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EDUCATIONAL COLUMN

THE WATER OF LIFE

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Abstract

The solid, liquid, and vapor states of water are discussed from a design perspective. Many physical properties of water such as heat capacity are described and compared with other materials. The importance of the hydrogen bond is emphasized. Implications of water's behavior regarding evolution, the hydrologic cycle, and the anthropic principle are summarized.

Introduction

It pours down on the earth at the rate of 1.5 trillion tons a day. It covers 72 percent of our planet's surface, 70 billion gallons for every person alive. This common compound called water has long been considered a cheap and humdrum resource with the lowly formula H_2O. Many people assume that the world owes them a pure stream from their faucet. However, closer inspection reveals that water is by no means an ordinary resource. In space it is an extremely rare compound—only slight traces are found on other planets. On the earth, its physical properties are carefully matched with the needs of the land and its inhabitants.

Consider a cup of cool, clear water. In the absence of dissolved gases and minerals it is colorless, tasteless, and odorless—nothing could be plainer. But what is really within this refreshing and essential drink? A few swallows comprise about 10 "moles" of water, a measure of the quantity of matter. One mole consists of 6×10^{23} molecules, also called Avogadro's number. At 10 moles, the simple cup of water contains hundreds of more water molecules than the total number of stars in the entire visible universe! An individual molecule is just under one-billionth meter in diameter. This small size results in immediate benefits to us. That is, water molecules are able to readily pass through our body membranes in vital fluid circulation. In the cup there are actually 18 varieties of H_2O molecules. This results from the fact that hydrogen is available in the isotopes H^1, H^2 (deuterium) and H^3 (tritium). The latter two have one and two neutrons in the nucleus. Oxygen also takes the isotopic forms O^{16}, O^{17}, and O^{18}, giving rise to 18 different possible H_2O combinations altogether. By far the most common form is $H^1{}_2O^{16}$, since these particular isotopes dominate. The molecule $H^2{}_2O^{16}$, called heavy water, was discovered in 1934 by Harold Urey. It occurs naturally to the extent of 200 parts per million, so trillions of these heavy molecules are harmlessly swallowed with every drink. As with all materials, heavy water has many useful purposes. Thus far it has been found most useful as a neutron moderator in nuclear power reactors.

The water molecule is very stable, breaking down into separate hydrogen and oxygen atoms only at about 3000°C. It simply cannot be destroyed in the environment, only polluted. Of course water does not burn, even though hydrogen alone is very explosive in the presence of oxygen. And just what are the water molecules doing in a filled cup? Rather than lying still, in which case the water would be frozen, they are in rapid motion. At room temperature their speed averages 1,000 miles per hour! With each molecule experiencing millions of collisions each second, the surface of the water is deceptively smooth. A few molecules are continually being given higher than average speeds by rear-end collisions. These molecules, if at the liquid surface, are able to leave the cup altogether and evaporate into the air. A few stray water molecules in the air are also continually falling into the cup! And beyond the liquid state, gaseous water vapor and solid ice likewise display countless intriguing properties. Water's characteristics have been discussed by others, usually from the perspective of "coincidences" or "eccentricities" of nature.[1-9] Instead, the purpose of this study is to explore the wonders of water in praise of the infinite Creator.

The Liquid State

I will send down showers in season;
there will be showers of blessing.
Ezekiel 34:26b

PHASE CHANGE The liquid state for any material is bounded by two temperatures. The low temperature is the melting or freezing point where the solid and liquid may exist together. This particular temperature depends on the strength of molecular bonds and also on the molecular weight of the material. Similarly, the boiling or vaporization temperature also is a function of molecular interaction. It is interesting to compare water with some other substances that have a similar molecular and electron structure such as H_2S, H_2Se, and H_2Te. The elements oxygen, sulfur (S), selenium (Se), and tellurium (Te) all occur

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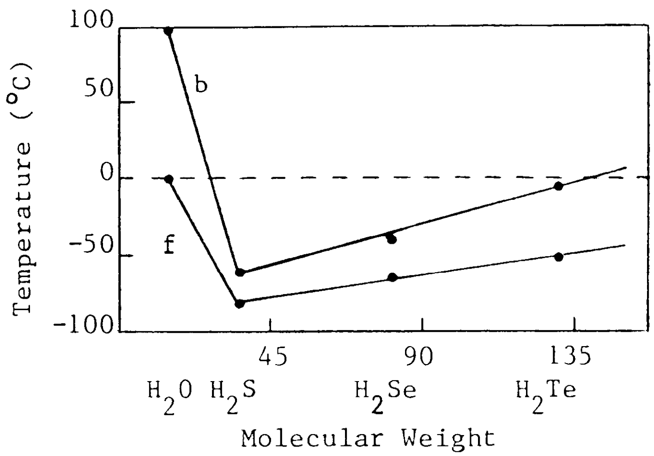


