



2017
Higher School Certificate
Half Yearly Examination

Engineering Studies

General Instructions

- Reading time - 5 minutes
- Working time - 2 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 separately

Total marks - 67

Section I

Total marks (20)

Attempt Questions 1 - 20

Allow about 30 minutes for this section

Section II

Total marks (47)

Attempt Questions 21-26

Allow about 90 minutes for this section

Answer all questions on the examination paper,

except for the Multiple Choice questions

This paper MUST NOT be removed from the examination room

STUDENT NUMBER:

Section I

20 marks

Attempt Questions 1–20

Allow about 30 minutes for this section

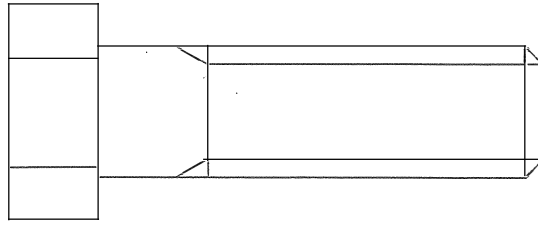
Use the Multiple-Choice Answer Sheet for Questions 1–20.

- 1 Which of the following defines a vector?
 - (A) Magnitude and an arrow
 - (B) Magnitude, sense, direction and size
 - (C) Magnitude, sense, direction and point of application
 - (D) Magnitude, point of application, a number and a dimension

- 2 Which of the following methods would be the most suitable to manufacture an engine block?
 - (A) Sand casting
 - (B) Wet wax casting
 - (C) Lost wax casting
 - (D) Injection moulding

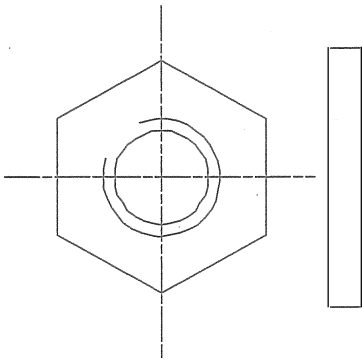
- 3 What is a loss of potential energy equal to?
 - (A) Nothing
 - (B) A gain in time
 - (C) Kinetic energy
 - (D) A gain in kinetic energy

4 A bolt drawn using AS1100 is shown.

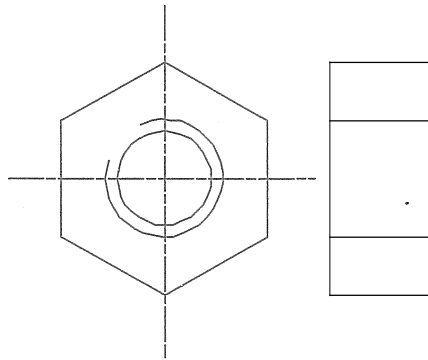


Which of the following correctly depicts how the accompanying nut should be drawn according to AS 1100?

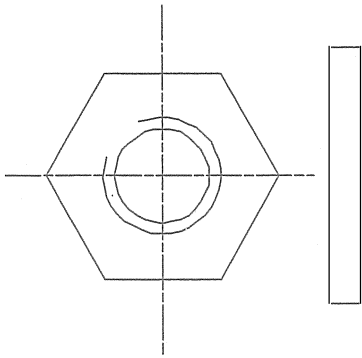
(A)



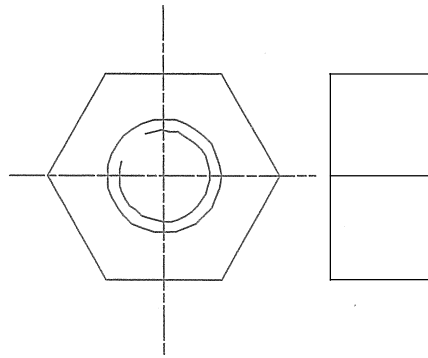
(B)



(C)



(D)

