AL/2015/24/E-I

අධ්‍යාපන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය, 2015 අගෝස්තු
கல்விப் பொதுத் தராதர பத்திர (உயர் தர)ப் பரீட்சை, 2015 ஓகஸ்ற்
General Certificate of Education (Adv. Level) Examination, August 2015

තර්ක ශාස්ත්‍රය හා විද්‍යාත්මක ක්‍රමය I அளவையியலும் விஞ்ஞானமுறையும் I **Logic and Scientific Method I**	**24 E I**	පැය දෙකයි இரண்டு மணித்தியாலம் ***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 at 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 : Λ, Existential quantifier : V

1. In traditional logic 'Mahaweli ganga is in Sri Lanka' is a/an
   (1) singular proposition. (2) particular proposition.
   (3) universal proposition. (4) hypothetical proposition.
   (5) atomic proposition.

2. The sentence 'Either it rains at Adam's Peak today or it does not' is
   (1) empirically true.
   (2) false.
   (3) a sentence in which the truth value is undecidable.
   (4) logically true.
   (5) probable.

3. Two sentences are contradictory if they are
   (1) not both true. (2) not both false.
   (3) not both true and not both false. (4) not equivalent.
   (5) if and only if not independent.

4. The steps in the new method for knowledge outlined by Francis Bacon are best stated as
   (1) from empirical observation to a generalization.
   (2) from empirical observation to a probable conclusion.
   (3) from generalization to prediction and empirical confirmation.
   (4) from empirical observation to simple generalizations and, step by step, to broader and broader generalizations.
   (5) coming up with hypotheses and testing them empirically.

5. The term 'ancestor' gives a/an
   (1) symmetrical transitive relation. (2) asymmetrical non-transitive relation.
   (3) asymmetrical transitive relation. (4) symmetrical non-transitive relation.
   (5) one-one relation.

6. Telescopes
   (1) use only refraction of light.
   (2) were first used by Galileo.
   (3) cannot be used for studying moving objects.
   (4) operate by collecting light and other electromagnetic waves.
   (5) bring distant objects physically close to the observer.

[see page two

7. The contradictory of "Some men are liars" is
   (1) all men are liars. (2) some men are not liars.
   (3) no man is a liar. (4) all liars are not men.
   (5) some liars are men.

8. Observation differs from experiment by
   (1) not using instruments.
   (2) not planning the observation.
   (3) not systematically recording data.
   (4) not consciously altering the phenomena observed.
   (5) not allowing any alteration in the phenomena observed even unconsciously.

9. Given that an I proposition is false, the truth values of the corresponding A, E, O, propositions in order are
   (1) true, false, true. (2) false, true, true.
   (3) false, true, false. (4) true, true, true.
   (5) true, false, indeterminate.

10. Methodologically, for establishment of the theory of gravitation Sir Isaac Newton depended on
   (1) Induction by enumeration. (2) Deductive falsification.
   (3) Mills methods. (4) Deductive verification.
   (5) Probability calculus.

11. "One and only one of P or Q" is symbolically expressible by
   (1) $(P \vee Q)$ (2) $(P \vee Q) \wedge \sim(P \wedge Q)$
   (3) $(\sim P \vee Q) \wedge (P \wedge \sim Q)$ (4) $(P \vee \sim Q) \wedge (\sim P \wedge Q)$
   (5) $\sim(P \vee Q) \vee (P \wedge Q)$

12. In deductivist methodology a prediction from a hypothesis
   (1) confirms the hypothesis.
   (2) falsifies the hypothesis.
   (3) is a logical consequence of the hypothesis.
   (4) is empirically true
   (5) is a probable conclusion.

13. What is the premise from which the contrapositive "No non-graduates are university teachers" is inferred?
   (1) Some university teachers are graduates.
   (2) No university teachers are graduates.
   (3) No graduates are non-university teachers.
   (4) All university teachers are graduates.
   (5) Some graduates are not university teachers.

