Insight Publications

INSIGHT

Trial Exam Paper

2008

PHYSICS

Written examination 1

STUDENT NAME:

QUESTION AND ANSWER BOOK

Reading time: 15 minutes
Writing time: 1 hour 30 minutes

Structure of book

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A – Core – Areas of study			
1. Motion in one and two dimensions	17	17	40
2. Electronics and photonics	13	13	25
B – Detailed studies			
1. Einstein's special relativity (page 20)	12	12	25
OR			
2. Investigating materials and their use in structures (page 25)	11	11	25
OR	12	12	25
3. Further electronics (page 31)			
		Total	140

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

Materials provided

- The question and answer book of 36 pages, with removable data sheet.

Instructions

- Write your **name** in the box provided.
- Remove the data sheet during reading time.
- Answer **all** the questions in the space provided.
- **Always** show your working where space is provided.
- Where an answer box has a unit printed in it, give your answer in that unit.
- You **must** answer all questions in English.

Students are NOT permitted to bring mobile phones or any other electronic device into the examination.

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

The following information applies to Questions 1 and 2.

Jimmy is running to catch a bus, but he has to go around the house on the corner. The dotted line represents Jimmy's path. The path lengths are allocated as shown in Figure 1. It takes him 20 seconds to reach the bus.

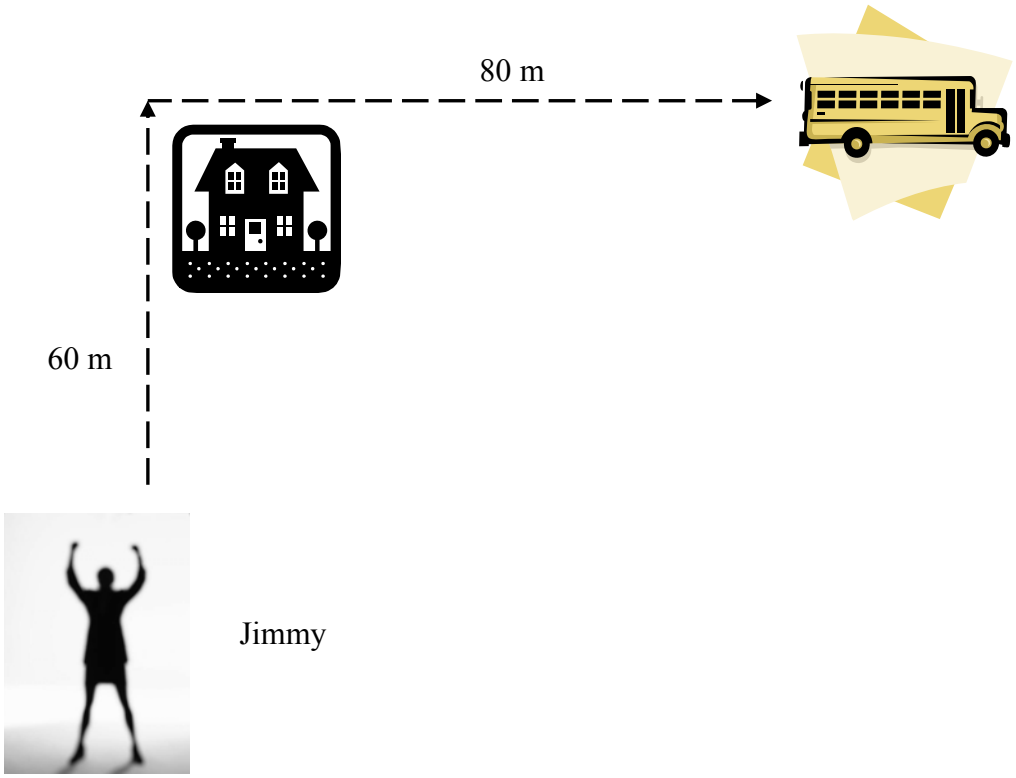


Figure 1

Question 1

Find Jimmy's average speed.

ms^{-1}

2 marks

Question 2

Find the magnitude of Jimmy's average velocity.

	ms^{-1}

2 marks

The following information applies to Questions 3 and 4.

Sarah is practising her sprint starts for the 2008 Olympics. She is accelerating over 70 metres from a static start, and this takes her 10 seconds. Assume that her acceleration is constant.

Question 3

What is Sarah's acceleration during her drills?

	ms^{-2}

2 marks

Question 4

At what velocity is Sarah running when she passes the 40-metre mark?

	ms^{-1}

2 marks

The following information applies to Questions 5–8.

Gussy is travelling at 20 ms^{-1} while riding his bike to Physics class when he realises he has left his books at home. He needs to do a U-turn, and fast! But he realises that the maximum friction between the bike and his tyres will be 3200 N. Gussy's speed remains at 20 ms^{-1} throughout the turn, and the total mass of Gussy and his bike is 80 kg. This is shown in Figure 2.

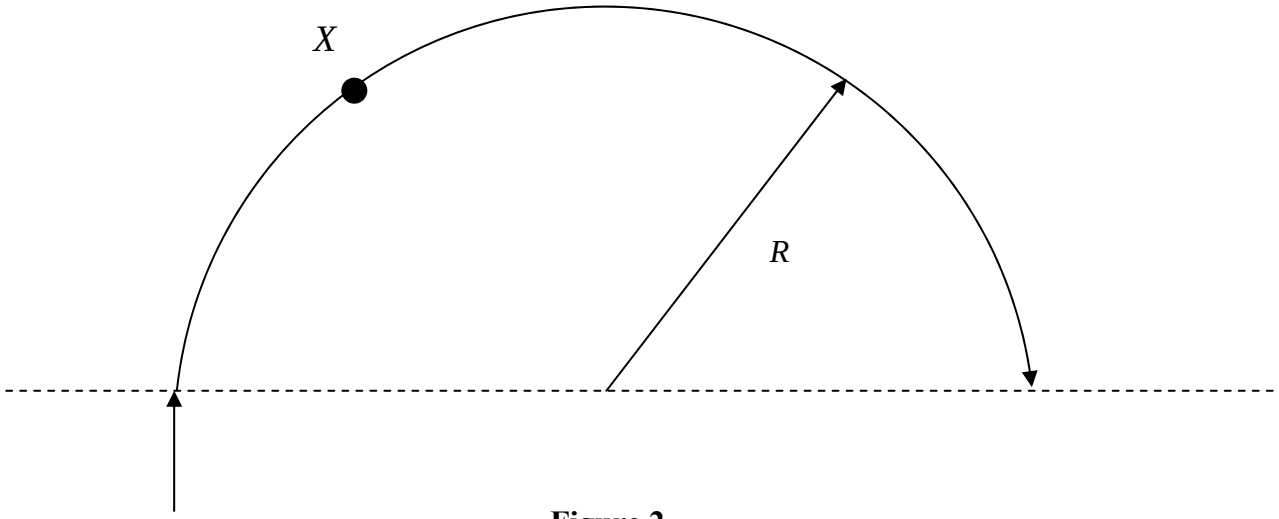


Figure 2

Question 5

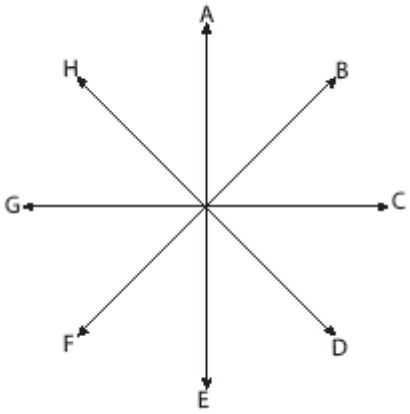
Calculate the radius of Gussy's turning circle, *R*, if he is to stay on his bike.

