G.C.E. (Advanced Level) Examination - 2021 (2022)

67 - Science for Technology

Marking Scheme

Distribution of Marks

Paper I:

MCQ (All fifty questions should be Answered) 1 x 50 = 50 Marks

Paper II:

Part A - Structured Essay (All four questions should be Answered)

Question No. 01: 100
Question No. 02: 100
Question No. 03: 100
Question No. 04: 100

Total (Structured Essay): 100 Marks x 4 = 400 Marks

Part B, C, D: Four questions should be answered selecting minimum one questions from parts B, C and D

Part B - Essay
Question No. 05: 150
Question No. 06: 150

Part C - Essay
Question No. 07: 150
Question No. 08: 150

Part D - Essay
Question No. 09: 150
Question No. 10: 150

Total (Essay): 150 Marks x 4 = 600 Marks

Total Marks of Paper II = 400 + 600 = 1000

Final Marks of Paper II = 1000 ÷ 20 = 50

Common Techniques of Marking Answer Scripts.

It is compulsory to adhere to the following standard method in marking answer scripts and entering marks into the mark sheets.

1. Use a red color ball point pen for marking. (Only Chief/Additional Chief Examiner may use a mauve color pen.)
2. Note down Examiner's Code Number and initials on the front page of each answer script.
3. Write off any numerals written wrong with a clear single line and authenticate the alterations with Examiner's initials.
4. Write down marks of each subsection in a △ and write the final marks of each question as a rational number in a □ with the question number. Use the column assigned for Examiners to write down marks.

Example: **Question No. 03**

(i) ..... √ △ $\frac{4}{5}$

(ii) ..... √ △ $\frac{3}{5}$

(iii) ..... √ △ $\frac{3}{5}$

03 (i) $\frac{4}{5}$ + (ii) $\frac{3}{5}$ + (iii) $\frac{3}{5}$ = □ $\frac{10}{15}$

MCQ answer scripts: (Template)

1. Marking templets for G.C.E.(A/L) and GIT examination will be provided by the Department of Examinations itself. Marking examiners bear the responsibility of using correctly prepared and certified templates.
2. Then, check the answer scripts carefully. If there are more than one or no answers Marked to a certain question write off the options with a line. Sometimes candidates may have erased an option marked previously and selected another option. In such occasions, if the erasure is not clear write off those options too.
3. Place the template on the answer script correctly. Mark the right answers with a 'V' and the wrong answers with a 'X' against the options column. Write down the number of correct answers inside the cage given under each column. Then, add those numbers and write the number of correct answers in the relevant cage.

structured essay type and assay type answer scripts:

1. Cross off any pages left blank by candidates. Underline wrong or unsuitable answers. Show areas where marks can be offered with check marks.

2. Use the right margin of the overland paper to write down the marks.

3. Write down the marks given for each question against the question number in the relevant cage on the front page in two digits. Selection of questions should be in accordance with the instructions given in the question paper. Mark all answers and transfer the marks to the front page, and write off answers with lower marks if extra questions have been answered against instructions.

4. Add the total carefully and write in the relevant cage on the front page. Turn pages of answer script and add all the marks given for all answers again. Check whether that total tallies with the total marks written on the front page.

Preparation of Mark Sheets.

Except for the subjects with a single question paper, final marks of two papers will not be calculated within the evaluation board this time. Therefore, add separate mark sheets for each of the question paper. Write paper 01 marks in the paper 01 column of the mark sheet and write them in words too. Write paper II Marks in the paper II Column and wright the relevant details.

***

සියලු ම හිමිකම් ඇවිරිණි / முழுப் பதிப்புரிமையுடையது / All Rights Reserved]

ශ්‍රී ලංකා විභාග දෙපාර්තමේන්තුව ශ්‍රී ලංකා විභාග දෙපාර්තමේන්තුව
Department of Examinations, Sri Lanka Department of Examinations, Sri Lanka
இலங்கைப் பரீட்சைத் திணைக்களம்
Department of Examinations, Sri Lanka

අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය, 2021(2022)
கல்விப் பொதுத் தராதரப் பத்திர (உயர் தர)ப் பரீட்சை, 2021(2022)
General Certificate of Education (Adv. Level) Examination, 2021(2022)

තාක්ෂණවේදය සඳහා විද්‍යාව I தொழினுட்பவியலுக்கான விஞ்ஞானம் I **Science for Technology I**	**67 E I**	පැය දෙකයි இரண்டு மணித்தியாலம் ***Two hours***

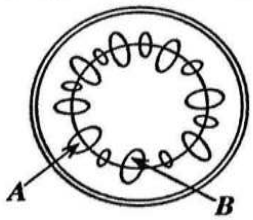
Instructions:

- * *Answer **all** the questions.*
- * *Write your **Index Number** in the space provided in the answer sheet.*
- * *Read the instructions given on the back of the answer sheet 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** (×) **in accordance with the instructions given on the back of the answer sheet.***
- * ***Use of non-programmable calculators is allowed.***

1. Which cellular structure is common in both prokaryotic and eukaryotic cells?
(1) Plasma membrane (2) Lysosome (3) Golgi bodies
(4) Mitochondria (5) Peroxisome

2. Amylase enzyme is produced by
(1) *Escherichia coli.* (2) *Aspergillus niger.*
(3) *Aspergillus oryzae.* (4) *Saccharomyces cerevisiae.*
(5) *Corynebacterium glutamicum.*

3. A cross section of a plant stem is shown in the picture.



Correct labelling of *A* and *B* are respectively
(1) Cortex and Phloem. (2) Xylem and Phloem.
(3) Cambium and Phloem. (4) Phloem and Xylem.
(5) Phloem and Cambium.

4. Consider the following statements regarding plant tissues.
A - Meristematic and permanent tissues are two main types of plant tissues.
B - Parenchyma, collenchyma and sclerenchyma tissues are abundant meristematic tissues in plants.
C - The cells present in meristematic tissues are continuously divided to produce new cells.
Of the above, the correct statement/s would be
(1) A only. (2) B only. (3) C only.
(4) A and B only. (5) A and C only.

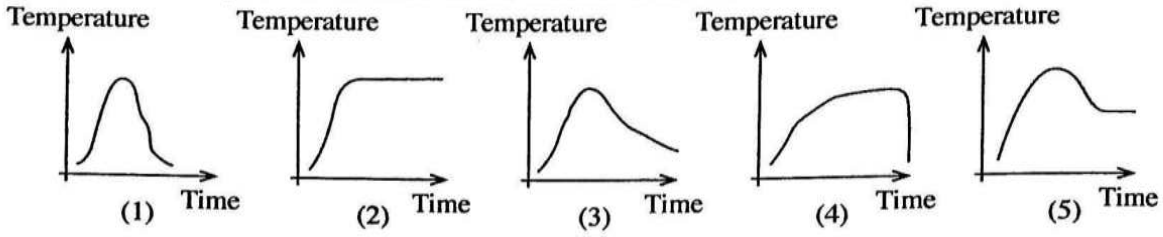
5. What is the main function of kinase enzyme?
(1) Digestion of lipids into fatty acids
(2) Phosphorylation of protein
(3) Digestion of enzymes to amino acids
(4) Digestion of medicines
(5) Metabolization of medicines into water soluble compounds

[*See page two*

6. What is the unit of retention factor (R_f) calculated in a thin layer chromatographic experiment?
(1) cm (2) cm^2 (3) cm^{-1} (4) $cm\ s^{-1}$ (5) No units

7. What chemical is used to remove lignin from wood in the paper industry?
(1) clay (2) chlorine
(3) calcium carbonate (4) sodium hydroxide
(5) sodium hypochloride

8. When equal volumes of 1 mol dm^{-3} HCl and 1 mol dm^{-3} NaOH are mixed, which graph correctly shows the temperature variation of the mixture with time?



9. All chemical reactions
(1) are exothermic.
(2) are single step reactions.
(3) are always require a catalyst.
(4) are endothermic and single step reactions.
(5) reactants must collide with each other to react.

10. Phthalates are used in the process of plastic production
(1) as a colouring agent. (2) as a stabilizing agent.
(3) as a filling agent. (4) to increase the flexibility.
(5) as a fire retarding material.

11. When multiple methods are available for a chemical industry, the method selected for a sustainable industry needs to
(1) recycle waste produced.
(2) utilize a large quantity of water.
(3) depend only on manpower.
(4) be based on imported raw materials.
(5) a method that uses fossil fuels.

12. Consider the following statements regarding hydrogen produced using fossil fuels.
A - Combustion of hydrogen gas produces poisonous gases.
B - Hydrogen production process increases the amount of CO_2 in the environment.
C - Combustion of hydrogen gas produces H_2O.
Of the above, the correct statement/s would be
(1) A only. (2) B only. (3) C only.
(4) A and B only. (5) B and C only.

13. What is the correct statement regarding proteins?
(1) Collagen is used to produce gelatin.
(2) All catalysts are proteins.
(3) All proteins are globular proteins.
(4) 'Whey protein' is found in corn starch.
(5) Gluten is found in eggs.

14. Caffeine in coffee is
(1) an alkaloid. (2) an antioxidant. (3) an essential oil.
(4) a primary metabolite. (5) a polyphenolic compound.

15. What is a process that can occur in the environment?
(1) Increase of the pH of ocean water due to the dissolution of CO_2.
(2) Combustion of wood releases new carbon to the environment.
(3) CO_2 gas in the atmosphere produces acid rain.
(4) Ozone amount near to the earth surface can be increased due to pollution.
(5) Ethane released by cattle creates green house effect.