Figure 1. Boiling (b) and freezing (f) points for water and similar compounds.

in the sixth column of the periodic table since each has six outer electrons. Thus the compounds are indeed similar. Figure 1 compares the transition temperatures of these materials with their respective molecular weights. Hydrogen telluride has high melting and freezing temperatures since its molecular weight is by far the greatest. More effort is thus required to either melt or vaporize H_2Te. In technical language, London dispersion forces are larger for heavier molecules. It is also expected that H_2O, the lightest molecule of the set, should have the lowest temperature changes. Figure 1 shows how unusual water actually is. Its boiling and freezing points are nearly 100°C above their predicted values. In fact, water *should* be a gas at room temperature! It is water's unique molecular attraction that makes the unexpected difference possible. Much extra energy is needed to break water's strong intermolecular hydrogen bonds, and the transformation temperatures are consequently much higher. Thus, water is the only naturally occurring material that readily exists in all three states (solid, liquid, gas) at earth temperatures. Such extraordinary properties are essential for water to carry out its many functions in our bodies and throughout the environment.

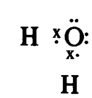
HEAT CAPACITY Remember the last time you ordered a baked potato in a restaurant? The outside silver foil was easily torn and removed with the fingers. But watch out for the potato itself! Handle it with care or you will be burned. The food seems to hold *more* heat for a *longer* time than the wrapping does. The enclosed water, 90 percent of the potato by weight, has a "heat capacity" over four times greater than that of aluminum. This heat capacity is a measure of a material's ability to absorb heat energy. Table I compares the heat capacity of water with several other common materials. Other than ammonia, water's heat capacity is higher than any known liquid or solid in nature. Water's value of 1.0 calorie/gram°C is used as the basis for defining heat absorption in general.

The large heat capacity of water has many implications. Practically, water is an ideal reservoir and transfer agent for heat. Hot water heaters, automobile radiators, nuclear reactors and cooling towers utilize this property. The heat-reservoir property of water also is responsible for "evening out" temperatures on the earth. Solar heat is readily absorbed by the seas and other surface waters, then re-emitted to the atmosphere when needed to moderate temperatures. Without this thermostat, temperature fluctuations would be extreme, perhaps similar to the moon's ± 200°F variation between darkness and light. Likewise the Gulf Stream which circles the North Atlantic basin picks up an immense quantity of heat from the Gulf and delivers it to Western Europe and the Arctic region. This vast current, equal to 1000 Mississippi Rivers in volume, warms Northern Norway as much as 28°C higher than the average for its latitude. In the Arctic, 150,000-ton icebergs may be melted in a single week by the Gulf Stream. Water's heat capacity definitely controls the climate of the world.

In our bodies the rapid movement of heat is also essential. Besides water's large heat capacity, its high thermal conduction together with fluid circulation helps the extremities of the body stay warm. As a thermostat, the water content of our bodies helps maintain a constant temperature while preventing any damaging cold or hot spots.

UNIVERSAL SOLVENT Water will dissolve practically anything. It is a solvent for more materials than any other liquid. Salt and silicon, oxygen and oil—all are eventually dissolved by water. There are a multitude of implications to this dissolving ability. Plants thrive by taking in dissolved nutrients from the soil with water as the carrier. Gases dissolved in sea water provide a reservoir that keeps the atmosphere stable in composition in spite of men's best efforts to upset the balance. If too much carbon dioxide accumulates in the air from burning coal, increased solution of the gas into the sea occurs. Contrarily if there is a CO_2 shortage so that the health of plants is endangered, gas will move back from sea water to the air. Such built-in regulation systems abound in our world. In our bodies, 70 percent water by weight, dissolved oxygen, carbon dioxide, and nutrients are freely circulated. The continuous processes of digestion, absorption, secretion and excretion all depend upon water transport.

A liquid's dissolving ability can be measured in terms of its dielectric constant. This quantity depends on a material's polarity, the extent of charge separation within the molecules. Water has an extremely large polarity (Table I). In the H_2O molecules, an oxygen atom shares the hydrogen electrons and thus becomes negatively charged. The hydrogen atoms become positively charged because they have partially given up their single electrons. This covalent bond for a water molecule may be diagrammed as follows, where dots represent the outer oxygen electrons and x's the hydrogen electrons:



Actually the angle between the hydrogen atoms for a free molecule is 104.5°. The covalent bond for water is very strong; most water molecules do not break down until temperatures exceed 3000°C. Figure 2 shows what happens when an ionic material such as salt, NaCl, is added to water. The polarized water molecule is symbolized by an ellipse with oppositely

Table I
Average Physical Properties of Several Substances Including Water.
Blank Spaces Represent Unknown Quantities. cal (calories), gm (grams), and cm (centimeter)

