Knowledge and Inquiry

Questions / *Parallels* / **Main Ideas**	Notes

Science: Its Validity and Function

Readings used so udh to read stufs

1. Bacon's Idols of the Mind

Science began with ATTEMPTS TO EXPLAIN NATURAL PHENOMENA through CAUSE AND EFFECT with Philosophers such as...

State 2 Significant Paradigm Shifts and what they suggest

State Aristotle's' 4 Causes

Thales

- Theory: Everything is made out of Water
  - Water changes with temperature: Rock → Water → Air
  - Plants: Appear after Rain → Another form of Water
  - All living things require Water
  - All Land ends at Water: The whole Earth is Floating on Water
    - Has Emerged from Water
    - Constituted of Water

Aristotle

- Causality: Aristotle's 4 Causes (with the e.g. of the Statue of Liberty)
  - Material: The **Materials** x is Composed of
    - E.g. Copper, Iron etc
  - Efficient: Preceding force that **pushes x into Existence**
    - Construction Workers, Soldering, Hammering
    - What brings the Materials together
  - Formal: Form, **Function or Essence** of x; what it does when it is **Flourishing**
    - Lady Liberty
    - Potential that can be Actualised > Conscious Choice
  - Final: What x exist "for the sake of"; the **ultimate purpose**
    - Celebrate Freedom
    - Subjective
- Aimed to come up with Consistent Definition of Something //Ship of Theseus
  - In rejection of Materialism: That everything consists Solely of Matter
  - Find Essential and Accidental Properties: What is needed to make something something?

//Aristotle & Thales: Trying to prove that x is made of y

Archimedes

- Testing the Purity of Gold through its Density
  - Practical Science

Claudius Ptolemy

- Astronomy
- Ptolemaic System: Geocentric; with Earth as the Centre of System of Planets
  - By observation

Nicolaus Copernicus

- Heliocentric System: Sun as the Center

Paradigm Shift: Copernican Revolution

- Change from Geocentric to Heliocentric System → Science depends on Coherence > Correspondence, but is affected by Correspondent Truths
- Change from believing that humans were created by God to Darwin's theory of evolution: humans were descended from apes
- //Fallibilism: Finds Better and Better Perceptions of Reality > Finds Correspondent Reality

Galileo

- Tradition in Religion vs Science: Trial due to Heliocentric Beliefs

Isaac Newton

- Clockwork Universe Model: Determinism; the Idea that Humans have no Free Will

Albert Einstein

- Theory of Relativity: Causal and Absolute → Causal and Relativistic; Newtonian Laws are the same in every inertial reference frame (what an observer considers to be at rest)
  - Laws of Physics behave differently in the reference frame of car going at a constant speed and reference frame of a car stopping
  - Explanation: https://curiosity.com/videos/breakthrough-junior-challenge-some-cool-ways-of-looking-at-the-special-theory-of-relativity-ryan-chester

Quantum Mechanics

- Planck
- Bohr
- Heisenberg Uncertainty: Observation affects Observed particle's position/velocity

With the Context of Science we can now explore Various QUALITIES OF SCIENCE to DESCRIBE WHAT SCIENTISTS DO

State the 3 Steps of Science in the Simplistic Baconian View

State the Theory-Based Paradox that undermines the Baconian View

State the 5 other problems with the Baconian View of Science

Qualities

- A Mode of Human Activity
- Body of Conceptual/Theoretical Knowledge
- Search for Universal Laws
- Methodology
- Cause & Effect

Google's Definition: The intellectual and practical activity encompassing the systematic study of the structure and behaviour of the physical and natural world through observation and experiment.

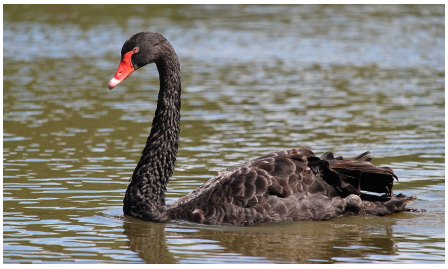
Baconian View

- Simplistic Definition
- Method:

1. Accumulate Observations
2. Infer General Law to Fit Observations
3. Conduct Experiments to Prove General Law (Possible but not necessary)

