අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය, 2017 අගෝස්තු
கல்விப் பொதுத் தராதரப் பத்திர (உயர் தரப் பரீட்சை, 2017 ஓகஸ்ற்
General Certificate of Education (Adv. Level) Examination, August 2017

තර්ක ශාස්ත්‍රය හා විද්‍යාත්මක ක්‍රමය **I**		පැය දෙකයි
அளவையியலும் விஞ்ஞானமுறையும் **I**	24 E I	இரண்டு மணித்தியாலம்
Logic and Scientific Method **I**		***Two hours***

Instructions:

* Answer *all* questions.
* Write your **Index Number** in the space provided in the answer sheet.
* Instructions are given on the back of the answer sheet. Follow those carefully.
* In each of the questions **1** to **50**, pick one of the alternatives from (1), (2), (3), (4), (5) which is *correct* or *most appropriate* and **mark your response on the answer sheet with a cross** (×) **on the** number of the correct option in accordance with the instructions given on the back of the answer sheet.
* Each question carries **02** marks making a total of **100** marks.

N.B.
* Logical constants used in this paper are the following:

   Negation: ~, **Implication:** →, **Conjunction:** ∧, **Disjunction:** ∨, **Biconditional:** ↔
   Universal quantifier : ∧, **Existential quantifier :** ∨

1. Which of the following pairs of sentences has contrary propositions?
   (1) All swans are white and some swans are white.
   (2) All swans are white and some swans are not white.
   (3) All swans are white and no swan is white.
   (4) Some swans are white and no swan is white.
   (5) Some swans are white and some swans are not white.

2. An ideal experiment is
   (1) any controlled observation.
   (2) an experiment in which every variable is measured.
   (3) an experiment in which one and only one variable is varied at a time.
   (4) an experiment which uses proper instruments for measurement.
   (5) an experiment which is repeated and the average of the results is taken as the final result.

3. The sub-contrary of an 'I' proposition is the corresponding
   (1) A proposition.   (2) E proposition.
   (3) O proposition.   (4) A proposition or E proposition.
   (5) A proposition and O proposition.

4. The barometer readings of the atmospheric pressure at bottom, middle and top of a mountain are taken in sequence. If these readings are B, M, T respectively, then
   (1) B < T.   (2) B > T.   (3) B = T.   (4) M < T.   (5) M > B.
   (< and > are the standard symbols which stand for 'is less than' and 'is greater than' respectively)

5. "All brothers are males." is true because,
   (1) we conduct observations and we do not find a female brother.
   (2) it is a highly probable proposition.
   (3) it consists of terms with clear meaning.
   (4) it is a tautology.
   (5) it is a universal proposition like "all men are mortal".

6. The obverse of the proposition "No Sri Lankan is tall." is
   (1) Some who are tall are not Sri Lankans.
   (2) All Sri Lankans are non-tall.
   (3) Those who are non-tall are Sri Lankans.
   (4) Some Sri Lankans are non-tall.
   (5) All Sri Lankans are not tall.

[see page two

7. The metal that was mostly used for instruments determining the temperature and atmospheric pressure was
   - (1) iron.
   - (2) silver.
   - (3) mercury.
   - (4) copper.
   - (5) water.

8. If the weakened moods are also counted how many valid moods are there in the following figure?
   MP
   SM
   ∴ SP
   - (1) 2
   - (2) 3
   - (3) 4
   - (4) 5
   - (5) 6

9. When inductive method is used for scientific generalization 'an inductive leap' has to be taken to reach the generalization. This leap is necessary because,
   - (1) science is empirical.
   - (2) science has to use imagination.
   - (3) scientific tests are never final.
   - (4) to reach the conclusion the scientist has to go over a large gap that exists between the premises and the conclusion.
   - (5) as Karl Popper says, observations are shaky like poles stuck in mud.

10. The conclusion of a valid argument is **false** only if
    - (1) two or more of the premises are false.
    - (2) the conclusion is only probable.
    - (3) all the premises are false.
    - (4) at least one of the premises is false.
    - (5) the conclusion does not logically follow from the premises.

