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

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	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

Area of study 1 – Motion in one and two dimensions

The following information relates to Questions 1–4.

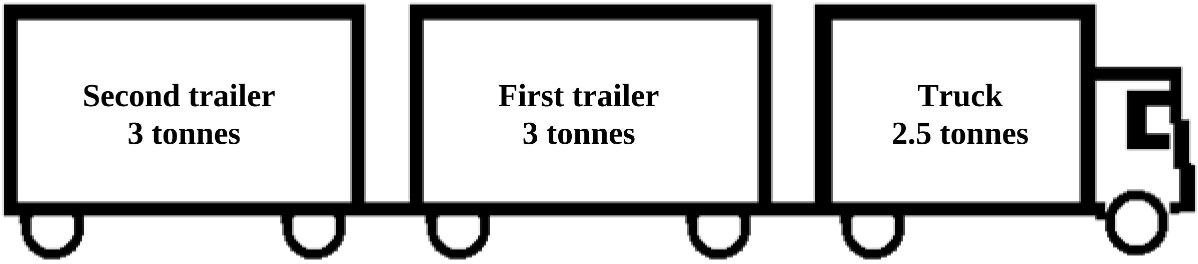

Figure 1

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.

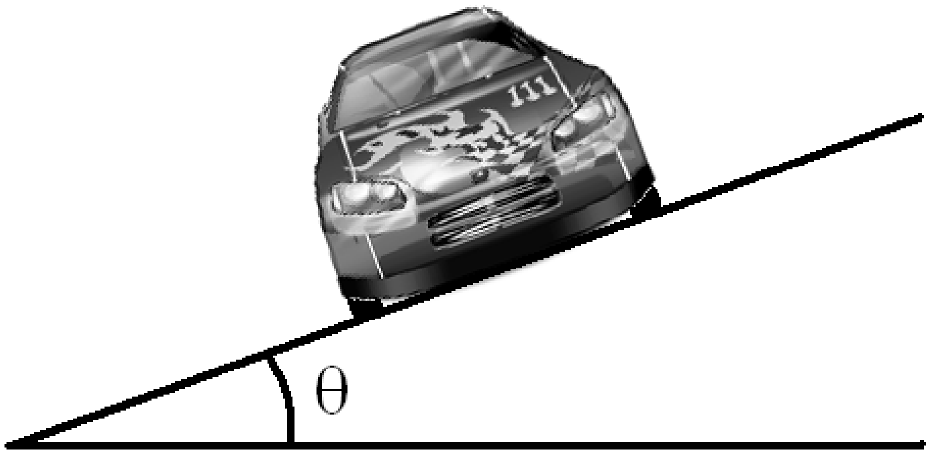

Figure 2

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.

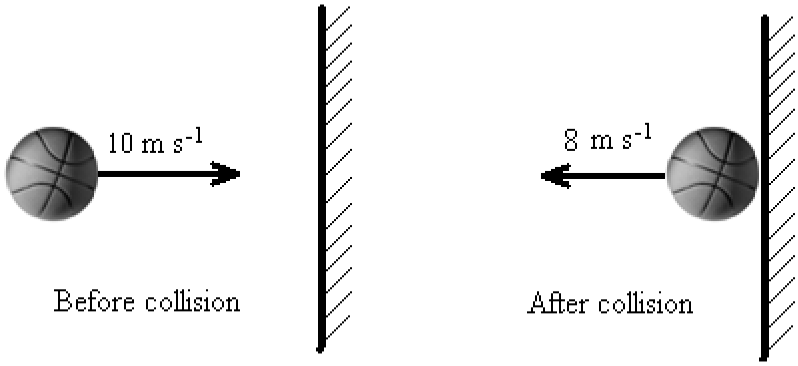

Figure 3

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).