Problems

- Inferred General Law Shapes evidence-gathering: **Confirmation Bias** upon noticing Pattern will lead Scientist to **find Examples fitting his specific Pattern**
- If no **General Law** is Postulated: **No Method to Guide Observations**
    - Even if one chooses to Observe Everything that occurs Without a postulation: Nothing to Guide him on what to Observe



Problem of Induction: Highlights lack of Justification for

1. Generalising a rule based on specific observations given that our observations may simply be limited
    a. "All Swans are White" given observed white swans before the discovery of black Swans
2. Uniformity of Nature: Presupposing that events in the future will occur as they have in the past
    a. Circular argument: Laws of physics will hold as they have always held in the past
3. Causal Connections: Induction from sense experience to find causal connections (A causes B; Fire causes one to feel heat when one's hand is nearby) comes from identifying a **constant conjunction** (of instances of fire and instances of heat) from which it is unjustified to claim that there is a causal connection
4. Numerous Different generalisations can be made by induction with same data

<table>
<tr>
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<td>
<ol type="a">
Analogy of Grue: Something is Grue if it has been observed at time t and it is green, or it is not observed yet at time t and it is blue
Premise 1: Observed Emeralds are Grue
Premise 2: All Emeralds are Grue
<ol type="i">
Suggests that unobserved emeralds would turn blue after time t

Argument from Occam’s razor that Grue is more Complex than Green
<ol type="i">
BUT if we create another definition Bleen where something is Bleen if it has been observed a t time t and it is blue, or it is not observed yet at time t and it is green, Green can be made to be the more complex definition as all emeralds are grue and bleen
Crux of the Problem: Inductive argument supports a generalisation of future instances that works and is not necessarily less complex

One’s sense may be Misleading
Scientist may Struggle to fit Theory into their Misguided Coherent System

Prevents Paradigm Shifts
Correspondent Truths arising from Observation that Challenge Theories Rejected

Khun: Theory-Ladeness of Observations due to language

Language holds theoretical assumptions → Guides Observations → Guides Expressions of Observations

Reinforces the paradigm

Bias: Other typifications could yield different observations
Theory provides the language for and precedes observation statements

Underdetermination of Theory by Evidence

// Confirmation Holism:Scientific Claims are tested during observation in large groups
// Grue POI: Theory Choice is not governed exclusively by observation

Different theories may be derived from the same set of data

KEY PROBLEM: WITH THEORY = BIASED, WITHOUT THEORY = UNGUIDED
</td>
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<tr>
<td colspan="2">Qualities of the nature of scientific knowledge in the Baconian View (that are carried over in HDM) include</td>
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<tr>
<td>Define Parsimony

Define Occam’s Razor

Give 3 Reasons why why Parsimony is a Valuable Heuristic</td>
<td>
<u>Parsimony</u>

To prefer the least complicated explanation for an observation when weighing hypotheses
A.k.a Occam’s Razor: When presented with competing hypothetical answers to a problem, one should select the answer that makes the fewest assumptions
//Abduction: Inference to the best explanation

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(practical rather than certain method)	Value ● ≠ An infallible optimal method ○ = A practical mode of thinking ● Simple theories are preferable to complex ones as they are **easier to test** ○ Prevents one from coming up with ad hoc hypotheses (hypotheses made to modify a theory to save it from being disproven) ■ Allows for **Falsifiability** so that one can find information in support of/against the theory ● Probability Theory: Increased Assumptions → Increased Possibilities of Error ● Supports Basic Axioms of Science by how they **have not been falsified despite their simplicity** ○ Realism: Existence of an Objective Reality ○ Existence of Natural Laws ○ Consistency of Natural Laws Problems ● Susceptible to Bias due to Upbringing
Define Induction ● //Reason ● Explain why it is needed in Science ● Does Induction bring Certainty? State the 4 variations of the problem of Induction Explain the problems with Reichenbach's Pragmatism and BonJour's Bread and Butter Abductive A Priori Argument in resolving the problem of Induction	**<u>Induction</u>** ● Reasoning that moves from **multiple specific instances to a general rule** ● Needed in Science to make laws and inferring a general rule for creating hypotheses ● Fallibilistic: Claims that conclusion follows from premises by **probability** given multiple instances ● Usually Empirical: Sense Experience used for finding multiple instances **Problem of Induction**: Highlights lack of Justification for 1. Generalising a rule based on specific observations given that our observations may simply be limited a. "All Swans are White" given observed white swans before the discovery of black Swans 2. Uniformity of Nature: Presupposing that events in the future will occur as they have in the past a. Circular argument: Laws of physics will hold as they have always held in the past 3. Causal Connections: Induction from sense experience to find causal connections (A causes B; Fire causes one to feel heat when one's hand is nearby) comes from identifying a constant conjunction (of instances of fire and instances of heat) from which it is unjustified to claim that there is a causal connection 4. Different generalisations can be made by induction with same data a. Analogy of Grue: Something is Grue if it has been observed at time t and it is green, or it is not observed yet at time t and it is blue b. Premise 1: Emeralds have been Grue