Substance	Melting Point (°C)	Heat of Fusion (cal/gm)	Liquid Heat Capacity (cal/gm°C)	Boiling Point (°C)	Heat of Vaporization (cal/gm)	Surface Tension (dyne/cm)	Dielectric Constant
Acetone C_3H_6O	−95	23.4	.506	56.5	125	26	
Ammonia NH_3	−78	108	1.2	−33.4	302	23	22
Benzene C_6H_6	5.5	30.3	.389	80.1	94.3	35	2.28
Carbon Tetrachloride CCl_4	−22.8	4.16	.198	76.8	46.4	27	2.24
Ethyl Alcohol C_2H_5OH	−117	24.9	.54	78	204	22	
Hydrogen Selenide H_2Se	−64	12.9		−42			
Hydrogen Sulfide H_2S	−86	16.8		−61			9
Hydrogen Telluride H_2Te	−49	12.9		−2			
Mercury Hg	−39	2.8	.033	357	71	487	
Methane CH_4	−183	14.5	.53	−164	138		1.7
Oxygen O_2	−219	3.3	.394	−183	51	13	1.5
Sulfuric Acid H_2SO_4	−10.5	24	.27	330	122	55	
Water H_2O	0	80	1.0	100	540	75	80

charged ends. The positively charged sodium and negative chlorine atoms are quickly surrounded and shielded from each other by water molecules. As rapidly as salt is added, its components are separated into the brine solution. The salt remains indefinitely ionized in the solution without recombination. Water is not as successful at dissolving *unpolarized* materials such as oils, except over longer periods of time.

SURFACE TENSION There is an attractive force between liquid water molecules which causes them to "stick" together. This force results from hydrogen bonding and is responsible for most of water's unique properties. The hydrogen bond acts between molecules containing hydrogen and any of the electronegative elements fluorine, nitrogen, or oxygen. In water, a hydrogen atom that is covalently bonded to an oxygen atom is also electrically attracted to surrounding oxygen atoms. The hydrogen bond is 20 times weaker than water's inherent covalent bond, but it still is very influential. Thus the separate water molecules in a sense "hold hands," especially in the solid state. When ice melts, about 85 percent of the hydrogen bonds remain active. Next to mercury, water has the largest surface tension or "stickiness" of any common liquid (Table I). Many common phenomena depend on this cohesiveness. A needle, razor blade, or insect will easily float on water's skin. Rain, fog, and cloud droplets assume a spherical shape as the molecules pull inward on themselves. Moisture clings to our joints for lubrication and to our mucous membranes and eyes for protection. When a narrow straw is inserted into water, the liquid will rise up into the tube somewhat. The first molecules are attracted upward to the surface of the tube itself, then other molecules are pulled upward after them. The smaller the channel is, the higher the water will climb against gravity. Absorbency of a blotter or towel is due to this capillary action. It also explains how sap is able to climb upward in trees to heights of over 100 feet. Without water's outstanding cohesiveness, trees simply could not grow tall. Flowers and plant leaves would also be in trouble. It is changing water pressure in tiny plant tubes that folds leaves by night and opens blossoms by day. It was not man who first designed hydraulic action!

POLYWATER Around 1970 many technical articles discussed a new polymerized form of water called polywater.[10] First reported by Russian chemists, the unusual water was said to boil at 1,000°F and to stay liquid down to −40°F. The differences from ordinary water supposedly resulted from a slight change in oxygen-hydrogen bond lengths. Instrumental in the formation was the presence of silicon dioxide (glass) which could initiate the process. Researchers at the National Bureau of Standards quickly confirmed the existence of the new water allotrope and began studying its properties. A few scientists even warned that polywater was a threat to life on our planet. A loose sample might rapidly duplicate itself in the environment and turn all natural water into polywater which would neither freeze nor evaporate. The hydrologic cycle would cease and all land areas would become deserts.

Notice that the preceding description of polywater is in the past tense. It was an exciting story but not

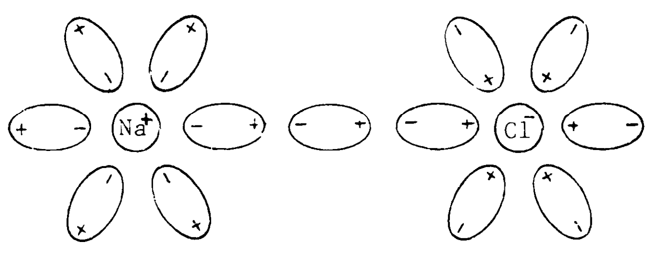


Figure 2. The dissociation of salt in water. The sodium (Na^+) and chlorine (Cl^-) ions are shielded from each other by surrounding polar water molecules.

a correct one. Spectral analyses of the anomalous water showed that the material apparently was a *combination* of natural water and silica. The system of two components had wrongly been taken as a single new substance with unique properties. The initial reports of polywater have long since been explained away; the subject is no longer discussed. However there is a lesson to be learned from this episode. For a time the science establishment rushed to "jump on the bandwagon" and explore this fascinating new material. Even though polywater did not exist, its preparation, transition temperatures, bond lengths, and dangers were fully described. Fortunately, science was self-correcting after a couple of years in this case. But it does cause one to wonder about many other currently popular ideas of science. Some are correct; others are most certainly false. The time-scale for self-correction may be long or short, if there is indeed self-correction in every case. The big bang, evolution, geologic chronology—all may be ideas standing in need of such major correction.

