VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

Victorian Certificate of Education 2010

SUPERVISOR TO ATTACH PROCESSING LABEL HERE

STUDENT NUMBER

Figures									Letter
Words									

PHYSICS
Written examination 1

Tuesday 8 June 2010

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	20	20	40
2. Electronics and photonics	11	11	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 49 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.

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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.
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.

NO WRITING ALLOWED IN THIS AREA

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Area of study 1 – Motion in one and two dimensions

The following information relates to Questions 1 and 2.

A racing car of mass 700 kg (including the driver) is travelling around a corner at a constant speed. The car's path forms part of a circle of radius 50 m, and the track is horizontal.

The magnitude of the central force provided by friction between the tyres and the ground is 11 200 N.

Question 1

What is the speed of the car?

$\boxed{\quad\quad\quad \text{m s}^{-1}}$

2 marks

Question 2

What is the acceleration of the car as it goes around the corner?

$\boxed{\quad\quad\quad \text{m s}^{-2}}$

2 marks

The following information relates to Questions 3 and 4.

Two physics students are conducting an experiment in which a block, m_1, of mass 0.40 kg is being pulled by a string across a frictionless surface. The string is attached over a frictionless pulley to another mass, m_2, of 0.10 kg. The second mass, m_2, is free to fall vertically. This is shown in Figure 1.

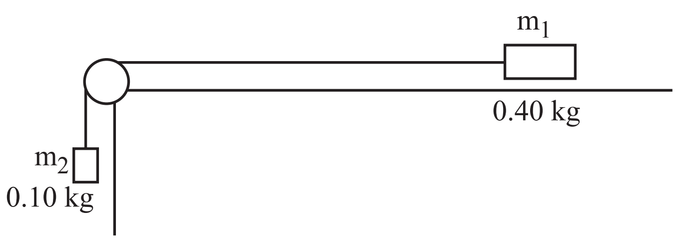

Figure 1

The block is released from rest.

Question 3

What is the acceleration of the block m_1?

m s^{-2}

2 marks

Question 4

What is the kinetic energy of the block m_1, after it has travelled 1.0 m?

J

2 marks

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The following information relates to Questions 5 and 6.

In designing a bicycle track at a racing track, the designer wants to bank the track on a particular corner so that the bicycles will go around the corner with no sideways frictional force required between the tyres and the track at 10 m s^{-1}.

Figures 2a and 2b below show the banked track and the bicycle.

Question 5

On **Figure 2b** draw two arrows to show the two forces acting on the bicycle and rider (treated as a single object).

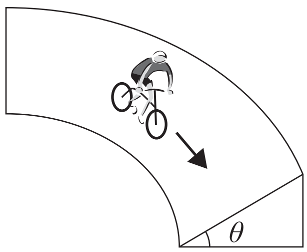

Figure 2a

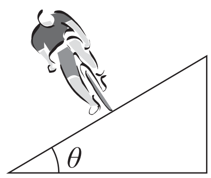

Figure 2b

2 marks

Question 6

The circular path of the bicycle has a constant radius of 100 m, and the bicycle will be travelling at a constant 10 m s^{-1}.

What should be the value of the angle of the bank, θ, so that the bicycle travels around the corner with no sideways frictional force between the tyres and the track?

°

3 marks

The following information relates to Questions 7–9.

Part of a roller coaster ride at an amusement park is shown in Figure 3. The car with people in it has total mass of 1000 kg. The car starts from rest at point A, a vertical height of 20 m above point B.

Ignore effects of friction.

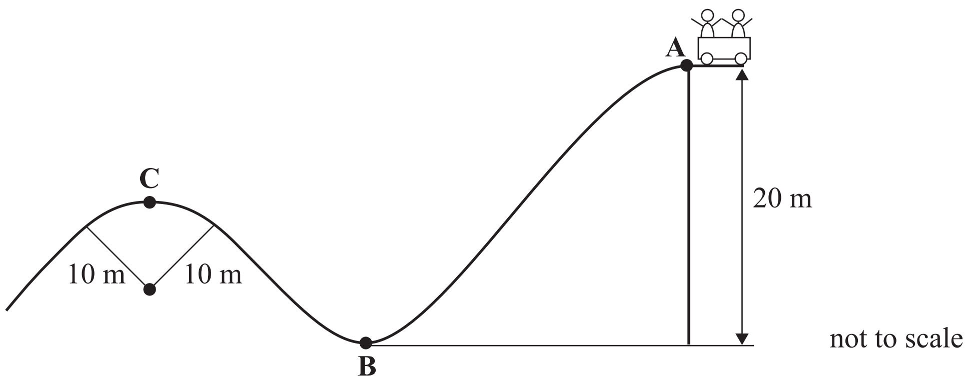

Figure 3

Question 7

What is the speed of the car at point B?

$m\ s^{-1}$

2 marks

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From point B, the car then travels up a slope to point C. At point C, the track is part of a vertical circle of radius 10 m. At this point, the riders in the car **feel as if they have no weight**.

Question 8

Rebecca says that they are not actually weightless.

Explain why Rebecca's statement is either correct or incorrect.

2 marks

Question 9

What must be the speed of the car at point C for the riders to **feel as if they have no weight**?

m s^{-1}

2 marks

The following information relates to Questions 10 and 11.

A helicopter is to drop a rescue package to a group of hikers. The helicopter is travelling with a speed of 10.0 m s^{-1} at a constant height of 200 m over level ground. The situation is shown in Figure 4.

You should ignore air resistance.

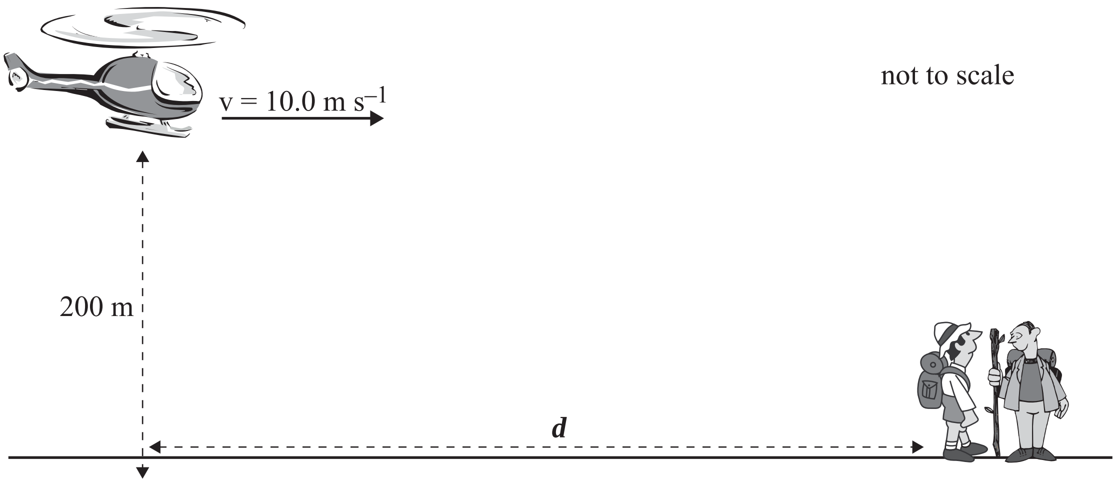

Figure 4

Question 10

The pilot wants the package to land beside the hikers. At what horizontal distance, ***d***, from the hikers must the package be released from the helicopter?

m

2 marks

Question 11

What is the speed with which the package then hits the ground?

m s^{-1}

2 marks

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In a game of tennis, the ball is thrown vertically upward. At the top of its motion the ball is momentarily stationary. At this point it is hit forward horizontally by the racquet.

In a particular serve, the ball of mass 57 g is given a horizontal impulse of 1.70 kg m s^{-1}.

Question 12

Assuming that the racquet and ball were in contact for a period of 0.0080 s, what was the average force exerted on the ball by the racquet?

N

2 marks

The following information relates to Questions 13 and 14.

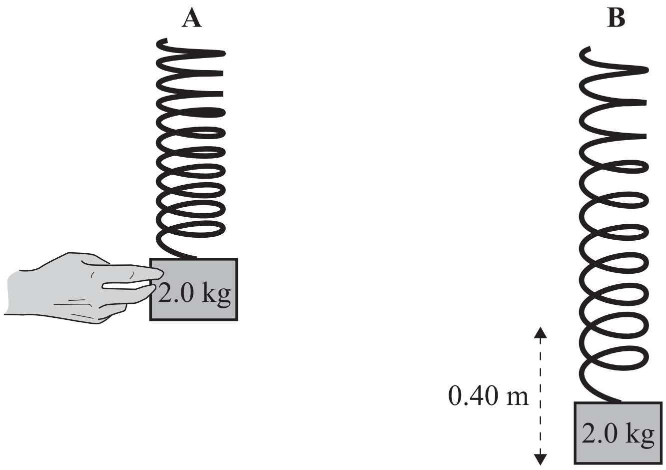

Figure 5a **Figure 5b**

Figure 5a shows an ideal spring with a 2.0 kg mass attached. The spring-mass system is held so that the spring is not extended. The mass is **gently** lowered and the spring stretches until, in Figure 5b, the spring-mass system is at rest. The spring has extended by 0.40 m.

Question 13

What is the value of the spring constant, k, of the spring?

$N\ m^{-1}$

2 marks

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Question 14

What is the difference in the magnitude of the total energy of the **spring-mass system** between Figure 5a and Figure 5b?

Write your answer in the box, and show your working in the space provided.

J

2 marks

The following information relates to Questions 15–17.

Physics students are conducting a collision experiment using two trolleys, m_1 of mass 0.40 kg and m_2 of mass 0.20 kg.

- Trolley m_1 has a light spring attached to it. When uncompressed, this spring has a length of 0.20 m.
- Trolley m_1 is initially moving to the right. Trolley m_2 is stationary.
- The trolleys collide, compressing the spring to a length of 0.10 m.
- The trolleys then move apart again, and the spring reverts to its original length (0.20 m), and both trolleys move off to the right.
- The collision is elastic.
- The trolleys do not experience any frictional forces.

The situation is shown in Figure 6.

