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Student name

PHYSICS
Unit 3
Trial Examination

QUESTION AND ANSWER BOOK

Total writing time: 1 hour 30 minutes

Structure of book

Section		Number of questions	Number of marks
	A – Core areas of study		
	1. Motion in One and Two Dimensions	18	40
	2. Electronics and Photonics	12	25
	B – Detailed studies		
	1. Einstein's Special Relativity	9	25
OR	2. Investigating Materials and their use in structures	10	25
OR	3. Further Electronics	11	25
		Total	**90**

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers, up to two pages (one A4 sheet) of pre-written notes (typed or handwritten) and an approved scientific calculator.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.

Materials supplied

- Question and answer book of 28 pages, with a detachable formula sheet in the centrefold.

Instructions

- Detach the formula sheet from the centre of this book during reading time.
- Write your **name** in the space provided above on this page.
- Answer all questions in this question and answer book where indicated.
- Always show your working where space is provided and place your answer(s) to multiple-choice questions in the box provided.

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SECTION A – Core

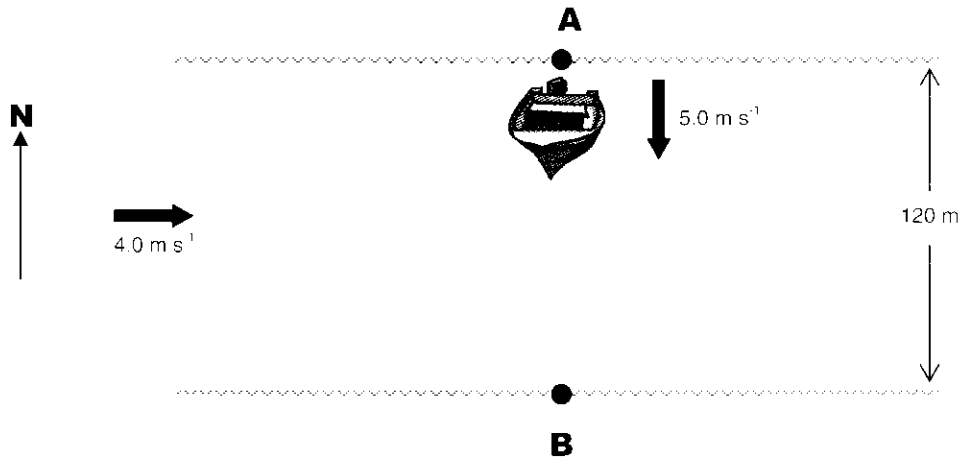
Instructions for Section A

Answer **all** questions **for both** Areas of study in this section of the paper.

Area of study 1 – Motion in one and two dimensions

Questions 1 to 4 relate to the following information

Craig owns a small boat that can travel at a speed of 5.0 m s^{-1}. Craig takes the boat to a local river where the current is flowing at 4.0 m s^{-1} East. The distance between the banks of the river is 120 m.



Question 1

What is the fastest possible time for Craig to travel from one side of the river to the other?

s

[2 marks]

Question 2

Rather than just crossing the river from one side to the other Craig wants to travel directly from point **A** to point **B** due South on the other bank.

On what bearing should Craig steer the boat in order to reach point **B**?

°

[3 marks]

Question 3

What is Craig's speed relative to the river bottom as he travels **directly** from **A** to **B**?

	m s^{-1}

[2 marks]

Question 4

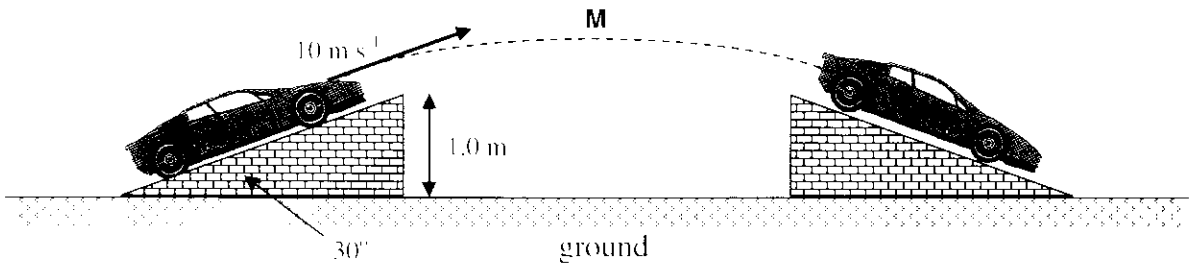
How long does it take Craig to travel **directly** from **A** to **B**?

	s

[2 marks]

Questions 5 to 8 relate to the following information.

