UNIT 2 PHILOSOPHY OF SCIENCE AND OTHER DISCIPLINES

Contents

2.0 OBJECTIVES

As philosophy seems to be the foundation of every discipline, a deeper inquiry into any discipline takes us to the philosophical basics of that discipline. Sciences (natural and social) also have their own philosophical basics. This discipline philosophy of science is not an isolated inquiry, rather it is related to many other domains of inquiry. This short essay seeks to discuss some important aspects of the interactions of Philosophy of Science with *Epistemology* and *Metaphysics*. It also has a cursory look at its relationship with *Values* (Ethics) and *Feminism*, just to give an idea of the vastness and depth of the impact of philosophy of science upon various disciplines.

2.1 INTRODUCTION

Like any other human inquiry and knowledge enterprise, science also involves philosophical issues, like the goals of science, the nature of scientific knowledge and the foundations of science; 'What is Science?', itself is a philosophical question. Though science emerged from philosophy and philosophy is said to be the *mother* of all the disciplines, in course of time all disciplines came of age, and got separated from the mother. For instance, by the 3rd BC, Euclid's work made geometry a 'science of space', though philosophers taught this in Plato's Academy; till 17th century science was known as 'natural philosophy' and scientists were 'natural philosophers'. In fact, the term scientist was coined only 1833, by William Whewell, an English Philosopher and Historian of Science. With Darwin's *The Origin of Species* (1859) biology was cut off from philosophy; the beginning of 20th century saw the separation of psychology from philosophy. By the middle of the same century computer science hijacked logic that has been with philosophy for more than two thousand years. Science and philosophy, therefore, are not strangers to each other. In the ancient times, Aristotle and many other philosophers were also scientists. Significant philosophers, like Bacon, Descartes, Leibniz and Locke, were influenced by science and their contributions to science were also very significant. Great scientists of the 19th century, Maxwell,

Hertz and Helmholz, gave serious thought to the above mentioned philosophical issues. Poincare, a prominent mathematical physicist, came up with insights into the nature of theories and hypotheses, the notions of explanation and probability.

Some philosophical Issues in Science

i) To understand certain concepts adequately, science has to go beyond to the realm of philosophy. For instance, the concept of time cannot be defined in terms of hours / minutes of duration, as all these presuppose the notion of time;

ii) The relation between the scientific theory and the world out there – realistic or instrumental relationship?;

iii) How do the scientists switch over to the new theories? Is it completely based on logic and observations? Or is it through a social process, like Kuhn and other historicists would propose?

iv) Evidence is generally based on the assumption that there are 'pure' observations. But there seems to no 'theory-free' observation in science. Even to see the time now as 12 noon, assumes that the clock and observer exist independently of each other and not deluded by a Cartesian demon, and to accept all the theories with which the clock has been manufactured. This raises further questions: Is there any real epistemic distinction between observational and theoretical assertions? Is there any safe and sound basis for science?

v) What is the meaning of 'systematically basing' the theories on the evidence? Any theory, with its universal applicability, goes beyond the observable data at hand. Same observational data can yield too many theories, even contradicting ones (notion of Under-determination);

vi) What are the extra factors to be considered to decide upon the 'correct' theory? If simplicity and predictive power of theories are considered, are they only pragmatic considerations or some sort of truth-revealing indicators?

vii) Philosophical analyses of the aims, methods, assumptions, foundations, practices and achievements of science, are to be undertaken as specific sciences will not have time for such aspects;

viii) The study of the very language of science, the methods and the structures of explanation used in science; it checks the validity of arguments used in science;

ix) Exploration of the worldviews based on important scientific theories to uncover the preferences of scientists for deterministic rather than statistical laws, or for mechanistic rather than teleological explanations;

x) The investigations into the broader implication of science and to see how the socio-cultural factors affect the growth and the subject matter of science.

