

Write your name here

Surname

Other names

Pearson BTEC Level 3
Extended Certificate,
Foundation Diploma,
Diploma, Extended
Diploma

Centre Number

| | | | | | | |
|--|--|--|--|--|--|--|
| | | | | | | |
|--|--|--|--|--|--|--|

Learner Registration Number

| | | | | | | | |
|--|--|--|--|--|--|--|--|
| | | | | | | | |
|--|--|--|--|--|--|--|--|

Engineering

Unit 1: Engineering Principles

Wednesday 7 June 2017 – Morning

Time: 2 hours

Paper Reference

31706H

You must have:

Information booklet of formulae and constants
Ruler, protractor, pencil and calculator

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and learner registration number.
- Answer **all** questions.
- Answer the questions in the spaces provided
– *there may be more space than you need.*

Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets
– *use this as a guide as to how much time to spend on each question.*
- You may use a non-programmable calculator that does not have the facility for symbolic algebraic manipulation or allow the storage and retrieval of mathematical formulae.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

P51751A

©2017 Pearson Education Ltd.

1/1/1/1/1/1/1




Pearson

Section A: Applied Mathematics

Answer ALL questions. Write your answers in the spaces provided.

The diagram shows a mounting plate that is stamped from sheet aluminium.

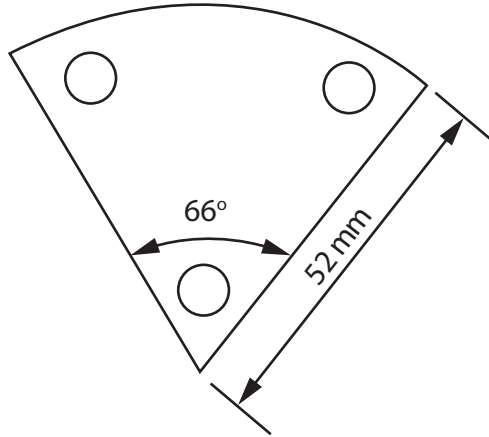


Diagram not to scale

- 1** Calculate the length of the curved side of the plate.

Answer

(Total for Question 1 = 2 marks)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



An automated electronic alarm is set to provide two warning beeps during a CNC cutting cycle. The timing of the alarm is given by the equation

$$6t^2 - 16t + 10 = 0, \text{ where } t \text{ represents the time in seconds.}$$

- 2 Find, by factorisation, the two times when the warning beeps sound.

Answer 1

Answer 2

(Total for Question 2 = 2 marks)



The diagram shows an example of a fully enclosed steel storage silo with a base.

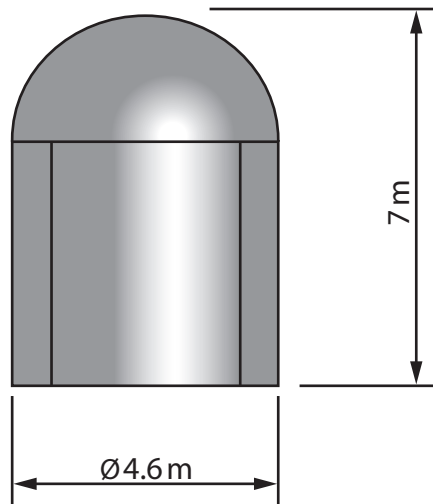


Diagram not to scale

- 3 Calculate the total surface area of the steel storage silo.

Answer

(Total for Question 3 = 4 marks)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



An electronic engineering technician has been asked to determine the signal-to-noise ratio value of a signal generator.

Four signal generators have been tested, and the results of the tests can be represented by

$$2\log 3 + \log 4 = \log A + 4\log 2$$

- 4 Solve the equation to find the value of A.

Show evidence of the use of the laws of logarithms in your answer.

Answer

(Total for Question 4 = 3 marks)

TOTAL FOR SECTION A = 11 MARKS



Section B: Mechanical and Electrical, Electronic Principles

Use appropriate units in your answers.

The diagram shows a ramp that links two work areas on a site where electrical equipment is manufactured. A technician has been asked to move a transformer of mass 450 kg from point A, up the ramp to point C.