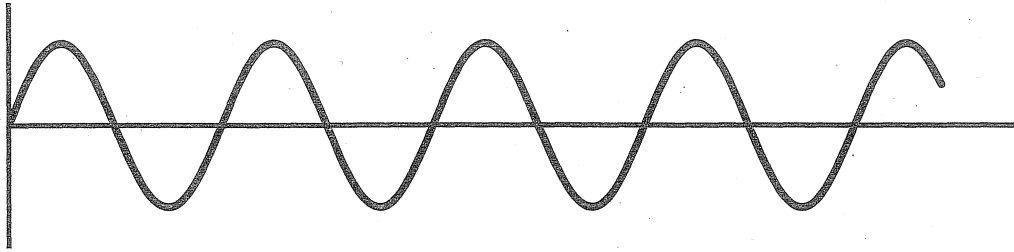


5 Which of the following stainless steel or iron allotrope is non-magnetic?

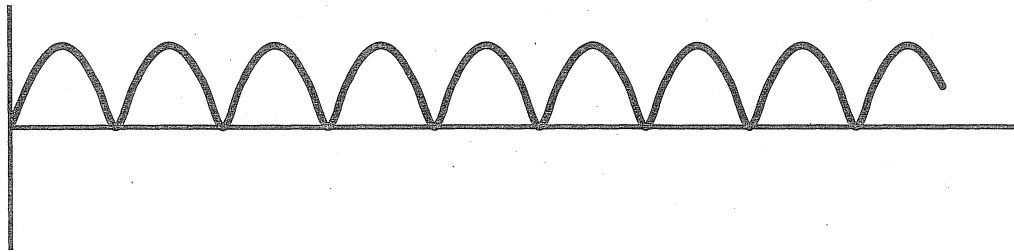
- (A) Austenitic
- (B) Magnetite
- (C) Martensitic
- (D) Pearlitic alpha

6 Which of the following graphs shows an AC input rectified with the use of a capacitor?

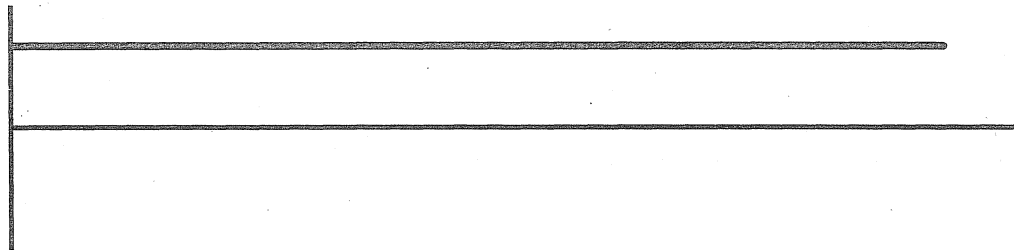
(A)



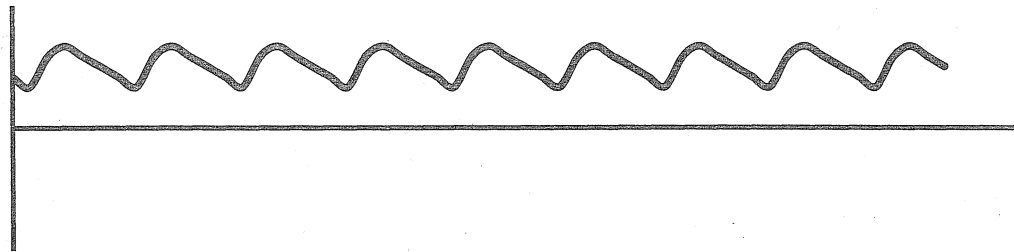
(B)



(C)

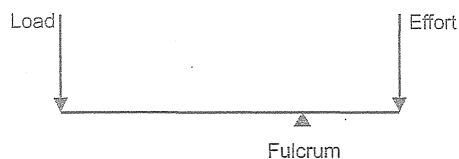


(D)

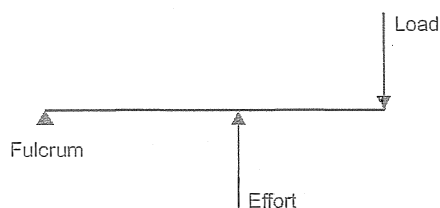


7 Which of the simple machines shown below produces a Mechanical Advantage (MA) greater than 1?

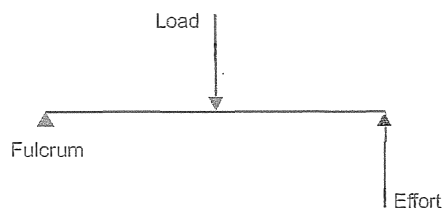
(A)



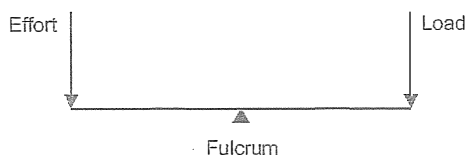
(B)