2.2 PHILOSOPHY OF SCIENCE AND EPISTEMOLOGY

Science aims at acquiring more knowledge about the world, by specific methods of observation and experimentation and it makes conclusions based on evidence. In philosophy also there is a branch, 'Epistemology', which deals with domains of knowledge. 'What is the difference between knowledge and mere beliefs?' 'Can one be sure that one can know at all? 'What are the things that one can know?' "What are the requirements for a proposition to be a piece of knowledge?' - are some of the questions that are crucial to both the disciplines. Science justifies its knowledge through specific method(s). However Hume already pointed out that the inductive reasoning, widely used in science, cannot be completely justified, as its conclusion involves claims about unknown elements. The ampliative inference – where the inference contains some factual content which has not been present in the premises – decides on something about the unexperienced, basing on the experienced. Science functions on many axioms, like the fundamental uniformity of nature, the future will resemble the past etc., which are known, *a posterori,* nor *a apriori*. Philosophy of science critiques the method used in science.

Scientific Methodology

The term 'Method' means 'a way to achieve an end' and the scientific method is way to achieve 'scientific ends', i.e. scientific knowledge [Greek terms, *meta* = after and *hodos* = way]. The basic steps of scientific methodology: i) *Stating the Problem* (success and progress of science greatly depends on the clear understanding of problem at hand); ii) *Framing a Hypothesis* (a tentative solution to the problem, based on one's creative and original imagination); iii) *Observing and Experimenting* (studying an event/phenomenon under varied conditions, controlled by the investigator, with or without instruments); iv) *Interpreting the Data* (making the resulting data – figures, pointer readings, graphical representations etc. – intelligible and useful, by means of analysis, synthesis, comparisons, analogies, models etc.); and v) *Drawing Conclusions and Inferences* (the aim of the whole process).

There are *Mental Devices* used in scientific methodology: i) Logic (the use of *induction,* to arrive at causal connections between events, and *deduction,* to arrive certain conclusion from the given premises; induction gives new information, but need not be certain, while deduction gives certain conclusion, but not new one); ii) *Classification* (to bring order into the multitude of complicated data); iii) Comparison and Analogy (especially useful in forming the hypothesis and in interpreting the data); iv) *Models* (a basic representation, from the known to the unknown); and v) *Mathematics* (a powerful device to make complicated concepts understandable).

Scientific Methods in the Modern Times: Though Aristotle in his *Prior Analytics* and *Posterior Analytics* used both the inductive and deductive reasoning, Francis Bacon, in his *Novum Organum* (1620) emphasized only the method of induction for scientific inquiry. But with the emergence of modern science (17^{th} – 19^{th} centuries) the need was felt to look for a new understanding of method of science and two predominant methods of science emerged: Inductivism and Hypotheism.

Inductivism	Hypotheism
i) The method of science is the method of induction.	i) The method of science is the method of hypothesis.
ii) Founder: Francis Bacon.	ii) Rene Descartes
iii) Rooted in Empiricism – (only those ideas that are traceable to sense experiences are to be treated as knowledge).	iii) Based on Rationalism – (At least some portion of human knowledge cannot be traced to, and thus, independent of sense experiences).
iv) Important features of science: Certainty and breadth. Science has to look for definite knowledge and more encompassing knowledge about reality.	iv) Novelty and Depth. Science has to go beyond the observational; it has to reach the depth of reality of unobservables, behind the observed.
v) Since science has to be certain, it has to limit itself only to the observable phenomena; then proceeds from particulars to general conclusions through induction. Science must remain from the beginning till the end at the level of observation; so there is no reference to unobservables.	v) Mere generalization in terms of observations is not enough; science has to explain the observable in terms of the unobservables.
vi) The aim of science: to arrive at laws, (i.e. established inductive generalizations).	vi) To generate hypotheses to explain what we observe. [Hypothesis meant 'a statement regarding unobservable entities & process. Today it means 'a tentative solution to a problem'].
vii) Inductivists are antirealists; they hold that the theoretical terms don't refer to anything real; as empiricists for them only observed reality is real and nothing outside exists; they are only useful tools.	vii) Hypothesists are realists; theoretical terms (like electrons, protons etc.) refer to really existing entities, though they are not given to us in observations.