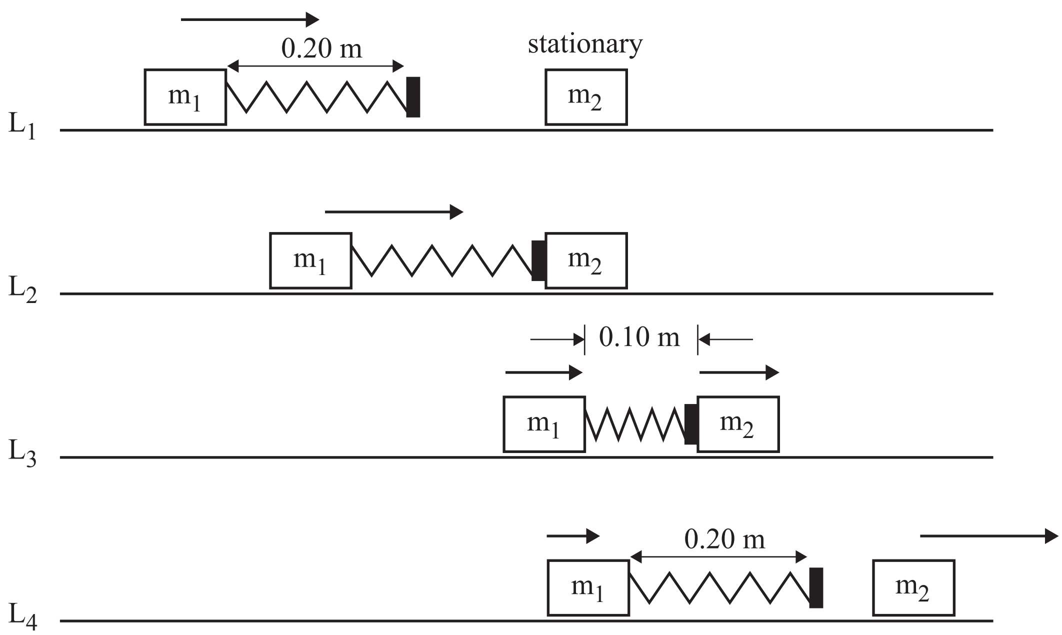
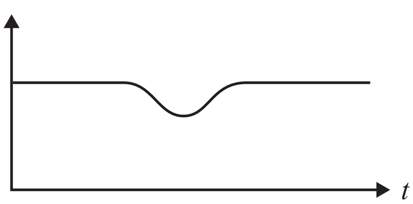


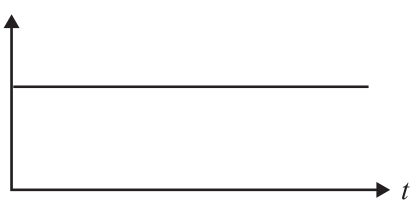
Figure 6

Use the graphs below to answer Questions 15–17.

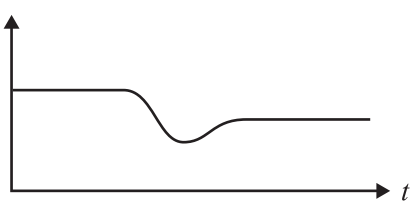
A.



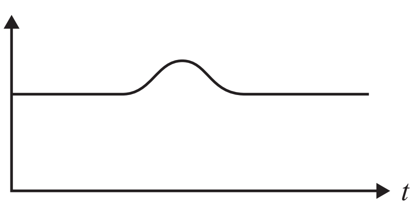
B.



C.



D.



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Question 15

Which graph best shows how the total kinetic energy of the system varies with time before, during and after the collision? Explain your answer.

2 marks

Question 16

Which graph best shows how the total momentum of the system varies with time before, during and after the collision? Explain your answer.

2 marks

Question 17

If the collision had been inelastic, which graph would best show how the magnitude of the total momentum of the system varies with time before, during and after the collision? Explain your answer.

2 marks

The following information relates to Questions 18–20.

The International Space Station (ISS) is currently under construction in Earth orbit. It is incomplete, with a current mass of 3.04×10^5 kg. The ISS is in a circular orbit of 6.72×10^6 m from the centre of Earth.

In the following questions the data below may be needed.

Mass of ISS	3.04×10^5 kg
Mass of Earth	5.98×10^{24} kg
Radius of Earth	6.37×10^6 m
Radius of ISS orbit	6.72×10^6 m
Gravitational constant	6.67×10^{-11} N m^2 kg^{-2}

Question 18

What is the weight of the ISS in its orbit?

N

2 marks

Question 19

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

s

2 marks

Question 20

When the ISS is completed in 2011, its mass will have increased to 3.70×10^5 kg.

Will the period of orbit of the ISS around Earth then be greater, the same, or less?

1 mark

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Area of study 2 – Electronics and photonics

The following information relates to Questions 1 and 2.

The circuit shown in Figure 1 was set up by a student to study the operation of a diode.

The characteristics of the diode in the circuit are shown in Figure 2.

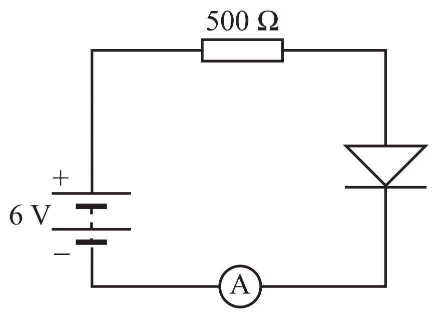

Figure 1

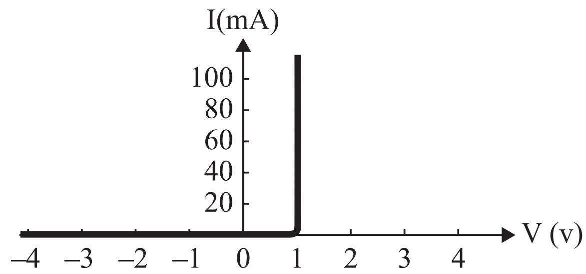

Figure 2

Question 1

What current will flow through the ammeter in the circuit shown in Figure 1?

mA

2 marks

A 200 Ω resistor is added to the circuit as shown in Figure 3.

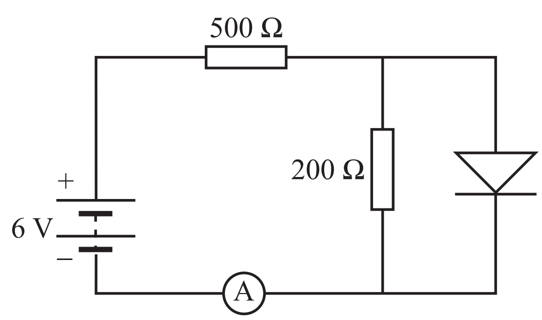

Figure 3

Question 2

What current will now flow through the ammeter?

mA

2 marks

The following information relates to Questions 3 and 4.

Tom's teacher has given him

- two light globes (A and B) that each have a constant resistance of 2.0 Ω.
- two 0.50 Ω resistors
- a 24 V battery.

Tom connects up the circuit shown in Figure 4.

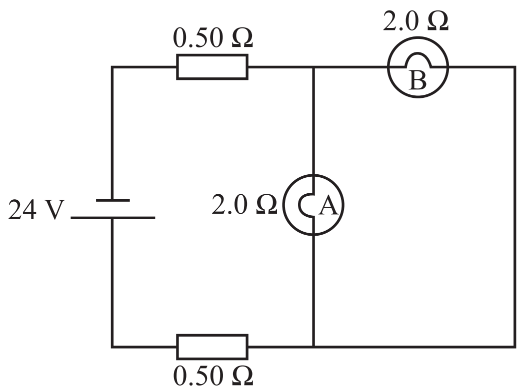

Figure 4

Question 3

Indicate the voltage (potential difference) across each of the globes.

light globe A	V
light globe B	V

2 marks

Question 4

What is the current drawn from the 24 V battery?

	A

2 marks

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Question 5

A particular device is used in a communications system to convert an electric signal into a light signal for transmission along an optical fibre.

The average voltage of the input signal is 10 V and the average current 10 mA.

The light beam output has a power of 50 mW.

The percentage efficiency of such a device is given by $\dfrac{\text{Power out}}{\text{Power in}} \times 100$.

What is the percentage (%) efficiency of the device?

%

2 marks

The following information relates to Questions 6–8.

Ryan wants to install some garden lights that will come on at sunset.

A circuit will be used to control the lights.

The circuit consists of

- a 12 V DC power source
- a Light Dependent Resistor (LDR)
- a resistor R
- a switching circuit.

The characteristics of the LDR are shown in Figure 5, and the circuit in Figure 6.