(C)



(D)

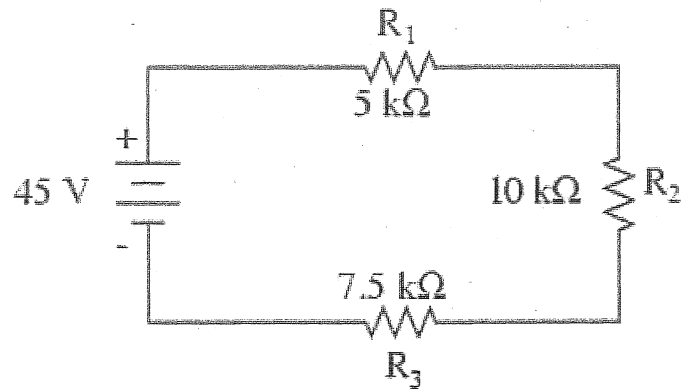


8 When carbon is added to steel, its properties of hardness and ductility change.

Which row below correctly identifies the changes that occur?

	Hardness	Ductility
(A)	Decreases	Decreases
(B)	Decreases	Increases
(C)	Increases	Decreases
(D)	Increases	Increases

9 Determine the current passing through the resistor R_1 .

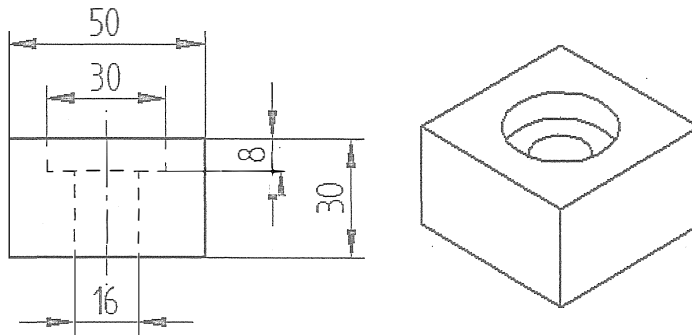


- (A) 2mA
- (B) 9mA
- (C) 2A
- (D) 9A

10 PVC sheeting, electrical conduit and cable coatings are all formed by which process?

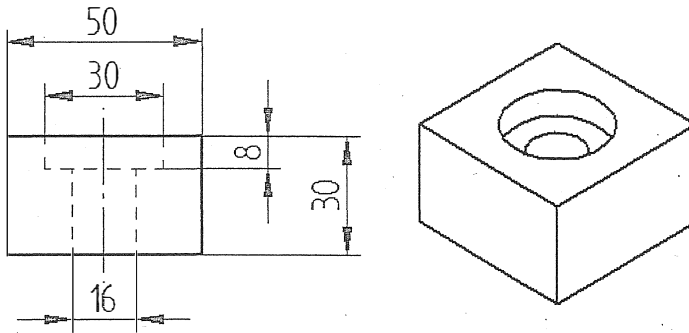
- (A) Drawing
- (B) Extrusion
- (C) Injection moulding
- (D) Compression moulding

- 11 Pictured is a side view and 3D view of a component. Which of the following would be the best AS1100 measurement for the boring operation?



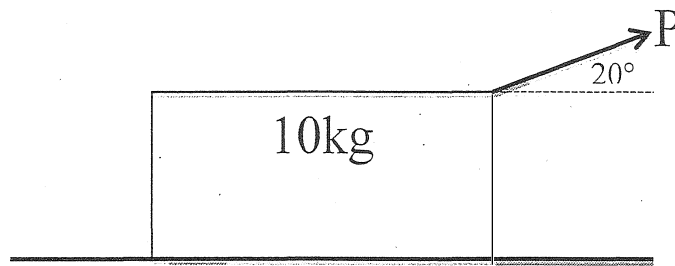
- (A) $\text{Ø}16\text{mm}$ \sqcap $\text{Ø}30$ \downarrow 8
(B) $\text{Ø}30\text{mm}$ \downarrow 50, $\text{Ø}30$ \downarrow 8
(C) $\text{Ø}30\text{mm}$ \sqcap $\text{Ø}16$ \downarrow 30
(D) $\text{Ø}30\text{mm}$ \downarrow 8, $\text{Ø}16$ \downarrow 50

- 11 Pictured is a side view and 3D view of a component. Which of the following would be the best AS1100 measurement for the boring operation?