By the middle of the 19th century science had to deal with many unobservable entities or process (e.g. Franklin's fluid theory of electricity, Vibratory theory of heat, Phlogiston theory of burning and neurophysiological theories of David Hartley etc.), which took science beyond observational methods of inductivism. Within philosophy too there were objections to show that there was no rational justification for induction.

Problems of Inductive Reasoning

Inductive reasoning is common-sensical and highly successful in sciences and practical lives. However, Hume astutely argued in his *Treatise of Human Nature*

(1739) that there is no logical justification for the principle of induction. N.R. Hanson points out the actual problem with the inductive thinking: "It is the problem of showing how 'The Inductive Principle'… can at once be synthetic (in that its negation is not demonstrably self-contradictory), yet necessary (in that its negation describes no intelligible state of affairs at all)" (1971, 248). *The decisive problem* with induction is that to justify induction we need to involve inductive reasoning itself; it can be illustrated as follows: The principle of induction worked successfully on occasion n_1, n_2, n_3….n_x. Therefore the principle of induction always works.

In the past few decades a number of solutions have been propose in order to defend the inductive reasoning: Reichenbach (*Experience and Prediction,* 1938 and *The Theory of Probability*, 1945) is satisfied with a pragmatic justification; Nelson Goodman replaced Hume's old problem of induction with the new problem of induction; Kant offered a transcendental deduction of a principle of universal causation; P. F. Strawson offered an ordinary language dissolution, and thereby making Hume's problem is only a pseudo-problem; Carnap appealed to 'inductive intuition'. (For analyses of all these proposed solutions, see: Wesley Salmon, 1967). Popper (1935, *Logic of Scientific Discovery*) did away with the need for induction in science, because science adopts hypothetico-deductive method. [*Note*: For explanation of this method, kindly see: Block 2, Unit 2: *Historicism*].

Bayesian Theory of Probability - A Reasonable Solution: Bayesian theorem, proposed by Thomas Bayes (an English non-conformist clergyman, a renowned mathematician, a fellow of the Royal Society, lived between 1702-61) is an attempt to supply rational basis for inductive reasoning in science. The degree of certainty of the conclusion of an experiment is measured by the probability of the conclusion. By probability Bayes meant "a rational acceptance: The probability of any event is the ratio between the value at which an expectation depending on the happening of an event ought to be computed, and the value of the thing expected upon it's happening" (1763, 376, as quoted by Barry Gower, 1997, 96). Salmon lists five leading philosophers, Carnap, Reichenbach, L. J. Salvage, Nelson Goodman and Popper, who show inclinations towards the Bayesian theorem, directly or indirectly (Wesley Salmon, 2002, 397-99). Howson and Urbach explain the Bayseian confirmation in simple terms. The relationship between the empirical data (evidence) and the hypothesis is crucial, because it helps in accepting or rejecting a hypothesis. A piece of evidence can be confirming or undermining or neutral to the hypothesis under the test: Say, h – hypothesis; e – evidence, P(h) – the prior probability, and P(h|e) – the posterior probability; e confirms h, if P(h|e) > P(h); and e disconfirms h, if P(h|e) < P(h); i.e. if the posterior probability is more the evidence confirms the hypothesis and vice versa. When the confirmation is at maximum, P(e|h) = 1 and then h logically entails e. When the disconfirmation is at maximum, P(e|h) = 0 and then h is refuted. No further evidence will confirm it, unless the refuting evidence or part of background knowledge is revoked. Posterior probability depends on prior probability but this dependence is related to the scientists' attitude towards *ad hoc* hypothesis; their preferences with regard to simpler hypotheses and their decision with regard to the credibility of the hypothesis. The authors are, in fact, very optimistic that "Bayesian approach is the only one capable of representing faithfully the basic principles of scientific reasoning" (Colin Howson and Peter Urbach, 1993, 2).

