Scientific Knowledge
Class Notes

Essay Questions

Use these essay questions to guide you in your study of Science as an area of knowledge in KI.

1. Discuss the view that scientific knowledge is the most important kind of knowledge for the progress of a society (2007 A Levels)
2. ‘The social sciences are not really sciences, because they do not construct their knowledge according to scientific methods.’ Discuss. (2008 A Levels)
3. Discuss critically the extent to which the investigator’s opinions and beliefs can influence enquiries in the field of either history or science. (2009 A Levels)
4. Science is the only field of human enquiry that can offer us explanations. (2010 A Levels)
5. The sciences are more successful than the humanities because they are based on empirical facts as opposed to opinions. Discuss. (2011 A Levels)
6. We cannot know about what cannot be falsified. Discuss. (2013 A Levels)
7. Can the sciences ever explain why people behave the way they do? (2014 A Levels)
8. Critically assess the claim that the sciences are the most important form of inquiry for learning about the world. (2015 A Levels)
9. ‘There are no significant differences between an inquiry into whether a painting is beautiful and an inquiry into the atomic composition of a molecule.’ Critically assess this view. (2016 A Levels)
10. ‘The value of natural science lies not in its truth but in its utility.’ Critically discuss this view. (2018 A Levels)
11. ‘Scientific knowledge is simply a matter of agreement among experts.’ Critically discuss this view. (2019 A Levels)
12. Assess the extent to which science gives us knowledge of the world. (2020 A Levels)
13. To what extent is scientific knowledge reliable? (Section B)
14. Compare the roles played by reasoning in Mathematics and Science. (Section B)
15. Does the Scientific Method make science reliable? (Section B)
16. ‘Mathematics is more reliable than Science.’ Discuss. (Section B)
17. Compare the roles played by reason and imagination in at least two areas of knowledge. (Section A)
18. If scientific knowledge is provisional, to what extent is it knowledge? (Section B)
19. Should we trust science to give us a complete understanding of the world? (Section B)
20. Science offers us certainty and objectivity. Discuss. (Section B)
21. As a means of knowledge acquisition, Science is a seriously flawed. Discuss. (Section B)
22. “We can believe in science because scientific knowledge is objectively acquired.” Compare the degree of objectivity between two different fields of science. (Section B)
23. “The notion of absolute truth is shown to be in poor correspondence with the actual development of science. Scientific truths are better regarded as relationships holding in some limited domain.” (David Bohm) To what extent do you agree? (Section B)

A) Nature & Construction of Science

The Scientific Method

Exercise: The Scientific Method Debate

Read the following 2 articles and make a summary of each of them in point form, making clear where the writers differ. Which point of view would you agree with?

Article 1: Introduction to the Scientific Method

I. The scientific method has four steps

1. Observation and description of a phenomenon or group of phenomena.

2. Formulation of an hypothesis to explain the phenomena. In physics, the hypothesis often takes the form of a causal mechanism or a mathematical relation.

3. Use of the hypothesis to predict the existence of other phenomena, or to predict quantitatively the results of new observations.

4. Performance of experimental tests of the predictions by several independent experimenters and properly performed experiments.

If the experiments bear out the hypothesis it may come to be regarded as a theory or law of nature (more on the concepts of hypothesis, model, theory and law below). If the experiments do not bear out the hypothesis, it must be rejected or modified. What is key in the description of the scientific method just given is the predictive power (the ability to get more out of the theory than you put in; see Barrow, 1991) of the hypothesis or theory, as tested by experiment. It is often said in science that theories can never be proved, only disproved. There is always the possibility that a new observation or a new experiment will conflict with a long-standing theory.

II. Testing hypotheses

As just stated, experimental tests may lead either to the confirmation of the hypothesis, or to the ruling out of the hypothesis. The scientific method requires that an hypothesis be ruled out or modified if its predictions are clearly and repeatedly incompatible with experimental tests. Further, no matter how elegant a theory is, its predictions must agree with experimental results if we are to believe that it is a valid description of nature. In physics, as in every experimental science, "experiment is supreme" and experimental verification of hypothetical predictions is absolutely necessary. Experiments may test the theory directly (for example, the observation of a new particle) or may test for consequences derived from the theory using mathematics and logic (the rate of a radioactive decay process requiring the existence of the new particle). Note that the necessity of experiment also implies that a theory must be testable. Theories which cannot be tested, because, for instance, they have no observable ramifications (such as, a particle whose characteristics make it unobservable), do not qualify as scientific theories.

