Candidate surname | Other names

Pearson BTEC Level 3 Nationals Extended Diploma

Centre Number | Learner Registration Number

Monday 11 January 2021

Morning (Time: 2 hours) | Paper Reference **31706H**

Engineering
Unit 1: Engineering Principles

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 need to recall a few formulae and constants that are not provided in the Information Booklet of Formulae and Constants and you may be rewarded for doing so.
- 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, show all your working and always answer to an appropriate degree of accuracy.

Turn over ▶

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Pearson

SECTION A

Applied Mathematics

Answer ALL questions. Write your answers in the spaces provided.
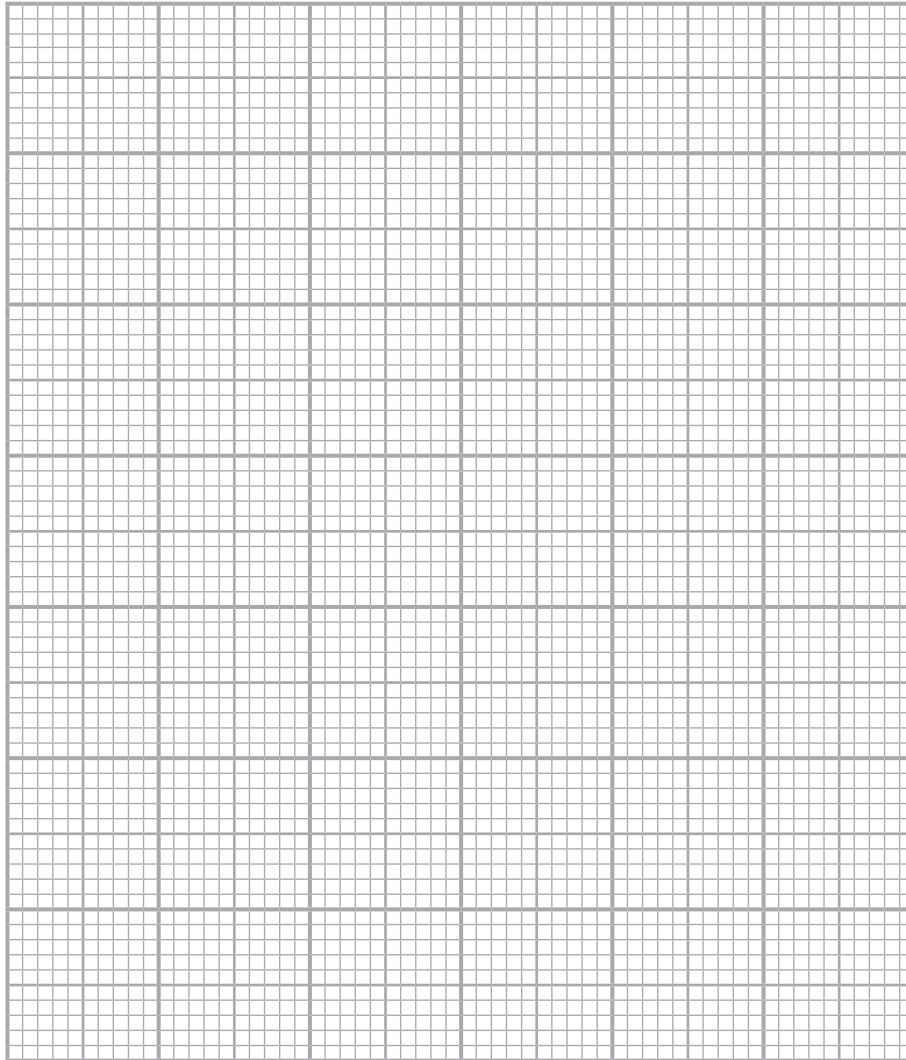
1   The volume of oil remaining in a storage tank is represented by the equation of a straight line:

$$V = 10 - 2t$$

where t is the time in hours and V is the volume in litres.