The *most basic objection* to the Bayesian approach is that it gives importance to subjective factors in the scientific appraisal. For instance, Lakatos claims that the states of mind, like one's beliefs, commitments, understanding etc. of the psychological approaches don't affect the cognitive value of a scientific value of a theory, which is actually "independent of the human mind, which creates it or understands it, its scientific value depends only on what objective support these conjectures have in facts" (Lakatos, 1978, 1). But the admirers of Bayesian reasoning seem to suggest that the so-called 'objectivists' of scientific methodologies deliberately close their eyes towards the indispensable subjectivist elements in the scientific reasoning. That is why a leading proponent I.J. Good argued persuasively that "the subjectivist (i.e. Bayesian) states his judgments, whereas the objectivist sweeps them under the carpet by calling assumptions knowledge, and he basks in the glorious objectivity of science'' (http://www.cs.ubc.ca/~murphyk/Bayes/bayesrule.html). Given the scenario, Howson is confident that "Eventually we shall all be subjective Bayesians" (Howson, 1991, 82). [For more on the objections against probabilists and Bayesians, kindly see: Karl Popper and D. Miller, 1984, 434].

Finally, conclusiveness always escapes us in inductive reasoning. Nevertheless, it need not make us nervous or skeptic towards the whole enterprise of inductive reasoning. Though we can always reject what has been inductively arrived at, we can still consider it as valid reasoning, "since they have as little chance in fact of going wrong" (Mellor, 1989, 7.). It seems to be reasonable to accept inductive reasoning as a species by itself.

Check Your Progress I

Note: Use the space provided for your answers.

1) Comment on the need and relevance of Philosophy of Science for other intellectual inquiries?

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2) What is a scientific method? Discuss the methods of modern science.

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3) What is the problem with inductive reasoning? Can it be convincingly solved or conveniently ignored?

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2.3 PHILOSOPHY OF SCIENCE AND METAPHYSICS

When science comes out with theories, especially about the unobservables, a crucial question can be raised: Do they portray the world as it is or are they only a convenient tool to understand the natural phenomena? Science not only describes, but also explains how and why a phenomenon takes place. By explaining the fundamental nature of things, about its existence, about its causation etc, science enters the domain of metaphysics. We focus only on these two aspects of *realism* and *causality* here.

Scientific Realism and Anti-realism

The question of realism and anti-realism arises in the context of the unobservable entities, like, viruses, radio waves, electrons, quarks, genes, atoms and sub-atomic particles, blackholes, etc. Though they are not observable science is able to acquire knowledge about their nature, behaviour, constituents etc. 20th century physics gives a picture of reality that is more abstract and far-removed from common sense. At this juncture, the question of justifying the ontological status of these unobservable entities arises very strongly. There are two opposing trends in philosophy of science with regard to the existence of unobservable entities: *Scientific Realism* and *Scientific Anti-realism*, where the former claims that the unobservables really exist, and the latter denies it.

The Basic Claims of Scientific Realism

i) Unobservable entities exist; ii) They exist independent of our minds; iii) We do make statements about them, with truth-value; iv) These statements are true or false, depending on how the world is, and v) We must believe in their existence and consider much of them as knowledge. For instance, the kinetic theory of gases speaks about the molecules in random motion, because that is what happens in a gas. Thus, they demand three kinds of philosophical commitments: *metaphysical* (mind-independent existence), *semantic* (literal interpretation of the theories and the correspondence theory of truth) and *epistemological* (the unobservable entities do exist and they count as knowledge).

The Basic Claims of Scientific Antirealism

i) Only what is empirically observed does exist, and all the other so-called unobservable entities don't. [*Note*: Most of the antirealists, though they deny the real existence of such entities, yet they agree that science is the most rational enterprise, because of its practical success and growth in accumulation of knowledge. So the issues of 'rationality in science' and 'realistic view of science' are different]; ii) The unobservable entities are only useful instruments to make calculations simpler or predictions more feasible, and the description about them are not true reflections of the state of affairs in the world. There are *different types of anti-realists* in science. To be an anti-realist it is sufficient to disagree with anyone of the above-mentioned five claims of the realists. [Sceptics deny (i), reductive empiricists deny (iii), Social constructivists, like Kuhn, deny (ii), constructive empiricists, like Bas van Fraassen, deny (v) and they are also unsure of (i)].