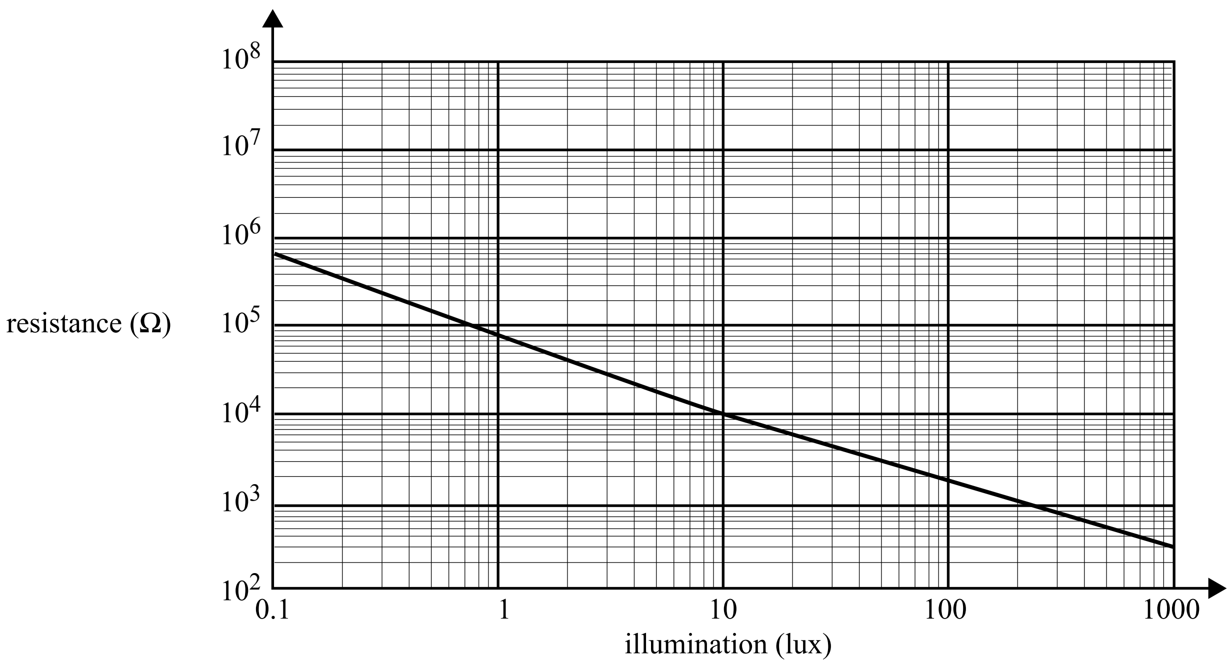

Figure 5

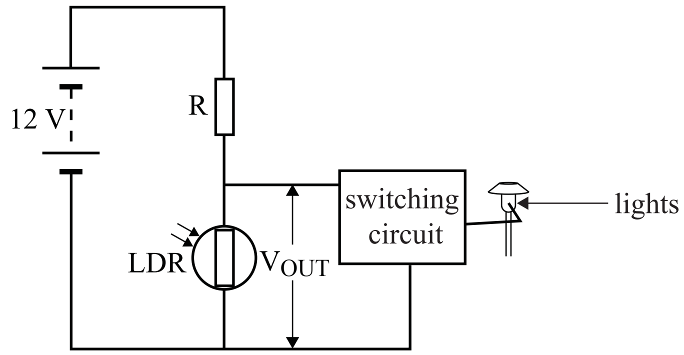

Figure 6

The switching circuit turns the lights ON when V_{OUT} is 4.0 volts.

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Ryan wants the lights to come on when the illumination has fallen to 10 lux.

Question 6

What must be the value of the resistor R in Figure 6, to ensure the lights come on at 10 lux?

Ω

2 marks

Question 7

As sunset approaches, and the daylight gets less bright, does the value of V_{OUT} increase or decrease as it approaches 4 V?

Explain your reasoning.

3 marks

Question 8

Ryan decides that he wants the lights to come on earlier. Should he increase or decrease the resistance R to achieve this? Explain your answer.

3 marks

The following information relates to Questions 9 and 10.

The input and output signals of a voltage amplifier are shown in Figures 7a and 7b.

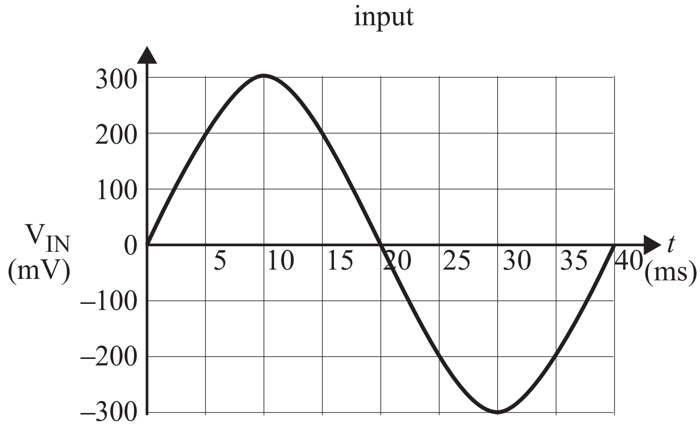

Figure 7a

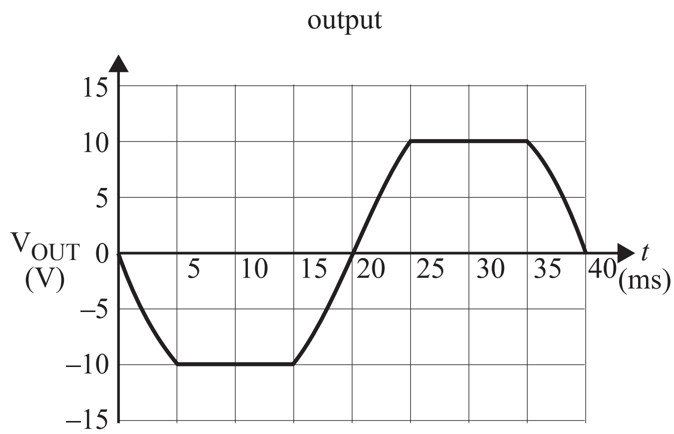

Figure 7b

Question 9

What is the voltage gain of the amplifier in the linear region?

2 marks

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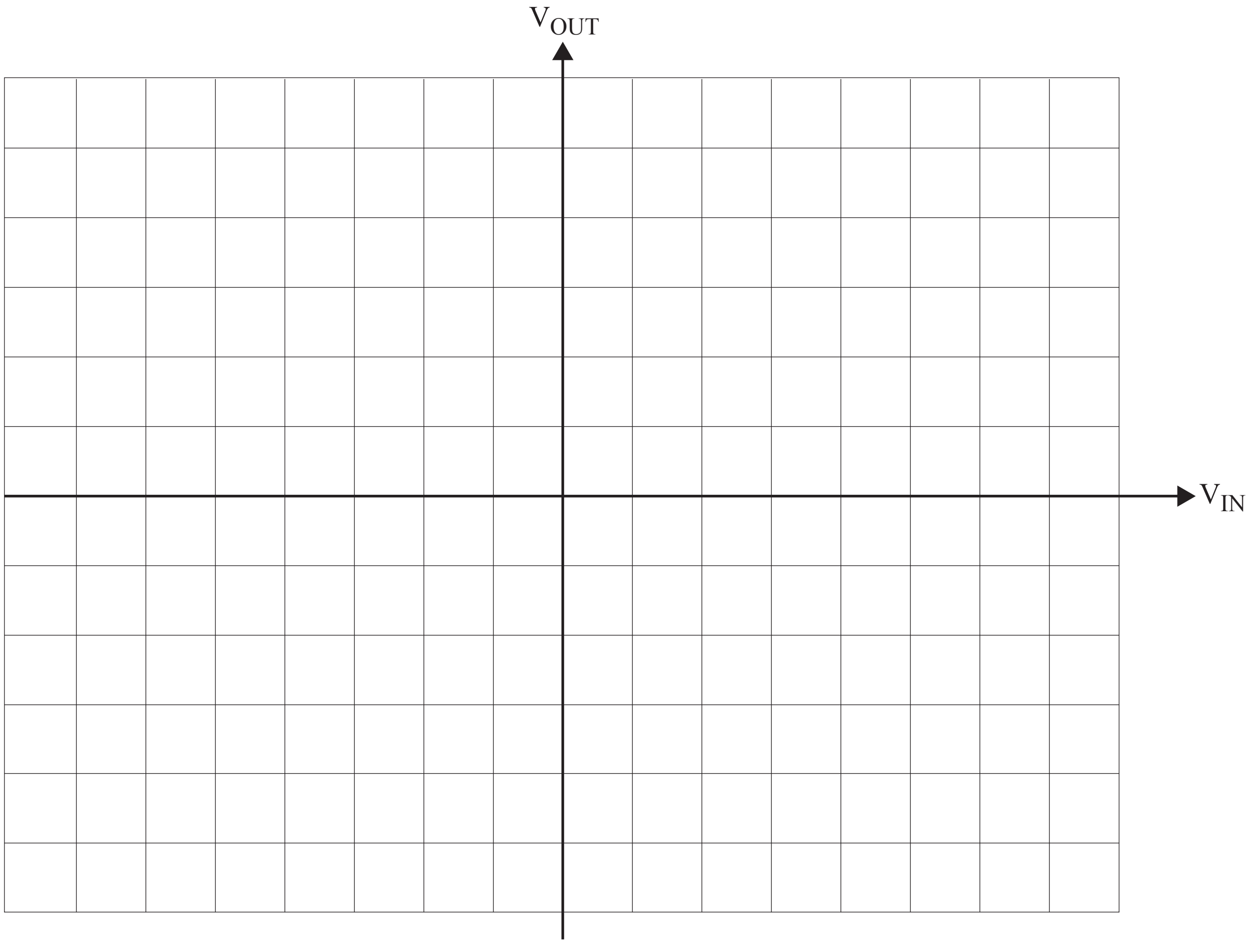
Question 10

On the grid below, sketch the voltage characteristics of the amplifier.

Include a scale on both axes.



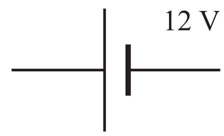
3 marks

Question 11

You are given a single 12 V ideal battery, three 1000 Ω resistors and connecting wires of negligible resistance.

Using only these components, draw a circuit in the space below in which the voltage (potential difference) across one of the resistors will be 8 V and across each of the other two will be 4 V.

Use the symbols below.

Resistor symbol	Battery symbol
	

3 marks

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END OF SECTION A

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SECTION B

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

On a planet a long way away, a racing car is moving at high speed (0.9*c*) along a straight track. It is heading straight for a post. Jim is standing next to the post. The situation is shown in Figure 1.

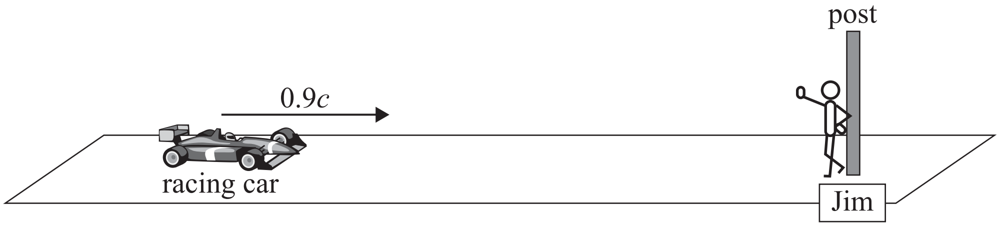

Figure 1

When the racing car is 1.00 km from the post (as measured by Jim), the driver sends a flash of light from the car.

Which of the following is closest to the time that the flash of light takes to reach the post (as measured by Jim)?

A. 1.5 microseconds

B. 1.8 microseconds

C. 3.3 microseconds

D. 3.7 microseconds

Question 2

The driver of the racing car, Susanna, measures the distance between herself and the post at exactly the same time that she sends the flash of light.

Which one of the following is closest to the distance that she measures?