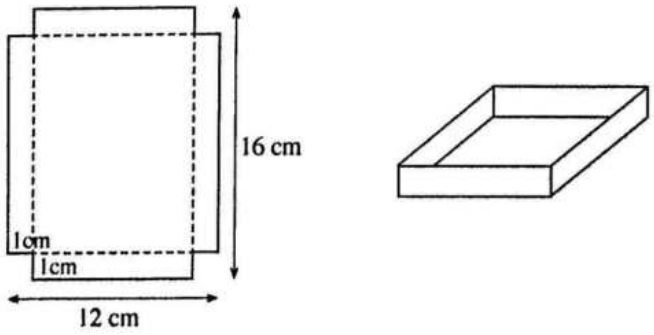
16. Consider the following statements regarding the uses of microorganisms.
A - for the production of fertilizers
B - for the production of food supplements
C - for the removal of poisonous organic compounds at the tertiary water purification stage
Of the above, the correct statement/s would be
(1) A only. (2) A and B only. (3) A and C only.
(4) B and C only. (5) all A, B and C.

17. What is the correct statement regarding carbohydrates?
(1) Carbohydrates contain nitrogen.
(2) Glucose is the sweetest natural sugar.
(3) Amylopectin is a branched polysaccharide.
(4) Simple sugars can be hydrolyzed further into smaller molecules.
(5) Nitrocellulose is commonly used for the production of fabrics.

18. What is the true statement regarding enzymes?
(1) Enzymes are pH resistance.
(2) Enzymes are active even at higher temperatures.
(3) Enzymes can be carbohydrates or proteins.
(4) Most enzymatic reactions produce multiple by-products.
(5) Some enzymes need a cofactor to maintain their function.

19. What distance has a bicycle ridden, if its wheel of radius 20 cm has turned 2500 rounds when it is ridden? (Consider $\pi = 3$)
(1) 350 m (2) 1200 m (3) 3000 m (4) 3500 m (5) 4000 m

20. An open-top box is made by removing four squares of side length 1 cm out of each corner of a rectangular piece of cardboard of length 16 cm and width 12 cm and by folding the tabs along the creases shown.



The volume of the box is
(1) 96 cm^3 (2) 140 cm^3 (3) 165 cm^3 (4) 192 cm^3 (5) 280 cm^3

15. What is a process that can occur in the environment?
(1) Increase of the pH of ocean water due to the dissolution of CO_2.
(2) Combustion of wood releases new carbon to the environment.
(3) CO_2 gas in the atmosphere produces acid rain.
(4) Ozone amount near to the earth surface can be increased due to pollution.
(5) Ethane released by cattle creates green house effect.

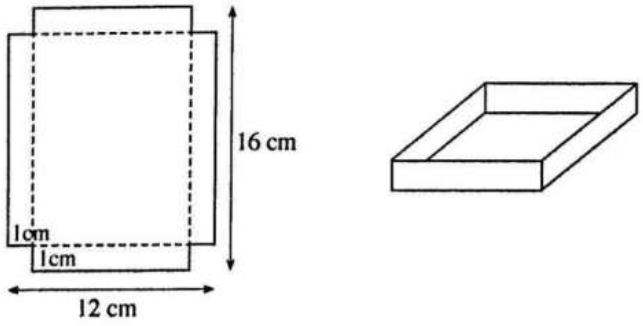
16. Consider the following statements regarding the uses of microorganisms.
A - for the production of fertilizers
B - for the production of food supplements
C - for the removal of poisonous organic compounds at the tertiary water purification stage
Of the above, the correct statement/s would be
(1) A only. (2) A and B only. (3) A and C only.
(4) B and C only. (5) all A, B and C.

17. What is the correct statement regarding carbohydrates?
(1) Carbohydrates contain nitrogen.
(2) Glucose is the sweetest natural sugar.
(3) Amylopectin is a branched polysaccharide.
(4) Simple sugars can be hydrolyzed further into smaller molecules.
(5) Nitrocellulose is commonly used for the production of fabrics.

18. What is the true statement regarding enzymes?
(1) Enzymes are pH resistance.
(2) Enzymes are active even at higher temperatures.
(3) Enzymes can be carbohydrates or proteins.
(4) Most enzymatic reactions produce multiple by-products.
(5) Some enzymes need a cofactor to maintain their function.

19. What distance has a bicycle ridden, if its wheel of radius 20 cm has turned 2500 rounds when it is ridden? (Consider $\pi = 3$)
(1) 350 m (2) 1200 m (3) 3000 m (4) 3500 m (5) 4000 m

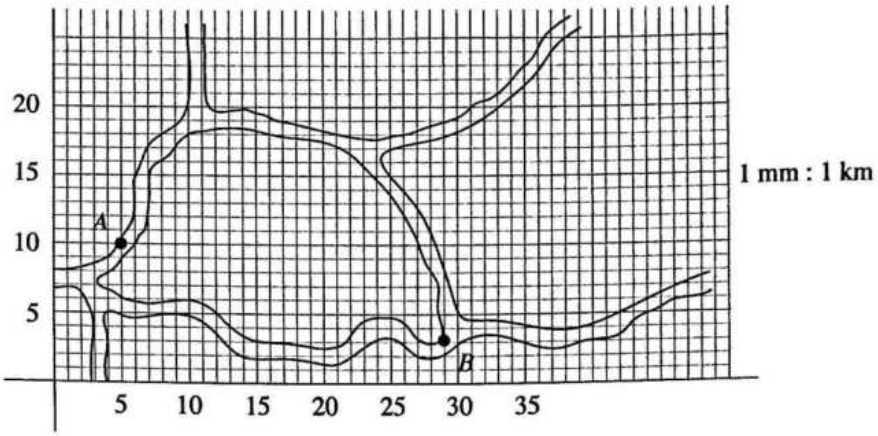
20. An open-top box is made by removing four squares of side length 1 cm out of each corner of a rectangular piece of cardboard of length 16 cm and width 12 cm and by folding the tabs along the creases shown.



The volume of the box is
(1) 96 cm^3 (2) 140 cm^3 (3) 165 cm^3 (4) 192 cm^3 (5) 280 cm^3

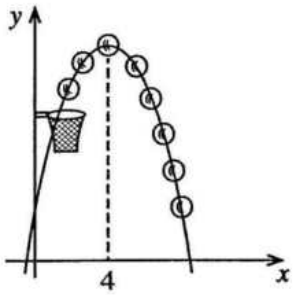
[See page four

21. Use the grid coordinates to find the direct distance between the two marked locations A and B in the following Google map. Consider, a small square here is 1 mm × 1 mm.



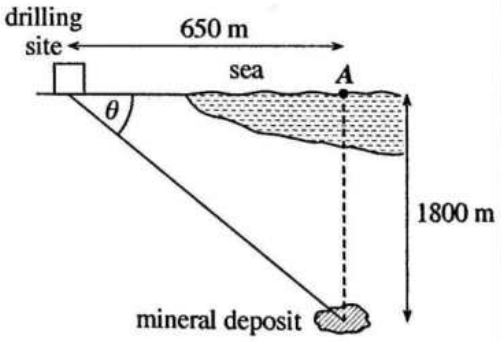
(1) 23 km (2) 24 km (3) 25 km (4) 26 km (5) 27 km

22. The path of the basketball shown in the picture can be modelled by the equation $y = -0.5x^2 + 4x + 2$. If the ball reached the maximum height at $x = 4$ units, this height is



(1) 8 units
(2) 10 units
(3) 16 units
(4) 20 units
(5) 26 units

23. In Pesalai, a mineral deposit is detected at a location 1800 m below the point A in the sea. The nearest drilling site is located 650 m away from A as shown in the diagram. In what angle θ, must the straight drilling path take place to reach the mineral deposit.

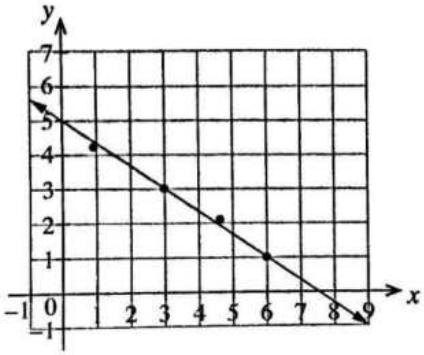


(1) $\tan^{-1}\left(\frac{1800}{650}\right)$ (2) $\tan^{-1}\left(\frac{650}{1800}\right)$

(3) $\sin^{-1}\left(\frac{1800}{650}\right)$ (4) $\cos^{-1}\left(\frac{1800}{650}\right)$

(5) $\cos^{-1}\left(\frac{650}{1800}\right)$

24. Data gathered in an experiment is plotted to identify the relationship between the two variables x and y. Which equation best describes the relationship between the variables?



(1) $y = \frac{2}{3}x + 5$

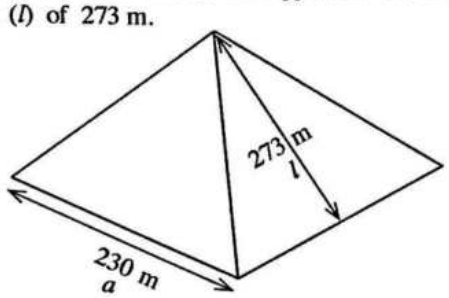
(2) $y = -\frac{2}{3}x + 5$

(3) $y = -\frac{2}{3}x + 7.5$

(4) $y = 1.5x + 5$

(5) $y = -1.5x + 5$

● Questions **25** and **26** are based on the pyramid of Giza in Egypt (shown in the figure) which is one of the Seven Wonders of the World. The pyramid has a square base of side length (a) 230 m and a slant height (l) of 273 m.



25. The vertical height (h) of the pyramid, to the nearest metre (m) is

(1) 147. (2) 225. (3) 248. (4) 296. (5) 357.