14. The explanation given by "The heart is there to pump blood" is
   (1) causal. (2) probabilistic. (3) teleological. (4) deductive. (5) functional.

15. Which of the following sentences, when it is converted, gives a conversion by limitation?
   (1) No elephant is white. (2) Some crows are white.
   (3) Some donkeys are not fools. (4) Men are intelligent.
   (5) All hare do not have horns.

16. Some men are tall.
   Some men are handsome people.
   Therefore, some handsome people are tall.
   is a syllogism which
   (1) is valid.
   (2) commits the fallacy of illicit major.
   (3) commits the fallacy of illicit minor.
   (4) breaks more than one rule necessary for a valid syllogism.
   (5) commits the fallacy of four terms.

[see page three

17. If A, B are events represented by non-empty classes which are not mutually exclusive and if $P(A)$, $P(B)$ and $P(A \cup B)$ are probabilities of A, B and A or B, and where $>$ means greater than, $\geq$ means greater than or equal to, $<$ means less than and $\leq$ means less than or equal to, then
(1) $P(A \cup B) = P(A) + P(B)$ (2) $P(A \cup B) \geq P(A) + P(B)$
(3) $P(A \cup B) \leq P(A) + P(B)$ (4) $P(A \cup B) < P(A) + P(B)$
(5) $P(A \cup B) > P(A) + P(B)$

18. A, B are classes. ϕ is the null class. $\overline{A}$, $\overline{B}$ are the complements of A, B respectively with the usual notations in class logic if $A\overline{B} \neq \phi$, then
(1) $A \neq \phi$ (2) $B \neq \phi$
(3) $B = \phi$ (4) if $B \neq \phi$, then $A = \phi$
(5) $\overline{A}\overline{B} = \phi$

19. Four coins are tossed. The probability of getting three or more heads is?
(1) $\frac{1}{4}$ (2) $\frac{5}{16}$ (3) $\frac{3}{8}$ (4) $\frac{7}{16}$ (5) $\frac{1}{2}$

20. In a normal truth table giving values to P and Q, the truth values of proposition $(P \vee Q) \leftrightarrow (P \rightarrow Q)$ are
(1) TTTT (2) TFTF (3) TTTF (4) FTTF (5) FTFT

21. Which of the following is most appropriate to indicate the meaning of simplicity of a scientific hypothesis?
(1) The hypothesis is expressed in simple terms.
(2) The hypothesis is expressed in familiar or common sense terms.
(3) The hypothesis could be tested easily.
(4) The hypothesis is expressed in-terms of a few concepts or variables which could be applicable to a wide field.
(5) The hypothesis is expressed mathematically.

22. "That vicious woman came to see the new born baby last morning and the rash appeared all over the baby's body last afternoon. The glance and the words of that vicious woman, no doubt, resulted in the baby's rash."

The inference in the above passage commits the fallacy of
(1) non-sequitur. (2) petitio principii.
(3) argumentum ad hominem. (4) ignoratio elenchi.
(5) post hoc, ergo propter hoc.

23. Usually in a distribution, the standard deviation
(1) is greater than or equal to the mean deviation.
(2) is greater than the mean deviation.
(3) is less than or equal to the mean deviation.
(4) is less than the mean deviation.
(5) shows no perceptible quantitative relation to the mean deviation.

24. $(P \rightarrow Q). \sim\sim Q. \therefore \sim\sim P$

The above argument
(1) commits the fallacy of the antecedent.
(2) commits the fallacy of petitio principii.
(3) uses the rule of double negation wrongly.
(4) commits the fallacy of assertion of the consequent.
(5) uses the rule of modus tollendo ponens incorrectly.