A. 0.44 km

B. 0.90 km

C. 1.00 km

D. 2.29 km

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Question 3

On another occasion, Vicky observes the racing car. She is standing exactly midway between two posts, A and B. At the instant the car passes her, the driver sends simultaneous flashes of light forwards and backwards towards the posts. The car is travelling at 0.9*c* towards post B. The arrangement is shown in Figure 2.

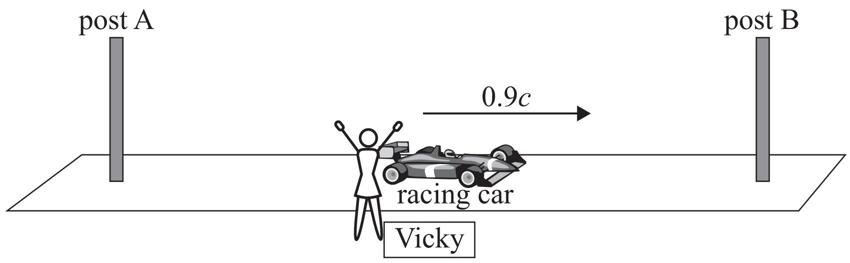

Figure 2

Which one of the following best describes when the flashes of light reach the posts, as observed by Vicky?

A. Post A receives the flash of light first.

B. Post B receives the flash of light first.

C. Post A and Post B receive a flash of light at the same time.

D. It is not possible to predict which receives a flash of light first.

Question 4

Which one of the following is the best description of the **proper length** of an object travelling with constant velocity?

A. The length when measured by any observer at the same location.

B. The length when measured by an observer at rest relative to the object.

C. The length when both ends of the object are measured at the same time.

D. The length when measured with a proper standard measuring stick.

Question 5

Two physics students are conducting accurate experiments to test Newton's second law of motion ($\Sigma F = ma$). Each student is in a windowless railway carriage. One carriage (carriage A) is moving at a constant velocity of 0.9*c*. The other carriage (carriage B) is moving at 10 m s^{-1} and decelerating.

Which one of the following best describes the likely results of their experiments?

A. Only the experiment in carriage A confirms Newton's second law of motion.

B. Only the experiment in carriage B confirms Newton's second law of motion.

C. Neither experiment confirms Newton's second law of motion.

D. Both experiments confirm Newton's second law of motion.

The following information relates to Questions 6–8.

A robot is heading radially towards the surface of a planet in the *Hoth* system at a constant speed of 0.85c. Observers on the surface of the planet observe it at a time when it is a distance x above the surface in their reference frame. The observers calculate the time that the robot will take to reach the surface of the planet as 784 microseconds.

The situation is shown in Figure 3.

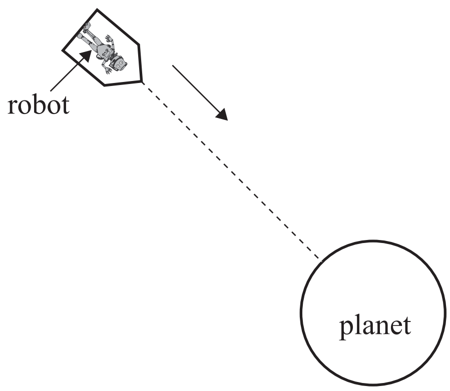

Figure 3

Question 6

Which one of the following is closest to the distance x?

A. 105 km

B. 200 km

C. 235 km

D. 380 km

Question 7

Which one of the following is the best estimate of the time, as measured by the **robot**, for it to reach the surface of the planet?

A. 413 microseconds

B. 666 microseconds

C. 784 microseconds

D. 1488 microseconds

Question 8

Which one of the following best describes the time of the robot's descent to the planet surface as measured by the robot, and the time as measured by the observers on the surface of the planet?

A. They are both measurements of proper time in their own reference frames.

B. Neither are measures of proper time.

C. Only the observers measure the proper time.

D. Only the robot measures the proper time.

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Question 9

Which one of the following best describes what follows directly from the measurements of the Michelson–Morley experiment?

A. The speed of light near the surface of Earth depends on the direction in which it is measured travelling.

B. The speed of light near the surface of Earth is the same in all directions.

C. Earth travels through a stationary ether.

D. The ether may exist, but it is not detectable.

Question 10

Muons and antimuons are anti-particles of each other. They have the same mass. When a muon meets an antimuon, both are destroyed and two photons (gamma rays) are formed. If the two particles are effectively stationary, then the two photons have a **total** energy of 3.38×10^{-11} J.

Using this data, which one of the following is closest to the mass of a single muon?

A. 3.76×10^{-28} kg

B. 1.88×10^{-28} kg

C. 1.13×10^{-19} kg

D. 5.64×10^{-19} kg

Question 11

In a particle accelerator, an alpha particle of mass 6.64424×10^{-27} kg is accelerated from rest to high speed. The total work done on the alpha particle is equal to 7.714×10^{-10} J.

Which one of the following is closest to its final speed?

A. $0.90c$

B. $0.95c$

C. $0.85c$

D. $0.80c$

Question 12

A conservation scientist is using a stun dart fired from a rifle to tranquilise a kangaroo to tag it for conservation research. He is travelling in a specially designed vehicle at a speed V in a straight line. He fires a dart from his rifle straight ahead. The dart has a speed U, measured relative to his rifle. At the same time, a flash of light is emitted from the laser sight mechanism on his rifle.

This is shown in Figure 4 below.

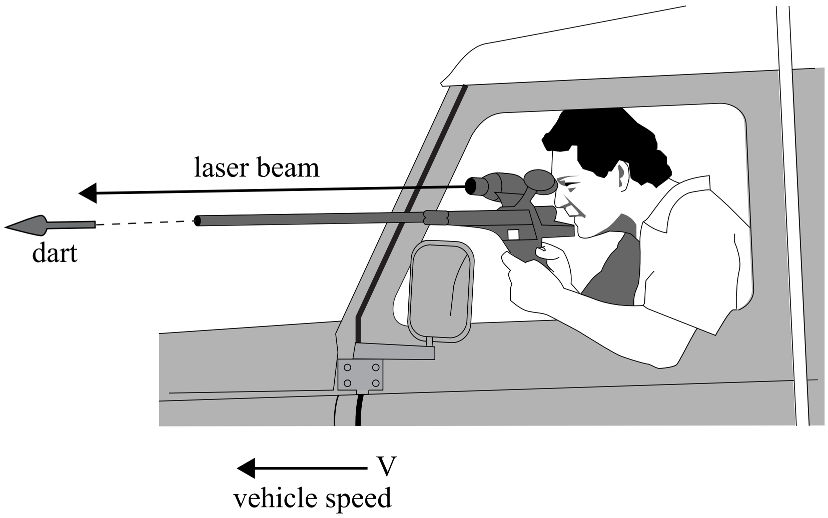

Figure 4

Which one of the following choices is the best estimate of the speed of the dart and the light flash, as measured by a stationary observer on the ground?

	Speed of **dart** relative to stationary observer	Speed of **light flash** relative to stationary observer
A.	$U + V$	c
B.	$U + V$	$V + \sqrt{\frac{V^2}{c^2}}$
C.	$U - V$	$V + c$
D.	U	c

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Detailed study 2 – Materials and their use in structures

The following information relates to Questions 1 and 2.

Figure 1 shows the atomic structure in a layer of an unstressed sample of a flexible material.

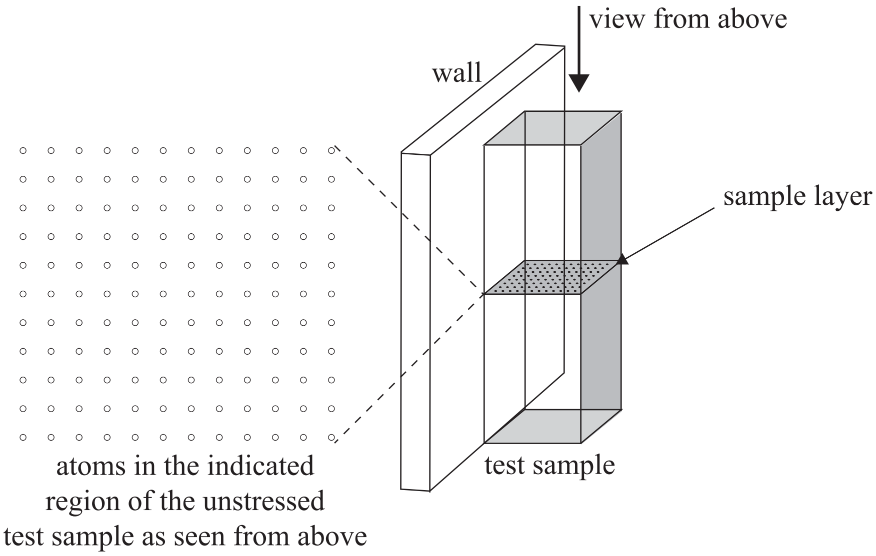

Figure 1

This sample is rigidly attached to a wall, and subjected to several different types of stress.

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Question 1

A stress is applied to the sample as shown in Figure 2.

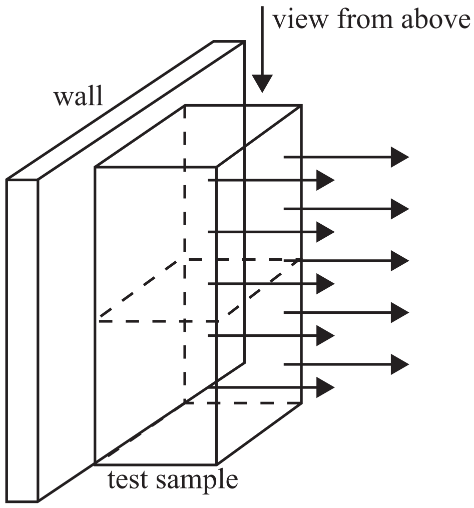
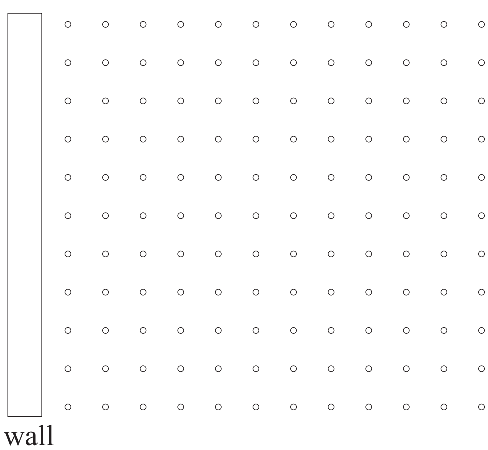


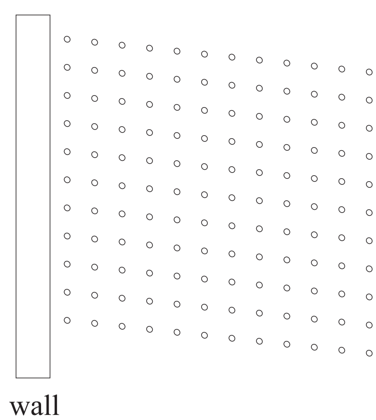
Figure 2

Which one of the figures below shows the atomic structure in the layer of the sample as seen from above?