26. What formula can be used to calculate the volume (V) of the pyramid?

(1) $V=\left(\frac{a}{2}\right)^2 h$ (2) $V=\frac{1}{3}a^2h$ (3) $V=\frac{1}{3}ahl$ (4) $V=\frac{1}{3}\left(\frac{a}{2}\right)^2 h$ (5) $V=\frac{1}{3}a^2hl$

27. A fair die numbered from 1 to 6 is tossed four times. The variable X is the number of times of the value 6 of the die turns up. The mean and the median of the **all possible values** of X are respectively

(1) 2.0 and 2.0. (2) 2.0 and 2.5. (3) 2.5 and 2.5. (4) 2.5 and 3.5. (5) 3.5 and 3.5.

28. $\sum_{i=1}^{10}(2x_i+5)$ is equal to

(1) $2\sum_{i=1}^{10}x_i+5$ (2) $2\sum_{i=1}^{10}x_i+50$

(3) $20\sum_{i=1}^{10}x_i+5$ (4) $20\sum_{i=1}^{10}x_i+50$

(5) $20\sum_{i=1}^{10}x_i+10$

29. Consider the following statements.

A - Control Unit, Arithmetic and Logic Unit and Memory Registers are the main components of the Central Processing Unit.

B - MS-DOS is an example of a single-user and multi tasking operating system.

C - The capacity of the RAM (Random Access Memory) is an important factor that impacts the efficiency of a computer.

Of the above, the correct statement/s would be

(1) A only. (2) B only. (3) C only.
(4) A and C only. (5) B and C only.

30. What is the first step of the booting process of a computer?

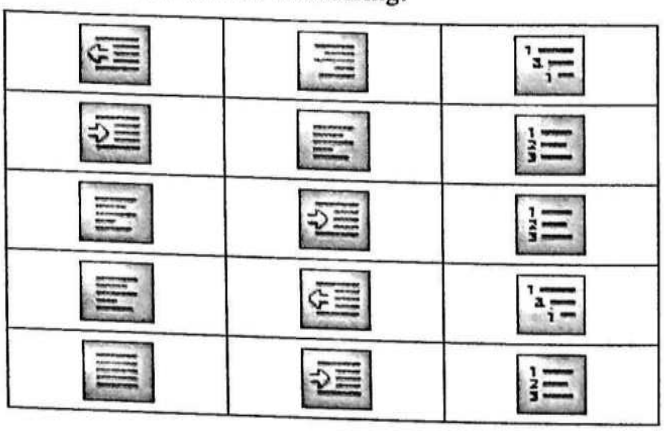
(1) User Test (2) Reliability Test
(3) Integrity Test (4) Correct Functioning Test
(5) Power-On Self Test

31. What tool can be used to insert the author's name at the bottom of every page of a word document?

(1) Header (2) Footer (3) WordArt
(4) Bookmark (5) Comment

[See page six

32. What is the correct order of icons used in a typical word processing software to indicate left align, increase indent and numbering.

(1) 

(2)

(3)

(4)

(5)

33. When a content is larger than a cell size of a spreadsheet, what tool can be used to show all the content within the same cell?

(1) Filter (2) Wrap Text (3) Merge Cells
(4) Text Direction (5) Fill Effect

34. What command can be used to display only the current date in a cell of a spreadsheet?

(1) =Today() (2) =Year() (3) =Date()
(4) =Time() (5) =Now()

35. What is the view in PowerPoint that can be used to see all slides of a presentation at once?

(1) Slide Show (2) Slide View (3) Normal View
(4) Reading View (5) Slide Sorter View

36. What feature in PowerPoint software is used to apply the motion effects when changing from one slide to the next slide?

(1) Slide Insert (2) Slide Design
(3) Slide Transition (4) Animation Objects
(5) Animation Scheme

37. What is the **incorrect** statement?

(1) SMTP is a communication protocol for mail servers to transmit email.
(2) 125.214.169.218 is an example for an IP address.
(3) Google Chrome and Mozilla Firefox are web browsers.
(4) www.doenets.lk is an example for a URL.
(5) HTTP stands for Hypertext Telecommunication Protocol.

38. Consider the following statements regarding cyberbullying.

A - It is the deliberate use of digital technologies to humiliate, harm or harass other people.
B - It can affect mental, emotional or physical wellbeing of a person.
C - It is a crime and laws are available to take actions against it.

Of the above, the correct statement/s would be

(1) A only. (2) B only. (3) C only.
(4) A and B only. (5) all A, B and C.

39. What is the unit of moment of inertia?

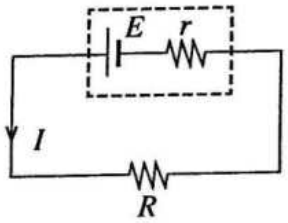
(1) $N m s^2$ (2) $kg m^2$ (3) $kg m$ (4) $J s^2$ (5) $kg^2 m^2$

40. Which one of the following is **not** a vector quantity?
(1) Torque (2) Linear acceleration
(3) Angular acceleration (4) Angular velocity
(5) Angular frequency

41. The angular velocity of a car engine is increased from 800 rpm to 3200 rpm in 15 s at a constant rate. What is its angular acceleration of the engine?
(1) 160 rpm/min (2) 4000 rpm/min (3) 9600 rpm/min
(4) 16000 rpm/min (5) 36000 rpm/min

42. What is the electricity cost for 30 days of a 1.5 kW air conditioner, if it operates for 2 hours per day? (Assume the cost of 1 kWh is 10 rupees)
(1) Rs. 450 (2) Rs. 600 (3) Rs. 900 (4) Rs. 1200 (5) Rs. 1800

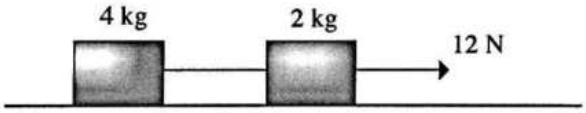
43. A battery (Electro motive force E, internal resistance r) is connected to an external load R as shown in the diagram. The battery delivers a current I through the circuit. Consider the following equations about the voltage (V_R) across the load R.



(A) $V_R = IR$
(B) $V_R = E - Ir$
(C) $V_R = E + Ir$

Of the above, the correct would be
(1) (A) only. (2) (B) only. (3) (C) only.
(4) (A) and (B) only. (5) all (A), (B) and (C).

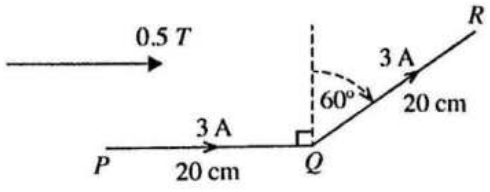
44. Consider two blocks of masses 4 kg and 2 kg placed on a frictionless horizontal surface connected with a light inextensible string as shown in the figure. If the mass 2 kg is pulled horizontally with a force of 12 N, what is the tension on the string?



(1) 2 N (2) 4 N (3) 6 N (4) 8 N (5) 10 N

45. A piece of copper is cooled in a refrigerator and then put in a thermally insulated jug with water at the room temperature. What information is **not** required to calculate the specific heat capacity of copper?
(1) Mass of the water
(2) Mass of the copper
(3) Specific heat capacity of water
(4) Temperature of cooled copper piece
(5) Time taken for the system to reach room temperature

46. A metal wire PQR of 40 cm long is placed in a magnetic field of 0.5 T parallel to PQ segment as shown in the diagram. What is the net force exerted on the wire segment, when current through the wire is 3 A?

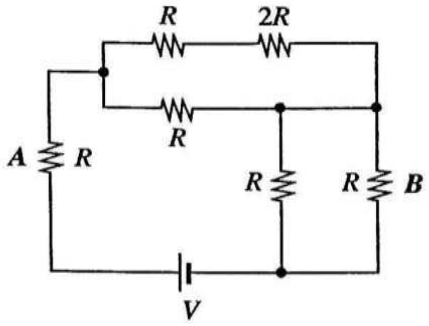


(1) 0.15 N
(2) 0.60 N
(3) 15 N
(4) 45 N
(5) 60 N

θ	30	45	60
sin	$\frac{1}{2}$	$\frac{1}{\sqrt{2}}$	$\frac{\sqrt{3}}{2}$
cos	$\frac{\sqrt{3}}{2}$	$\frac{1}{\sqrt{2}}$	$\frac{1}{2}$

[See page eight

47. Six resistors and a battery are connected in a circuit as shown in the diagram. How many times of the power dissipation of resistor A, as power dissipation of resistor B?

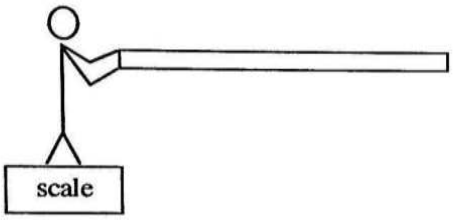


(1) 1 (2) 2 (3) 3 (4) 4 (5) 5

48. The potential energy stored in a light spring is E when stretched by 1 m. What is the potential energy of the spring when the same spring is stretched by 2 m?

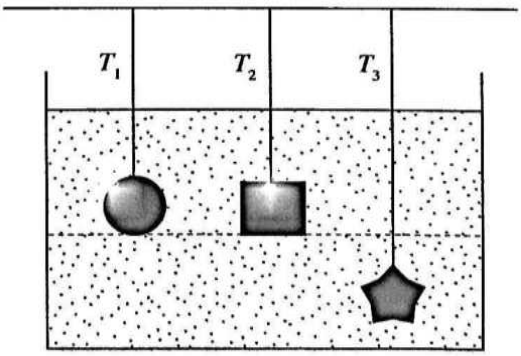
(1) $\frac{E}{2}$ (2) E (3) 2 E (4) 3 E (5) 4 E

49. A man of mass 70 kg is standing in a stable position on a weighing scale while horizontally holding a uniform pole of length of 2 m and mass of 5 kg as shown below. What is the reading of the scale?