If the predictions of a long-standing theory are found to be in disagreement with new experimental results, the theory may be discarded as a description of reality, but it may continue to be applicable within a limited range of measurable parameters. For example, the laws of classical mechanics (Newton's Laws) are valid only when the velocities of interest are much smaller than the speed of light (that is, in algebraic form, when $v/c << 1$). Since this is the domain of a large portion of human experience, the laws of classical mechanics are widely, usefully and correctly applied in a large range of technological and scientific problems. Yet in nature we observe a domain in which v/c is not small. The motions of objects in this domain, as well as motion in the "classical" domain, are accurately described through the equations of Einstein's theory of relativity. We believe, due to experimental tests, that relativistic theory provides a more general, and therefore more accurate, description of the principles governing our universe, than the earlier "classical" theory. Further, we find that the relativistic equations reduce to the classical equations in the limit $v/c << 1$. Similarly, classical physics is valid only at distances much larger than atomic scales ($x >> 10^{-8}$ m). A description which is valid at all length scales is given by the equations of quantum mechanics.

We are all familiar with theories which had to be discarded in the face of experimental evidence. In the field of astronomy, the earth-centered description of the planetary orbits was overthrown by the Copernican system, in which the sun was placed at the center of a series of concentric, circular planetary orbits. Later, this theory was modified, as measurements of the planets motions were found to be compatible with elliptical, not circular, orbits, and still later planetary motion was found to be derivable from Newton's laws.

Error in experiments have several sources. First, there is error intrinsic to instruments of measurement. Because this type of error has equal probability of producing a measurement higher or lower numerically than the "true" value, it is called random error. Second, there is non-random or systematic error, due to factors which bias the result in one direction. No measurement, and therefore no experiment, can be perfectly precise. At the same time, in science we have standard ways of estimating and in some cases reducing errors. Thus it is important to determine the accuracy of a particular measurement and, when stating quantitative results, to quote the measurement error. A measurement without a quoted error is meaningless. The comparison between experiment and theory is made within the context of experimental errors. Scientists ask, how many standard deviations are the results from the theoretical prediction? Have all sources of systematic and random errors been properly estimated? This is discussed in more detail in the appendix on *Error Analysis* and in Statistics Lab 1.

III. Common Mistakes in Applying the Scientific Method

As stated earlier, the scientific method attempts to minimize the influence of the scientist's bias on the outcome of an experiment. That is, when testing an hypothesis or a theory, the scientist may have a preference for one outcome or another, and it is important that this preference not bias the results or their interpretation. The most fundamental error is to mistake the hypothesis for an explanation of a phenomenon, without performing experimental tests. Sometimes "common sense" and "logic" tempt us into believing that no test is needed. There are numerous examples of this, dating from the Greek philosophers to the present day.

Another common mistake is to ignore or rule out data which do not support the hypothesis. Ideally, the experimenter is open to the possibility that the hypothesis is correct or incorrect. Sometimes, however, a scientist may have a strong belief that the hypothesis is true (or false), or feels internal or external pressure to get a specific result. In that case, there may be a psychological tendency to find "something wrong", such as systematic effects, with data which do not support the scientist's expectations, while data which do agree with those expectations may not be checked as carefully. The lesson is that all data must be handled in the same way.

Another common mistake arises from the failure to estimate quantitatively systematic errors (and all errors). There are many examples of discoveries which were missed by experimenters whose data contained a new phenomenon, but who explained it away as a systematic background. Conversely, there are many examples of alleged "new discoveries" which later proved to be due to systematic errors not accounted for by the "discoverers."

In a field where there is active experimentation and open communication among members of the scientific community, the biases of individuals or groups may cancel out, because experimental tests are repeated by different scientists who may have different biases. In addition, different types of experimental setups have different sources of systematic errors. Over a period spanning a variety of experimental tests (usually at least several years), a consensus develops in the community as to which experimental results have stood the test of time.

IV. Hypotheses, Models, Theories and Laws

In physics and other science disciplines, the words "hypothesis," "model," "theory" and "law" have different connotations in relation to the stage of acceptance or knowledge about a group of phenomena.

