AL/2021(2022)/15/E-I

அध्යයන பொது சான்றிதழ் (உயர் தரப்) விභாගය, 2021(2022)
கல்விப் பொதுத் தராதரப் பத்திர (உயர் தர)ப் பரீட்சை, 2021(2022)
General Certificate of Education (Adv. Level) Examination, 2021(2022)

யாந்த்ரிக தாக்ஷணவேத்ய
பொறிமுறைத் தொழினுட்பவியல் **I**
Mechanical Technology I

15 E I

பெரிய நேரகை
இரண்டு மணித்தியாலம்
*Two hours*

Instructions:

✲ *Answer all the questions.*
✲ *Write your Index Number in the space provided in the answer sheet.*
✲ *Instructions are given on the back of the answer sheet. Follow them 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 in the back of the answer sheet.*
✲ *Use of calculators is not allowed.*

1. What is the units of force in base units?
   (1) $kg\, m\, s^{-1}$ (2) $kg\, m\, s^{-2}$ (3) $kg^{-1}\, m^{-1}\, s^{-2}$ (4) $kg^{-1}\, m^{-1}\, s^{2}$ (5) $m\, s^{-2}$

2. Following voltage sources are prepared by a student group. What is the circuit with lowest voltage between terminals *A* and *B*?
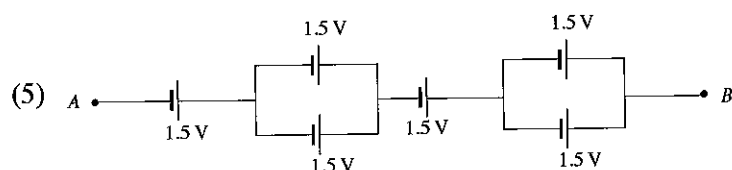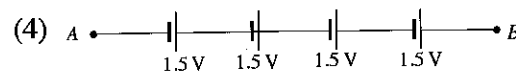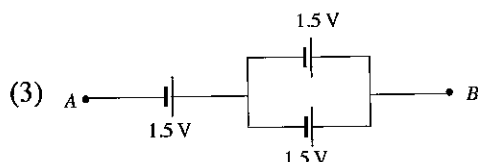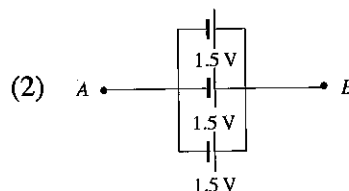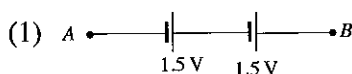
3. A student group has selected, a capacitor (A), an inductor (B) and a resistor (C) for the following circuit. Select the correct option for A, B and C.
   (1) A - 10 kΩ B - 1 mH   C - 1000 μF
   (2) A - 1 μF   B - 1 mH   C - 1 kΩ
   (3) A - 1 kΩ B - 1 μF   C - 1 mH
   (4) A - 1 kΩ B - 1 mH   C - 1 mH
   (5) A - 1000 μF   B - 1 kΩ C - 1 mH
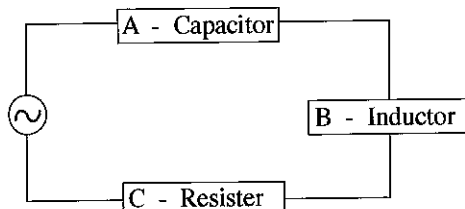
4. What is the component that is **not** normally used in the domestic electric circuits?
   (1) Main switch
   (2) Residual current circuit breaker (RCCB)
   (3) Miniature circuit breaker (MCB)
   (4) Socket outlet
   (5) Oscilloscope

5. Two items with static electrical charges, positive or negative are placed near by. Select the answer with correct directions of forces exerted on them.

(1) ←—⊖   ⊕←—

(2)   ⊕—→   ←—⊕

(3)   ⊖—→   ←—⊖

(4)   ⊕—→   ←—⊖

(5) ←—⊕   ⊖←—
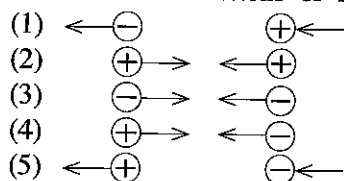
6. What is the correct option for the units of voltage, current, frequency and electric power respectively?

(1) A, V, Hz and W   (2) V, A, Hz and W   (3) W, A, Hz and V

(4) A, W, Hz and V   (5) V, W, Hz and A

7. R_1, R_2, R_3 and R_4 resistors are connected in parallel and series combinations as shown in the figure, where $R_1 < R_2$ and $R_3 < R_4$. If a potential difference is applied to this circuit across A and B points. What is/are the resistor/resistors with the highest power dissipation?

R_2

R_4

A —WWW—   —WWW— B

R_1

—WWW—

R_3

(1) R_1 (2) R_2 (3) R_3 (4) R_4 (5) R_2 and R_3

8. The discrepancy between the 'measured value' and 'actual value' is called,
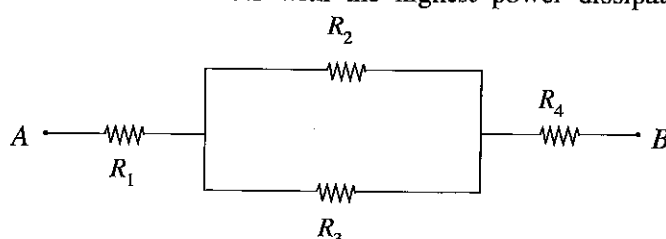
(1) Constant error.   (2) True error.   (3) Random error.

(4) Systematic error.   (5) Mistakes.

9. What is the correct statement regarding the error due to the thermal contraction of steel measuring tapes?

(1) The error is positive.   (2) The error is negligible.

(3) The error is negative.   (4) The error only depends on the temperature.

(5) No error to be considered.

10. Diagram shows a truss arrangement carrying three forces. If the roller B can sustain a maximum load of 18 kN, what is the maximum value of force F that can be supported by the truss?

(1) $\sqrt{2}$ kN

(2) $1.5\sqrt{2}$ kN

(3) $6\sqrt{2}$ kN

(4) $9\sqrt{2}$ kN

(5) $12\sqrt{2}$ kN
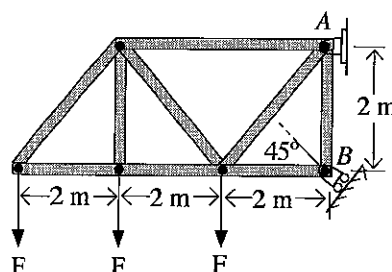
11. A hollow square cross sectioned steel element shown in the figure is subjected to an axial compressive load of 100 kN along 'O' axis. Wall thickness is 0.25 m. Following gives some statements regarding stresses and strains in the steel element.
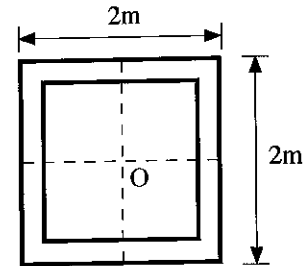
   A - Element is subjected to an axial compressive stress of 57 kPa.
   B - Element is subjected to an axial compressive stress of 25 kPa.
   C - By increasing the wall thickness, axial stress can be reduced.
   D - There is an axial compressive strain in the element.
   E - If the compressive stress is increased, corresponding axial strain is proportionally decreased.

Which of the above statements are correct?