EVOLUTION In evolutionary theory life is assumed to have originated in an ancient sea. The reasons are several, though they are rather bizarre and without a sound basis. *First,* attention is called to the salt content of all body fluids—whether blood, sweat or tears. This is supposed to show a connection between primordial life and sea water. Also stressed is the fact that the human body is 70 percent water by weight, every cell of which has a fluid interior. *Second,* emphasis is given to the fluid environment of the human embryo and also its alleged early tadpole shape and gill-like slits. *Third,* water is assumed to have given ancient molecules mobility to permit their eventual arrangement together. In fact, Miller and Urey used boiling water as the molecule carrier in their 1953 origin of life experiments. *Fourth,* water has a liquid temperature range over which proteins are stable. Also water's large heat capacity is seen as providing a constant temperature and favorable environment in early seas. The list of reasons could be continued, but one soon gets the point that water's especially designed properties are being called forth to deny the Designer!

Just one fundamental problem will be mentioned here, since the preceding reasons are inherently inadequate anyway. The problem concerns the condition of the evolutionists' early earth, assumed to have been accreted as a hot mass—too hot for surface water to exist. Thus only 10 percent of present day surface water is thought to have been present on the original earth. However, plentiful sea water is essential for life development in the secular scenario. Thus it is guessed that the remaining 90 percent of present day surface water was volcanically outgassed from the earth's interior *after* the planet cooled. Such conjecture is certainly permitted, but should not be promoted as scientific fact.

The Solid State

Have you entered the storehouses of the snow or seen the storehouses of the hail?

Job 38:22a

THERMAL EXPANSION Imagine a fictional world where ice is different in that it sinks rather than floats. Broken water pipes due to freezing would no longer be a problem for ice would contract instead of expand. Iceberg collisions would also be a thing of the past since ice formations would quickly sink to the sea bottom. But other problems would be evident. With no floating layer of insulating ice, lakes would freeze solid from the bottom upward, perhaps during a single winter. Thick ice layers would quickly form at the bottom of polar seas. Such subsurface ice would have devastating consequences on the earth's hydrologic cycle. Frozen lakes would only partially thaw during the summer season. Less fresh water would therefore be available for precipitation. The seas would grow colder and more saline, probably killing most sea life. Human life itself would soon be endangered by this ecological upset.

The preceding scenario sounds ridiculous. After all, everyone knows that ice floats. However it is this property that again sets water apart from other materials. A piece of solid H_2S would quickly sink in its own liquid solution. So would H_2Te, H_2Se and practically everything else. The very few materials that expand with lowering temperature include the elements germanium, silicon and bromine. Consider a fresh water lake which is cooling in the Fall. At high temperatures, water acts like other materials. That is, a lowering of temperature results in a slight contraction and an increase in water's density. This is the principle of the mercury thermometer. Cold lake water in the Fall thus sinks beneath the warmer water. The process continues until the entire lake is cooled to about 4°C. This "Fall overturn" of oxygenated surface water is very important to the lake's biological activity. When the surface water continues to cool below 4°C, it no longer sinks. Instead, the water begins to expand as the temperature is further reduced to the freezing point. The resulting ice provides a floating insulation blanket that protects the entire lake from freezing solid. The expansion behavior of water is sketched in Figure 3. Note the minimum volume

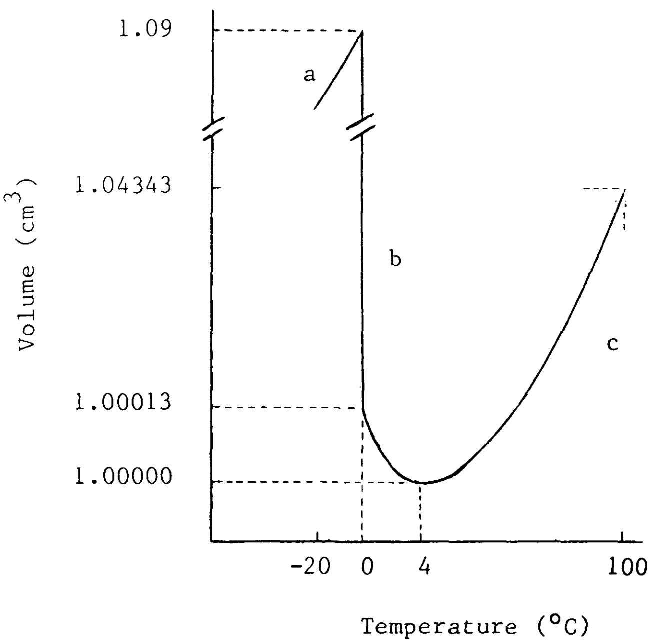


Figure 3. The expansion of water above and below the 4°C minimum volume. Both the temperature and volume scales are exaggerated for clearness. The broken vertical line (b) on the graph at 0°C represents the liquid-solid phase transition. Curve (c) represents cooling or warming of liquid water. Curve (a) represents cooling or warming of solid ice.

