VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

Victorian Certificate of Education 2012

SUPERVISOR TO ATTACH PROCESSING LABEL HERE

STUDENT NUMBER

Figures

Words

Letter

PHYSICS

Written examination 1

Tuesday 12 June 2012

Reading time: 11.45 am to 12.00 noon (15 minutes)

Writing time: 12.00 noon to 1.30 pm (1 hour 30 minutes)

QUESTION AND ANSWER BOOK

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	8	8	40
2. Electronics and photonics	5	5	26
B – Detailed studies			
1. Einstein's special relativity **OR**	12	12	24
2. Materials and their use in structures **OR**	12	12	24
3. Further electronics	12	12	24
			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 one 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 43 pages. A formula sheet.
- Answer sheet for multiple-choice questions.

Instructions
- Write your **student number** in the space provided above on this page.
- Check that your **name** and **student number** as printed on your answer sheet for multiple-choice questions are correct, **and** sign your name in the space provided to verify this.
- Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.
- All written responses must be in English.

At the end of the examination
- Place the answer sheet for multiple-choice questions inside the front cover of this book.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.

SECTION A – Core

Instructions for Section A

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

Where an answer box has a unit printed in it, give your 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.

Area of study 1 – Motion in one and two dimensions

Question 1

A spring is resting against a wall. The spring is compressed by a distance of 8.0 cm from its uncompressed length. Jemima holds a block of mass 1.2 kg stationary against the compressed spring as shown in Figure 1.

Figure 1

Jemima releases the block and it slides to the right on a frictionless surface. It leaves the spring with a kinetic energy of 5.4 J and slides at constant speed as shown in Figure 2.

Figure 2

a. Calculate the speed of the block as it leaves the spring.

m s^{-1}

1 mark

b. Calculate the work done by the spring on the block.

J

1 mark

c. Calculate the spring constant, *k*, of the spring. Assume that the spring obeys Hooke's law.

$N\ m^{-1}$

2 marks

d. Calculate the magnitude of the total impulse that the spring gives to the 1.2 kg block by the time it leaves the spring.

N s

2 marks

Question 2

A 1.2 kg block moves to the right along the frictionless surface and collides elastically with a stationary block of mass 2.4 kg as shown in Figure 3.

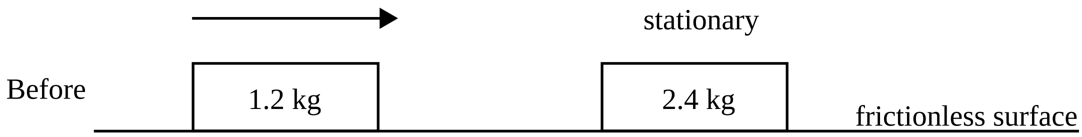


Figure 3

After the elastic collision, the 1.2 kg block moves to the left as shown in Figure 4.

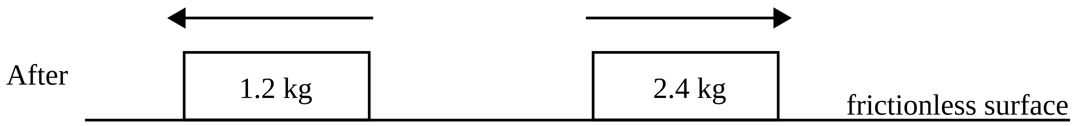


Figure 4

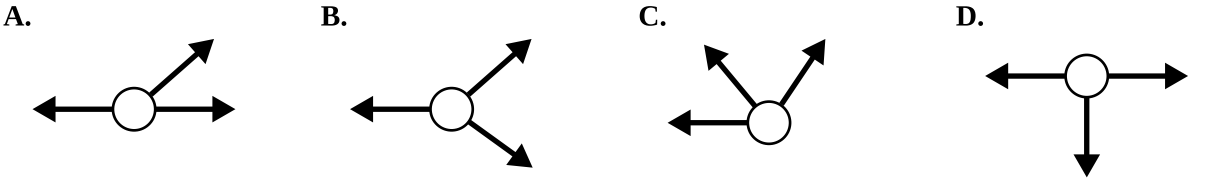
After the collision, the momentum of the 2.4 kg block is **greater** than the momentum that the 1.2 kg block had before the collision.

Explain why the greater momentum of the 2.4 kg block is consistent with the principle of conservation of momentum.

3 marks

Question 3

A metal ring is to be held stationary by three forces that are all pulling on the ring. All the forces are greater than zero, but their magnitudes are not given. Possible directions of the forces on the ring are shown in the arrangements in Figure 5. Only one of these arrangements can hold the ring stationary.



Not to scale

Figure 5

Identify which one of the arrangements (**A.–D.**) shown in Figure 5 could hold the metal ring stationary and explain the reasons for your answer.

2 marks

Question 4

Two metal spheres hang from the ceiling as shown in Figure 6. Cable A runs between the ceiling and the upper sphere of mass 2.0 kg. Cable B runs between the 2.0 kg sphere and the 1.0 kg sphere. Assume that the cables have no mass.

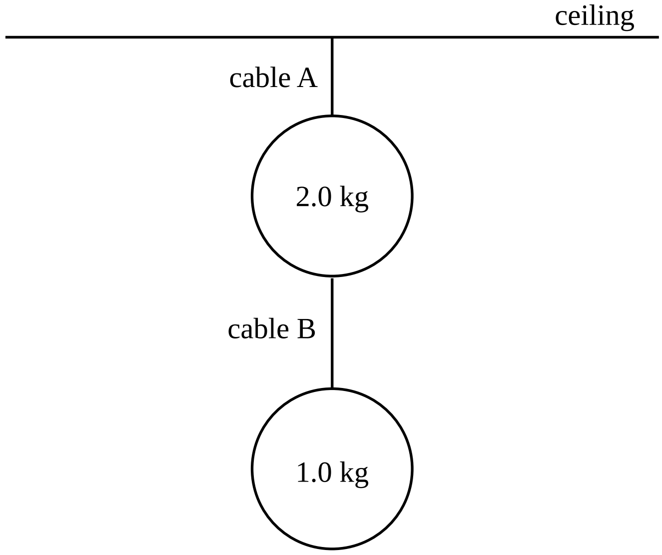


Figure 6

a. State the force (magnitude and direction) that cable A applies to the 2.0 kg sphere.

Force magnitude	N
Force direction	

2 marks

b. Newton's third law is sometimes stated as 'To every action there is an equal and opposite reaction'. If the weight (the gravitational force by Earth) of the 2.0 kg sphere is taken as the 'action' force, identify the corresponding 'reaction' force and give its direction.

2 marks

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Question 5

A truck is dragging two logs along level ground in a straight line. The mass of each log is 600 kg and each log experiences a constant retarding friction force of 400 N with the ground.

The connections between the truck and the logs are made with ropes that have a breaking force of 2400 N.

T_1 and T_2 are the tensions in the ropes as shown in Figure 7. The truck and the logs are moving towards the **left** in Figure 7.

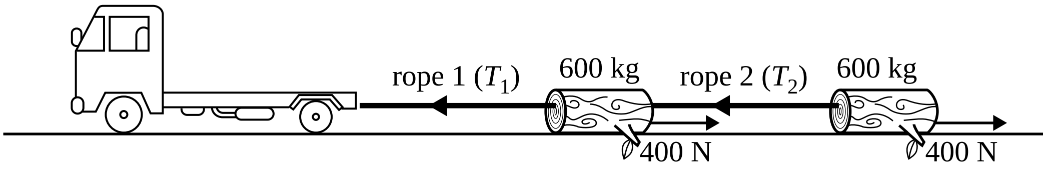

Figure 7

a. Calculate the magnitude of T_1 when the truck is driving at a constant speed.

N

1 mark

b. The truck then accelerates at a rate of 0.50 m s^{-2}. Calculate the magnitude of T_2.

N

2 marks

c. At a point in time, the driver observes that the speed of the truck is 4.0 m s^{-1}. The truck then keeps accelerating at 0.50 m s^{-2} for another 20 m. Calculate the speed of the truck at the end of the 20 m.

m s^{-1}

2 marks

d. The ropes have a breaking force of 2400 N. Rope 1 connects the truck to the front log and rope 2 connects the two logs.

The truck, still on level ground, increases its acceleration until one of the ropes is about to break. Identify which rope is about to break, and calculate the magnitude of the acceleration of the truck and the logs at this instant.

Rope ____________________

$m\ s^{-2}$

3 marks

Question 6

Fred throws a ball at an angle of 60° to the horizontal so that it rises to a vertical distance of 15 m above the point from which he throws it. The landing point is at the same height as the starting point as shown in Figure 8. Ignore air resistance.