25. A researcher studying the problem of ragging in universities wants to get views of the students in a university. He selects a stratified sample of 100 students to be interviewed. The numbers are chosen in proportion to the number of students in each of the first, second and third years. The number of students in the first, second and third years are respectively 600, 500 and 400. Adjusting the fractions to the nearest whole number the numbers chosen from the 1st, 2nd and 3rd years respectively would be
(1) 40, 34, 26 (2) 40, 33, 27 (3) 41, 33, 26 (4) 40, 33, 26 (5) 40, 34, 27

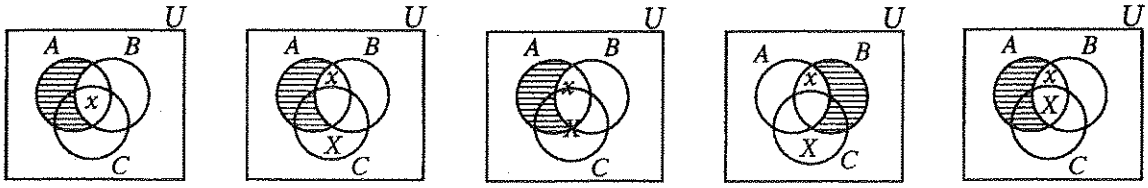
[see page four

26. P E M
S A M
$\therefore$ S E P

The correct mood of the above valid symbolic syllogism is
(1) CELARENT (2) CESARE (3) FELAPTON (4) CAMESTRES (5) FESAPO

27. Kinetic theory of gases explains
(1) why water boils at 100° C.
(2) Kepler's Third Law.
(3) Charles's Law.
(4) how the gases Oxygen and Hydrogen combine to form water.
(5) Law of conservation of mass.

28. Which of the given Venn diagrams is the one appropriate for the symbolic expression $A\bar{B} = \phi$, $x \in AB$, $C \neq \phi$?



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

29. For which of the following generalizations using induction from empirical observation is sufficient for its formulation?
(1) Kepler's First Law
(2) Darwin's Theory of Evolution
(3) Hooke's Law
(4) Atomic Theory
(5) Newton's First Law of Motion

30. Which of the following mathematicians did **not** directly contribute to the development of mathematical logic?
(1) Boole (2) Frege (3) Russell (4) Ramanujan (5) Peano

31. For a contemporary scientist the idea of 'there being parallel universes' is
(1) a popular science story.
(2) a directly testable hypothesis.
(3) an indirectly testable hypothesis.
(4) science fiction.
(5) mythology.

32. Ludwig Wittgenstein was a pioneer logician in the use of
(1) deductive method.
(2) class analysis.
(3) indirect proof.
(4) truth-table method.
(5) method of derivations.

33. Generally one of the **insurmountable** problems in the social scientific method is
(1) lack of instruments.
(2) inability to conduct experiments.
(3) defects in their statistical analysis.
(4) having to use samples.
(5) avoidance of participant observation.

34. A strong disjunction is true if
(1) one or more of the disjuncts is true.
(2) both disjuncts are true.
(3) one and only one of the disjuncts is true.
(4) the weak disjunction is false.
(5) at least one disjunct is false.

35.

A	**B**
(I) Behaviour of elephants in the wild.	(*a*) Experiment
(II) A patient with a history of hysteria.	(*b*) Observation
(III) Study Micro-particles using high energy collision.	(*c*) Control group method
(IV) Effect of super market culture on consumer behaviour	(*d*) Case study method
(V) Effect of applying ointment *O* on people affected with rash *X*.	(*e*) Use of samples in tests

When the most suitable methods for the respective studies in list **A** are selected from the list **B** the sequence of studies in **B** is
(1) *a, b, c, d, e* (2) *b, d, a, e, c* (3) *a, c, d, b, e* (4) *e, a, b, c, d* (5) *c, d, a, b, e*

[see page five

36. If in a Second Figure syllogism, the major premise is particular and the conclusion negative then it commits the fallacy of

(1) illicit Major. (2) illicit Minor.
(3) undistributed Middle term. (4) four terms.
(5) multiple terms.

37. The tables of Presence, Absence, Degrees and Exclusion of Francis Bacon are a forerunner of the methods outlined by

(1) Carl Hempel. (2) Russell Hanson. (3) J.S. Mill.
(4) Rudolf Carnap. (5) Imre Lakatos.