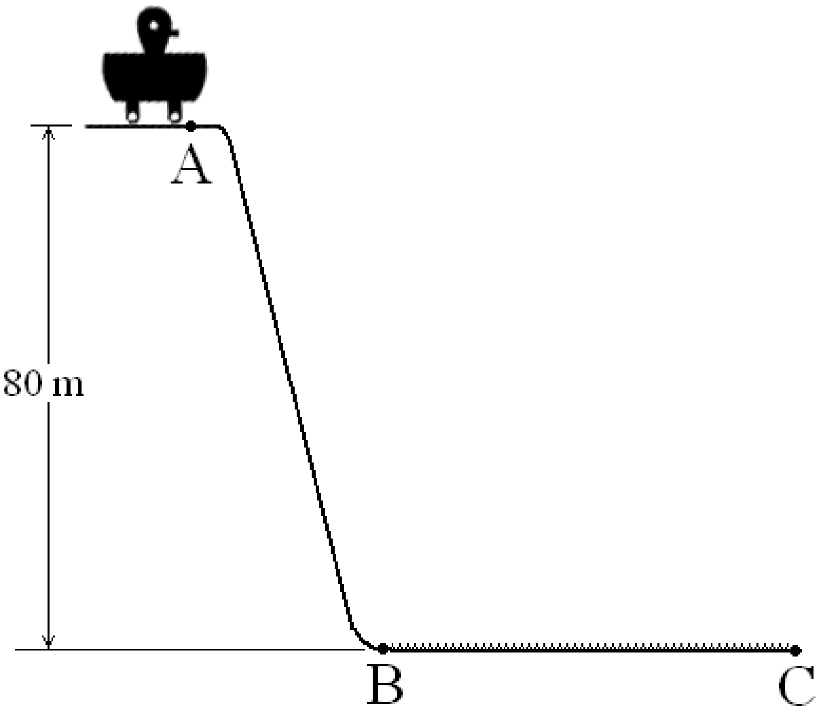

Figure 4

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.

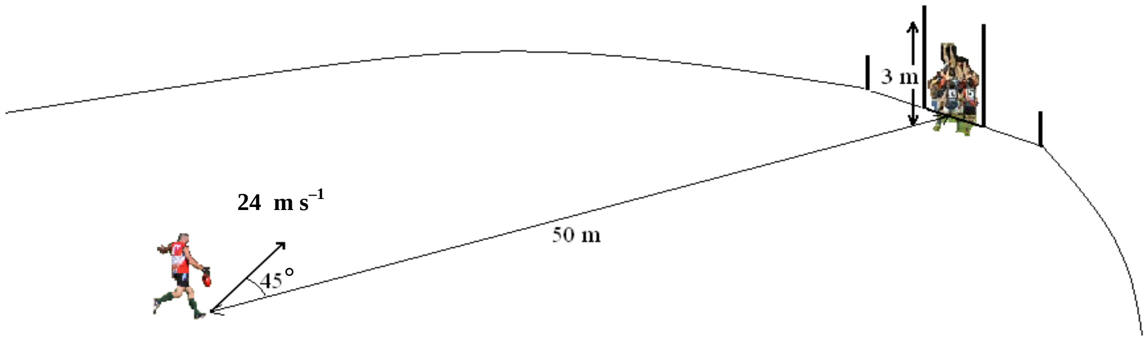

Figure 5

m	Yes / No

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.

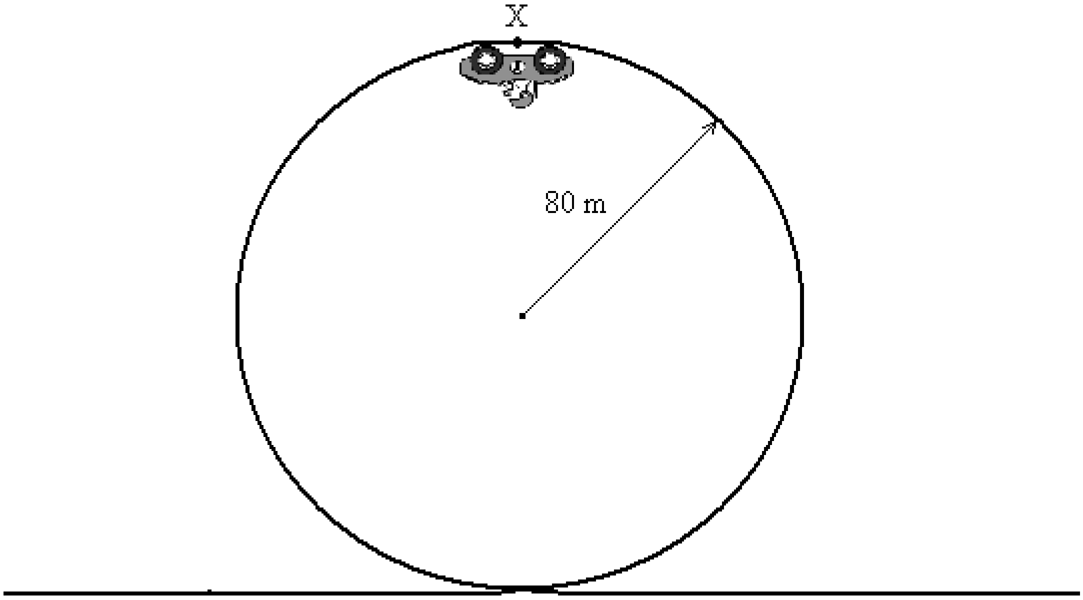


Figure 6

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.