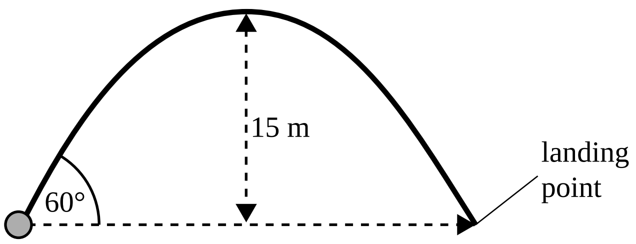

Figure 8

a. Calculate the speed at which the ball leaves Fred's hand.

$m\ s^{-1}$

3 marks

b. Calculate the time of flight of the ball.

s

2 marks

Question 7

Kim has attached a ball of mass 0.20 kg to a piece of string of length 1.8 m and is making it move in a **horizontal** circle on a frictionless surface. Kim gradually increases the speed, *v*, of the ball. The situation is shown from above in Figure 9. The string has a breaking force of 4.0 N.

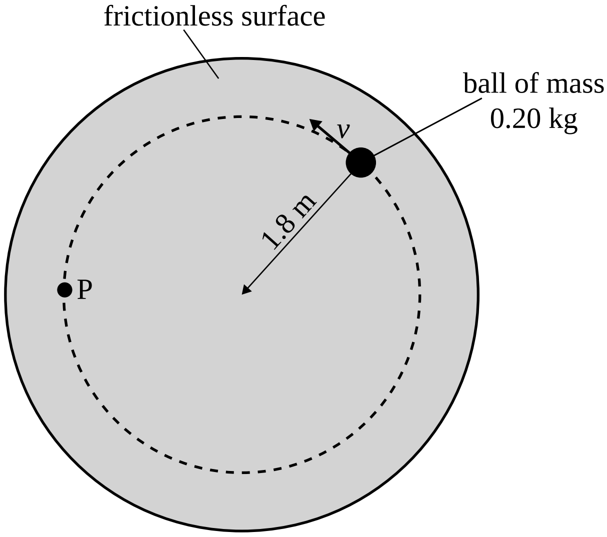

Figure 9

a. Calculate the greatest speed the ball can reach before the string breaks.

m s^{-1}

2 marks

b. When the ball is at position P, the string breaks. Draw an arrow on Figure 9 from point P, indicating the direction in which the ball travels **immediately after** the string breaks.

1 mark

c. On another occasion, Kim swings the same ball of mass of 0.20 kg in a **vertical** circle at constant speed. She uses a much stronger string, which does not break.

She notices that the tension in the string is greater at the bottom of the circle than it is at the top of the circle.

Explain why the tension at the bottom is greater than the tension at the top. You may include a diagram as part of your explanation.

3 marks

Question 8

a. Before the spacecraft *Apollo 11* landed on the Moon, it travelled around the Moon in an orbit with a period of 2.0 hours.

Calculate the **height** of *Apollo 11* above the Moon's surface during its orbit of the Moon. Take the orbit to be circular.

Take $G = 6.67 \times 10^{-11}$ m^3 kg^{-1} s^{-2}; $M_{moon} = 7.36 \times 10^{22}$ kg; $R_{moon} = 1.74 \times 10^6$ m.

m

4 marks

b. Explain the terms 'weightlessness' and 'apparent weightlessness', and identify which term best applies to the astronauts in *Apollo 11* during its orbit of the Moon.

2 marks

Area of study 2 – Electronics and photonics

Question 1

A resistor network is shown in Figure 1. All resistors have a value of 150 Ω.

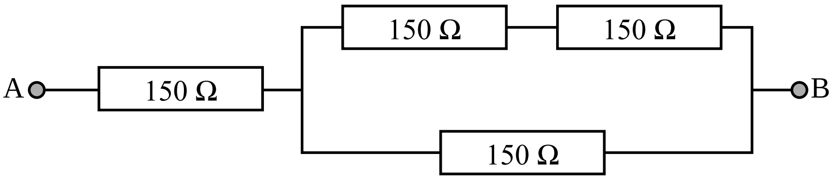

Figure 1

Calculate the resistance of the network between points A and B.

Ω

2 marks

Question 2

Students are using LEDs to make model traffic lights. They have two types of diodes, D1 (red) and D2 (green). The characteristics of each are shown in Figure 2.

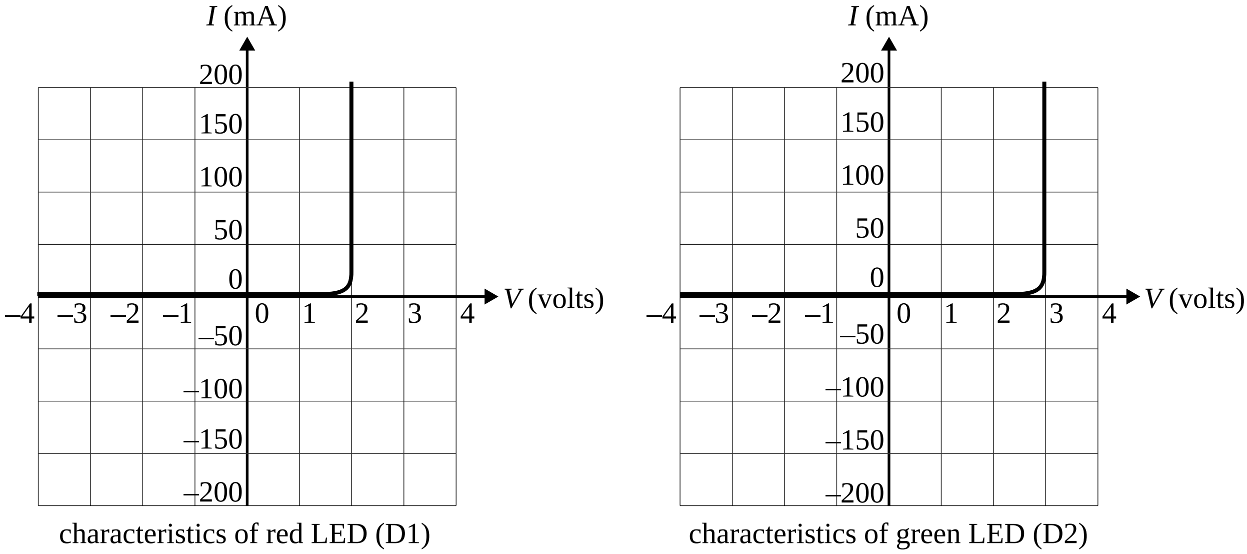

Figure 2

Using D1 only, they set up the circuit shown in Figure 3.

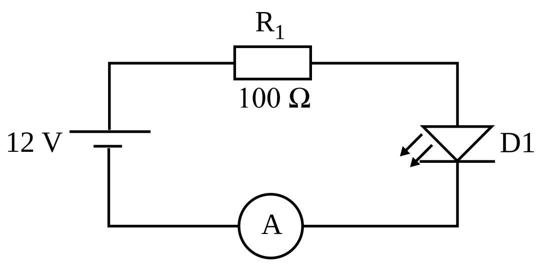

Figure 3

a. Calculate the value of the current measured by the ammeter.

mA

2 marks

Using both D1 and D2, they now set up the circuit shown in Figure 4.

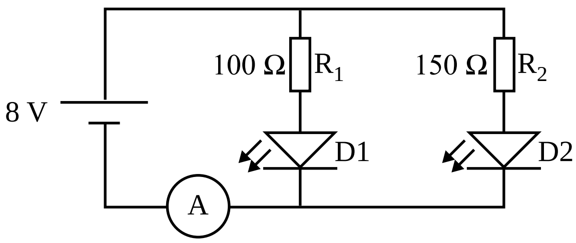

Figure 4

b. Calculate the value of the voltage across R_2.

V

2 marks

c. Calculate the value of the current through the ammeter in Figure 4.

mA

2 marks

d. The diodes are now tested independently to determine how effectively they convert electrical energy into light energy.

Each diode is supplied with a suitable voltage and a current of 100 mA. The power **output** of the light emitted from D1 is measured as 150 mW, and the power **output** of the light emitted from D2 is measured as 200 mW.

Use calculations to determine which of the diodes converts the largest fraction of its electrical input energy into output light energy. Show your working and give reasons for your answer.

4 marks

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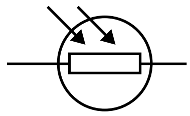
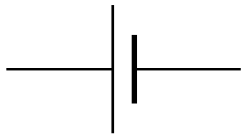
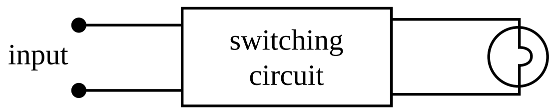
Question 3

The equipment shown in the table below is provided to students in a school laboratory. Symbols for the components are shown.

One light-dependent resistor	
One 10 V battery	
Resistors with values that are chosen by the students	
One switching circuit that turns on a light when the voltage across the input is **greater** than 6.0 V. This switching circuit has a very high input resistance.	