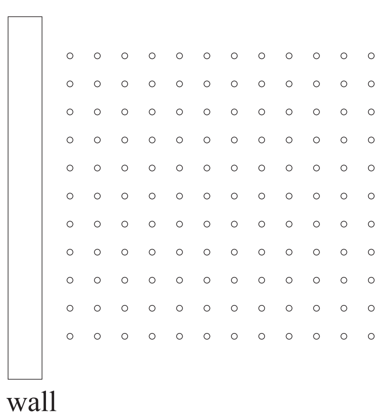
A.



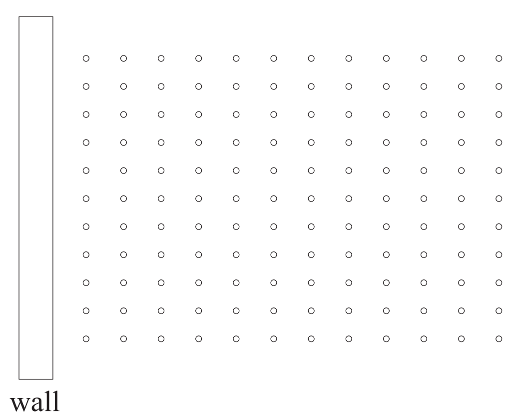
B.



C.



D.



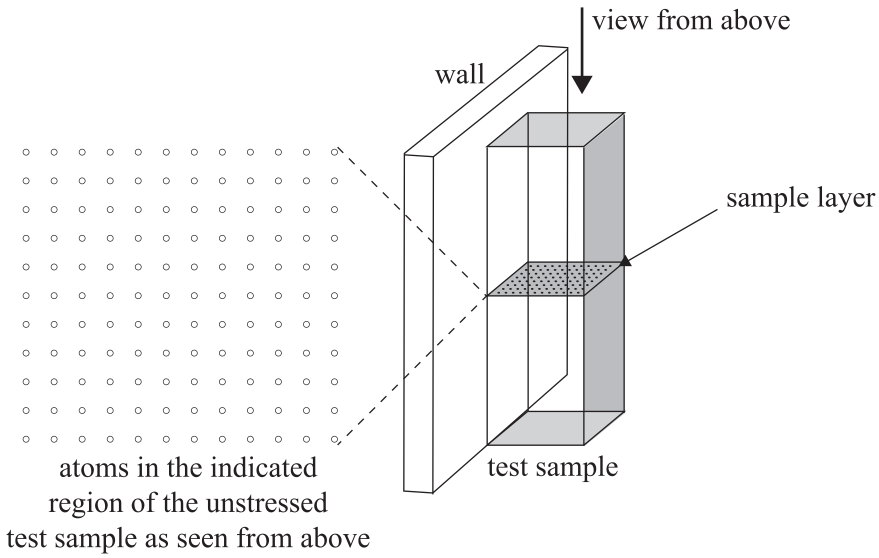


Figure 1 (repeated)

NO WRITING ALLOWED IN THIS AREA

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Question 2

The original sample, Figure 1, is repeated on the opposite page.

A stress is now applied to the sample as shown in Figure 3.

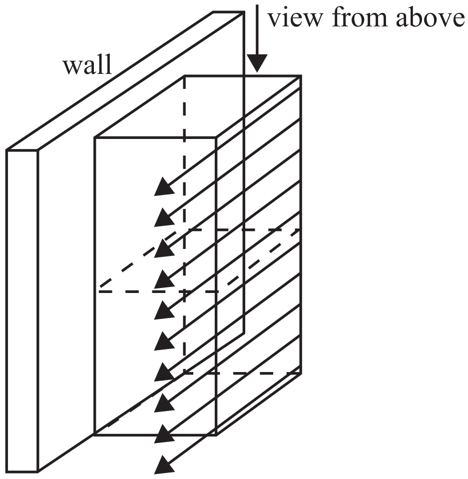
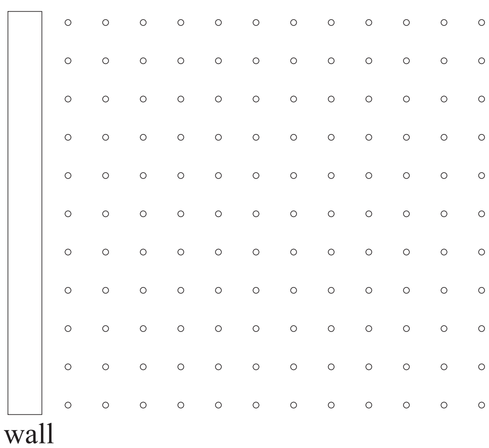


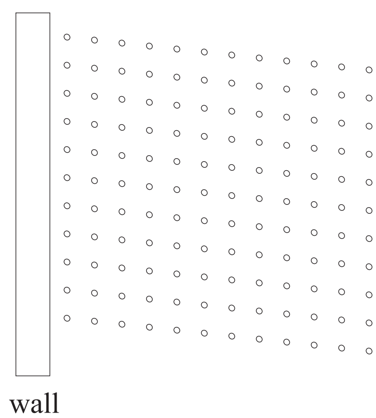
Figure 3

Which one of the figures below now shows the atomic structure in the layer of the sample as seen from above?

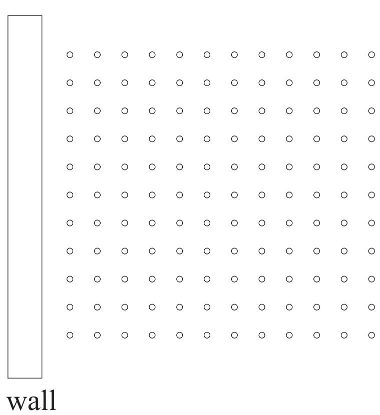
A.



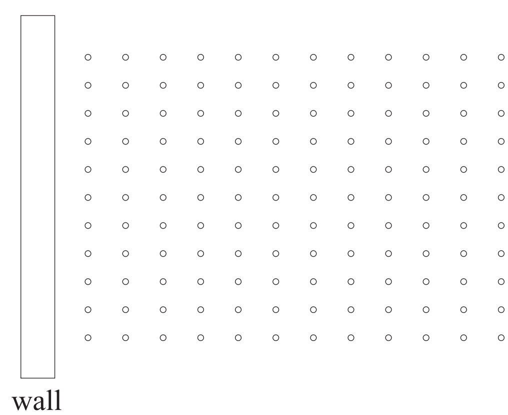
B.



C.



D.



The following information relates to Questions 3–8.

Engineers are testing steel cables for use in a lift. The first cable they test is sample X. The sample has a length of 10.0 m exactly, when unstretched.

The stress-strain graph for the material from which the cable is made is shown in Figure 4.

F represents the breaking point.

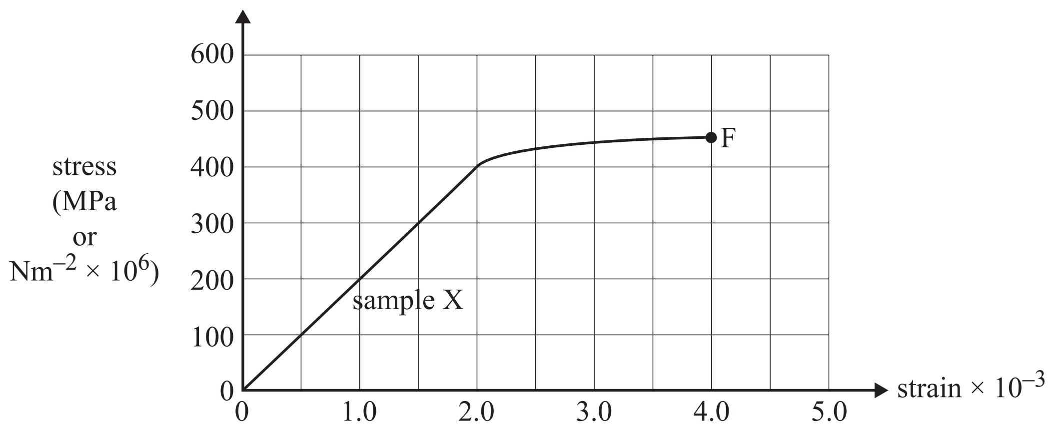


Figure 4

Question 3

Which one of the following best gives the value of Young's modulus for the steel?

A. 200 N m^{-2}

B. 400 N m^{-2}

C. 2.0×10^{11} N m^{-2}

D. 4.0×10^{11} N m^{-2}

Question 4

The sample of cable breaks at point F, when the force on it is 1.8×10^5 N.

Which one of the following is the best estimate of the cross-sectional area of the cable sample?

A. 1.25×10^{-4} m^2

B. 2.0×10^{-4} m^2

C. 4.0×10^{-4} m^2

D. 5.0×10^{-4} m^2

Question 5

Which one of the following is the best estimate of the length of the cable sample when it breaks?

A. 9.060 m

B. 10.004 m

C. 10.040 m

D. 10.400 m

NO WRITING ALLOWED IN THIS AREA

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The engineers now test another cable sample, Y, of a different material. The stress-strain graph for both X and Y are shown in Figure 5.