- (A) $\text{Ø}16\text{mm}$ \sqsubset $\text{Ø}30$ \downarrow 8
- (B) $\text{Ø}30\text{mm}$ \downarrow 50, $\text{Ø}30$ \downarrow 8
- (C) $\text{Ø}30\text{mm}$ \sqsubset $\text{Ø}16$ \downarrow 30
- (D) $\text{Ø}30\text{mm}$ \downarrow 8, $\text{Ø}16$ \downarrow 50

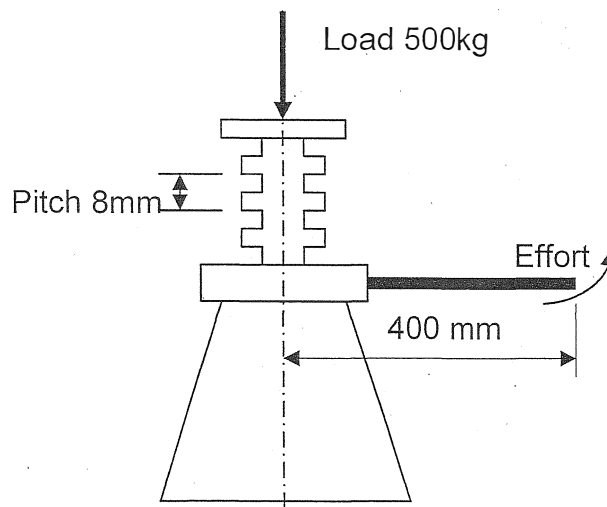
- 12 What are the main advantages of die casting?
- (A) Dimensional accuracy and excellent surface finish
 - (B) Inexpensive and easy to cast with a fine grain structure
 - (C) Requires minimal tooling to set up and is quick to carry out
 - (D) Creates a more desirable product due to lack of porous oxides
- 13 Why would a pre-stressed concrete beam be used in preference to a simple steel reinforced cast concrete beam in a large span bridge?
- (A) It gives a much better surface finish.
 - (B) Casting concrete in situ is too difficult.
 - (C) Pre-stressed concrete is less expensive to produce.
 - (D) The pre-stressed concrete beam can support a much greater load.
- 14 Which combination of properties makes ABS a suitable polymer for car bumpers?
- (A) Thermosetting, high strength and tough
 - (B) Thermosoftening, high strength and tough
 - (C) Thermosoftening, low density, heat resistant and tough
 - (D) Thermosetting, low density, high strength and is an insulator
- 15 Cast Iron is a material often used for disc brakes in cars. This material is a good choice because of the following two mechanical properties. What are these properties?
- (A) Hardness and ability to be cast
 - (B) Hardness and brittleness
 - (C) Strength and ability to be cast
 - (D) Strength and brittleness



A 10kg box is being pulled by a force P , at an angle of 20° . The coefficient of static friction between the box and the surface is 0.5. Calculate the force P required to move the box.

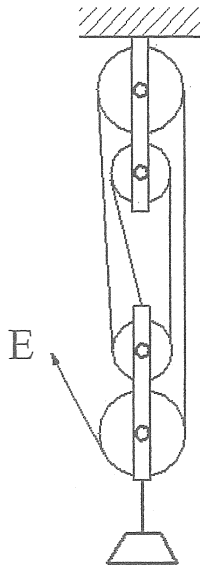
- (A) 4.4N
- (B) 43N
- (C) 44N
- (D) 50N

- 17 Determine the effort needed to lift the 500kg load if a screw thread of pitch 8mm is used. Assume there are no frictional losses.



- (A) 10N
- (B) 11.2N
- (C) 13.8N
- (D) 15.9N

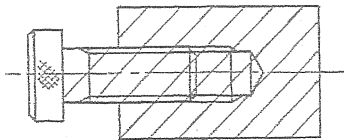
- 18 The image below shows a 'block and tackle' pulley system. If the required mass is to be lifted 1m how far will the rope need to be pulled? NOTE; the system is 100% efficient.



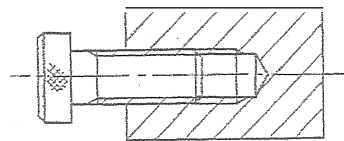
- (A) 1m
- (B) 2m
- (C) 3m
- (D) 4m

- 19 Identify the correct AS 1100 drawing of the sectioned view.