(1) A, C and D only
(2) A, D and E only
(3) B, C and D only
(4) B, D and E only
(5) C, D and E only

12. The equivalent resistance between terminals A and B for the network shown below is,

(1) 2 Ω

(2) 4 Ω

(3) 6 Ω

(4) 8 Ω

(5) 10 Ω
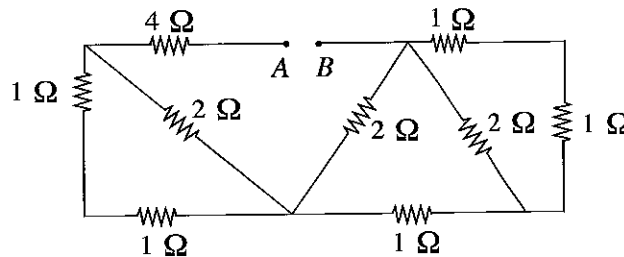
13. DC power sources, diodes and bulbs are connected in following circuits. What is the circuit which the bulb is light up?
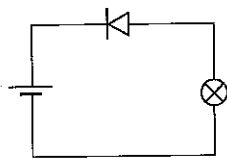
(1)
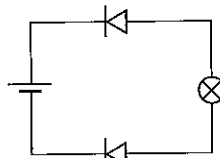
(2)
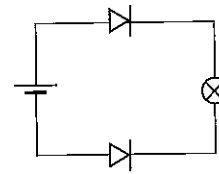
(3)
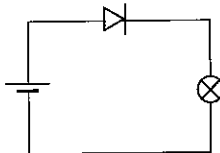
(4)
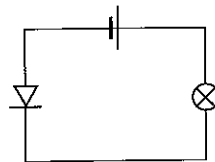
(5)

14. Diagram shows a man attempting to pull a 150 kg crate. The weight of the man is 80 kg and the coefficient of static friction between the ground and the crate is 0.3. The coefficient of static friction between this man's shoe and the ground is

(1) 0.28

(2) 0.3

(3) 0.4

(4) 0.56

(5) 0.6
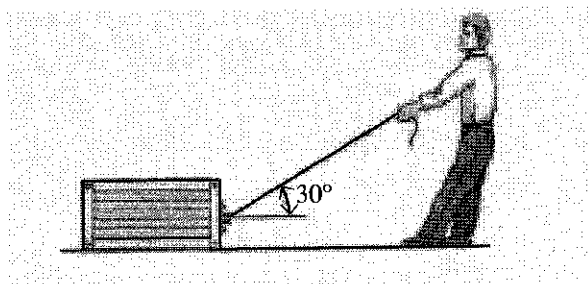
15. Following circuit is connected to an AC supply. Select the answer with correct output.
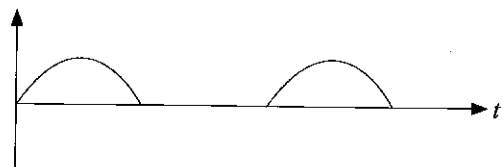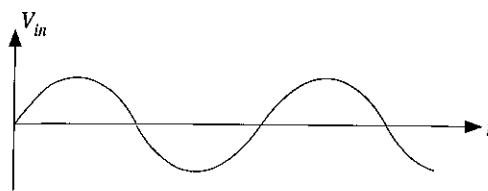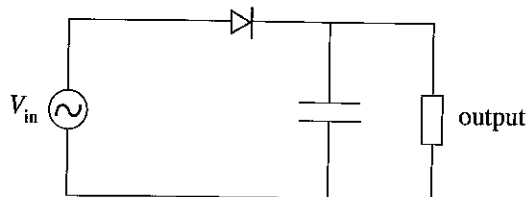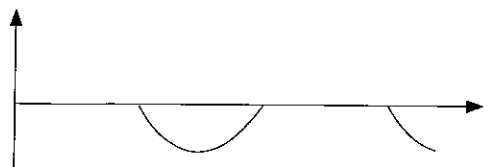
(1)   (2)
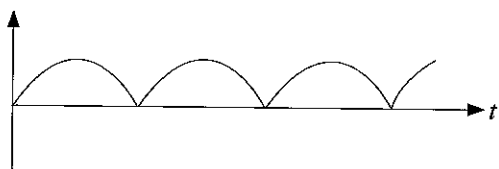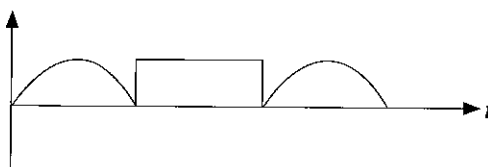
(3)   (4)
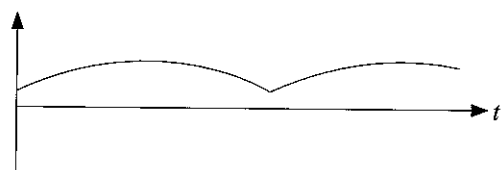
(5)

16. Consider the following statements.

A - Water can be used to stop any type of fire.

B - Blue coloured fire extinguishers are suitable to stop fires involving flammable liquids and flammable gasses.

C - Black coloured fire extinguishers contain CO_2 and they are suitable to stop electrical fires.

D - The colour of 'Foam fire extinguisher' is green.

Which of the above statements are correct about the fire extinguishers?

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

17. Consider following statements.

A - Bakelite is the first synthetic plastic which is made of phenol-formaldehyde.

B - Chlorine can be manufactured by the electrolysis of calcium chloride.

C - Calcium Carbonate is a main component found in Ordinary Portland Cement.

D - Crude Oil is used in the manufacturing process of polyvinyl chloride.

Which of above statements are correct regarding chemicals used in industries?

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

18. Rate of change of momentum is defined as,

(1) acceleration.   (2) force.   (3) impulse.   (4) inertia.   (5) work.

19. What is the correct isometric view for the orthogonal projections?
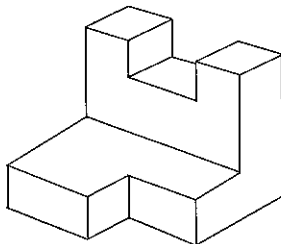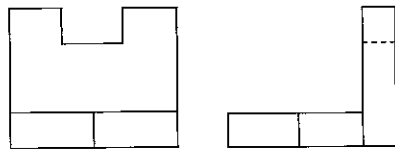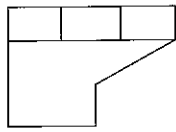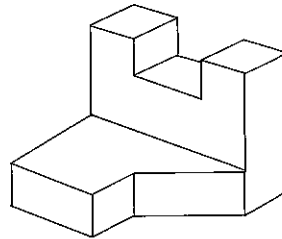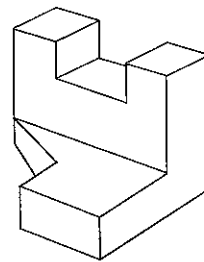
(1)   (2)   (3)
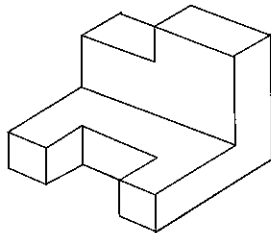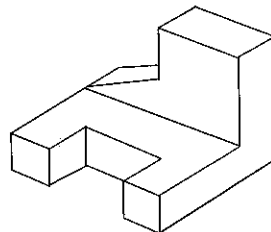
(4)   (5)

20. Consider the following statements.

A - Higher worker motivation will lead to a higher productivity.
B - Senior management support is not necessary to achieve higher productivity levels.
C - Overnight shifts and longer working hours will improve the productivity.
D - Maintaining clean and organized workspace will improve the productivity levels.

Which of the following statements are correct about improving construction productivity at site?

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

21. Consider the following statements.

A - All objects dropped freely are subjected to a same acceleration.
B - Objects with different masses take different times to reach ground.
C - All objects dropped freely are subjected to the air friction.
D - The velocity of an object on the air is gt. (t - time, g - acceleration)

What are the correct statements regarding movement of objects dropped freely from a height?

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

22. A ball is partly submerged in the water as shown in the figure. The ball is attached to the bottom of the tank using a rope. Out of the below statements, what is the correct statement?
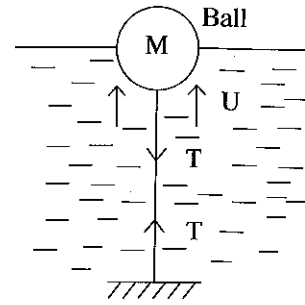
(1) U - Upward thrust, U = Mg+T

(2) U - Surface tension, U = Mg–T

(3) U - Surface tension, U = Mg+T

(4) U - Water pressure, U = Mg+T

(5) U - Upward thrust, U = Mg–T

23. Propane and Butane are the main gases available in domestic LPG cylinders. The main reason for mixing Propane with Butane is to
    (1) increase mixture vapor pressure.
    (2) reduce the liquefying pressure.
    (3) reduce the liquefying temperature.
    (4) reduce the cost.
    (5) maintain a stable flame during combustion.