m

2 marks

Question 6

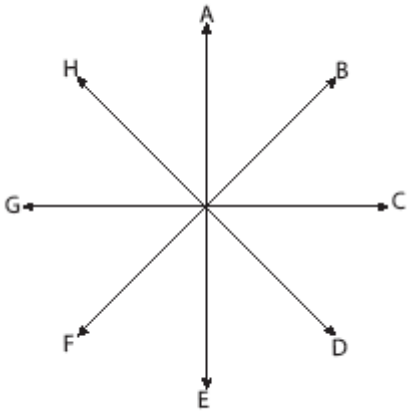
At point *X*, which is the closest direction to the net force on Gussy? Choose from:



2 marks

Question 7

At point *X*, which is the closest direction to Gussy's velocity? Choose from:



2 marks

Question 8

Which of the following is the best estimate of the magnitude of Gussy's **change** in momentum?

A. 0 kg ms^{-1}

B. 80 × 20 kg ms^{-1}

C. 2 × 80 × 20 kg ms^{-1}

D. –80 × 20 kg ms^{-1}

2 marks

Sammi, a 70 kg skier, is flying down a 40° slope with an acceleration of 5 ms^{-2}. He realises that there must be some retarding force upon him.

Question 9

Find the force opposing Sammi's progress.

N

3 marks

The following information applies to Questions 10–12.

Paulke is punting a football. He initially kicks it with a speed of 45 ms^{-1}, and the ball goes 50 m high, as shown in Figure 3.

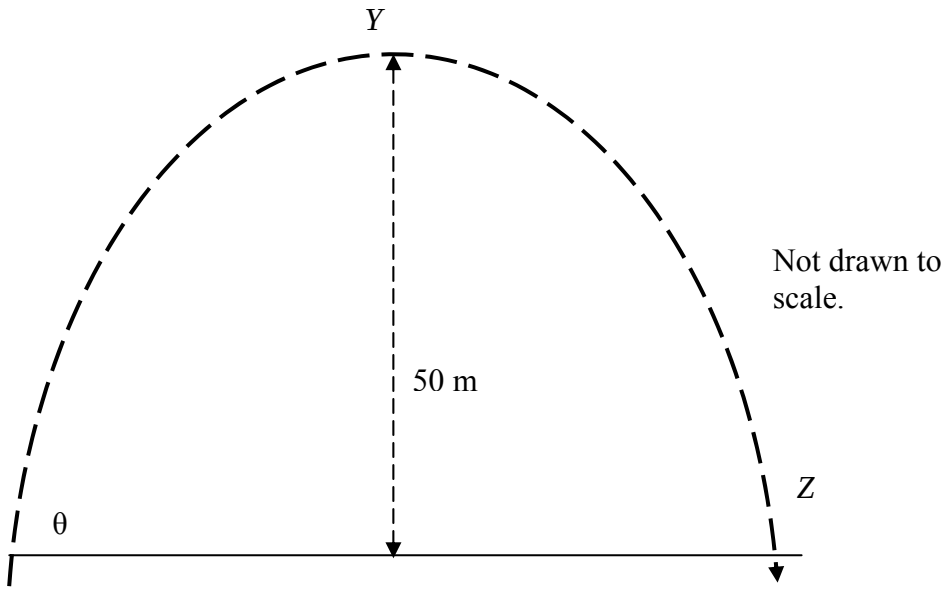


Figure 3

Question 10

Calculate the vertical velocity of the ball as it leaves Paulke's foot.

	ms^{-1}

3 marks

Question 11

In what direction is the acceleration of the ball at point *Y*, the highest point in the ball's flight?

A. zero
B. left
C. right
D. down

2 marks

Question 12

In what direction is the acceleration of the ball at point *Z*, just before the ball hits the ground?

A zero
B left
C right
D down

2 marks

A fat 2 kilogram cat is sunbaking in a tree when it has a nightmare and falls out! It falls 5 m, but is able to land on its feet and it takes 0.05 seconds to come to a stop. It then scampers back up the tree.

Question 13

What is the average force that the cat needs to exert against the ground to stop its fall in 0.05 seconds?

N

4 marks

Angus and Matilda are walking in the park, listening to music, and not taking much notice of where they are going. Angus is walking south at 5 ms^{-1}, and Matilda is walking west, also at 5 ms^{-1}.

Question 14

The relative velocity of Angus relative to Matilda is:

A. $\sqrt{50}$ ms^{-1} south–east

B. $\sqrt{50}$ ms^{-1} north–east

C. 5 ms^{-1} north–east

D. 5 ms^{-1} south–east

2 marks

The following information applies to Questions 15 and 16.

A satellite is orbiting the planet Saturn and its period is 11.86 hours.

Mass of Saturn = 5.685×10^{26} kg

Radius of Saturn = 60 268 km

Mass of Earth = 6.0×10^{24} kg

Radius of Earth = 6400 km

Question 15

What is the average radius of the satellite's orbit around Saturn?

	m

3 marks

Question 16

Which of the following gives the best value for the acceleration due to gravity at the 'surface' of Saturn?

A. 1000 ms^{-2}
B. 100 ms^{-2}
C. 10 ms^{-2}
D. 1 ms^{-2}

2 marks

Jeremiah is setting up a tyre swing in the backyard of his house. He had designed it so there would be a 50 cm gap between the bottom of the tyre and the ground. But when he attached his 2 kg tyre to the rope, he noticed that there was only a 40 cm gap. He deduced that the rope had stretched when the tyre was placed on it, and that it behaves in an elastic manner.

Question 17

Find the force constant, k, for the rope. Include the unit.

Nm^{-1}

3 marks

END OF AREA OF STUDY 1
SECTION A – continued

Area of study 2 – Electronics and photonics

The following information applies to Questions 1–3.

Allan and Beth have set up a simple circuit with four identical resistors to a 20 V power supply, as shown in Figure 1.