A stunt driver attempts to complete a dare devil leap in his car across two ramps. The set up is shown in the diagram below. The ramp is set at an angle of 30° to the horizontal.
His take off speed is 10 m s^{-1}. Assume that air resistance is negligible.



Question 5

What is the maximum height the car reaches **above the ground**?

m

[3 marks]

Question 6

How long was the car in the air?

s

[2 marks]

Question 7

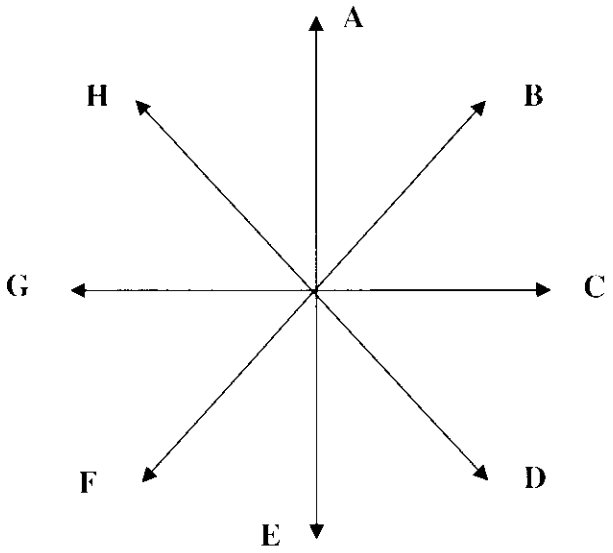
What is the horizontal gap between the two ramps if the driver just makes a successful 'leap'?

m

[2 marks]

Question 8

Which of the choices (A – H) gives the best direction for the net force on the car at the point **M** shown on the previous diagram?



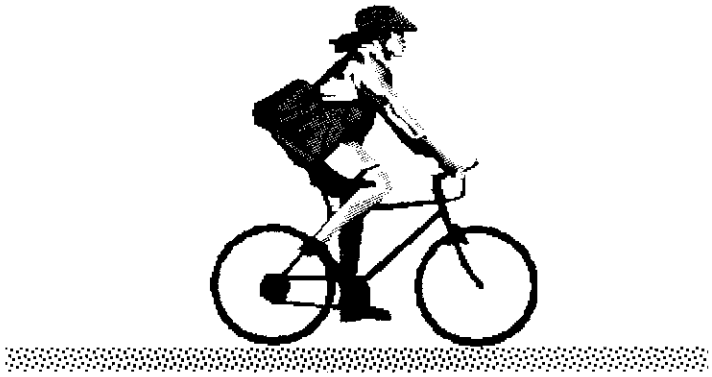
[2 marks]

Questions 9 to 13 relate to the following information

A bicycle rider and his bike have a combined mass of 80 kg. The cyclist is supplying a constant driving force through the pedals. The motion of the cyclist is opposed by a variety of friction forces including air resistance. These frictional forces are NOT constant.