24. Consider the following statements on ergonomics.

    A - An ergonomic chair can assist to reduce lower back pain of a person with work related musculoskeletal disorders.
    B - Location of light bulb switches is also an important ergonomic consideration.
    C - Ergonomics helps to develop products that can be used easily.
    D - Production cost of a product can always be reduced by using ergonomics.

    Which of the above statements are correct?

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

25. Which of the following particle sizes are considered as nano particles under nanotechnology?
    (1) 10^{-8} m   - 10^{-9} m
    (2) 0.01 m   - 0.001 m
    (3) 1 μm   - 100 μm
    (4) 1×10^{-9} m   - 100×10^{-7} m
    (5) 10^{-6} m   - 10^{-9} m

26. Increasing compression ratio of Diesel and Otto engines increase the work on the compression stroke. Which of the following statements correctly explain the change in thermal performance with increasing compression ratio?

    (1) Thermal efficiency decreases with increasing compression ratio.
    (2) Work output reduces due to increased compression ratio.
    (3) Work done on the compression stroke is completely recovered during the power stroke.
    (4) Work done on the compression stroke is recovered in the expansion stroke and thermal efficiency is increased.
    (5) More fuel can be burnt at higher compression ratios and hence the power output increases.

27. The turbulence inside the combustion chamber of a Diesel engine,
    (1) decreases the volumetric efficiency.
    (2) increases the volumetric efficiency.
    (3) decreases combustion efficiency.
    (4) increases the combustion efficiency.
    (5) increases the compression ratio.

28. Select the option which correctly shows magnitude of the resultant force when the forces are acting as shown in the force diagram. (70 N and 80 N are horizontal and vertical forces respectively.)

(1) $10\sqrt{(7-12\cos60^o)^2+(12\sin60^o-8)^2}$

(2) $\sqrt{(7-12\cos60^o)^2+(12\sin60^o-8)^2}$

(3) $\sqrt{(7-12\cos30^o)^2+(12\sin30^o-8)^2}$

(4) $10\sqrt{(7-12\cos30^o)^2+(12\sin30^o-8)^2}$

(5) $\sqrt{(7-8\cos30^o)^2+(12\sin30^o-12\cos30^o)^2}$

120 N

120°

70 N

80 N
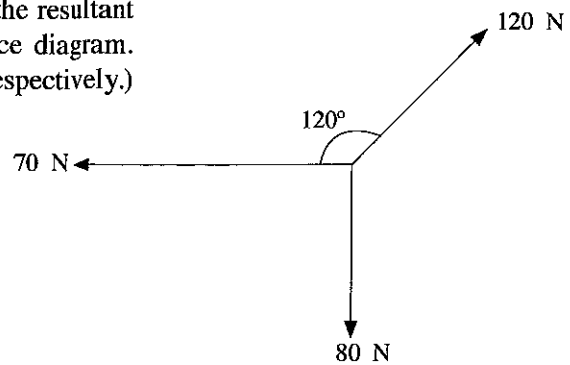
29. An ideal thermal power cycle working between a heat reservoir and heat sink generates an output power 'P' for a given heat flow of $\dot{Q}$ as shown in the figure. If P is the maximum possible work output an ideal cycle can generate, the P is

(1) $\dot{Q}\times(1-30/1000)$ (2) $\dot{Q}\times(1-1273/303)$

(3) $\dot{Q}\times(1-243/727)$ (4) $\dot{Q}$

(5) $\dot{Q}\times(1-303/1273)$

Reservoir (1000 °C)

P

Sink (30 °C)
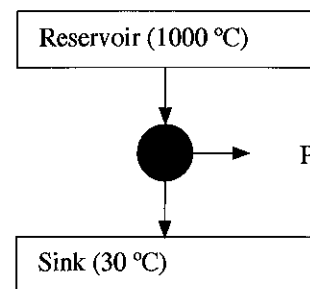
30. The figure shows diagrams of a hydraulic jack (A) and a screw jack (B).

(A)   (B)
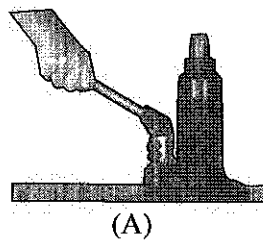
If the load and the distance lifted vertically by each jack are same, which of the following statements is correct?
(1) The work done on the hydraulic jack is higher than that of the screw jack.
(2) The work on both jacks are same.
(3) The work on the hydraulic jack is less than that of the screw jack.
(4) The work on the hydraulic jack depends upon the diameter of the body.
(5) Both jacks have same efficiency.

31. Three types of wooden joints are given below.
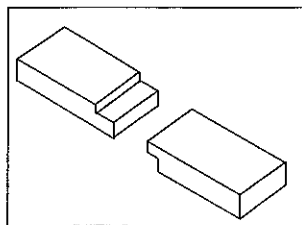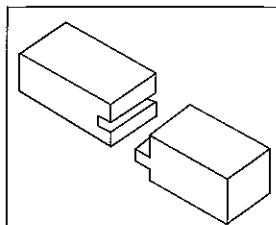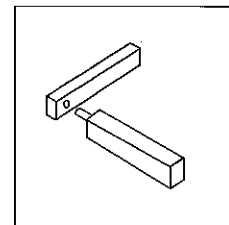
A   B   C

Which option gives the correct joint types respectively?
(1) Half-Lap, Tongue and Groove, Mortise and tenon
(2) Butt, Half-Lap, Mortise and tenon
(3) Tongue and Groove, Mortise and tenon, Half-Lap
(4) Butt, Mortise and tenon, Tongue and Groove
(5) Half-Lap, Butt, Tongue and Groove

32. Three dimensional view of an object is shown below.
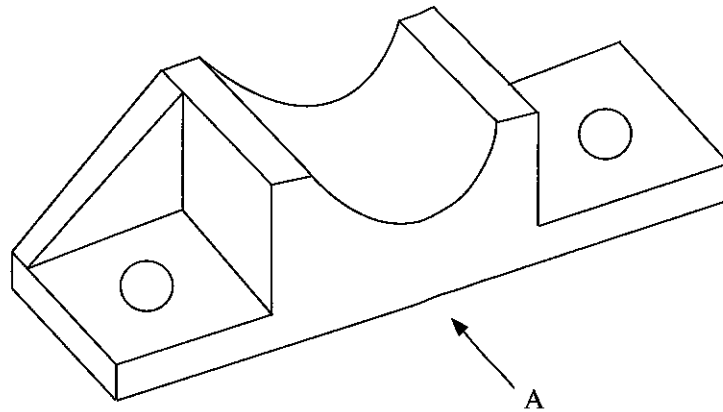
Select the correct orthographic projection view when looking from direction A.

(1)

(2)

(3)

(4)

(5)
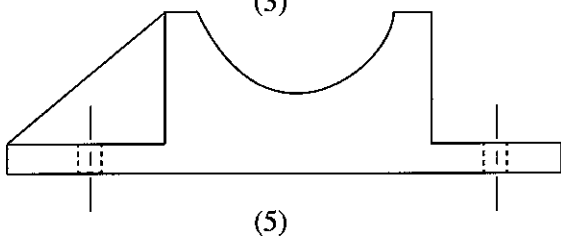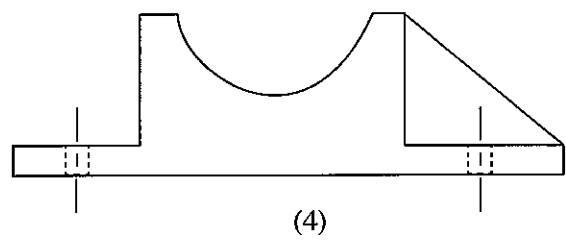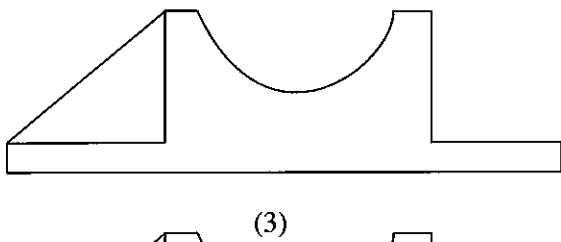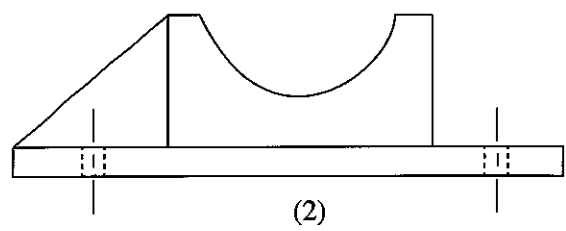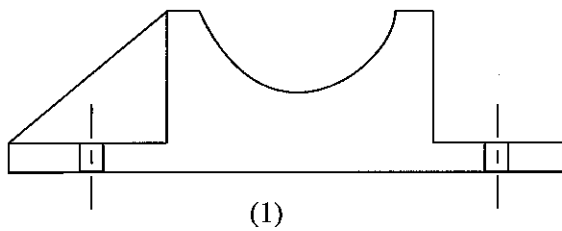
33. Following statements relates metal extrusion process.

