2015

Higher School Certificate

Half Yearly

Examination.

Engineering Studies

Total marks: 82

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 at the end of this paper

Section I – Pages 2 – 7
Total marks (20)
Attempt Questions 1 – 20
Allow about 30 minutes for this section

Section II – Pages 11 – 21
Total marks (62)
Attempt Questions 21 – 26
Allow about 1 hours 30 minutes for this section

This paper MUST NOT be removed from the examination room

STUDENT NUMBER/NAME: ....

Section I
20 marks
Attempt Questions 1 – 20
Allow about 30 minutes for this part

Select the alternative A, B, C or D that best answers the question and indicate your choice with a cross (X) in the appropriate space on the grid below.

	A	B	C	D
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20				

1. Which best describes addition polymerisation in the forming of polymers?

    (A) The linking of the same monomers into larger polymer molecules
    (B) The linking of different monomers into larger polymer molecules
    (C) The polymerisation process that produces a by-product, usually water
    (D) The linking of molecular chains to form a three dimensional cross bonded network

2. How is the toughness of a material indicated on a stress-strain curve?

    (A) The value of the ultimate tensile stress divided by the force applied
    (B) The tangent of the straight line section of the stress-strain curve
    (C) The ultimate tensile/compressive stress divided by the.strain
    (D) The area under the stress-strain curve

3. Which best describes electromagnetic induction?

    (A) The induction of a magnetic field in a conductor
    (B) Production of an electric current in a conductor that is subjected to a changing magnetic field
    (C) Production of a magnetic field due to an alternating current
    (D) Production of a magnetic field in a conductor that is subjected to a changing current

4. What is the most appropriate method of manufacturing cast motor vehicle engine blocks?

    (A) Shell moulding
    (B) Lost wax (or investment) casting
    (C) Die casting
    (D) Full mould (or lost foam) casting

5. What is the correct sequence that takes place when a cold-worked metal is heated to above recrystallisation temperature?

    (A) Grain growth, recovery, recrystallisation,
    (B) Nucleation, recovery, recrystallisation
    (C) Recovery, recrystallisation, grain growth
    (D) Recovery, nucleation, recrystallisation

6. What is the best method of protecting metal structures from corrosion?

    (A) Galvanisation of the structure
    (B) Use of sacrificial anodes to protect the structure
    (C) Elimination of potential corrosion areas during the design phase
    (D) Impressed current cathodic protection (ICCP

7. A tip truck is shown unloading road base during road construction.

    If the coefficient of friction between the truck's tray and road base is 0.35, what is the angle of the tray to initiate unloading of the road base?

    (A) 25.4°
    (B) 19.3°
    (C) 16.0°
    (D) 20.5°
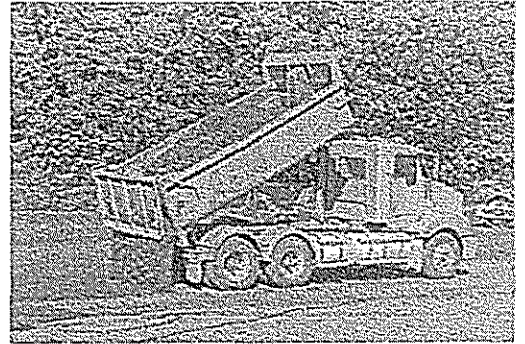
8. The gear train shown has an efficiency of 85%.

    What is the mechanical advantage of the system?

    (A) 9.35
    (B) 11.0
    (C) 4.45
    (D) 0.25

Gear A - 50 teeth

GearB - 200 teeth

Gear C - Ø80

Gear D - Ø220
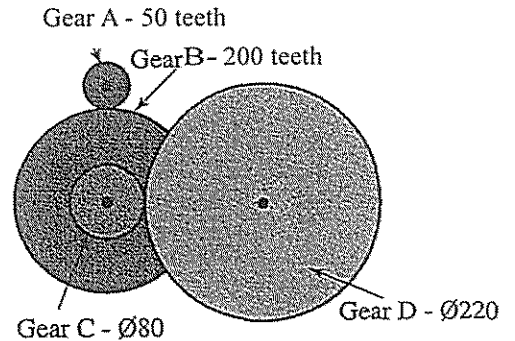
9. What are the most significant reasons why electric motors are more suitable for driving motor vehicles than internal combustion engines?

