

INSIGHT

Year 12 Trial Exam Paper

2012

PHYSICS

Written examination 1

STUDENT NAME:

QUESTION AND ANSWER BOOK

Reading time: 15 minutes

Writing time: 1 hour 30 minutes

Structure of book

<i>Section</i>	<i>Number of questions</i>	<i>Number of questions to be answered</i>	<i>Number of marks</i>
A – Core – Areas of Study			
1. Motion in one and two dimensions	22	22	44
2. Electronics and photonics	11	11	26
B – Detailed Studies			
1. Einstein's special relativity	10	10	20
OR			
2. Further electronics	10	10	20
OR			
3. Materials and their use in structures	10	10	20
Total			90

- 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 one scientific calculator.
- Students are NOT permitted to bring sheets of blank paper or white out liquid/tape into the examination.

Materials provided

- The question and answer book of 39 pages, with a separate data sheet.
- An answer sheet for multiple-choice questions.

Instructions

- Write your **name** in the box provided, and on the answer sheet for multiple-choice questions.
- Remove the data sheet during reading time.
- Unless otherwise indicated, the diagrams in this book are NOT drawn to scale.
- You must answer all questions in English.

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

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SECTION A**Instructions for Section A**

Answer **all** questions for **both** Areas of Study in this section in the spaces provided. Write using a black or blue pen.

If a unit is printed in an answer box, give your final answer in that unit.

You should take the value of g to be 10 m s^{-2} .

In questions where more than one mark is available, appropriate working should be shown.

Areas of study

Motion in one and two dimensions

Page 4

Electronics and photonics

Page 18

Area of study 1 – Motion in one and two dimensions

The following information relates to Questions 1–4.

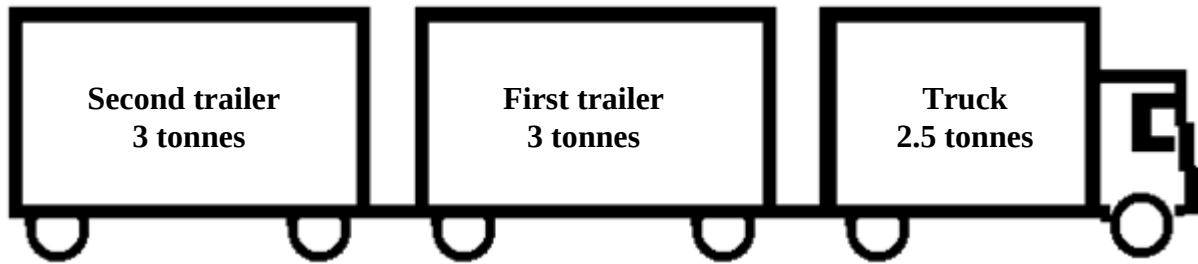


Figure 1

A truck of mass 2.5 tonnes is attached to two trailers, each of mass 3 tonnes as shown in Figure 1. There are frictional forces acting of 0.25 N kg^{-1} , which remain constant. The truck accelerates at a constant rate of 0.75 m s^{-2} from rest until it reaches the speed limit of 60 km h^{-1} .

Question 1

What is the magnitude of the net force on the system of the truck and trailers while the truck accelerates?

N

2 marks

Question 2

What is the driving force provided by the truck engine to propel the load forwards while accelerating?

N

2 marks

Question 3

Calculate the tension between the second and first trailers while the truck is accelerating.

N

2 marks

Question 4

How long would it take for the truck to reach the legal speed limit of 60 km h^{-1} , at which time it will stop accelerating?

S

2 marks

The following information relates to Questions 5–8.

During a NASCAR race, a driver and his racing car have a combined mass of 2500 kg. At a particular circular section of the track, which is inclined at an angle θ to the horizontal, the car is travelling at a constant speed of 50 m s^{-1} around a radius of 150 m. Ignore retarding friction.

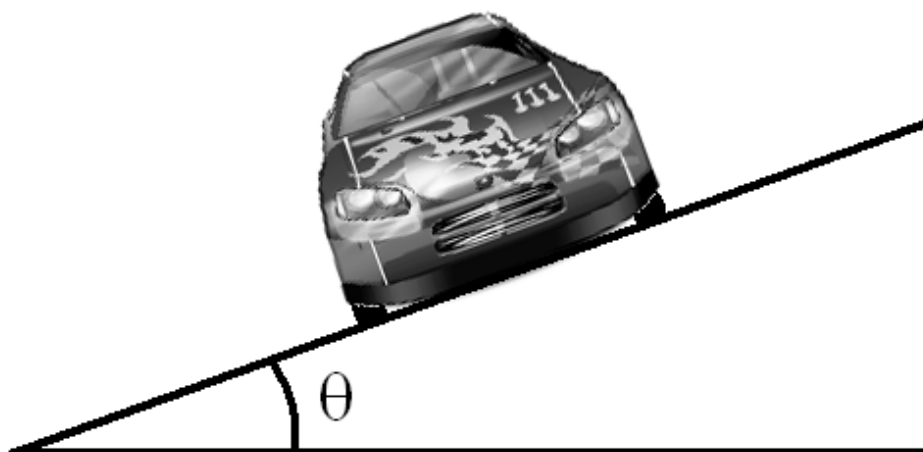


Figure 2

Question 5

What is the magnitude of the net force on the driver and car?

N

2 marks

Question 6

On Figure 2, draw the normal reaction force (R) and the weight force (W) acting on the car.

2 marks

Question 7

Calculate the angle θ of the banked curve that the NASCAR travels around.



2 marks

Question 8

Explain the purpose of having banked curves.

2 marks

The following information relates to Questions 9–13.

A basketball of mass 1.5 kg strikes a wall at 10 m s^{-1} horizontally and rebounds at 8 m s^{-1} horizontally. The collision between the ball and the wall lasts for 0.1 seconds. This situation is shown in Figure 3.