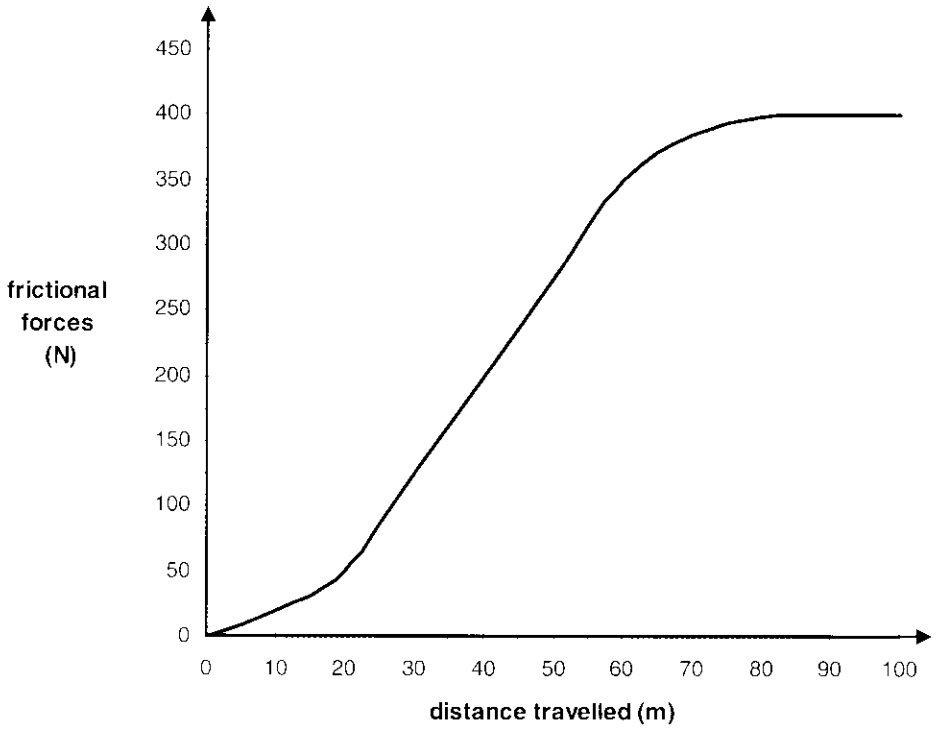
Question 9

On the diagram below indicate the forces acting **horizontally** on the cyclist and his bicycle when he is travelling at constant speed while supplying a constant driving force.



[2 marks]

The graph below shows the friction forces opposing the cyclist's motion as a function of the distance that the cyclist has travelled from rest along a horizontal road. The cyclist is providing a constant driving force and reaches a final constant speed after 80 metres.



Question 10

What is the magnitude of the constant driving force supplied by the cyclist?

N

[2 marks]

Question 11

How much total work has been done **by the cyclist** after he has travelled a distance of 100 metres from his starting position?

J

[2 marks]

Question 12

If it took him 20 seconds to travel the first 100 metres what power was the cyclist generating?

W

[2 marks]

Question 13

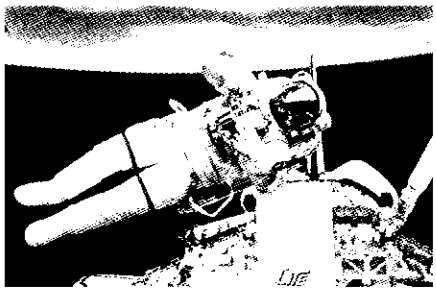
What was the magnitude of the acceleration of the cyclist after 60 metres?

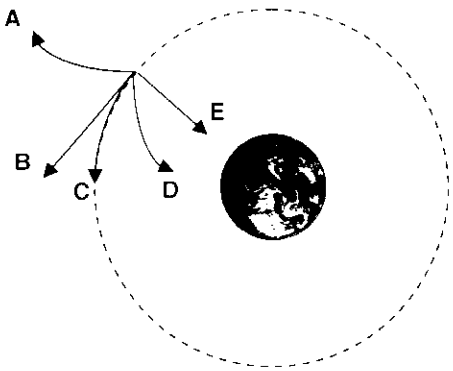
$m\ s^{-2}$

[3 marks]

Question 14

While working on a satellite in orbit around the Earth an astronaut lets go of his specially designed wrench. Which of the options (A – E) best describes the path of the wrench the instant it slips free from the astronaut's grasp?

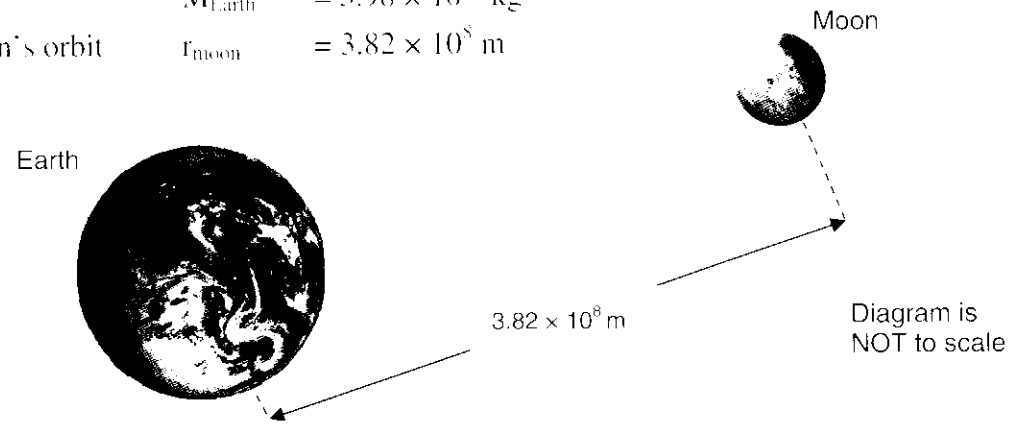




[2 marks]

Questions 15 & 16 relate to the following information.