    A - It is extensively used for making bolts and nuts.

    B - It is used for reducing the diameter of round bars and tubes.

    C - It is used to improve durability of metal by setting up compressive stresses in its surface.

    D - It consists of pressing the metal inside a chamber to force it out by high pressure through an orifice which is shaped to provide the desired form of the finished part.

Out of the above, select the correct statement/s.

(1) C only.   (2) D only.   (3) A and D only.

(4) B and D only.   (5) B, C and D only.

34. The figure shows the isometric view of a component. What is the option which shows the correct orthographic projections when viewed from the directions *A* and *B*.
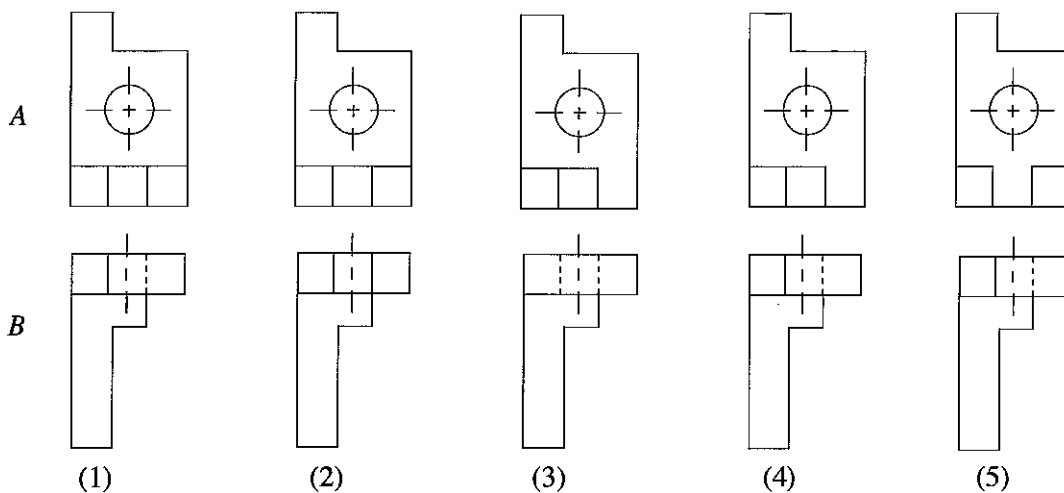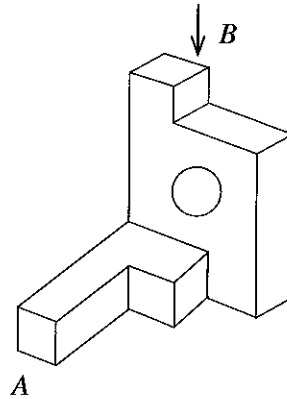
35. What are the two most common materials used for cylinder head and block construction of an automobile engine?

(1) Cast iron and steel
(2) Cast iron and aluminium alloy
(3) Steel and aluminium alloy
(4) Brass and steel
(5) Cast iron and Ceramics

36. Under or over inflation causes a tyre to wear unevenly. Which option shows the location of such uneven wear?

	Under inflated tyre	Over inflated tyre
(1)	shoulder	center
(2)	center	shoulder
(3)	side wall	center
(4)	center	side wall
(5)	side wall	shoulder

Center, Shoulder Side wall
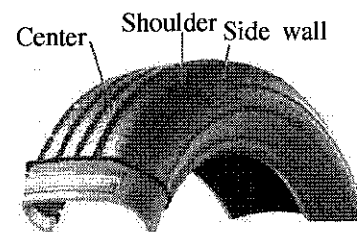
37. In addition to the cabin temperature shown on the dashboard of a car, the other temperature indicator shows the temperature of,

(1) Air inside tyre.
(2) Battery.
(3) Engine oil.
(4) Brake oil.
(5) Radiator coolent.

● Answer questions 38 and 39 considering below details.

A carpenter make a wooden door for a room. Its' size is 30"×84" and $1\frac{1}{4}$" thick teak wood is to be used to make the door.

38. What are the tools required to make the door?

A - Saw   B - Planer

C - Mallet   D - Chisel

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

39. Which answer includes only the components that are usually required to fix the door sash to the door frame and facilitate using it?

A - Hinges   B - Screws

C - Door lock   D - Glue

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

40. The figure shows an arrangement of a Liquid Petroleum Gas (LPG) burner system. Which of the components should comply with the most stringent safety guidelines in design?

(1) Stove   (2) Cylinder
(3) Regulator   (4) Hose
(5) Stove and Hose
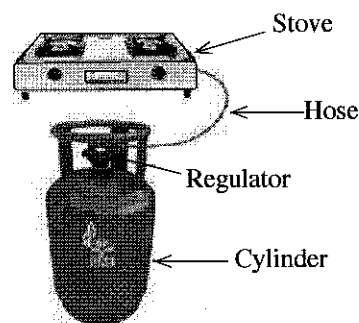
41. The liquid phase of Propane and Butane mixture in a LPG cylinder contains similar amounts by mole (denoted by M_P and M_B respectively). If Propane is relatively volatile than Butane, what proportions of these two represent in the gas phase?

(1) $M_P > M_B$ (2) $M_P = M_B$ (3) $M_P < M_B$
(4) $M_B = 0$ (5) $M_P = 0$

42. When fixing a pantry cupboard, you are supposed to fix an Aluminium hinge to a hollow Aluminium box frame where you have access from one side only. What would be the most suitable joining method for this?

(1) Pop or blind rivets
(2) Screws
(3) Welding
(4) Nut and bolt
(5) Nails

43. When the front wheels of a vehicle are locked during a panic braking situation, then
   (1) stopping distance becomes extremely long.
   (2) driver loses control over the steering and results shorter stopping distance.
   (3) front tyres skid across the road surface, and the vehicle spins around.
   (4) rear tyres skid across the road surface, and the vehicle spins around.
   (5) driver loses control over the steering, and the vehicle continues moving in its current direction.

44. Which of the following manufacturing processes mainly used for producing components for high strength applications?
   (1) Casting   (2) Forging   (3) Extrusion   (4) Rolling   (5) Machining

45. A micrometer screw gauge with a pitch of 0.5 mm and a circular scale with 50 division is used to measure the thickness of a thin sheet of Aluminium. Before starting the measurement, it is found that when the two jaws of the screw gauge are bought in contact, the 45th division coincide with the main scale line and that the zero of the main scale is barely visible. What is the thickness of the sheet if the main scale reading is 0.5 mm and the 25th division coincides with the circular scale?
   (1) 0.50 mm   (2) 0.60 mm   (3) 0.70 mm   (4) 0.75 mm   (5) 0.80 mm

46. Spot welding is used for welding,
   A - lap joints in sheets having 0.025 mm to 1.25 mm thickness.
   B - lap joints in plates having thickness above 3 mm.
   C - butt joints in sheets having 0.025 mm to 1.25 mm thickness.
   D - butt joints in plates having thickness above 3 mm.
   Out of the above, select the correct statement/s.
   (1) A only.   (2) C only.   (3) A and D only.
   (4) B and C only.   (5) B, C and D only.

