



INSIGHT

Year 12 Trial Exam Paper

2013

PHYSICS

Written examination

STUDENT NAME:

QUESTION BOOK II – DETAILED STUDIES

Reading time (Core & Detailed Studies): 15 minutes

Writing time (Core & Detailed Studies): 2 hours 30 minutes

Structure of book

<i>Section</i>	<i>Number of detailed studies</i>	<i>Number of detailed studies to be answered</i>	<i>Number of marks</i>
B – Detailed Studies	6	1	22
Total			22

- 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 **Core** question and answer book of 43 pages, with a separate data sheet.
- The **Detailed studies** question and book of 43 pages
- 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 unauthorised electronic devices into the examination.

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SECTION B**Instructions for Section B**

Select **one** Detailed study and answer **all** questions within that Detailed study in pencil on the answer sheet provided for multiple-choice questions.

Show the Detailed study you are answering by shading the matching box on your multiple-choice answer sheet and writing the name of the Detailed study in the box provided.

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Detailed study 1 – Einstein’s special relativity**Question 1**

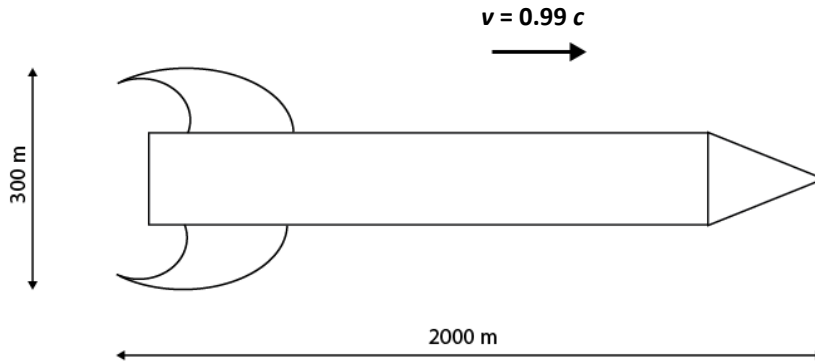
An alpha particle (rest mass 6.64×10^{-27} kg) is accelerated to $0.95c$.

Which one of the following is closest to its relativistic mass?

- A. 2.97×10^{-26} kg
- B. 2.13×10^{-26} kg
- C. 6.81×10^{-26} kg
- D. 6.64×10^{-27} kg

Question 2

A passenger in a spaceship measures the ship as having the dimensions shown in Figure 1. The ship moves past a stationary observer at $0.99c$.

**Figure 1**

What dimensions does the spaceship appear to have to the observer?

- A. $14\,180\text{ m} \times 2130\text{ m}$
- B. $282\text{ m} \times 42.3\text{ m}$
- C. $2000\text{ m} \times 42.3\text{ m}$
- D. $282\text{ m} \times 300\text{ m}$

Question 3

A spacecraft (rest mass $7.0 \times 10^{12}\text{ kg}$) fires its engines to accelerate from $0.90c$ to $0.98c$. What quantity of work is done on the spacecraft in this process?

- A. $1.72 \times 10^{30}\text{ J}$
- B. $3.15 \times 10^{30}\text{ J}$
- C. $1.45 \times 10^{30}\text{ J}$
- D. $4.6 \times 10^{30}\text{ J}$

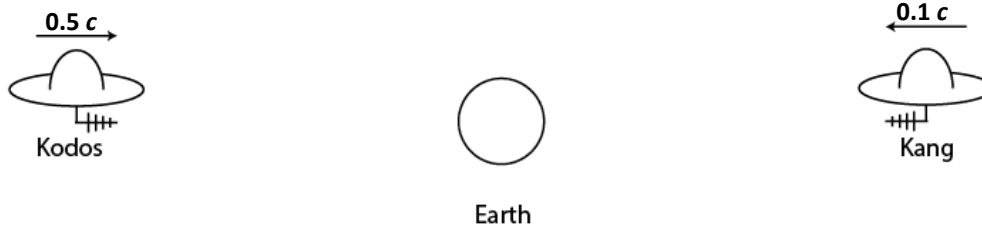
Question 4

10 000 radioactive particles with a half-life of $5.00 \times 10^{-5}\text{ s}$ are released from geostationary orbit above the Earth. Observers on the ground measure the particles' travel time as being $1.00 \times 10^{-4}\text{ s}$. Detectors on the ground measure only 625 radioactive particles arriving. What is the value of γ for the particles during their journey?

