Monday 13 January 2020

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.
- 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.
- 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, show all your working and always answer to
  an appropriate degree of accuracy.

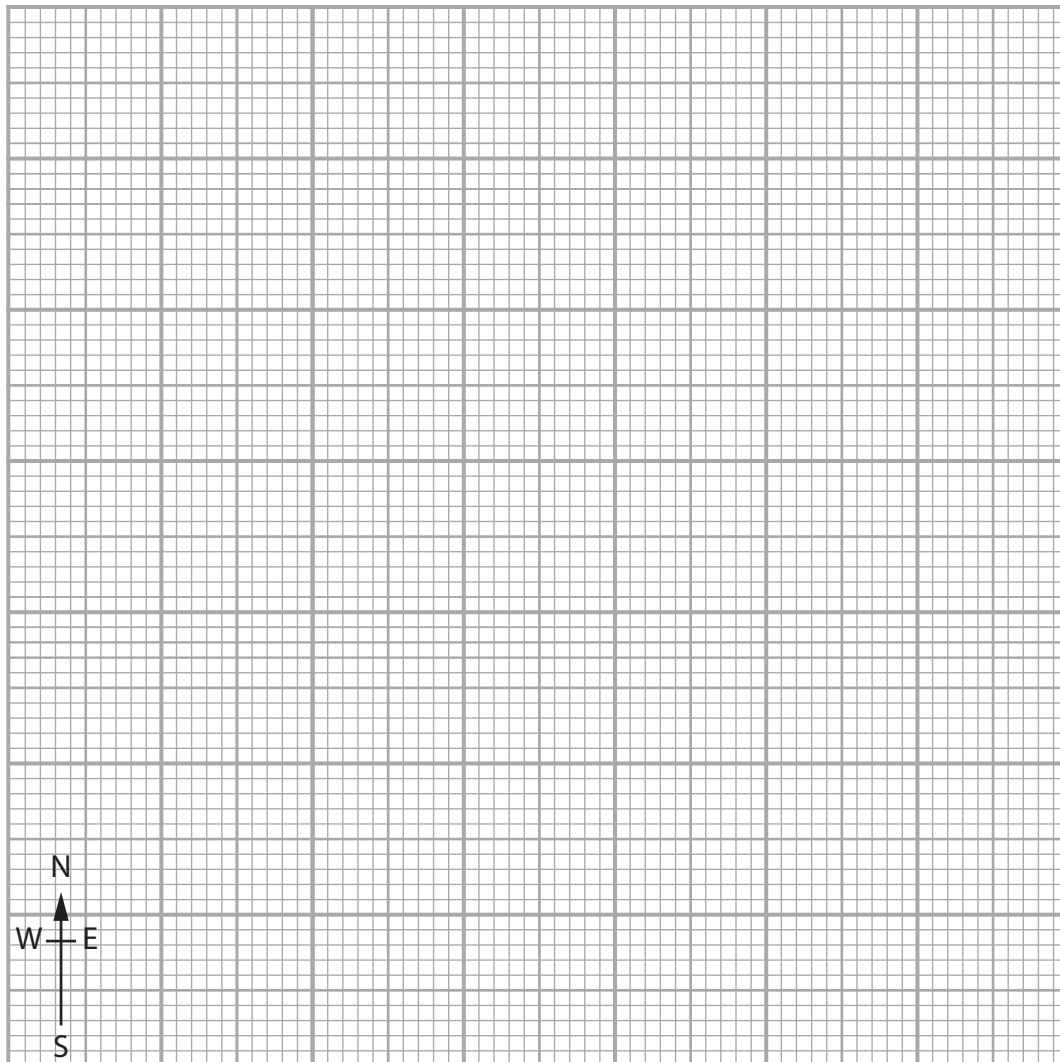*Turn over* ▶

SECTION A

Applied Mathematics

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

1   An aeroplane travels east at a velocity of 250 m/s and at the same time is blown north with a velocity of 50 m/s.

Draw a vector diagram of the velocities, including the resultant velocity of the aeroplane.

You should include labels and axes values on your diagram.