The characteristics of the light-dependent resistor (LDR) are shown in Figure 5.

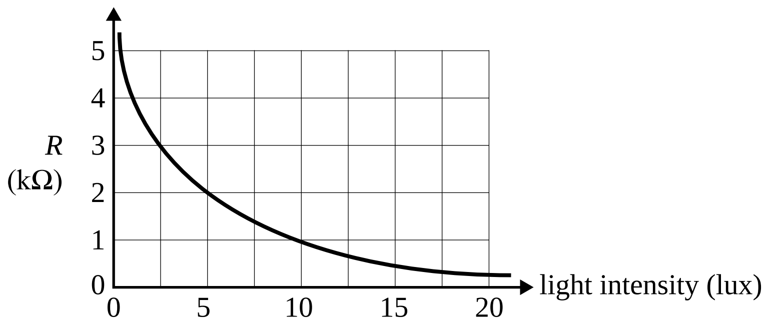


Figure 5

The students test the LDR by using the circuit shown in Figure 6.

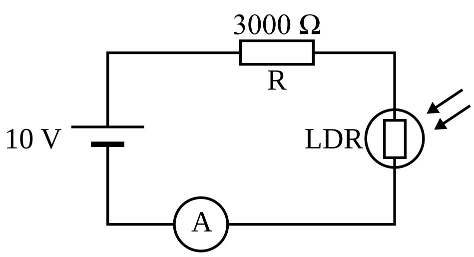


Figure 6

a. Calculate the intensity of light (in lux) falling on the LDR when the current in the circuit is equal to 2.5 mA.

lux

3 marks

b. Using the LDR, the 10 V battery, the switching circuit and a resistor, design and draw a circuit to switch the light **on** when the light intensity is 2.5 lux or less.

The value of the resistor used must be included on your diagram.

4 marks

Question 4

The voltage characteristics of an amplifier are shown in Figure 7.

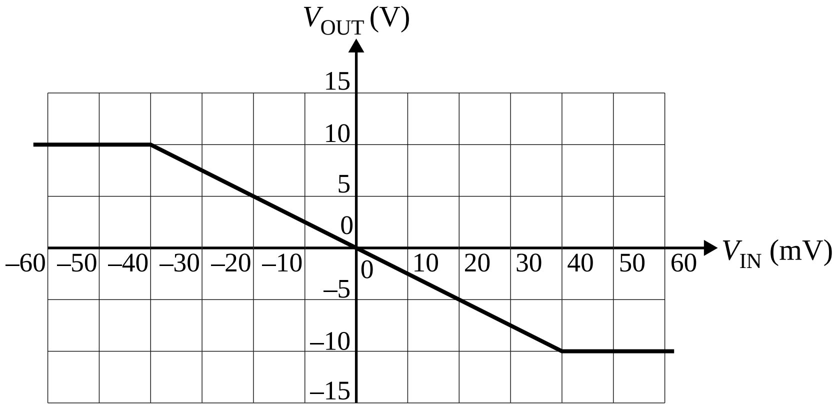


Figure 7

a. Calculate the magnitude of the voltage gain of the amplifier in its linear region.

1 mark

The input signal to the amplifier is shown in Figure 8.

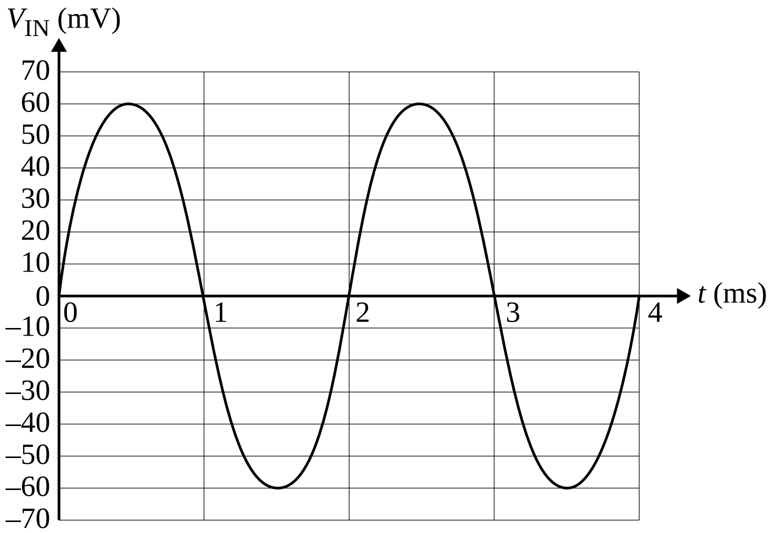


Figure 8

b. On Figure 9, sketch the output signal, V_{OUT}, that would result from the input signal shown in Figure 8. Assign a scale to the vertical axis. Show the output signal from $t = 0$ ms to $t = 4$ ms.

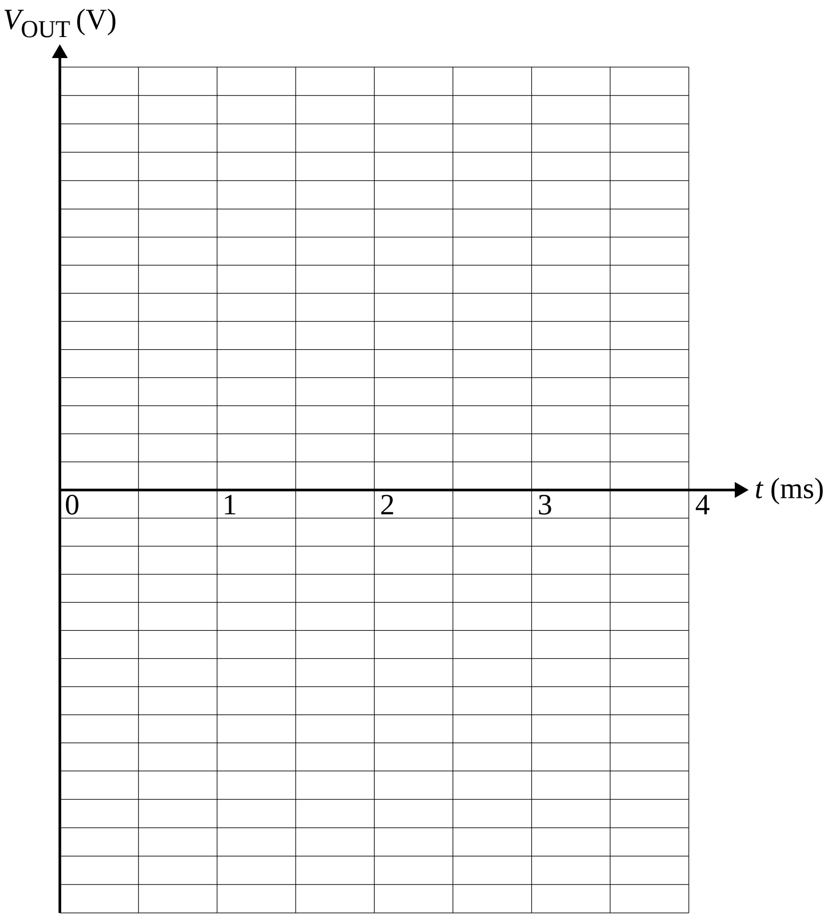


Figure 9

3 marks

Question 5

The block diagram in Figure 10 shows a modulation/demodulation system.

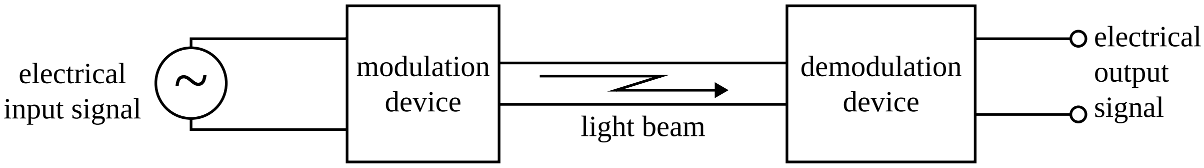


Figure 10

Outline the functions of the modulation device, the light beam and the demodulation device in this system.

3 marks

END OF SECTION A

SECTION B – Detailed studies

Instructions for Section B

Select **one** Detailed study.

Answer **all** questions from the Detailed study, in pencil, on the answer sheet provided for multiple-choice questions.

Write the name of your chosen Detailed study on the multiple-choice answer sheet **and** shade the matching box.

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

A correct answer scores 2, an incorrect answer scores 0.

Marks will **not** be deducted for incorrect answers.

No marks will be given if more than one answer is completed for any question.

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

Detailed study **Page**

Detailed study 1 – Einstein's special relativity

Question 1

Which of the following factors affects the speed of light?