The Major Groups among the Anti-realists

Instrumentalism: i) Scientific theories don't describe the world, rather they are tools to approach the world and to relate a set of observable states of affairs with other sets; ii) Theories about the unobservable entities are not to be taken literally as they are only logical constructs used as useful instruments to relate with the external world; iii) Theories are judged in terms of their efficiency and usefulness, and not in terms of truth / falsity; iv) Since theories are only instruments they don't have predictive powers; b) *Conventionalism*: i) Scientific theories are only conventions; ii) The theoretical entities don't exist as nothing beyond observational reality exists; iii) The concepts used in a theory, say, 'force' and 'mass' in the Newtonian theories, are mere conventions; however they are empirically significant and useful to explain the world of facts. c**)** *Descriptionism*: The theoretical claims of the unobservable entities are only convenient descriptions of reality, as they don't refer to anything that actually exists.

Remarks

The debates between realists and antirealists seem to go for ever; For, antirealists have to explain how scientific theories, if they are just convenient tools to deal with reality, produce practical successes; on the other hand, realists have to deal with the problems with the theory-ladennes of observation and the fact the whole enterprise of science is increasingly seen as a product of psycho-social and cultural milieu of a given time. [More arguments against 'pure' observations will be given in *Historicism* (Unit 2 of Black 2]. ii) All observational terms are theoretical constructs to a certain extent. Stars, planets, light rays, gases etc. acquire their meaning, to some extent, only from the theoretical contexts in which they occur. For example, instrumentalists argue that only the billiard balls are observable and real, while the force and friction that exist among them are only tools, invented by physicists to understand certain physical phenomena. But one needs to realize that the concept of a billiard ball also involves some theoretical constructs like individuality, rigidity, made of a particular substance etc., without which we cannot speak of those balls. iii) Realists argue that unless we assume the unobservables really exist, how can one justify the efforts of the contemporary scientists to unify various kinds of theories and to arrive at one theory of everything (TOE)? However, instrumentalists would reply that the efforts to unify theories are still worth the trouble, because the scientific community will arrive at one 'big' and 'unified' instrument to deal with nature. Some of them may deny the very effort of unifying as baseless, as science is only a assortment of various tools to deal with variety of problems (Nancy Cartwright,1983). iv) Further, the predictive feature of science gives science a distinguishing characteristic for science and this feature is possible only when science treats theories as true descriptions of reality. v) Given these circumstances, there are authors coming up with nuanced understanding of realism, as instrumentalism seems to have more problems than realism. [e.g. **'***Unrepresentative Realism'* by A. F. Chalmers, in *What is This Thing Called Science?*, 1992): It is realism, because we need to assume the independent existence of reality and acknowledge the practical and predictive power of scientific theories. It is *unrepresentative*, because it does not involve correspondence theory of truth between theories and the reality out there].

Causality and Science

One of the significant aims of science is to explain events or phenomena in terms of natural laws or cause-effect relationships. A natural law is expected to

have authenticity, a measure of certainty and it must be universal (i.e. reliable in all situations, at all the times). For example, Newton's theory of gravitation is true at all times. Accidents (unlike laws) don't have predictive power.