An hypothesis is a limited statement regarding cause and effect in specific situations; it also refers to our state of knowledge before experimental work has been performed and perhaps even before new phenomena have been predicted. To take an example from daily life, suppose you discover that your car will not start. You may say, "My car does not start because the battery is low." This is your first hypothesis. You may then check whether the lights were left on, or if the engine makes a particular sound when you turn the ignition key. You might actually check the voltage across the terminals of the battery. If you discover that the battery is not low, you might attempt another hypothesis ("The starter is broken"; "This is really not my car.")

The word model is reserved for situations when it is known that the hypothesis has at least limited validity. A often-cited example of this is the Bohr model of the atom, in which, in an analogy to the solar system, the electrons are described has moving in circular orbits around the nucleus. This is not an accurate depiction of what an atom "looks like," but the model succeeds in mathematically representing the energies (but not the correct angular momenta) of the quantum states of the electron in the simplest case, the hydrogen atom. Another example is Hook's Law (which should be called Hook's principle, or Hook's model), which states that the force exerted by a mass attached to a spring is proportional to the amount the spring is stretched. We know that this principle is only valid for small amounts of stretching. The "law" fails when the spring is stretched beyond its elastic limit (it can break). This principle, however, leads to the prediction of simple harmonic motion, and, as a model of the behavior of a spring, has been versatile in an extremely broad range of applications.

A scientific theory or law represents an hypothesis, or a group of related hypotheses, which has been confirmed through repeated experimental tests. Theories in physics are often formulated in terms of a few concepts and equations, which are identified with "laws of nature," suggesting their universal applicability. Accepted scientific theories and laws become part of our understanding of the universe and the basis for exploring less well-understood areas of knowledge. Theories are not easily discarded; new discoveries are first assumed to fit into the existing theoretical framework. It is only when, after repeated experimental tests, the new phenomenon cannot be accommodated that scientists seriously question the theory and attempt to modify it. The validity that we attach to scientific theories as representing realities of the physical world is to be contrasted with the facile invalidation implied by the expression, "It's only a theory." For example, it is unlikely that a person will step off a tall building on the assumption that they will not fall, because "Gravity is only a theory."

Changes in scientific thought and theories occur, of course, sometimes revolutionizing our view of the world (Kuhn, 1962). Again, the key force for change is the scientific method, and its emphasis on experiment.

V. Are there circumstances in which the Scientific Method is not applicable?

While the scientific method is necessary in developing scientific knowledge, it is also useful in everyday problem-solving. What do you do when your telephone doesn't work? Is the problem in the hand set, the cabling inside your house, the hookup outside, or in the workings of the phone company? The process you might go through to solve this problem could involve scientific thinking, and the results might contradict your initial expectations.

Like any good scientist, you may question the range of situations (outside of science) in which the scientific method may be applied. From what has been stated above, we determine that the scientific method works best in situations where one can isolate the phenomenon of interest, by eliminating or accounting for extraneous factors, and where one can repeatedly test the system under study after making limited, controlled changes in it.

There are, of course, circumstances when one cannot isolate the phenomena or when one cannot repeat the measurement over and over again. In such cases the results may depend in part on the history of a situation. This often occurs in social interactions between people. For example, when a lawyer makes arguments in front of a jury in court, she or he cannot try other approaches by repeating the trial over and over again in front of the same jury. In a new trial, the jury composition will be different. Even the same jury hearing a new set of arguments cannot be expected to forget what they heard before.

VI. Conclusion

The scientific method is intricately associated with science, the process of human inquiry that pervades the modern era on many levels. While the method appears simple and logical in description, there is perhaps no more complex question than that of knowing how we come to know things. In this introduction, we have emphasized that the scientific method distinguishes science from other forms of explanation because of its requirement of systematic experimentation. We have also tried to point out some of the criteria and practices developed by scientists to reduce the influence of individual or social bias on scientific findings.

Further Reading: Wilson, E. Bright. An Introduction to Scientific Research (McGraw-Hill, 1952). 2. Kuhn, Thomas. The Structure of Scientific Revolutions (Univ. of Chicago Press, 1962). 3. Barrow, John. Theories of Everything (Oxford Univ. Press, 1991).

Article 2: What is Science?