    (A) More efficient, less pollution, maximum torque at all speeds, smaller
    (B) Less noise pollution, higher torque at low revs, no air pollution
    (C) Easier to drive, less mass, less cost to purchase
    (D) Long range, better acceleration, less maintenance

10. What are the main ingredients in concrete?

    (A) Sand, clinker, gypsum, aggregate
    (B) Sand, cement, water, aggregate
    (C) Sand, bauxite, water, cullet
    (D) Sand, resin, aggregate, blue metal

11. An electronic circuit is shown below:
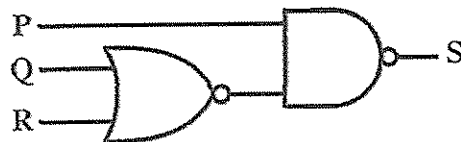
    What inputs (P, Q, R) are required to have an output (S) of zero?

    (A) P=1,Q=O,R=1
    (B) P=1,Q=1,R=1
    (C) P= 1, Q=O, R=O
    (D) P=1,Q=1,R=O

12. Two plain carbon steel microstructures are shown below. Material 1 has 0.16% carbon and material 2 has 0.8% carbon.
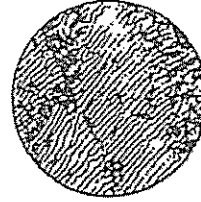
1. 0.16% Carbon   2. 0.8% Carbon

Which statement best describes the relative mechanical properties of each material?

(A) Material 1 is soft and strong; material 2 is more malleable and stronger.
(B) Material 1 is harder, less ductile and stronger; material 2 is soft and ductile
(C) Material 1 is soft and strong; material 2 is softer and less ductile.
(D) Material 1 is soft and ductile; material 2 is harder, less malleable and stronger.

13. The type of bridge pictured below is.
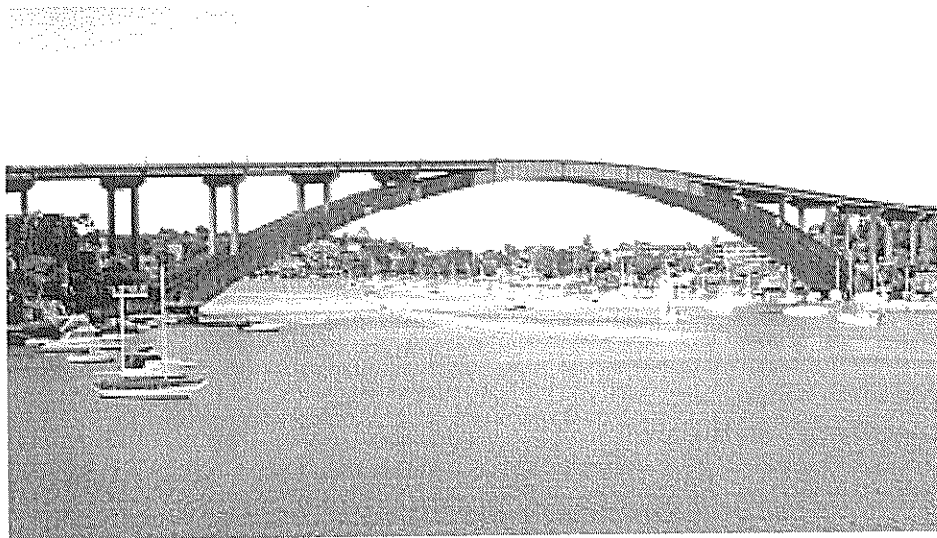
(A) a steel arch bridge
(B) a concrete arch bridge
(C) a cantilever bridge
(D) a box girder beam bridge.

14.

20 kN

1 m

2 m
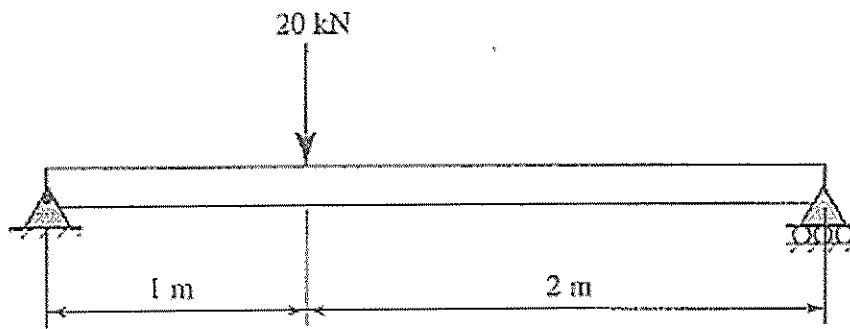
What is the maximum bending moment acting on the beam?