Mass of Earth	M_{Earth}	$= 5.98 \times 10^{24}$ kg
Radius of Moon's orbit	r_{moon}	$= 3.82 \times 10^{8}$ m



Question 15

What is the strength of the Earth's gravitational field at the Moon's location?

N kg^{-1}

[2 marks]

Question 16

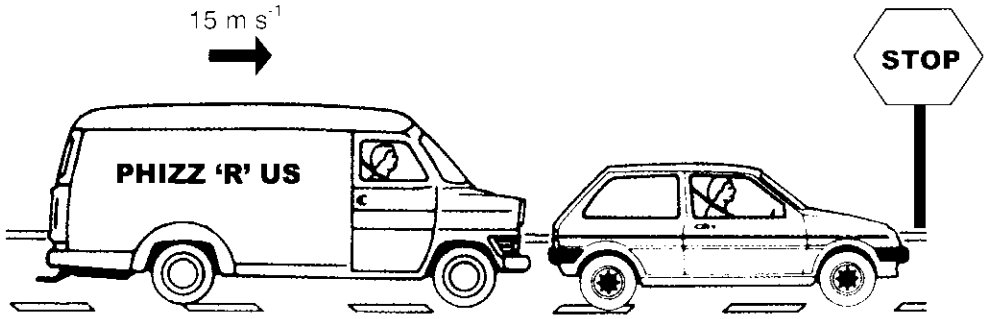
What is the speed of the Moon around the Earth?

m s^{-1}

[2 marks]

Questions 17 & 18 relate to the following information.

The diagram below shows a collision about to happen. The van has a mass of 2200 kilograms. The van is travelling with a speed of 15 ms^{-1} at the instant of the collision. The car has a mass of 710 kilograms and is stationary at a stop sign just prior to the collision. Both vehicles lock together after the collision.



Question 17

What is the speed of the combined van and car at the instant after the collision?

m s^{-1}

[3 marks]

Question 18

If the average friction force acting on the car and van after the collision is 5000 N, how far does the car and van move from their original position till they come to rest after the collision?

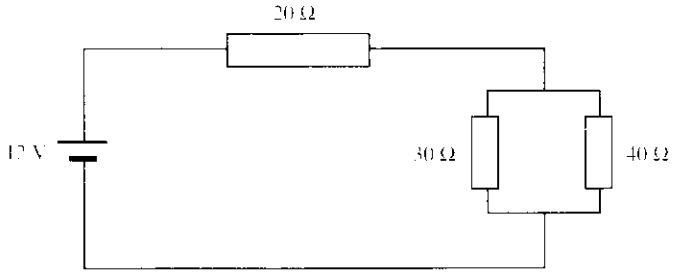
m

[2 marks]

Area of study 2 – Electronics and photonics

Questions 1 to 3 relate to the following information.

A circuit is constructed using a combination of resistors and a 12 volt battery as shown in the circuit diagram below.



Question 1

What value single resistor would have the same effective resistance as the given 3 resistor combination shown above?

Ω

[2 marks]

Question 2

What is the voltage drop across the 40 Ω resistor?

V

[2 marks]

