



Engineering Studies

2016 Trial Examination

General Instructions

- Reading time -5 minutes
- Working time -3 hours
- Board approved calculators may be used
- Write using black or blue pen
- Draw diagrams using pencil
- Write your student number and/or name at the top of every page
- A formulae sheet is provided at the end of this paper

Section I Pages 3–7 Total marks (20)

Attempt Questions 1-20

Allow about 30 minutes for this section

Section II Pages 8–22 Total marks (80)

Attempt Questions 21-27

Allow about 2 hours 30 minutes for this section

Total marks - 100

This paper **MUST NOT** be removed from the examination room

STUDENT NUMBER/NAME:

1. Which new material was introduced into radio construction in the 1930's?
 - A. Plastic
 - B. Bakelite
 - C. Aluminium
 - D. Steel

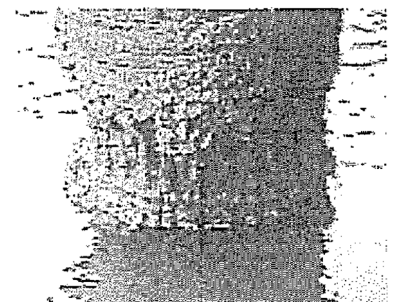
2. How is Young's modulus determined from a stress-strain curve?
 - A. The area under the stress-strain curve
 - B. The slope of the straight-line section of the stress-strain curve
 - C. The ultimate tensile stress divided by the strain
 - D. The amount of plastic deformation that occurs in the tensile sample

3. What are the major components in most electronic circuit?
 - A. Resistors, diodes, Capacitors, transistors (switch)
 - B. Capacitors, transistors (switch), light bulb
 - C. Resistors, diodes, plugs, transistors (switch)
 - D. Resistors, diodes, Capacitors, LED

4. What is the most appropriate method of manufacturing steel universal beams or I-beams) used for the structural frame in high-rise buildings?
 - A. Investment casting
 - B. Drop forging
 - C. Casting
 - D. Rolling

5. Which best describes the engineering forming process of fabricating?
 - A. The manufacture of components such as body panels for cars
 - B. The construction or manufacture of projects from assembled components
 - C. Fabricating includes processes that form metals such as casting and forging
 - D. The maintenance of components used in machinery

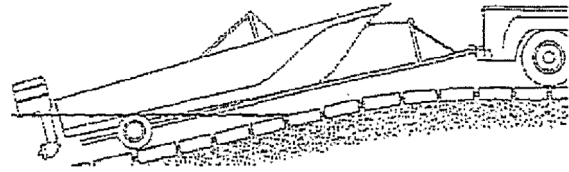
6. A jetty pile that has been subjected to waterline corrosion is shown. What is main reason for waterline corrosion?
 - A. A variation of oxygen concentration where the lower oxygen concentration region becomes anodic
 - B. The seawater has a high salt concentration that produces anodic areas just below the waterline
 - C. The pile has not been suitably treated for corrosion in seawater
 - D. Micro-organisms in seawater attack sunken objects that cause corrosion just below the waterline



7. When launching a boat from a trailer, the boat starts to slide at a slope of 28° .

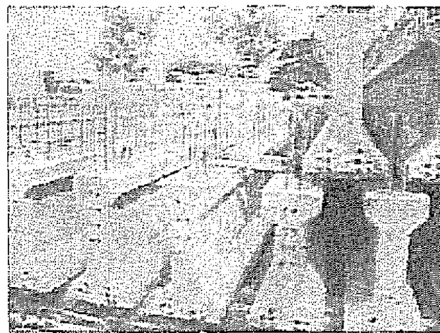
What is the coefficient of friction between the boat, and trailer when the boat begins to slide off the trailer?

- A. 0.15
- B. 0.28
- C. 0.4
- D. 0.53



8. The beams shown below are pre-tensioned prestressed concrete beams used for short span beam road bridges.

Which part of the beam has the highest tensile strength?