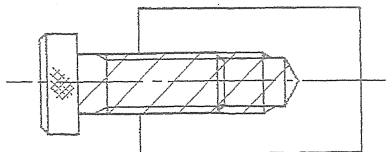
(A)



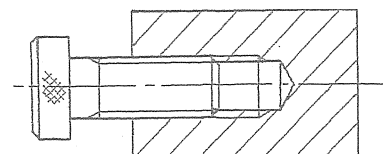
(B)



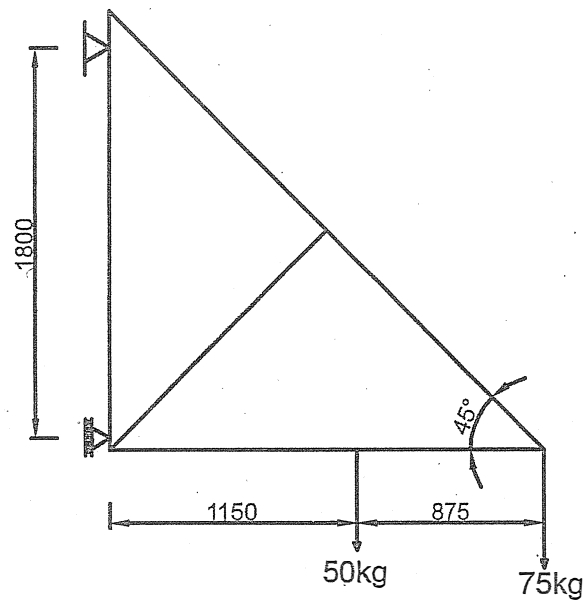
(C)



(D)



20 The diagram below shows a simple wall mounted truss.



What is the reaction at the roller support?

- (A) 1.195 kN vertically up
- (B) 1.2 kN horizontally to the right
- (C) 1,300 kN horizontally to the right
- (D) 1,200,000 N horizontally to the right

Section II

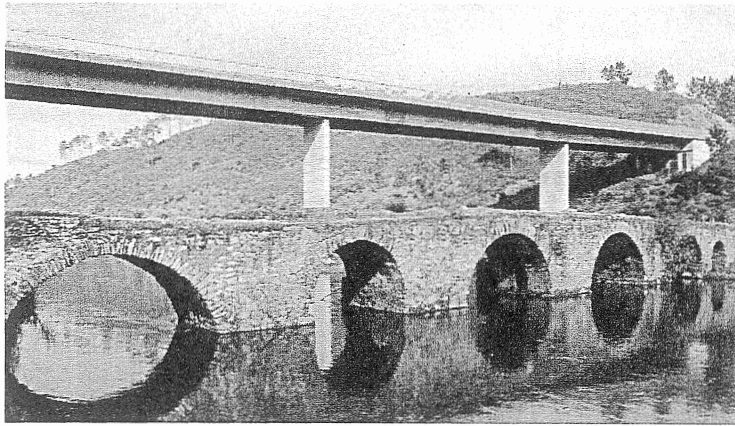
80 marks

Attempt Questions 21-26

Allow about 1 hour: 30 minutes for this section

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

Question 21 (12 marks)



The photo shows two bridges over a river.

(a) Outline three ways HOW these two bridges differ.

3

.....

.....

.....

.....

.....

.....

.....

.....

.....

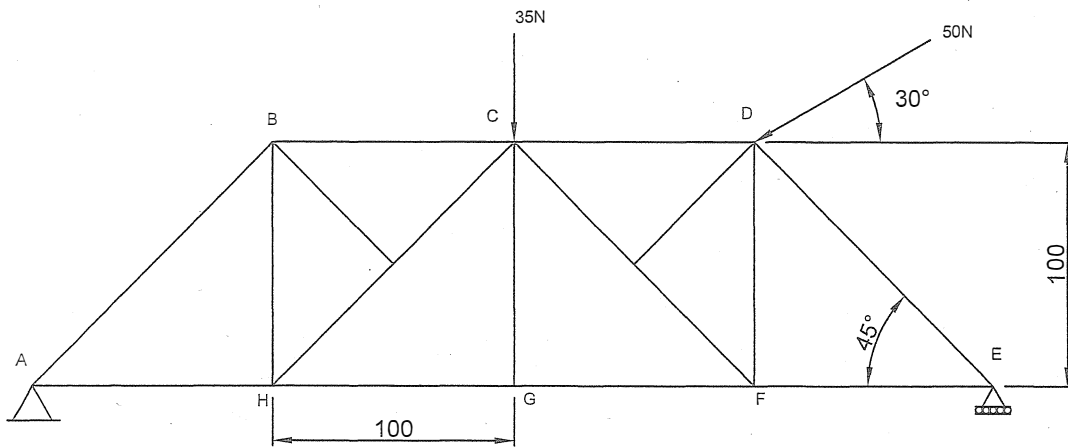
.....