c. Premise 2: All Emeralds are Grue
    i. Suggests that emeralds would turn blue after time t
d. Argument from Occam's razor that Grue is more Complex than Green
    i. BUT if we create another definition Bleen where something is Bleen if it has been observed at time t and it is blue, or it is not observed yet at time t and it is green, Green can be made to be the more complex definition as all emeralds are grue and bleen
    ii. Crux of the Problem: Inductive argument supports a generalisation of future instances that works and is not necessarily less complex

Solutions to the Second Problem of Induction

Fredrick L. Will: Claims that it commits the fallacy of Equivocation

- When we say that "we cannot know if the future will resemble the past"
    - We define future as the portion of the space-time universe which is always "beyond the line of the moving present"
- Conversely, we are continually confirming another definition of future
    - Specific events and things that are currently future but will eventually become past
- BUT: Still begs the question; the second definition that claims that "Specific events and things that are currently future but will eventually become past" is being repeatedly confirmed dogmatically assumes that induction holds

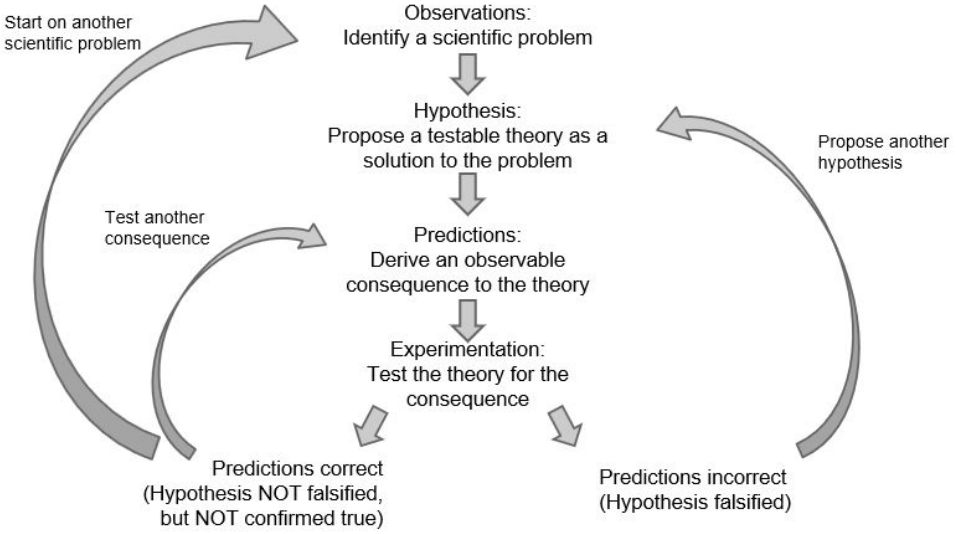
Max Black: Considers the Inductive Justification of Induction (for real world; see Circular Argument Above) as second-level inductive argument (for arguments)