Draw a straight line graph to represent the volume of oil remaining in the storage tank, between zero and four hours.

You should include labels and axis values on your graph.

(Total for Question 1 = 4 marks)

2 A plasma cutter is used to produce parts for motorcycles.

The running cost of the plasma cutter is determined using the formula:

$$(4c - 2n) - 3(n - 2c) = c + n$$

Solve the equation to find the value of c when $n = 6$.

Answer: ....

(Total for Question 2 = 4 marks)

3 The diagram shows a solid cylindrical roller that is manufactured from steel.

Ø800 mm

1.2 m
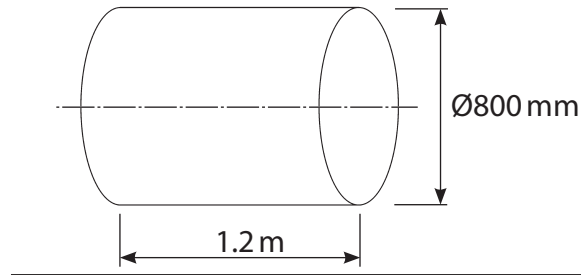
Diagram not to scale

Calculate the total surface area (TSA) of the solid cylindrical roller.

Answer: ....

(Total for Question 3 = 4 marks)

4 A milling machine depreciates due to wear and tear and this is represented by the formula:

$$d = \frac{a^9}{a^2}$$

where d is the depreciation and a is the age of the milling machine.

(a) Simplify the formula using one of the laws of indices.

(2)

Answer: ....

(b) Calculate the value of d when $a = 3$.

(1)

Answer: ....

(Total for Question 4 = 3 marks)

Turn over ▶

5 The diagram shows a component that is part of a circular guard for a portable power tool.

The component is shaded grey.

70⁰

30 mm
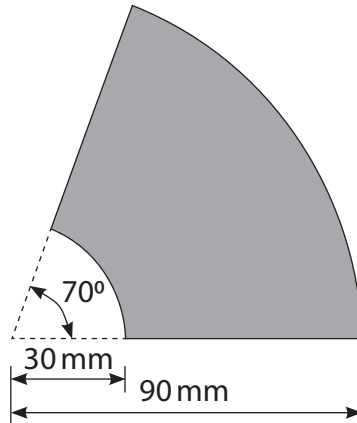
90 mm

Diagram not to scale

Calculate the area of the component.

Answer: ....

(Total for Question 5 = 5 marks)

TOTAL FOR SECTION A = 20 MARKS

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P 6 7 4 8 4 A 0 7 2 0

SECTION B

Mechanical Principles

Some questions must be answered with a cross in a box ⊠. If you change your mind about an answer, put a line through the box ⊠ and then mark your new answer with a cross ⊠.

6 Identify the substance that the relative density of a solid material is usually compared to.

⊠	**A**	Mercury
⊠	**B**	Water
⊠	**C**	Hydrogen
⊠	**D**	Carbon

(Total for Question 6 = 1 mark)

7 Identify the feature of the beam that has a value of 12 kN/m.

25 kN   12 kN/m
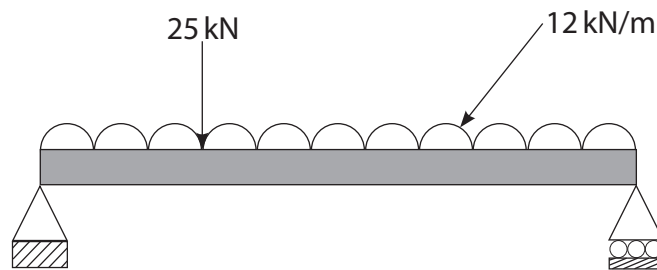
⊠	**A**	Concentrated load
⊠	**B**	Pin reaction force
⊠	**C**	Uniformly distributed load
⊠	**D**	Roller reaction force

(Total for Question 7 = 1 mark)

8 Identify the unit of measure for rotational inertia.

⊠	**A**	Watt metre squared
⊠	**B**	Joule per second squared
⊠	**C**	Metre per second squared
⊠	**D**	Kilogram metre squared

(Total for Question 8 = 1 mark)

9 The diagram shows a section of a gradually tapering circular pipe.

(a) Calculate the cross sectional area ($A1$) of the pipe inlet.