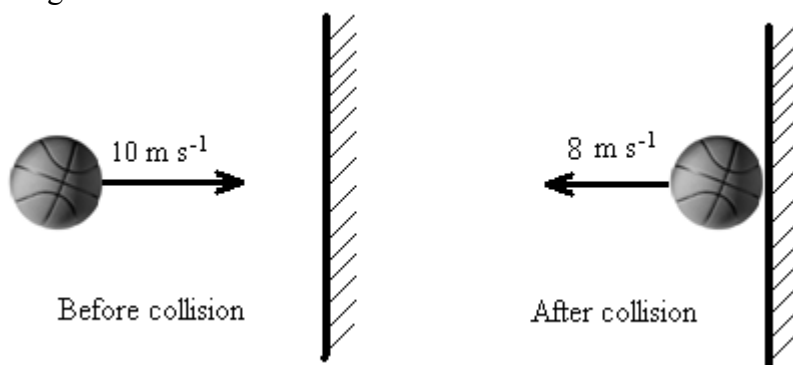


Figure 3

Question 9

What is the change in speed of the ball after the collision?

m s^{-1}

2 marks

Question 10

Calculate the magnitude of the change in momentum of the ball.

kg m s^{-1}

2 marks

Question 11

What is the average force the wall exerts on the ball? Also indicate the direction of the force.

N	Direction =
---	-------------

2 marks

Question 12

What is the force the ball exerts on the wall? Also indicate direction.

N	Direction =
---	-------------

2 marks

Question 13

Using calculations, show if the collision is inelastic.

2 marks

The following information relates to Questions 14 & 15.

Sean takes a ride in a cart at a theme park. The combined mass of Sean and the cart is 200 kg. He begins from rest (point A) at a height of 80 m above the ground (Figure 4).

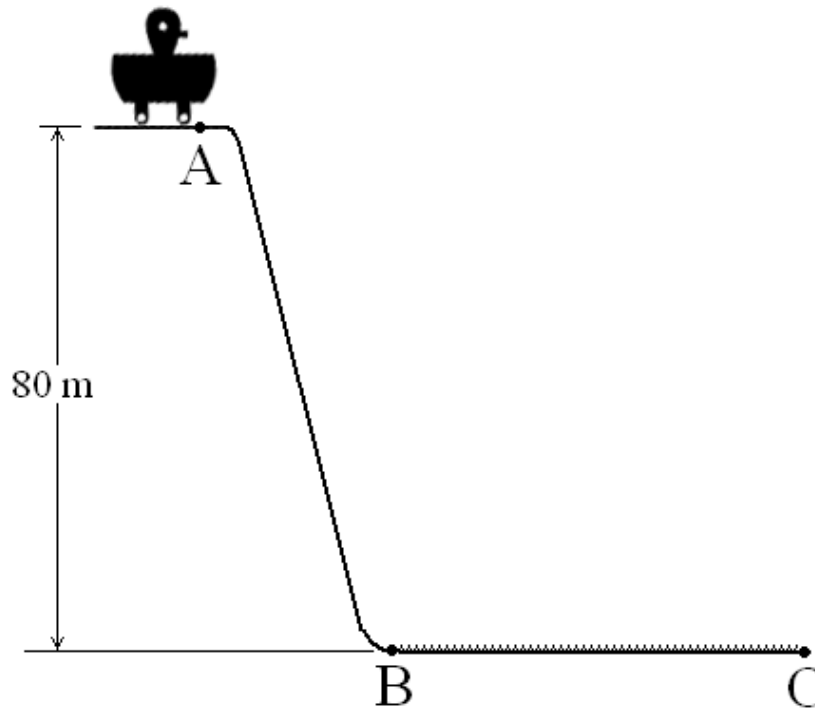


Figure 4

Question 14

Calculate Sean's speed at point B, if frictional forces are ignored.

m s^{-1}

2 marks

Question 15

After point B, friction is introduced in order to bring the cart and Sean to rest at point C. If the distance between point B and C is 40 m, calculate the deceleration of the cart.

m s^{-2}

2 marks

Question 16

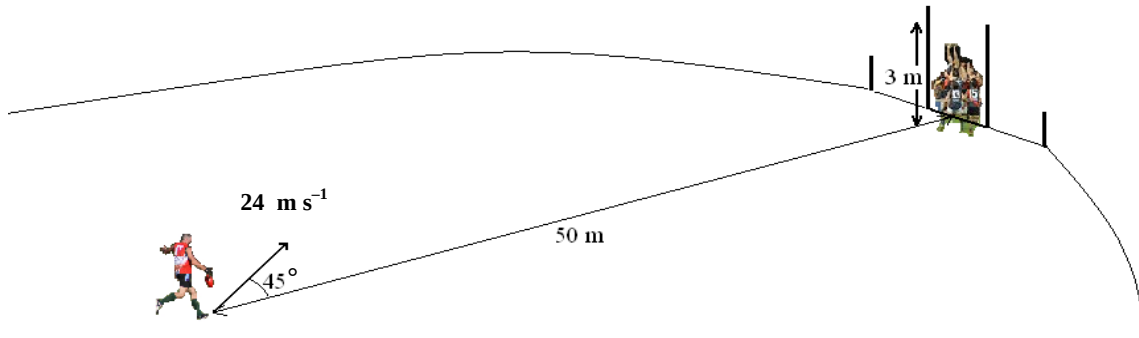
A spring-loaded gun fires 10 g bullets at a speed of 100 km h^{-1} . If the spring is compressed by 20 cm, calculate its spring constant.

N m^{-1}

2 marks

Question 17

Malcolm takes a set shot 50 m from goal (Figure 5). He realises that to clear the last defender, the ball needs to have a minimum height of 3 m at the goal line. If he kicks the ball at 24 m s^{-1} from ground level at an angle of 45° to the horizontal, assuming he is accurate, does he kick a goal? Use calculations to explain your answer.