(A)   13.3 kNm
(B)   13.3 MPa
(C)   6.7 MPa
(D)   6.7 kN

15.   A force of 75 kN is required to punch a diameter 12 mm hole in 10 mm thick metal plate. Using a factor of safety of 2, which material will be satisfactory for use as the punch?

 (A) Mild steel with a compressive strength of700 MPa
 (B) Titanium alloy with a tensile strength of 1000 MPa
 (C) Alloy steel with a shear strength of 1300 MPa
 (D) Alloy steel with a compressive strength of 1400 MPa

16.   Which drawing correctly represents the threaded hole in a nut according to AS 1100?

 (A)   (B)   (C)   (D)
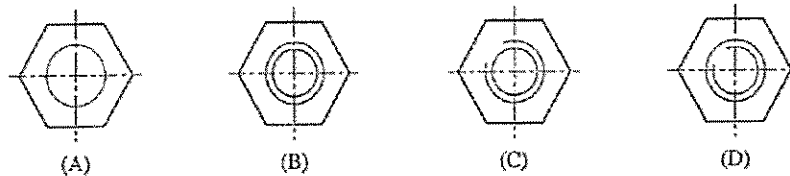
17.   What is the main reason why semiconductors are doped?

 (A) To increase the number of electrons in the semiconductor
 (B) To increase the toughness and strength of the semiconductor
 (C) To increase the thermal properties of the semiconductor
 (D) To increase the conductivity of the semiconductor

18.   Deduce from the two microstructures what manufacturing processes were used to form thread shape X and thread shape Y.

X   Y
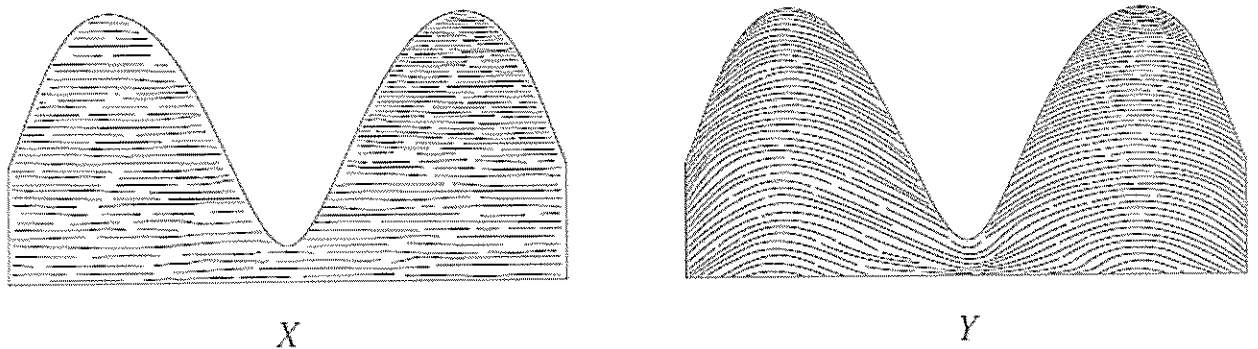
 (A) X by cutting and Y by cutting

 (B) X by rolling and Y by rolling

 (C) X by cutting and Y by rolling

 (D) X by rolling and Y by cutting_

19. Two sheets of copper are joined by a steel rivet as shown.
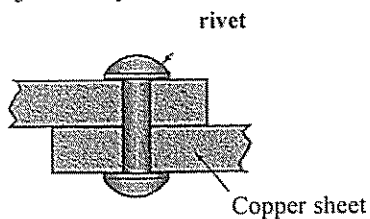
rivet

Copper sheet

Why will the steel rivet corrode very quickly compared to the copper sheet?

(A) Steel is less reactive than copper and the cathode has a larger surface area
(B) Steel is more reactive than copper and the cathode has a larger surface area
(C) Steel is more reactive than copper and the anode has a larger surface area (D)
(D) Steel is less reactive than copper and the cathode has a smaller surface area

20. The coefficient of friction is equal to which of the following relationships given that θ is the angle of repose of the inclined plane?