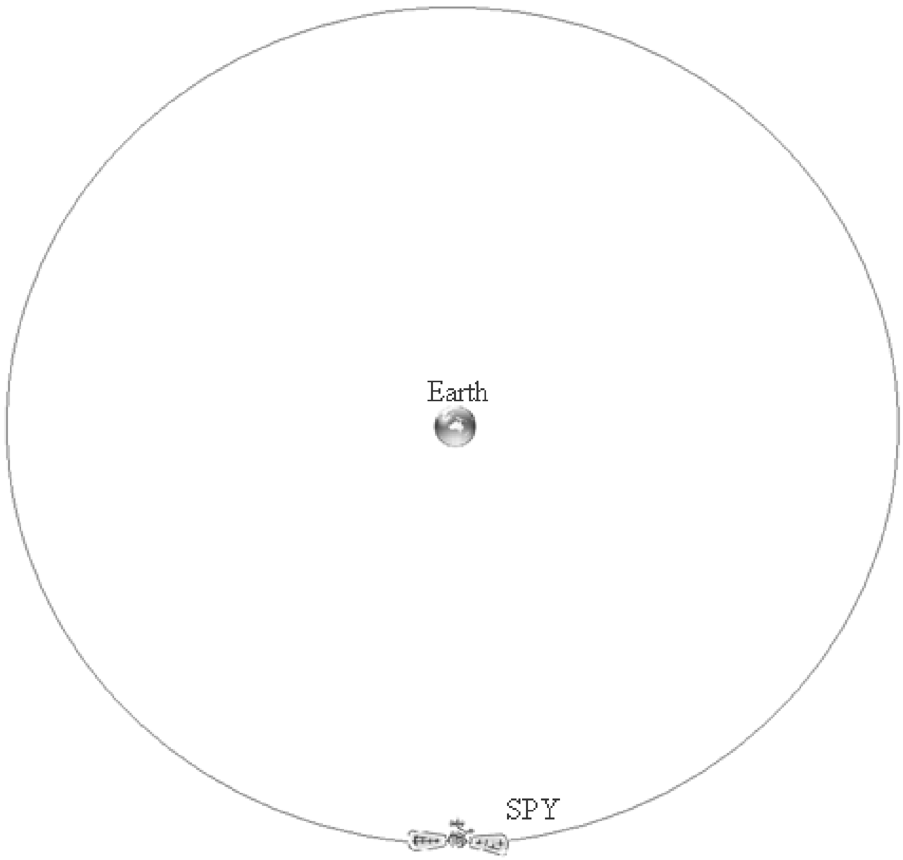


Figure 7

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

Area of study 2 – Electronics and photonics

The following information relates to Questions 1–4.

Luke sets up the circuit shown in Figure 1.

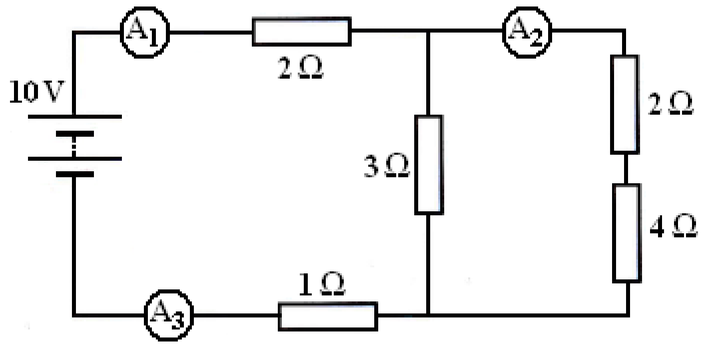


Figure 1

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 Ω resistor?

V

2 marks

Question 4

What is the power across the 3 Ω resistor?

W

2 marks

The following information relates to Questions 5 & 6.

Quang sets up the circuit shown in Figure 2 using two identical LEDs and an 18 Ω resistor.
The *I–V* characteristics of the diodes are shown in Figure 3.