**Figure 5**

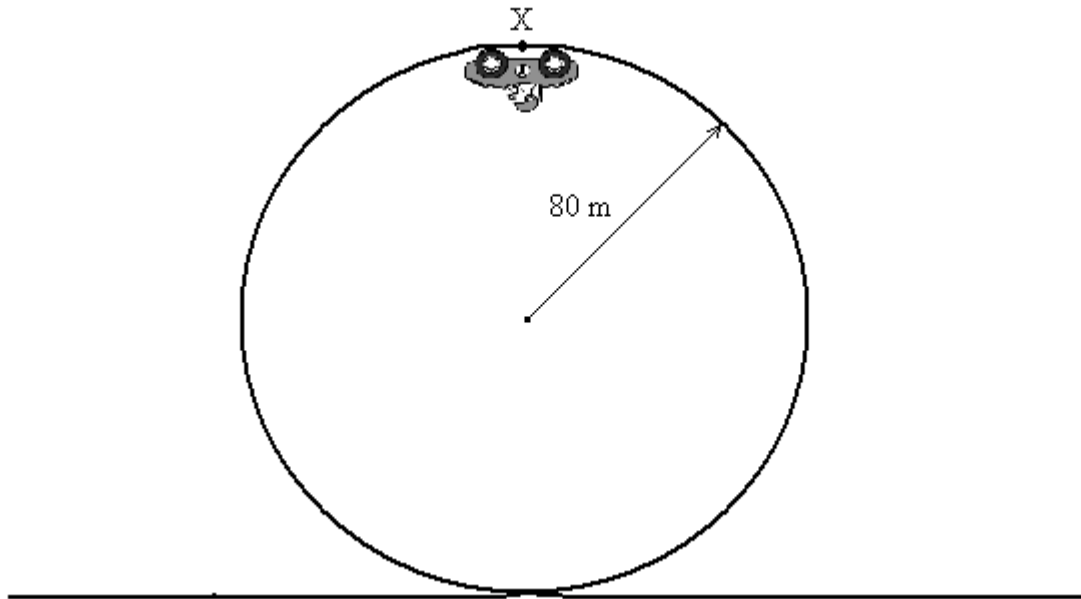
m	Yes / No
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3 marks

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Question 18

Luke and his car have a combined mass of 2500 kg. He decides to compete a stunt by driving his car around a vertical track of radius 80 m, as shown in Figure 6.

**Figure 6**

In order to successfully complete the stunt, the car wheels must not leave the track at point X. What is the minimum speed the car must have at X so that it does not leave the track?

m s^{-1}

2 marks

The following information relates to Questions 1–22.

The secret satellite ‘SPY’ has a circular orbit of radius 1.50×10^7 m and a mass of 1000 kg.

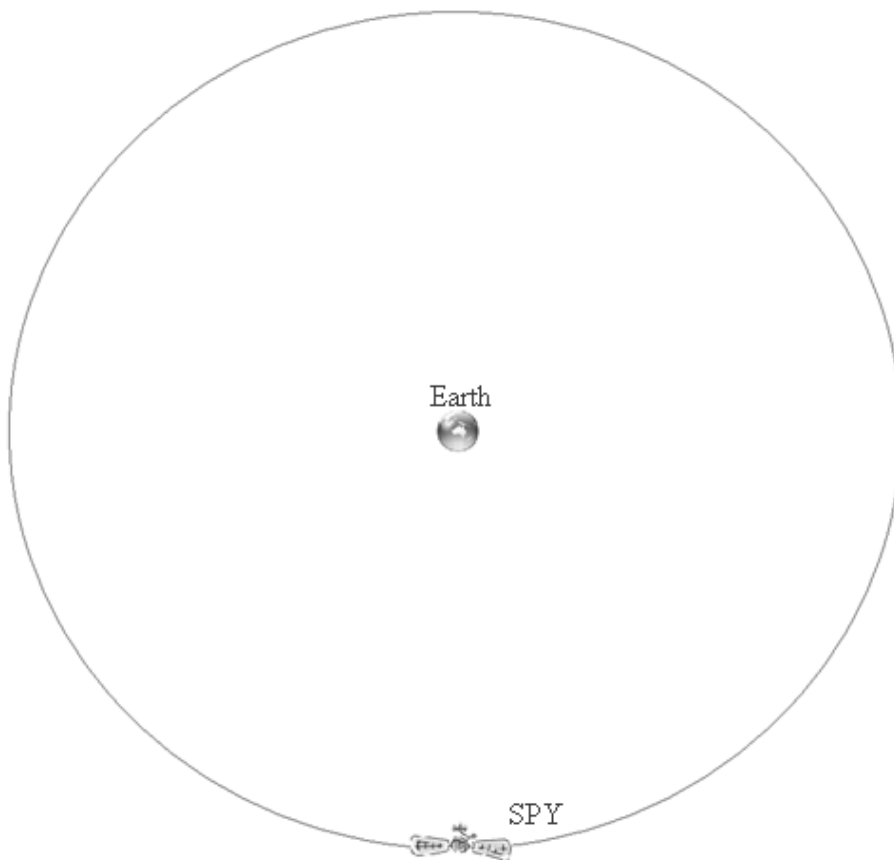


Figure 7

Question 19

On Figure 7 above, draw one or more arrows to indicate the direction of any force acting on the satellite SPY..

1 mark

Question 20

What is the weight of the satellite SPY in its orbit?

N

2 marks

Question 21

What is the period of orbit of the satellite around Earth?

s

2 marks

Question 22

An astronaut repairing the satellite while in orbit believes he is weightless. Is his assumption correct? Explain your answer.

2 marks

END OF AREA OF STUDY 1

END OF AREA OF STUDY 1
SECTION A – continued
TURN OVER

Area of study 2 – Electronics and photonics

The following information relates to Questions 1–4.

Luke sets up the circuit shown in Figure 1.

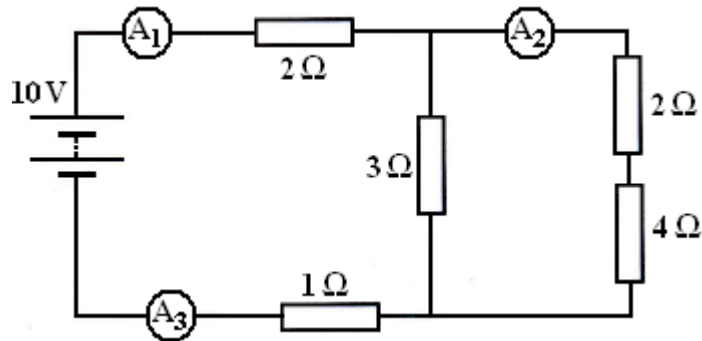


Figure 1

Question 1

Calculate the total resistance of the circuit. Show your working.

Ω

2 marks

Question 2

What is the reading on the ammeters?

$A_1 =$ A

$A_2 =$ A

$A_3 =$ A

3 marks

Question 3

What is the potential difference across the $1\ \Omega$ resistor?

V

2 marks

Question 4

What is the power across the $3\ \Omega$ resistor?

W

2 marks

SECTION A – Area of study 2 – continued
TURN OVER

The following information relates to Questions 5 & 6.

Quang sets up the circuit shown in Figure 2 using two identical LEDs and an $18\ \Omega$ resistor. The I - V characteristics of the diodes are shown in Figure 3.