.....

Question 21 continues on page 13

(b) (i) Calculate the reactions and their directions at A and E in the truss system shown.

3



Reaction at A =N, Direction is:

Reaction at E =N, Direction is:

Question 21 continues on page 14

(b) (ii) For the same truss system, calculate the force in member CF and its nature.

3

Reaction force in CF =N, Nature:

(c) Name three different types of bridges and explain ONE advantage for each one.

3

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

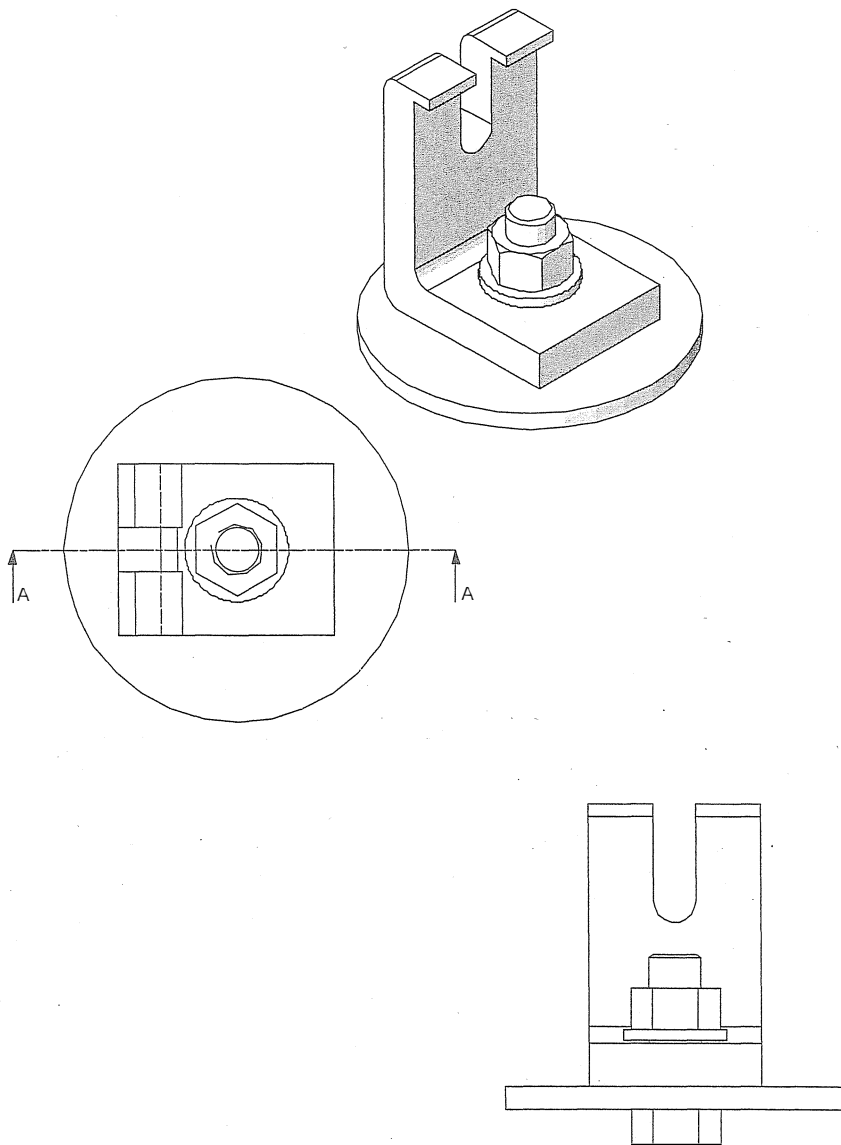
.....

End of Question 21

Question 22 (6 marks)

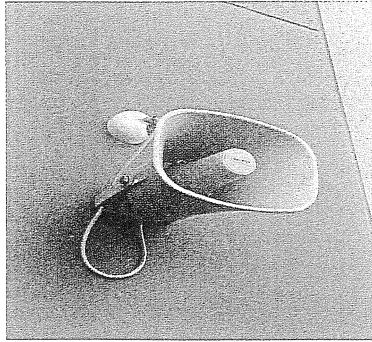
Sketch a full sectioned front view of the satellite dish support bracket shown.