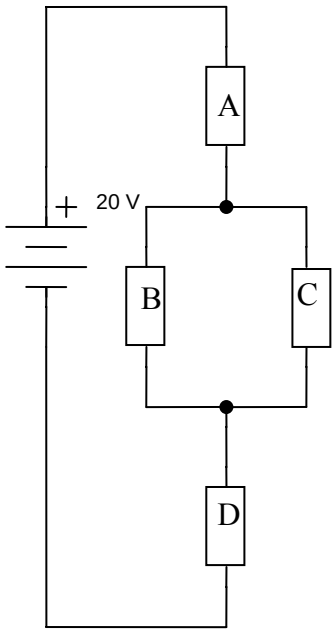


Figure 1

Question 1

If the resistance of each resistor is expressed as R, find the total resistance of the circuit in terms of R.

R

2 marks

Question 2

Find the ratio of:

$$\frac{\text{Current through resistor A}}{\text{Current through resistor C}}$$

2 marks

Question 3

What is the voltage drop across resistor C?

V

2 marks

The following information relates to Questions 4 and 5.

The current–voltage characteristic of a LED is shown in Figure 2. It has a maximum voltage drop of 0.7 V.

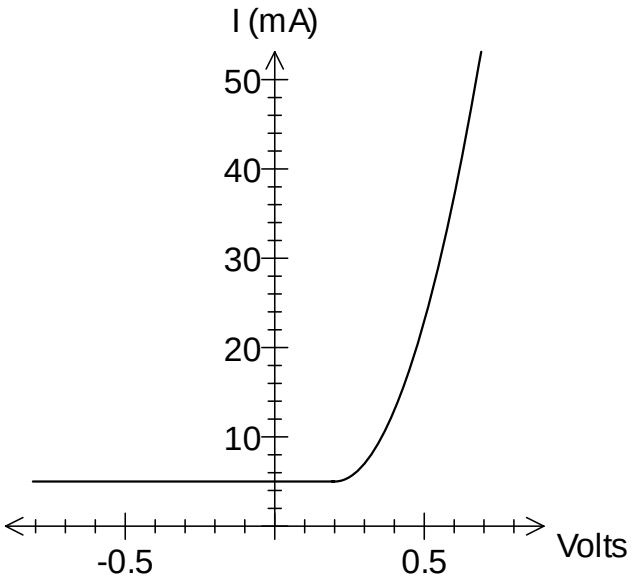


Figure 2

A LED is placed in a simple circuit with a resistor and a 3 V power supply, as shown in Figure 3.

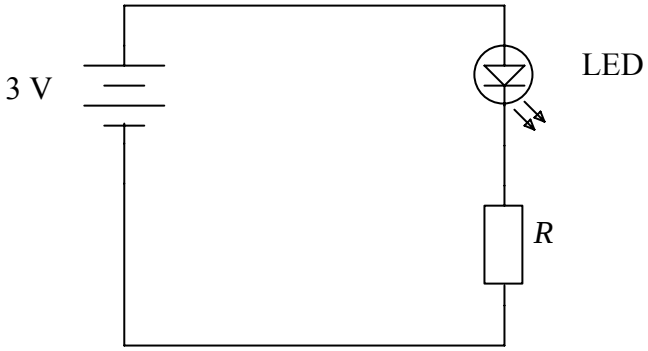


Figure 3

Question 4

If the ammeter reads 20 mA, what is the value of the resistor, *R*?

Ω

2 marks

Question 5

Two LEDs are now placed in a circuit with two 50 Ω resistors, as shown in Figure 4. The LEDs are of the same design as the one in Question 4.

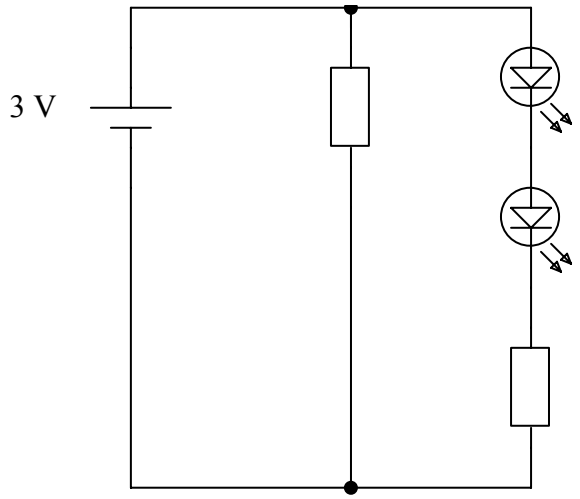


Figure 4

Calculate the current flowing through the LEDs. Express your answer in mA.

mA

2 marks

The following information applies to Questions 6–8

The graph of the resistance of an LDR with respect to the light intensity is shown below in Figure 5.

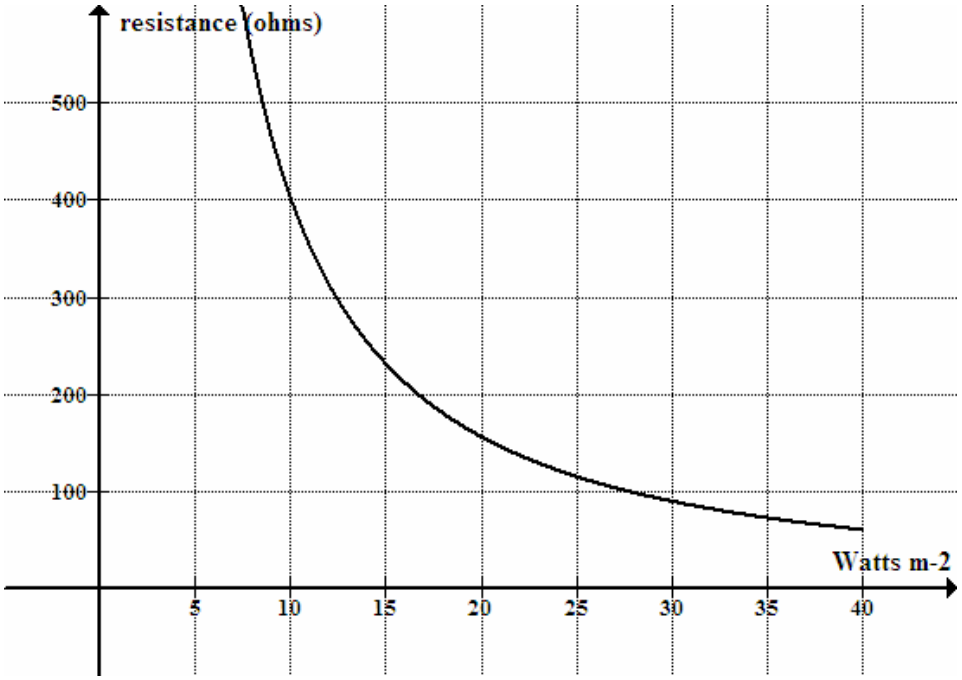


Figure 5

Question 6

What is the resistance of the LDR when the light intensity is at 10 watts m^{-2}?

Ω

1 mark

The LDR is placed in the circuit below in order to turn on the lights in a house at a specified light intensity, as shown in Figure 6.