(maximum density) at 4°C, slightly above the normal freezing point.

The forces involved in the expansion of ice are remarkable. Many people have experienced broken water pipes or cracked engine blocks which were allowed to freeze. New England farmers once split large granite boulders in their fields by boring small holes in the rock and filling them with water. Today this mechanical weathering process continues on our northern highways, resulting in a fresh crop of "pot holes" each spring! The expansive pressures generated when ice forms amounts to several thousand pounds per square inch. This is large enough to shatter any container of freezing water, sometimes violently.

The unusual expansion of ice is due to hydrogen bonding, as described earlier. The intermolecular bonds for ice are illustrated in Figure 4. The structure is actually three-dimensional. Each H_2O molecule has four nearest neighbors to which it is hydrogen bonded. Notice the open structure of ice. It is this unusual low-density arrangement that results in the unique floating ability of ice.

HEAT OF FUSION Melting is a cooling process. When a material turns from solid to liquid form, heat energy must be added. This heat of melting, or fusion, is likewise given off when the material converts back to its solid form. On earth water continually makes this transition in both directions. Rain changes to snow, cloud droplets freeze, and accumulated ice melts. Table I compares the heat of fusion for several materials. The value for water is obviously extremely high, certainly a fortuitous circumstance. The alternative is not a pleasant one. If the value were small all available water in lakes and pipelines would quickly freeze in cold weather. Frostbite would become a much more common and serious problem. Earth's total weather system would be upset. The spring thaw of ice, if there *were* a spring season, would bring a sudden flood. No ice would remain in the mountains to supply water and power during the summer months. It is the large heat of fusion that slows water's melting.

SNOW Are there any two snowflakes that are exactly alike? The question is like asking if there are two people exactly alike—most certainly not, but it is hard to prove! There are innumerable snowflakes, about 20 million in every cubic foot. At the same time, the possibilities for their interior and exterior arrangement of water molecules are endless. The outward form of snow depends on the temperature of formation. The familiar star shape occurs when cloud temperatures are between 3 and 10°F. Above and below this range, small ice "plates" grow. The intricate shape of snowflakes can be partially understood from the bonding mechanism of ice. As Figure 4 shows, the sharing of hydrogen atoms between molecules leads to a "chickenwire" pattern. The entire snowflake crystal which contains trillions of molecules shows this beautiful hexagonal symmetry.

The variety of crystal shapes in nature and their growth was studied by Robert Boyle and Robert Hooke around 1700. They concluded that crystals such as snow "receive their regular figures from the texture or nature of their own parts."[11] Today, active study continues on the "fine structure" dendrites of ice crystals.[12, 13] The many patterns are at least partially controlled by the previously described heat of fusion. When a group of water molecules freeze together a significant amount of heat is released (80 calories per gram). This heat exchange shapes nearby parts of the ice crystals by local melting. But this microscopic melting depends on air temperature, wind currents, humidity, nearby snowflakes, etc. One can understand why no two flakes are identical, either on the outside or inside, since each microenvironment is unique.

Although snow encourages many northern people to flee south for the winter, the material nevertheless provides a wealth of benefits for the earth. *First*, a snow cover provides a "warm" protective blanket from the cold for plants and ground animals. A two-foot thickness of snow can result in as much as a 40°C differential in temperature between top and bottom. *Second,* falling snow clears the atmosphere. Each snow flake begins its growth around a dust speck. As the snow falls it then filters additional pollutants from the air. Also absorbed from the air is nitrogen which is eventually carried into the soil for plant use. *Third,* winter snows ensure an even flow of moisture into the subsurface water table. A rapid spring thaw may cause some local flooding but the majority of new water soaks downward. The list of practical benefits of snow could go on indefinitely. Upon reflection, however, perhaps the creationist should not always look for such economic blessings in nature. After all, the Creator has ordained the occurrence of snowflakes and that is surely sufficient reason for their existence. The usefulness of snow to us and the enjoyment we get from its beauty are secondary. Can anyone actually enter into a full understanding of the "storehouses of the snow (Job 38:22)" or any other part of the magnificent Creation?