(A) tan θ

(B) mg cos θ

(C) mg sin θ

(D) FS cos θ

End of Section I

Section II
80 marks
Attempt Questions 21- 26
Allow about 1 hour and 30 minutes for this section

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

Question 21 (12 marks)   **Marks**

Engineers Australia code of ethics for professional engineers in Australia states that engineers should:
- Demonstrate integrity
- Practice competently
- Exercise leadership
- Promote sustainability

(a)   Describe TWO considerations for EACH of the four headings that professional engineers should follow to support the Engineers Australia code of ethics.   8

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Question 21 (continued)   **Marks**

(b)   Explain the importance of engineers as managers in the engineering profession.   2

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(c)   Outline why collaboration is a significant aspect of successful modern professional engineering.
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End of Question 21

Question 22 (12 marks)   **Marks**

A cantilever truss with external forces acting at A and B is shown below:

(a)   Determine the force in the pin reaction (R right).   5
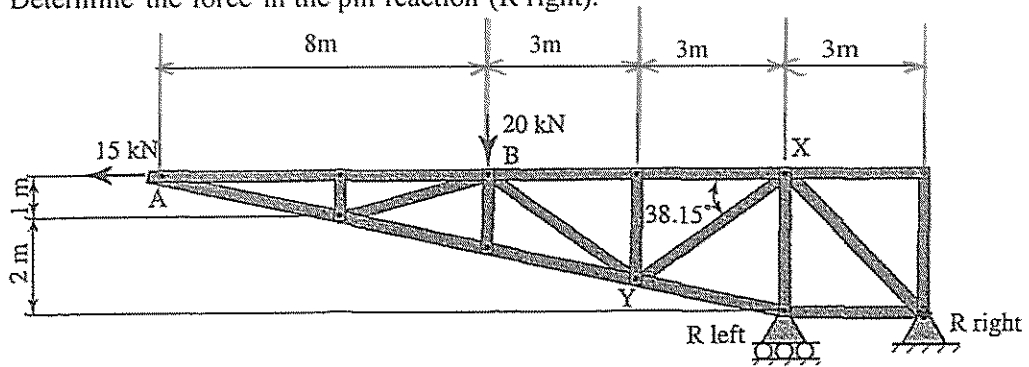
Force in the pin reaction= ....

Question 22 continues on the next page

Question 22 (continued)   **Marks**

(b)   Determine the force in member XY and state whether it is in tension or compression.   3

Force in member XY = ... kN; Tension OR compression= ....

The truss bars (members) are made from 0.15% carbon steel which cannot be effectively hardened and strengthened by heat treatment.

(c)   (i) Describe one method of hardening and strengthening this material.   2

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(ii) Explain why steels with a carbon content below 0.2% are excellent for joining by electric welding when compared to steels with a carbon content above 0.4%.   2

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End of Question 22

Page 15

Question 23 (continued)

Marks

Question 23 (12 marks)

Marks

The three cars below are part of the new generation of motor vehicles, designed to reduce emissions and to have better fuel efficiency. Manufacturers generally use petrol/diesel, hybrid and electric cars to achieve these outcomes.

VW petrol/diesel Polo   Toyota Prius hybrid   Electric car
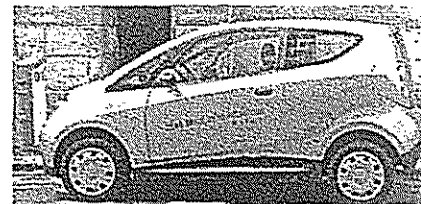
(a)   Explain, by providing at least two features for each car, how each of these new generation motor vehicles achieve less pollution and better fuel efficiency.

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Marks

A car of mass 1 tonne is allowed to coast down a hill of altitude 50 m. The loss of energy due to frictional resistance when the car reaches the bottom of the hill is 200 J.

(b)   Calculate the velocity of the car at the bottom of the hill in km/h.   **2**

Velocity of the car at the bottom of the hill = ... km/h

A hydraulic system has an efficiency of 85% and a mechanical advantage of 2. The diameter of the input (or effort) cylinder is dia 20.