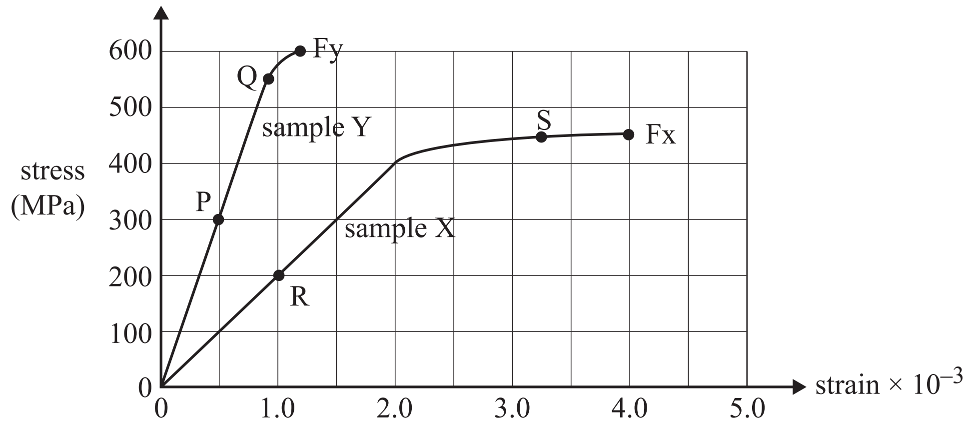

Figure 5

In successive tests, the cable Y is stretched to point P and then Q. Cable X is stretched to point R and then S.

Question 6

From which of these points (P, Q, R, S) is it likely that the cables will **not** return to their original lengths; that is, be permanently distorted?

A. none

B. S only

C. Q, R, S

D. all

Question 7

Comparing the materials in cables X and Y, which one of the following best compares their stiffness and toughness?

A. X has greater stiffness and greater toughness than Y.

B. Y has greater stiffness and greater toughness than X.

C. X has greater stiffness but lower toughness than Y.

D. Y has greater stiffness but lower toughness than X.

Question 8

The engineers test another cable (sample Z) of the same material as used in sample X. The cable (sample Z) has a stress of 300 MPa. This cable has a cross-sectional area of 10^{-4} m^2 and a length of 10 m.

Which one of the following best gives the total energy stored in the cable sample at this stress?

A. 225 J

B. 450 J

C. 2.25×10^4 J

D. 30.0 J $\times 10^6$ J

The following information relates to Questions 9 and 10.

Pete the painter has a mass of 80 kg. He is standing in the centre of a plank of mass 120 kg. The plank sits on two supports (P and Q), each 2.0 m from the centre of the plank, shown in Figure 6.

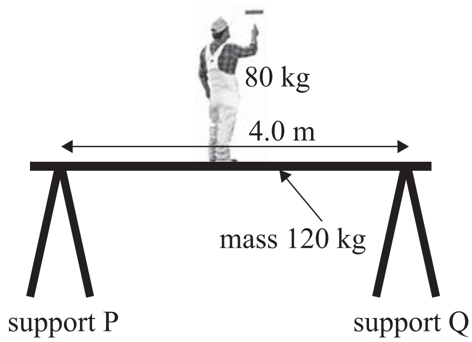

Figure 6

Question 9

Which one of the following is the best estimate of the upward force each support exerts on the plank?

A. 100 N
B. 200 N
C. 1000 N
D. 2000 N

Question 10

Pam, who has a mass of 60 kg, now takes over to complete the job. She stands at position X, 1.0 m from support Q, shown in Figure 7.

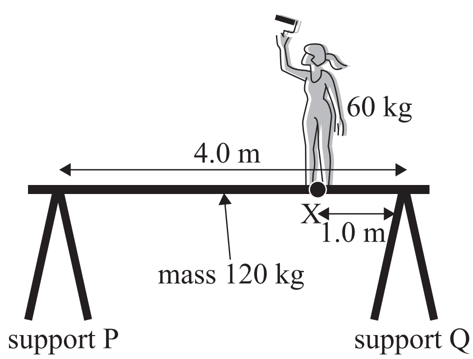

Figure 7

Which one of the following is the best estimate of the force exerted on the plank by support Q?

A. 600 N
B. 750 N
C. 900 N
D. 1050 N

NO WRITING ALLOWED IN THIS AREA

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The following information relates to Questions 11 and 12.

Engineers are designing a simple footbridge, consisting of a concrete slab. The concrete slab is reinforced with stretched steel wires embedded in it.

Question 11

Which one of the following gives the best positioning of the steel wires?

A. Near the top of the slab, because steel wires are strong in compression but weak in tension compared to concrete.

B. Near the top of the slab, because steel wires are weak in compression but strong in tension compared to concrete.

C. Near the bottom of the slab, because steel wires are strong in compression but weak in tension compared to concrete.

D. Near the bottom of the slab, because steel wires are weak in compression but strong in tension compared to concrete.

Question 12

The engineers calculate the overall strength of the slab. They find that, out to its breaking point, it has sufficient safety margin for the task.

With the bridge in place, they test the slab with a load three times the designed maximum, but still within the designed strength. The bridge sags slightly with the load, as expected.

However, when the load is removed, the bridge retains its sag.

The best explanation for this is that the material used in the slab

A. has been extended beyond its breaking point.

B. has been extended beyond its elastic limit.

C. has too large a Young's modulus.

D. has too small a Young's modulus.

Detailed study 3 – Further electronics

Catherine is designing, building and testing an AC to DC voltage-regulated power supply system.

The overall circuit design she is using is shown in Figure 1.

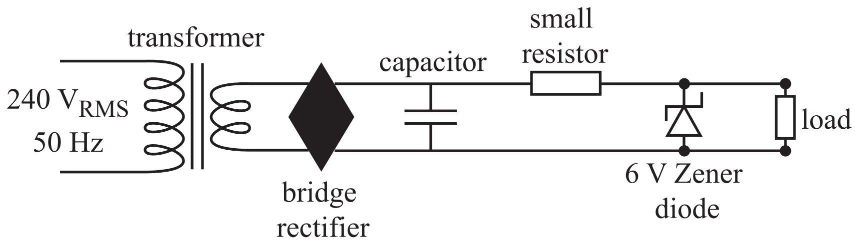

Figure 1

She removes and adds various components, and changes their values as she tests the system. In each of the following questions, the circuit she is using is shown.

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In Question 1 Catherine is testing the transformer by itself.

This is shown in Figure 2.

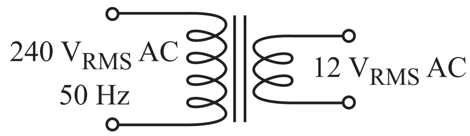


Figure 2

The primary windings are connected to a 240 V_{RMS} AC 50 Hz supply, and there are 3600 turns in the primary. The output required in the secondary is 12 V_{RMS} AC.

Question 1

Which one of the following best gives the number of turns in the secondary to provide the required 12 V output?

A. 72 000

B. 255

C. 180

D. 120

The following information relates to Questions 2 and 3.

Catherine now adds a full-wave bridge rectifier made up of four diodes. The circuit, including a load, is shown in Figure 3.

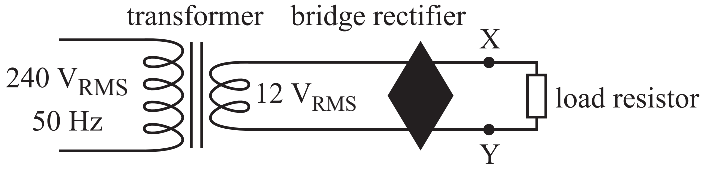


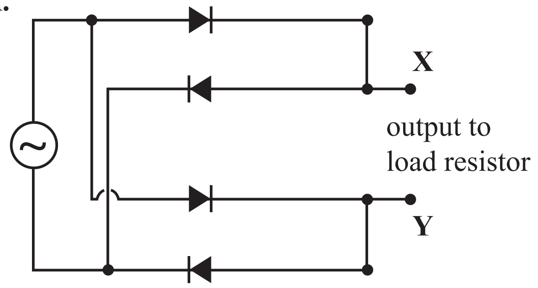
Figure 3

Question 2

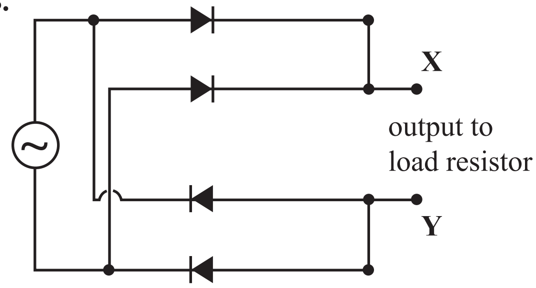
The bridge rectifier consists of four diodes mounted side by side on a heat sink, and connected by wires.

Which one of the following circuits shows the diodes correctly connected?

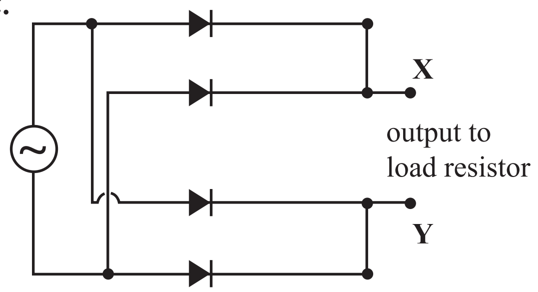
A.



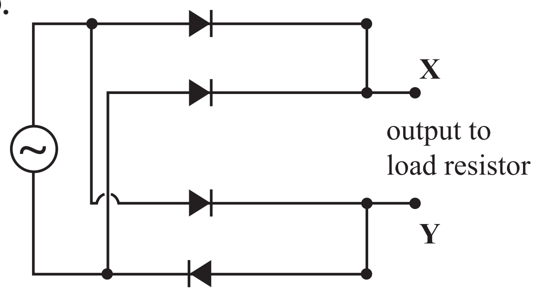
B.



C.



D.



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Question 3

The characteristic curve for each of the diodes used is shown in Figure 4.

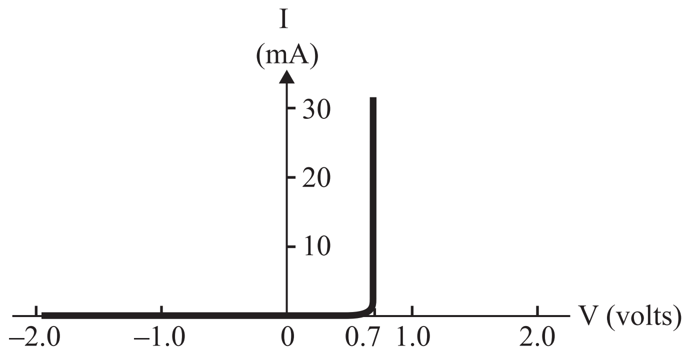

Figure 4

Catherine uses a multimeter (set on 0–20 V DC scale) to measure the voltage (potential difference) across XY.