A. the electrical properties of the medium through which light is travelling

B. the speed of the observer of the light

C. the speed of the light-emitting source

D. none of the above; the speed of light never changes

Question 2

An alarm is sounding in the centre of a large indoor basketball court. A stationary player measures the speed of sound as 335 m s^{-1}. A player runs directly towards the alarm (at 5 m s^{-1}) and another runs directly away from the alarm (also at 5 m s^{-1}). As they run they both measure the speed of sound using a small portable device. The situation is shown in Figure 1.

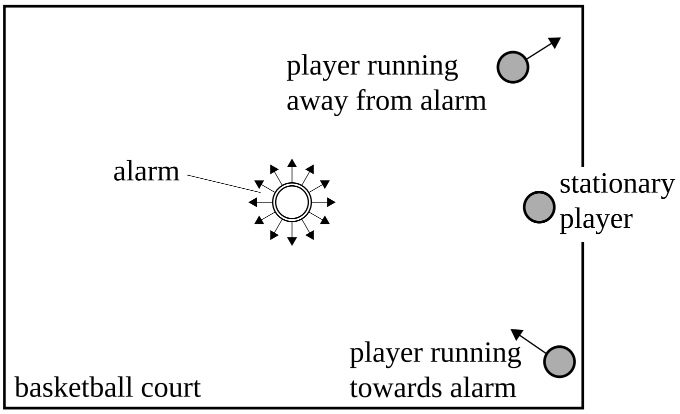


Figure 1

Which one of the following pairs of measurements is the best estimate of the speed of sound that would be measured by the running players?

	Player running away from alarm	Player running towards alarm
A.	335 m s^{-1}	335 m s^{-1}
B.	340 m s^{-1}	330 m s^{-1}
C.	325 m s^{-1}	345 m s^{-1}
D.	330 m s^{-1}	340 m s^{-1}

Question 3

A quasar, a distant star, is visible to amateur astronomers. When observed, it is at a distance of 2.5×10^{25} m from Earth and is travelling away from Earth at a speed of 0.16*c*.

Which of the following is the best statement about the light from the quasar?

A. The light from the quasar will be travelling slower than 3×10^8 m s^{-1} when the light reaches Earth.

B. The light from the quasar will be travelling faster than 3×10^8 m s^{-1} when the light reaches Earth.

C. The light from the quasar has taken 2.6×10^9 years to reach Earth.

D. The light from the quasar has not yet had time to reach Earth.

Question 4

One of Einstein's postulates for special relativity was that the laws of physics are the same in all **inertial** reference frames.

Which of the following best describes the properties of an inertial reference frame?

A. Its movement is consistent with the general expansion of the universe.

B. No observer in the frame can detect any acceleration of the frame.

C. It is travelling at speeds much less than c.

D. It is travelling in a straight line.

Question 5

The Michelson–Morley experiment was an attempt to detect the motion of Earth through the aether. To achieve this, the speed of light was measured first in one direction and secondly in a perpendicular direction to the first direction.

Which of the following best describes the result that Michelson and Morley found?

A. The result depended on where Earth was located in its orbit around the Sun.

B. The first value for the velocity of light was greater than the second.

C. The first value for the velocity of light was the same as the second.

D. The first value for the velocity of light was less than the second.

Question 6

The rest mass of every proton is 1.67×10^{-27} kg. A particular proton has a kinetic energy of 9.00×10^{-11} J.

Which of the following is the best estimate of the **total** energy of the proton?

A. 1.50×10^{-10} J

B. 9.00×10^{-10} J

C. 1.50×10^{-11} J

D. 2.40×10^{-10} J

Question 7

A particle is travelling at a speed of 1.4×10^{8} m s^{-1}.

If its speed is doubled to 2.8×10^{8} m s^{-1}, which of the following is the best estimate of the ratio

$$\frac{\text{value of } \gamma \text{ at the higher speed}}{\text{value of } \gamma \text{ at the lower speed}} ?$$

A. 1.4

B. 2.0

C. 2.5

D. 3.0

Question 8

Which of the following statements about the **proper time** between two events is the most accurate?

A. It is always shorter than or equal to another measurement of the time interval between the two events.

B. It is always longer than or equal to another measurement of the time interval between the two events.

C. It may be greater than, equal to or less than another measurement of the time interval between the two events.

D. It can never be measured by an observer who is located at the same position as the two events.

Use the following information to answer Questions 9 and 10.

Spaceship A has a circular window in its side. Alan, a crew member of spaceship A, measures the diameter of the window as 20 m. Figure 2 shows spaceship A at **rest**.

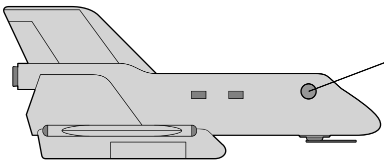


Figure 2

Briony is a crew member of spaceship B. She measures the dimensions of the window as spaceship B moves past spaceship A at a relative speed of 0.866c (γ = 2.00).

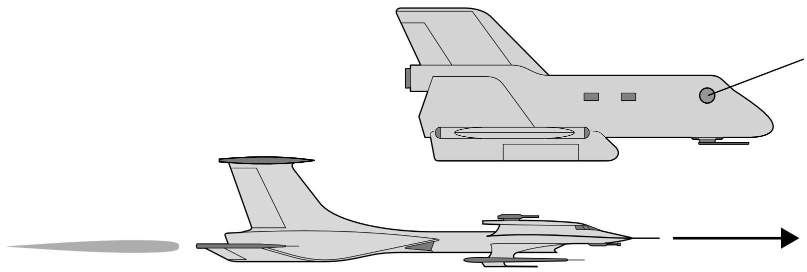
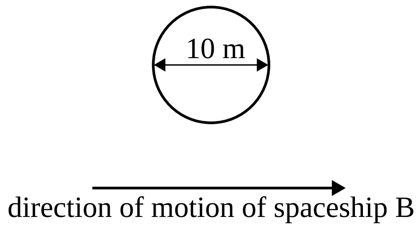


Figure 3

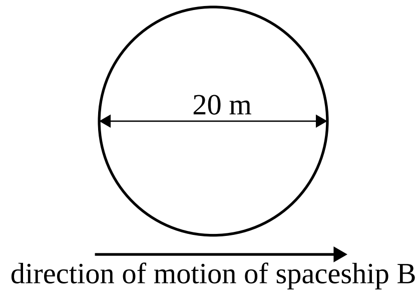
Question 9

Which of the following diagrams best shows the dimensions of the circular window on spaceship A as measured by Briony on spaceship B?

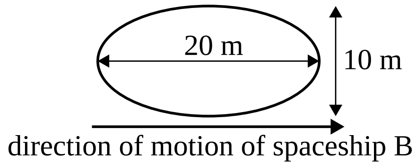
A.



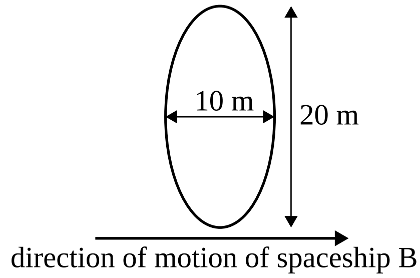
B.



C.



D.



Question 10

Briony (on spaceship B) also measures the time that she takes to pass the window.

Which of the following is the best estimate of the time that she measures?

A. 1.92×10^{-8} s

B. 3.33×10^{-8} s

C. 3.85×10^{-8} s

D. 7.70×10^{-8} s

Question 11

A sealed container of gas is heated from a low temperature to a very high temperature. The particles of the gas have greatly increased their speed. Students are debating whether special relativity predicts that the mass of the gas will increase, remain constant or decrease.

Which one of the following statements is correct?

A. The mass will increase.

B. The mass will decrease.

C. The mass will remain constant.

D. Special relativity does not apply to gas particles.

Question 12

A helium ion is accelerated from a speed of 9.0×10^7 m s^{-1} to a speed of 1.5×10^8 m s^{-1}. Scientists calculate accurately the **work done** on the helium ion during this acceleration.

Data

- Rest mass of a helium ion: 6.64×10^{-27} kg
- Rest mass energy of a helium ion: 5.98×10^{-10} J
- At a speed of 9.0×10^7 m s^{-1}, $\gamma = 1.05$; at a speed of 1.5×10^8 m s^{-1}, $\gamma = 1.15$

Which of the options below is the best estimate of the answer they obtain?

A. 2×10^{-19} J

B. 6×10^{-11} J

C. 1×10^{-9} J

D. 6×10^{-9} J

Detailed study 2 – Materials and their use in structures

Question 1

Figure 1 shows a view of a simple tent. It has been pitched using a centre pole on the inside and three ropes on the outside. The ropes are shown as dashed lines.

The ropes are all of equal length and all make an angle of 45° with the vertical centre pole.

The force that the ground exerts on each of the ropes is equal to 100 N. The pole and ropes can be considered to have no mass.