N
W—E
S

(Total for Question 1 = 4 marks)

2 The diagram shows a cone that is used to provide a reference line.

0.8 m

1.2 m
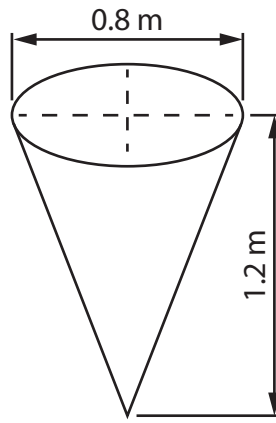
Diagram not to scale

Calculate the volume of the cone.

Answer: ....

(Total for Question 2 = 3 marks)

Turn over ▶

3 A helicopter takes off vertically from the ground and is stationary at point A.

Diagram not to scale

The helicopter is observed from point B.

Calculate the height above ground level of the helicopter at point A.

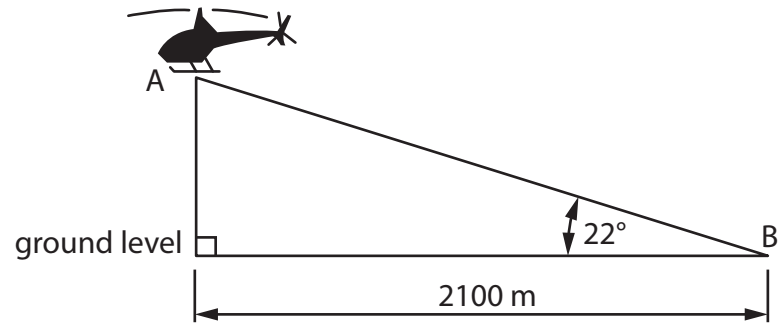Answer: ....

(Total for Question 3 = 4 marks)

4 The results of tests on an electronic circuit are represented by the following simultaneous equations:

Equation 1: $12a + 3b = 16$
Equation 2: $4a + 15b = 24$

Calculate the values of a and b.

Answer: ....

(Total for Question 4 = 4 marks)

P 6 4 7 1 5 A 0 5 2 0

5 Air pressure is represented by the formula:

$$P = P_0 e^{\frac{h}{k}}$$

where P is the pressure at height h and P_0 is the air pressure at sea level.

(a) Simplify the formula using logarithms and make h the subject of the formula.

(4)

Answer: ....

(b) Calculate the value of h when $P = 70 \times 10^3$ Pa, $P_0 = 100 \times 10^3$ Pa, and $k = -8150$

(1)

Answer: ....

(Total for Question 5 = 5 marks)

TOTAL FOR SECTION A = 20 MARKS

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 **one** method that would be used to find the density of a material.

⊠ **A** Archimedes' principle

⊠ **B** Kirchhoff's law

⊠ **C** Newton's law

⊠ **D** Pythagoras' theorem

(Total for Question 6 = 1 mark)

7 Identify the unit of measure for shear stress.

⊠ **A** Kilograms per metre squared

⊠ **B** Litres squared per second

⊠ **C** Metres squared per second

⊠ **D** Newtons per metre squared

(Total for Question 7 = 1 mark)

8 A car is on a road with a set of traffic lights ahead.

At
rest

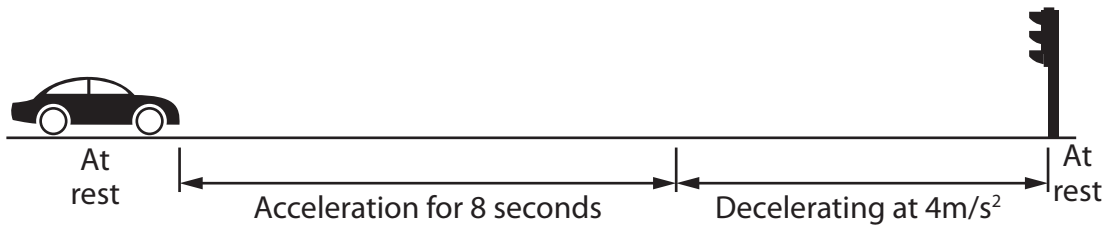Acceleration for 8 seconds

Decelerating at 4m/s²

At
rest

Diagram not to scale

The car starts from rest. The car then accelerates at a constant rate of 3 m/s² for 8 seconds.