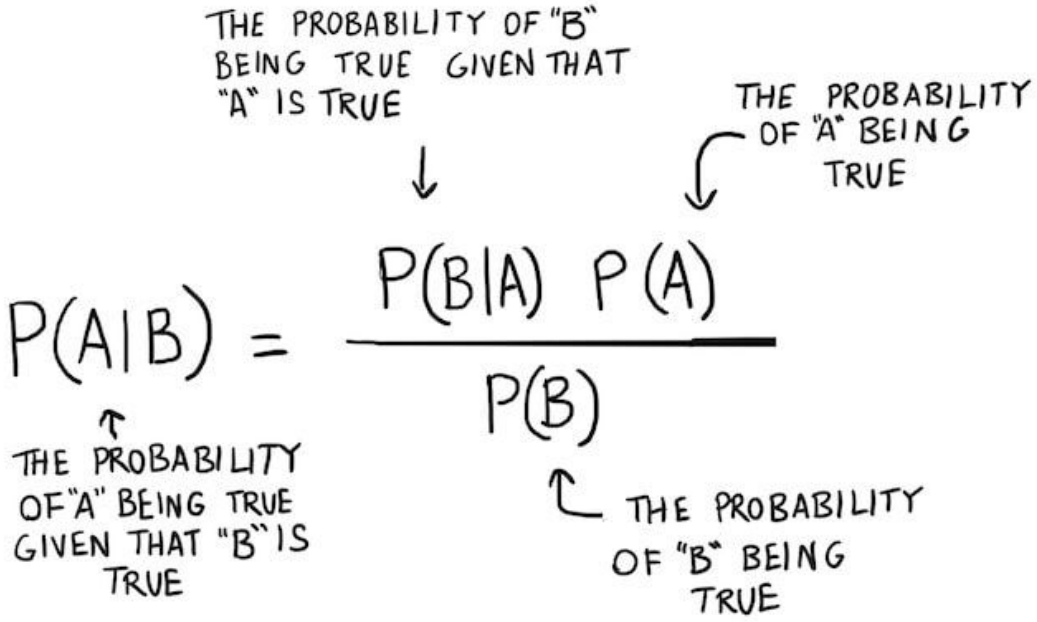
- Distinct, thus avoids circularity
- Can appeal to third level induction if required and so on
- BUT: Infinite Regress, and misses the point as the problem of induction applies to induction in all subject matters (both the real world and for arguments)

Reichenbach's Pragmatism

- Prudent to "bet" on inductive reasoning as it has been consistent in producing successful results
- Induction may not be Justified; but it is useful in Practice
- BUT:
    - *The relevance of the success of induction in the past in to bringing success in the future is, in itself, derived inductively*
    - Pragmatic rather than Epistemic: Does not give us any information on the likelihood of success of inductions
    - Moreover pragmatic knowledge may still be untrue
        - Got to the moon based on newtonian mechanics

	Strawson's Screw You: Argues that our very understanding and use of the word "reasonable" includes the idea of conformance with inductive standards ● Induction is derived analytically from claiming that science is reasonable ● BUT: ○ One can always rephrase the problem of induction without using the word "reasonable" ○ Analytic Results can be based on flawed premises ■ For example, suppose there were a community for whom wishful thinking was considered a respectable and reasonable way of coming to conclusions about the future. ■ For that community, with its own peculiar linguistic usage, the statement "wishful thinking is reasonable" would be analytically true ■ But nonetheless we would be entirely within our rights to question their reliance on such dubious epistemic methods. ■ Though "induction is reasonable" is now true by a proposed definition of "reasonable"; it is still questionable if "reasonable" which now contains "inductive" is a valid method of knowing; Strawson has only shifted the question to from "induction" to "reason" BonJour's Bread and Butter Abductive A Priori Argument ● Claims that the Law of Universal Regularity is the best explanation for standard inductive evidence ○ BUT: Law of Induction justified by Abductive reasoning from repeated cases presupposes causal relations (no. 3 of Problem of Induction) *Applying the Problem of Induction to the Problem of Induction* ● *We have no proof that the problem of induction will hold in the future* ● *Therefore it is possible that Induction Holds* ● *As Induction functions based on Probability > Certainty, Induction Holds*
Due to Problems with the SIMPLISTIC BACONIAN VIEW a new Definition of science arose called...	