It continues to amaze me how many "educated" people do not understand what Science is or what is meant by the term "scientific method." The statements of Nobel Prize physicist Percy W. Bridgman[1] shows that such ignorance shows no regard for academic stature when he states, "No working scientist, when he plans an experiment in the laboratory, asks himself whether he is being properly scientific, nor is he interested in whatever method he may be using *as method.*" What arrogance![2]

But in order to realize whether this is a valid concept or not, we need to understand what Science really is. Here is a typical dictionary definition of Science: "The observation, identification, description, experimental investigation [scientific method], and theoretical explanation of phenomena. Such activities restricted to a class of natural phenomena. Such activities applied to an object of inquiry or study."[4]

Science on the other hand is an interesting definition in that it previously has applied to those fields of study which utilize the scientific method. For physics and chemistry, this is easy, but when we get into archeology, psychology, geology, environmental studies, and so on, the use of scientific methodology becomes less applicable but yet aren't these still Science? What about archeology where even though one can not perform repeatable experiments we can yet validate hypotheses?

Let's say that I am an archeologist and that I hypothesize that an ancient culture "X" existed based upon a piece of pottery that I had found and I further hypothesize various characteristics of this culture. Later it is found that I was correct in my hypothesis through continued validation from other findings. I then hypothesize that any culture that can make such pottery will have a high lead content in their remains. Again this is found to be true. These hypotheses have now become theories as they have been verified yet they did not follow the definition of scientific method nor could they. This is Science.

Some may say that in archeology, we use carbon-14 dating (or similar process) which does follow the scientific method. Though archeology does utilize some aspects of other sciences that do follow the scientific method, this is archeology's use of physics. It is the physics that is following the scientific method in this case, not archeology.

The scientific method is fine for experimentation but it is inadequate in determining what is Science. In the past if a discipline could not be subject to the scientific method, it was not Science. Therefore, I would like to propose that **the scientific method should only be applied to experimentation when appropriate and not be used in the determination of what is or is not science, nor should it have any application in defining what is a hypothesis, theory, fact, or law.****

In terms of the definition of what is or is not a Science, we need to find a definition that is timeless and few could argue against. One of the best way to understand the current definition of something is to look at its history (ignorance of the past will lead to mistakes of the future[5]) but I will leave that for a book on the subject because even though it is engrossing reading, it can get lengthy. I would like to propose that we define **Science as the "the field of study which attempts to describe and understand the nature of the universe in whole or part."*** Though simple, it is an encompassing and elegant definition, as we will see.

Therefore those fields of study which attempt to describe and understand the nature of the universe on a "whole" scale such as physics and chemistry would fit our definition but so would those fields which study it in "part" such as biology whose field has been limited to only those life forms on Earth. Archeology attempts to describe and understand the fossil and archeological record (a part of the universe) and this understanding includes what its function, purpose, state of existence, etc. was. The archeological example previously given also shows how a hypothesis, theory, and fact can develop in the field of archeology...all without using the scientific method.

Why do I think that it is important that we all be on the same page in our definition of Science?

- I am a stickler for being exact in our communications because if we do not have the same definitions then we can not communicate accurately and if we can not accurately communicate then we can not progress.
- By defining Science accurately, it is easy to see that scientific theory, fact, and law can be developed and verified totally outside the walls of the academic experimentalist and the scientific method.
- By knowing what academic disciplines are Sciences, we can better approach or attempt to describe and the universe in a more organized manner thereby maximizing the progress that mankind can make in developing his knowledge base.
- It shows us that hypothesis and theories are not the sole purview of the experimentalist with his/her scientific method.

It is only through the field of Theoretics that we can get a logical overview of Science from which we can all get on the same page and allow Science to progress in all of its facets.

Sources: http://www.angelfire.com/mn2/tisthammerw/science.html, http://www.isi.salford.ac.uk/dooy/physical.html

(3) Falsifiability in Science – Karl Popper

Reading: On Falsifiability

The passage below gives a fuller account of how Popper's requirement of falsifiability lends more credibility to science through the use of deductive logic.

The Problem of Demarcation

On this criterion of demarcation physics, chemistry, and (non-introspective) psychology, amongst others, are sciences, psychoanalysis is a pre-science (i.e. it undoubtedly contains useful and informative truths, but until such time as psychoanalytical theories can be formulated in such a manner as to be falsifiable, they will not attain the status of scientific theories), and astrology and phrenology are pseudo-sciences. Formally, then, Popper's theory of demarcation may be articulated as follows: where a 'basic statement' is to be understood as a particular observation-report, then we may say that a theory is scientific if and only if it divides the class of basic statements into the following two non-empty sub-classes: (a) the class of all those basic statements with which it is inconsistent, or which it prohibits - this is the class of its potential falsifiers (i.e. those statements which, if true, falsify the whole theory), and (b) the class of those basic statements with which it is consistent, or which it permits (i.e. those statements which, if true, corroborate it, or bear it out).