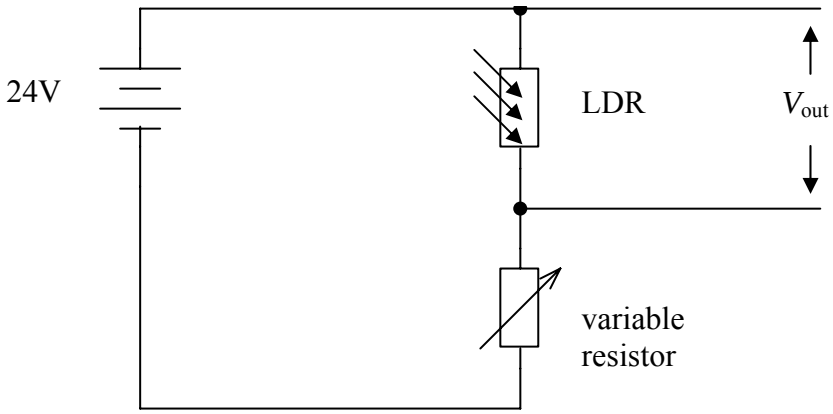


Figure 6

Question 7

The home owner requires the lights to turn on automatically when the light intensity is less than 10 watts m^{-2}. What is the value of the variable resistor if the required value of V_{out} is 16 V?

Ω

3 marks

The homeowner then turns the variable resistor to a higher value.

Question 8

Will this make the light come on earlier or later than before? Explain your answer.

2 marks

Question 9

Explain the operation of a photodiode.

_____

_____

_____

_____

2 marks

Question 10

Give two reasons why phototransistors may be used in place of photodiodes.

_____

_____

_____

_____

2 marks

Question 11

An amplifier has the following characteristics, as shown in Figure 7a.

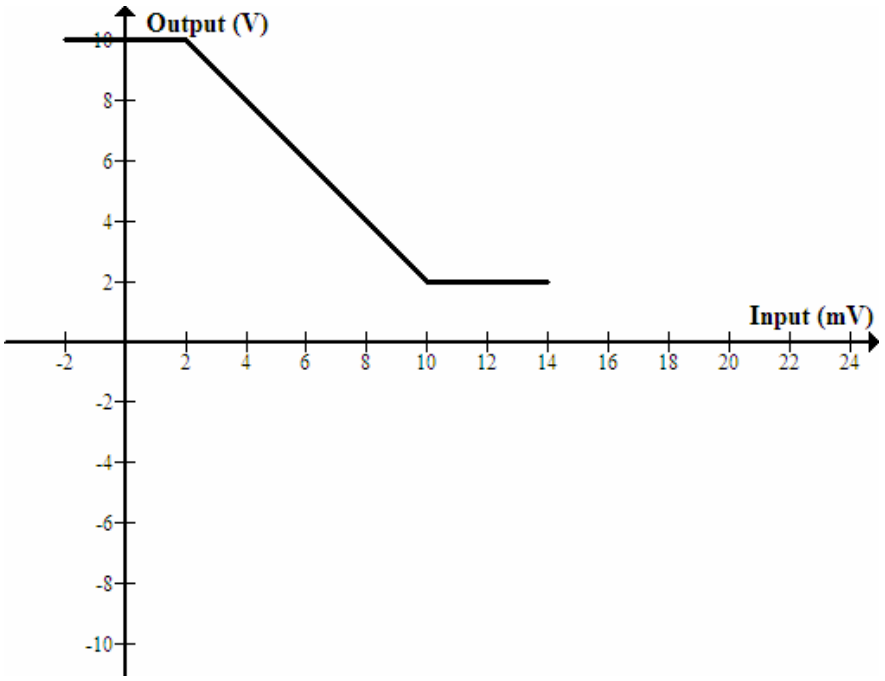


Figure 7a

An input of the following is put into the amplifier, as shown in Figure 7b.

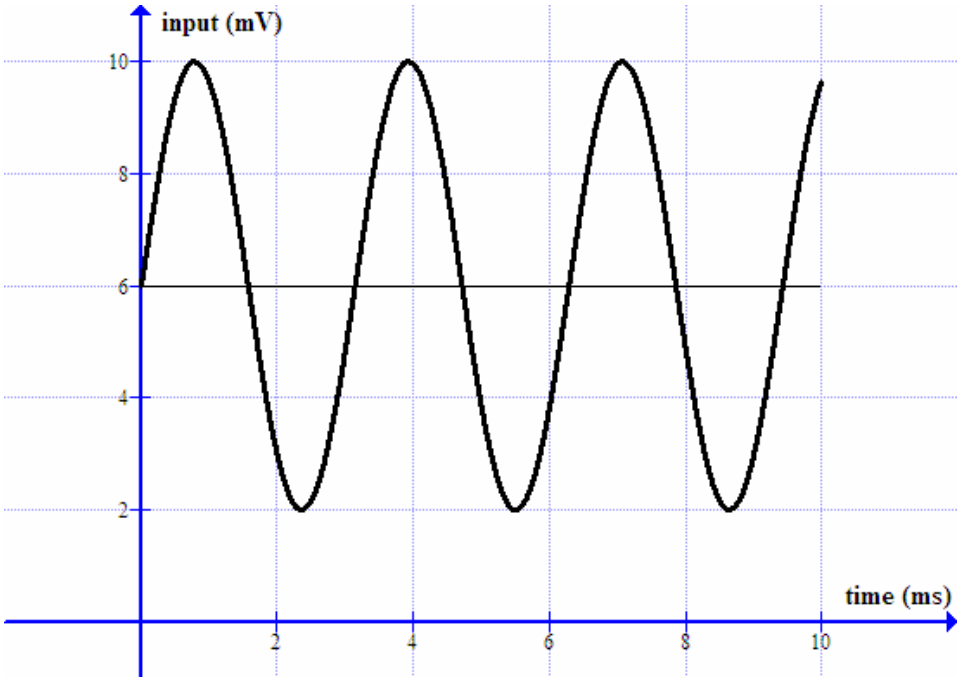
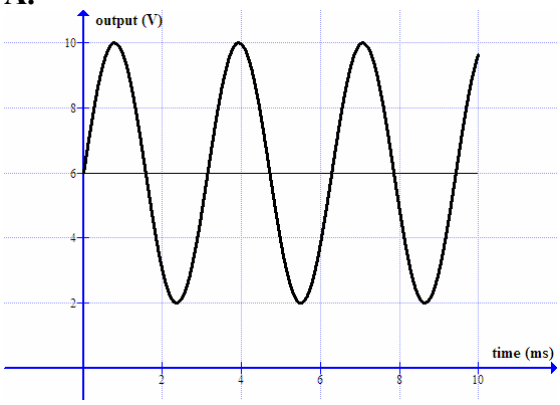


Figure 7b

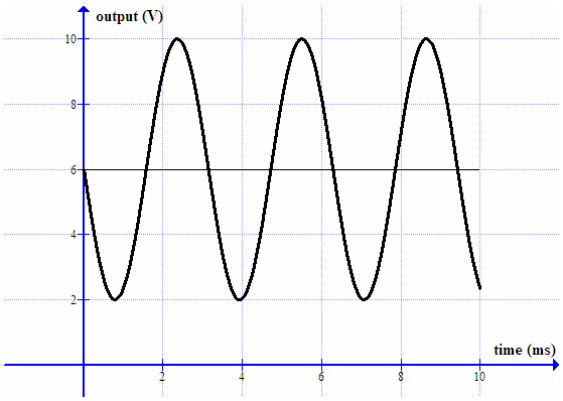
Which of the following best describes the output?