(a) Calculate the velocity of the car after 8 seconds.

(2)

Answer: ....

The car then decelerates at a constant rate of 4 m/s² and stops at the traffic lights.

(b) Calculate the distance travelled by the car while it is decelerating.

Give your answer in an appropriate unit.

(4)

Answer: ....

(Total for Question 8 = 6 marks)

9 A bicycle wheel rotates at 120 revolutions per minute. The radius of the bicycle wheel is 280 mm.

(a) Calculate the angular velocity of the bicycle wheel.

(3)

Answer: ....

(b) Calculate the centripetal acceleration of the bicycle wheel.

(3)

Answer: ....

(Total for Question 9 = 6 marks)

10 Explain what is meant by the term non-concurrent forces.

....

....

....

....

(Total for Question 10 = 2 marks)

11 A packing crate is placed onto an inclined plane. The inclined plane is friction free.

Acceleration
force (Fa)

30°

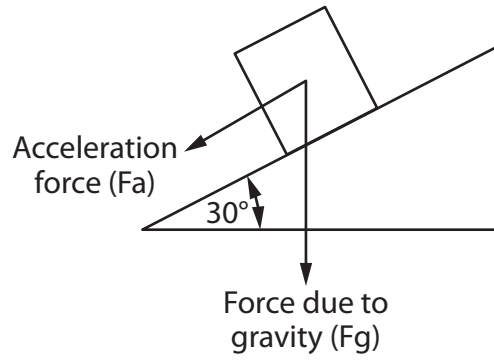Force due to
gravity (Fg)

Diagram not to scale

The force due to gravity (Fg) acting on the crate is 75 N.

Calculate the acceleration force (Fa) acting to move the crate down the slope.

Answer: ....

(Total for Question 11 = 5 marks)

12 A storage tank has a capacity of 18 m^3.

The tank is filled with water through a gradually tapering pipe that runs full.

The inlet diameter of the pipe is 50 mm and the outlet diameter is 30 mm.

Assume the water enters the pipe with a velocity of 2 m/s and that the tank is empty.

Calculate the time taken (in seconds) for the tank to fill.

Answer: ....

(Total for Question 12 = 9 marks)

TOTAL FOR SECTION B = 30 MARKS

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 ☒.

13 Identify the unit of electrical power.

☒ **A** Coulomb

☒ **B** Farad

☒ **C** Volt

☒ **D** Watt

(Total for Question 13 = 1 mark)

14 Identify the property of a material that allows it to store electrical energy in an electric field.

☒ **A** Capacitance

☒ **B** Hysteresis

☒ **C** Permittivity

☒ **D** Viscosity

(Total for Question 14 = 1 mark)

15 A variable resistor is used to adjust electrical resistance.

State **one** use of a circuit that includes a variable resistor.

....

....

(Total for Question 15 = 1 mark)

16 A DC power source is connected to two capacitors in a series network.
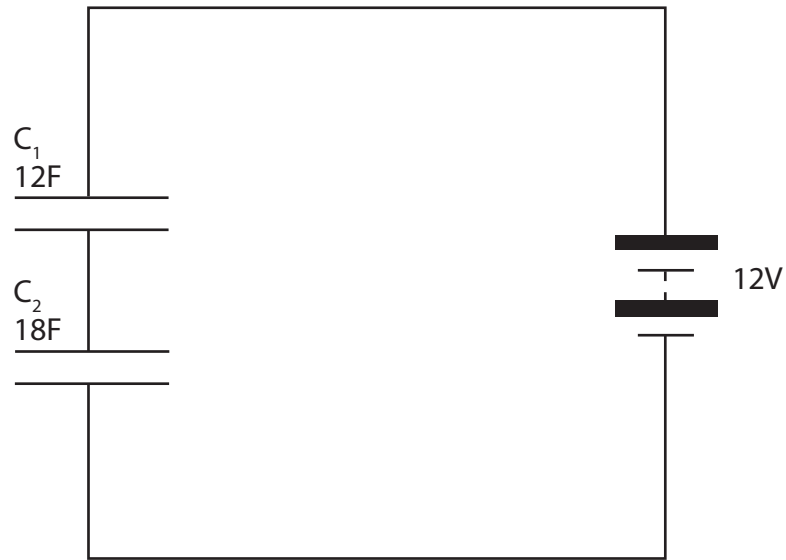
Calculate the total capacitance of the two capacitors.