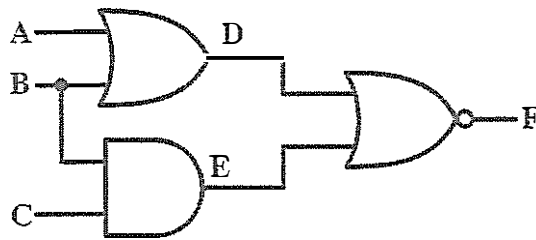
- A. The top of the beams because there are fewer steel tendons running through the beams
 - B. The top of the beams because of the vertical steel shear connectors on the top of each beam
 - C. The bottom of the beams because there are more steel tendons running through the beams
 - D. The sides of the beams because of the I beam shape
9. The world's first successful powered flight in an aeroplane by the Wright Brothers was achieved because they:
- A. designed the lightest aircraft of the time.
 - B. had the most powerful motor of the time.
 - C. had developed a useful system for controlling flight
 - D. used a biplane design.

10. Geotextiles are polymers that are used extensively in road construction.

What are the main purposes for the use of geotextiles in road construction?

- A. To separate, filter, reinforce, protect or drain soil under the road surface
- B. To provide a smooth and impervious layer underneath the asphalt road surface
- C. To prevent water from leaching through to the bitumen road surface
- D. To stabilise the road base and protect it from the asphalt layer on top

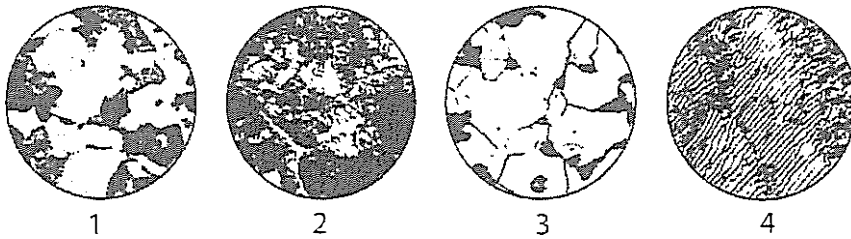
11. A combination of logic gates is shown below:



What is the output at D, E & F for an input of $A = 0, B = 0, C = 0$?

- A. $D=0, E=0, F=0$
- B. $D=1, E=0, F=0$
- C. $D=0, E=0, F=1$
- D. $D=1, E=0, F=1$

12. Four plain carbon steel microstructures are shown below.

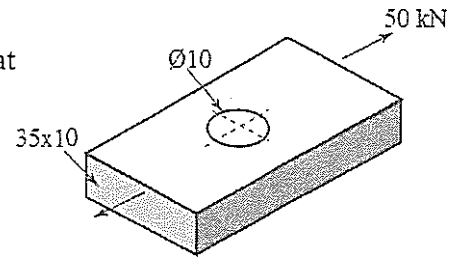


What are the correct carbon contents for the four microstructures?

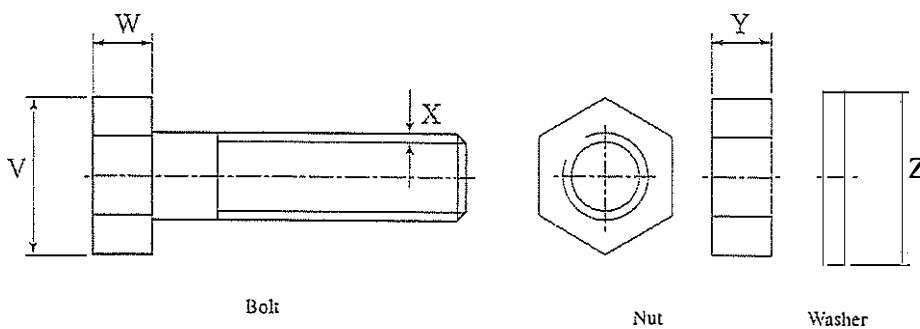
- A. 1 = >1% carbon; 2 = 0.35% carbon; 3 = 0.16% carbon; 4 = 0.8% carbon
- B. 1 = 0.35% carbon; 2 = 0.8% carbon; 3 = 0.16% carbon; 4 = >1% carbon
- C. 1 = 0.16% carbon; 2 = >1% carbon; 3 = 0.35% carbon; 4 = 0.8% carbon
- D. 1 = 0.35% carbon; 2 = >1% carbon; 3 = 0.16% carbon; 4 = 0.8% carbon