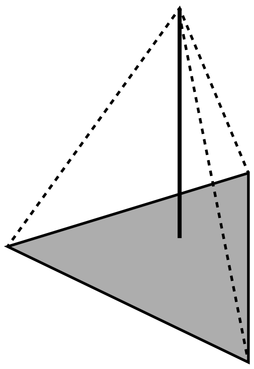


Figure 1

Which of the following best describes the force in the centre pole?

A. The pole is in tension; it applies a force of 212 N to the ground.

B. The pole is in compression; it applies a force of 212 N to the ground.

C. The pole is in tension; it applies a force of 100 N to the ground.

D. The pole is in compression; it applies a force of 300 N to the ground.

Use the following information to answer Questions 2–7.

Cylindrical samples of four different metal alloys – Alloy A, Alloy B, Alloy C and Alloy D – are placed in a stress tester and extended under tension to test their properties. A sketch of the apparatus is shown in Figure 2.

The initial length of each sample in the stress tester was 20 cm (0.20 m) and each sample had a cross-sectional area of 2.0×10^{-3} m^2.

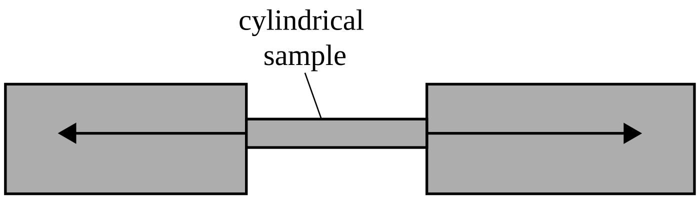


Figure 2

The results of the stress tests are shown in Figure 3.

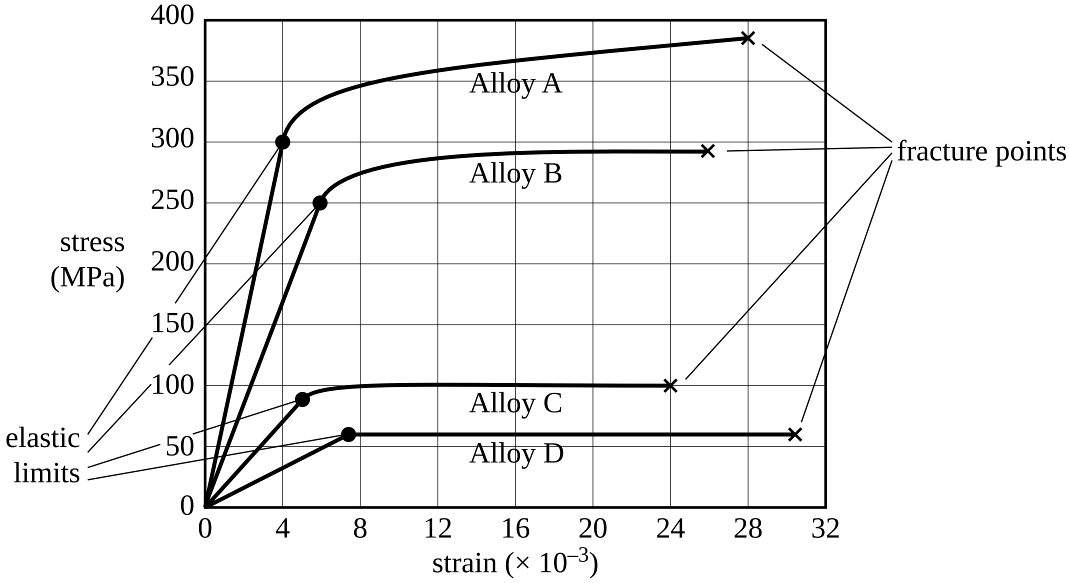


Figure 3

Question 2

Which of the following is the best estimate of Young's modulus of the stiffest alloy?

A. 7.5×10^{10} Pa

B. 1.4×10^{10} Pa

C. 9.0×10^{9} Pa

D. 1.3×10^{-11} Pa

Question 3

When Alloy B is stressed to 250 MPa, which of the following is the best estimate of the force applied to the sample?

A. 1.3×10^{11} N

B. 7.5×10^{5} N

C. 5.0×10^{5} N

D. 6.0×10^{-3} N

Question 4

Which alloy shows **elastic** behaviour over the greatest range of **strain** values?

A. Alloy A

B. Alloy B

C. Alloy C

D. Alloy D

Question 5

Which alloy shows **plastic** behaviour over the greatest range of **stress** values?

A. Alloy A

B. Alloy B

C. Alloy C

D. Alloy D

Question 6

Which alloy would be described as the toughest?

A. Alloy A

B. Alloy B

C. Alloy C

D. Alloy D

Question 7

The initial length of each sample in the stress tester was 20 cm (0.20 m) and each sample had a cross-sectional area of 2.0×10^{-3} m^2.

Which of the following values is the best estimate of the total energy required to strain Alloy C to a strain of 0.024?

A. 9 J

B. 90 J

C. 900 J

D. 9000 J

Use the following information to answer Questions 8 and 9.

A new theatre has an entrance with a cantilever roof protruding from the main structure.

The cantilever roof has a mass of 12 000 kg and is attached by a securing bolt to an anchor structure that is embedded firmly in the ground.

The cantilever roof has uniform thickness and density, and is also supported (as shown) 40 m from its free end. Figure 4 shows the situation from the side.

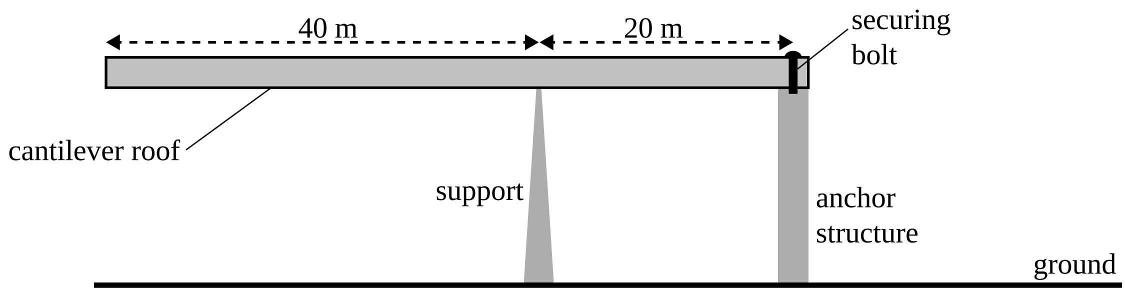


Figure 4

Question 8

Which of the following is the best estimate of the magnitude of the force that the support exerts on the cantilever roof?

A. 40 000 N

B. 60 000 N

C. 120 000 N

D. 180 000 N

Question 9

Which of the following is the best estimate of the force with which the anchor structure is pulling downward on the cantilever roof?

A. 40 000 N

B. 60 000 N

C. 120 000 N

D. 180 000 N

Question 10

Igloos are temporary structures that can be made from blocks of compacted snow.

These blocks of snow are very weak in tension, yet it is possible to build a strong and stable igloo using them, provided the igloos are shaped as arches (or domes, which can be considered as a collection of arches). Figure 5 shows a cross-section of a strong and stable igloo.

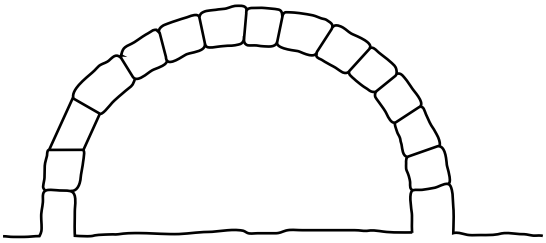


Figure 5

Which of the following statements best describes why it is possible to build a strong and stable structure from material that is so weak in tension?

A. Although snow is very weak in tension, its Young's modulus under tension is high enough to support the structure.

B. The arch shape and the force of gravity ensure that the blocks of snow are always in compression, and snow is strong in compression.

C. Strong and stable igloos can only be built when reinforcing material is included in the snow blocks, forming a strong composite material.

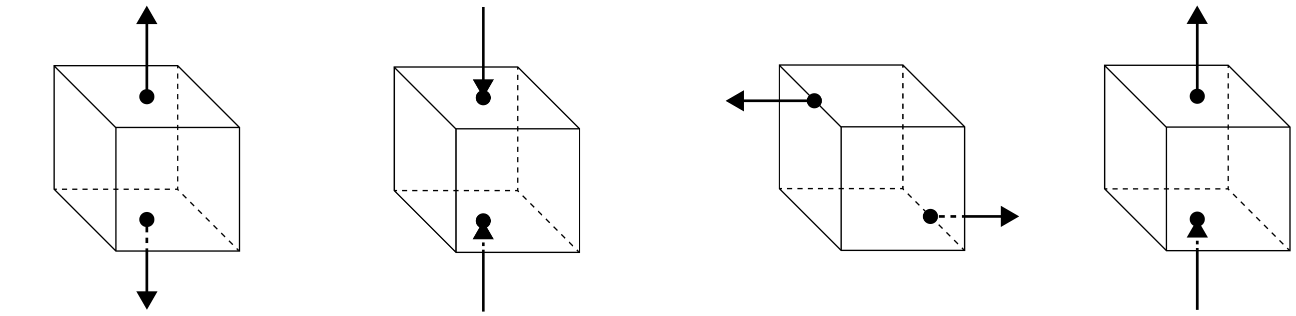
D. Although snow blocks are weak in tension they are strong under shear stresses, thus suitable for the task.