- A. 1.5
- B. 2
- C. 3
- D. 10

Question 5

Figure 2 shows two aliens in UFOs, Kang and Kodos, approaching planet Earth from opposite directions. Kang is travelling at $0.1c$ and Kodos is travelling at $0.5c$. When they are both 1 million kilometres away, they each fire a laser beam at Earth.

**Figure 2**

Which of the following statements is correct from the point of view of Earth?

- A. Kodos is travelling faster than Kang so his laser arrives first.
- B. Kang experiences less time dilation than Kodos so his laser arrives first.
- C. The Doppler effect means that Kodos's laser arrives first.
- D. Both lasers arrive at the same time.

Question 6

In which of the following situations will Newton's laws of motion NOT be observed?

- A. On a train travelling at 100 km/h in a straight line
- B. In a rocket ship travelling at a constant $0.99c$
- C. Inside a bus travelling at 20 km/h around a corner
- D. In a laboratory on the surface of the Earth

Question 7

Boris is in a spaceship moving at $0.8c$ relative to Allan. Both are holding large clocks. Allan and Boris watch each other through powerful telescopes.

Which of the following statements is true?

	Allan sees ...	Boris sees ...
A.	Boris's clock ticking slowly	Allan's clock ticking normally
B.	Boris's clock ticking quickly	Allan's clock ticking normally
C.	Boris's clock ticking slowly	Allan's clock ticking slowly
D.	Boris's clock ticking quickly	Allan's clock ticking quickly

Question 8

The development of Einstein's special relativity resulted in many previous assumptions being overturned.

Which scientist's assumptions were proved wrong by special relativity?

- A.** Newton's absolute space and time
- B.** Galileo's principle of relativity
- C.** Maxwell's equations of electromagnetism
- D.** Michelson's measurements of the speed of light

Use the following information to answer Questions 9 and 10.

An observer in a space station, equidistance between two planets, Alpha and Beta, observes flashes of light occurring on both planets simultaneously. Another observer watches both planets from the same position as the stationary observer but is moving towards Beta at close to the speed of light. The arrangement is shown in Figure 3.

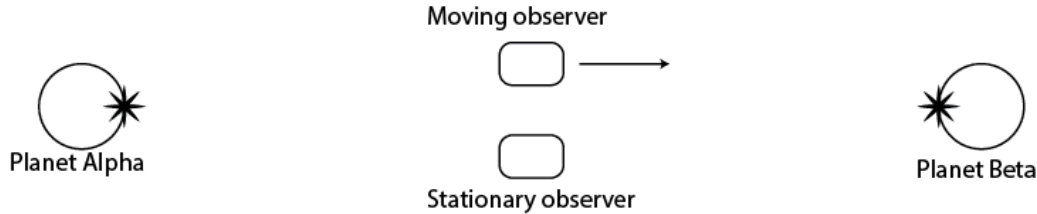


Figure 3

Question 9

Which of the following best describes how the moving observer sees the flashes?

- A. She sees the flashes occur simultaneously.
- B. She sees the flash at Beta before the flash at Alpha.
- C. She sees the flash at Beta after the flash at Alpha.
- D. She never sees the flash at Alpha.

Question 10

The stationary observer measures the distance to Beta as 1.00×10^{16} km. The moving observer measures the distance to Beta (as she passes the stationary observer) as 2.50×10^{15} km.