(2)

Answer: ....

(b) Calculate the cross sectional area ($A2$) of the pipe outlet.

Assume that the pipe is rigid and the fluid is incompressible.

(3)

Answer: ....

(Total for Question 9 = 5 marks)

10 Free-body diagrams are used by engineers.

Describe **one** use of a free-body diagram.

....

....

....

....

(Total for Question 10 = 2 marks)

P 6 7 4 8 4 A 0 1 0 2 0

11 The diagram shows a compound gear train. The driver gear is rotated at 300 revs/min.

6 teeth

driver

driven

10 teeth

18 teeth
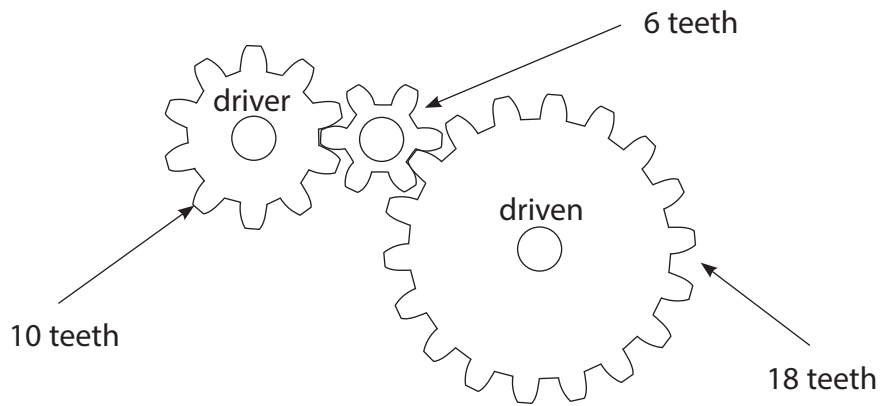
Diagram not to scale

(a) Calculate the velocity ratio of the compound gear train.

(3)

Answer: ....

(b) Calculate the velocity of the driven gear in revs/min.

(3)

Answer: ....

(Total for Question 11 = 6 marks)

12 The diagram shows a connecting rod.

The direct stress in the connecting rod is 857 N/mm².

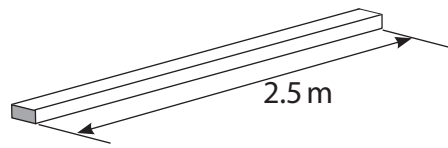The connecting rod extends by 0.03 m when it is subjected to a tensile load of 60 kN.

2.5 m

Diagram not to scale

Calculate the Young's Modulus of the material used for the connecting rod.

Give your answer in an appropriate unit.

Answer: ....

(Total for Question 12 = 5 marks)

13 The diagram shows a drop hammer and spike.

The 12 kg hammer is dropped onto the stationary 8 kg spike.

The hammer remains in contact with the spike.

The ground has a resistive force of 800 N.
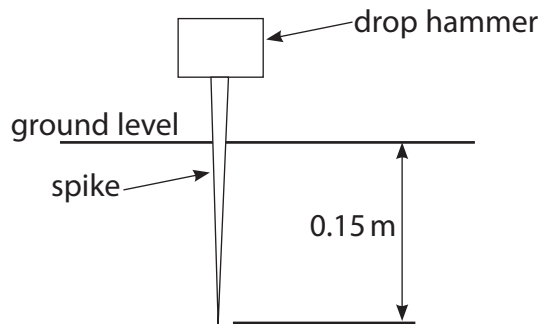
The spike is driven 0.15 m into the ground.

Diagram not to scale

Calculate the velocity of the hammer just before it makes contact with the spike.