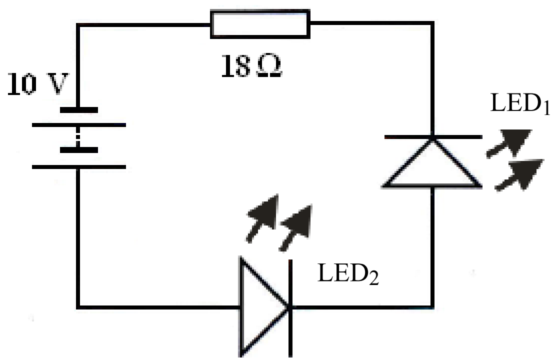


Figure 2

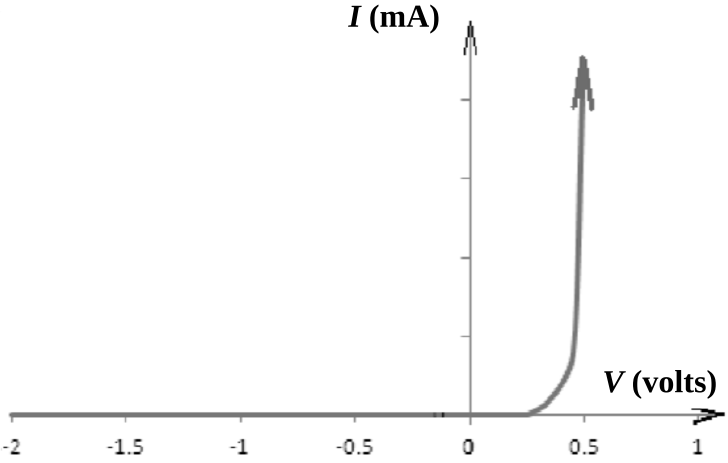


Figure 3

Question 5

What is the power rating across LED_1? Show your working.

W

3 marks

Question 6

Quang decides to reverse LED_1 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.

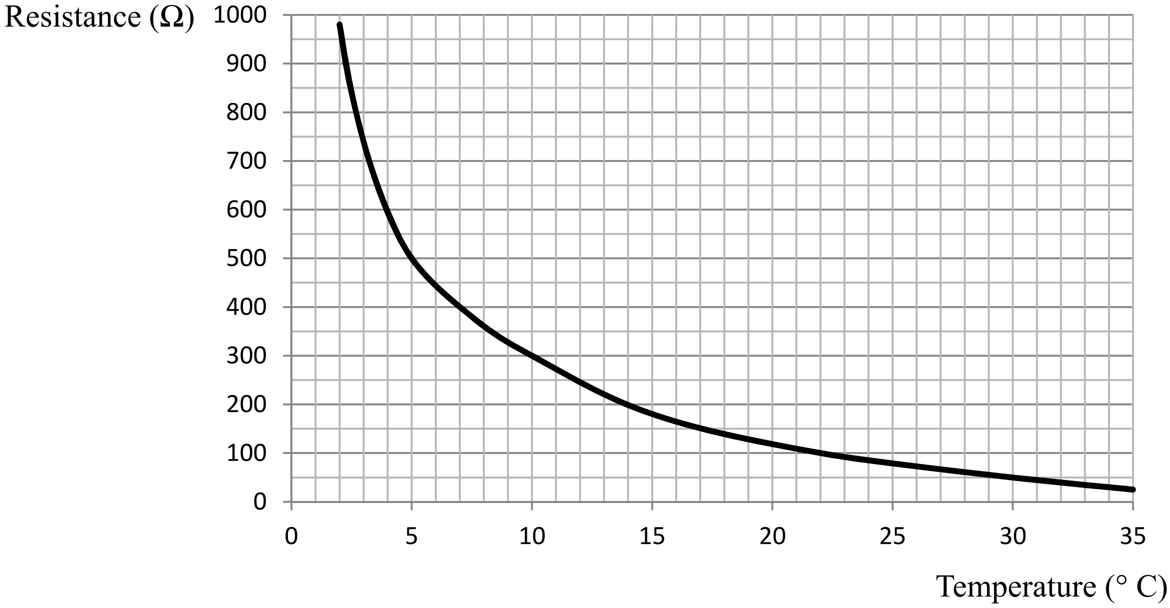


Figure 4

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.

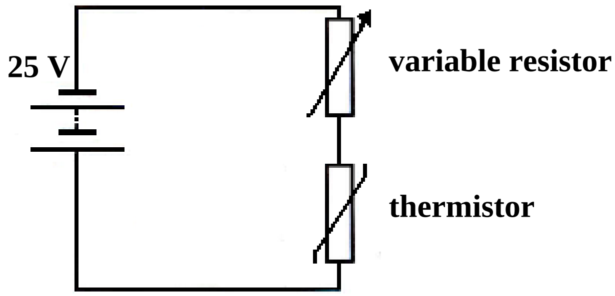


Figure 5

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.