13. Chemical corrosion occurs when;
- A. the metal is exposed to water.
 - B. the metal reacts directly with substances with which it comes in contact.
 - C. the metal is exposed to intense heat.
 - D. the metal is exposed to substances located in the same vicinity.

14. A 50 kN load is applied to the 35 wide and 10 thick steel plate as shown. A $\text{Ø}10$ hole is drilled through the plate. What is the maximum stress in the plate when the 50 kN load is acting?



- A. 50 MPa
 - B. 120 MPa
 - C. 143 MPa
 - D. 200 MPa
15. Assume the shear strength of the plate in Q14 is 222.8 MPa. What is the force required to punch the $\text{Ø}10$ hole in this plate?
- A. 70 kN
 - B. 85 kN
 - C. 222 kN
 - D. 350kN
- 16 An M20 x 2 bolt, nut and washer are shown below.



What are the common AS1100 drawing sizes V, W, X, Y, Z for a bolt of this size?

- A. V = 36; W = 16; X = 1; Y = 16; Z = 40.
- B. V = 30; W = 12; X = 1; Y = 12; Z = 30.
- C. V = 36; W = 14; X = 1; Y = 16; Z = 40.
- D. V = 40; W = 16; X = 2; Y = 16; Z = 42.

17. What were some of the physical limitations of early cathode ray tubes using domestic televisions?

- A. The tubes were very long and had to be mounted backwards whilst the image was projected onto a mirror
- B. The image was projected onto a mirror and the chords were too short
- C. The image was projected onto a mirror but mirrors were not easily installed in the television
- D. The tubes were very long and had to be mounted vertically whilst the image was projected onto a mirror

18. Australia has a rich heritage in the pioneering of flight.

For which of the following Australian aviation achievements was Lawrence Hargrave responsible?

- (A) The development of the 'black box' flight recorder in 1958
- (B) The use of box kites to demonstrate the principle of lift in 1894
- (C) The establishment of QANTAS at Longreach in 1920
- (D) The first solo flight from England to Australia in 1928

19. Which materials tests can detect deep subsurface cracks?

- (A) Dye penetrant and ultrasonic tests
- (B) Radiography and eddy current tests
- (C) Radiography and ultrasonic tests
- (D) Magnetic particle and eddy current tests

20. What is the venturi effect?

- A. The turbulence created when a wing exceeds its maximum angle of attack
- B. The reduction in pressure when a fluid moves through a constricted part of a pipe
- C. The increase in pressure when a moving fluid increases velocity
- D. The lift caused by an airstream accelerating over a wing

End of Section I

Section II

80 marks

Attempt Questions 21 – 27

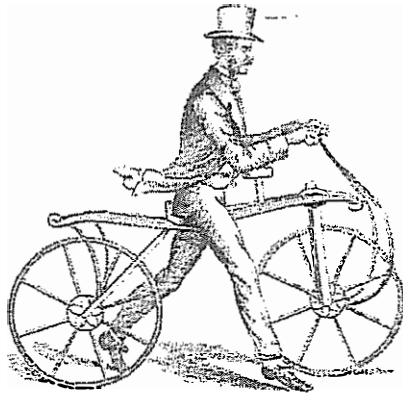
Allow about 2 hours and 30 minutes for this section

Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.

Marks

Question 21 (10 marks)

Transport systems throughout the world are adapting so that people can use bicycles as a viable means of transportation.