11. The sequence of the values of the mean, mean deviation and standard deviation of numbers 2, 3, 4, 7 is
    - (1) 3, 1.4 and $\sqrt{2}$
    - (2) 4, 1.4 and $\sqrt{3}$
    - (3) 1.5, 4 and $\sqrt{3.5}$
    - (4) 4, 1.5 and $\sqrt{3.5}$
    - (5) 2, 1.4 and $\sqrt{3}$

12. "All Greeks are liars said Caeser the X."
    To make the above statement a paradox the term 'X' has to be
    - (1) trustworthy one.
    - (2) Roman.
    - (3) Greek.
    - (4) Roman Consul and dictator Julius.
    - (5) Cleopatra's lover.

13. The view that induction is **not** a process of correct reasoning is explicitly held by
    - (1) Thomas Kuhn.
    - (2) Francis Bacon.
    - (3) Carl Hempel.
    - (4) Karl Popper.
    - (5) Bertrand Russell.

14. Given the original proposition, "All clever are rich", the proposition "Some non-clever are non-rich" is its
    - (1) converse.
    - (2) contrapositive.
    - (3) obvert.
    - (4) obverted inverse.
    - (5) inverse.

15. If, with the usual notation, °C and °F indicate, 'degrees Celsius' and 'degrees Fahrenheit' respectively then 1 °C is equivalent to
    - (1) 98.4 °F
    - (2) 1.9 °F
    - (3) 1.4 °F
    - (4) 0.555 °F
    - (5) 1.8 °F

16. The syllogism "Goats are animals. Some goats are not dangerous. Therefore no animals are dangerous."
    - (1) is valid.
    - (2) commits the fallacy of four terms.
    - (3) commits the fallacy of the undistributed middle.
    - (4) commits the fallacy of illicit major.
    - (5) commits the fallacy of illicit minor.

17. In the modern era, the first methodologist who emphasized taking count of the negative (the differing) instances of phenomena as well in the process of arriving at generalizations was
    - (1) Francis Bacon.
    - (2) David Hume.
    - (3) Karl Popper.
    - (4) John Stuart Mill.
    - (5) Paul Feyerabend.

18. The symbolic sentences (P ∨ $\sim Q$) and $\sim(\sim P \rightarrow \sim Q)$ are
    - (1) logically equivalent.
    - (2) contradictory.
    - (3) contrary.
    - (4) neither logically equivalent nor contradictory.
    - (5) have no determinable relation.

19. A fact in history of science which indicates that observation as theory-laden is
  (1) even in the same test, the observed data vary even by quantities expressed in decimals.
  (2) some observers may be having myopic vision.
  (3) Alexander Fleming did not observe that a mold had contaminated his culture until part of the culture on the plate had been destroyed.
  (4) the Europeans did not observe the changes or new objects in the sky for centuries while other nations like Chinese observed and studied them.
  (5) Kuhn says that what were ducks in the scientists' world before the revolution become rabbits afterwards.

20. If A, B and C are non-empty classes such that $AB = 0$, $BC \neq 0$ and $AC \neq 0$, then
  (1) $\bar{A} = 0$ (2) $\bar{A}\,\bar{B}\,\bar{C} \neq 0$ (3) $AB\,\bar{C} = 0$ (4) $\bar{A}BC = 0$ (5) $AB\,\bar{C} = 0$

21. What is the median of the ranges of the following sequences of numbers?
  5, 1, 10, 98
  78, 33, 13, 20
  65, 110, 19, 37
  36, 9, 19, 27   is
  (1) 65 (2) 91 (3) 54 (4) 78 (5) 46

22. A valid argument has three premises, A, B and C and the conclusion R which have two sentential variables occurring in them. What are the truth values of the implication in the expression $((A \wedge B) \wedge C) \rightarrow R$?
  (1) TFTT (2) TTTFTTT (3) TTTT (4) TTTTTTT (5) TTTTTTFF

23. A group of anthropologists researching in a small Sri Lankan island off Kalpitiya selects a stratified sample of 5% of the population for their investigations. The numbers selected were as follows:

  People of
  Arabian origin   45
  Tamil origin   30
 Sinhala origin   60
  African (Negro) origin   15

  If the sample is fair and representative, what percentage of the islands population is of African origin?
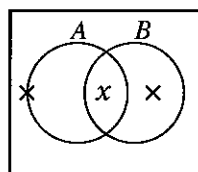 (1) 5% (2) 3% (3) 10% (4) 12% (5) 30%