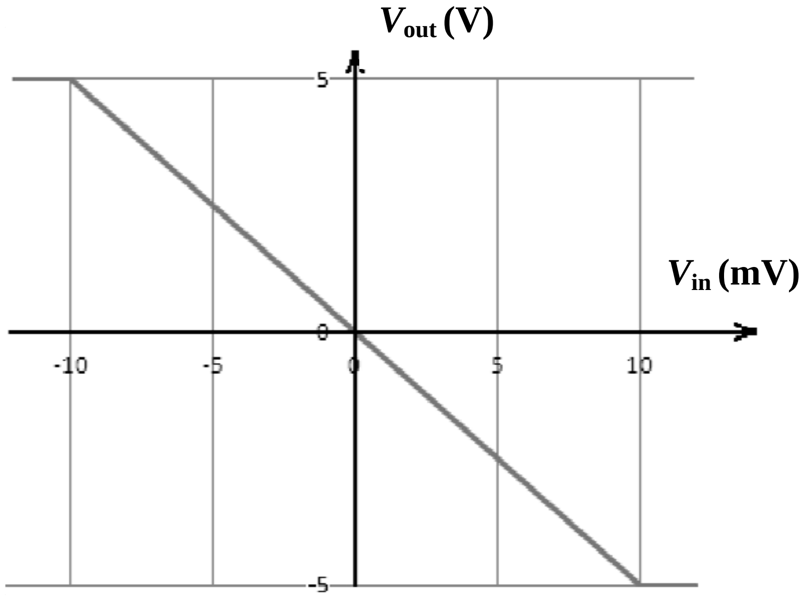


Figure 5

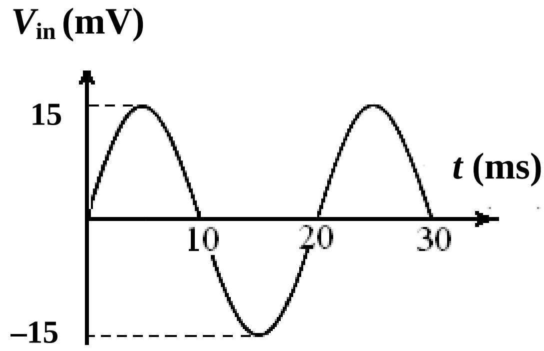
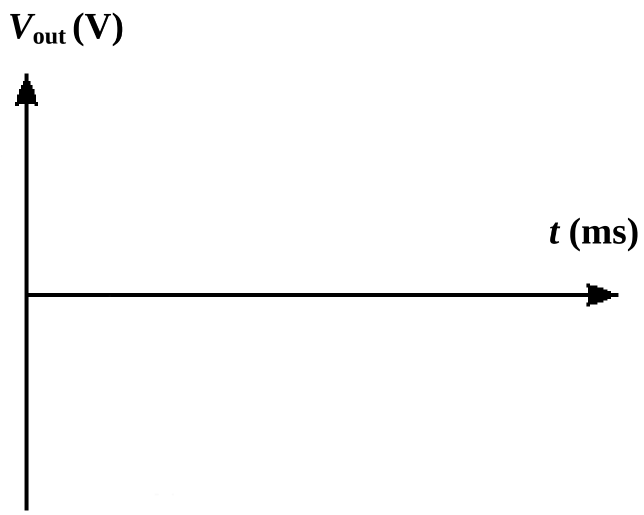


Figure 6

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

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. 1.35×10^{7} m s^{-1}

B. 2.65×10^{7} m s^{-1}

C. 3.00×10^{8} m s^{-1}

D. 2.65×10^{9} m s^{-1}

Question 8

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

A. 9.1×10^{-31} kg

B. 3.2×10^{-30} kg

C. 1.65×10^{-30} kg

D. 9.1×10^{-30} kg

The following information relates to questions 9 & 10.

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

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

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.