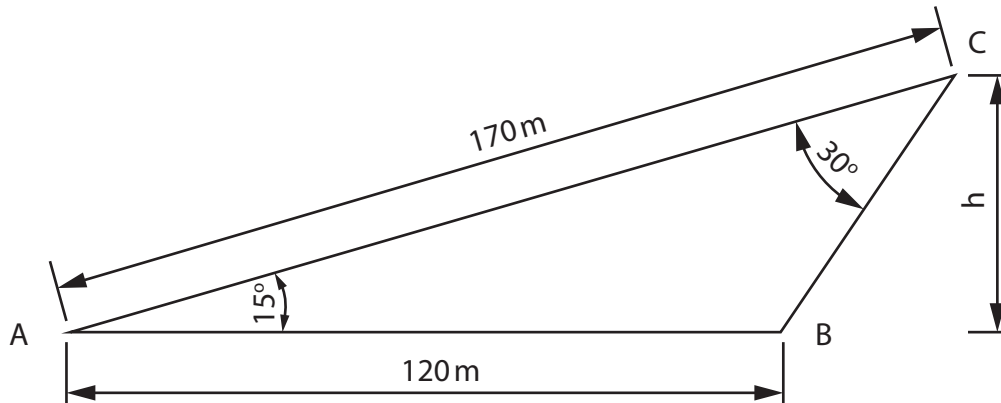


Diagram not to scale

- 5 (a) Calculate the potential energy of the transformer at point C. (4)

Answer

- (b) Explain **one** advantage of using a ramp for moving the transformer compared to lifting the transformer vertically. (2)

(Total for Question 5 = 6 marks)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



The diagram shows a steel plate used to connect three steel ropes that are in tension.
The plate is in static equilibrium.

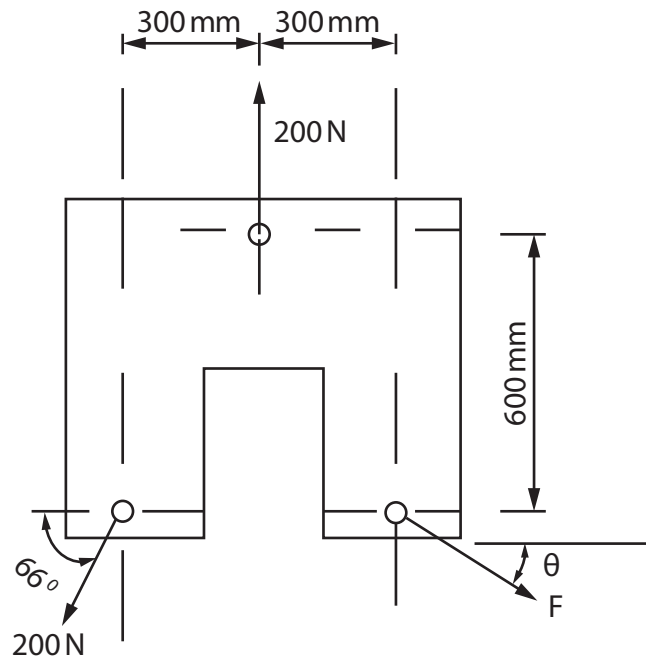


Diagram not to scale

6 Calculate the magnitude and direction of the force F from the horizontal.

Magnitude

.....

Direction

.....

(Total for Question 6 = 5 marks)

.....



P 5 1 7 5 1 A 0 7 2 0

A 10 m wide retaining wall separates sea water from a fresh water pool.

Assume the following:

- density of fresh water is 1000 kg/m^3
- density of sea water is 1030 kg/m^3 .

