral on earth – requires 1558 °C. Aluminum is more abundant, only requiring (600-700 °C), but it's not as hardy as iron. Lead was easy to separate due to its density (it sinks) and its low melt temperature of 375 °C; however, lead is dangerous when consumed. Lead poisoning plagued many of the Roman elites who's plumbing, cooking and eating utensils were made with lead in the 1st century BC.



Psalm 119:118-119 *You reject all who stray from your decrees, for their delusions come to nothing. All the wicked of the earth you discard like dross; therefore I love your statutes.*

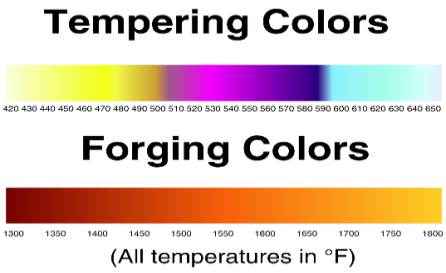
Magnetite, hematite, and other iron oxides are often locked in silicate rock. Silicates make up more than 90% of earth's crust whereas iron is only around 5.5%. The most pure iron ore is the mineral magnetite. Lodestone, a naturally magnetized magnetite, was originally described near Magnesia in modern-day Turkey – hence the name **magnet**. Although iron ores were previously known, a naturally magnetic iron was novel. Around 600 BC, the properties of magnetism were extolled by Thales of Miletus, a Greek philosopher.

Pure iron metal extraction, however, required the efficiency and power of an improved smelter. Early ovens were dug into the earth for insulation, like a survival pit or earthen oven. These ovens primarily relied on an initial fire, not an ongoing fire. Blacksmiths and metal workers learned how to insulate, vent, and add fuel to a fire to achieve greater temperatures. Improved smelters added hot air/oxygen near the fire, heated ore rather than cold ore, and higher vents for "waste" gas and doors for adding ore. Smelters release molten metal near the base and dross or slag near the top of the molten liquid where it accumulates due to its lower density.

Forging and Tempering – both are aspects of metal work. Forging is done by hammering heated and pressing heated metals. Tempering is a heat treatment, at lower temperatures, that hardens and reduces brittleness. **Quenching** is used to quick cool iron/steel to increase its strength and hardiness. Electron bonds change with temperature; therefore, quick cooling may preserve desired electron bond configurations.

color	approximate temperature		
	°F	°C	K
faint red	930	500	770
blood red	1075	580	855
dark cherry	1175	635	910
medium cherry	1275	0690	0965
cherry	1375	0745	1020
bright cherry	1450	0790	1060
salmon	1550	0845	1115
dark orange	1630	0890	1160
orange	1725	0940	1215
lemon	1830	1000	1270
light yellow	1975	1080	1355
white	2200	1205	1480

Proverbs 27:17 *As iron sharpens iron, so one person sharpens another.*



EXPERIMENT: Kinetic Thermal Energy

Using a camp stove you create, observe: a) temperature change, b) fan motion, c) color changes. Temperature is a measure of kinetic energy; fan motion is indicative of expanding and escaping gas; color change is possible but may be primarily due to carbon/ash accumulation.

RECORD TEMPERATURES AND TIMES ON A NOTEPAD

Other observations may be recorded but will not be graphed.

 Published 2024-2025

STEP ONE: Set up a small firepit/stove floor. Add fuel.
STEP TWO: Test outside temperatures using thermometers or infrared sensors. Record both the beginning temps and time (T_0 and t_0).
STEP THREE: Create a fire in your stove. Test can and air temperatures (10 cm from vents). Record the time and temperatures.
STEP FOUR: Once your fire is purely coals (no visible flames), test both the can and air temperatures (10 cm from vents). Record the time and temperatures.
STEP FIVE: Measure one more time giving time and temperature. (T_f and t_f).

Graph your results as a record of your cook stove use and temperatures. Place Temperature on the y axis and time on the x axis. If you improve your stove in any way, you can use your graph as a way to compare efficiency or performance.