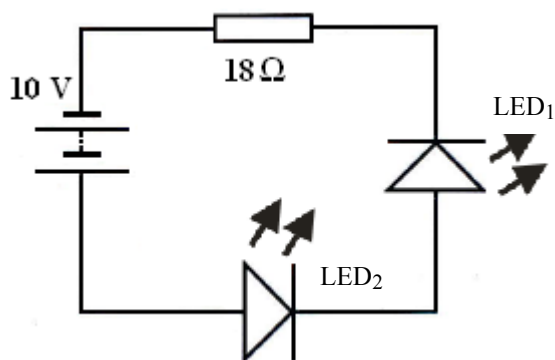


Figure 2

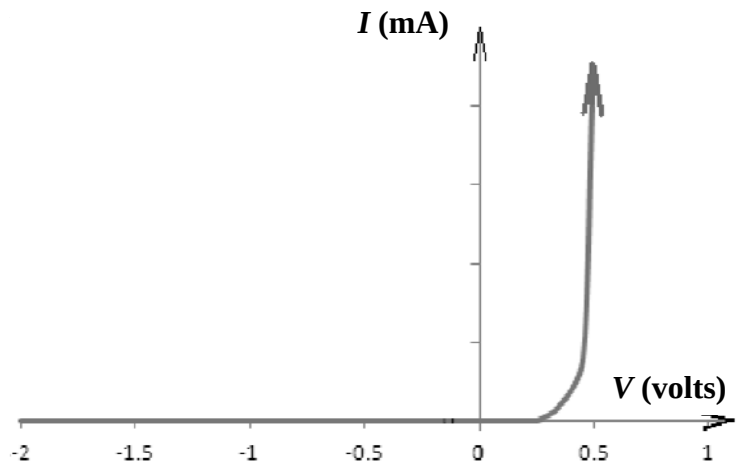


Figure 3

Question 5

What is the power rating across LED₁? Show your working.

W

3 marks

Question 6

Quang decides to reverse LED₁ and measure the potential difference across it. What is the reading on the voltmeter? Explain your answer.

V

2 marks

The following information relates to Questions 7–10.

The temperature-resistance characteristics of a thermistor are shown in Figure 4.

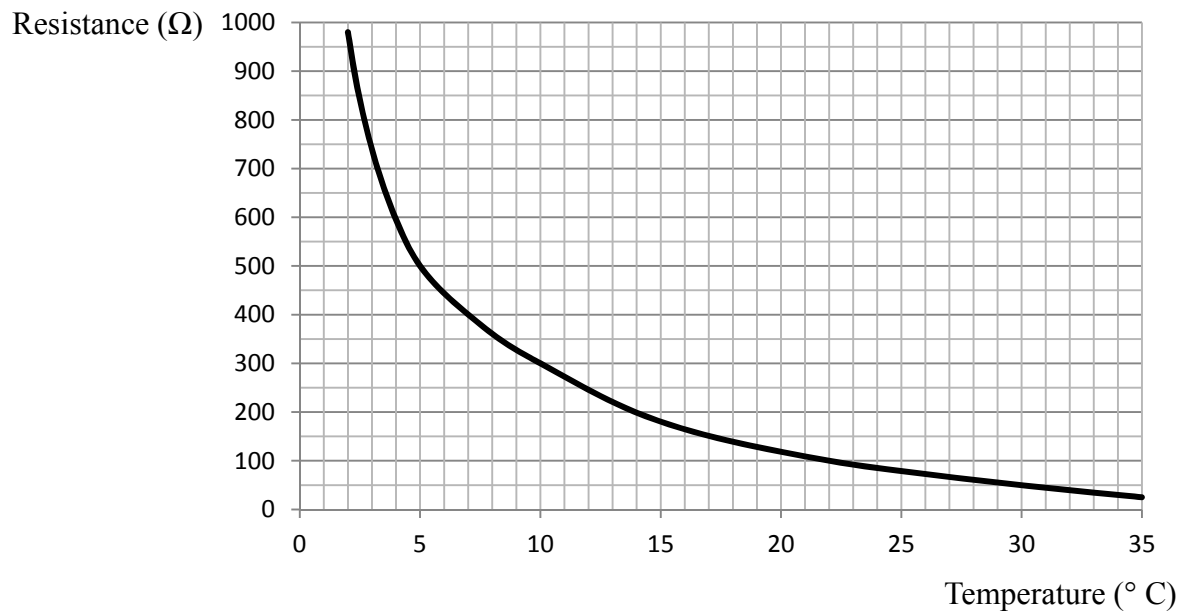


Figure 4

Question 7

What is the resistance of the thermistor at 5°C?

 Ω

1 mark

Peter uses the thermistor in series with a variable resistor as shown in Figure 5.

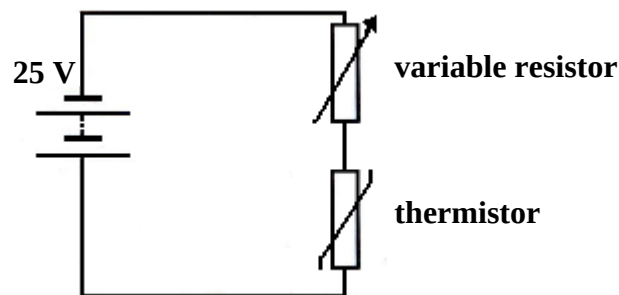


Figure 5

Question 8

Calculate the potential difference across the thermistor at 10°C, when the variable resistor is 1200 Ω.

 V

2 marks

Peter wants to use the circuit as an input switch to a heater. The heater will switch on when the input of the switch is 5 V or more.

Question 9

Where should the input of the heater be placed: across the thermistor or across the 1200 Ω resistor? Explain your answer.