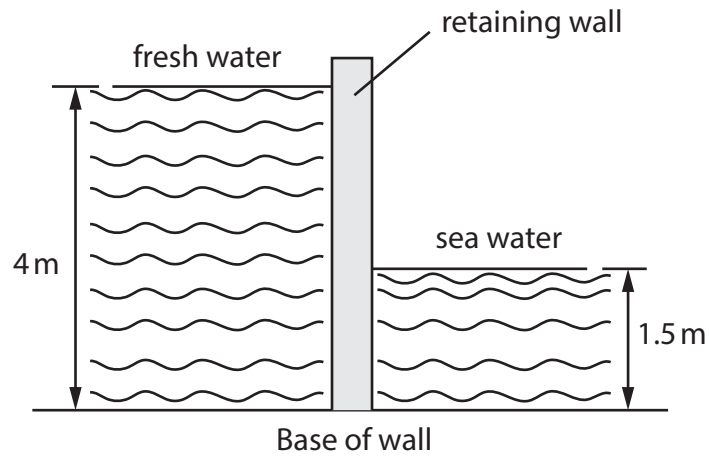


Diagram not to scale

7 Calculate the resultant turning moment of the wall about the base.

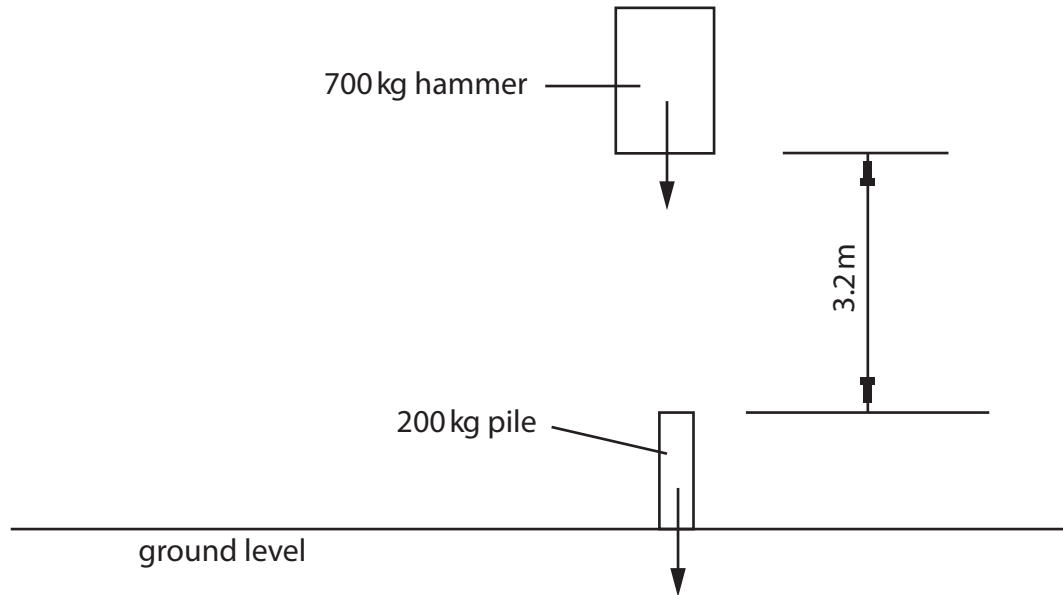
Answer

(Total for Question 7 = 6 marks)



A pile driving hammer that has a mass of 700 kg falls 3.2 m from rest on to a pile that has a mass of 200 kg.

There is no rebound, and the pile is driven 175 mm into the ground.



- 8 Calculate the average resistance force exerted by the ground in bringing the pile and hammer to rest.

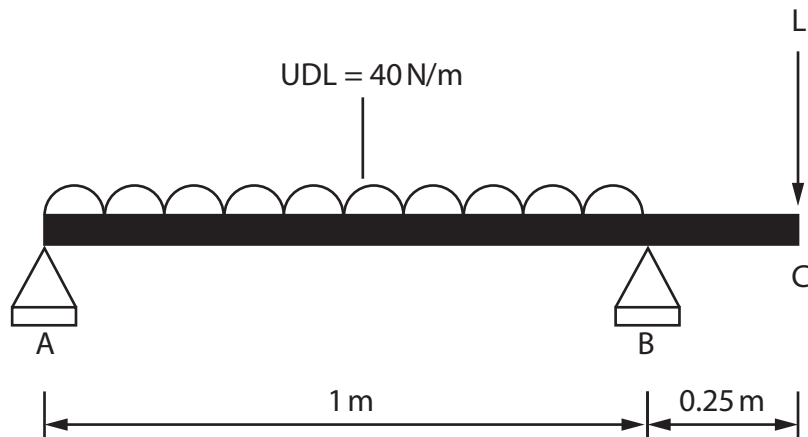
Answer

(Total for Question 8 = 6 marks)



A simply supported beam of length 1.25 m is designed to support a Uniformly Distributed Load (UDL), with the ability to support a further point load (L) at the overhang.