6



End of Question 22

Question 23 (5 marks)



The horn of the speaker shown is manufactured from Acrylonitrile Butadiene Styrene (ABS).

- (a) (i) List TWO important properties of the material chosen for the horn of the speaker. 2

.....

.....

.....

.....

.....

- (ii) Name and describe a suitable manufacturing process used to produce the horn of the speaker. 3

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

End of Question 23

Question 24 (6 marks).

- (a) The 0.6% carbon high tensile steel bolt needs to undergo hardness testing. Name and describe ONE way this can be done. 3

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

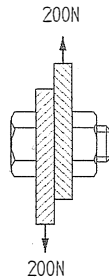
.....

.....

.....

.....

- (b) (i) A bolt is loaded with a 200 N force as shown: Calculate the shear stress in the bolt if its diameter is 8 mm. 2

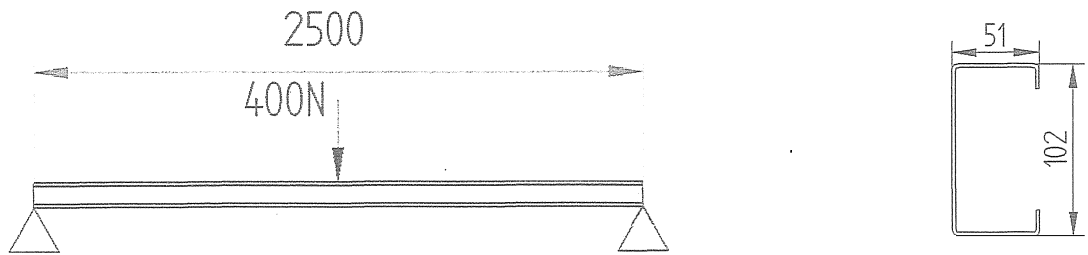


Shear stress =

Question 24 continues on page 18

- (ii) The beam of a carport is made from a “110-10 C Purlin”. If it is loaded as shown, calculate the bending stress if the second moment of area is $5.36 \times 10^6 \text{ mm}^4$

3



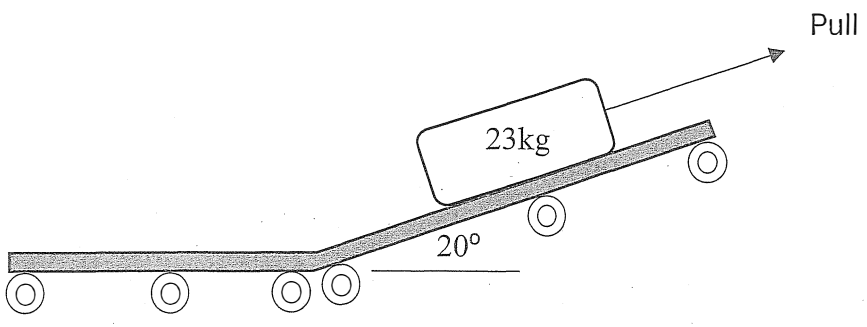
110-10 C Purlin

Bending stress =

End of Question 24

Question 25 (12 marks)

A conveyor belt is used to transport luggage in an airport.



The belt has stopped working and a 23kg suitcase lies stationary on the incline.

- (a) (i) If the coefficient of friction between the case and belt is 0.43, describe why the suitcase does not slide backwards. 2

.....

.....

.....

.....

.....

- (ii) Calculate the force required to slide the suitcase to the top of the conveyor belt. 3

Force required = N

Question 25 continues on page 20

- (iii) The broken section of the conveyor belt, which weighs 500 kg, is raised by a hydraulic lifting system. 2

The diameter of the driven piston (ram) below the conveyor belt is 100 mm and the diameter of the driving piston is 10 mm.