Question 3

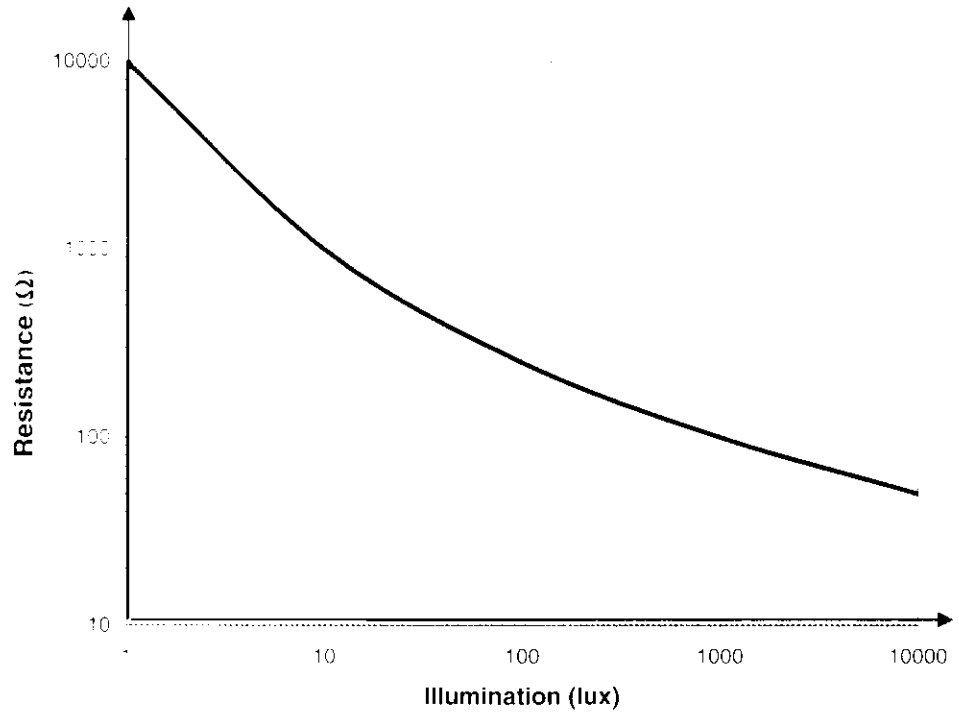
What is the current flowing through the 20 Ω resistor?

A

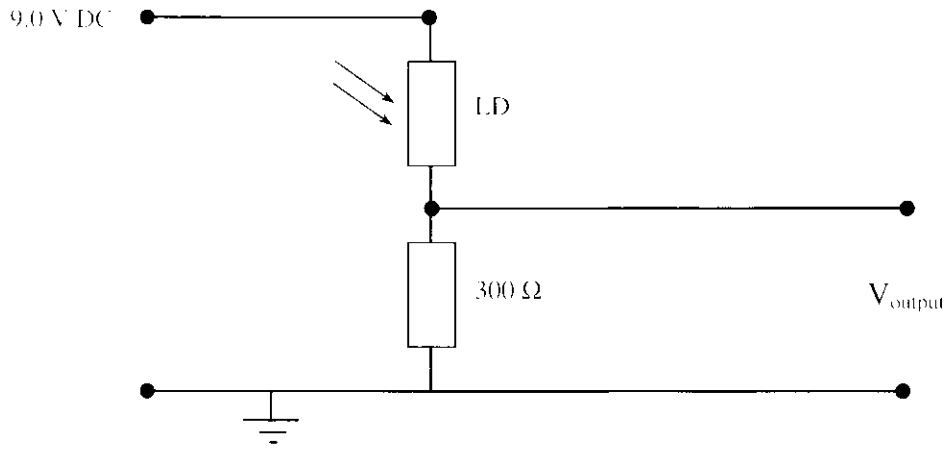
[2 marks]

Question 4

A light Dependent resistor has the following resistance versus illumination characteristic graph.



The LDR is placed in the following circuit.



What is the output voltage of the circuit if the LDR is illuminated by light with an intensity of 20 lux?