2 marks

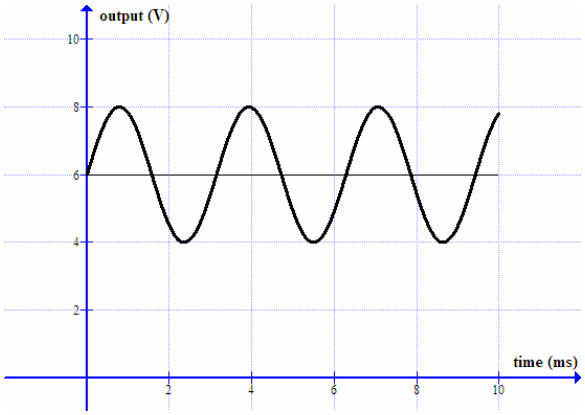
A.



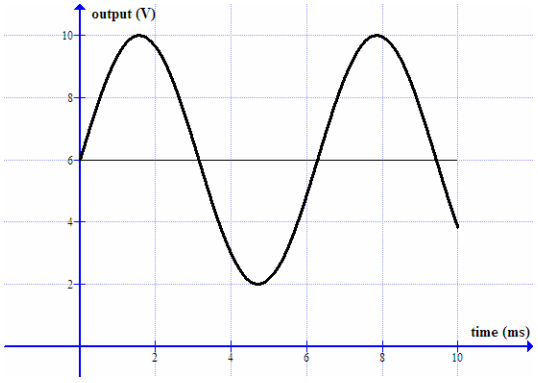
B.



C.



D.



Question 12

For the transistor shown in Figure 8, label the base (B), emitter (E) and collector (C).

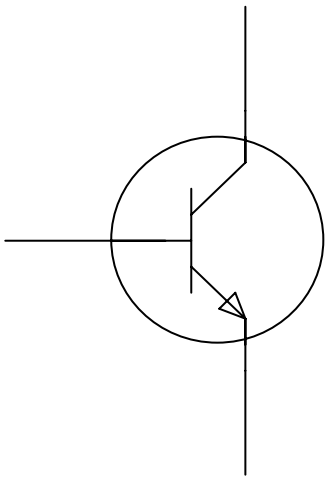


Figure 8

1 mark

Question 13

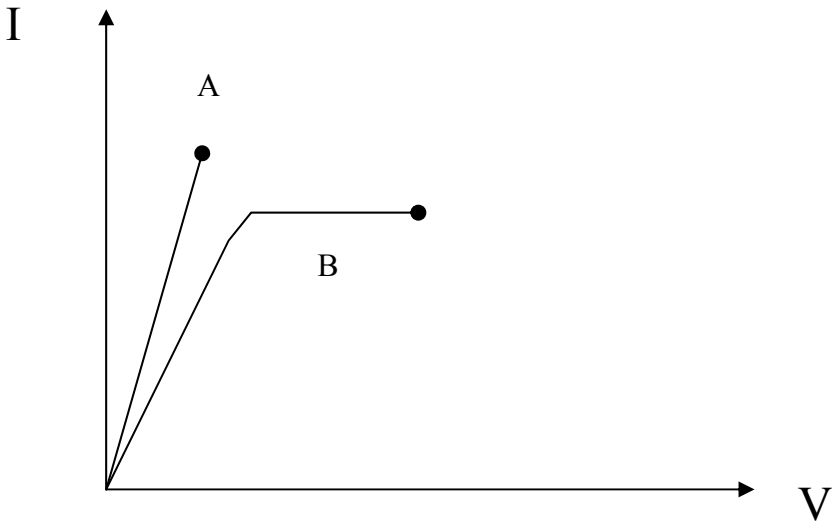


Figure 9

Which of the resistors in Figure 9 is 'ohmic'? Explain.

_____

_____

_____

2 marks

END OF SECTION A
TURN OVER

SECTION B – Detailed studies

Detailed study 1 – Einstein's special relativity

The following information applies to Questions 1–3.

Michelson and Morley set up a famous experiment, as shown in Figure 1.

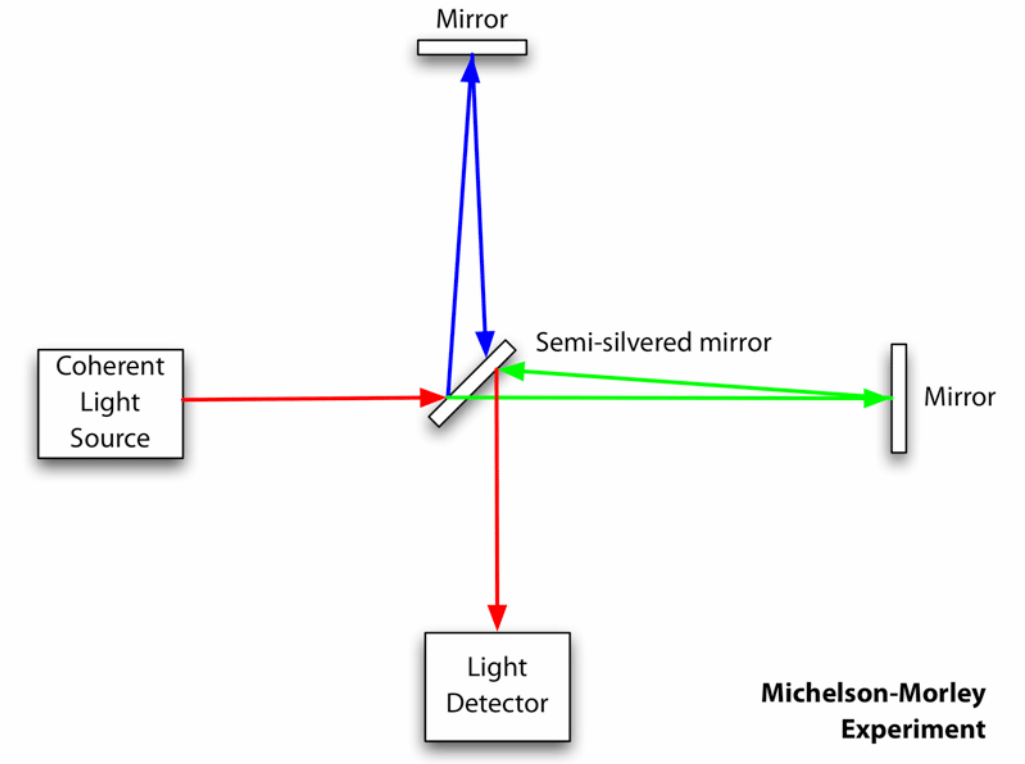


Figure 1

Question 1

What is the name of this piece of apparatus?