24. A bag contains two white balls and one black ball. What is the probability that first a white ball and then a black ball is drawn from the bag if the first ball drawn is not replaced?
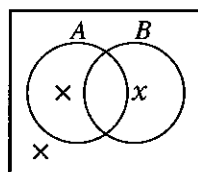 (1) $\dfrac{2}{9}$ (2) $\dfrac{1}{6}$ (3) $\dfrac{1}{9}$ (4) $\dfrac{5}{6}$ (5) $\dfrac{1}{3}$

25. If A, B are classes such that $\bar{A} \neq 0$, $\bar{B} \neq 0$ and $x \in \bar{A}B$, which of the following Venn diagrams represents these facts properly?
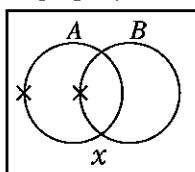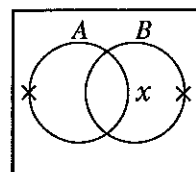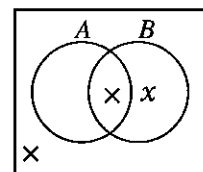

  (1)   (2)   (3)   (4)   (5)

26. The concept of 'force' gets defined by Newton's Laws of motion as that which changes a body's
  (1) speed. (2) mass. (3) position.
 (4) direction of motion. (5) velocity.

27. In "A large number of women were literate"
  (1) only the predicate is distributed.
  (2) only the subject is not distributed.
  (3) both subject and predicate are distributed.
  (4) neither the subject nor the predicate is distributed.
  (5) only the predicate is undistributed.

28. Galileo's Law is reduced to and explained by
  (1) the Kinetic theory of gases. (2) Copernicus' heliocentric theory.
  (3) Kepler's Laws. (4) Einstein's special theory of relativity.
  (5) Newton's theory of gravitation.

29. Which of the following is the correct truth tree for the argument $(\sim(P \to Q) \to Q) \cdot P \therefore Q$?
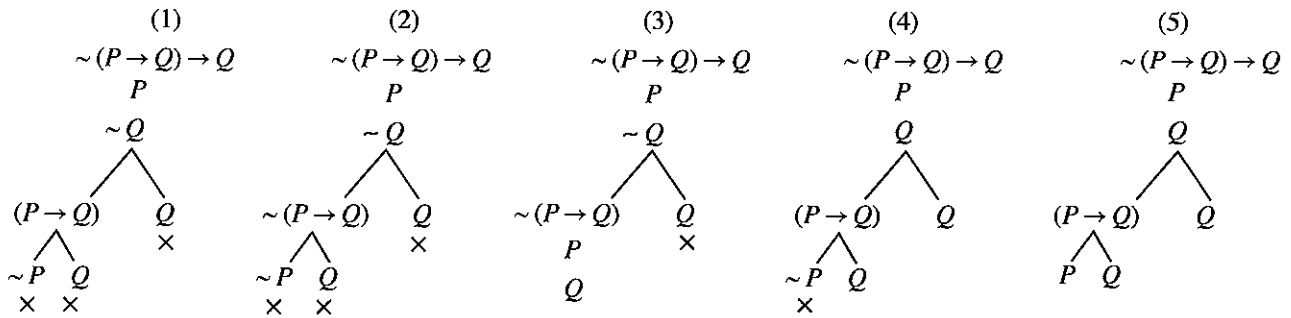

30.

P (Method or Instrument)	Q (Subject of investigation)
(i) Radio telescope	a - Study of cells and tissues
(ii) Observation and interview	b - Effective treatments for dengue
(iii) Electron microscope	c - Distant astronomical objects
(iv) Wide experimental and observational tests	d - The social developments in the Rajarata colonies
(v) Field survey	e - Study of the condition of persons displaced due to landslides

When the subjects of investigation given under **Q** above are arranged to respectively correspond to the methods or instruments given under (i) - (v) in **P**, the resultant correct order is

(1) a, b, c, e, d.   (2) a, d, b, c, e.   (3) c, e, a, b, d.   (4) d, e, b, c, a.   (5) a, e, b, d, c.
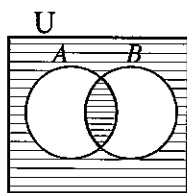
31. Which of the following gates could be taken as a representation of $\sim(\sim P \to Q)$?
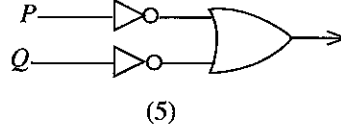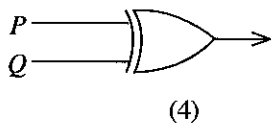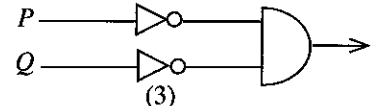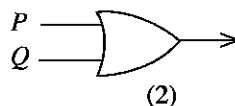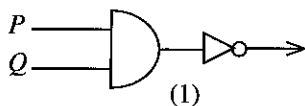
32. Which of the following admitted that in addition to explanation, understanding also should be an aspect of social scientific methodology?