An example of the earliest bicycle



Storage for bicycles on public transport

- (a) Identify and explain TWO significant design features of the modern bicycle that allows it to be easily transported and stored on public transport.

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Question 21 continues on the next page

Question 21 (continued)

Marks

- (b) Describe TWO positive and TWO negative impacts on society resulting from bicycles becoming a more widely used form of transportation.

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The frame of the original bicycle design was manufactured from wood.

- (c) Explain why wood was an appropriate material at the time.

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End of Question 21

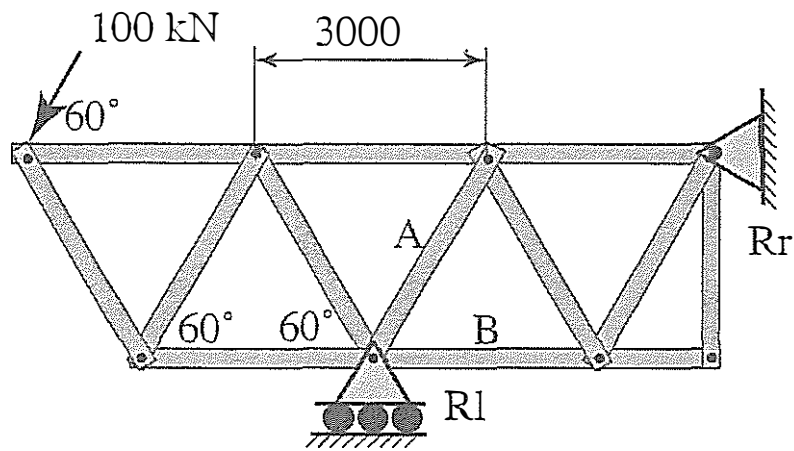
Question 22 (12 marks)

Marks

Details of a cantilever truss are given below:

- (a) Determine the force in the right reaction (R_r) and the left reaction (R_l).

4



Force in the right reaction (R_r) =

Force in the left reaction (R_l) =

Question 22 continues on the next page

Question 22 (continued)

Marks

- (b) Determine the force in members A and B and state whether they are in tension or compression.

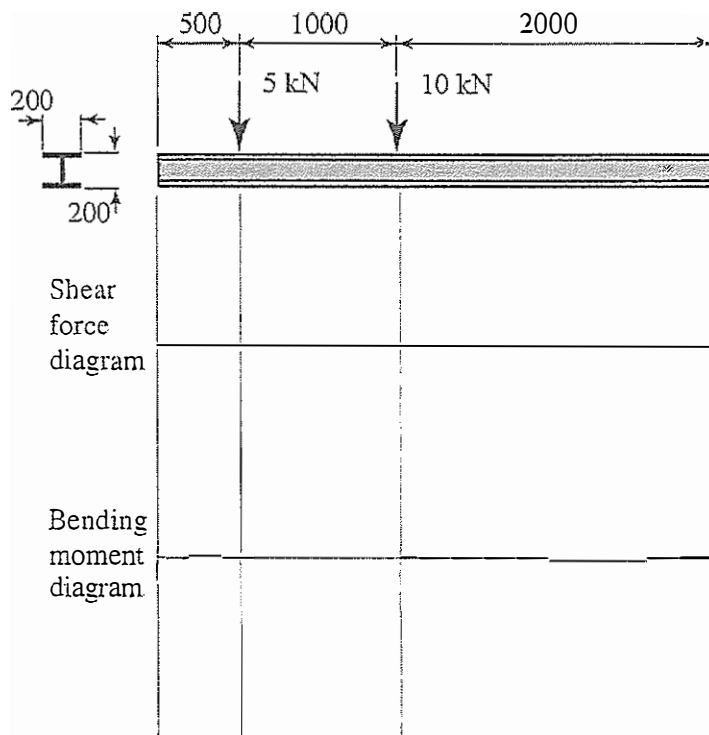
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Force in member A = kN; Tension OR compression =
 Force in member B = kN; Tension OR compression =

A universal beam (or I beam) is shown as a cantilevered beam. Two forces are acting on the beam as shown.