The output current is 20 mA.

Which one of the following readings is most likely?

A. 9.2 V

B. 10.6 V

C. 11.3 V

D. 12 V

The following information relates to Questions 4 and 5.

Catherine uses an oscilloscope to test the circuit.

Catherine now connects the oscilloscope to an AC signal generator.

The vertical scale is set on 2 V/cm, and the horizontal scale on 20 ms/cm.

She observes the display on the oscilloscope, as shown in Figure 5.

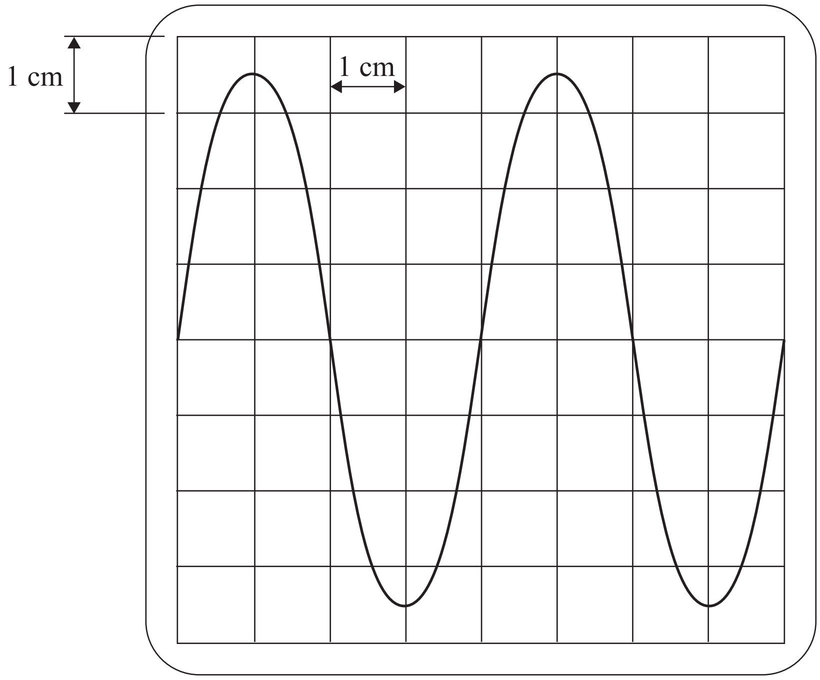

Figure 5

Question 4

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

A. 7 V
B. 10 V
C. 14 V
D. 20 V

Question 5

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

A. 12.5 Hz
B. 50 Hz
C. 63 Hz
D. 125 Hz

NO WRITING ALLOWED IN THIS AREA

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The following information relates to Questions 6–8.

Catherine now intends to add a capacitor to smooth the full-wave rectified signal. Firstly, however, she uses the following circuit shown in Figure 6 to test the value of the capacitor.

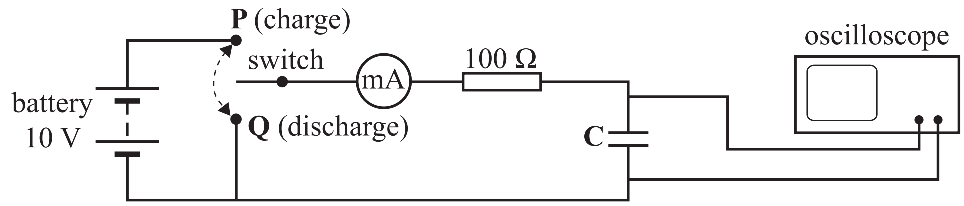

Figure 6

With the capacitor fully charged (to 10 V), she moves the switch to position Q (discharge). From the oscilloscope she plots the graph of voltage across the capacitor versus time as shown in Figure 7.

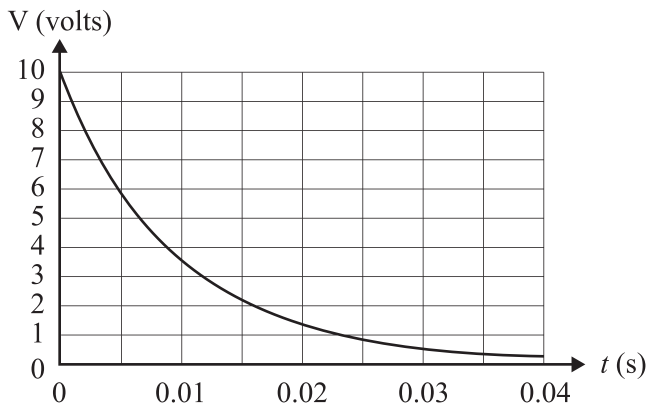

Figure 7

Question 6

Which one of the following best gives the value of the capacitor?

A. 10 μF

B. 50 μF

C. 100 μF

D. 500 μF

Question 7

Which one of the following gives the best estimate of the current through the resistor after 0.03 s?

A. 0 mA

B. 5 mA

C. 95 mA

D. 100 mA

NO WRITING ALLOWED IN THIS AREA

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Question 8

This capacitor is now to be used to smooth a half-wave rectified, 50 Hz, 10 V peak signal. The unsmoothed signal is shown below in Figure 8.

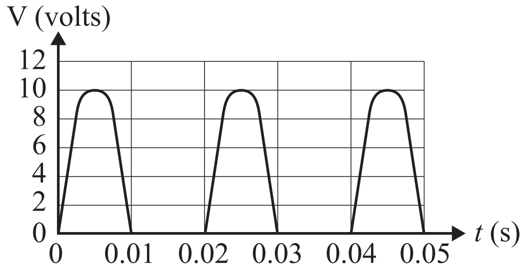


Figure 8

The circuit, as shown in Figure 9 below, is set up.

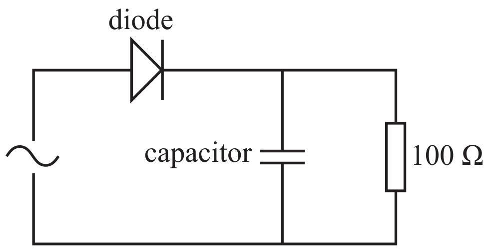
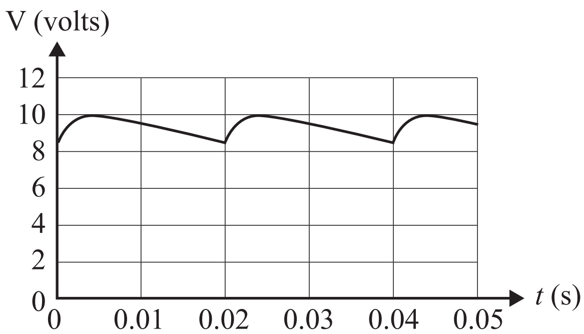


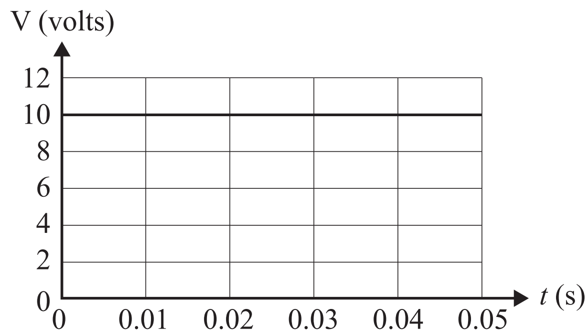
Figure 9

Which one of the following best shows the signal after the smoothing capacitor is added?

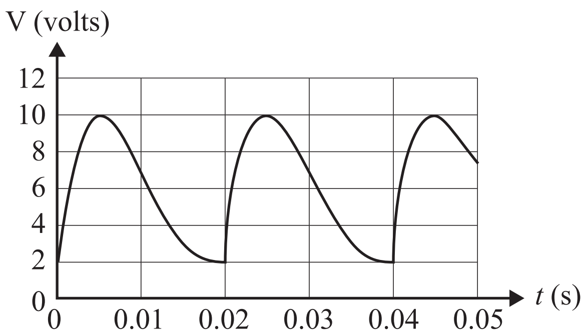
A.



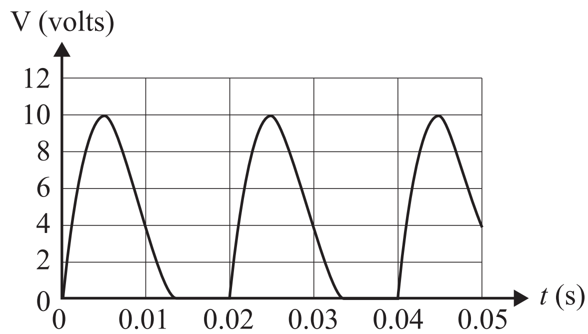
B.



C.



D.



The following information relates to Questions 9 and 10.

Catherine now sets up the whole smoothed power supply, incorporating a Zener diode, a suitable small protection resistor R (which may be ignored), and a load resistor of 100 Ω.

The circuit is shown in Figure 10.

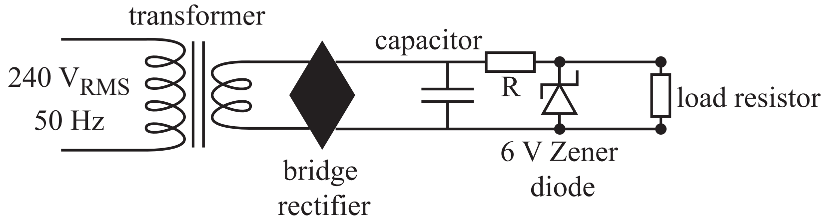


Figure 10

With the 100 Ω load resistor, she measures the output signal as shown in Figure 11 below.