Question 11

The following diagrams show combinations of forces (as arrows) acting in various places on a solid cube.

Which diagram best illustrates combinations of forces that provide a **shear stress**?

A. **B.** **C.** **D.**



Question 12

A 300 kg steel beam is supported so that it is in compression on the top surface and in tension on the bottom surface as shown in Figure 6.

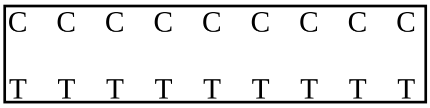
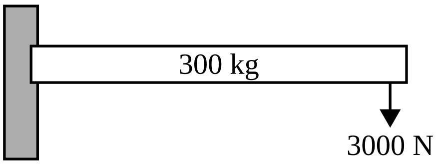


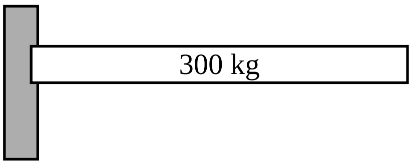
Figure 6

Which of the following methods of support will achieve this?

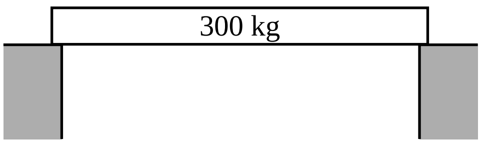
A. The beam is clamped firmly at its left-hand end.
There is an additional force of 3000 N acting as shown.



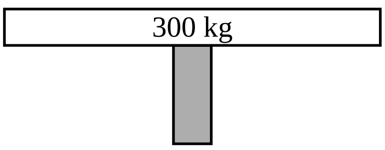
B. The beam is clamped at its left-hand end.



C. The beam rests freely on two supports.



D. The beam rests freely on one central support.



Detailed study 3 – Further electronics

Question 1

Maxi has an AC generator that is powered by batteries. He attaches the output of the AC generator to the input of a properly adjusted oscilloscope.

The voltage signal shown in Figure 1 appears on the oscilloscope.

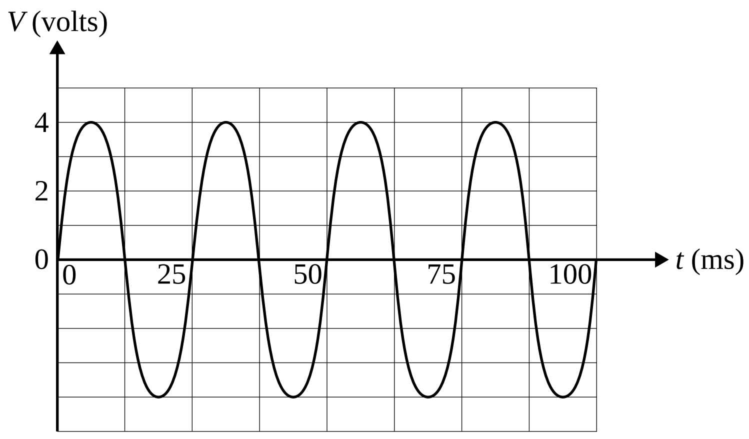


Figure 1

Which of the following is the best estimate of the frequency of the output voltage of the AC generator?

A. 20 Hz

B. 40 Hz

C. 50 Hz

D. 80 Hz

Question 2

Minnie tests a transformer. The primary coil of the transformer has 1200 turns and the secondary coil has 50 turns. The input to the primary coil of the transformer is 240 V_{RMS}.

Which of the following is closest to the voltage that will appear across the terminals of the secondary coil of the transformer? The transformer can be considered ideal.

A. 10 V_{RMS}

B. 14 V_{RMS}

C. 240 V_{RMS}

D. 5760 V_{RMS}

Use the following information to answer Questions 3 and 4.

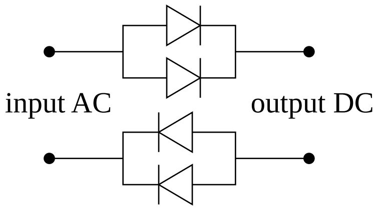
Minnie and Maxi connect four identical diodes to form a full-wave bridge rectifier.

Question 3

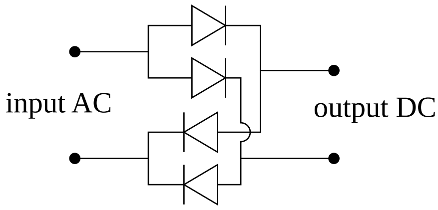
Minnie and Maxi need to make sure that the connections between the diodes are correct.

Which of the following circuits best shows the correct connections for the diodes so that they will act as a full-wave bridge rectifier?

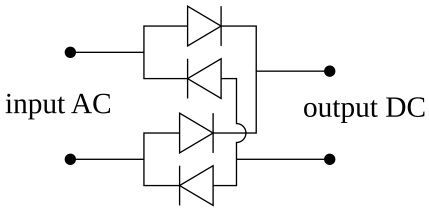
A.



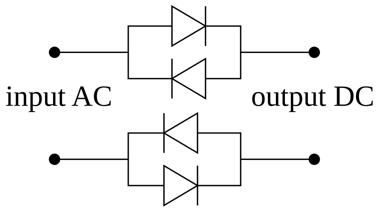
B.



C.



D.



Question 4

Each diode is mounted on a metal plate to provide cooling. With a particular power supply attached, each diode has a potential difference of 0.7 V_{RMS} across it and a current of 140 mA_{RMS} flowing through it.

Each metal plate is capable of dissipating 100 W per square metre (m^2) of plate. Each metal plate has to be large enough to dissipate all the heat produced in each diode.

Which of the following is the best estimate of the required size of one of the metal plates?

A. 0.001 m^2

B. 0.01 m^2

C. 0.1 m^2

D. 1.0 m^2

Question 5

Minnie and Maxi are constructing a smoothed and regulated power supply. They test various parts of their power supply. They set up the circuit shown in Figure 2.

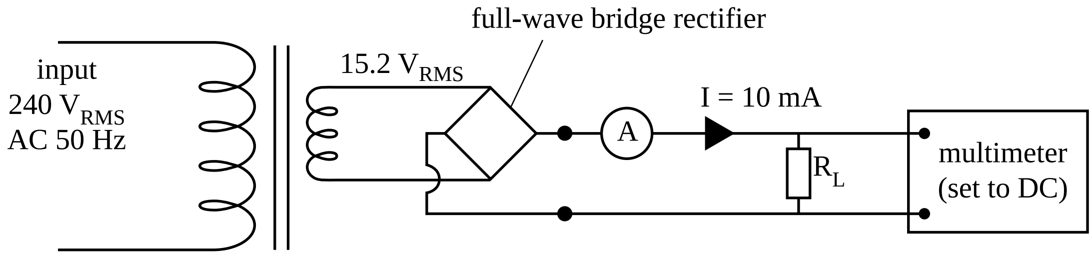


Figure 2

The transformer has an output of 15.2 V_{RMS}. The resistor R_L is the load resistor. The characteristics of each of the four diodes in the full-wave bridge rectifier are shown in Figure 3.

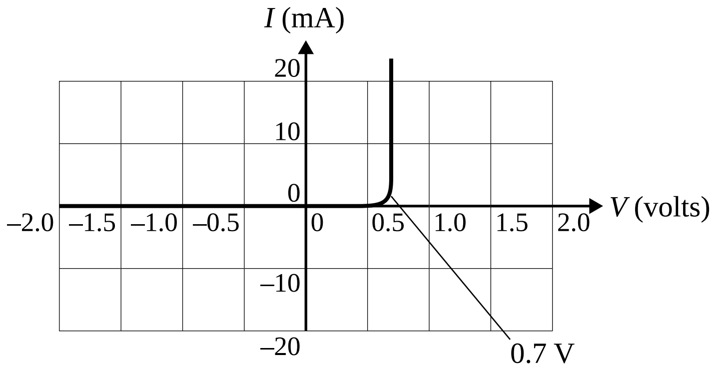


Figure 3

There is a current of 10 mA flowing through the ammeter.

They use a multimeter on a DC setting to measure the voltage across the load resistor R_L in the circuit in Figure 2.

Which of the following is the best estimate of the value that will be read on the multimeter?

A. 21 V

B. 15 V

C. 14 V

D. 12 V

Use the following information to answer Questions 6 and 7.