Cause-Effect Relationship

How causes are related to effects is of philosophical interest: *a) Logical Necessity:* Causes necessitate some events that are effects. As causes are sufficient for their effects, the relation of causal necessity between particular events makes one *an inevitable consequence* of another. Due to the inherent connection between the cause and its effect, the effect must happen whenever and wherever the cause exists. If laws are universally valid there must be necessary relationship between the phenomena; thus, when one heats the water, it not only normally evaporates but it must evaporate. *b) Constant Conjunction* (Hume): There is no logical justification for any necessary connection but only "constant conjunctions" (exceptionless regularities) between cause and effect. As we are conditioned by these regularities in our experiences, we form an idea of causal necessity and mistakenly think that second billiard ball not only *will*, but also *must*, move when the first ball strikes it. The idea of necessary connection between them is only a psychological expectation and nothing is based on sense impression. Since any cause is perfectly separable in our mind from their effects, we can imagine any cause (without any absurdity) without its accustomed effect or even with effect with which never accompanies. Only from my experience I learn that when water is heated it boils, instead of freezing; but there is nothing tells me that the latter *cannot* happen. Therefore, since anything might cause anything, an effect cannot be inferred from a cause; both are conjoined, and not connected. *c) Empirical Necessity:* The cause-effect relationship is only *a hypothetical or conditional* necessity, given a set of natural laws. Boiling of water on heating is just a consequence of the law of nature. If there were different sets of laws the effects could have been very different. Such an empirical analysis looks at causation**,** *not in terms of what can and cannot happen, not in terms of what is and what is not possible, but solely in terms of what does happen.*

Remarks

a) Problems with the Hume's notion of *constant conjunction*: i) Basing on this one cannot distinguish *genuine causal* relations and *accidental conjunctions*. Not all constant conjunctions can be taken as causal relationships. (E.g. "Whenever the Minister visits my town it rains". Even if this statement is always true, the visit of the Minister cannot be the cause for the rain. ii) In the Humean understanding the direction of causation cannot be figured out, since constant conjunction has only a relationship of symmetry, whereas the causation is the one of asymmetry. iii) Does the constant conjunction mean that sometimes the causes don't result in the effects? It is only a probablisitic causation?

b) Problem with Hume's notion *similarity*: Events similar to *A* are always followed by things similar to *B*. The idea of 'similarity' is not clear - Is it exactly similar? If so, the only thing exactly similar to an event is that event itself, and it cannot be reproduced exactly, because at least the space-time factors will differ; or is it 'more-or-less' similar? Humeans claimed that the similarity must be in certain crucial and relevant respects. But what is the basis to decide upon the relevance? If they claim that only those changes

which are similar in relevant respects are always followed by other changes which are similar relevant respects, then their analysis of the causal relationship becomes tautological; for it just says that *those changes that are similar in the respects that causally connect them with their effects have similar effects*.

c) Since the concept cause is indispensable not only in our practical lives but also in sciences, there are efforts by philosophers, like D.M. Armstrong, Fred Dretske, Tooley in the late 1970s, to propose some sort of clear notion of necessitation in causal relationships; for *necessitation implies constant conjunction but not conversely*. This necessitation, of course, is not known *a priori*, rather what necessitates is an empirical matter, known by *a posteriori* inspection.

Check Your Progress II

Note: Use the space provided for your answers.

1) Discuss some of the areas where Metaphysics and scientific inquiries come together?

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2) What is more appealing and reasonable: Scientific realism or Scientific anti-relism? Substantiate your position.

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2.4 FEMINIST ACCOUNTS OF SCIENCE

In the recent years, Feminists, Sociologists of Knowledge and Postmodernists criticize science from various angles. From the early 1970s feminism began critiquing science. The research on the gender bias in the fields of science is highly complex and multi-faceted; it includes issues like the research on the presence of women doing hard-core science, the ill-treatments done to them in the scientific circles, the gender partiality exhibited in the content, methodology and epistemology of science, the selection of the problem for scientific investigations, especially in the fields of biology and health sciences, the decisions and policies drafted by the males, and so on. Feminists point out that scientific researches are gender-biased, for instance medical researches use only the males of any species for their study.