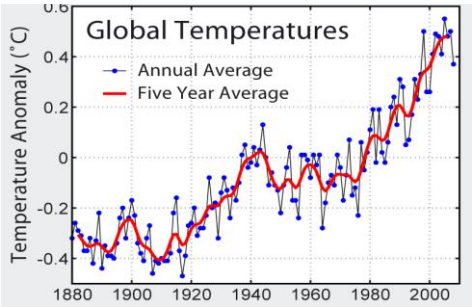


Image GT →

Global temperature variations over the last 150 years are shown as a graph (Image GT right). Slight temperature changes are illustrated on the y axis (0 near the y axis center). Twenty-year intervals are depicted on the x axis. Your graph might cover an hour or two of time whereas your temperature changes may vary several hundred degrees.

GOT-IT/Apologetics:

Job 28:1-28 1-2 *Surely there is a mine for silver, and a place where gold is refined. Iron is taken from the earth, and copper is smelted from ore*. **Deuteronomy 8:7 ...***For the Lord your God is bringing you into a good land,* **9** *...a land whose stones are iron and out of whose hills you can dig copper.*

The Book of Job is considered one of the earliest writings of the Old Testament. During God's discourse with Job, the topics of mining, refining, and smelting were used to illustrate the search or quest for something valuable. It's clear from Job, Chapter 28, that God's intent is to lift a veil and expose truth. Long before the Iron Age would come to pass, God made iron's presence known.

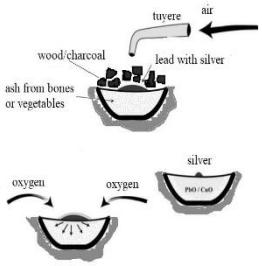
In Deuteronomy 8, God tells of all the blessings of the Promised Land including iron stones, but He also warns about their potential to harm. God knew the future of iron smelting would transform both "work and war." While mining the earth to uncover God's treasures is an honorable pursuit, worthy of our labor; these "good things" are worthy of caution. How amazing and true are the Words of the Lord!

God's Word may reveal future events, but it always reveals truth. Iron was valuable. Prior to the Iron Age, iron often sold for higher prices than gold, silver, or copper and was either pure magnetite or part of a meteor. The iron industry built skyscrapers and intercontinental railways; but, it also revolutionized warfare. You see, the Word of the Lord endures forever.

REFLECTION/Devotion:

Malachi 3:2 *But who can en dure the day of his coming? Who can stand when he appears? For he will be like a refiner's fire or a launderer's soap.*

The Bible is a commentary on history, socioeconomic conditions, physical attributes of the earth and nature, and reflections on the character of God and mankind. Allusions to mining, refining, and metal working are common and provide metaphors for life. A refiner's fire removes or separates impurities just as a smelter oven is designed to do. Laundry soap is used to "capture and bind" impurities that rinse off with water.



Slag and dross, like dirt, are often compared to the sin we allow to remain in our lives. The potter's hands, the shepherd's rod, the smelter's fire allude to the purifying aspects of being subjected to refinement, chastisement, or being molded into better, more useful vessels. These are befitting for the child of God.

Isaiah 1:25 *I will turn My hand against you, and thoroughly purge away your dross…*

REMEMBER THESE THINGS/Devotion:

God knows our needs before we do. Moses brought Joshua and the Israelites back to the land God promised to Abraham. This fertile land, with streams and springs, had stones of iron and copper. Stones of iron were of little value in that day. The Iron Age hadn't begun when Moses wrote down these words. God warns His people to remember where wealth, power, and strength really reside. Like the manna and quail, these were His provisions.

Deuteronomy 8:7-9, 17 *For the Lord your God is bringing you into a good land, a land of brooks of water, of fountains and springs, that flow out of valleys and hills; a land of wheat and barley, of vines and fig trees and pomegranates, a land of olive oil and honey; a land in which you will eat bread without scarcity, in which you will lack nothing; a land whose stones are iron and out of whose hills you can dig copper. 17 You may say to yourself, "My power and the strength of my hands have produced this wealth for me."*

"Redeeming time" refers to making the most of every opportunity and using time wisely, recognizing its value and the potential for spiritual growth and service (AI). To redeem, we must do something. Prayer is doing. "The prayer of the righteous is very powerful in its working." James 5:16b. Time is irreversible.

Ephesians 5:15-16 *See then that you walk circumspectly, not as fools but as wise, redeeming the time, for the days are evil.*