- (c) Construct shear force and bending moment diagrams of the loaded beam.

2



The symmetrical universal beam in part (c) is 200 x 200 as shown. The second moment of area for the beam is $90 \times 10^{-6} \text{ m}^4$.

- (d) Calculate the maximum bending stress on the beam.

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End of Question 22

- (b) (iii) Which events happened in the 1920's that enabled further development of visual communications?

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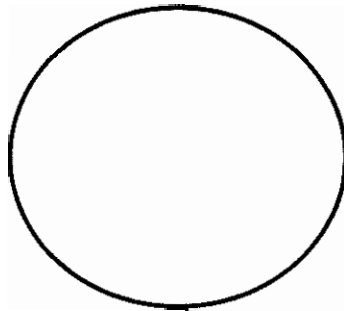
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- (c) Draw the microstructure of Grey Cast Iron and explain its properties and uses in the Transport Industry.

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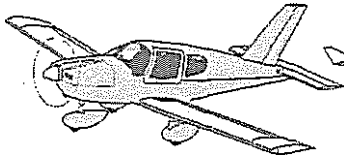
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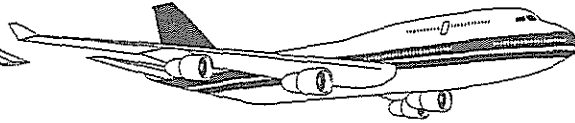
Question 24 (12 marks)

Marks

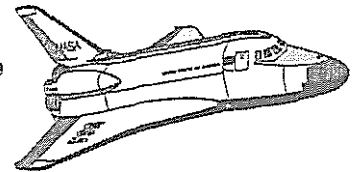
Aircraft are powered by internal combustion engines. Light aircraft generally use 4 stroke piston intermittent combustion engines while larger commercial aircraft use continuous combustion gas turbine engines. Rocket internal combustion engines are limited, at present, to experimental aircraft.



Light aircraft - piston engines



Commercial aircraft – gas turbine engines



Experimental – rocket engines

- (a) Explain the main differences between 4 stroke piston engines, turbofan gas turbine engines and rocket engines.

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Question 24 continues on the next page

The commercial aircraft shown on the previous page has winglets on the end of the wings.

- (b) Explain how winglets enhance the efficiency of aircraft wings. 2

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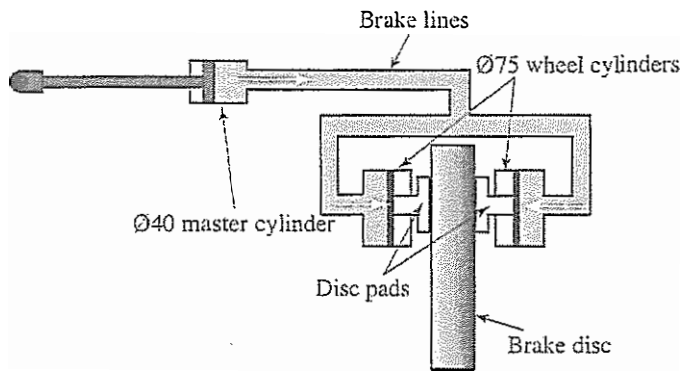
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An hydraulic brake circuit used on light aircraft is shown below. The master cylinder (input) is $\text{\O}40$ and the two wheel cylinders (output) are $\text{\O}75$.



- (c) (i) Calculate the velocity ratio of the system. 2

Velocity ratio =

- (c) (ii) Calculate the force on each wheel cylinder if the input load is 400 N. The efficiency of the system is 78%. 2

Force on each wheel cylinder =

Question 25 (12 marks)

Marks

(a) Describe the nature and range of work of TWO areas of telecommunications engineering.

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(b) Explain how AM signals work.