With what fraction of the speed of light is the moving observer moving?

- A. $0.97c$
- B. $0.94c$
- C. $0.75c$
- D. $0.25c$

Question 11

It is estimated that the world produced 1.695×10^{11} GJ of energy from burning coal in 2011. How much matter would need to be destroyed to produce an equivalent amount of energy?

- A. 5.65×10^{11} kg
- B. 565 kg
- C. 1883 kg
- D. 1.88×10^{-6} kg

End of Detailed study 1
SECTION B – continued
TURN OVER

SECTION B**Instructions for Section B**

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Detailed study 2 – Materials and their use in structures

Use the following information to answer Questions 1–5.

Engineers are testing a sample of steel cable. The steel's properties are shown in Figure 1. The sample they are testing has a radius of 1.0 cm and is 2.0 m long.

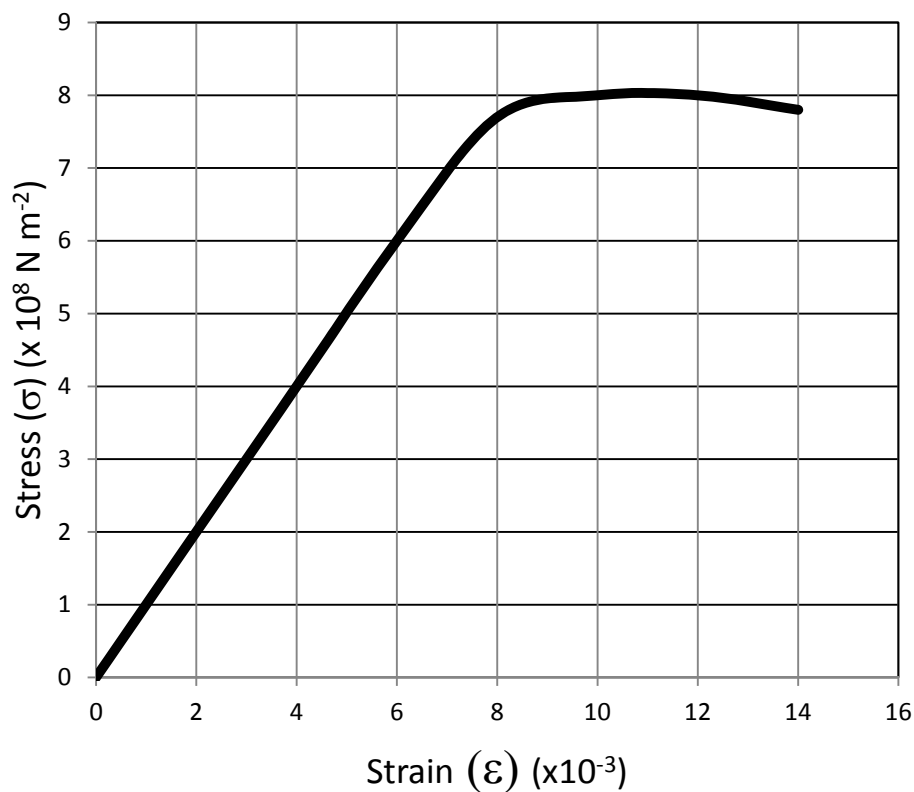


Figure 1

Question 1

What is the magnitude of the force required to apply a stress of $6 \times 10^8 \text{ N m}^{-2}$ to the steel?

- A. $6.0 \times 10^6 \text{ N}$
- B. $1.9 \times 10^5 \text{ N}$
- C. $1.9 \times 10^7 \text{ N}$
- D. $6.0 \times 10^8 \text{ N}$

Question 2

How far will the cable stretch when a stress of $6 \times 10^8 \text{ N m}^{-2}$ is applied?