Draw out the Hypothetico Deductive Method Explain how the HDM resolves problems with the Baconian View State the two problems with the HDM and their resolutions State the 3 differences between HDM and Baconian Views	**<u>The Hypothetico Deductive Method</u>**  ● Meant to find <u>Explanatory Power of Hypothesis</u> by testing <u>how stringently they are corroborated</u> by their predictions ○ Falsify > Verify //Fallibilism ● //Induction <u>Strengths of the HDM</u> ● Resolves Issues of Baconian View with Falsifiability to focus on Accounting for and Promoting the Growth of Scientific Knowledge ○ Law-Inference Dilemma; Problem of Induction, Coherent System-Forcing: Creates Hypothesis that is not True but has Strong Explanatory Power ■ Accepts the Bias and resolves that the Hypothesis is a Good Explanation > True ● Carl Hempel: Can also Incorporate Probabilities *Bayes Theorem*



Where A is the Hypothesis (e.g. I have the Flu) and B is the Condition (I am Sneezing)

- Therefore when Considering the Probability of a Hypothesis given its Condition
    - Directly Proportional:
        - Probability of Conditions given Hypothesis
        - Probability of Hypothesis
    - Inversely Proportional:
        - Probability of Condition

<u>Limitations of the HDM</u>

Confirmation Holism: Theories/Hypothesis cannot be tested in Isolation; the **consequences from a test depend on many theories/hypotheses**

- Problem 1: When a prediction fails, we cannot know if the fault lies in the **hypothesis itself** or any of the other beliefs and hypotheses used to generate **the failed prediction**
    - E.g when the movements of Uranus failed a prediction from Newton's law of gravitation, it turned out to falsify the assumption that there were no planets affecting its movement, rather than Newton's laws
        - Planet: Neptune
- RESPONSE: Lakatos' "sophisticated falsificationism"
    - When a hypothesis is falsified, it is not taken as false, but rather as inconsistent with the hard core of a research program
        - Be conscious of the theories that are contributing to the experiment
        - Negative Heuristic: Theories that are excluded

- Positive Heuristic: Theories that are intimately linked with the hypothesis
- Fallibilistic: More Gentle view of Falsificationism

- Problem 2: Ad Hoc Modifications; When a Hypothesis is falsified by prediction, the **body of Theory** behind the Falsification can be **modified** to save the Hypothesis by making it an **exception**
  - E.g. Hypothesis that Water Boils at 120°C disproven by sticking thermometer x in Boiling water → Conclusion that Water Boils at a 120°C given that you do not use "unreliable" thermometer x → Hypothesis not Falsified
- Essence of the Problem:
  - **Strong Adherence** to Body of Theories & Hypothesis = Wrong Falsifications and Missing out on Past Theories & Hypothesis that are wrong
  - **Weak Adherence** to Body of Theories & Hypothesis = Shifting of Theories & Hypothesis to save Hypothesis in Question

Popper's Response
- Must follow critical and methodical rules to avoid such problems

The Raven Paradox (Carl Hemper)

- Hypothesis: **All Ravens are Black** (All As are B)

1. Instance Hypothesis: <u>If a Raven is found to be Black, it increases the probability that the Hypothesis is Correct</u>
   a. If A = B occurs, All A is B is more likely
2. Equivalence Condition: <u>All Ravens are Black is equivalent to All non-Black things are Non-Raven</u>
   a. Saying All A's are B is the same as saying All non-A's are non-B
3. <u>If an Apple is found to be Red, it increases the probability that All non-Black things are non-Raven is correct</u>
   a. Appeals to Instance Hypothesis
4. <u>If an Apple is found to be Red it increases the probability that All Ravens are Black is Correct</u>
   a. Appeals to Equivalence Condition

Responses
- Fallibilism; Measures Evidence on a Scale: Non-falsifying observations can be distinguished to be strong, moderate or weak
  - One example that All non-Black things are non-Raven is infinitesimal in the possibly infinite set of All non-black things that are non-Raven, compared to

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One example that a Raven is Black which is a finite set
However, How would one know for sure that one set is much bigger than the other in all cases?

There will always be one Finite and one Possibly Infinite set, as if the original hypothesis involves a possibly infinite set (e.g. All matter is made of atoms), the inverse hypothesis would be a set that is impossible to prove (all non-things are made of non-atoms)

Investigations can be distinguished to provide, or not provide a potentially falsifying test of the hypothesis

<u>Lack of a Scale</u>

No definite number or indicator of the explanatory power of a hypothesis
No benchmark to show when a hypothesis becomes accepted for application
No method to compare the Explanatory power of Hypothesis

Can only wait for a piece of evidence to completely disprove one theory/limit it to one non-universal context