The Growth of Human Knowledge

For Popper accordingly, the growth of human knowledge proceeds from our problems and from our attempts to solve them. These attempts involve the formulation of theories which, if they are to explain anomalies which exist with respect to earlier theories, must go beyond existing knowledge and therefore require a leap of the imagination. For this reason, Popper places special emphasis on the role played by the independent creative imagination in the formulation of theory. The centrality and priority of problems in Popper's account of science is paramount, and it is this which leads him to characterise scientists as 'problem-solvers'. Further, since the scientist begins with problems rather than with observations or 'bare facts', Popper argues that the only logical technique which is an integral part of scientific method is that of the deductive testing of theories which are not themselves the product of any logical operation. In this deductive procedure conclusions are inferred from a tentative hypothesis. These conclusions are then compared with one another and with other relevant statements to determine whether they falsify or corroborate the hypothesis. Such conclusions are not directly compared with the facts, Popper stresses, simply because there are no 'pure' facts available; all observation-statements are theory-laden, and are as much a function of purely subjective factors (interests, expectations, wishes, etc.) as they are a function of what is objectively real.

How then does the deductive procedure work? Popper specifies four steps:

(a) The first is formal, a testing of the internal consistency of the theoretical system to see if it involves any contradictions.

(b) The second step is semi-formal, the axiomatising of the theory to distinguish between its empirical and its logical elements. In performing this step the scientist makes the logical form of the theory explicit. Failure to do this can lead to category-mistakes - the scientist ends up asking the wrong questions, and searches for empirical data where none are available. Most scientific theories contain analytic (i.e. a priori) and synthetic elements, and it is necessary to axiomatise them in order to distinguish the two clearly.

(c) The third step is the comparing of the new theory with existing ones to determine whether it constitutes an advance upon them. If it does not constitute such an advance, it will not be adopted. If, on the other hand, its explanatory success matches that of the existing theories, and additionally, it explains some hitherto anomalous phenomenon, or solves some hitherto unsolvable problems, it will be deemed to constitute an advance upon the existing theories, and will be adopted. Thus science involves theoretical progress. However, Popper stresses that we ascertain whether one theory is better than another by deductively testing both theories, rather than by induction. For this reason, he argues that a theory is deemed to be better than another if (while unfalsified) it has greater empirical content, and therefore greater predictive power than its rival. The classic illustration of this in physics was the replacement of Newton's theory of universal gravitation by Einstein's theory of relativity. This elucidates the nature of science as Popper sees it: at any given time there will be a number of conflicting theories or conjectures, some of which will explain more than others. The latter will consequently be provisionally adopted. In short, for Popper any theory X is better than a 'rival' theory Y if X has greater empirical content, and hence greater predictive power, than Y.

(d) The fourth and final step is the testing of a theory by the empirical application of the conclusions derived from it. If such conclusions are shown to be true, the theory is corroborated (but never verified). If the conclusion is shown to be false, then this is taken as a signal that the theory cannot be completely correct (logically the theory is falsified), and the scientist begins his quest for a better theory. He does not, however, abandon the present theory until such time as he has a better one to substitute for it. More precisely, the method of theory-testing is as follows: certain singular propositions are deduced from the new theory - these are predictions, and of special interest are those predictions which are 'risky' (in the sense of being intuitively implausible or of being startlingly novel) and experimentally testable. From amongst the latter the scientist next selects those which are not derivable from the current or existing theory - of particular importance are those which contradict the current or existing theory. He then seeks a decision as regards these and other derived statements by comparing them with the results of practical applications and experimentation. If the new predictions are borne out, then the new theory is corroborated (and the old one falsified), and is adopted as a working hypothesis. If the predictions are not borne out, then they falsify the theory from which they are derived. Thus Popper retains an element of empiricism: for him scientific method does involve making an appeal to experience. But unlike traditional empiricists, Popper holds that experience cannot determine theory (i.e. we do not argue or infer from observation to theory), it rather delimits it: it shows which theories are false, not which theories are true. Moreover, Popper also rejects the empiricist doctrine that empirical observations are, or can be, infallible, in view of the fact that they are themselves theory-laden.