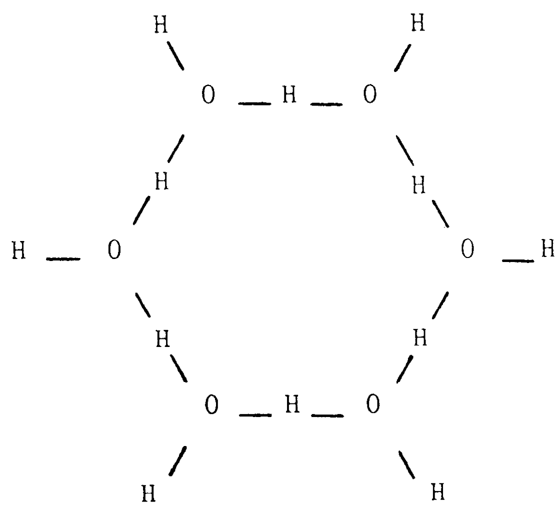


Figure 4. The hexagonal crystal structure of water in the solid state. The oxygen atoms are 2.72 angstroms apart in ice.

The Vapor State

He draws up the drops of water,
which distill as rain to the streams
Job 36:27

WATER VAPOR Suppose 10 moles of water is changed to gas, either by heating or by evaporation. At standard atmospheric pressure it will expand 1244 times to 224 liters, about the volume of a desk. The gaseous water molecules will have greatly increased their speed and will exert a large outward force as a consequence. Steam engines which utilize this pressure were instrumental in uniting our nation's states and powering the industrial revolution.

HEAT OF VAPORIZATION Just as in the solid-to-liquid transition, materials also absorb energy in turning from liquid to vapor. This energy is needed to separate the individual molecules into the gaseous state. For water vapor the molecular separation is about 10 times that of the liquid. As expected from the trend of this study, water has a very unusual heat of vaporization. It is not low or even average, for this would be disastrous. Surface waters would readily evaporate and our own bodies would suffer from overheating. Instead water absorbs a very *high* 540 calories for every gram vaporized. Thus only limited amounts of surface water evaporate from lakes and equilibrium is soon reached. One can only imagine the alternative: dried up rivers, 100 percent humidity, increased atmospheric pressure, and perhaps even a permanent vapor canopy.

The number 540 calories/gram has much to do with our personal health. Water is part of our internal cooling system. When we are hot, moisture is released at the surface of our skin from a million pores where it can evaporate. Since much heat is absorbed from the body in the process, perspiration is an essential and efficient process of heat regulation in spite of society's frown! Even a cup of hot tea is able to cool a person on a warm day. Its eventual evaporation from the skin removes about 10 times the original intake of heat. Many animals do not have the skin perspiration mechanism that we have. A dog, for example, removes excess heat largely by evaporation from its tongue and mouth. Its panting habit and exposed tongue are necessary to prevent heat stroke. Pigs also lack sweat glands on their bodies. Their inclination to ooze in the mud is a health requirement for the removal of their excess body heat.

CLOUD FORMATION Water's large heat of fusion results in a remarkable stability of the weather. Consider the formation of a cotton-like cumulous cloud on a summer day. Initially, warm moist air rises from the earth's surface. Water is carried along since its molecular weight is less than the molecular weight of "air" molecules. As the bouyant air mass rises it encounters regions of lower atmospheric pressure. Expansion and adiabatic cooling of the air follows. However, the cooled air now cannot hold as much moisture as it initially did. Droplets are "squeezed" from the expanding air, thus constituting the visible cloud. For each gram of water that condenses, 80 calories are given off to the surrounding air. This flow of heat limits the formation of more droplets and thus limits the size of the cloud. As the air mass moves to a higher altitude, more cooling and condensing can occur. You can watch this activity in a cloud as it slowly changes shape and bulges of visible white droplets appear. Incidentally, the droplets in a cumulus cloud are typically a million times smaller than rain drops. They are similar to the fog particles that sometimes bring traffic to a halt on the ground. How these cloud droplets, unlike fog, eventually group into larger raindrops is not known. Fortunately, the Creator by His laws directs the process of pleasant raindrop formation without fail.

HYDROLOGIC CYCLE King Solomon described the constant flow of rivers 3000 years ago:

> All streams flow into the sea, yet the sea is never full. To the place where the streams come from, there they return again. Ecclesiastes 1:7