38. A logical equivalent of $(P \leftrightarrow Q)$ is

(1) $(P \wedge Q)$ (2) $(\sim P \wedge \sim Q)$ (3) $\sim(P \wedge \sim Q)$
(4) $(P \leftrightarrow \sim Q)$ (5) $(P \wedge Q) \vee (\sim P \wedge \sim Q)$

39. Relativist idea that paradigms in natural science change from time to time brought natural science closer to social science as

(1) social sciences did not have paradigms.
(2) social sciences also could develop paradigms.
(3) the view that knowledge in the natural sciences grow linearly and progressively lead to ultimate truths was no longer tenable
(4) subject matter of social sciences could accordingly merge with those of the natural sciences.
(5) Kuhn was heavily influenced by ideas in social sciences.

40. The truth tree for the argument $(\sim P \rightarrow Q) \therefore (Q \rightarrow P)$ is

(1)
$(\sim P \rightarrow Q)$
$\sim (Q \rightarrow P)$
$\sim Q$
P
$\sim P$ Q

(2)
$(\sim P \rightarrow Q)$
$\sim (Q \rightarrow P)$
Q
$\sim P$
P Q
X X

(3)
$(\sim P \rightarrow Q)$
$\sim (Q \rightarrow P)$
Q
$\sim P$
P Q
X

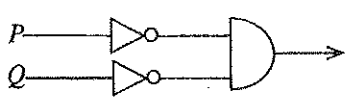
(4)
$(\sim P \rightarrow Q)$
$\sim (Q \rightarrow P)$
$\sim Q$
$\sim P$
P Q
X X

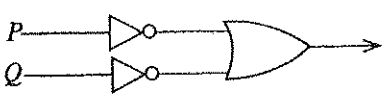
(5)
$(\sim P \rightarrow Q)$
$\sim (Q \rightarrow P)$
$\sim Q$
$\sim P$
P
Q

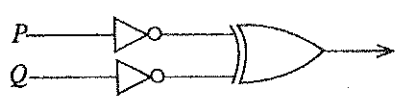
41. The logical validity of the Popperian argument for the falsity of the hypothesis under test is based on the assumption that

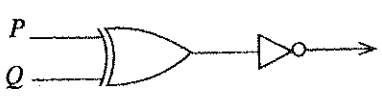
(1) the hypotheses is in the natural sciences.
(2) initial conditions and auxiliary hypotheses are all true.
(3) the observation supports the hypotheses.
(4) the observation is repeated.
(5) experimental data are quantitative.

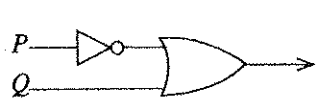
42. Which of the following gates results in the strong disjunction of the negations of each of P and Q?

(1) 

(2) 

(3) 

(4) 

(5) 

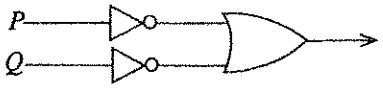
43. Which methodologist of science developed the Covering Law Model of Explanation?

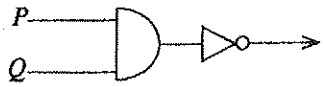
(1) Aristotle (2) Ernest Nagel (3) Carl Hempel
(4) Rudolf Carnap (5) Galileo

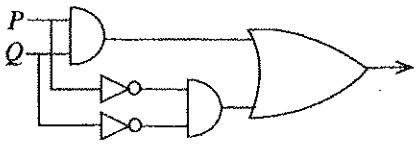
[see page six

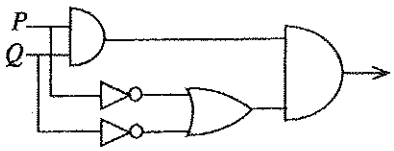
44. In Lakatos' methodology a scientist in a Research Programme should
(1) keep the protective belt intact.
(2) ignore the negative heuristic.
(3) change the hardcore and bring about a revolution.
(4) act in accordance with the positive heuristic and make changes in the protective belt.
(5) change the hardcore and protective belt to make the programme progressive.