1 mark

Question 2

What is its purpose and how does it work?

3 marks

Question 3

What was the outcome of the experiment?

_____

_____

_____

_____

_____

2 marks

The following information applies to Questions 4–8.

In the year 2200, a mission is sent to an 'Earth-like' planet to explore its possibilities of human habitation. A group of astronauts is sent at 80% the speed of light (0.8 c), as measured by astronomers on Earth. The planet is known to be 20 light years away.

Question 4

As soon as the astronauts arrive, they send a message back to Earth. In what year will Earth receive their message?

Year

3 marks

Question 5

What is the Lorenz factor for the astronauts?

2 marks

Question 6

From the astronauts' reference, how long will the trip take to reach the Earth-like planet?

years

2 marks

Question 7

Before the rocket leaves Earth, its length is measured to be 250 metres. When the astronauts leave Earth at 0.8 c, compared to its actual length, the rocket will appear, to an observer on Earth:

A. longer than 250 m
B. 250 m
C. shorter than 250 m
D. depends which way observer is travelling

2 marks

Question 8

On the trip, the astronauts measure the ship. To them, its length appears:

A. longer than 250 m
B. 250 m
C. shorter than 250 m
D. depends which way astronauts are travelling

2 marks

The following information applies to Questions 9 and 10.

The rest mass of an electron is 9.11×10^{-31} kg. It is then accelerated to 1.9×10^{8} ms^{-1}.

Question 9

What is the resting energy of the electron?

J

2 marks

Question 10

What is the relativistic mass of the electron travelling at 1.9×10^{8} ms^{-1}?

kg

2 marks

Question 11

The sun loses 5×10^{9} kg of mass every second. How much energy does it lose in one Earth hour?

J

2 marks

Question 12

Explain the meaning of the term ’inertial frame of reference’.

_____

_____

_____

_____

_____

_____

2 marks

END OF DETAILED STUDY 1
SECTION B – continued

Detailed study 2 – Investigating materials and their use in structures

The following information applies to Questions 1–3.

A fishing line of length 2 m, with a cross-sectional area of 3×10^{-6} m^2, has a stress breaking limit of 2×10^8 Nm^{-2} with a strain rating of 0.05.

Question 1

How much force can the line hold?

N

2 marks

Question 2

How much will it stretch?

m

2 marks

Question 3

What is the Young's modulus for the fishing line?

Nm^{-2}

2 marks

Question 4

What does the area under a stress–strain graph measure? What is its unit?

_____

_____

_____

3 marks

The following information applies to Questions 5–7.

A new concrete sign has been erected in Capital City. It is supported by a concrete column, as shown in Figure 1.

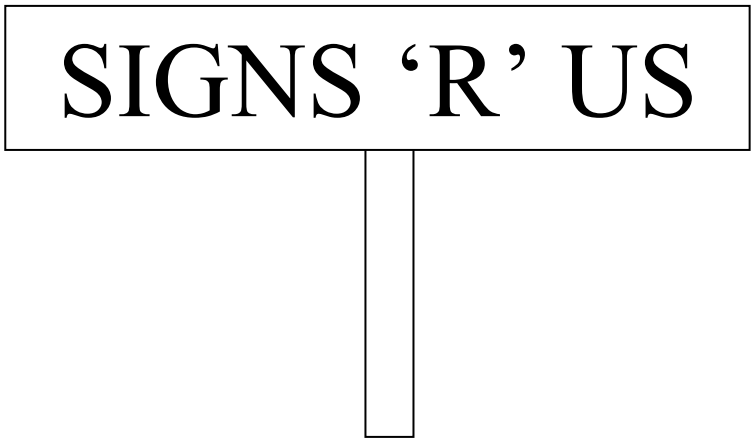
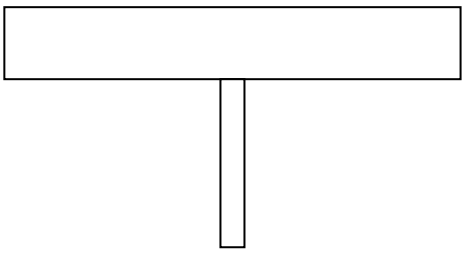


Figure 1

Question 5

Place C for compression and T for tension in appropriate spots on the sign and column.

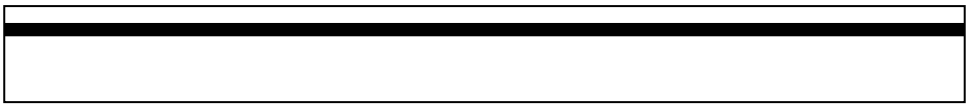


2 marks

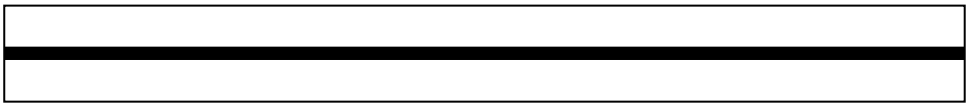
Question 6

Which of the following shows the best placement of reinforcing steel rods to provide maximum strength for the **sign**?

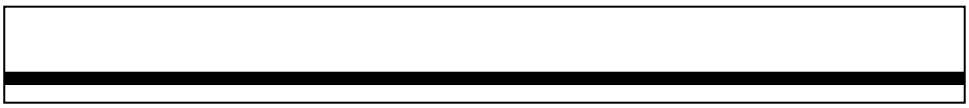
A.



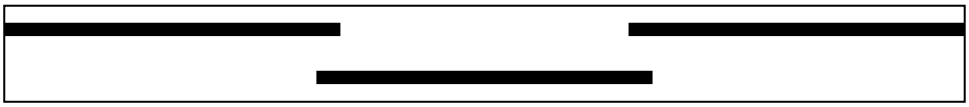
B.



C.



D.



2 marks

Question 7

Explain your choice.

_____

_____

_____

2 marks

The following information applies to Questions 8 and 9.

When Ash, who weighs 100 kg, gets into his car, his car sinks towards the ground by 10 cm. He has four identical shock absorbers.

Question 8

What is ***k***, the spring constant, for the spring in one shock absorber? You may assume that Ash's weight is distributed evenly amongst the four shock absorbers.

Nm^{-1}

2 marks

Ash is now driving his car over a 20 m beam bridge, which is supported by two pillars. The bridge has a mass of 2000 kg, and Ash and his car have a combined mass of 800 kg. Ash stops 5 m from the end of the bridge to admire the view, as shown in Figure 2.