The world has many essential interlocking cycles of energy flow. These include the movement of nitrogen, carbon, oxygen, water, and even rocks through the environment. The transfer of water from the earth's surface to the atmosphere, and back again, is called the hydrologic cycle. Figure 5 illustrates the process with some numerical estimates. Average world-wide precipitation is 80 cm/year. This moisture is put in the air by solar evaporation and also by transpiration. Plants carry out the latter step with their leaves and cool themselves in the process. Just one apple tree may transfer as much as 2,000 gallons of water into the air during a single six-month growing season. Once water is precipitated as rain or snow, it begins its movement back toward sea level. Along the way it carves the topography of our planet. Many canyons, valleys, and plains result from water erosion. On the land's surface the flow may be rapid. Underground water slowly percolates through soil and permeable rock. A rough estimate of the *average* time for a given molecule of water to move from the sea to the land and back again is 1000 years or more. Of course not all water participates in the active cycle. Fully two percent of earth's water supply remains locked in ice with only small glacial movement. This ice covers seven percent of the earth's land area, most of it in Antarctica. Figure 5 indicates that the quantity of moving underground water is seven times that of the surface flow. Rivers and lakes are impressive but most of water's activity is out of sight! This ground water provides the earth with a remarkable purification system and reservoir. As water slowly moves downward toward the saturated water table, cleansing by the breakdown and filtering of contaminants occurs. Millions of Americans pump water from home wells and consume it without a thought of its purity. Unfortunately this efficient ground water system is beginning to feel the effects of abuse. Poisoning of ground water and lowering of the water table may soon lead to a water crisis of far more significance than the energy shortage.

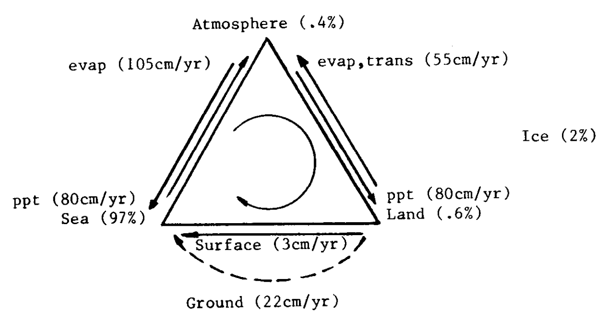


Figure 5. Diagram of the hydrologic cycle. Abbreviations: (evap), evaporation; (trans), transpiration; (ppt), precipitation; (cm/yr), centimeters of water per year. Distribution of the earth's water is shown by percentage.

The hydrologic cycle is driven by the sun's evaporation work. But beyond solar distillation it is the Creator that directly controls the weather. Job 37:13 even supplies three of His motives:

> He brings the clouds to punish men, or to water His earth and show His love.

First, storms may provide correction or discipline for men. From Noah to Jonah to Dunkirk, the Lord clearly commands nature to direct history. *Second,* varieties of weather are given for the good of the land. Precipitation, wind, lightning—each detail has its own purpose, of which our understanding is yet limited. Notice that it is ***His*** land that is watered; we are only stewards of the earth. *Third,* the Creator's mercy and love are clearly shown in the rain and in the rainbow. Even deadly storms, a sad consequence of the curse, have important lessons to teach us concerning our dependence on the Lord.

For 40 years meteorologists have tried to gain control of the hydrologic cycle by cloud seeding.[14] Dominion over the rain would indeed be an achievement, but we are still far from it. A 1978-81 study was done in Florida regarding the effects of cloud seeding with silver iodide crystals. Three million dollars later it was concluded that the total rainfall had not been increased at all! There were minor changes in the distribution of rainfall, but this only served to upset those neighbors whose rain had been "stolen!" It is certainly to our greater benefit that the hydrologic cycle has not come under man's control.

The Anthropic Principle

We have surveyed several of the unusual properties of water. Certainly these evidences point toward a beneficent and wise Creator. However such an argument is challenged in our day. Two full centuries have gone by since William Paley's argument that just as a watch requires a watchmaker, so a complex universe requires a Designer. Today, design or fitness for a purpose in living creatures is usually attributed to the mechanistic progress of mutation and natural selection. We may marvel at the complexity of the human eye, but we are told that such a sensitivity to electromagnetic radiation is an inevitable consequence of evolution! In truth, of course, the evolution argument in no way explains the origin of sight. And when inanimate objects are considered, the evolutionary argument does not even apply. After all, objects such as protons or water molecules cannot be expected to change or improve themselves with time.

The anthropic principle describes the experimental finding that the universe appears to be especially designed for man. Texts refer to "cosmic coincidences," the "delicate balance," and the "exceedingly improbable coincidences" observed in nature. The presence of abundant water on our planet is a good example, but one that is usually missed. Instead, small but intriguing details are studied. One such example involves the proton, a central component of the hydrogen atom, the water molecule, and every other material as well. The "delicate balance" involves the mass of the proton, which is slightly lighter than a neutron. A free neutron (n) spontaneously beta decays into a proton (p) and an electron (e) with a half-life of 12 minutes.

$$n \rightarrow p + e$$

n: 1.008665amu	p: 1.007276amu
	e: 0.000548amu
	sum: 1.007824amu

The atomic mass units (amu) of the particles are listed under the reaction equation. This neutron decay is possible because its rest mass is greater than that of the decay products. The net mass lost in the reaction turns into energy. Now what would be the consequence if the mass of the proton was 0.2 percent greater than it actually is? The previous reaction could not occur, and instead the proton would decay into a neutron, positron (e^+), and a massless neutrino (ν).