Assume there are no energy losses from the collision between the hammer and the spike and from air friction.

Answer: ....

(Total for Question 13 = 9 marks)

TOTAL FOR SECTION B = 30 MARKS

Electrical and Electronic Principles

Some questions must be answered with a cross in a box ⊠. If you change your mind about an answer, put a line through the box ⊠ and then mark your new answer with a cross ⊠.

14 Identify the material that is an electrical insulator and can be polarised by an applied electric field.

⊠	**A**	Smart
⊠	**B**	Dielectric
⊠	**C**	Composite
⊠	**D**	Magnetic

(Total for Question 14 = 1 mark)

15 Identify the electronic component represented by the symbol.
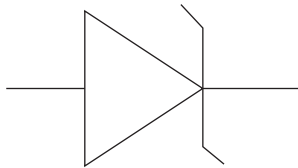
⊠	**A**	Photo transistor
⊠	**B**	Trim capacitor
⊠	**C**	Motion sensor
⊠	**D**	Zener diode

(Total for Question 15 = 1 mark)

16 A 3 v DC battery is connected to a 32 Ω resistor in series.

Calculate the power dissipated by the resistor.

Answer: ....

(Total for Question 16 = 2 marks)

17 The diagram shows two charged conducting plates with a potential difference applied across them.

+12V

5 mm

0V
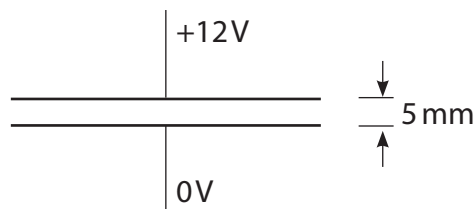
Diagram not to scale

Calculate the uniform electric field strength between the two plates.

Give your answer in an appropriate unit.

Answer: ....

(Total for Question 17 = 3 marks)

18 Explain **one** advantage of using a stabilised power supply when prototyping electronic circuits.

....

....

....

....

(Total for Question 18 = 2 marks)

19 A single phase A.C. power supply has an RMS voltage of 230 v.

(a) Calculate the peak value of the power supply.

(3)

Answer: ....

(b) Calculate the average value of voltage for the power supply.

(2)

Answer: ....

(Total for Question 19 = 5 marks)

20 The diagram shows a coil with 120 turns wrapped around a former. The coil has a relative permeability (μ_r) of 200.
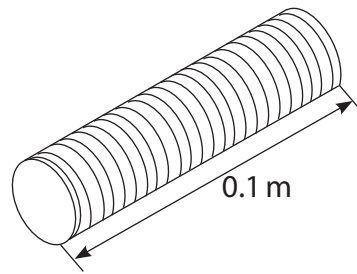

0.1 m

Diagram not to scale

A current of 1.5 A flows through the coil.

Calculate the flux density of the magnetic field around the coil.

Answer: ....

(Total for Question 20 = 6 marks)

P 6 7 4 8 4 A 0 1 8 2 0

21 A 32×10^{-6} F capacitor is connected to a 60V A.C. supply in series with a 56Ω resistor.
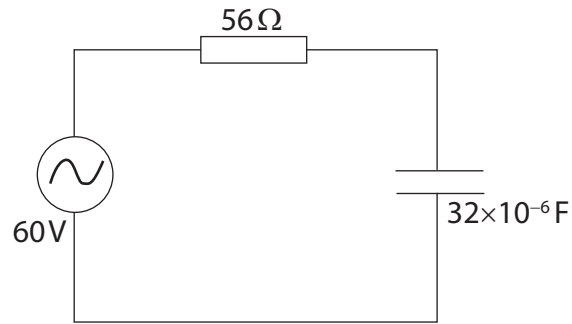
The current flowing in the circuit is 0.16A.

Calculate the frequency of the A.C. supply.

Answer: ....

(Total for Question 21 = 10 marks)

TOTAL FOR SECTION C = 30 MARKS

TOTAL FOR PAPER = 80 MARKS

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