Feminist accounts of science, not only reveal the gender bias in theories, practices and assumptions of science, but also most of them go further to show how this androcentric prejudices shape the very notion of rationality, objectivity and scientificity. They substantiate their claims with case studies that there have been systematic omissions or distortions of women / gender issues, which have resulted in faulty conclusions. Case studies show that even contradicting claims are given in order to claim the superiority of the males, in terms of smartness, intelligence and physical robustness. To argue for the natural tendency for women to have subordinate role in the society and family, as Fausto-Sterling maintains, some evidence is consistently not considered, some questions are never raised, some hypotheses are ignored and some experimental controls are never instituted (Okruhlik, 2001). Feminist critiques point out the gender bias of Darwin in his theory that evolutionary development exclusively belongs to males, the hunter-gatherers'. This androcentric bias serves as an auxiliary theory in other disciplines, like Anthropology, to justify the behaviours and social roles of the males. Similarly, Francis Bacon made use of gender metaphors to refer to nature. He saw nature as female, as a wild and uncontrollable female to be restrained and controlled. Feminists argue that a dualistic and detached pursuit of science to study nature should be removed in order to save women from male domination. Even the scientific revolution of the modern science is seen as the reflection of gender ideology, whereby the mechanistic world view looked at the earth and nature as something to be dominated and controlled by humans.

Women's experience and women's epistemology must be taken into consideration in order to have a holistic picture of science. In a reconstructed feminist epistemology of science, according to Anne M. Clifford, "the scientist is not an impersonal authority standing above nature and human concerns, but a person whose thought and feelings, logical capacitates and institutions are all relevant and involved in the process of enquiry" (Clifford, 1992, 77). They argue that the gender does influence the investigations and the conclusions arrived thereupon; they even that feminists can point out the bias in the masculinist science and even produce better science (Harding, 1986, and 1991). Wendey Kohli points out that reason and reasoning need to be addressed historically within the context of gender differences; for centuries down the history masculinity and reason have been treated as synonyms, making feminine inferior, and even subservient to masculine rationality (Fleming, 1992 and Lloyd, 1995).

All are not ready to buy the arguments of the feminists. Some don't see even theoretical possibility of feminist critique, while Ronald Giere (1998) argues for such possibility. Feminists' convictions that women can produce better science and 'feminist epistemology' is privileged are challenged by many critiques. Cassandra Pinnick (1999) for instance does not find any evidence to support such convictions. Though the feminists may exaggerate, there must be, I think, some grains of truth in their claims. For, the traditional understanding of rationality seems to have not paid attention to non-cognitive elements of thoughts and feelings. The rational mind of men and the intuitive mind of women need to be in collaboration with each other for the betterment of humanity; this distinction reveals the complementary nature, not superiority-inferiority divide, between men and women. If women are also involved in the important decisions and policy-making we can certainly expect a better 'human touch' in all those policies. For instance, it is a painful irony to see in India that while we produce millions of surplus food-grains, there are thousands of starvation deaths every year. If

women are involved more and more in the administration and decision-making process, I strongly believe, that, with their intuitive and maternal touch, they will not easily tolerate the wastage of food-grains and the starvation deaths. With their in-born quality of dividing the stuff among the children lovingly and equally, they will certainly bring down, if not totally eradicate, the hunger deaths on the streets.

2.5 VALUES AND SCIENCE

For the Greeks, the pioneers of the Western thought and culture, there was no significant distinction between science (knowledge) and values (good), science and philosophy, objective and subjective and factual (descriptive) and normative (evaluative). The problem arises with the mechanical view of nature (or Newtonian science). The epistemological and methodological revolution in science and philosophy, initiated by Descartes, insisted upon a sharp distinction between objective and subjective dimensions in the knowledge-seeking enterprise. Since science is said to be rational and objective, factual and experimental, values are beyond the purview of science. However, such value-neutral approach of science is strongly challenged today by philosophers of science, sociologists, historicists, humanists, and even by scientists themselves. For instance, the very fact that there are goals in science shows the need of value- consideration. Science involves several types of goals: i) *Epistemic goals* (e.g. advancing human knowledge with explanations and predictions; teaching science to next generations ...); ii) *practical goals* (e.g. increasing technological power, improving standards of life ...); iii) *Goals of scientists* (their personal interests for name, fame, money ...); Personal goals *at their personal level* (openness, freedom, readiness to take risks, social responsibility, mutual respect, efficiency ...), *at the level of scientific publications* (objectivity in publication, intellectual properties...), *at the level of personal relations among those involved in science* (mentor-mentee relationship, harassment, reporting misconduct in science, sharing & preserving resources) and so on. Thus, the need to discuss the role of value judgments and ethical considerations in science has become more crucial and urgent with the uncontrollable explosion of war technology, ecological degradation and the bio-ethical issues arising from bio-sciences of the 20th century.