3 marks

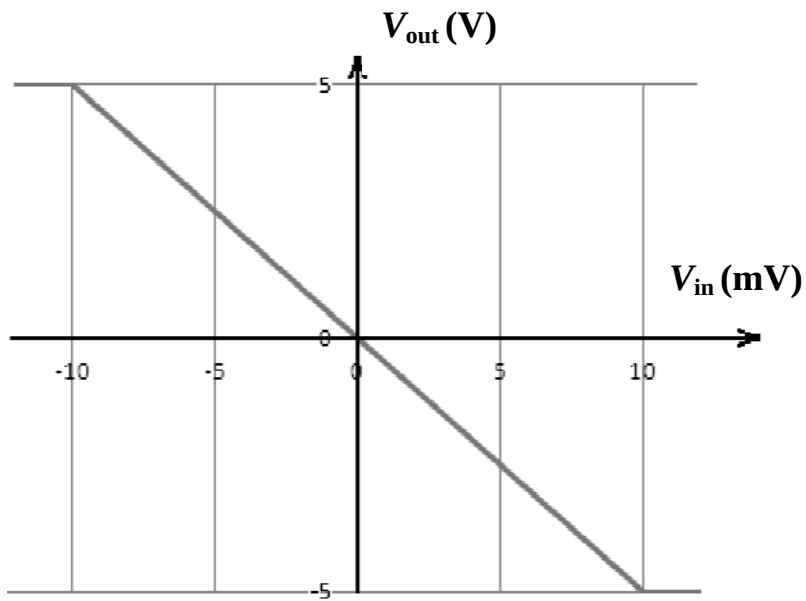
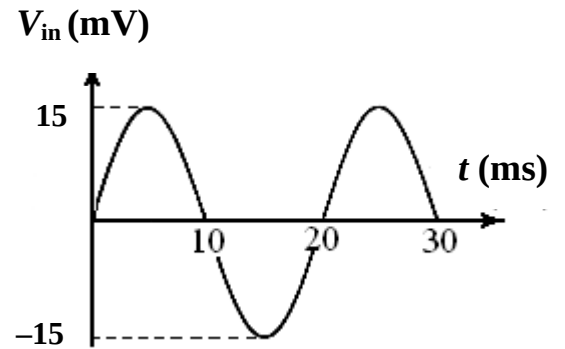
Question 10

Peter wants the heater to switch on when the temperature drops below 15°C. Should the variable resistor be increased or decreased to achieve this? Explain your answer.

3 marks

Question 11

A voltage amplifier has the characteristics shown in Figure 5. The input signal is displayed in Figure 6.

**Figure 5****Figure 6**

Draw the output signal and include values on your axes.



3 marks

END OF SECTION A

SECTION B**Instructions for Section B**

Choose **one** Detailed study.

Answer **all** the questions for the Detailed study you have chosen on the multiple-choice answer sheet, in pencil.

Write the name of the Detailed study you have chosen on the multiple-choice answer sheet.

Choose the response that is correct or that best answers the question.

A correct response scores 2 marks, and incorrect response scores 0 marks.

No marks are deducted for an incorrect response.

No marks will be given if more than one response is completed for a question.

You should take the value of g to be 10 m s^{-2} .

Detailed study

Einstein's special relativity

Page 26

Further electronics

Page 30

Materials and their use in structures

Page 36

Detailed study 1 – Einstein's special relativity

Question 1

When Einstein's equation $E = mc^2$ is applied to an electron with mass ' m ', which of the following is true?

- A. Electrons travelling at high speeds convert their energy into light, according to $E = mc^2$.
- B. Electrons have no energy since their mass is extremely small.
- C. Electrons have an energy of E , purely because of their existence.
- D. Einstein's relativity does not apply to quantum particles.

Question 2

The mass of an electron at rest is 9.1×10^{-31} kg according to Einstein's special theory of relativity. This is equivalent to an energy of:

- A. 0 J
- B. 9.1×10^{-31} J
- C. 4.1×10^{14} J
- D. 8.2×10^{-14} J

Question 3

An electron accelerator can accelerate an electron to a speed that will increase its mass by a factor of 22. As the electron leaves the accelerator, what is the value of the Lorentz factor?

- A. 11
- B. 22
- C. 44
- D. 220

The following information relates to questions 4 & 5.

A radioactive particle in an accelerator is found to have a half-life of 20 seconds when travelling at $0.8c$ and is observed by a stationary scientist.

Question 4

What is the particle's half-life in its own frame of reference?

- A. 20 s
- B. 12 s
- C. 40 s
- D. 10 s

Question 5

The radioactive particle is inside a detector of length 8 m. From the particle's frame of reference, how long is the detector?

- A. 4.8 m
- B. 4.0 m
- C. 8.0 m
- D. 13.3 m

Question 6

Which of the following quantities is *not* affected by travel at speed close to the speed of light when measured by both stationary and moving observers?

- A. speed of light
- B. mass in kg
- C. velocity
- D. length

Question 7

An electron of mass 9.1×10^{-31} kg is accelerated across a potential of 20 MeV. The speed of this electron in Newtonian physics would be

- A. $1.35 \times 10^7 \text{ m s}^{-1}$
- B. $2.65 \times 10^7 \text{ m s}^{-1}$
- C. $3.00 \times 10^8 \text{ m s}^{-1}$
- D. $2.65 \times 10^9 \text{ m s}^{-1}$

Question 8

At the Synchrotron an electron is accelerated to a speed of $2.5 \times 10^8 \text{ m s}^{-1}$. The mass of such an electron measured by an observer would be

- A. $9.1 \times 10^{-31} \text{ kg}$
- B. $3.2 \times 10^{-30} \text{ kg}$
- C. $1.65 \times 10^{-30} \text{ kg}$
- D. $9.1 \times 10^{-30} \text{ kg}$

The following information relates to questions 9 & 10.

A neutron of rest mass 1.675×10^{-27} kg travels at $0.2c$.

Question 9

The momentum of the neutron would be

- A. 8.350×10^{-27} kg m s⁻¹
- B. 3.350×10^{-28} kg m s⁻¹
- C. 1.675×10^{-19} kg m s⁻¹
- D. 1.026×10^{-19} kg m s⁻¹

Question 10

The kinetic energy of the neutron would be

- A. 8.35×10^{-12} J
- B. 3.10×10^{-12} J
- C. 3.35×10^{-12} J
- D. 1.69×10^{-12} J

END OF DETAILED STUDY 1
SECTION B –continued
TURN OVER

Detailed study 2 – Further electronics

Question 1

An audio amplifier operates on a DC power supply, but the supply has an AC ripple component. The magnitude of the ripple voltage is best measured using

- A. an oscilloscope
- B. an ammeter
- C. a voltmeter
- D. a variable resistor

The following information relates to questions 2–4.

A regulated DC power supply is shown in Figure 1 below. The input voltage is from 6 V RMS AC supply. The AC power supply has an input supply of 240 V RMS.