- A. $6.0 \times 10^{-3} \text{ m}$
- B. 6.0 m
- C. 1.2 m
- D. $1.2 \times 10^{-2} \text{ m}$

Question 3

How much energy is stored in the cable when a stress of $6 \times 10^8 \text{ N m}^{-2}$ is applied?

- A. $1.1 \times 10^3 \text{ J}$
- B. $2.2 \times 10^3 \text{ J}$
- C. $1.1 \times 10^5 \text{ J}$
- D. $2.2 \times 10^5 \text{ J}$

Question 4

Which of the following is the closest to the value of Young's modulus for the steel?

- A. 1.0 Pa
- B. $1.0 \times 10^5 \text{ Pa}$
- C. $1.0 \times 10^{11} \text{ Pa}$
- D. $1.0 \times 10^{13} \text{ Pa}$

The sample of steel cable is compared to another type of steel. The properties of these two materials are shown in Figure 2.

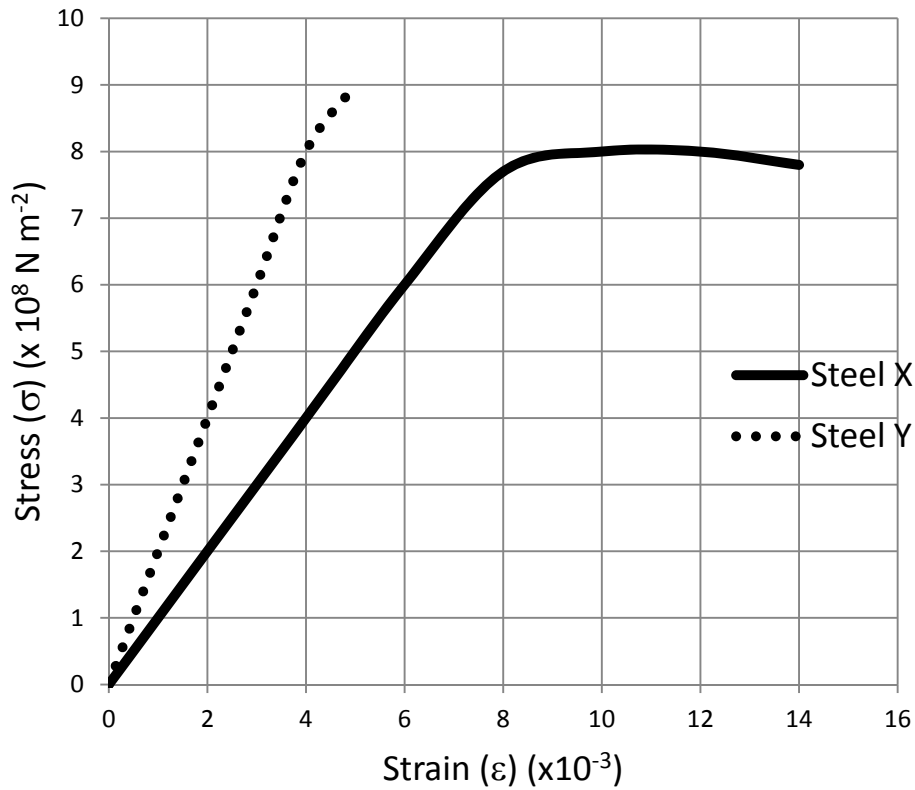


Figure 2

Question 5

Which of the following is correct?

	Strongest	Stiffest	Toughest
A.	Y	Y	X
B.	X	X	Y
C.	X	Y	X
D.	Y	X	Y

Use the following information to answer Questions 6 and 7.

A 2000 kg balcony rests on a pair of poles as shown in Figure 3. The balcony is not attached to the poles.