(1) Auguste Comte   (2) Max Weber   (3) Carl Hempel   (4) J.S. Mill   (5) Émile Durkheim

33.

The above diagram shows two classes A and B which

(1) are empty.   (2) have common members.
(3) are in an empty universe.   (4) are mutually exclusive and together exhaustive.
(5) have their class union as the null class

34. Margret Mead conducted anthropological research in Samoan Islands for years which also resulted in her best known work 'Coming of Age in Samoa'. Her method in this work is characterised by

(1) experimental research.
(2) logical analysis.
(3) observation and participatory observation.
(4) statistical analysis.
(5) study of fossils using carbon 14 dating.

35. On the basis of the scheme of abbreviation,
    F : a is a man
    G : a is mortal,
    the sentence, "It is not the case that all men are mortal." can be symbolized by
    (1) Λx (Fx ∧ Gx)
    (2) Vx ∼(Fx → Gx)
    (3) Λx (Fx → ∼Gx)
    (4) Vx ∼(Fx ∧ Gx)
    (5) Vx (Fx ∧ ∼Gx)

36. To which of the following do all the qualifiers 'The greatest experimental scientist', 'chemist', 'physicist', 'inventor of the motor and dynamo', 'beginner of electro chemistry', could apply?
    (1) Sir Humphrey Davy.
    (2) Andre Ampere.
    (3) Clerk Maxwell.
    (4) Benjamin Franklin.
    (5) Michael Faraday.

37. "There cannot be a vacuum because if there is nothing between the bodies, they must touch."
    The above argument commits the fallacy of
    (1) post hoc ergo propter hoc (after this, therefore because of this)
    (2) argumentum ad ignorantum (appeal to ignorance).
    (3) composition.
    (4) irrelevant conclusion.
    (5) petitio principii (circular argument).

38. Russell Hanson asks the question, "Do Kepler (who believed in Heliocentric theory) and Tycho (who believed in geocentric solar movement) see the same thing in the east at dawn?" and then says "(there are) differences between experiences and physical states. People, not their eyes, see. Cameras and eye-balls are blind... there is more to seeing than meets the eye."
    Hanson is here arguing for
    (1) Heliocentric theory.
    (2) Geocentric theory.
    (3) Tycho de Brahae's theory.
    (4) Theory-ladenness of observation.
    (5) necessity for use of instruments in observation.

39. Which of the following is a theorem?
    (1) Λx (Fx → Gx)
    (2) (P → Q) → (Q ∧ P)
    (3) (Vx Fx ↔ ∼Λx∼Fx)
    (4) (P ∨ Q) → ∼(P ∧ ∼Q)
    (5) P

40. In Karl Popper's explicit statement, the empirical nature of a theory shines when it is
    (1) tested.
    (2) verified by empirical test.
    (3) found to be false by empirical test.
    (4) found to be in agreement with empirical experience.
    (5) able to give logical consequences which are testable.

41. Which of the following could be properly derived from Vx (Fx ∧ Gx)?
    (1) Fy   (2) ∼Fx   (3) FA   (4) (FA ∧ GA)   (5) (Fx ∧ Gx)

42. In Kuhn's view, a change of paradigm in a science is
    (1) normal science.
    (2) the solution of all anomalies.
    (3) unusual.
    (4) a revolution.
    (5) a crisis.

43. The sentence, "Did you like that girl?" is
    (1) true.
    (2) false.
    (3) neither true nor false.
    (4) sometimes true, sometimes false.
    (5) both true and false.

44. Einstein's General Theory of Relativity was considered to be confirmed by the verification of the novel prediction derived by Einstein from that theory that a ray of light passing near (a massive body like) the Sun would be bent towards the Sun by its gravity. This verification of the curvature of a ray of light passing near the Sun was done by
  (1) the Michelson–Morley experiment.
  (2) observations of Mercury.
  (3) observation made by a team led by Sir Arthur Eddington during a solar eclipse.
  (4) mathematical analysis using $E = mc^2$
  (5) verifying space-time relativity.