(1) 73 kg
(2) 74 kg
(3) 75 kg
(4) 77 kg
(5) 80 kg

50. Three solid blocks each with equal volumes and masses are immersed in a water tank using three light ropes with negligible volumes as shown in the given diagram. What is the correct relationship among the tensions T_1, T_2 and T_3 of these three ropes?



(1) $T_1 = T_2 = T_3$ (2) $T_1 = T_2 > T_3$ (3) $T_1 = T_2 < T_3$ (4) $T_1 < T_2 < T_3$ (5) $T_1 > T_2 > T_3$

* * *

ශ්‍රී ලංකා විභාග දෙපාර්තමේන්තුව

Department of Examinations – Sri Lanka

අ.පො.ස.(උ.පෙළ)විභාගය/G.C.E. (A/L)- 2021(2022)

විෂයය අංකය
Subject No: 67

විෂයය
Subject: **Science For Technology**

ලකුණු දීමේ පටිපාටිය/Marking Scheme
I පත්‍රය/Paper I

ප්‍රශ්න අංකය Question No.	පිළිතුරු අංකය Answer No.	ප්‍රශ්න අංකය Question No.	පිළිතුරු අංකය Answer No.	ප්‍රශ්න අංකය Question No.	පිළිතුරු අංකය Answer No.	ප්‍රශ්න අංකය Question No.	පිළිතුරු අංකය Answer No.	ප්‍රශ්න අංකය Question No.	පිළිතුරු අංකය Answer No.
01.	1	11.	1	21.	3	31.	2	41.	3
02.	2	12.	5	22.	2	32.	3	42.	3
03.	4	13.	1	23.	1	33.	2	43.	4
04.	5	14.	1 or 2	24.	2	34.	1	44.	4
05.	2	15.	4	25.	3	35.	5	45.	5
06.	5	16.	2	26.	2	36.	3	46.	1
07.	4	17.	3	27.	1	37.	5	47.	4
08.	3	18.	5	28.	2	38.	5	48.	5
09.	5	19.	3	29.	4	39.	2	49.	3
	4		2		5		5		1

✪ **විශේෂ උපදෙස්/Special Instructions:**
එක් පිළිතුරකට ලකුණු 01 බැගින්/ 01 Mark for each question
මුළු ලකුණු/Total Marks 01 × 50 = 50

(1) (A) Primary and secondary are two main types of natural forests. **A** and **B** are schematic diagrams of these two types of forests.

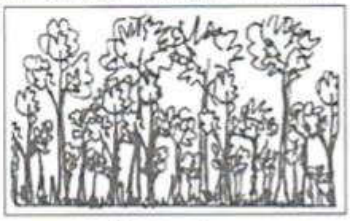


Diagram **A**

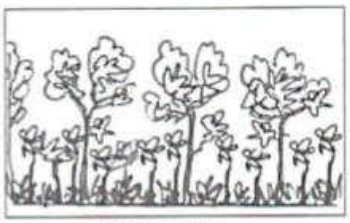


Diagram **B**

(i) Identify diagrams **A** and **B**, and write the forest type in the given box below.

Diagram **A**	Primary Forest	**05 marks**
Diagram **B**	Secondary Forest	**05 marks**

(ii) Write **two** examples for primary forests in Sri Lanka.

Sinharaja , Kanneliya, Ritigala, Piduruthalagala, Adams Peak, Dadiya Gala, Nakiya Deniya

Any two correct answers, provide marks only for the first two (05 marks × 2)

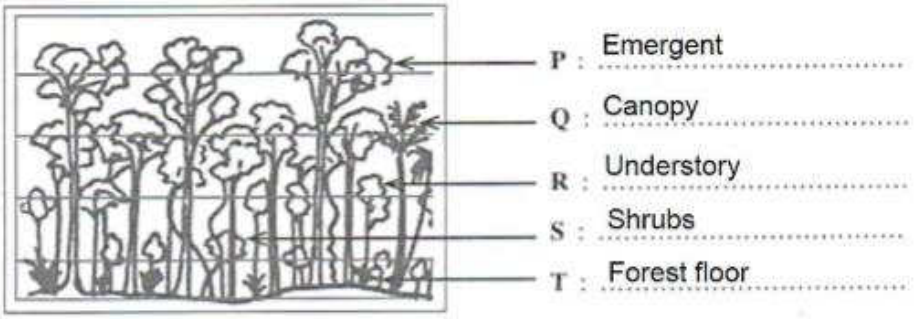
(iii) Write **two** main structural differences between primary and secondary forests.

Primary	Secondary
Trees at different ages	Most of the trees at the same age
Many different layers of trees	maximum two or three layers
High biodiversity	less biodiversity

(Offer 10 marks when the fact is correct for both primary and secondary)

(10 marks × 2)

(B) The diagram below represents the stratification of a tropical rain forest. Name each layer labelled as **P**, **Q**, **R**, **S** and **T** in this tropical rain forest.



(03 marks × 5)

(C) Forests exposed to destruction can be regrown artificially using suitable plants.

(i) Name **two** plants suitable for artificial regrowing of the forests.

Teak. Mahogany, Eucalyptus, Pinus, Turpentine

Any two correct answers, provide marks only for the first two (05 marks × 2)

(ii) Write **two** reasons for selecting such plants for artificial regrowing of the forests.

Easy to grow
high growth rate
easy adaptation
easy adaptation/ resistant for pathogens/resistant for adverse environmental conditions

Any two correct answers, provide marks only for the first two (05 marks × 2)

(D) Tissue culture can be used to propagate an endangered plant in a forest to secure it's existence.

(i) Name **two** explants that can be used in tissue culture.

Apical meristem, young leaves, young stems, pollen, embryos, buds

Any two correct answers, provide marks only for the first two (05 marks × 2)

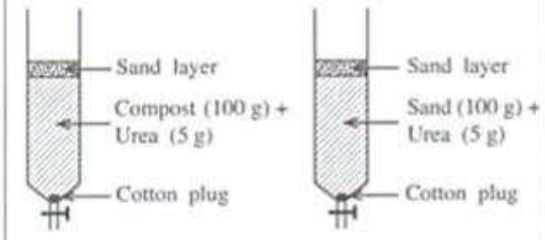
(ii) Write **five** major components that must contain in a tissue culture growth media.

Water, organic nutrients, inorganic nutrients, growth regulators (Hormones), vitamins

Any five correct answers, provide marks only for the first five (03 marks × 5)

Question 02 = Total Marks 100

(02) Compost fertilizer can improve the quality of soil and increase the retainability of nutrients in soil. A group of students conducted an experiment to determine the amount of nutrients removed with water when urea is added with the compost fertilizer. The experiment setup and the collected data is provided in the table below.



Day	Amount of amonium ions released	
	Experimental setup (Compost + Urea)	Control setup (Sand + Urea)
01	0.3 g	1.0 g
02	0.4 g	0.7 g
03	0.3 g	0.6 g
04	0.3 g	0.3 g
05	0.3 g	0.2 g
06	0.2 g	0.2 g
07	0.2 g	0.0 g
08	0.1 g	0.0 g
09	0.1 g	0.0 g
10	0.1 g	0.0 g

(A) 5.0 g of urea is mixed with the 100.0 g of compost fertilizer and packed in a column. A layer of sand added on top of the compost-urea mixture as shown in the figure. A control setup was arranged by using sand-urea mixture as shown in the figure. Each day a 50 g of water was added, and measured the amount of nutrient in the leachate.

(i) What is the nutrient provided by urea?

Nitrogen or N (No marks for N_2)

(05 marks)

(ii) Why should plant nutrients be soluble in water?

Dissolve in soil water/ to absorb by the roots (plant)

(05 marks)

(B) When a urea sample of 5.0 g was dissolved in 100.0 g of water, the temperature of the mixture dropped by 2 °C.

(i) Calculate the amount of energy absorbed by the water due to the dissolution of urea. (Specific heat capacity of water = 4.2 J g^{-1} $°C^{-1}$).

$\Delta E = m\ c\ \Delta\theta$

(05 marks)

$= 100\ g \times 2 \times 4.2\ J\ g^{-1}\ °C^{-1}$

(05 marks) No units required

$= 840\ J$

(04 + 1 marks)

(ii) Calculate the dissolution reaction heat of urea in water. (Molar mass of urea = 60 g mol^{-1})

Energy when 5 g of urea dissolved = 840 J (or the answer of i)

(05 marks)

Energy when dissolve 60 g urea (one mole) = 840 J × 60/5

(05 marks)

= 10080 J (10.08 kJ)

(04 +1 marks)

(C) When 5.0 g of urea is dissolved in water, about 3 g of NH_4^+ ions is produced.

(i) Calculate the amount of NH_4^+ ions retained in the compost fertilizer after ten days.

Retained after 10 days = 3 – 2.3

(05 marks)

= 0.7 g

(04 + 01 marks)

(ii) What is the reason for adding a layer of sand on top of the mixture in the column?

To minimize the disturbance to the top surface due to the addition of water

(05 + 05 marks)

(iii) Calculate the average rate of release of NH_4^+ ions within the ten days.

Rate = Mass difference / time

(05 marks)

2.3 g / 10 days

(05 marks)

0.23 g per day

(9 + 1 marks)

(iv) Write one economical and one environmental advantage of mixing urea with compost fertilizer when adding to the soil.

Economical – less fertilizer(chemical) required / low cost

(05 marks)

Environmental – Less nutrients are released into the environment / Less environmental pollution

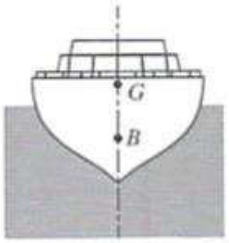
(05 marks)

(v) Why is it not recommended to add fertilizers to a crop on a heavy rainy day?