(c)   Calculate the diameter of the output (or load) cylinder.   **2**

Diameter of the output (or load) cylinder= .... mm

(d)   Explain control technology and how it is applied to an area of Personal and Public Transport.   **2**

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End of Question 23

Question 24 (6 marks)

(a) A pictorial drawing of a bracket with webs and a threaded hole is shown. The bracket is attached to a metal base by two hexagonal head cap screws.
Sketch in third angle orthogonal projection, a front view and a right side view of the bracket. The front view is to be viewed from the direction shown.
Omit all hidden detail in both views.
Do not include any dimensions.
Take sizes directly from the pictorial drawing.   **Marks 6**
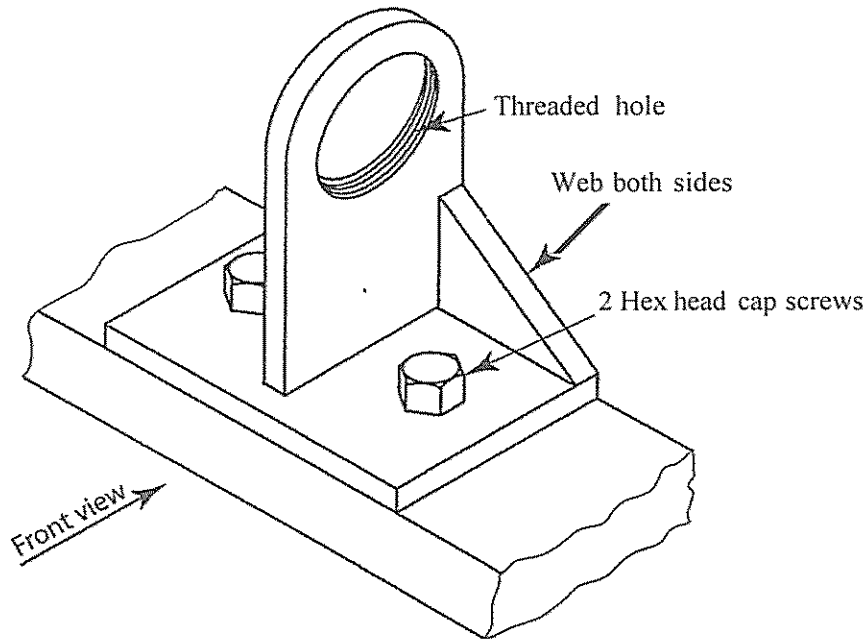
End of Question 24

Question 25 continues on the next page

Question 25 (10 marks) **Marks**

(a) An orthogonal drawing showing a front view and a top view of a bearing cap is shown. Make a full size pictorial sketch of the bearing **4**

Ø10

22   22

60

23

TOP VIEW

View direction

Ø22

Ø30

8

FRONT VIEW
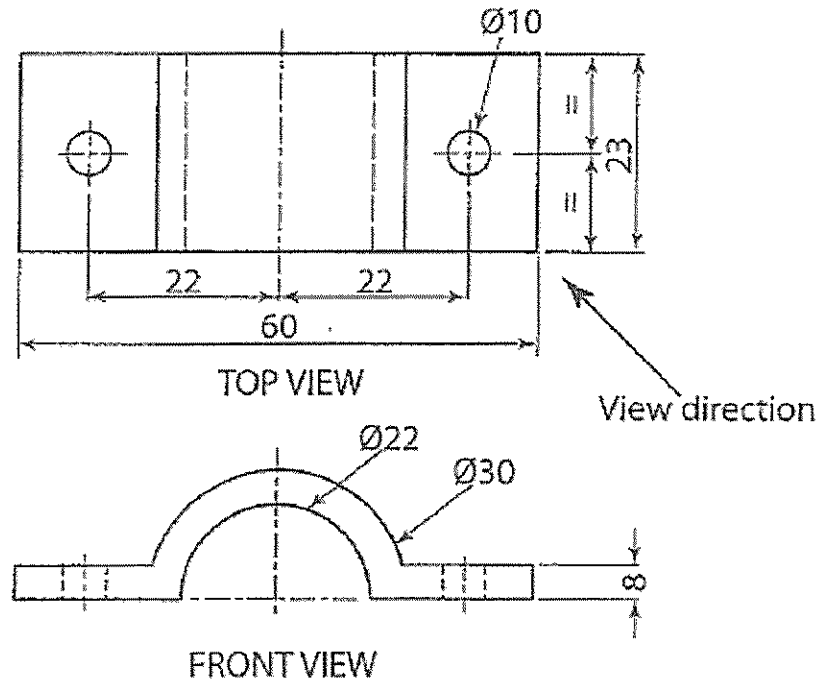
Question 25 continues on the next page

Question 25 (Continued)   **Marks**

A tow truck of mass 15 tonnes is to tow a 5 tonne disabled truck up an incline of 30° as shown. The tow cable is at an angle of 25° to the incline. The coefficient of static friction for both vehicles and the inclined surface is 0.3.