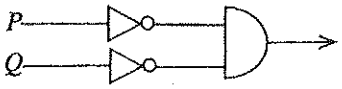
45. Which of the following is a correct logic gate for $(\sim P \leftrightarrow \sim Q)$?

(1) 

(2) 

(3) 

(4) 

(5) 

46. When Paul Feyerabend says "anything goes" in his anarchistic methodology what he intends to say is best expressed by
(1) a scientist must tell lies.
(2) a scientist may distort data.
(3) what the history of science shows is that it is the establishment of acceptable hypothesis that matters irrespective of the methods used.
(4) there are no method that a scientist can use.
(5) development of more and more refined methods is the purpose of science.

47. If the variable of instantiation is new which following formula is obtained by existential instantiation from the formula $\forall y(Fx \wedge Gy) \wedge HB$
(1) $(Fx \wedge Gy) \wedge HB$ (2) $(Fx \wedge Gz) \wedge HB$ (3) $(Fz \wedge Gy) \wedge HB$ (4) $(Fx \wedge GA) \wedge HB$ (5) $(Fx \wedge GA) \wedge HA$

48. In Kuhn's view Newtonian physics **cannot** be reduced the Einsteinian Physics as
(1) reductions are only approximate.
(2) Newton did not have sophisticated instruments that Einstein used.
(3) the world has changed very fast during the last three centuries.
(4) all theories are only probable.
(5) the conceptual systems of Newton and Einstein are different.

49. Which of the following is a symbolic sentence?
(1) $(\Lambda x(Fx \rightarrow Gx) \wedge P)$
(2) $\forall x(Fx \wedge Gy)$
(3) $\Lambda x Fx \wedge \Lambda z Gx$
(4) $(FA \rightarrow Gx)$
(5) $(\Lambda x(Fx \rightarrow Gx) \wedge Hx)$

50. Who was the scientist at Cambridge University with whom Ramanujan collaborated?
(1) Ernest Rutherford
(2) Bertrand Russell
(3) G.H. Hardy
(4) P.A.M. Dirac
(5) Francis Crick

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இலங்கைப் பரீட்சைத் திணைக்களம்
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අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය, 2015 අගෝස්තු
கல்விப் பொதுத் தராதரப் பத்திர (உயர் தர)ப் பரீட்சை, 2015 ஓகஸ்ற்
General Certificate of Education (Adv. Level) Examination, August 2015

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

Instructions:

* *Answer* ***eight*** *questions selecting* ***four*** *questions each from Part* **I** *and* **II.**

N.B.

* Logical constants used in this paper are the following:
Negation: ~, Implication: →, Conjunction: ∧, Disjunction: ∨, Biconditional (Equivalence): ↔
Universal quantifier : Λ, 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*) Determine whether the following are valid or invalid syllogisms. When the syllogism is invalid state the rule/rules violated and name the resulting fallacy/fallacies.

   (i) Some Sri Lankans are not women.
   Some women are pretty.
   Therefore some Sri Lankans are pretty.

   (ii) X is a crow.
   X flies.
   Therefore crows fly.

   (05 marks)

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

   (i) Elephants are black.
   Some elephants are not tuskers.
   Therefore some tuskers are not black.

   (ii) Five men climbed Everest.
   Those who climb Everest are mountaineers.
   Therefore men are mountaineers.

   (05 marks)

2. (*a*) What are empirical tests? State and explain the **two** main types of empirical tests giving an example each.

   (05 marks)

   (*b*) "Both types of tests in the answer to (*a*) is a test of a hypothesis." Comment.

   (05 marks)

3. (*a*) Symbolize the following argument giving your scheme of abbreviation and determine its validity or invalidity by the indirect method of truth tables.