<u>Differences between HDM and Baconian View</u>
<table>
<tr><th>Hypothetico-Deductive Method</th><th>Baconian View</th></tr>
<tr><td>Deduction + Induction
Deduction involved in Prediction of Result in Specific Cases in Experimentation</td><td>Induction only
Generalises previous Instances without Prediction of Future ones
Simple Conducting of Experiments to Show General Law without Falsifiable Predictions</td></tr>
<tr><td>Specifies Hypothesis Testing</td><td>Does not Specify Hypothesis Testing</td></tr>
<tr><td>Prediction Involved
Corroboration of Predictions and Hypothesis allows for Falsifiability</td><td>No Prediction
Law merely Fits the Facts
Theory for Prediction: Theory-Ladenness vs Unguided Observation Dilemma</td></tr>
</table>
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</tr>
<tr>
<td colspan="2">The Qualities of HDM include...</td>
</tr>
<tr>
<td>Define Falsifiability

Give examples of non-falsifiable claims</td>
<td>
<u>Falsifiability</u>

HDM Makes definite predictions that can be tested against experience

Predictions proven Wrong = Falsified

Resolves Problem of Induction

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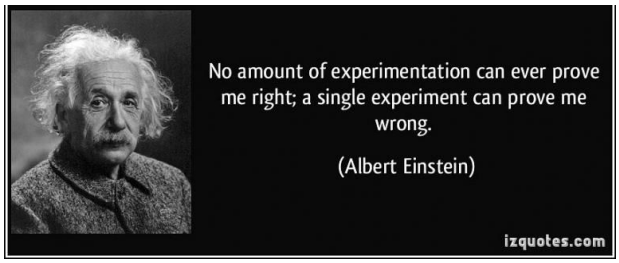
Explain the utility of Falsifiability in Science State the 3 Problems in Falsifiability	○ Does not prove “the sun will rise tomorrow” by Induction but claims that it is Falsifiable but generally correct claim ○ Also resolves: Paradigm shifts, Forcing experimentation into coherent system, Law-Inference Dilemma ● Theories have been **Difficult to Falsify despite our best efforts** > Theories are Certainly True ● ≠ Pseudoscience: No Falsifiable Claims that cannot fit any Observation ○ E.g. Repressed Memories, Barnum Statements ○ Impossible to Falsify by Human Competence/Experience ■ Difficult of Testing in Isolation given Current Technology  Rationale ● Utility: ○ Falsified: Encourages the development of hypotheses which are not so easily falsified ○ Falsification + Parsimony → Bold claims that gradually grow complex where needed to fit experimental data whilst resisting attempts at falsification ○ Difficult to Falsify: Convincing ○ Claims which are impossible to falsify cannot increase or decrease in truth value, and cannot be improved upon ○ The falsifiability is directly related to the usefulness of it ■ *A necessary but not sufficient condition though* ● Paradigm Shifts: Imply Impossibility of Certainty ○ Response: Problem of Induction; Paradigm of Science has changed in the past ≠ Paradigm of Science will change in the future ■ Apply P.O.I to itself: Just because P.O.I has held in the past ≠ will hold in the future → Continued need for Caution ■ P.O.I itself also rationalises Falsifiability: Induction involved in Science does not Guarantee that Induction will hold in their Theory-making that moves from the specific to the general Problems: ● Disregards the value of confirmed Hypothesis ○ Successful predictions are not valuable ● Possibility of Human Error causing Falsification and Improvement/Abandonment of already correct Hypothesis ○ BUT Popper’s Response: Investigate sources of possible error also in Falsification