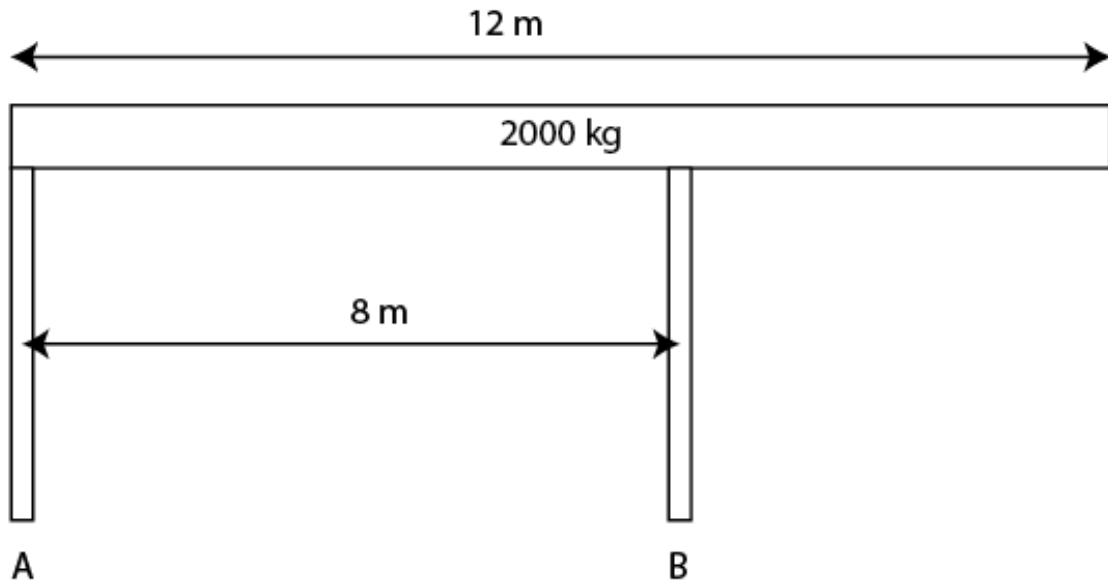


Figure 3

Question 6

What is the magnitude of the upward force of pole B on the balcony?

- A. 2.0 kN
- B. 5.0 kN
- C. 10.0 kN
- D. 15.0 kN

Question 7

What is the maximum number of people (mass 70 kg each) that can stand at the overhanging edge of the balcony without toppling the structure?

- A. 10
- B. 14
- C. 18
- D. 22

Use the following information to answer Questions 8 and 9.

The veranda on a house extends 3.4 m from the wall and is supported by a single cable as shown in Figure 4. Four forces have been drawn in dotted lines.

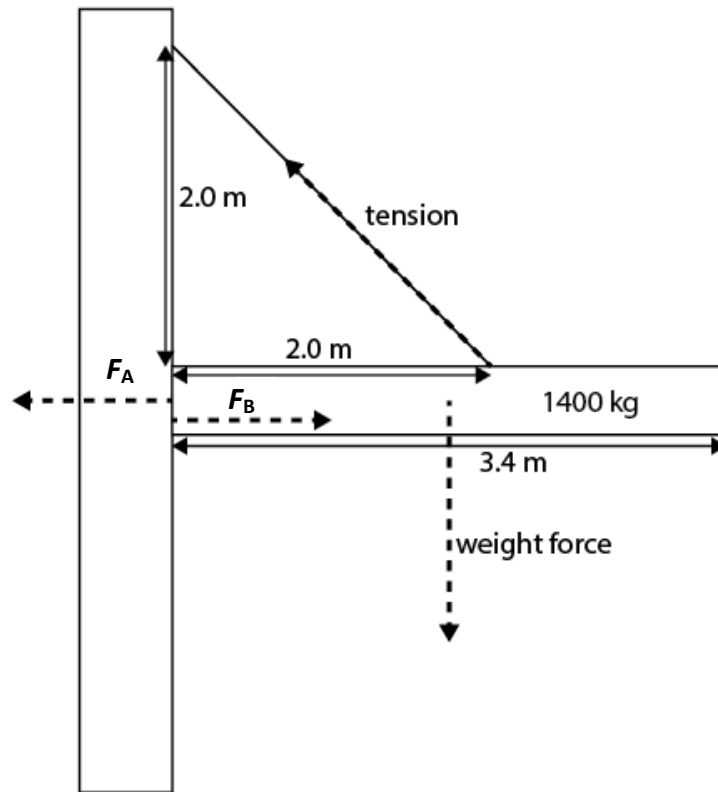


Figure 4

Question 8

What is the magnitude of the tension force in the cable?