V

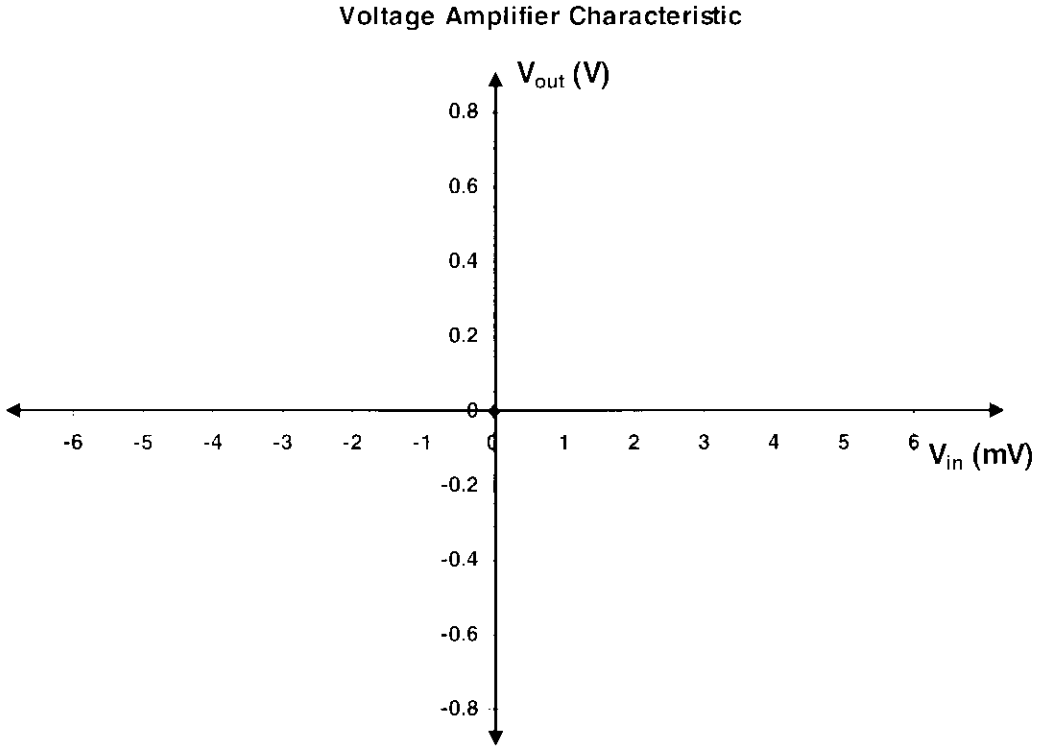
[2 marks]

Questions 5 to 8 relate to the following information.

A simple inverting voltage amplifier has a gain of 200 and a linear operating input voltage range of -3.0 mV to +3.0 mV (i.e. ± 3.0 mV).

Question 5

On the following set of axes draw the input versus output voltage characteristic for this simple inverting amplifier.



[2 marks]

Question 6

What is the output voltage for an input voltage of 4.0 mV? With reference to the operation of the amplifier, explain the significance of this input voltage.

V

[3 marks]

Question 7

An alternating voltage signal is fed into the input of the amplifier. The input signal has a voltage of 1.5 mV RMS and a frequency of 120 Hz. What is the peak voltage of this input signal?

mV

[2 marks]

Question 8

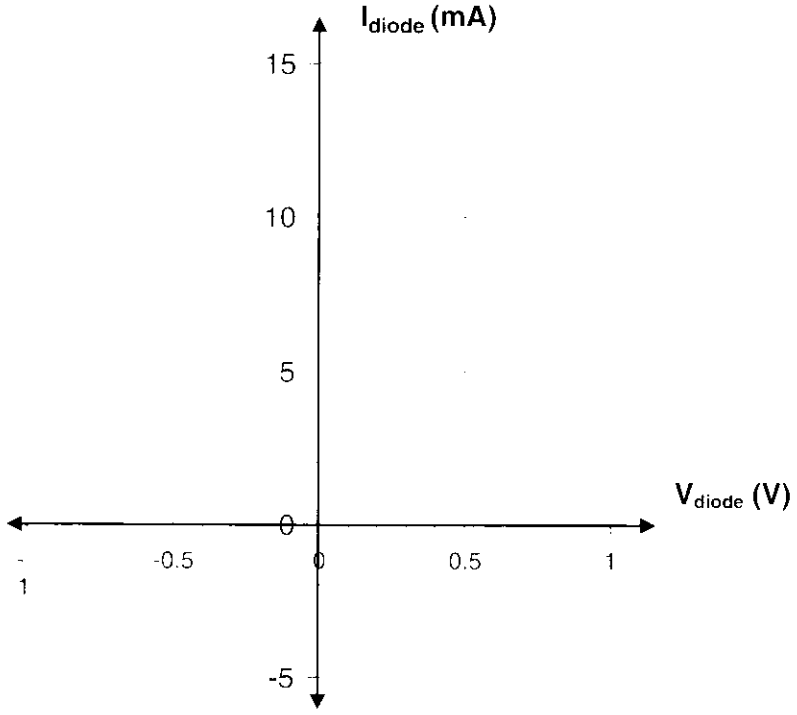
The AC input voltage has a frequency of 120 Hz. What is the frequency of the output voltage?