The support reaction at point B is given as $R_B = 26 \text{ N}$



9 Calculate:

- the maximum load (L) that can be supported at point C
- the reaction force at point A when L is applied.

Maximum load (L)

Reaction force (R_A)

(Total for Question 9 = 4 marks)



An electronics engineering technician is performing tests on a capacitor that is connected to a 60 V DC supply.

The capacitor plates have an area of 80 mm^2 and are separated by a dielectric that is 0.3 mm thick, with a permittivity of 5.

10 Calculate the charge stored.

Answer

(Total for Question 10 = 3 marks)

Two parallel plates are connected across a battery. The distance between the conductors is 3.5 mm, and each is fed from the same 20 V DC power supply.

11 Calculate the uniform electric field strength generated by the plates.

Answer

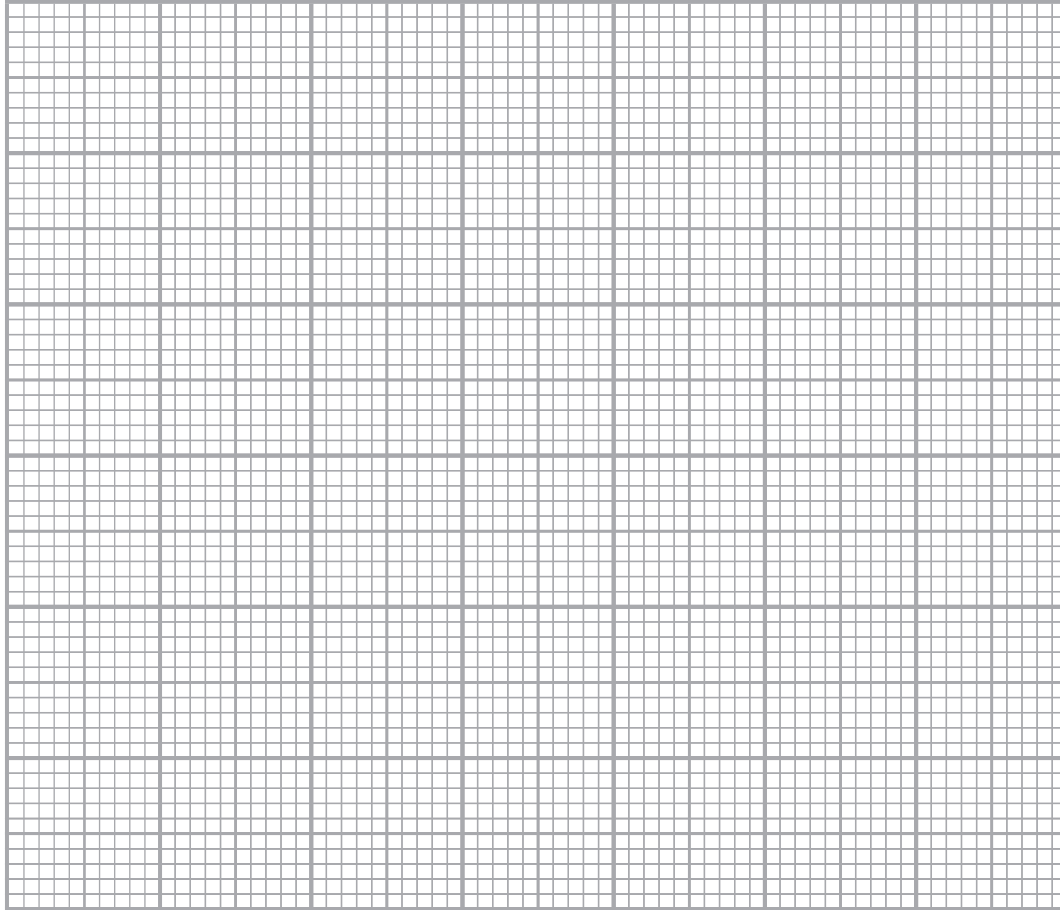
(Total for Question 11 = 1 mark)



An electrical engineering technician is testing an AC circuit using an oscilloscope.