Dissolve all fertilizer at once (release nutrients at once)
Leached to the ground/ surface water

(10 marks)

(3) (A) As shown in the below diagram ship of mass 8000×10^3 kg floats in the sea and remains stable. The centre of gravity and the centre of buoyancy of the ship are indicated by G and B respectively.



Stable vertical floatation of the ship

(i) What is the magnitude of each of the following forces?
(Consider gravitational acceleration as 10 N kg^{-1})

(a) Weight of the ship

$8000 \times 10^3 \times 10$ N

(05 marks)

8×10^7 N

Provide substitution marks to the correct final answer **(04 + 01 marks)**

(b) Upthrust on the ship

$8000 \times 10^3 \times 10$ N

(05 marks)

8×10^7 N

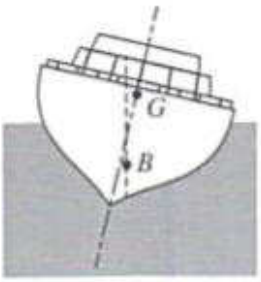
Provide substitution marks to the correct final answer **(04 + 01 marks)**

(ii) How must the lines of action of weight and upthrust be positioned for the stable vertical floatation of the ship?

G and B must lie on the same vertical line

(05 marks)

(iii) Under a stormy condition the ship comes to a titled position from the previous stable vertical floatation as shown in the diagram below.



(a) If the horizontal distance between G and B is 50 cm, calculate the moment of the couple of forces acting on the ship.

Moment $= (8 \times 10^7) \times 50 \times 10^{-2}$

(05 marks)

4×10^7 Nm

(04 + 01 marks)

(b) Is the direction of the above moment clockwise or anticlockwise?

Clockwise

(05 marks)

(c) Would the ship come back to its stable vertical floatation?

If the Answer is NO

(05 marks)

(d) Give reasons for the answer you gave for the above part (iii)(c).

Clockwise moment causes ship to roll continuously.

(05 marks)

(c) If Answer is YES

(05 marks)

(d) B will shift to a new position so as to make the moment anticlockwise

(05 marks)

Question 03 Part A = 50 marks

(B) The labels of four boxes containing, each of starch, glucose, sucrose and protein, in a cargo ship were faded due to soaking in sea water. In order to identify the biomolecule in each box, the boxes were labelled as A, B, C, D and two tests were conducted on the materials in boxes A, B and D. Details of those tests are given in the table below.

Box	Test	Result
A	Benedict Test	Turn to brick red
B	Iodine Test	Turn to blue/purple
D	Iodine Test	No colour change

(i) Based on the test results, identify the biomolecule in boxes A, B and D.

	Box	Type of biomolecule
(1)	A	Glucose
(2)	B	Starch
(3)	D	Sucrose OR Protein

Any correct answer (05 marks x 3) = 15 marks

(ii) Name a reagent that can be used to identify proteins.

Biuret reagent (05 marks)

(iii) Write the observation, when a protein sample is mixed with the reagent named in above part (ii).

color changes from blue color (05 marks) to purple (05 marks)

(iv) Which group of carbohydrates does sucrose belong to?

disaccharides (05 marks)

(v) Write the **two** monosaccharides produced when sucrose is hydrolyzed.

(1) glucose and fructose

(2) (05 marks × 2)

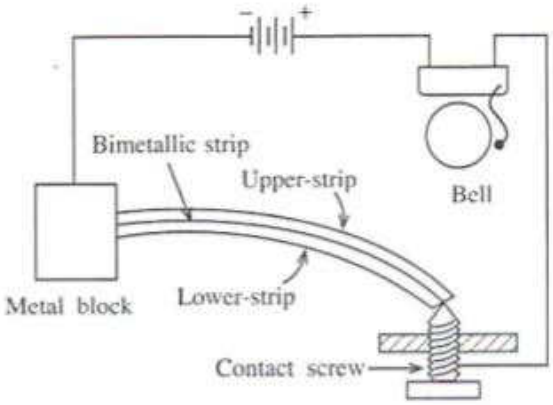
(vi) Which biomolecule stores energy in animals?

glycogen (05 marks)

Question 03 Part B = 50 marks

Question 03 = 100 marks

(4) (A) The diagram shows the circuit of an electric bell that is used to alarm the increasing temperature inside the boiler room in a factory.



The bimetallic strip in this, is made of two thin metal strips X and Y with coefficients of linear thermal expansions α_x and α_y respectively. The initial length of each of the strips at room temperature is l_0. If the temperature in the boiler room rises by $\Delta\theta$ from the room temperature.

(i) Write the new lengths l_x and l_y, of the metal strips X and Y in terms of $\Delta\theta$?

$l_x = l_0 (1 + \alpha_x \Delta\theta)$

(05 marks)

$l_y = l_0 (1 + \alpha_y \Delta\theta)$

(05 marks)

(ii) (a) If $\alpha_x > \alpha_y$, which metal from X and Y would you select as the upper-strip in the bimetalic strip?

Metal X

(10 marks)

(b) Explain the reason for your choice.

Length of upper strip > Length of lower strip

OR

$l_x > l_y$

OR

$\alpha_x > \alpha_y$

(10 marks)

(iii) (a) Suppose the contact screw of the above setup is adjusted to ring the alarm bell at the temperature 45 °C. If the alarm bell needs to be operated at a lower temperature than 45 °C, should the contact screw be moved upward or downward?

Upward direction

(10 marks)

(b) Giving reasons explain your answer.

At 40 °C (a lower temperature) the amount of bending is smaller
Therefore, the screw must be moved upwards

(10 marks)

(B) The circular scale of a micrometer screw gauge is divided into 50 equal parts. When the circular scale is rotated one full turn, the spindle shifts by 0.5 mm on the linear scale.

(i) What is the least count of the micrometer screw gauge?

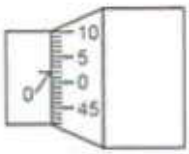
Least count = 0.5 / 50

(05 marks)

= 0.01 mm

(04 + 01 marks)

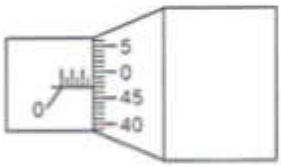
(ii) According to the following diagram what is the zero error of the instrument?



Zero error is positive OR
Zero error = 0.02 (mm) OR
Zero error = +0.02 (mm)

(10 marks)

(iii) The reading of a measurement obtained with the above micrometer screw gauge is shown below.



(a) What is the reading shown in the diagram?

= (2.5 + 0.47)

(10 marks)

= 2.97 mm

(04 + 01 marks)

(b) What is the correct measurement, if the instrument has a zero error as indicated in part (ii)?

= (2.97 - 0.02)

(10 marks)

= 2.95 mm

(04 + 01 marks)

Question 04 = 100 marks

(05) **Table 1** shows the distribution of the monthly cost of internet data for children's education of randomly selected 150 families during the Covid pandemic period.

Table 1: Grouped frequency distribution of 150 families for the monthly cost of internet data.

Cost of internet data (Rs.)	Number of families (f)
51 – 200	33
201 – 350	27
351 – 500	24
501 – 650	18
651 – 800	21
801 – 950	12
951 – 1100	9
1101 – 1250	6
Total	**150**

(a) (i) Copy **Table 2** given below to the answer booklet and complete the columns of class boundary, class mark, more than cumulative frequency and more than percentage cumulative frequency.

Table 2: Grouped frequency distribution for the monthly cost of internet data

Class interval	Number of families (frequency)	Class boundary	Class mark	More than cumulative frequency (F<)	More than percentage cumulative frequency
51 – 200	33				
201 – 350	27				
351 – 500	24				
501 – 650	18				
651 – 800	21				
801 – 950	12				
951 – 1100	9				
1101 – 1250	6				

(i)

Class interval	Number of families (frequency)	Class boundary	Class mark	More than cumulative frequency (F<)	More than percentage cumulative frequency
51 – 200	33	**50.5 – 200.5**	**125.5**	**150**	**100**
201 – 350	27	**200.5 – 350.5**	**275.5**	**117**	**78**
351 – 500	24	**350.5 – 500.5**	**425.5**	**90**	**60**
501 – 650	18	**500.5 – 650.5**	**575.5**	**66**	**44**
651 – 800	21	**650.5 – 800.5**	**725.5**	**48**	**32**
801 – 950	12	**800.5 – 950.5**	**875.5**	**27**	**18**
951 – 1100	9	**950.5 – 1100.5**	**1025.5**	**15**	**10**
1101 - 1250	6	**1100.5 – 1250.5**	**1175.5**	**6**	**4**
	150				

For a given column, (column 3 to 6) if everything is correct = 10 marks

10 marks × 4 = 40 marks

(ii) In this study, find the average of monthly costs of internet data of the families.

(b) Calculate the maximum value that can be taken for the range of the above grouped frequency distribution.

(c) Draw the **more than percentage cumulative frequency curve** for the above distribution in **Table 2** on the graph paper provided with this question paper.

(d) Based on above (c), the more than percentage cumulative frequency curve you have drawn,

(i) find the median of monthly costs of internet data of the families.

(ii) calculate the inter quartile range of the distribution.

(iii) calculate the number of families who spent Rs. 750 or more for internet data per month.

(e) **Table 3** below shows the frequency distribution of the number of school-going children for the above sample of 150 families.

Table 3: Frequency distribution of number of school going children in the sample.

Number of school going children per family	Number of families
1	47
2	56
3	32
4	12
5	3
Total	**150**

Calculate the expected monthly cost of internet data for a family with 6 school-going children.