Minnie and Maxi then test a capacitor to use as a smoothing capacitor. They connect the circuit shown in Figure 4.

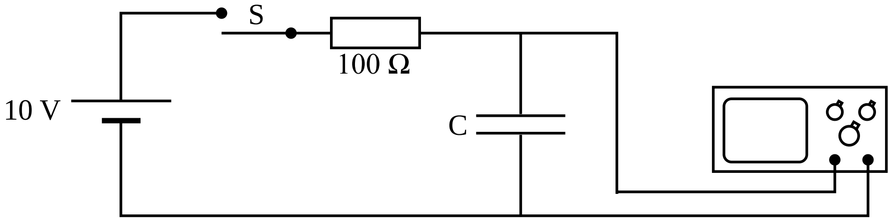


Figure 4

With the capacitor initially uncharged and the switch S open, they close the switch and observe the voltage display on the oscilloscope as shown in Figure 5.

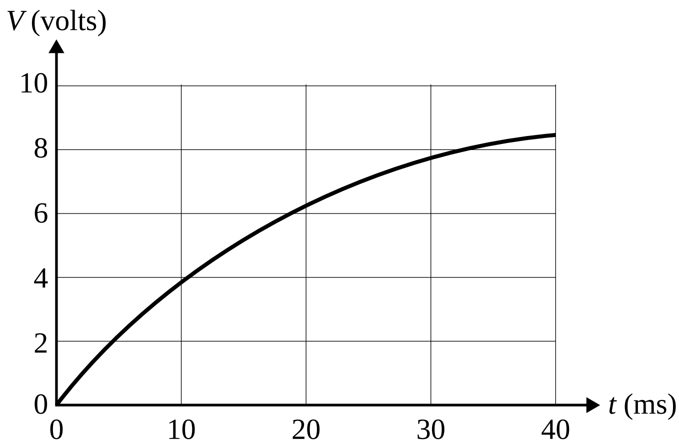


Figure 5

Question 6

Which of the following is the best estimate of the value of the capacitor C?

A. 100 μF

B. 150 μF

C. 200 μF

D. 20 mF

Question 7

Minnie and Maxi next connect an extra resistor R as shown in Figure 6. The capacitor is again initially uncharged and the switch S is open. They then close the switch and observe the voltage display on the oscilloscope as shown in Figure 7.

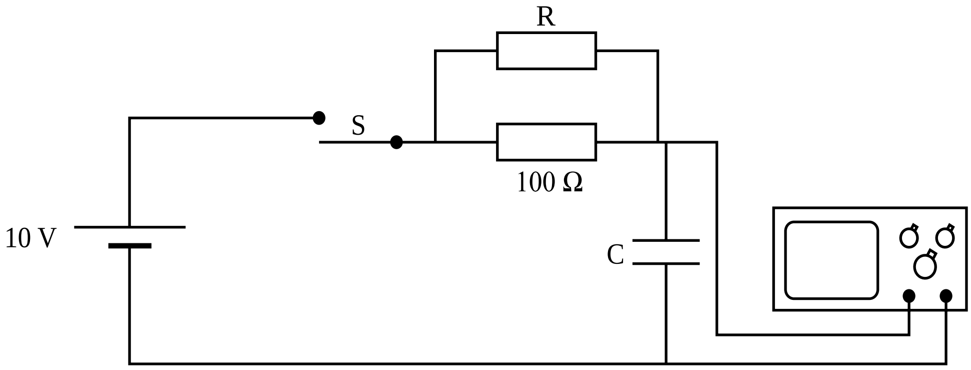


Figure 6

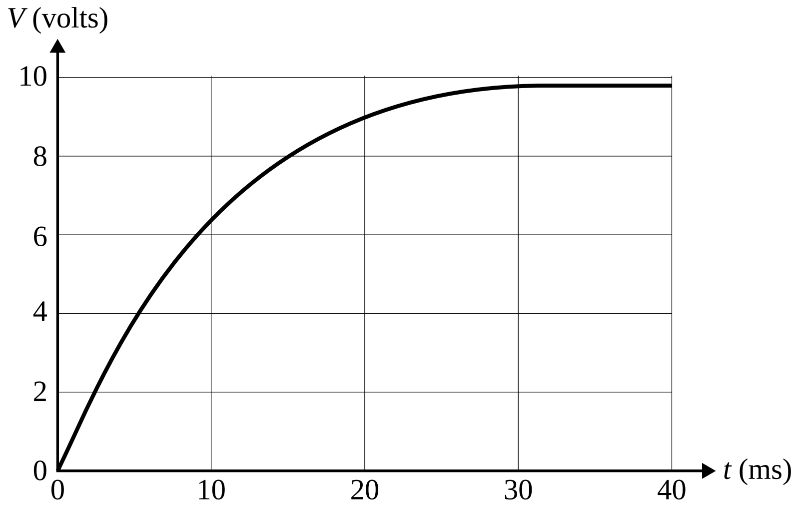


Figure 7

Which of the following is the best estimate of the value of the resistor R?

A. 50 Ω
B. 100 Ω
C. 200 Ω
D. 400 Ω

Question 8

Minnie and Maxi then set up the circuit shown in Figure 8. This includes a transformer with an output of 15.2 V_{RMS}, a full-wave bridge rectifier, a 100 μF smoothing capacitor C and a 100 Ω load resistor. An oscilloscope is connected across points LM. The input voltage to the transformer has a frequency of 50 Hz.

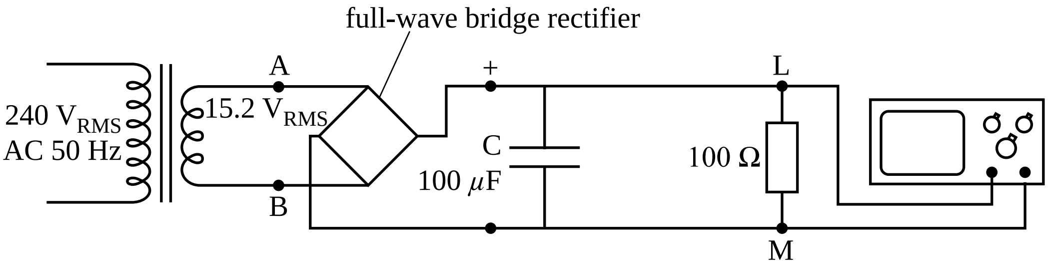
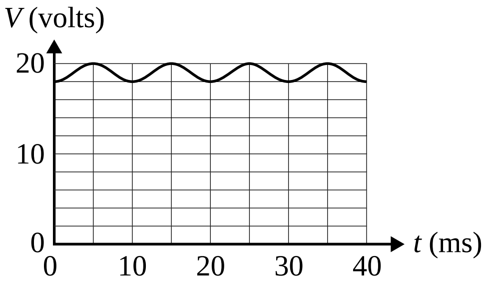


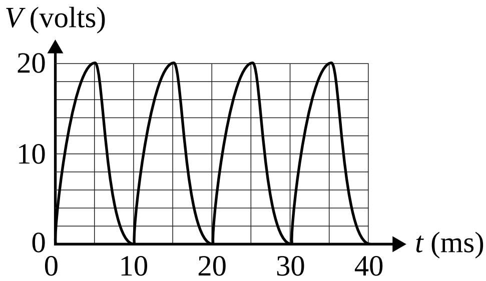
Figure 8

Which of the following best shows the signal that will be observed on the oscilloscope (set to DC)?

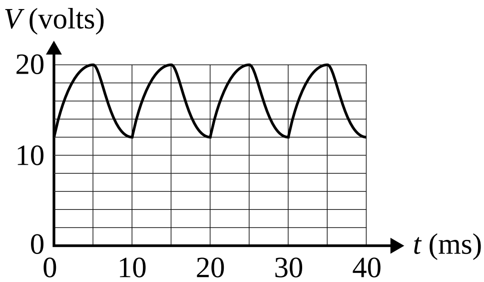
A.



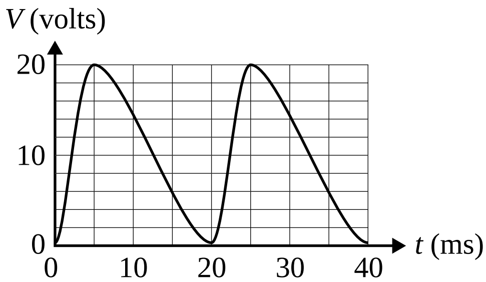
B.



C.



D.



Question 9

They next test the Zener diode that they intend to use as a voltage regulator. The current-voltage characteristics of the Zener diode are shown in Figure 9.