The general picture of Popper's philosophy of science, then is this: Hume's philosophy demonstrates that there is a contradiction implicit in traditional empiricism, which holds both that all knowledge is derived from experience and that universal propositions (including scientific laws) are verifiable by reference to experience. The contradiction, which Hume himself saw clearly, derives from the attempt to show that, notwithstanding the open-ended nature of experience, scientific laws may be construed as empirical generalisations which are in some way finally confirmable by a 'positive' experience. Popper eliminates the contradiction by rejecting the first of these principles and removing the demand for empirical verification in favour of empirical falsification in the second. Scientific theories, for him, are not inductively inferred from experience, nor is scientific experimentation carried out with a view to verifying or finally establishing the truth of theories; rather, all knowledge is provisional, conjectural, hypothetical - we can never finally prove our scientific theories, we can merely (provisionally) confirm or (conclusively) refute them; hence at any given time we have to choose between the potentially infinite number of theories which will explain the set of phenomena under investigation. Faced with this choice, we can only eliminate those theories which are demonstrably false, and rationally choose between the remaining, unfalsified theories. Hence Popper's emphasis on the importance of the critical spirit to science - for him critical thinking is the very essence of rationality. For it is only by critical thought that we can eliminate false theories, and determine which of the remaining theories is the best available one, in the sense of possessing the highest level of explanatory force and predictive power. It is precisely this kind of critical thinking which is conspicuous by its absence in contemporary Marxism and in psychoanalysis.

Source: http://plato.stanford.edu/entries/popper/

B) History of Science

Brief History of Modern Science

Discovery in the Ptolemaic Era (2CE – 1500CE)

Taking after Aristotle's idea of cosmology and ideas in the Bible, philosophers observed and recorded the movement of the stars, planets and the sun around the earth in big circles. This confirmed Ptolemy's account of a geo-centric universe.

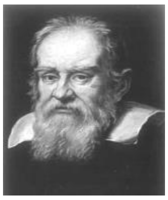
__Existing widely accepted views / theories__: solar system is geocentric; God made earth the centre of the universe; Bible's authority not to be doubted.

Discoveries in the Copernican Era (1500CE – 1600CE)

Copernicus found that the best way to explain the observed irregular orbits of the planets around the earth was if we didn't assume they revolved around the earth. In fact, if they revolved around the sun, their orbits would be mathematically easier to explain. He suggested that the earth, too, orbited around the sun and not the other way round.

But his idea faced intense resistance, particularly from the church.

Following up from Copernicus, Kepler used Brahe's data (from his observatory) to calculate that planets do not move in perfect circles but in ellipses. This challenged the church's view that all planets, because they were created by a perfect God, need to move in perfect circles. Kepler came up with three laws of planetary motion. These laws supported Copernicus' findings above.



Further support for Copernicus was lent by Galileo. His founding of the telescope allowed him to make amazing discoveries, like mountains on the moon, sun spots, etc, all of which contradicted Aristotle's ideas of cosmology.

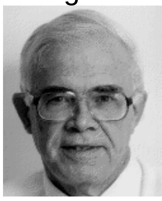
After such repeated confirmations, the scientific community started to change its mind about geo-centricity.

__Existing widely accepted views / theories__: solar system is geocentric; God made earth the centre of the universe; Bible's authority not to be doubted.

Discoveries in the Post-Copernican Era (1700CE – present)

Newton's Laws of motion and his theory of gravitation confirmed the Copernican model by explaining that it is gravity that keeps the planets moving in orbits around the sun.

In 2004, it made the news that a 10th large planet (tentatively called Quaoar or Sedna) was found circling the sun by Michael Brown, an American scientist. It is about 1,300km from Pluto. It was



first observed in the 1980s, but was only recently confirmed as an additional world in our solar system. Scientists had predicted that since the solar system revolved around the Sun, there should be a belt of objects called the Kuiper Belt made up of ice and rock that orbits the sun beyond Neptune. These objects are the necessary remnants of the debris that coalesced to form the Solar System 5 billion years ago. Brown confirmed this prediction when he found Sedna.

Existing widely accepted views / theories : solar system is heliocentric; earth and man not at centre of the universe; Science is powerful and can help us figure out the universe.

PMC 2006; BWT July 2006; GLKM Aug 2007
MK 2010, JJL 2023