- A. 10 kN
- B. 12 kN
- C. 14 kN
- D. 17 kN

Question 9

What is the magnitude of the force of the wall on the veranda, F_B ?

- A. 10 kN
- B. 12 kN
- C. 14 kN
- D. 17 kN

Question 10

A suspended walkway is to be built from concrete suspended from cables as shown in Figure 5.

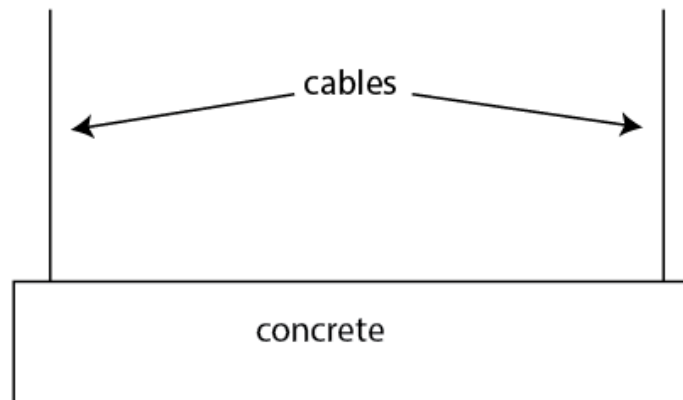
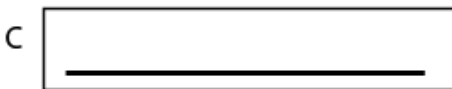
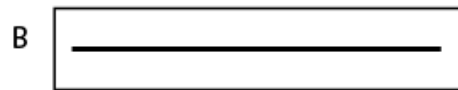
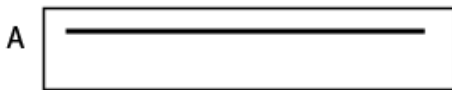


Figure 5

If the concrete is to be reinforced with steel, which one of the sketches below shows the best placement of steel reinforcement?



Question 11

The property of steel that makes it useful for reinforcing concrete is its

- A. brittleness.
- B. tensile strength.
- C. compressive strength.
- D. plasticity.

End of Detailed study 2
SECTION B – continued
TURN OVER

SECTION B**Instructions for Section B**

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Detailed study 3 – Further electronics

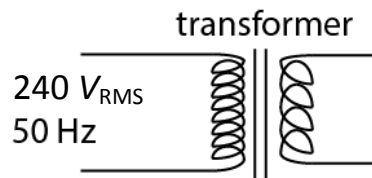
Use the following information to answer Questions 1 and 3.

Patrick is constructing an AC to DC voltage-regulated power supply system. His intention is to build one that includes a transformer, a full-wave bridge rectifier, a capacitor and a zener diode.

He tests each of the components individually first.

Question 1

The primary coil of Patrick's transformer, shown in Figure 1, is connected to the $240 V_{\text{RMS}}$ 50 Hz AC mains power supply. The primary coil has 6000 turns and the secondary has 500 turns.