(ii)

$$\bar{x} = \frac{\sum f_i x_i}{\sum f_i}$$

$$= \frac{(33 \times 125.5) + (27 \times 275.5) + (24 \times 425.5) + (18 \times 575.5) + (21 \times 725.5) + (12 \times 875.5) + (9 \times 1025.5) + (6 \times 1175.5)}{150}$$

(10 marks)

$$= \frac{4141.5+7438.5+10212+10359+15235.5+10506+9229.5+7053}{150} = \frac{74175}{150} =$$

$$= \text{Rs. } 494.50$$

(04+1 marks)

(Part a = 55 marks)

(b) 1250.5 – 50.5 = 1200 = 1199 OR (1250 – 51 + 1 = 1200)

(05 marks)

(Part b = 05 marks)

(c) Arises with the correct scale (03 marks × 2 = 06 marks)

Correct labels (02 marks × 2 = 04 marks)

For the correct 08 points (02 marks × 8 = 16 marks)

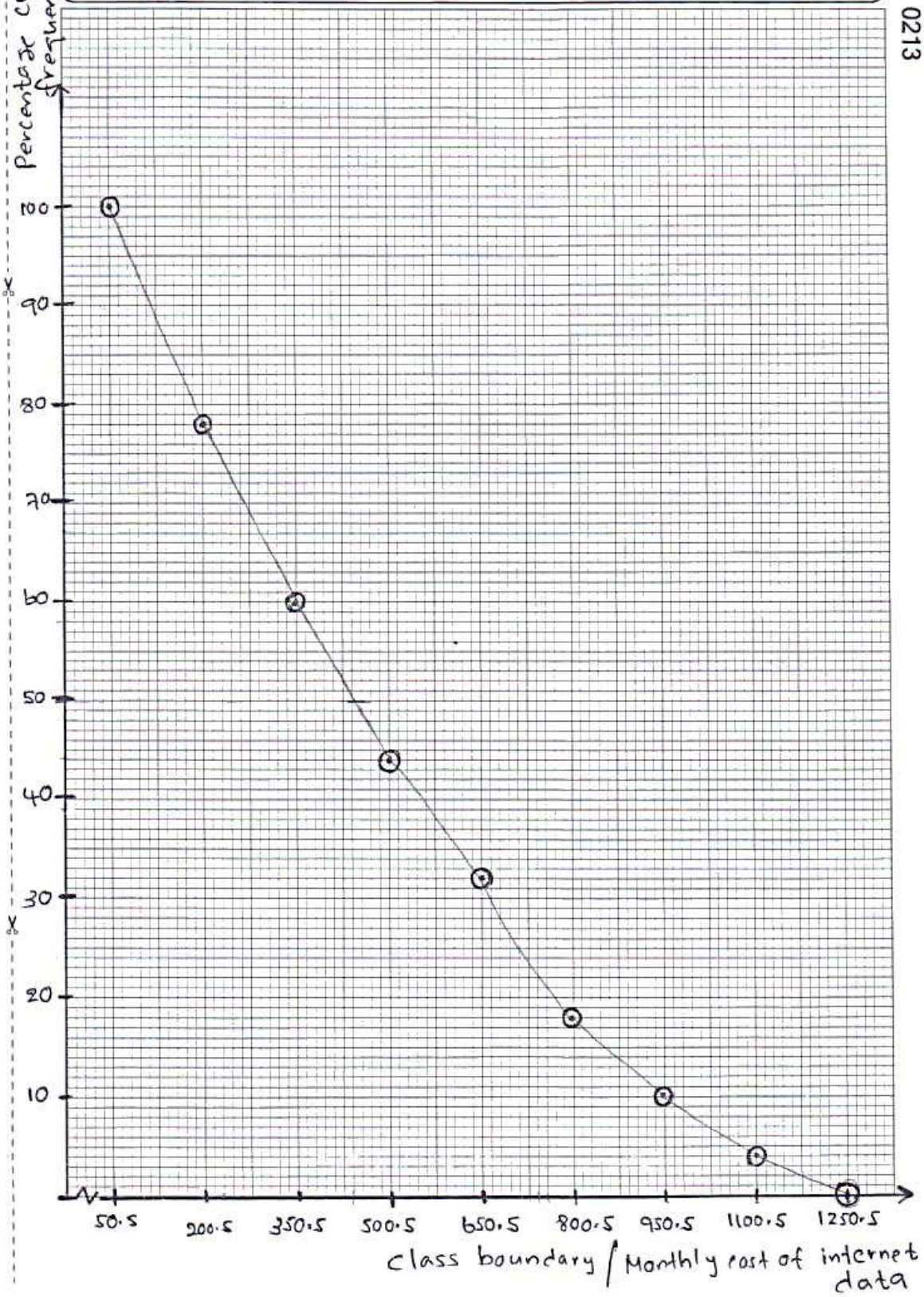
Including the point (1250.5, 0) and correct shape of the graph (04 marks)

(Part c = 30 marks)

AL/2020/67-II(NEW) විභාග අංකය/ சுட்டெண் / Index No. : .....

තාක්ෂණවේදය සඳහා විද්‍යාව தொழினுட்பவியலுக்கான விஞ்ஞானம் Science for Technology	II II II	67 II	ප්‍රශ්න අංකය வினா இல. Question No. 5 (b)

0213



(d)

(i) Any value in between [Rs. 433.00, Rs. 448.00]

(04 + 1 marks)

(ii) Q1 = 230.5 OR
Any value in between [215, 245]

(05 marks)

Q3= 710.5 OR
Any value in between [695, 725]

(05 marks)

No marks when Q1 and Q3 are wrong
IQR = Q3 – Q1 = 710 .5 – 223.5 = 487 OR
Any value in between [450, 510]

(10 marks)

(iii) Any value in between [21%, 22%]

(Use of the graph to obtain the percentage, 05 marks)

Number of families, any value in between

$$\left[\frac{21}{100} \times 150 , \frac{22}{100} \times 150\right] = [31.5 , 33] \text{ OR } [31 , 33]$$

(Final answer, 05 marks)

(Part d = 35 marks)

(e) The average number of school going children per family

$$= \frac{(1\times47)+(2\times56)+(3\times32)+(4\times12)+(5\times3)}{150} = \frac{318}{150} = 2.12$$

(Number of children in a family, 10 marks)

Expected amount of money spent on online data for a family of 6 children =

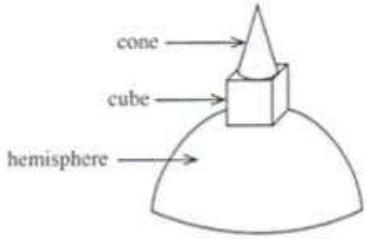
$$\frac{494.5}{2.12} \times 6 = \text{Rs. } 1399.53 \text{ OR Rs. } 1400.00$$

(For the expected value, 10 marks)

(Final Answer, 04 + 01 marks)

(Part e = 25 marks)

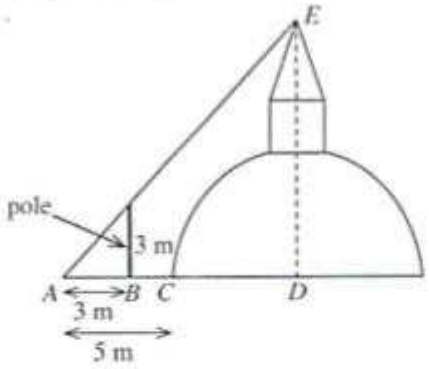
(6) The amount of paint needed to paint a religious construction Stupa needs to be estimated. As shown in the figure, assume that the Stupa consists of a hemisphere, a cube and a cone whose base coincides with the width of the cube. (**consider $\pi = 3$.**)



(a) The vertical height of the Stupa needs to be determined. By tracing a rope around the base of the hemisphere, the circumference of the base is measured to be 36 m.

(i) Show that the radius of the base of the hemisphere section is 6 m.

In order to work out the angle of elevation of the tip of the Stupa, a point A is chosen 5 m away from the Stupa as shown in the following diagram. A pole of height 3 m had to be positioned at point B which is 3 m away from A, so that the angles of elevation of the tip of the pole and the tip of the Stupa were the same.



(ii) Calculate the angle of elevation of the tip of the Stupa from A.

(iii) D is the centre of the hemisphere. What is the distance from A to D?

(iv) Giving steps or reasons, calculate the height DE of the Stupa.

(b) It was found that the ratio between the height of the cone and the height of the cube is 3 :

(i) Find the heights of the cone and the cube.

(ii) What is the radius of the cone?

(iii) Calculate the slant height of the cone to the nearest first decimal place.

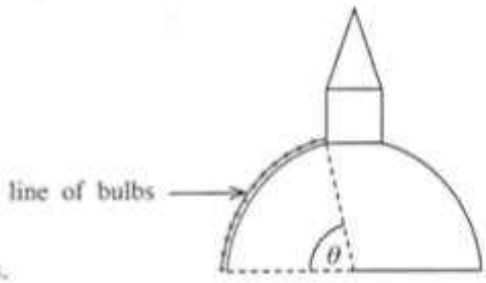
(c) Calculate each of the following surface area.

(i) the curved surface of the hemisphere of the Stupa.

(ii) the curved surface of the cone of the Stupa.

(iii) the four vertical sides around the cube.

(d) For decoration of the stupa, lines of bulbs are to be hung around as shown in the diagram. The θ angle is estimated to be 80°.



(i) Find θ in radians.

(ii) Calculate the length of one line of bulbs.