47. The main task of a battery in automobiles is to
   A - supply electricity to the alternator.
   B - act as a reservoir or stabilizer of electricity.
   C - supply electricity to the vehicle's electrical system at all times while the engine is running.
   D - supply a large amount of power to turn the starter motor, when the engine is being started.
   From the above, select the correct accurate statement/s.
   (1) B only.   (2) D only.   (3) A and C only.
   (4) B and D only.   (5) A, B and D only.

48. Three statements describing the purposes of an air cleaner of an engine are given below.
   A - It controls the compression ratio of the engine.
   B - It reduces the engine vibration.
   C - It prevents dust and other foreign matter from entering the engine.
   From the above, select the correct statement/s.
   (1) A only.   (2) C only.   (3) A and B only.
   (4) B and C only.   (5) A, B and C all.

● Use the below figure to answer questions **49** and **50**. The figure shows a coconut scraper. *A*, *B* and *C* denote joining methods and *D* shows teeth of the blade.

49. What tool can be used to sharpen the scraper teeth shown in *D*?

    (1) Pliers
    (2) Mallat
    (3) File
    (4) Hacksaw
    (5) Vice

50. What are the most suitable assembly methods that can be used to assemble the joints shown by *A*, *B* and *C* respectively?

    (1) Screwing, Welding, Riveting
    (2) Riveting, Welding, Screwing
    (3) Welding, Riveting, Screwing
    (4) Riveting, use of nut and bolt, Welding
    (5) Welding, Riveting, use of nut and bolt

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

යාන්ත්‍රික තාක්ෂණවේද්‍යය	**II**				
பொறிமுறைத் தொழினுட்பவியல்	**II**	**15**	**E**	**II**	
Mechanical Technology	**II**				

පැය තුනයි மூன்று மணித்தியாலம் ***Three hours***	අමතර කියවීම් කාලය - මිනිත්තු 10 යි மேலதிக வாசிப்பு நேரம் - 10 நிமிடங்கள் **Additional Reading Time - 10 minutes**

Use additional reading time to go through the question paper, select the questions you will answer and decide which of them you will prioritise.

Index No. : ....

Important :
✻ *This question paper consists of **16** pages.*
✻ *This question paper comprises **Parts A, B** and **C**. The time allotted for **all parts** is **three** hours. (Use of calculators is **not** allowed.)*

Part A - Structured Essay (11 pages)
✻ *Answer **all** the questions on this paper itself.*
✻ *Write your answers in the space provided for each question. Note that the space provided is sufficient for your answers and that extensive answers are not expected.*

Part B and C - Essay (05 pages)
✻ *Select **two** questions from each of the parts **B** and **C** and answer **four** questions only. Use the papers supplied for this purpose. At the end of the time allotted for this paper, tie the **three parts** together so that **Part A** is on the top of **Part B and C** before handing over to the supervisor.*
✻ *You are permitted to remove only **Parts B and C** of the question paper from the Examination Hall.*

For Examiner's Use Only

Part	Q. No.	Marks
A	1	
	2	
	3	
	4	
B	5	
	6	
	7	
C	8	
	9	
	10	
Total		

Total	
In Numbers	
In Words	

Code Numbers	
Marking Examiner 1	
Marking Examiner 2	
Checked by	
Supervised by	

PART A — Structured Essay
*Answer **all** questions on this **paper** itself.*
(Each question carries 10 marks)

1. An isomeric view of a machine component is shown in the figure. The machine component is symmetric along the vertical plane passing through **X-X**. Assuming any missing dimensions draw the following views to a suitable scale using first angle projection principle. Show all relevant dimensions in the sketches. Use the graph papers provided in pages 3 and 4 to answer the question. (All dimensions are in millimeters.)
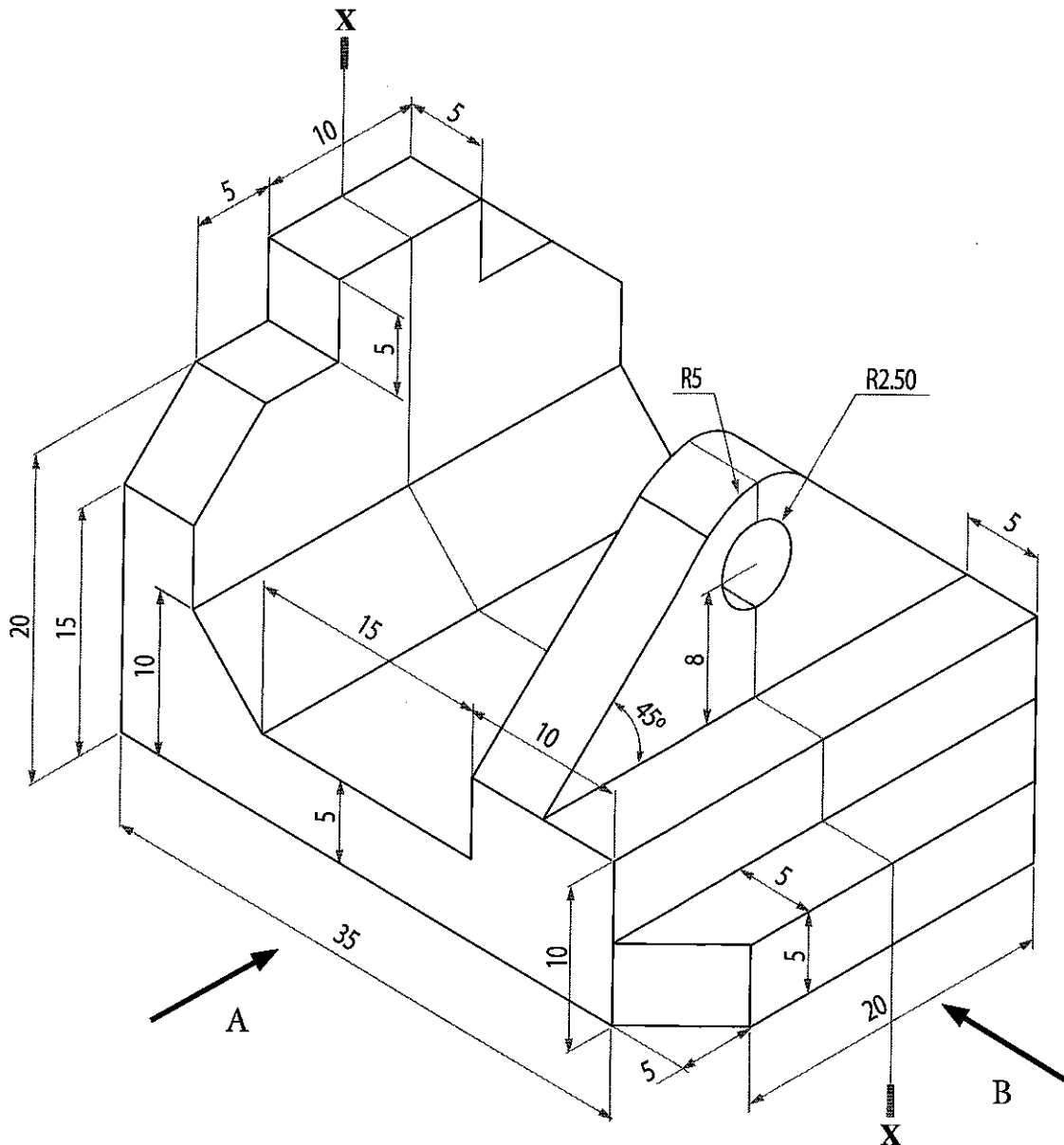
(i) Front elevation seen through direction A