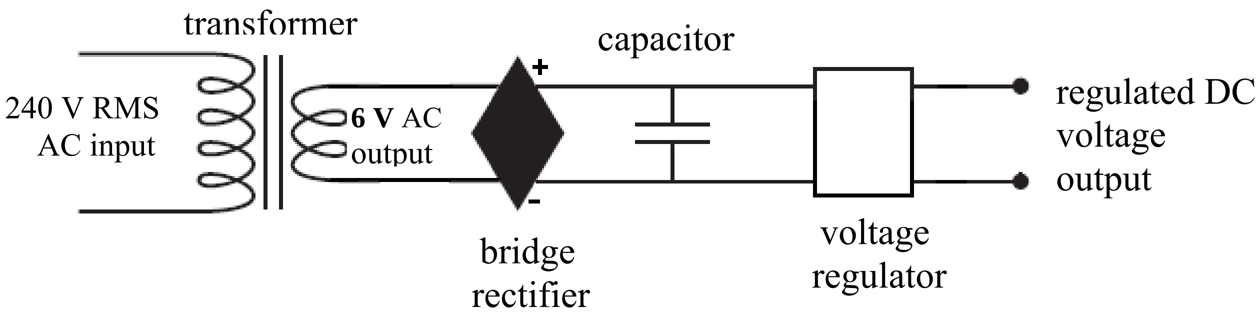


Figure 1

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

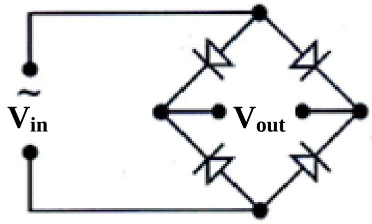
The following information relates to Questions 5 & 6

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

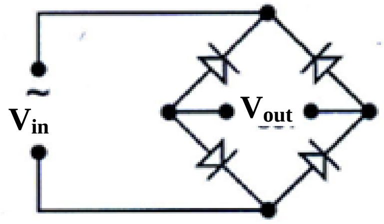
Question 5

Which of the following circuits would be most suitable?

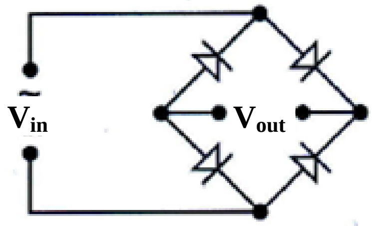
A.



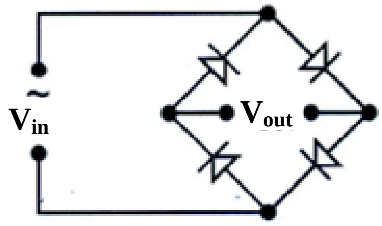
B.



C.



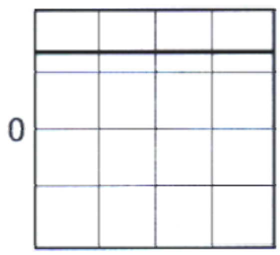
D.



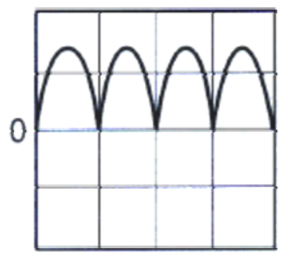
Question 6

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?

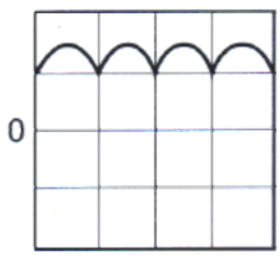
A.



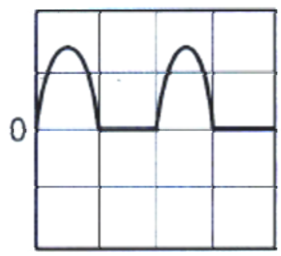
B.



C.



D.



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.