	● Historical Inaccuracy ○ Heliocentric model: Not testable ○ Newton's Theory of Gravity: Supposedly falsified by Moon, but falsifications turned out to be wrong ○ Khun: Paradigmatic Shifts contribute to the Progress of Science > Falsification
//Problem of Induction	**<u>Causality</u>** Problem: Correlation ≠ Causation ● X implies y repeatedly ≠ x causes y ● How does one prove that x causes y? ○ Response: Multiple Correlations imply Causation ■ However, How many Times is Sufficient?
Assumptions in Claiming that "Science is making Progress" 1. Science has Progressed Steadily 2. Theories have Been Coherent 3. Knowledge has been Cumulative 4. Direction of Science is Legitimised and Defined 5. Unsolved Problems problems will be Solved in Due Course However, this is Unlikely due to Paradigm Shifts that have Occurred throughout History//History of Science in Introduction *Dasrite Screw u P/BCMKIers hey u wan fight isit meet me behind the weights room. Bring beyblades* Therefore, Science is...	
Define Paradigmatic State the 3 Problems raised by Paradigm Shifts	**<u>Paradigmatic</u>** The Validity of Scientific Theories are based on their **Paradigm** (Khun) ● Paradigm: The current widely-accepted body of scientific theories ● Scientific Knowledge is more Coherent than Correspondent *<u>Personal View</u>* *Science is based on Foundherentism* ● *Foundherentism: Knowledge is built in a Coherent System based on Correspondent Claims* ○ *Analogy of a Crossword Puzzle: Clues are Correspondent Facts, Answers are Coherent Claims* ● *Has Coherent Qualities: Knowledge is mutually supported by other facts within paradigm* ○ *Not Correspondent* ● *Has Correspondent Qualities: Affected by evidence motivating Paradigm Shifts* ○ *Not Coherent* <u>Problems raised by Paradigms</u> ● Suggests that Scientific Knowledge is **not Cumulative**: There is always the threat of a piece of Evidence throwing off the Paradigm ○ Cyclical

	○ *Possible to reach a point where we know with certainty that no more paradigm shifts will occur?* ● Theory-Ladenness: Observations made through lens of existing Paradigm ○ Skewed Data = Not Objective ● Incommensurability: 2 Consecutive Paradigms may be so Different that Viewpoints and Knowledge cannot be carried over ○ Loss of Common Language across Paradigms ■ E.g. Different definitions of "Mass" in Newtonian and Einsteinian Paradigms; as the amount of matter and substance in the body and as a curvature in space-time ■ Counter-E.g: Newtonian Laws are Carried over to Theory of Relativity but Limited by Inertial Frame //Introduction ○ Creates Bias that worsens Theory-Ladenness: Scientists will hold onto Theory until there is a Strong reason to Change ○ Accumulate Scientific Knowledge vs Finding Truth
State the Bacon's 4 Idols of the Mind and their proposed Solutions	**<u>Challenges to Science: Bacon's Idols of the Mind</u>** *Warning: the answers to the problems here seem rather GP-ish, it works as a summary of the problems facing science tho* **Idol of the Tribe**: ● Danger of Hasty Generalisation from a Particular Instance ○ BUT Induction: Avoids hasty generalisations with multiple specific instances ■ BUT: Cannot grant universal certainty (Black Swan; see problem 1 of induction) ● BUT: Science pursues Fallibility > Certainty ● Passion: Bias in Scientists to make Scientific Progress ○ BUT Scientific Community: Does peer-reviews to prevent problem of Passion ● Limitations of our Senses: Earth = Flat and Planets are of the Same Size ○ BUT Technology: Overcomes problem of Senses ■ Sight: Microscopes, Telescopes and X-rays ■ Now understand the limits of our senses **Idols of the Cave**: ● Individual Upbringing creates Bias: Education, Habits, Personal History ○ BUT Education creates self-awareness of Bias ○ BUT Education adapts to Scientific Paradigm **Idols of the Marketplace** ● Words used in Scientific Knowledge may cause Confusion and Retard its Progress: Change in definition of Mass ○ Process of Clarification > Retardation ● Words symbolise concepts and may constrain thinking to concepts ○ Clear understanding of concepts, derivations and limitations behind words resolves issue

	Idols of the Theatre ● Systems of philosophy, religious dogmas and scientific theories may impede thought ○ Church teachings of geocentric system ○ BUT: Fallibility > Certainty
Philosophers are also split on Science in...	
Define Realism and Anti-Realism in the context of Science	**<u>Realism vs Anti-Realism</u>** Realism: Phenomena Exist Independent of Observation ● Science is a method of Explaining Reality ● Science is a Method of Explanation: Success of Science = Truth ● Externalist: Justification can come from facts beyond one's awareness e.g. Reliable Processes ● Limitation: Paradigm Shifts Anti-Realism: Scientific Knowledge is Dependent on Observation and seeks the Best version of Reality ● Rationale ○ Unobservable Phenomena ○ Paradigm Shifts ● Internalist ● Science is a Method of Description > Explanation ○ Science Constructs Knowledge > Discovers Knowledge

"Great are the works of the LORD; They are studied by all who delight in them." (Psalms 111:2)