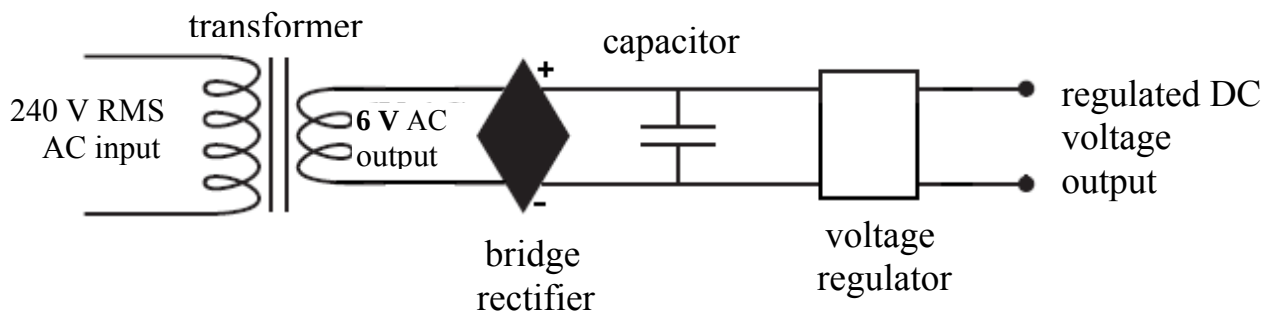


Figure 1

Question 2

If the primary side of the transformer has 120 turns, how many turns are there on the secondary side of the transformer?

- A. 40
- B. 3
- C. 6
- D. 24

Question 3

If the current flowing in the primary coil is 0.1 A, what is the power supplied to the bridge rectifier, assuming the transformer is ideal?

- A. 12 W
- B. 6 W
- C. 18 W
- D. 24 W

Question 4

What is the peak current supplied to the bridge rectifier?

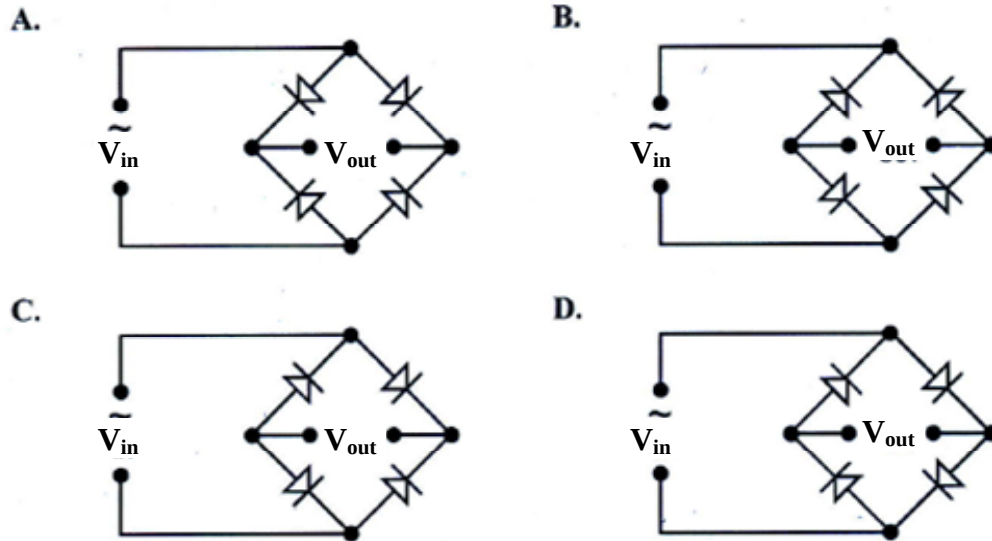
- A. 0.143 A
- B. 1.43 A
- C. 5.66 A
- D. 2.83 A

The following information relates to Questions 5 & 6

A full-wave bridge rectifier is to be used in a circuit that produces DC from an AC input.

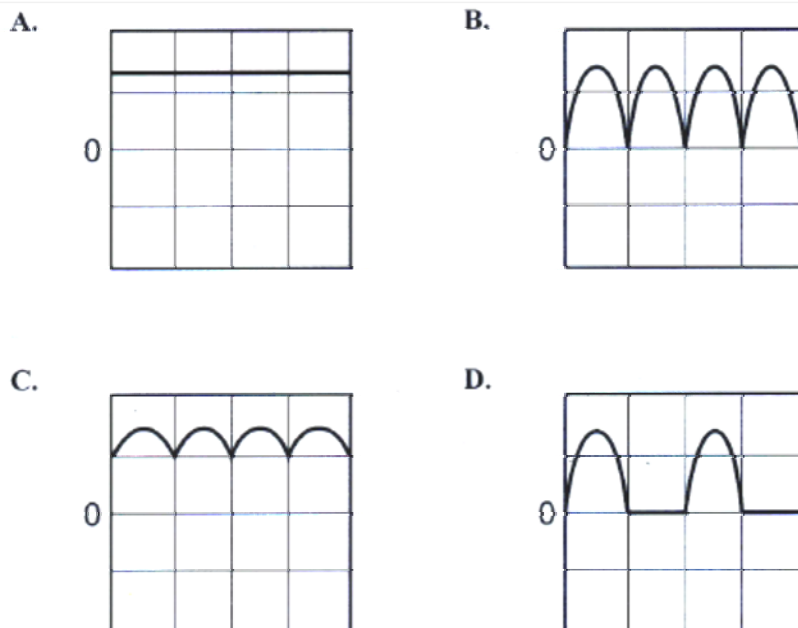
Question 5

Which of the following circuits would be most suitable?



Question 6

With the rectifier correctly connected and functioning, which of the following signals would be observed if an oscilloscope was connected across the output (V_{out}) of the bridge rectifier?



The following information relates to Questions 7 & 8.

Malcolm uses an oscilloscope to test a circuit. He connects the oscilloscope to an AC signal generator. The vertical scale is set on 4 V cm^{-1} , and the horizontal scale on 40 ms cm^{-1} . He observes the display on the oscilloscope, as shown in Figure 2.