Hz

[1 mark]

Question 9

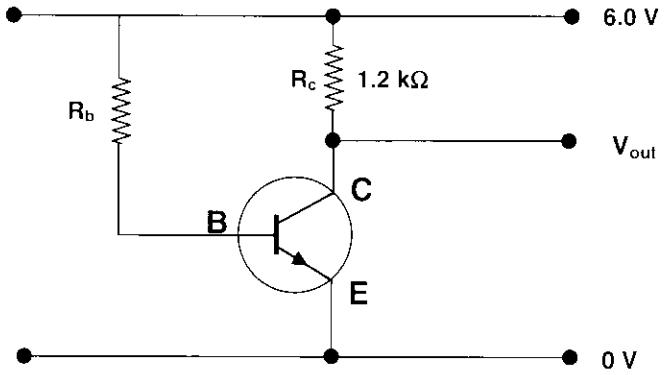
A silicon diode has a 'turn-on' voltage of 0.7 volts. On the following set of axes carefully draw the typical current – voltage characteristic for this type of diode.



[2 marks]

Questions 10 to 12 relate to the following information

A transistor amplifier is made from a silicon ***npn*** Bipolar Junction Transistor as shown in the following circuit. The base current is 24.1 μA. Take the value of V_{BE} = 0.70 V. The current gain of this amplifier is 100.



Question 10

What is the value of R_b? Give your answer in kiloohm.

kΩ

[2 marks]

Question 11

What is the voltage drop across the 1.2 kΩ resistor?

V

[3 marks]

Question 12

What is the output voltage, V_{out}?

V

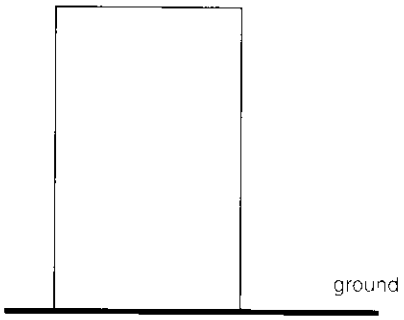
[2 marks]

Detailed study 2 – Investigating materials and their use in structures

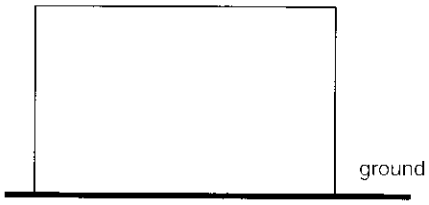
Question 1

Which one of the following structures, made from a uniformly dense material, is the most **unstable** when placed on level ground?

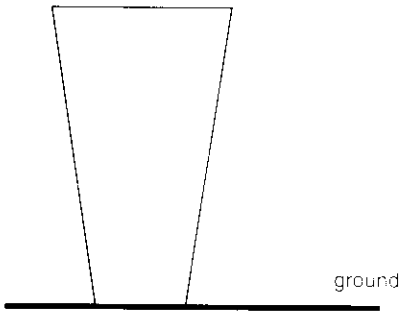
A.



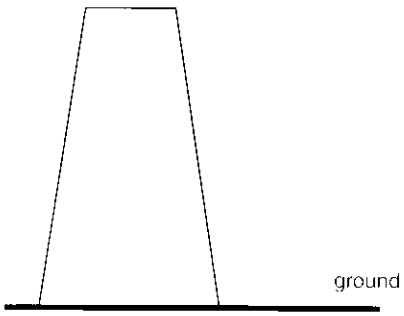
B.



C.



D.



[2 marks]

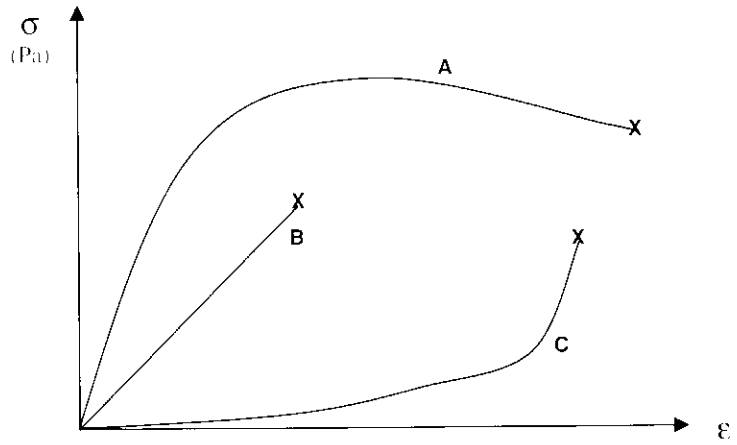
Question 2

Explain your choice of answer to Question 1.