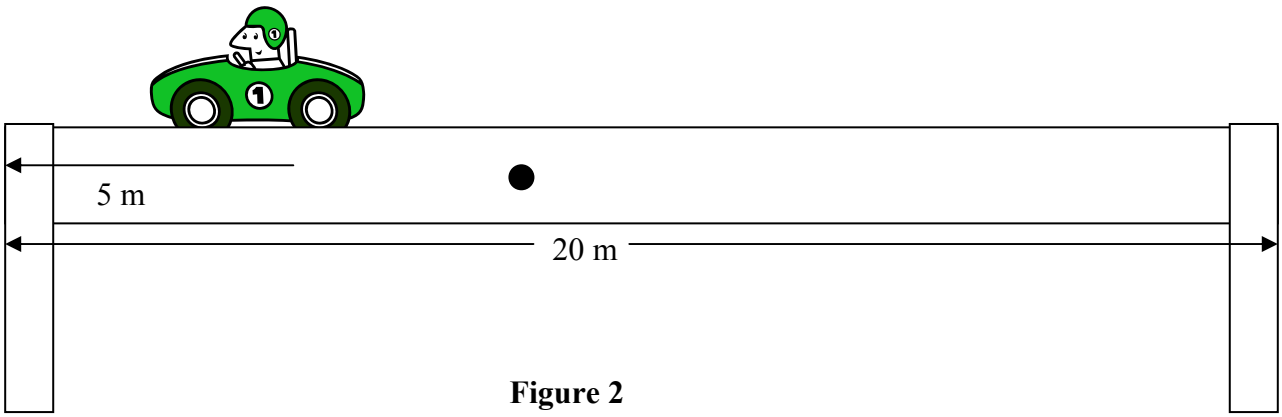


Figure 2

Question 9

What are the compression forces on the left pillar?

	N

4 marks

The following information applies to Questions 10 and 11.

Figure 3 is a stress–strain graph for two different materials.

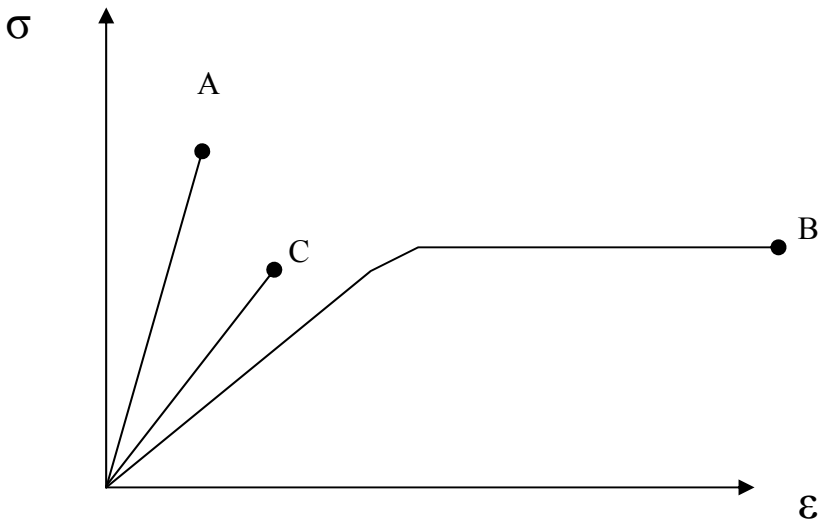


Figure 3

Question 10

Which of the materials is the most ductile? Explain.

_____

_____

_____

2 marks

Question 11

Which of the materials is the strongest? Explain.

_____

_____

_____

2 marks

END OF DETAILED STUDY 2
SECTION B – continued

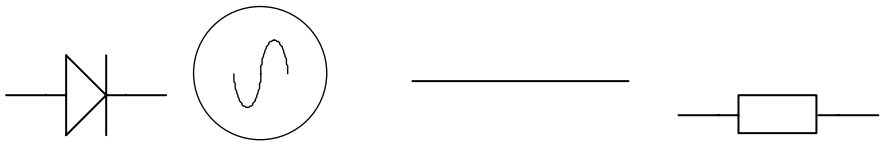
Detailed study 3 – Further electronics

The following information applies to Questions 1–5.

Bill and Bob are making some rectified power supplies. They have only an AC power supply, some diodes (6), wire (plenty) and a load/resistor they want to run off DC. The AC power supply is 12 V_{RMS}, 25Hz.

Question 1

Bill wants to make a half-wave bridge rectifier. Draw one in the space provided. Use the following symbols.