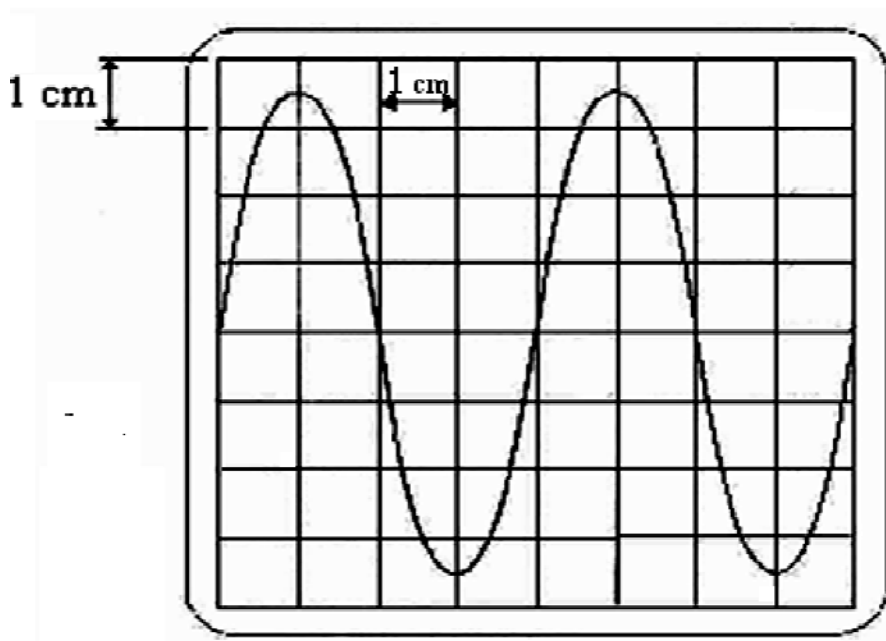


Figure 2

Question 7

Which of the following best gives the correct value of the peak-to-peak voltage of the AC signal generator?

- A. 14 V
- B. 20 V
- C. 7 V
- D. 28 V

Question 8

Which one of the following best gives the frequency from the signal generator?

- A. 6.25 Hz
- B. 4 Hz
- C. 16 Hz
- D. 13.5 Hz

The following information relates to Questions 9 & 10.

Nabilla studies the voltage–current characteristics of a zener diode as shown in Figure 3.

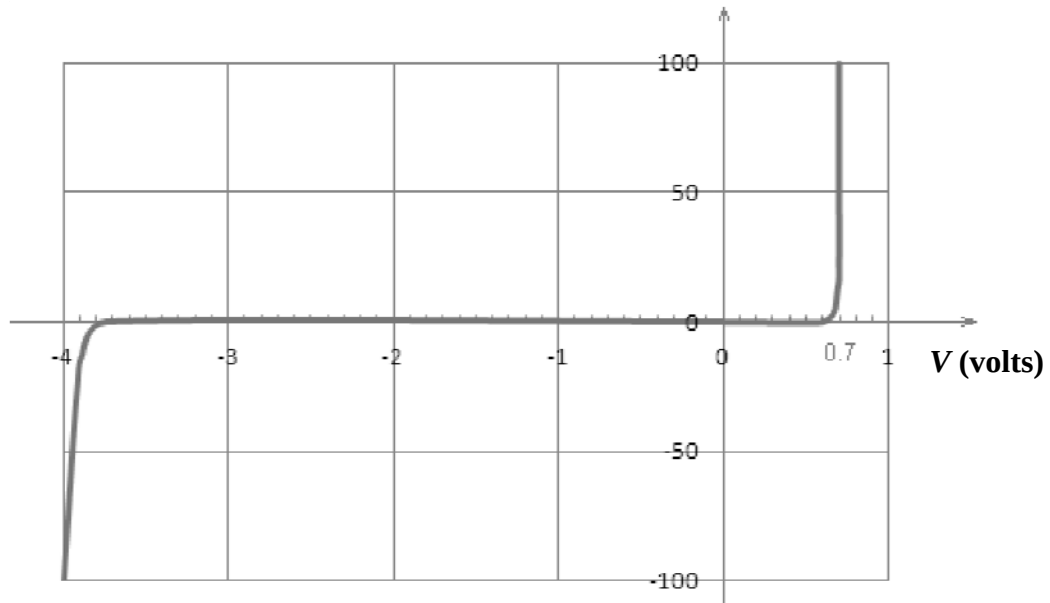


Figure 3

Nabilla places the zener diode in the circuit as shown in Figure 4.

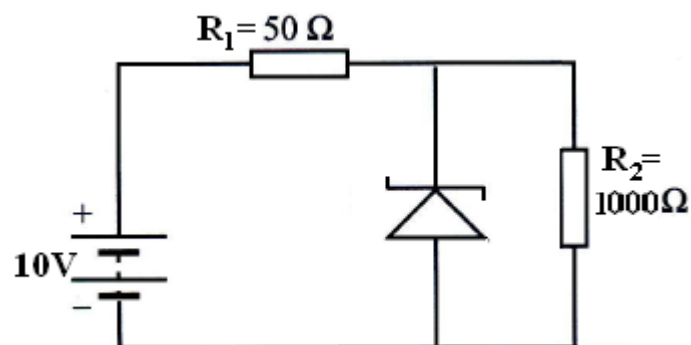


Figure 4

Question 9

The voltage Nabilla measured across R_1 is?

- A. 4 V
- B. 6 V
- C. 0.6 V
- D. 12 V

Question 10

What will be the current across the zener diode?

- A.** 0.105 A
- B.** 0.011 A
- C.** 0.116 A
- D.** 0.120 A

END OF DETAILED STUDY 2
SECTION B – continued
TURN OVER

Detailed study 3 – Materials and their use in structures

The following information relates to Questions 1–5.

A group of students are testing the tensile strength of three different materials. Each material has a length of 5.00 m exactly when no tension is applied. The materials are labelled as 1, 2 and 3 on the graph below (Figure 1). The letter B represents the point where the material breaks.