[2 marks]

Questions 3 & 4 relate to the following information.

The stress-strain graphs for three different materials are shown below.



Question 3

Complete the following table to indicate which graph corresponds to which type of material.

Material	Most brittle	Toughest
Graph		

[2 marks]

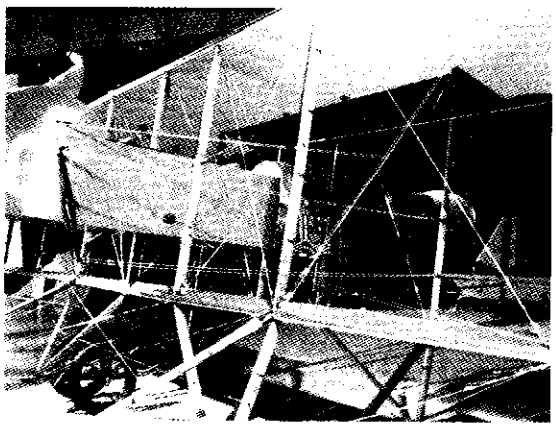
Question 4

Material A is considered to be ductile. State what features of the graph for material A indicate this fact.

[2 marks]

Question 5

Vintage aeroplanes use a large number of bracing wires in the construction of their wings as shown in the photograph. Give two reasons for using stainless steel wire in this application.



Reason 1:

_____

_____

_____

Reason 2:

_____

_____

_____

[4 marks]

Questions 6 to 8 relate to the following information.

The following questions refer to a steel cable under a tension of 1.8 tonne of weight.
Young's modulus for steel is 2.0×10^{11} N m^{-2}
The steel cable has a diameter of 7.0 mm
The unstrained natural length of the steel cable is 2.8 m

Question 6

What is the tension in the cable?

	N

[2 marks]

Question 7

Show by appropriate calculations, that the stress in the steel cable is 4.7×10^8 N m^{-2}.

[3 marks]

Question 8

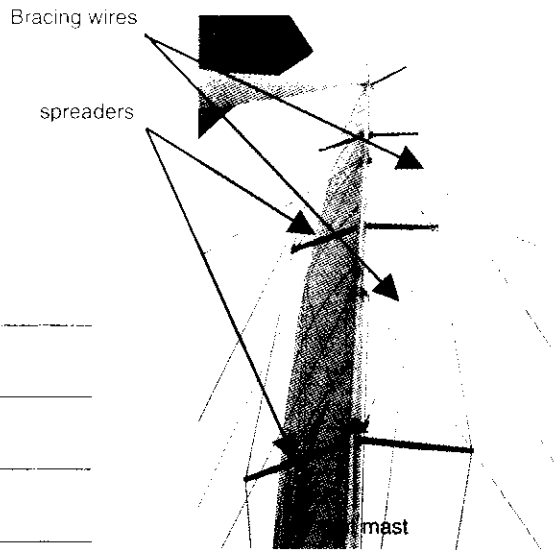
By how much does the tension of 1.8 tonne of weight extend the cable?
Give your answer in millimetre.

mm

[3 marks]

Question 9

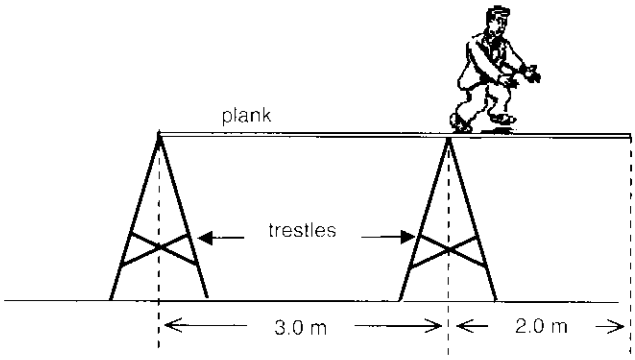
The very tall thin masts of sailing yachts are braced by wires and cross trees (spreaders). Explain the purpose of these structural elements (the bracing wires and spreaders) in the design of the mast.



[2 marks]

Question 10

A 20.0 kg plank of length 5.00 m is placed (but not attached) across two trestles as shown in the diagram on the right. A 75.0 kg man tempts fate by walking towards the unsupported end of the plank. How close to the **end** of the plank can he get before the plank begins to tip over?



m

[3 marks]

END OF DETAILED STUDY 2