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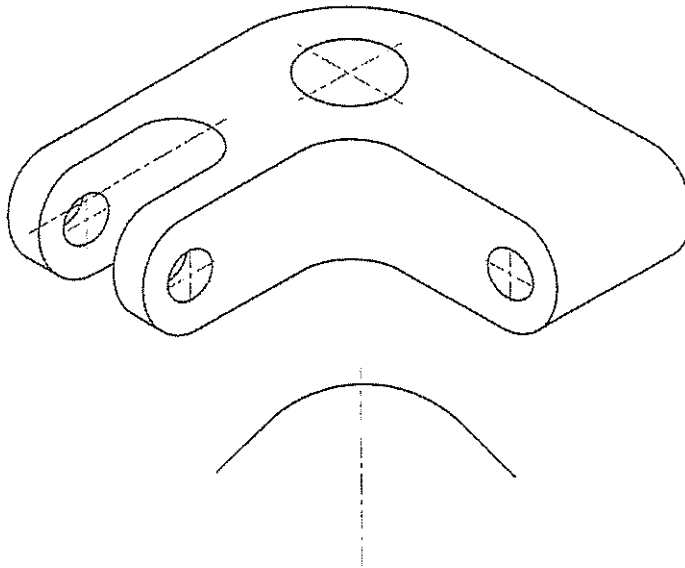
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- (c) A pictorial drawing of a telecommunications bracket is shown. Sketch, in third angle orthogonal projection, a front view and a top view of the bracket. Include all hidden detail in both views. Do not include any dimensions. A partially completed top view is provided to indicate where you should place your drawing. Take sizes directly from the pictorial drawing.

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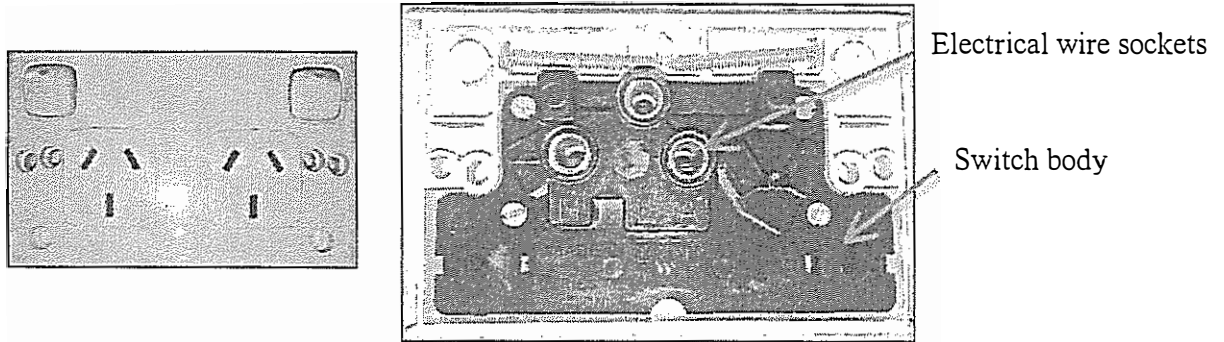
TOP VIEW

End of Question 25

Question 26 (12 marks)

Marks

Copper and its alloys are used extensively in the electrical and telecommunications industry. For the production of the domestic electrical switch shown below, decisions have to be made by materials engineers regarding the most appropriate materials.



Rear view of the electrical switch

- (a) Discuss ONE health and safety issue that materials engineers must consider in relation to the selection of appropriate materials for the switch. 2

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- (b) Explain how materials engineers may use an engineering report to justify and communicate their final decision to clients or colleagues regarding material choices for the switch. 4

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Question 26 continues on the next page

Materials engineers decided to use brass for the electrical wire sockets and a thermosetting polymer for the switch body.

- (c) (i) Justify the choice of brass for the electrical wire socket when compared to copper. 2

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- (c) (ii) Justify the choice of a thermosetting polymer for the switch body when compared to a thermosoftening polymer. 2

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The thermosetting switch body is to be manufactured by injection moulding.