(b)   Determine the tension in the tow cable when both trucks are on the verge of moving up the plane.   3

Tension in the tow cable= .... kN

Marks
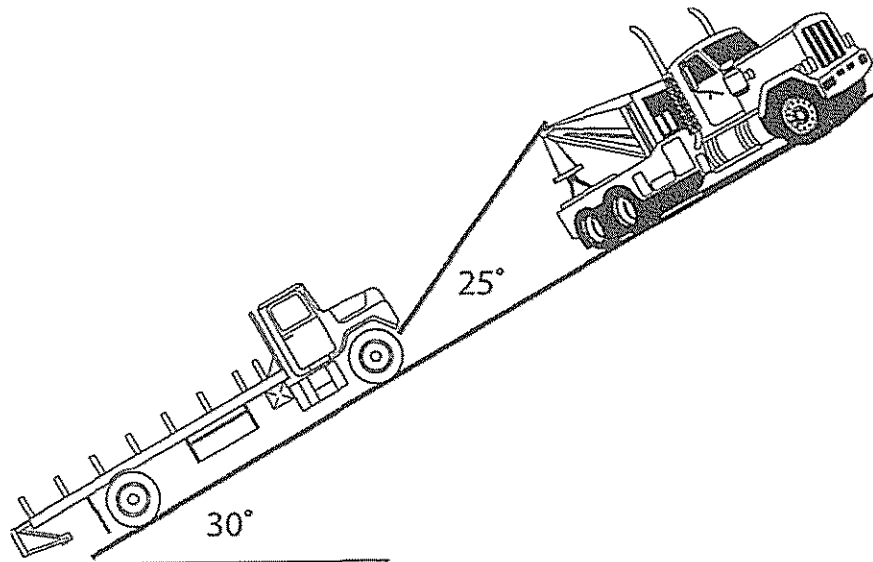
Question 25 (continued)

The tow cable used for the towing operation in (b) above is made from woven strands of steel wire with a carbon content of about 0.4%.

(c)   (i) Explain why cable is used rather than solid metal for towing and lifting operations.   **1**

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Wire is manufactured by drawing the metal through successively smaller dies to reduce the diameter to the desired size.

(c)   (ii) Justify why the drawn wire has to be annealed between the various drawing stages.   **2**

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End of Question 25

Page 21

Question 26 (10 marks) **Marks**

(a) Name and describe ONE technology that is or was unique to the civil engineering profession. **2**

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Engineering reports are used extensively in all areas of the engineering profession.

(b) Outline the importance of engineering reports using an example from the area of civil engineering. **2**

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(c) Determine the maximum bending stress in the cantilevered universal beam shown below. Assume the second moment of area for the beam is 90×10^6 mm^4.

Marks

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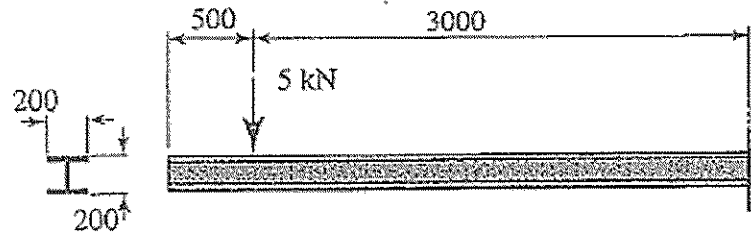
Question 26 (continued)   **Marks**

The calculations for finding the bending stress in the universal beam in (c) above are to be incorporated into an engineering report.

(d)   Name the most appropriate section of the engineering report to show these calculations and provide one reason for your choice.   2

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The cantilevered universal beam is to be used in a coastal environment.

(e)   Name and describe a suitable method to protect the beam from corrosion during service.   2

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End of paper