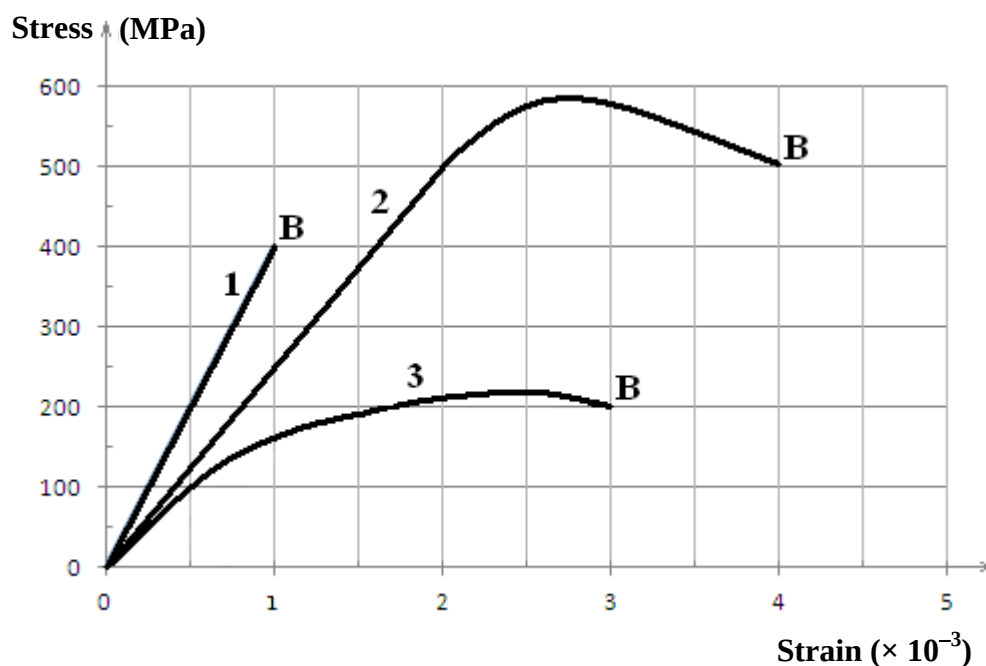


Figure 1

Question 1

Which of the following is the best estimate of Young's modulus for material 2?

- A. $2.5 \times 10^{11} \text{ N m}^{-2}$
- B. $5 \times 10^6 \text{ N m}^{-2}$
- C. $2 \times 10^{-3} \text{ N m}^{-2}$
- D. $4 \times 10^{-9} \text{ N m}^{-2}$

Question 2

Material 1 breaks when the force applied to it is $1.5 \times 10^5 \text{ N}$. This indicates that it would have a cross sectional area of

- A. $4.50 \times 10^{-3} \text{ m}^2$
- B. $6.00 \times 10^{-3} \text{ m}^2$
- C. $3.75 \times 10^{-4} \text{ m}^2$
- D. $2.50 \times 10^{-4} \text{ m}^2$

Question 3

What is the length of material 1 when it breaks?

- A. 5.500 m
- B. 5.005 m
- C. 5.050 m
- D. 4.995 m

Question 4

Comparing the three materials, which statement is true regarding strength and toughness?

- A. 1 is the strongest and 3 is the toughest.
- B. 1 is the toughest and 2 is the strongest.
- C. 2 is the toughest and the strongest.
- D. 2 is the toughest and 3 is the strongest.

Question 5

The students further investigate material 3, which has a cross-sectional area of $2.5 \times 10^{-5} \text{ m}^2$ and length of 5 m. Which of the following best gives the energy stored in the sample just before it breaks?

- A. 62.5 J
- B. 25.5 J
- C. 35.5 J
- D. 12.5 J

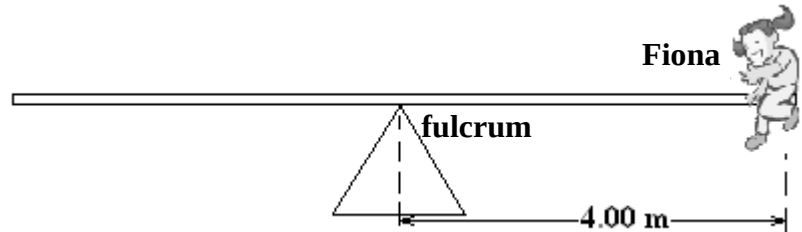
The following information relates to Questions 6 & 7.

Jack, with a mass of 80 kg, and his friend Fiona, with a mass of 50 kg, are playing on a see-saw.

Question 6

If Fiona sits at 4.00 m from the pivot point, where should Jack sit to balance the see-saw?

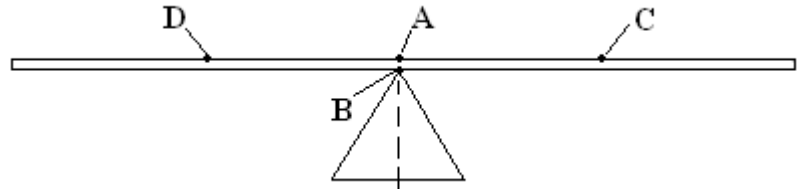
- A. 0.63 m left of fulcrum
- B. 1.6 m left of fulcrum
- C. 2.0 m left of fulcrum
- D. 2.5 m left of fulcrum



Question 7

The see-saw is made of concrete. Where is the see-saw most likely to fracture?

- A. point A
- B. point B
- C. point C
- D. point D



The following information relates to Questions 8 & 9.

A sign of weight 50 N hangs from a beam, which has a weight of 10 N and is supported by a strut (ignore weight) as shown in Figure 2.

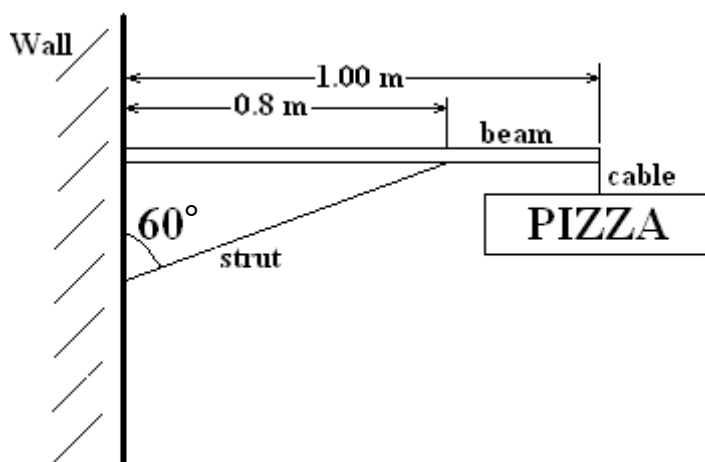


Figure 2

Question 8

The tension in the cable holding the pizza sign up is best estimated as

- A. 50 N
- B. 60 N
- C. 25 N
- D. 43 N

Question 9

The compressive force acting on the strut is

- A. 1.4×10^2 N
- B. 60 N
- C. 2.6×10^2 N
- D. 6.8×10^2 N

Question 10

A shear force is best defined as

- A. a stretching force where molecules are pulled apart
- B. a compressive force where molecules are squashed
- C. a twisting force where molecule layers slide over each other
- D. a compressive force at the top and tensile stress at the bottom of a material

END OF QUESTION AND ANSWER BOOK