- (d) With the aid of a diagram, explain the process of injection moulding. 2

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Question 27 (10 marks)

Marks

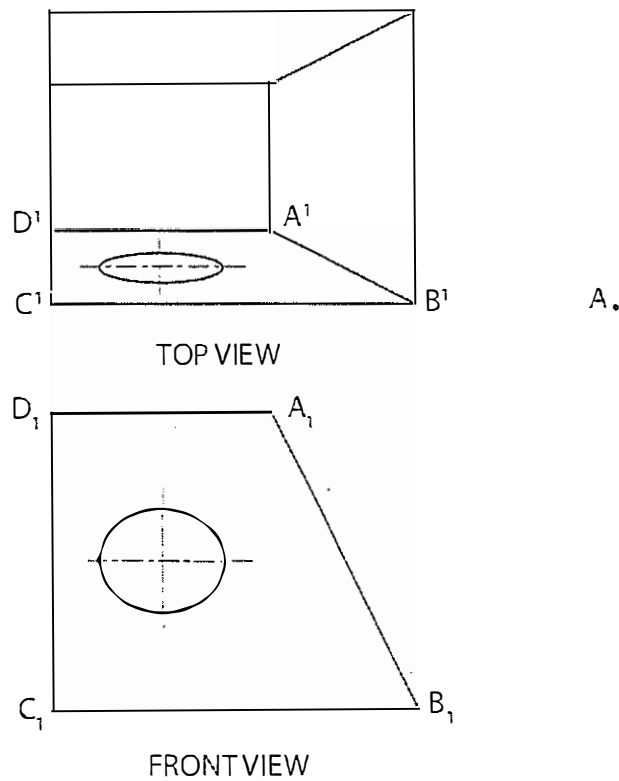
A dust extraction unit for a small cabinet making business is shown below:



A galvanised sheet metal transition piece used for part of the ducting system is provided below in third angle orthogonal projection.

- (a) In the space provided, construct a development of the face ABCD. As a starting point, A is given below.

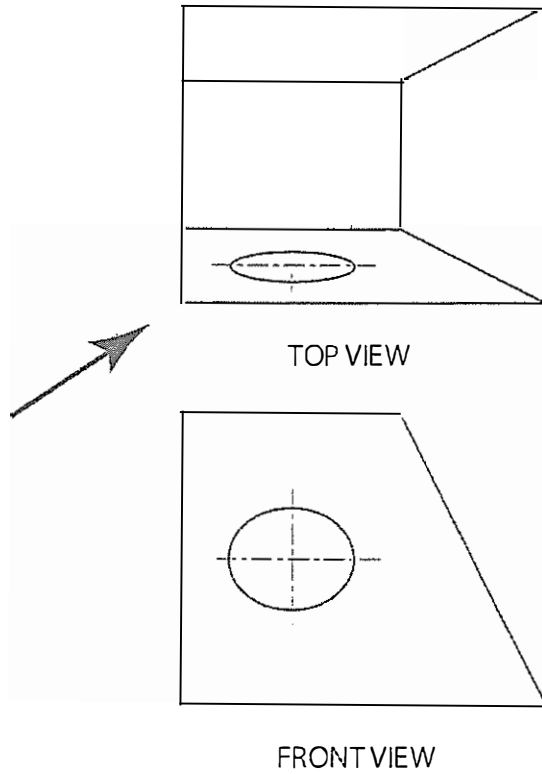
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Question 27 continues on the next page

- (b) By taking sizes directly from the orthogonal drawing of the transition piece, sketch in the space below, a pictorial drawing when viewed in the direction of the arrow. Do not draw hidden outlines.

4



Question 27 (continued)

Marks

Most sheet metal ducting has been protected against corrosion by the process of galvanising.

(c) Explain how galvanising protects metals against corrosion.

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End of paper