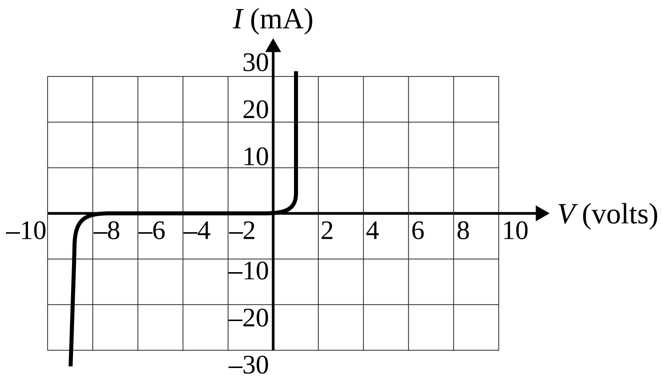
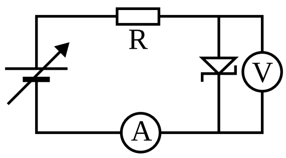


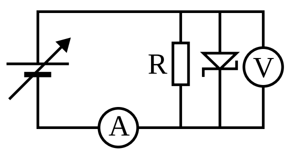
Figure 9

Which of the following circuits best shows the Zener diode correctly connected to test it as a 9 V voltage regulator?

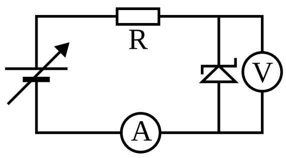
A.



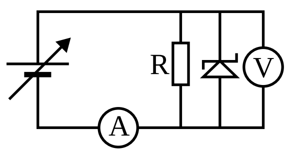
B.



C.



D.



Use the following information to answer Questions 10–12.

Minnie and Maxi now construct the complete circuit for a smoothed regulated 9 V DC power supply as shown in Figure 10.

The circuit contains a transformer, a full-wave bridge rectifier, a 100 μF smoothing capacitor, a 100 Ω resistor (resistor A), a 9 V Zener diode and a 1000 Ω load resistor (R_L).

The output of the circuit is connected to an oscilloscope.

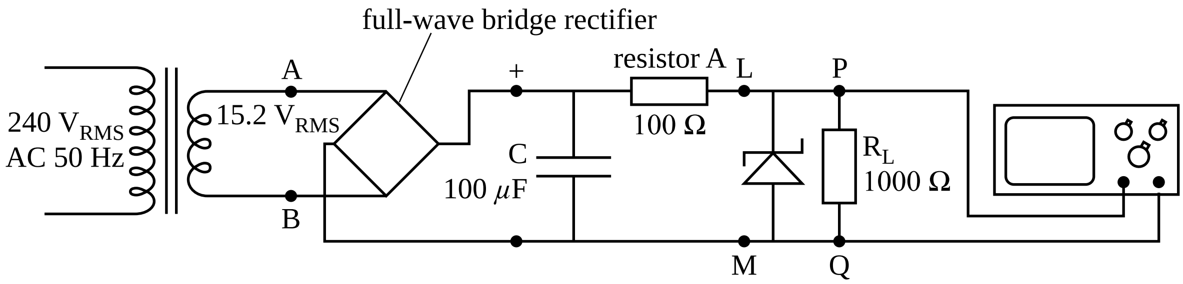


Figure 10

Question 10

Which of the following best describes the function of resistor A in the circuit shown in Figure 10?

A. Resistor A limits the total power output.

B. Resistor A reduces the voltage across the capacitor.

C. Resistor A protects the capacitor from excessive current through it.

D. Resistor A protects the Zener diode from excessive current through it.

Use the following additional information to answer Questions 11 and 12.

With a load resistor (R_L) of 1000 Ω as shown in Figure 10, the circuit operates correctly, delivering a smoothed DC output of 9 V. The voltage display on the oscilloscope is shown in Figure 11.

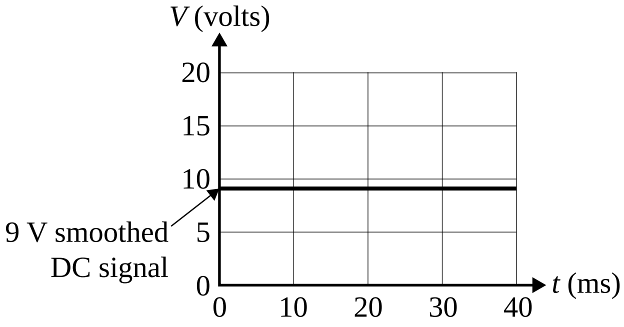


Figure 11

However, a faulty component causes the circuit to stop operating correctly. Instead of a smoothed 9 V DC signal, the voltage display shown in Figure 12 appears on the oscilloscope.

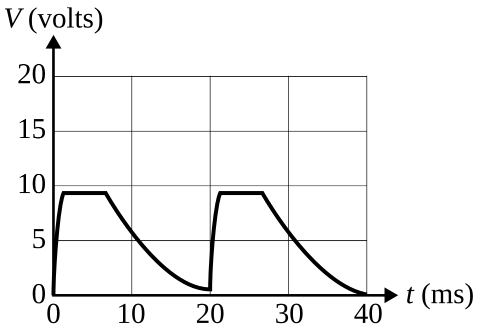


Figure 12

Question 11

Which of the following is the best explanation for the incorrect operation of the circuit?

A. One diode in the full-wave bridge rectifier has failed. The failed diode now does not conduct current.

B. All the diodes in the full-wave bridge rectifier have stopped conducting current.

C. Resistor A has stopped conducting current.

D. The capacitor has failed.

Question 12

The faulty component is replaced and the circuit now operates correctly as shown in Figure 11.

The 1000 Ω resistor is now replaced with a 100 Ω resistor and the output voltage drops below the required value of 9 V.

Which of the following is the most likely cause for this?

A. The voltage drop across the diodes has increased.

B. The voltage drop across the capacitor has increased.

C. The output voltage of the transformer has decreased.

D. The voltage drop across resistor A has become too high.

END OF QUESTION AND ANSWER BOOK

VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

Victorian Certificate of Education
2012

PHYSICS

Written examination 1

Tuesday 12 June 2012
Reading time: 11.45 am to 12.00 noon (15 minutes)
Writing time: 12.00 noon to 1.30 pm (1 hour 30 minutes)

FORMULA SHEET

Directions to students

- A question and answer book is provided with this formula sheet.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.

1	velocity; acceleration	$v = \frac{\Delta x}{\Delta t}; \quad a = \frac{\Delta v}{\Delta t}$
2	equations for constant acceleration	$v = u + at$ $x = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2ax$ $x = \frac{1}{2}(v + u)t$
3	Newton's second law	$\Sigma F = ma$
4	circular motion	$a = \frac{v^2}{r} = \frac{4\pi^2 r}{T^2}$
5	Hooke's law	$F = -kx$
6	elastic potential energy	$\frac{1}{2}kx^2$
7	gravitational potential energy near the surface of the Earth	mgh
8	kinetic energy	$\frac{1}{2}mv^2$
9	Newton's law of universal gravitation	$F = G\frac{M_1 M_2}{r^2}$
10	gravitational field	$g = G\frac{M}{r^2}$
11	stress	$\sigma = \frac{F}{A}$
12	strain	$\varepsilon = \frac{\Delta L}{L}$
13	Young's modulus	$E = \frac{\text{stress}}{\text{strain}}$
14	transformer action	$\frac{V_1}{V_2} = \frac{N_1}{N_2}$
15	AC voltage and current	$V_{\text{RMS}} = \frac{1}{\sqrt{2}}V_{\text{peak}} \qquad I_{\text{RMS}} = \frac{1}{\sqrt{2}}I_{\text{peak}}$
16	voltage; power	$V = RI \qquad P = VI = I^2 R$

17	resistors in series	$R_T = R_1 + R_2$
18	resistors in parallel	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$
19	capacitors	time constant : $\tau = RC$
20	Lorentz factor	$\gamma = \frac{1}{\sqrt{1 - v^2 / c^2}}$
21	time dilation	$t = t_o\gamma$
22	length contraction	$L = L_o/\gamma$
23	relativistic mass	$m = m_o\gamma$
24	total energy	$E_{total} = E_k + E_{rest} = mc^2$
25	universal gravitational constant	$G = 6.67 \times 10^{-11}$ N m^2 kg^{-2}
26	mass of Earth	$M_E = 5.98 \times 10^{24}$ kg
27	radius of Earth	$R_E = 6.37 \times 10^6$ m
28	mass of the electron	$m_e = 9.1 \times 10^{-31}$ kg
29	charge on the electron	$e = -1.6 \times 10^{-19}$ C
30	speed of light	$c = 3.0 \times 10^8$ m s^{-1}

Prefixes/Units

p = pico = 10^{-12}

n = nano = 10^{-9}

μ = micro = 10^{-6}

m = milli = 10^{-3}

k = kilo = 10^3

M = mega = 10^6

G = giga = 10^9

t = tonne = 10^3 kg

END OF FORMULA SHEET