45. If it is agreed that the sentence, "If he has no money then he goes abroad is false." is ambiguous, and that ambiguity makes it possible for the sentence to be symbolised in two different ways, the symbolization of the sentence on the basis of the scheme of abbreviation P: He has money, Q: He goes abroad is
  (1) $(\sim P \rightarrow \sim Q)$ or $\sim(\sim P \rightarrow Q)$
  (2) $(\sim P \rightarrow \sim Q)$ or $(\sim P \rightarrow Q)$
  (3) $\sim(P \rightarrow Q)$ or $\sim(\sim P \rightarrow Q)$
  (4) $(\sim P \rightarrow \sim Q)$ or $(P \rightarrow Q)$
  (5) $((P \rightarrow Q) \wedge (\sim P \rightarrow \sim Q))$

46. In his earlier phase, Paul Feyerabend held that the task of the methodologist is
  (1) descriptive.
  (2) prescriptive.
  (3) neither prescriptive nor descriptive.
  (4) both descriptive and prescriptive.
  (5) anarchic.

47. A correct derivation from the premises $\Lambda x (Fx \rightarrow Gx)$ and $VyFy$ would be
  (1) Gx
  (2) Gy
  (3) Gz
  (4) Fx
  (5) $(Fy \wedge Gy)$

48. Which of the following should be modified and developed in a Lakatosian Research Programme?
  (1) Negative heuristic
  (2) Positive heuristic
  (3) Hard core
  (4) Protective belt
  (5) methods of falsification

49. Which of the following is derivable from $VxFx$?
  (1) Fx
  (2) Gy
  (3) $Vx (Fx \rightarrow Gx)$
  (4) ΛxFx
  (5) $Vx (Gx \rightarrow Fx)$

50. The Economist who worked on famines and deprivation as well as welfare economics, held the Unorthodox View that development should be a process of expanding real freedom of the people and was awarded the Nobel Prize for Economics was
  (1) Gunnar Myrdal.
  (2) John Maynard Keynes.
  (3) John Kenneth Galbraith.
  (4) Tinbergen.
  (5) Amartya Sen.

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கல்விப் பொதுத் தராதரப் பத்திர (உயர் தர)ப் பரீட்சை, 2017 ஓகஸ்ட்
General Certificate of Education (Adv. Level) Examination, August 2017

තර්ක ශාස්ත්‍රය හා විද්‍යාත්මක ක්‍රමය	**II**		පැය තුනයි
அளவையியலும் விஞ்ஞானமுறையும்	**II**	**24 E II**	மூன்று மணித்தியாலம்
Logic and Scientific Method	**II**		***Three hours***

Instructions:

   ❈ *Answer only **eight** questions selecting **four** questions from each of the Parts **I**, and **II**.*

N.B.

  ❈ Logical constants used in this paper are the following:

     Negation: ~, Implication: →, Conjunction: ∧, Disjunction: ∨, Biconditional (Equivalence): ↔
     Universal quantifier : ∧, Existential quantifier : V

  ❈ Candidates are advised **not** to use any other logical constants.

  ❈ Candidates should **not** use theorems (**e.g.** De Morgan's theorem) in the derivations except when
    the theorem itself has been proved by the candidate.

Part I

1. (*a*) Explain the immediate inference of obversion illustrating it by obverting the
        A, E, I, O forms of the A proposition 'All S is P.'   *(04 marks)*

    (*b*) Determine whether the following syllogisms are valid or invalid. When the syllogism is
       invalid state the rule/rules it violates and the fallacy/fallacies that results.

       (i) No Sri Lankans dance.
          All Sri Lankans are rich.
          Therefore, some who dance are not rich.

       (ii) Jackals hoot.
           Dogs bark.
           Therefore, some which bark do not hoot.   *(03 × 2 = 06 marks)*

2. (*a*) Symbolize the following arguments in terms of classes and determine their validity or invalidity
       using Venn diagrams.

       (i) Many figures are round.
          A few figures are square.
          Therefore, there are a few round square figures.