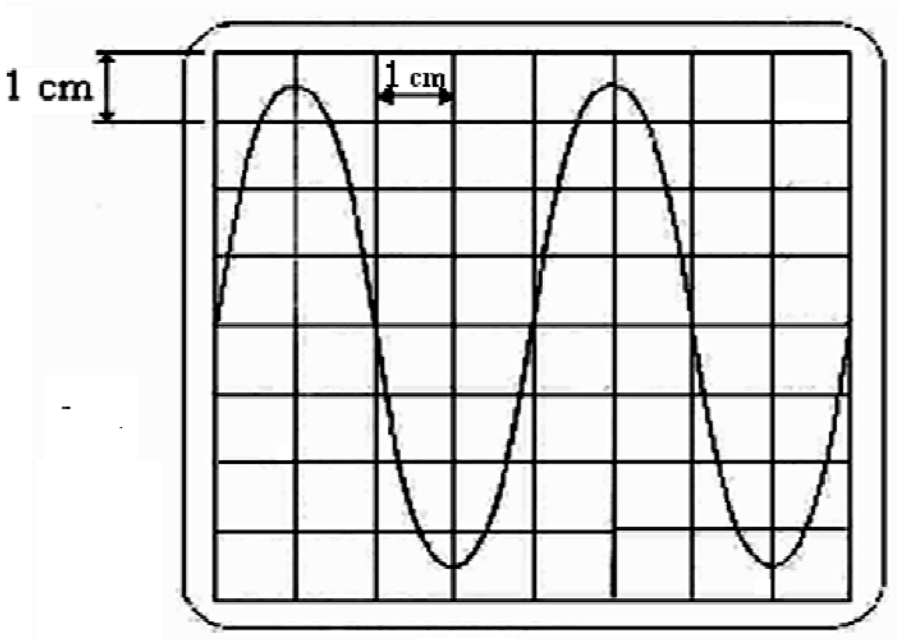


Figure 2

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.

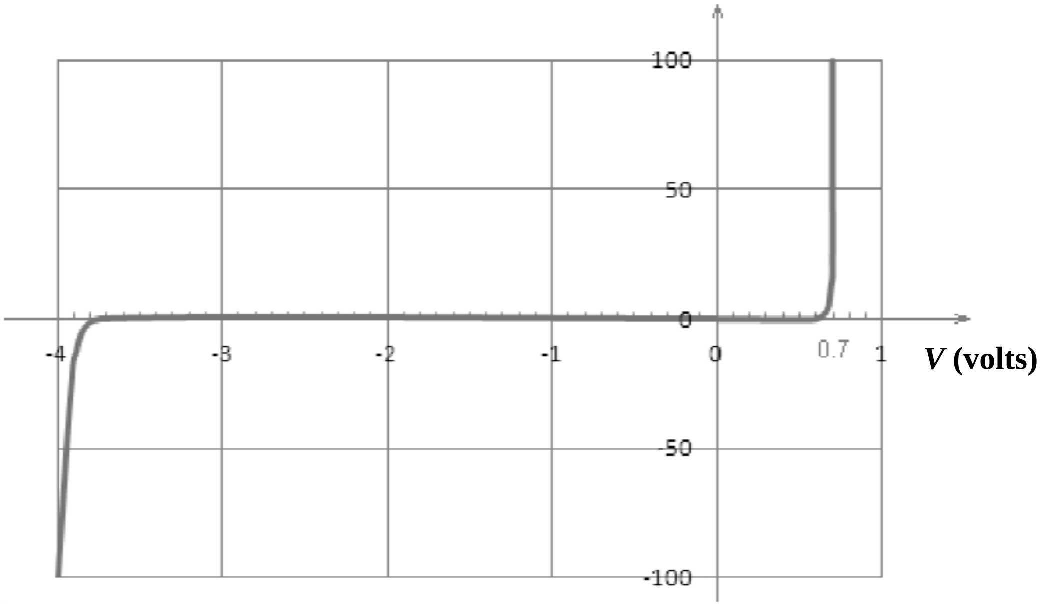


Figure 3

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

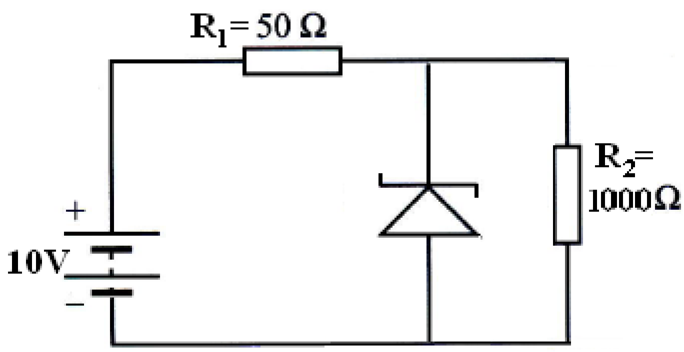


Figure 4

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

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.