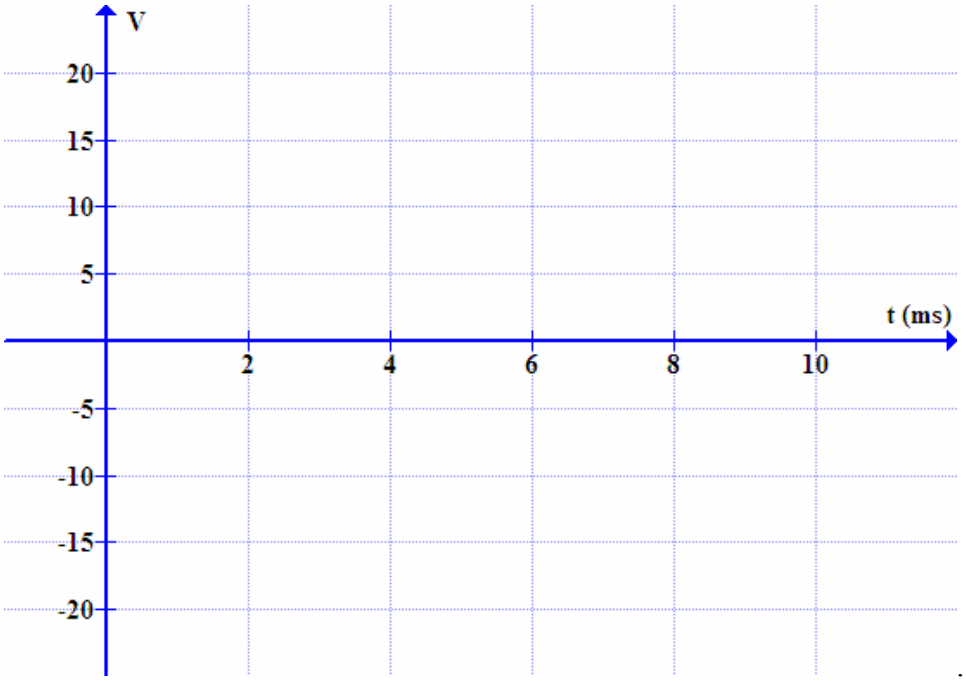


Diode AC power Wire Load

2 marks

Question 2

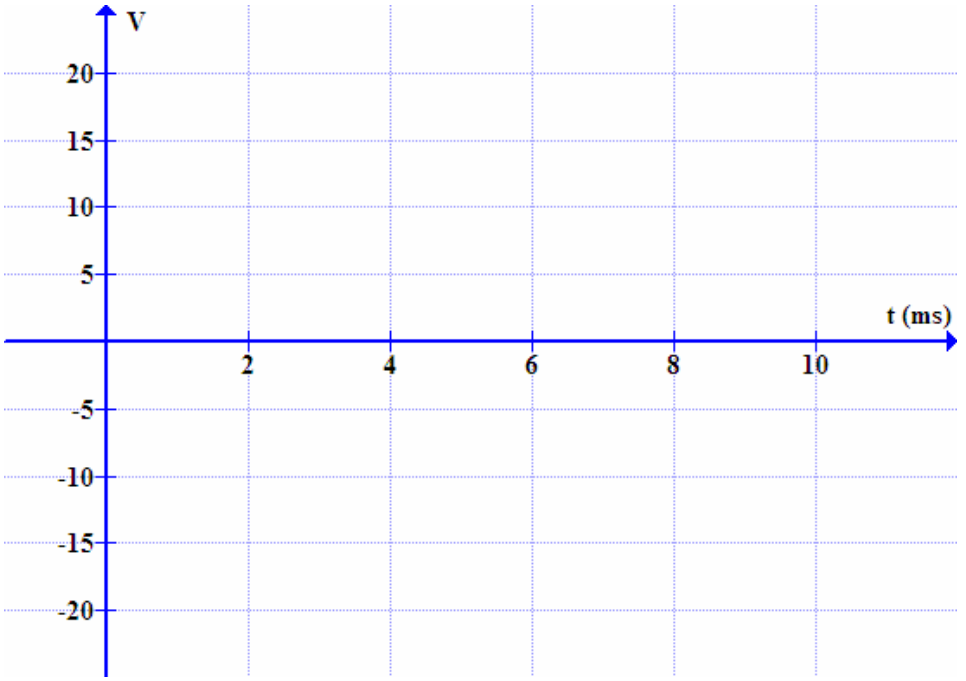
Sketch the display that Bill would see if he connected his Cathode Ray Oscilloscope (CRO) across the AC power supply.



3 marks

Question 3

Bill now places his CRO across the load. Sketch the display on the CRO.



2 marks

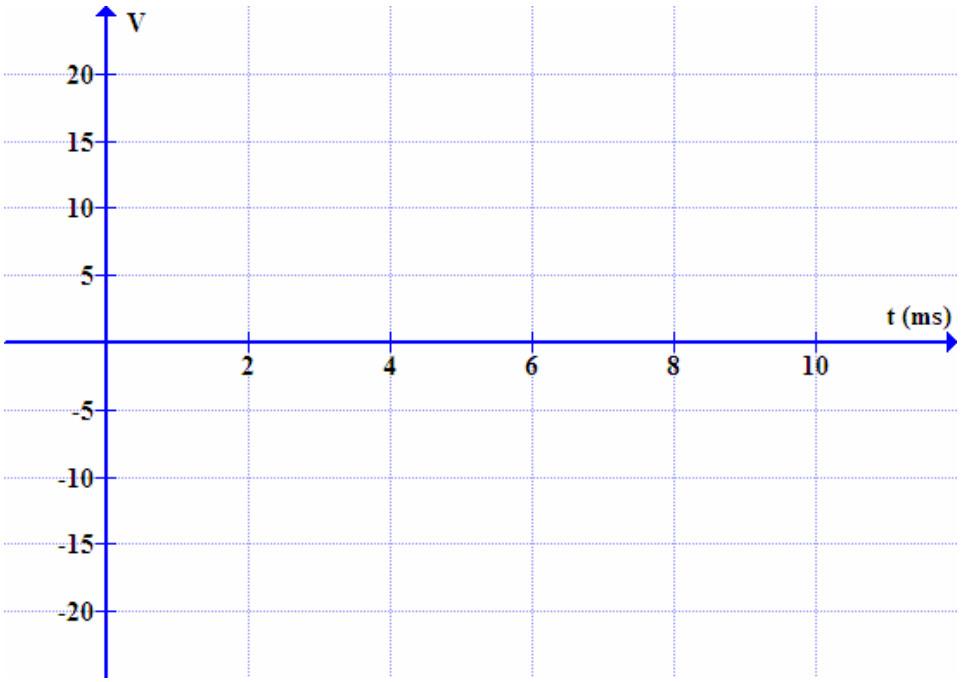
Question 4

Bob now wants to make a full-wave bridge rectifier. Draw one from the available supplies. Connect it to his load.

3 marks

Question 5

Bob connects a CRO across the load. Sketch the display.



2 marks

The following information applies to Questions 6 and 7.

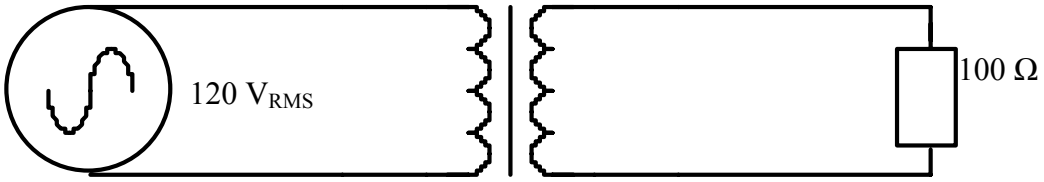


Figure 1

A transformer, as shown in Figure 1, is connected to a 120 V_{RMS} AC power supply. The output voltage required is 24 V_{RMS} and is connected to a load of 100 Ω. The number of coils in the secondary is 10.

Question 6

What number of coils is required in the primary?

coils

2 marks

Question 7

How much power is dissipated through the 100 Ω resistor?

W

2 marks

The following information applies to Questions 8 and 9.

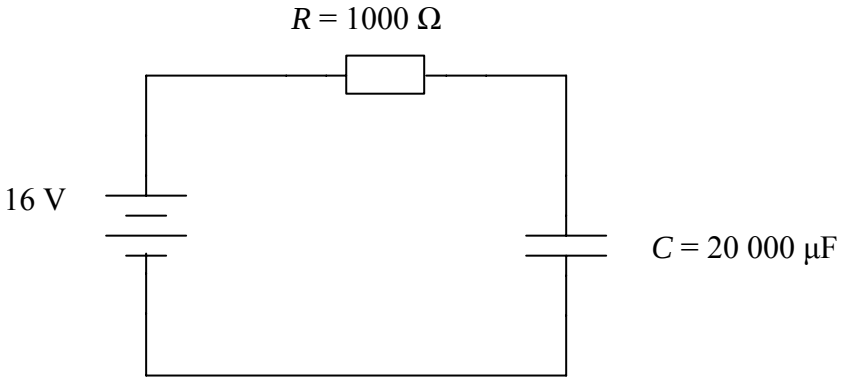


Figure 2

A capacitor and resistor are connected to a 16 V DC power supply, as shown in Figure 2.

Question 8

What is the time constant (τ) for this circuit?

s

2 marks

Question 9

How long until the potential difference across the capacitor is 10.7 V?

s

2 marks

Question 10

Explain the purpose of a heat sink.

_____

_____

_____

_____

2 marks

The following information applies to Questions 11 and 12.

A CRO is connected to the output of a power supply. The CRO is set on CAL. The trace displays a peak to peak voltage of 34 V and a period of 25 ms.

Question 11

What is the RMS voltage?

	V

2 marks

Question 12

What is the frequency of the AC supply?

	Hz

1 mark

END OF QUESTION AND ANSWER BOOK