       (ii) Dushyanta is a happy person.
           Sakuntala is a happy person.
           Therefore, some happy persons exist.   *(02 × 2 = 04 marks)*

    (*b*) Write short notes on the following:

       (i) 'Term' in Aristotelian Logic

       (ii) 'Class' in Class Logic   *(02 × 2 = 04 marks)*

    (*c*) Show that a categorical proposition like "All men are mortal" in Aristotelian logic gets
       symbolised into a hypothetical sentence in modern predicate calculus.   *(02 marks)*

3. (*a*) "Experiments use observation, but experiments are different from natural observations." Explain
       giving examples.   *(05 marks)*

    (*b*) "Making a sharp separation of the observer from the observation in both natural observation
       and experiment as the traditional scientific methodology required is no longer justifiable in
       view of the developments in social scientific as well as natural scientific methodology."
       Comment.   *(05 marks)*

4. (*a*) Three boys each toss a coin to decide as to who will sweep the classroom. If two boys get the same side up, the one who doesn't get that side up has to sweep. If three heads or three tails come up, they play again. What is the probability that a decision as to who will sweep is reached on the third round of tossing?

(04 marks)

(*b*) What is (i) a random sample (ii) a stratified sample. Give examples.

(03 marks)

In an island in the Indian Ocean which has a heterogenous population of 20,000 people, a stratified sample of 1% of the population selected. 20% the islands' population consists of Tamils and if the Sinhala and Muslim groups form the rest. How many non-Tamils would be in the stratified sample selected? If the selected number of Muslims in the sample is 50, what is the Muslim population in the island?

(03 marks)

5. (*a*) Draw the logic gate for the expression $(P \to \sim Q) \to \sim (P \to Q)$ following the direction:

Implications are converted into disjunctions with the sentential variable in the antecedent of the implication occurring in the left hand side of the disjunction.

(04 marks)

(*b*) Prove the following theorems by derivation.

    (i) $((\sim P \wedge \sim Q) \to \sim (P \vee Q))$

    (ii) $(\sim Q \to ((P \vee Q) \leftrightarrow P))$

(03 × 2 = 06 marks)

Part II

6. (*a*) Write notes on

    (i) the interview method,

    (ii) field survey method in social scientific investigation.

(04 × 2 = 08 marks)

(*b*)   (i) "To understand a culture one has to live it."

    Does participatory observation provide a method of understanding and/or a method of collecting proper data?

(04 marks)

    (ii) How far is the data in participatory observation non-subjective?

(03 marks)

7. Symbolize the following arguments giving your schemes of abbreviation and show them to be valid by the method of derivation.

(*a*) Given that Sri Lanka has the human resources and the strategic location, Sri Lanka has the potential for development. Sri Lanka does not have the potential for development, if there is corruption. Therefore, if there is corruption then given that Sri Lanka has the strategic location it does not have the human resources.

(*b*) If and only if Leela goes to the well she meets Kamala. Only if Lela goes to the well she meets Champa. Therefore, if Leela meets Champa then she meets Kamala.

(*c*) Seetha marries either Rama or Ravana but not both. If Seetha marries Rama then Ravana will kidnap her. Seetha marries Rama. Therefore, although Ravana kidnaps her, she does not marry Ravana.

(05 × 3 = 15 marks)

8. (*a*) Outline the main features of Karl Popper's methodology of science and discuss the statement, "Although Popper opted for a deductively valid methodology the tentativeness of scientific knowledge is the dominating presumption in his approach."

(07 marks)

(*b*) "Lakatos' methodology of scientific research programmes loosens the rigid falsifiability of Popper, accommodates features of Kuhn's paradigms and struggles with Feyerabend's anarchism." Substantiate.

(08 marks)

9. (a) Test for the validity of the argument $(\sim P \to (P \lor Q)) \therefore Q$ using

    (i) truth trees

    (ii) indirect method of truth tables.   *(03 × 2 = 06 marks)*

  (b)   (i) Symbolize the following statement, using predicate calculus and giving your scheme of abbreviation.

        "If all men are mortal then some women do not dance and no child sings."   *(03 marks)*

      (ii) Symbolize the following argument in terms of predicate calculus and giving your scheme of abbreviation and show it to be valid by the method of derivation.

        All men are wise.

        Kamal is not wise but he is a man.

        Therefore Kamal is a Sri Lankan.   *(06 marks)*

10. Write notes on the following:

  (i) A Scientific Revolution in Kuhn's sense

  (ii) Feyerabend's conception of Anarchism in Methodology

  (iii) An ethical code for the scientists – its necessity and possibility   *(05 × 3 = 15 marks)*

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