M stands for "Method marks" that should be awarded for correct work with a previously obtained wrong answer.

a) i) $c = 2\pi r$

$36 = 2 \times 3 \times r$

$r = \frac{36}{6}$

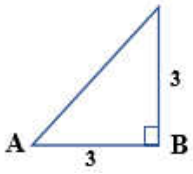
$r = 6$ m

Formula: 5 marks
Substitution: 5 marks

Answer: 4 + 1 marks

15

ii)



Method 1	Method 2
$\tan\theta = \frac{3}{3}$ $\tan\theta = 1 \quad [or \ \theta = \tan^{-1}(1)]$ $\theta = 45^0$ or $\frac{\pi}{4}$	A right-angled and isosceles triangle $\therefore \ \theta = 45^0$ or $\frac{\pi}{4}$

Apply *tan* OR mention *right-angled* and *isosceles*: 10 marks

Answer: 5 marks

15

iii) $AD = AC + CD$

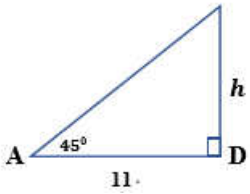
$= 5 + 6$

$= 11$ m

Answer: 4 + 1 marks

5

iv)



Method 1	Method 2	Method 3
$\tan 45 = \frac{h}{11}$ $h = 11 \times 1$ $h = 11$ m	The two triangles are similar $\therefore h = AD$ $h = 11$ m	An isosceles triangle $\therefore h = AD$ $h = 11$ m

Reason OR steps: 10 marks

Answer: 4 + 1 marks

15

Total for part a: 50 marks

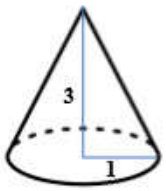
b) i) Total height of cone and cube $= \mathbf{11} - 6 = 5$ m — Subtraction (**M**): 5 marks
$\therefore$ Height of cone $= 3\ m$, Height of cube $= 2$ m — Answer: $4 + 1$ marks

10

ii) Radius of the cone $= \frac{2}{2} = 1$ m — Divide cube height by 2 (**M**): $5 + 1$ marks

5

iii)



$l = \sqrt{\mathbf{3}^2 + \mathbf{1}^2}$ — Apply Pythagoras (**M**): 5 marks
$l = \sqrt{10}$
$l = 3.162$ — Answer in surd or decimal form (**M**): 5 marks
$l = 3.2$ m $(1\ d.p.)$ — Answer to 1 d.p.: $4 + 1$ marks

15

Total for part b: 30 marks

c) *In this part, ignore irrelevant extra area additions or subtractions to the correctly found areas given below, and award full marks.

i) $SA = \frac{4\pi r^2}{2} = 2\pi r^2$ — Formula: 5 marks
$SA = 2 \times 3 \times 36$ — Substitution: 5 marks
$SA = 216$ m^2 — Answer: $4 + 1$ marks

15

ii) $SA = \pi rl$ — Formula (**M**): 5 marks
$SA = 3 \times 1 \times \mathbf{3.2}$ — Substitution (**M**): 5 marks
$SA = 9.6$ m^2 — Answer: $4 + 1$ marks

15

iii) One face of cube $= \mathbf{2} \times \mathbf{2} = 4$ — (**M**) 5 marks
Four faces $= 4 \times 4$ — (**M**) 5 marks
$SA = 16$ m^2 — Answer: $4 + 1$ marks

15

Total for part c: 45 marks

d) i) Angle in radians $= \frac{\pi}{180} \times 80$
$= \frac{4\pi}{9}$ or $\frac{4}{3}$

Use any degree-radian equivalency: 5 marks

Answer: 5 marks

10

ii) Arc length $= r\theta$ or $\frac{\theta}{360} \times 2\pi r$
$= 6 \times \frac{4}{3}$ or $\frac{80}{360} \times 2 \times 3 \times 6$
$= 8$ m (or $\frac{8\pi}{3}$ m)

Radian or Degree Formula: 5 marks

Substitution: 5 marks

Answer: 4 + 1 marks

15

Total for part d: 25 marks
Total marks for Question 06 = 150

(07)

7. (a) Chemical fertilizers are used in agriculture to provide nutrients to plants. The use of organic and biofertilizers can avoid some of the disadvantages of using chemical fertilizers.
   (i) Name the three primary nutrients required for the plant growth.
   (ii) State **two** main **disadvantages** of overusing chemical fertilizers in agriculture.
   (iii) Super phosphate is a chemical fertilizer. Write one natural raw material and one synthetic raw material used to produce super phosphate.
   (iv) Why is it essential to have a high water solubility for fertilizers?

   (b) Minerals can also be added to improve the quality of organic fertilizers.
   (i) Write **two disadvantages** of using organic fertilizers over chemical fertilizers.
   (ii) A student mixes urea and apatite with compost fertilizer to produce a hybrid fertilizer.
   (1) Explain **two** advantages of mixing above chemicals with compost.
   (2) Write **two** methods that can be used to increase water solubility of apatite.
   (iii) Explain why organic fertilizers can be considered as a sustainable approach to agriculture.
   (iv) "An advantage of organic fertilizers is causing less environmental issues compared to chemical fertilizers" Explain.

   (c) Cleaner production concept minimizes the effect on the environment and can be used to improve the efficiency of an industrial process.
   (i) Write the **three** main objectives of cleaner production concept.
   (ii) Explain how cleaner production concept can be used in organic fertilizer production process to improve the productivity.

(a)

(i) (i) Nitrogen (N), Phosphorous (P) and Potassium (K)

Any correct answer 05 marks × 3 = 15 marks

(ii) Release of nutrients to the environment / eutrophication
High cost
Soil pollution (soil acidification OR addition of heavy metal OR destroy soil organisms)
Damage to the crop

05 marks × 2 = 10 marks

(iii) Natural – Apatite
Synthetic – Sulfuric Acid OR Hydrochloric Acid OR ammonium salts
Accept the chemical formula also, 05 marks × 2 = 10 marks

(vi) To be available (provide nutrients) for the short-term crops
05 marks × 2 = 10 marks
Part A = 45 marks

(b)
(i) Amount of nutrients available is less
The amount required is high/ required volume is high
Not suitable for all crops
Addition of pathogens/pests
Addition of weeds
(Contaminated with heavy metals)
05 marks × 2 = 10 marks

(ii)
(1) Increase the amount of N or P in the organic fertilizer OR
Can provide a greater amount of nutrients using less weight

Can control the level of nutrient targeting a crop
10 marks × 2 = 20 marks

(2) Reacting with Sulfuric acid
Reacting with Nitric Acid
Reacting with Sodium carbonate
Reacting with Serpentine
Reacting with Hydrochloric Acid
Reacting with peat
05 marks × 2 = 10 marks

(iii) Organic fertilizer is based on the renewable materials
Production/ use is environmentally friendly (less harm to the environment)
Can be developed as a home-based industry (easy to produced)
Any two correct answers, 05 marks × 2 = 10 marks

(iii) Organic fertilizer is based on the renewable materials
Production/ use is environmentally friendly (less harm to the environment)
Can be developed as a home-based industry (easy to produced)
Any two correct answers, 05 marks × 2 = 10 marks

(vi) Provide nutrients only the required amount/ provide nutrients to the plant slowly
Improve the soil condition
Do not provide/ provide fewer toxic materials to the soil
Any two correct answers 10 marks × 2 = 20 marks
Part B = 70 marks

(c)
(i) Reduce the use of raw material
Recycling
Redesign to reduce the amount of waste produced
05 marks × 3 = 15 marks

(ii) Use of automated/ new instruments to minimize the wastage
Recycle the waste produced during the production process
Biological/Agricultural waste can be used for the production

Any two correct answers 10 marks × 2 = 20 marks
Part C = 35 marks

Question 07 = 150 marks

(08)

8. (a) A waste recycling center sorts daily collected biodegradable and non-biodegradable waste into five categories A, B, C, D and E as shown below.

A. Ebonite and vulcanized rubber
B. Food and plant waste
C. Metal cans and glass bottles with chlorinated organic solvents
D. Rechargeable batteries and other items with heavy metals
E. Paper and cardboard

(i) What is meant by non-biodegradable waste?
(ii) Which categories contain non-biodegradable waste?
(iii) Why is it essential to recycle non-biodegradable waste?
(iv) What is the main environmental benefit of recycling paper and cardboard?

(b) Devulcanization can be used to convert vulcanized rubber to non-vulcanized rubber.
(i) What properties can be added to rubber by vulcanization?
(ii) What is the main difference between ebonite and vulcanized rubber?
(iii) Which bond in vulcanized rubber is required to be broken in the process of devulcanization?

(c) Glass bottles can be reused to fill distilled organic solvents.
(i) Write **two** environmental issues that may arise due to release of organic solvents to the environment.
(ii) Why is it essential to distill organic solvents before reuse?
(iii) Explain how the release of rechargeable batteries to the environment produces adverse effects.
(iv) Write **two** methods widely used to remove heavy metals in water.