Value-neutrality of Science is usually based on two factors: a) *Fact-value dichotomy*: Science is for what 'is', not what 'ought to be'; science can only describe, not prescribe (Perera, 2005). But now it is realized that both facts and values are thoroughly interdependent. There does not seem to be any significant difference between the so-called scientific values, like justification, coherence, truth etc., and moral or aesthetic values (Putnam, 1982). Truth is considered as a scientific value, but relevance, interests and significance of such truths in the social contexts are also equally important scientific values. The latter may be called as extra-scientific values, but they are also equally important. To remove these value-considerations from a scientist is to remove his / her humanity as well. One cannot suppress his/her value judgment unless one is ready to destroy him/her as a human being and as a scientist. Scientists are not seeking for merely objective truths, knowledge, but truths that are interesting, useful and valuable to humanity as a whole. Therefore, knowledge, truth, objectivity and so on are rooted in values and human purposes; b) *Skeptical attitude*: Skepticism abhors authoritarianism and orthodoxy, subjecting everything to a severe scrutiny. It

demands openness to check whether one is misguided or not. It is a part of rationality in science. However, consistent and absolute skepticism is not possible, even in science. One needs to be reasonable in being skeptic. Riniold and Nisbet argue that *no one is consistently skeptic but only selectively skeptic*, due to our built-in biases. Even hard core sceptics, therefore, become the *victims* of i) *Confirmation bias* (the tendency to look for evidence that is consistent with our beliefs); ii) *Biased assimilation* (bias in assimilating information that suits our belief system); and iii) *Belief perseverance* (the tendency not to give up a long-cherished belief, though there is pressing evidence against them). (Riniolo and Nisbet, 2007, 50-51).

Moral considerations of science and the social responsibilities of science and scientists are no more at the periphery of philosophy of science but they take the centre-stage. Science does not develop in a void. Technological revolution is not a non-social concept. Therefore, "It would be highly irrational to overestimate the powers at the disposal of science and the scientists in the humanization of advances in science and technology. It is still less rational, in fact, irresponsible, to ignore the active socio-ethical humanistic stand taken by the scientific community" (Froov and Yudin, 1989, 352-3). As long as scientists are humans, who are part and parcel of human society, scientists are bound by, at least, certain final values. One such value demands science to enhance and enrich humanity and alleviate its sufferings and the damage to the environment.

Check Your Progress III

Note: Use the space provided for your answers.

1) "Gender-issues in science is a pseudo problem; it is a waste of time to engage in such meaningless quibbles" – Do you agree with this claim? Substantiate your position.

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2) "Science cannot, and should not, be confused with moral issues, as it is objective and rational" - Give your comments.

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2.6 LET US SUM UP

Philosophy of Science deals with the philosophical issues of science. It critiques, among many other tasks, the methods and assumptions of science. Philosophy of science as a discipline is related with many other disciplines. We have focused in this essay a few of them: i) since science aims at acquiring knowledge, it is related with *Epistemology*, a branch of philosophy that deals with the nature and validity of knowledge enterprise; ii) since science is particular about revealing the *true* nature of reality it is related with *Metaphysics*, a branch of philosophy that focuses on the issues of reality; iii) since science is *by* humans and *for* humans and it is essentially a social enterprise, all that affects human society becomes a serious concern for science, including moral and environmental issues.

2.7 KEY WORDS

Inductive Reasoning **:** It is a process of inferring conclusions about unknown phenomena based on the known individual instances. It assumes "the uniformity of nature", and that "the future will resemble the past".

Scientific Realism and Anti-realism **:** Trends in of philosophy of science that deals with issues of actual existence of the theoretical entities and that of the reality independent of the observers as postulated by scientific theories.

The Principle of Causality **:** It demonstrates the relation between causes and effect. This philosophical concept has serious implications for science.

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