(ii) End elevation seen through direction B
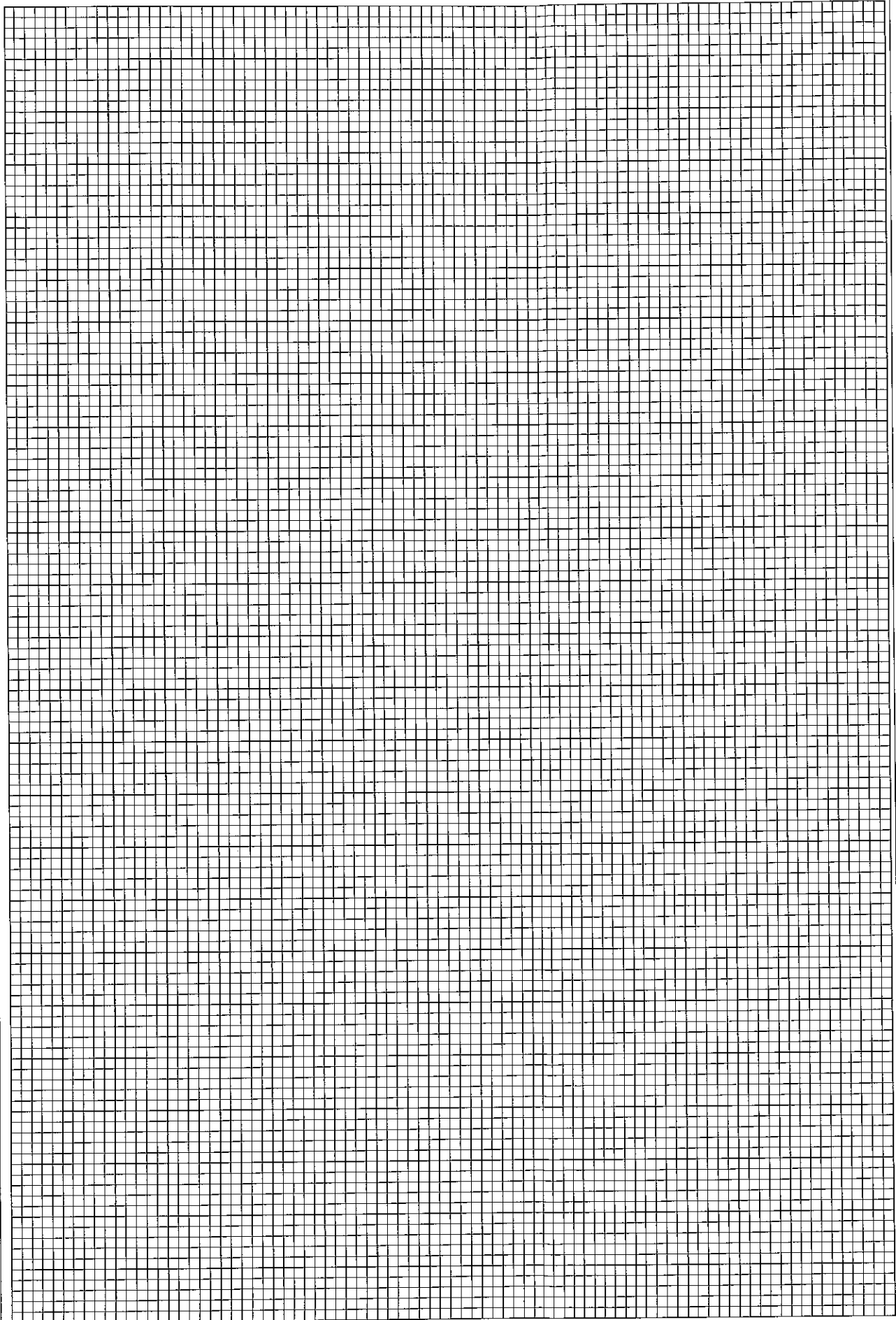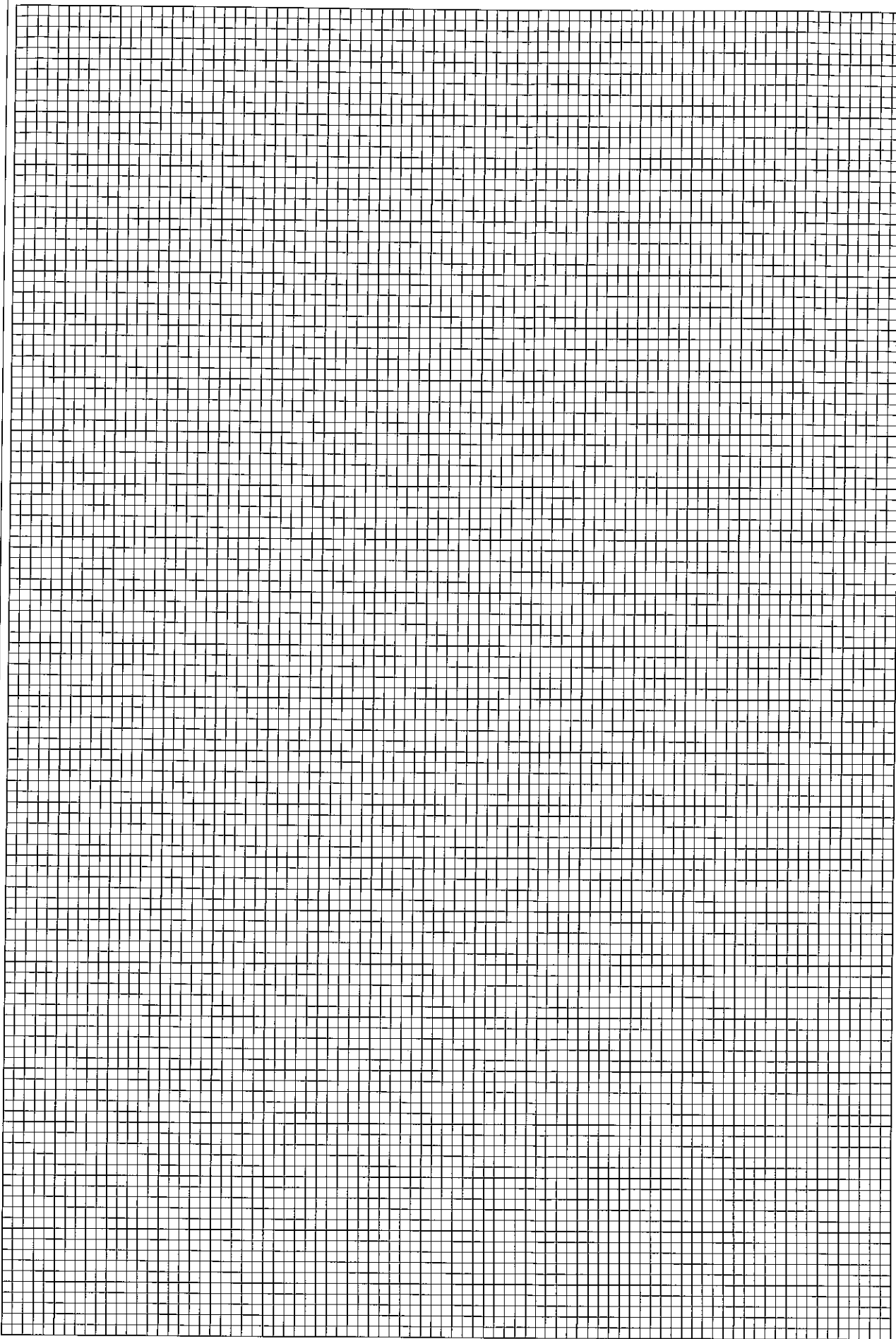
(iii) Plan

2. Many nations world wide struggle to handle rising number of infections due to Covid - 19. It is essential to detect infections and release PCR results in a timely manner. A software development company has proposed a computer-based system to reduce the time taken to release the results of PCR tests by using computer software and hardware.

Public Health Inspectors or relevant health officials are expected to take the sample which is sent to the testing laboratory. A sticker will be pasted on the sample and a part of the sticker is given to the patient.

(a) State **three** information that may be entered to the computer system by the sample collecting officer regarding the person who is going to be tested.

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(b) Mention additional hardware needed at the sample collecting center.

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(c) Mention additional hardware needed at the testing lab.

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(d) Briefly explain how the data is stored and results should be given to the patient.

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(e) State the advantages of using internet for this task.