(a)
(i) Cannot be broken into basic components via biological (microbial) processes

05 marks × 2 = 10 marks

(ii) Group (A), C and Group D (provide marks only for the first two answers)

05 marks × 2 = 10 marks

(iii) To minimize the environmental impact due to release of waste
acquire valuable elements/ raw material to minimize the use of natural resources
reduce the cost/ reduce the importation cost

10 marks × 2 = 20 marks

(vi) To minimize the use of plants to produce the papers
To minimize the impact on the environment due to removal of plants
Reduce the release of chemicals to the environment
Reduce the damage to the environment

Any point 15 marks
Part A = 55 marks

(B)

(i) To control the stretchability of rubber (to improve the hardness)

10 marks

(ii) Ebonite – All double bonds are used to produce S-S cross links (harder)
Vulcanized rubber – Only some double bonds are used to produce S-S cross links (less hard)

10 marks × 2 = 20 marks

(iii) S-S cross links

10 marks

Part B = 40 marks

(c)

(i) Increase the greenhouse effect (increase the global temperature)
Damage to the ozone layer
Photo Chemical smog
Increase of COD/ BOD

05 marks × 2 = 10 marks

(ii) Remove impurities OR obtain one type of compounds
Remove decomposed fraction OR remove the unusable fraction

Any correct answer = 10 marks

(iii) Contains heavy metals
Contaminate the soil and natural water sources
Adsorbed by plants
Addition to the food
Reach food chain (Harmful to the humans/animal)

Any correct point 05 marks × 5 = 25 marks

(vi) Reverse osmosis
Electrodialysis

Any correct answer 05 marks × 2 = 10 marks

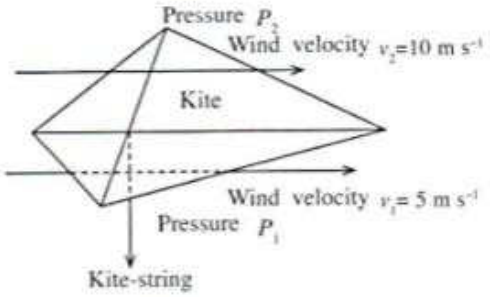
Part C = 55 marks

Question 08 = 150 marks

(09) In the usual notation, the Bernoulli principle for any two points lying on the same streamline but at different heights h_1 and h_2 can be expressed as $P_1 + \rho g h_1 + \frac{1}{2}\rho v_1^2 = P_2 + \rho g h_2 + \frac{1}{2}\rho v_2^2$.

(a) Show that, for two points lying on the same horizontal streamline, the above equation reduces to $P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2$.

(b) A kite flown by a student floats horizontally in the sky as shown in the following diagram. The air velocities at two points just below and just above the kite are $v_1 = 5\ m\ s^{-1}$ and $v_2 = 10\ m\ s^{-1}$ respectively. The pressure at the above two points are P_1 and P_2 respectively. Assuming the mass and the thickness of the kite are negligible, calculate the following.

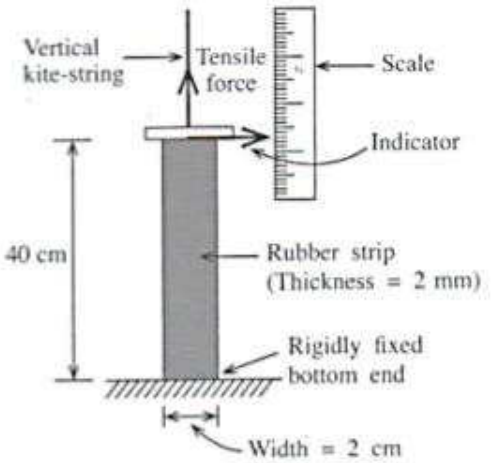


(i) Using the answer in part (a), write an expression for the pressure difference $(P_1 - P_2)$.

(ii) If the density of air $\rho = 1.2\ kg\ m^{-3}$, calculate the pressure difference $(P_1 - P_2)$.

(iii) If the surface area of the kite is $0.5\ m^2$, calculate the tensile force required on the string to keep the kite stationary.

(c) The figure shows a setup used for measuring the tensile force of the kite string which is vertical. Here, a rubber strip (length = 40 cm, width = 2 cm and thickness = 2 mm) is attached firmly to the kite-string at the top and to the ground at the bottom. An indicator running on a vertical linear scale is attached to the upper end of the rubber strip.



(i) What is the use of the indicator and the scale of the setup?

(ii) Calculate the cross-sectional area of the rubber strip normal to the tensile force.

(iii) If the extension of the rubber strip due to the tensile force in the kite-string is found to be 2 cm, calculate the tensile force. Young's modulus of the material of the rubber strip is $2 \times 10^7\ N\ m^{-2}$.

(iv) It is not recommended to connect the kite-string to the rubber strip through a hole pierced at the upper end of the rubber strip. Explain the reason for this.

(a) $$P_1 + \rho g H + \frac{1}{2}\rho v_1^2 = P_2 + \rho g H + \frac{1}{2}\rho v_2^2$$

(20 marks)

Therefore, $P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2$

(10 marks)

OR

for the same / equal height ($h_1 = h_2$ and hence) ρgh terms mutually cancel

(20 marks)

and then $P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2$

(10 marks)

(b)

(i) $P_1 - P_2 = \frac{1}{2}\rho(v_2^2 - v_1^2)$

(10 marks)

(ii) $P_1 - P_2 = ½ \times 1.2 \times (10^2 - 5^2)$

(15 marks)

$= 45\ N\ m^{-2}$

(04 + 01 marks)

(iii) Tensile force $= (45) \times (0.5)$

(10 marks)

$= 22.5\ N$

(09+01 marks)

(c)

(i) to read the extension / to read the increase in length

(10 marks)

(ii) Area = (2 cm) x (2 mm)

(05 marks)

$= (2 \times 10^{-2}) \times (2 \times 10^{-3})$

(05 marks)

$= 4 \times 10^{-5}\ m^2$

(04 + 01 marks)

(iii) $Y = \frac{F\,l}{A\,e}$ **OR** $F = \frac{Y\,A\,e}{l}$

(05 marks)

$$F = \frac{(2 \times 10^7)\ x\ (4 \times 10^{-5}) \times (2 \times 10^{-2})}{40 \times 10^{-2}}$$

(05 marks × 4 = 20 marks)

F = 40 N

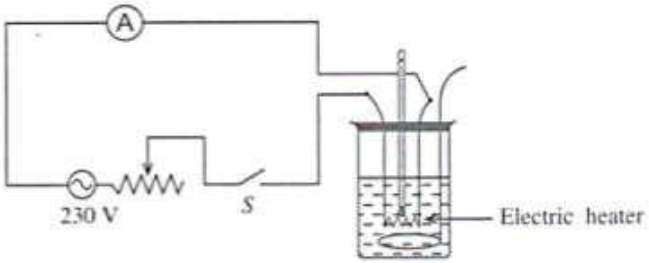
(09 + 01 marks)

(vi) Any one of the following
Tensile force is not equally / symmetrically distributed across the rubber band
Total cross-sectional area of the rubber band is not effective
Can damage/tear the rubber band

(10 marks)

Total marks = 150

(10) (a) A typical electric heating setup is shown in the following diagram. When the heater is connected to a 230 V electric supply and the switch S is on, a current of 10 A flows through the circuit. Resistance of the connecting wires is negligible.



(i) Calculate the resistance of the heating coil.

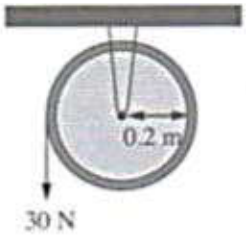
(ii) Calculate the heat energy, in joules, produced by the heater in 1 minute.

(iii) This setup is used to heat 5 kg of milk. Assuming that the heat capacity of the vessel is negligible and the initial temperature of the milk is 30 °C, calculate the temperature of the milk after 7 minutes. The specific heat capacity of milk is 3900 J kg^{-1} K^{-1}.

(iv) If the resistance of the connecting wires is 0.02 Ω, calculate the rate of energy loss, in watts, in the connecting wires.

(b) A light string wrapped around a pulley is pulled with a constant vertical force of 30 N as shown in the diagram. The moment of inertia of the pulley around the axis of rotation is 2×10^{-2} kg m^2. Radius of the pulley is 0.2 m. Assume the pulley starts from rest and the string does not slip.
Equations related to rotational motion are listed below.

$$\tau = I\alpha,\ \tau = Fr,\ E = \frac{1}{2}I\omega^2,\ I = mr^2,\ \theta = \omega t,\ \omega = \omega_0 + \alpha t,\ \theta = \omega_0 t + \frac{1}{2}\alpha t^2,\ \omega^2 = \omega_0^2 + 2\alpha\theta$$



(i) Calculate the torque applied on the pulley.

(ii) Write an equation to show the relationship among torque, angular acceleration and moment of inertia.

(iii) Calculate the angular acceleration of the pulley.

(iv) When the pulley has rotated 25 turns, calculate the following:

(1) Angular displacement

(2) Angular velocity

(3) Kinetic energy

of the pulley (Consider $\pi = 3$)

(v) By giving reasons or showing steps, calculate the work done by the 30 N force in rotating the pulley through 25 turns.

(a)

(i) Resistance of the coil is = V / I

(05 marks)

= 230 V / 10 A

(05 marks)

= 23 Ω (ohm)

(04 + 01 marks)

(ii) Heat energy produced by the heater = V x I x t OR I^2 x R x t OR $\frac{V^2 t}{R}$

(05 marks)

= 230 V x 10 x (1 x 60 s)

(05 marks)

= 138,000 J

(04 + 01 marks)

OR

Power of the heater = V x I = 230 V x 10

= 2300 W

(05 marks)

Heat energy produced by the heater = power of the heater x t

= 2300 W x (1 x 60 s)

(05 marks)

= 138,000 J

(04 + 01 marks)

(iii) Supplied heat (Q) = 138, 000 × 7

= 966000 J

(05 marks)

Heat supplied to milk = Q = mcΔθ,

(05 marks)

mcΔθ, = 138, 000 × 7 = 966000 J

For equalizing the two sides (05 marks)

Δθ = 7 x 138 000 J / 5 kg x 3900 J kg^{-1} $°C^{-1}$

Units are not required, For substitution (05 marks)

Δθ = 49.5 °C

Temperature of milk = 30 + 49.5 = 79.5 °C (accept the answer in K)

(04 + 01 marks)

OR

The temperature gain = Heat produced in 7 min / (mass x specific heat capacity)

For equalizing the two sides (05 marks)

= H / (m x c)

(05 Marks)

= (138,000 x 7) / (5 x 3900)

For substitution (05 marks)

= 49.5 °C

(05 marks)

Temperature of milk = 30 + 49.5 = 79.5 °C

(04 + 01 marks)