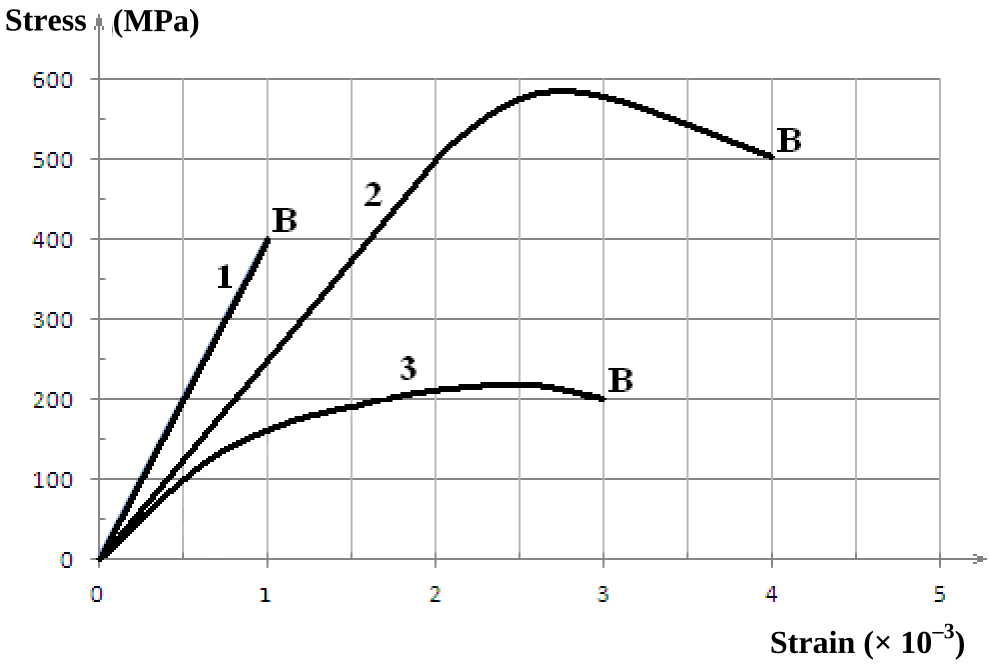


Figure 1

Question 1

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

A. 2.5×10^{11} N m^{-2}

B. 5×10^{6} N m^{-2}

C. 2×10^{-3} N m^{-2}

D. 4×10^{-9} N m^{-2}

Question 2

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

A. 4.50×10^{-3} m^{2}

B. 6.00×10^{-3} m^{2}

C. 3.75×10^{-4} m^{2}

D. 2.50×10^{-4} 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 2.5×10^{-5} 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

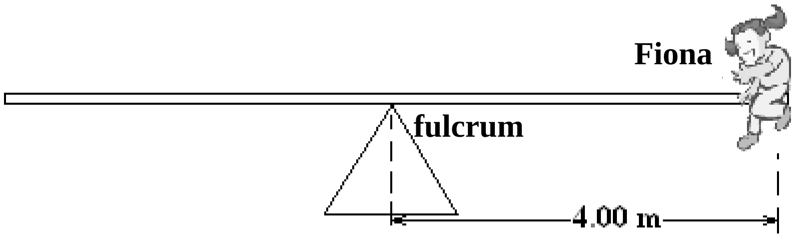
If Fiona sits at 4.00 m from the pivot point, where should Jack sit to balance the see-saw?

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

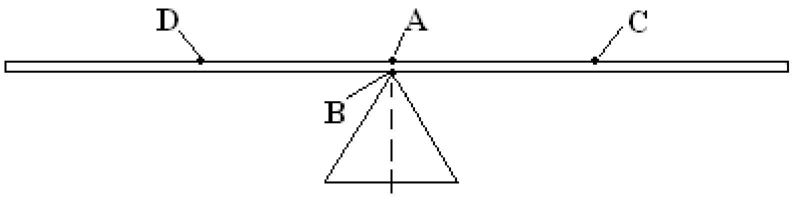
The see-saw is made of concrete. Where is the see-saw most likely to fracture?

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.

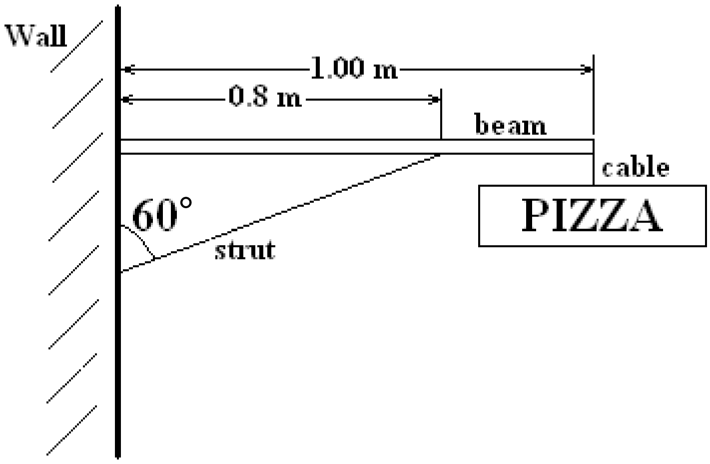


Figure 2

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