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(f) Mention the security threats and the possible mitigation actions that can be taken when implementing this system.

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3. It is required to design and develop an organic waste shredder machine shown in the figure to make compost fertilizer.

(a) Identify the components A, B, C and D and briefly describe their functionality for the organic waste shredder machine.

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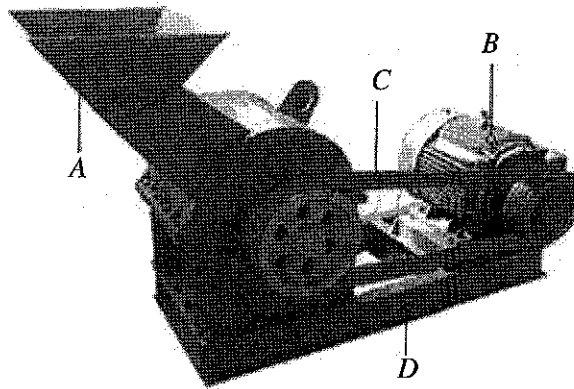..

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(b) Mention the materials that can be used for fabricating the component A and briefly explain the fabrication process of it?

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(c) Considering the requirement of an organic waste shredder machine, propose a suitable motor type and power transmission belt for this machine.

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(d) State **two** advantages of a belt drives system over a gear drive system.

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(e) A flat belt pully of diameter 25 cm is fitted to the shaft of an electric motor. It drives the machine through a pully of diameter 40 cm fitted to the shaft of the organic waste shredder machine. If the electric motor rotates at 1200 rev/min, calculate the angular speed of the driven pully in rev/s and the belt speed of the system in m/s.

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4. Figure 1 shows the front elevation and the plan of a square pyramid. (All dimensions are given in millimeters).

Front Elevation

30

20

20

Plan

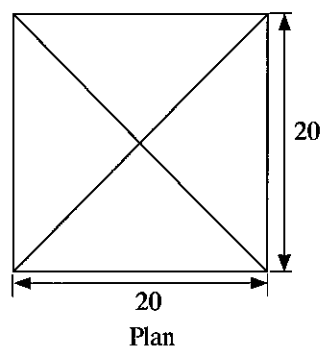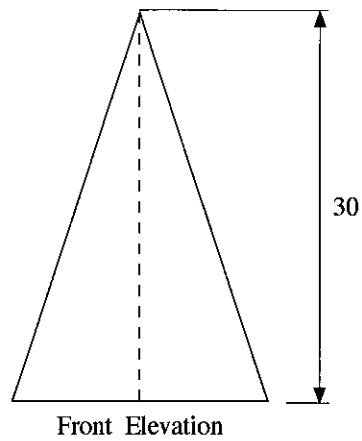Figure 1

(a)   Draw the given views to scale 1:1.

(b)   A square pyramid is truncated by a cutting plane inclined to the horizontal as shown in the Figure 2. Draw the complete plan view. (Use the given graph paper in page 10.)
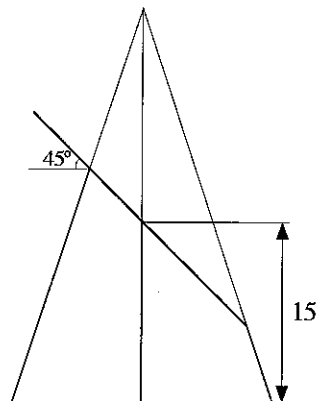

Figure 2

(c)   A square pyramid is truncated by two cutting planes inclined to the horizontal as shown in the Figure 3. Draw the development of the remaining portion of the square pyramid. Assume that the base is hollow. Use the given graph paper in page 11.)

Figure 3

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General Certificate of Education (Adv. Level) Examination, 2021(2022)

යාන්ත්‍රික තාක්ෂණවේදය	II
பொறிமுறைத் தொழிநுட்பவியல்	II
Mechanical Technology	II

15 **E** **II**

Essay

* Select **two** questions from each of the **Parts B** and **C** and answer **four** questions only.
(Each question carries **15** marks.)

Part B

5. Liquid Petroleum Gas (LPG) is one of the main fuel sources used for cooking. Leakages of LPG can cause different accidents.

   (a) (i) State **two** other applications of LPG.

       (ii) State **two** accidents caused due to LPG leakages.

   (b) Briefly describe how to identify a LPG leakage at a household.

   (c) Explain how new technology can be applied to identify the gas leaks and minimize the accidents.

6. Electricity supply is considered as one of the essential services in modern society. Ceylon Electricity Board (CEB) is supplying electricity in following tariff rates.

   Table 1 - Tariff for monthly total usage between monthly consumption 0 - 60 kWh

Monthly consumption (kWh)	Unit charge (Rs. /kWh)	Fixed charge (Rs. /kWh)
0 - 30	2.50	30.00
31 - 60	4.85	60.00

   Table 2 - Tariff for monthly total usage higher than monthly consumption 60 kWh

Monthly consumption (kWh)	Unit charge (Rs. /kWh)	Fixed charge (Rs. /kWh)
0 - 60	7.85	0
61 - 90	10.00	90.00
91 - 120	27.75	480.00
121 - 180	32.00	480.00
more than 180	45.00	540.00

   (Ref: www.ceb.lk)

   (a) Identify **four** essential activities that require electricity for comfortable daily life in domestic context.

(b) (i) The following table shows selected items used in a modern house and their power ratings. Use reasonable assumptions to calculate monthly energy consumption.

Calculate monthly electricity consumption for each item completing following table. (Copy this table in the answer scripts and complete it.)

Item	Number of items	Power rating (W)	Usage per month (hours)	Units consumed per month (kWh)
Refrigerator with inverter	02	500		
Electric iron	02	1500		
Rice cooker	01	500		
Ceiling fans	08	80		
Bulbs	10	40		
	4	60		
	1	100		

(ii) Briefly describe how did you consider on/off cycles, daily activities, and relevant assumptions in calculating the units consumed per month in the table in part (i) for each item.

(c) (i) Monthly electricity consumption of a modern house with higher electricity consumption is 350 kWh. Calculate the cost of lighting load (bulbs) for the modern house considering the lighting loads as in the part (b) (i).

(ii) Briefly describe how to reduce the monthly usage for lighting by using energy efficient LED bulbs.

(iii) Refer to the following chart and calculate the reduction in the cost for lighting in the modern house mentioned in above (i).

Normal incandescent bulb (W)	Equivalent LED (W)
40	4
60	6
100	16

(d) Mention the other ways in which electricity consumption can be reduced.

7. A Mini Hydro Power Plant (MHPP) is to be designed in a certain location in the Central province of Sri Lanka. The water stream that is to be harnessed for the power generation, has an average water flow of 20 m³/s. The environmental authority allows only 40% of the average flow to be used for power generation. The height difference between water diversion point to the turbine inlet (H) is 150 m. Water is carried through a concrete channel up to the forebay tank and then through the penstock (a steel pipe) up to the turbine. The width of concrete channel section (B) is twice the water height (h) in the channel. Following figure shows the sectional view of the concrete channel.
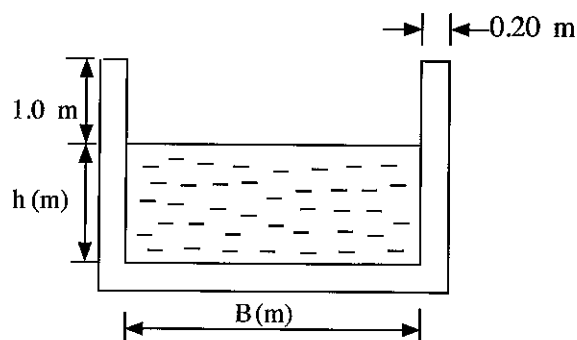
(a) Determine the available water flow for power generation.

(b) If the free board (channel height above water level) is 1.0 m and the concrete wall thickness is 0.2 m, calculate the overall channel width and overall channel height. (Velocity of water in the channel is $1\,ms^{-1}$)

(c) Calculate the potential energy available for power generation. (Consider gravitational acceleration as 10 m s^{-2} and density of water is 1000 kg m^{-3})

(d) The plant factor is efficiency of the turbine and generator works. In this case, plant factor is assumed to be 0.95 from the electrical and mechanical machinery of the power plant. Determine the power output from the generator in kWs.