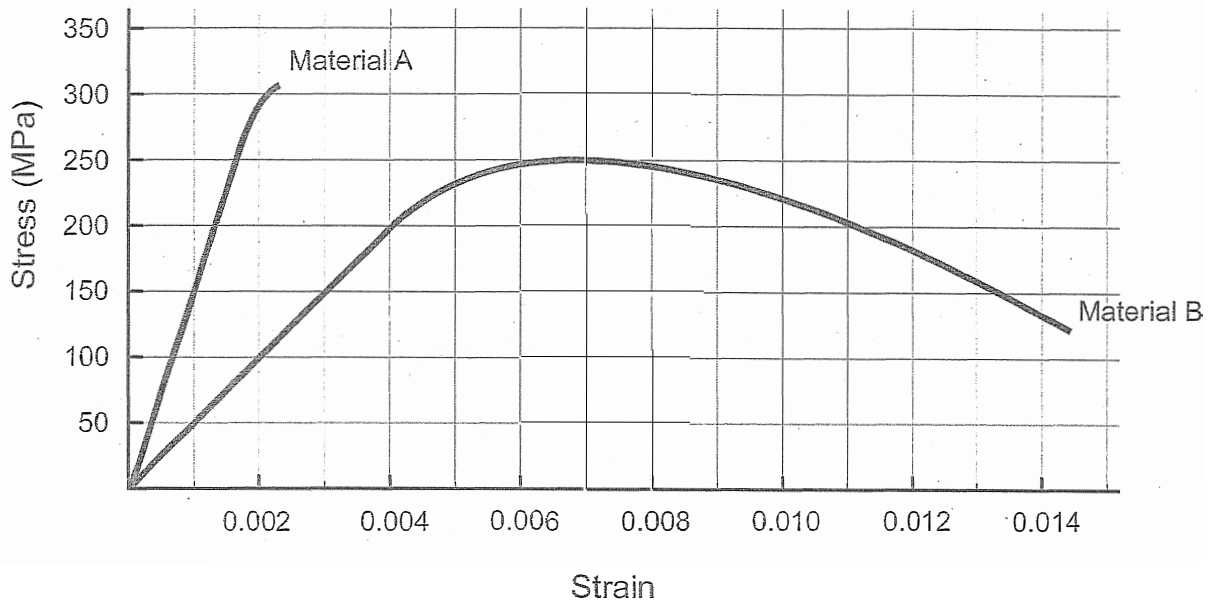
Calculate the force that occurs in the driving piston if the system is 65% efficient.

Force in drive piston = N

Question 25 continues on page 21

The conveyor belt pulleys can be made from a variety of materials.

A tensile test was carried out on two different material specimens with a cross sectional area of 20 mm^2 and the results are shown below:



The ductility and toughness of a material are important considerations when selecting a material to produce pulleys.

- (b) (i) By making reference to the results of the above tension test, evaluate the following properties of the two materials tested.

2

	Ductility	Toughness
Material A
Material B

Question 25 continues on page 22

(b) (ii) Material B has been selected by an engineer to produce the pulley.

3

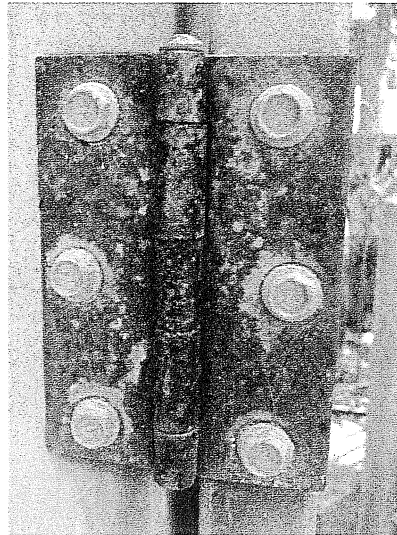
If the material has a cross-sectional area of 20 mm^2 , determine Young's Modulus for Material B by using the data supplied on the graph.

Young's Modulus = GPa

End of Question 25

Question 26 (4 marks)

The image shows corrosion on a gate hinge where the screws used are a different metal alloy to the hinge.



- (a) (i) Identify the type of corrosion and how to prevent it occurring in the future. 2

.....

.....

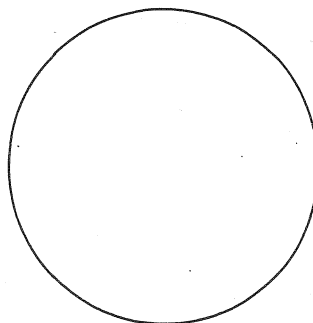
.....

.....

.....

.....

- (ii) In a different situation, a high tensile bolt has been used to hold two pieces of plate steel together. Draw and label the microstructure of the bolt if it has a carbon content of 0.6%. 2



0.6% carbon

END OF EXAMINATION PAPER