   Either he wears a helmet or he gets arrested by the police. If he gets arrested by the police he will be prosecuted. If he is prosecuted he will be either fined or jailed. Therefore he is fined and jailed.

   (05 marks)

   (*b*) Symbolize the following argument giving your scheme of abbreviation and determine its validity or invalidity using the truth tree method.

   Sri Lanka wins the match if it is held in Colombo. Sri Lanka does not win it otherwise. The match was held. Sri Lanka won the match. Therefore the match was held in Colombo.

   (05 marks)

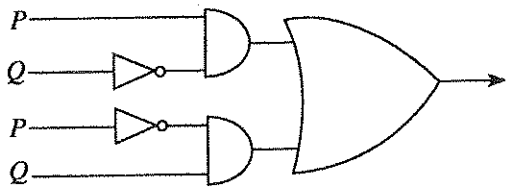
[see page two

4. (*a*) What is the range in the following set of quantities?

1, 5, 2, 9, 19, 24 *(02 marks)*

(*b*) Calculate the ratio between the standard deviation and the mean deviation of the (a) above quantities, giving all your steps clearly. (Square roots in your reply may be left without further calculation) *(08 marks)*

5. (*a*) Express the symbolic formula represented by the logic gate given below using only the logical constants of negation and implication.



(05 marks)

(*b*) Prove the following theorems.

(i) $((P \wedge Q) \rightarrow R) \leftrightarrow ((P \wedge \sim R) \rightarrow \sim Q)$

(ii) $(P \rightarrow Q) \leftrightarrow \sim (P \wedge \sim Q)$ *(05 marks)*

Part II

6. Symbolize the following arguments, giving your scheme of abbreviation and show them to be valid by the method of derivation.

(i) The Wesak pandols are beautiful and instructive but costly. If Wesak pandols are beautiful then they are attractive, but if they are costly then they are not attractive. Therefore Buddhists observe *sil* on Wesak day. *(05 marks)*

(ii) Cricket is a gentlemen's game but it is also a lucrative one. If it is a lucrative game then it is a Twenty-twenty game. If it is a gentlemen's game then it is Test cricket. Therefore cricket is both a Twenty-twenty game or a Fifty over game and Test cricket or a fifty over game. *(05 marks)*

(iii) Unless he wins the election, he would become a businessman. If and only if he wins the election he becomes a businessman. Therefore if he does not win the election, then the earthquake in Nepal brings down the Himalayan mountains. *(05 marks)*

7. (*a*) Discuss the salient aspects of field survey method used for social scientific investigation. *(07 marks)*

(*b*) "Scientific explanation, in the way it is possible in the natural sciences, is not possible in the social sciences. Social sciences should aim at understanding rather than at explanation." Make your observations on this matter. *(08 marks)*

8. (*a*) Symbolize the following sentences using Predicate Calculus, giving your schemes of abbreviation.

(i) Only dual citizens are voters.

(ii) If all crocodiles are dangerous then some men were their victims. *(05 marks)*

(*b*) Symbolize the following arguments using predicate calculus and giving your schemes of abbreviation and show them to be valid by derivation.

(i) All rabbits are lovable little things. Therefore if this is a rabbit then there are lovable little things. *(05 marks)*

(ii) All swimmers, unless they are over eighteen, they are accompanied by security guards. She is a pretty girl who is a swimmer but she is not accompanied by security guards. Therefore she is a pretty girl over eighteen. *(05 marks)*

9. (*a*) Outline Karl Poppers' methodology of science and discuss the problems that it faces in practice. *(06 marks)*

(*b*) Give a brief account of Thomas Kuhn's view of the process of science. In what main aspects does it differ from Popper's. *(09 marks)*

10. (*a*) The anarchistic view which Feyerabend's "Anything goes (in methodology)" expresses, holds that the distinction between sciences and other fields is more made up than real. What would you say about this view? *(07 marks)*

(*b*) Give the normal distinction between ethical statements and scientific statements and explain why an ethics is needed for science. *(08 marks)*

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