The waveform of the AC voltage is represented by $V = 3 \sin 100 \pi t$ volts.

12 Draw a labelled waveform showing the characteristics of one full cycle of the voltage.



(Total for Question 12 = 4 marks)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



An electrical engineering technician has been asked to carry out an investigation into two charged particles.

The technician has carried out some investigations and has found that the charge on the first particle is measured as 0.3 C, which has a repelling force of 172 N on a second particle.

The second particle is 1.2 m away from the first particle.

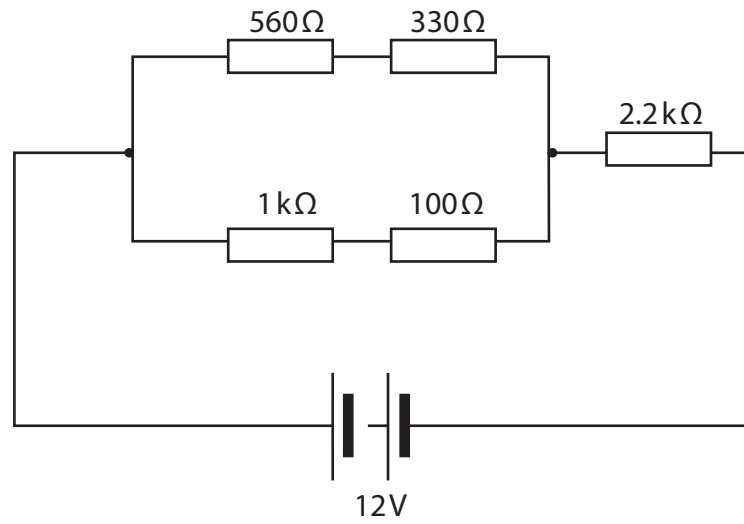
13 Calculate the charge on the second particle.

Answer

(Total for Question 13 = 2 marks)



The circuit diagram shows a DC power supply connected to a number of resistors in a series and parallel combination.



14 Calculate the power dissipated in the circuit.

Answer

(Total for Question 14 = 5 marks)



DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

An apprentice electrical engineer is investigating the use of forward and reverse mode diodes in electronic circuits.

15 (a) Explain **one** forward mode application of diodes.

(2)

.....

.....

.....

.....

(b) Explain **one** reason why Zener diodes are used for voltage regulation.

(2)

.....

.....

.....

.....

(Total for Question 15 = 4 marks)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