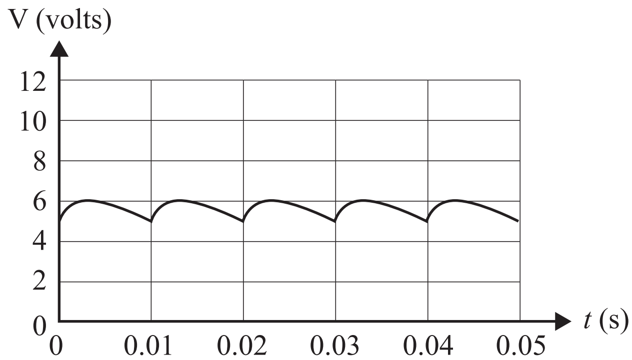
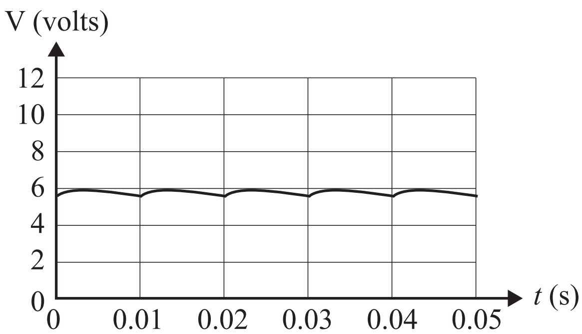


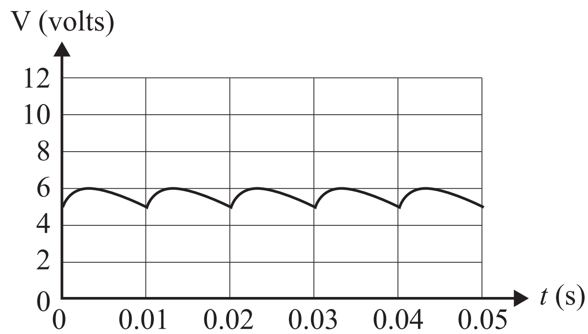
Figure 11

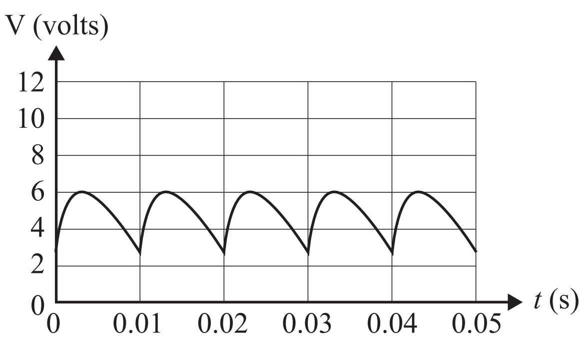
She now replaces the 100 Ω load resistor with a 30 Ω resistor.

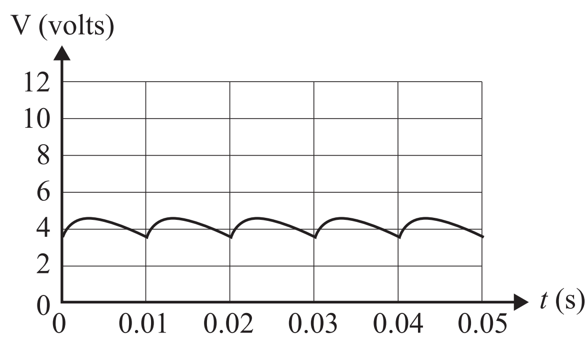
Question 9

Which one of the following best shows the effect on the ripple voltage of replacing the 100 Ω resistor with the 30 Ω resistor?

A. 

B. 

C. 

D. 

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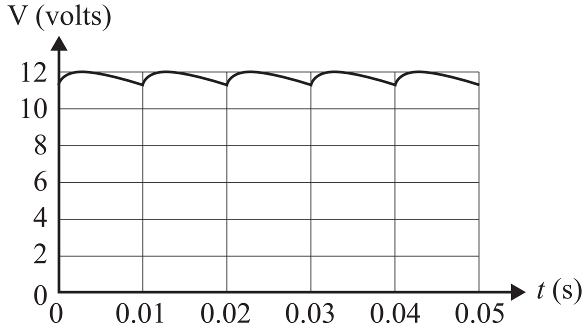
Question 10

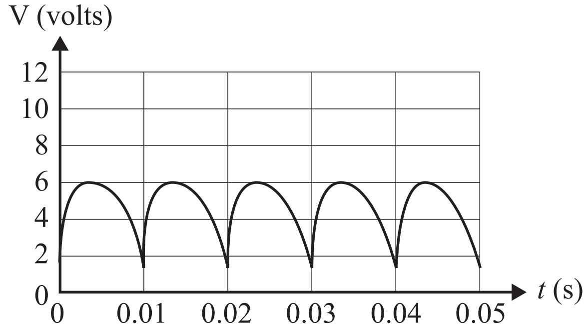
Catherine puts back the original 100 Ω load resistor. She selects a different output of the transformer so that the input to the bridge rectifier increases from 12 V to 20 V.

Which one of the following best shows the effect on the output signal (with the original 100 Ω load resistor)?

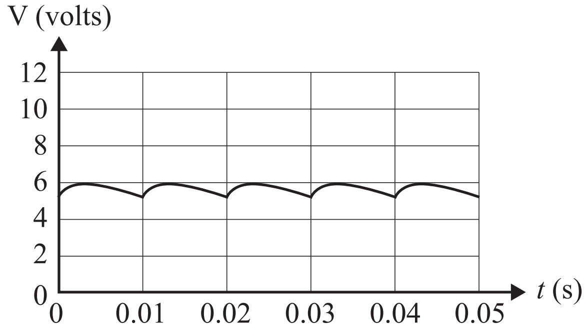
A.



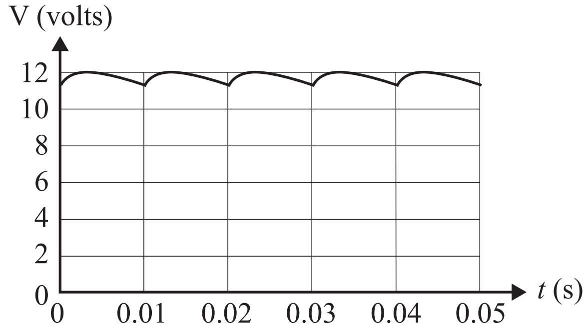
B.



C.



D.



Question 11

Catherine resets the transformer so that the input to the bridge rectifier is back to 12 V, and sets up the circuit so that it is as shown in Figure 12 below.

A different load resistor is used.

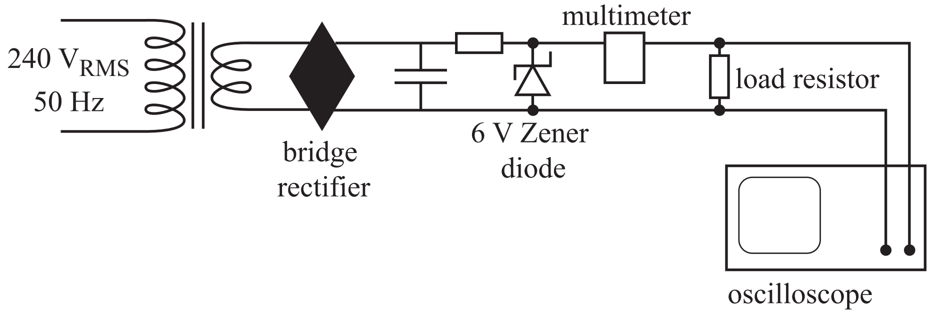


Figure 12

The multimeter is set on DC amps, on the 0–20 mA range.

The oscilloscope is set on 1 V/cm vertically, with the zero line at the bottom of the display.

The horizontal scale is 5 ms/cm.

The reading on the multimeter is 20 mA.

The display on the oscilloscope is shown in Figure 13.

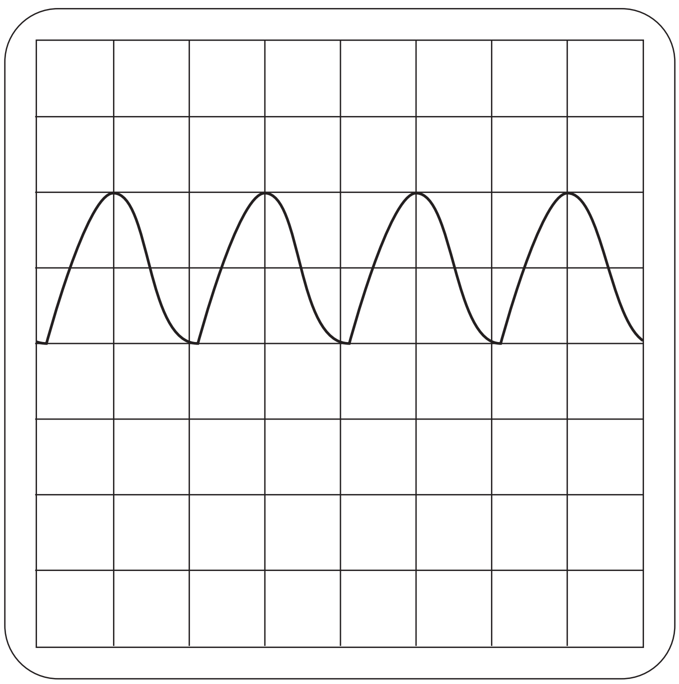


Figure 13

Which one of the following best gives the power dissipated in the load resistor?

A. 0.01 W

B. 0.08 W

C. 0.1 W

D. 1.2 W

NO WRITING ALLOWED IN THIS AREA

NO WRITING ALLOWED IN THIS AREA

Question 12

In her experiment, Catherine has mounted the Zener diode on a heat sink.

Which one of the following best describes the purpose of the heat sink?

A. The heat sink shields the Zener diode from outside heat.

B. When the input voltage to the Zener diode is above 6 V, some current passes through the Zener diode, heating it. The heat sink removes this heat.

C. The Zener diode needs to be at a temperature above 20° C to operate, and the heat sink maintains this temperature.

D. The whole output current passes through the Zener diode heating it. The heat sink removes this heat.

END OF QUESTION AND ANSWER BOOK

Victoria
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Victorian Certificate of Education
2010

PHYSICS

Written examination 1

Tuesday 8 June 2010
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.

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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	$V_{\text{RMS}} = \frac{1}{2\sqrt{2}}V_{\text{p-p}} \qquad I_{\text{RMS}} = \frac{1}{2\sqrt{2}}I_{\text{p-p}}$
16	voltage; power	$V = RI \qquad P = VI = I^2R$

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 : $\tau = \mathrm{RC}$
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