Answer: ....

(Total for Question 16 = 3 marks)

17 A conductor is connected to a 12V DC supply. A charge of 36 coulombs (C) passes along the conductor in 24 seconds.

(a) Calculate the current in the conductor.

(2)

Answer: ....

(b) Calculate the resistance of the conductor.

(3)

Answer: ....

(Total for Question 17 = 5 marks)

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P 6 4 7 1 5 A 0 1 5 2 0

18 A conductor with a length of 250 mm is moving at right angles through a magnetic field of flux 2.2 T. The conductor is moving at a velocity of 8 m/s.
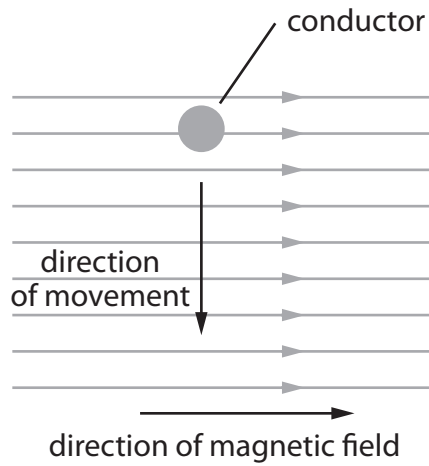
conductor

direction of movement

direction of magnetic field

Diagram not to scale

Calculate the induced EMF.

Give your answer in an appropriate unit.

Answer: ....

(Total for Question 18 = 4 marks)

19 A transformer has 750 primary turns and is designed to be supplied by a 110 V AC supply.

Soft iron core

110 volt input supply

Primary coil 750 turns of wire

Secondary coil
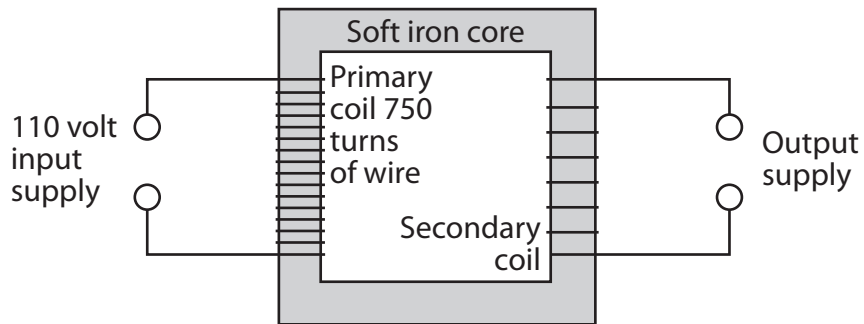
Output supply

A peak voltage of 34 V is required as the output from the transformer.

Calculate the number of secondary turns required on the transformer.

Answer: ....

(Total for Question 19 = 6 marks)

20 A coil is connected to a 230 V AC power supply that has frequency of 50 Hz.

The current in the coil is 0.125 A, and the resistance of the coil is 560 Ω.
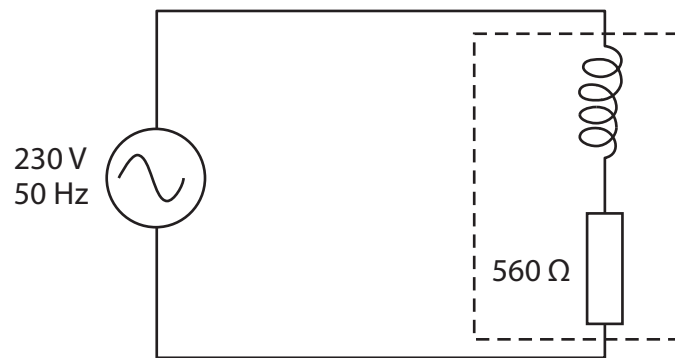
Calculate the inductance (L) of the coil.

Answer: ....

(Total for Question 20 = 9 marks)

TOTAL FOR SECTION C = 30 MARKS
TOTAL FOR PAPER = 80 MARKS

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