(e) State **two** reasons why environmental authority does not allow to divert full water flow of the stream.

Part C

8. According to the information available at Sri Lanka Sustainable Energy Authority, the electricity generation share for national grid in 2017 is shown in table below.

Type of Power Plant	Share in Generation (%)
Major hydro	21
New renewable energy	11
Thermal-oil	34
Thermal-coal	34
Total	**100**

The government is expecting a substantial share of renewable energy in the national electricity generation in future. Hence, they plan to increase the renewable energy contribution up to 70% by 2030.

(a) Mention **four** other renewable energy sources except solar and wind energy available in Sri Lanka.

(b) Determine the required percentage increase in renewable energy contribution in the national grid from 2017 to 2030 to fulfil the government expectation.

(c) Identify the uncertainties in solar and wind energy resources and explain how you address those uncertainties to cater the electricity demand in the national grid.

(d) Following figure shows a solar irradiance for 10 hour from 8.00 AM to 6.00 PM in a day.
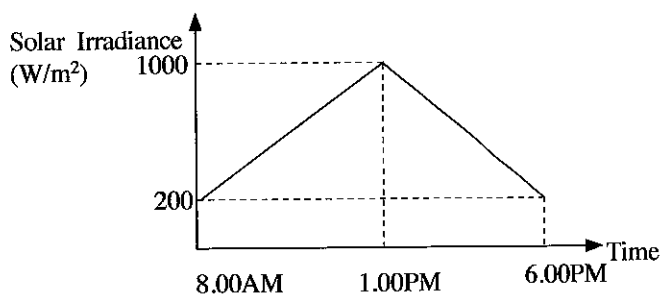
(i) Calculate the maximum possible daily electrical energy yield in kWh/m^2, if the photo voltaic cell efficiency is 17%.

(ii) Calculate the minimum size of the PV panels for a house having a flat electricity demand of 340 W throughout the day. (Assume no storage is possible)

(iii) Calculate the minimum capacity of a 12 V battery bank in Ah, if you plan to utilize entire daily solar electricity yield from the panels you calculated in above (ii).

9. A landloard of a household has received complain about increasing of water bill of a house that he has rented. September water bill was Rs. 650.00 and the October bill was Rs. 9624.00. The water bill tariff was not changed during the period. Assume no calculation error at the bill.

  (a) Briefly explain **three** possible reasons to increase the water bill.

  (b) The diagram of water distribution in the household is given below. Pipelines from *A* to *D* is on the ground and *B* to *E* is under the concrete and *E* to *F* is under the soil (Standard symbols have not been used).
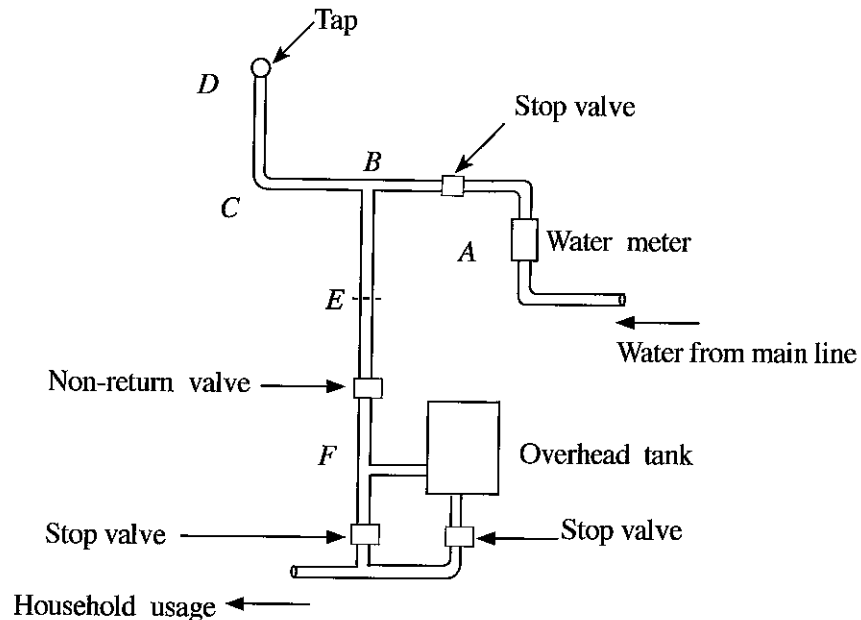
If a water leakage is available in the distribution system, explain how to identify the section of water leakage (Sections - *AB*, *BC*, *CD*, *BE*, *EF*)

  (c) 1000 *l* empty overhead tank is to be filled from main line water supplied from National Water Supply and Drainage Board. Calculate the time to completely fill the tank. Assume water flow rate of main line is 7.5 *l*/min. Average water usage from the tank is 2.5 *l*/min. State any assumptions you made.

10. The figure shows an automated sliding gate used in households.

Control unit
(Motor, Gear box
and control circuits)

Gear rack

Box bar
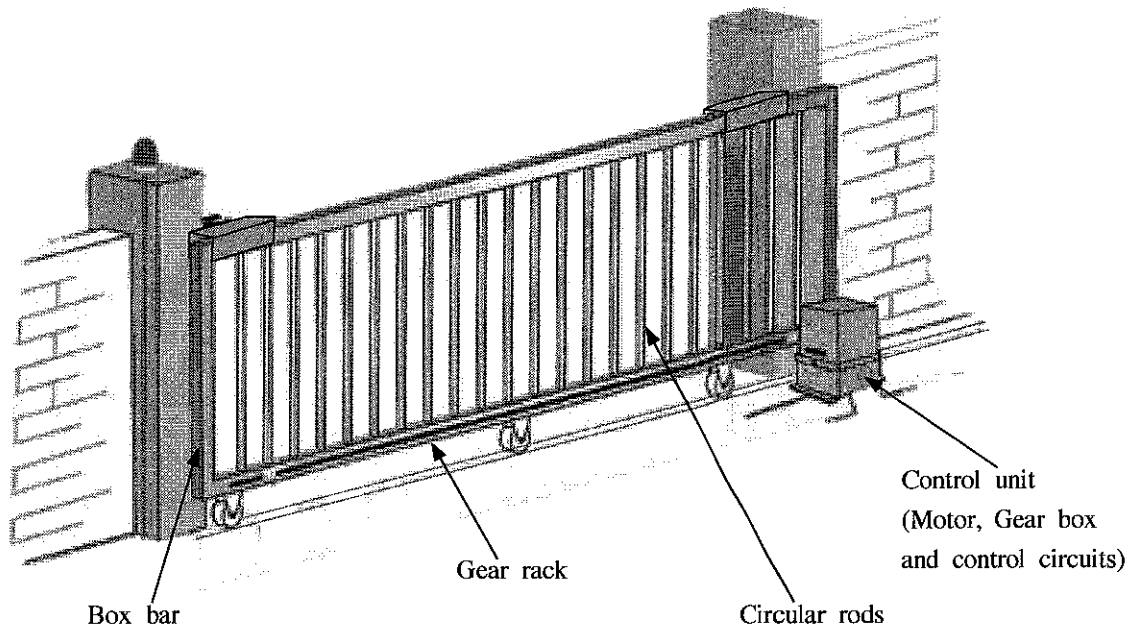
Circular rods

(a) The sliding gate is made of hollow box shaped bars and circular rods. Mention **three** production processes used in making the metal structure of the gate.

(b) Mention suitable materials for the following components giving reasons for using the material.

(i) Wheel fork

(ii) Tyre

(iii) Gate frame

(c) The gate is mounted on three wheels. Mention **two** considerations when selecting bearings for the axels of the wheels.

(d) Explain the sliding mechanism with a labelled sketch showing the motor, driving gear, and the gear rack.

(e) If the gear reduction of the gear box is 20:1, motor speed is 1400 rpm and the pinion diameter (effective diameter for calculations) is 60 mm, calculate the sliding speed of the gate.

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