$$p \rightarrow n + e^+ + \nu$$

p: 1.009213amu	n: 1.008665amu
	e^+: 0.000548amu
	ν: 0.0
	sum: 1.009213amu

As a consequence, free neutrons would be stable but free protons could not exist. But a hydrogen atom is essentially a single proton. Hence there would be no hydrogen, a major component of water, as well as the major component of the sun, stars, and the entire universe! Thus a 0.2 percent change in the proton's mass would make the entire universe unstable. Now the finely-tuned mass values of protons and neutrons are either "cosmic coincidences" or else an evidence of the fingerprint of the Creator. There is no physical reason why the neutron is indeed heavier than the proton. In fact logic would say that the proton should be heavier. The particles themselves are very similar except that the proton carries an electric field. One would expect that the proton would be heavier by the amount of mass-energy required to establish the electric field.[15] But the opposite is fortunately the case. Literally hundreds of other unexpected numerical examples occur, including the nuclear force, fine structure constant, electron charge, etc.[16]

How does secular science deal with the anthropic principle? Is it a "Paley's watch" argument that cannot fail to turn men toward the Creator? Unfortunately, human minds remain totally blinded to the truth. Instead there is a retreat into the 300 year old philosophy of Leibnitz to find a way around the design evidence. It is thus boldly proposed by cosmologists that there are actually an infinite number of physical universes existing at this very moment. Within this plurality of universes, every possible variation in structure and history exists somewhere. It is concluded that we happen to live in one of the many universes where everything (water, proton mass, etc.) has "just happened" to work out to our benefit. If everything were *not* accidentally balanced, we could not exist to notice it. Thus the multiple miraculous coincidences of the anthropic principle are said to be inevitable! Such metaphysical meddling makes no scientific or common sense, either in Leibnitz's time or today. It does show the extremes to which some will go in denying a beautifully planned universe.

Conclusion

Water is important to our existence and is found to be delicately balanced in all of its physical properties for our benefit. The phrase "Water of Life" is also found in Revelation 22:17 with reference to salvation. How appropriate that water, the most mentioned natural resource in the Bible, should be used to symbolize the Creator's greatest gift to His creatures. Both are free; both are priceless. May this study help the reader worship the Creator and Giver of every good thing.

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ON THE IMPORTANCE OF PHILOSOPHY IN THE ORIGINS DEBATE

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Abstract

The importance of philosophy in the origins debate, in addition to empirical science, is underscored. This is done first by outlining some historically older philosophical issues in the areas of epistemology and ontology which allowed for the subsequent acceptance of modern-day evolutionism. Secondly, the effect of some of these views on thought in general and in relation to some aspects of biology, physics and origins in particular is examined. Finally, the nature of the origins debate and the limits of science are considered. It is concluded that the origins debate does involve questions of philosophy and that empirical science alone cannot resolve the issue.

Introduction

In the problem of ultimate origins, the correct evaluation and interpretation of the empirical data have played a major role. Creationists have repeatedly taken the evolutionists to task in their interpretations of physics, biology and geology. However, it should be equally clear that in any discussion of ultimate origins there is more involved than the data of the natural sciences. Questions dealing with the nature or definition of science, for example, clearly are not matters of scientific data and cannot be answered "scientifically." They are, rather, philosophical questions. While creationists have dealt with some of the philosophical aspects involved in the debate on ultimate origins, there is still room for both a more rigorous and consistent approach. It is therefore the burden of this paper to show the relevance of considering some basic philosophical issues, especially in examining (1) the epistemological and ontological views which in some respects have adumbrated the rise of modern evolutionism, (2) the problem of language and universals in relation to science and (3) the relation of science to origins studies.

The Epistemological/Ontological Problem

One of the major issues underlying the question of origins is the problem of epistemology, the theory of knowing. This is important because the evolutionist is capitalizing on a set of assumptions which gained ascendancy in the last century but had centuries earlier been articulated and promoted philosophically. Evolutionism is the terminal expression of a long, historical trend.

That trend begins philosophically with what Molnar calls the "God-problem." Historically there have been three positions possible regarding the existence of God and His relationship with man. The traditional Christian position holds that God is both personal and transcendent, an accessible, caring God. The two main opposing views include the position (A) that God exists but is distant or remote so as to be inaccessible. (This view can lead ultimately to agnosticism or atheism: God is so inaccessible as to be indistinguishable from non-existence.) A second opposing position (B) holds that God exists and is indistinguishable from man (and finally from nature). In position A the attempt is made to bridge the distance or remoteness between man and the "inaccessible" God by undergoing a process of growth whereby man becomes one with God. In position B it is already assumed that man partakes of the divine substance, at least he did originally, but that as a result of Creation, man has become alienated from God and from his own true self. Again a process is envisioned in which this alienation is overcome and man becomes reunited with God or the Godhead.[1]

These two positions have profound implications for the problem of how man acquires knowledge (epistemology) which arises out of the conditions of man's

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