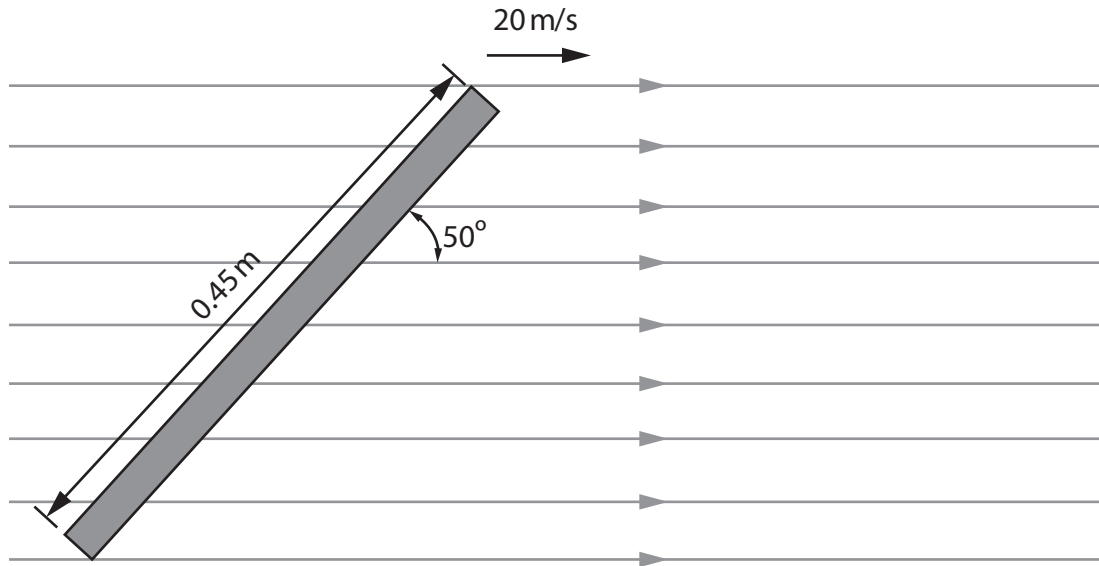
DO NOT WRITE IN THIS AREA



A conductor that has a length of 0.45 m cuts through a magnetic flux field of 1.3 T.

The velocity of the conductor is 20 m/s.

The angle of the conductor is initially 50° .



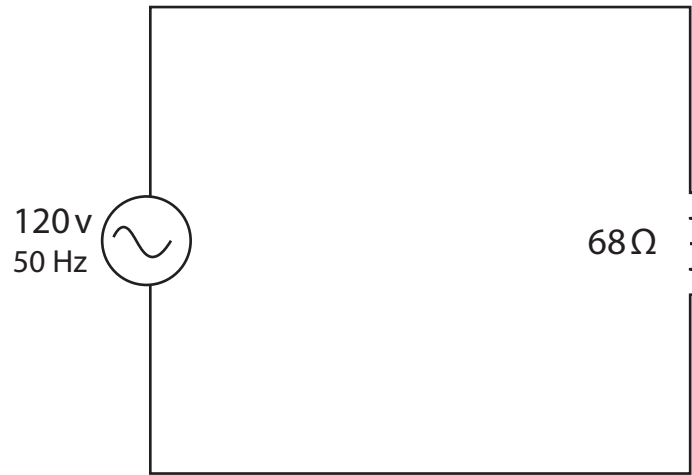
16 Calculate the change in the induced electromotive force if the angle of the conductor is altered to 90° .

Answer

(Total for Question 16 = 5 marks)



An electrical engineer has connected a coil to a 120 V AC supply at a frequency of 50 Hz.
The current through the coil is 150 mA, and the coil has a resistance of 68Ω .



17 Calculate the inductance of the coil.

Answer

(Total for Question 17 = 4 marks)

TOTAL FOR SECTION B = 55 MARKS



Section C: Synoptic Question

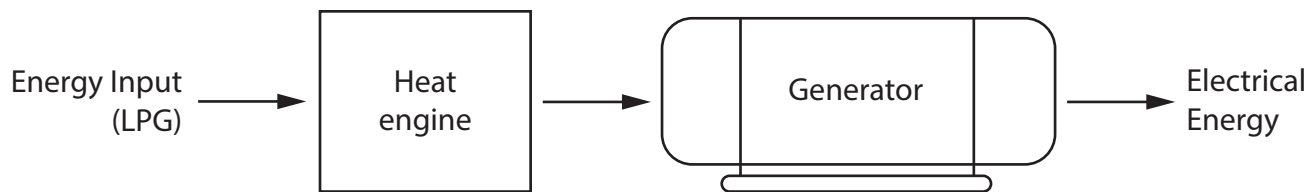
Answer ALL questions. Write your answers in the spaces provided.

The diagram shows a schematic of an electrical generator driven by a heat engine.

The input energy is provided by a combustion process that uses air and liquefied petroleum gas (LPG) that has an energy content of 46 MJ/kg supplied at a rate of 0.005 kg/s.

The generator has a rotor assembly that has a torque of 300 Nm and produces 56.5 kW of power.

The output of the generator is 80 A at 415 V.



18 (a) Calculate the speed with which the rotor assembly turns (in rpm).

(4)

Answer



(b) Calculate the overall system efficiency.

(6)

Answer

(c) Explain **two** effects on the efficiency of the system if the generator is adapted to operate at 2500 rpm.

(4)

(Total for Question 18 = 14 marks)

TOTAL FOR SECTION C = 14 MARKS
TOTAL FOR PAPER = 80 MARKS



DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

BLANK PAGE