**Figure 1**

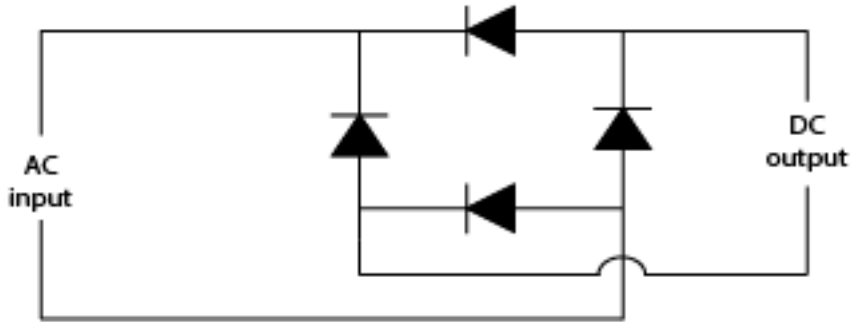
Which of the following is the voltage across the terminals of the secondary coil?

- A. $28 V_{\text{peak}}$
- B. $40 V_{\text{P-P}}$
- C. $240 V_{\text{RMS}}$
- D. $12 V_{\text{RMS}}$

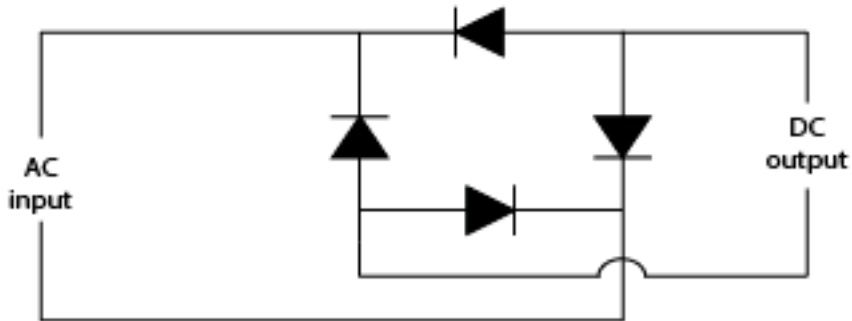
Question 2

Patrick considers four designs for his full-wave bridge rectifier. Which of the following designs will work correctly?

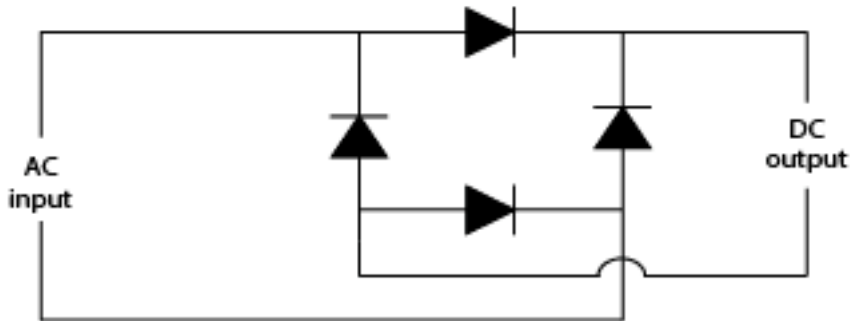
A.



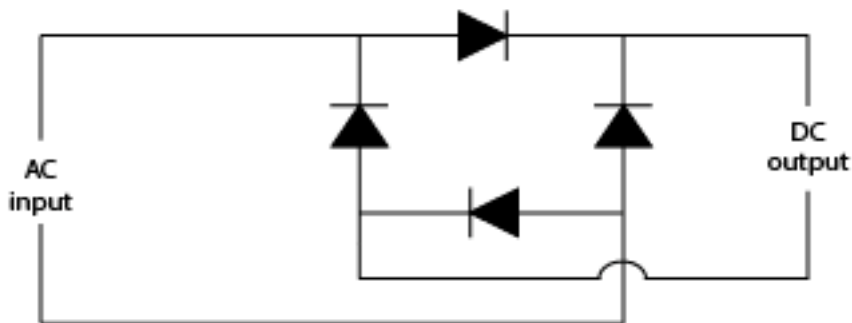
B.



C.



D.



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Question 3

The diodes used in the bridge rectifier have characteristics shown in Figure 2.

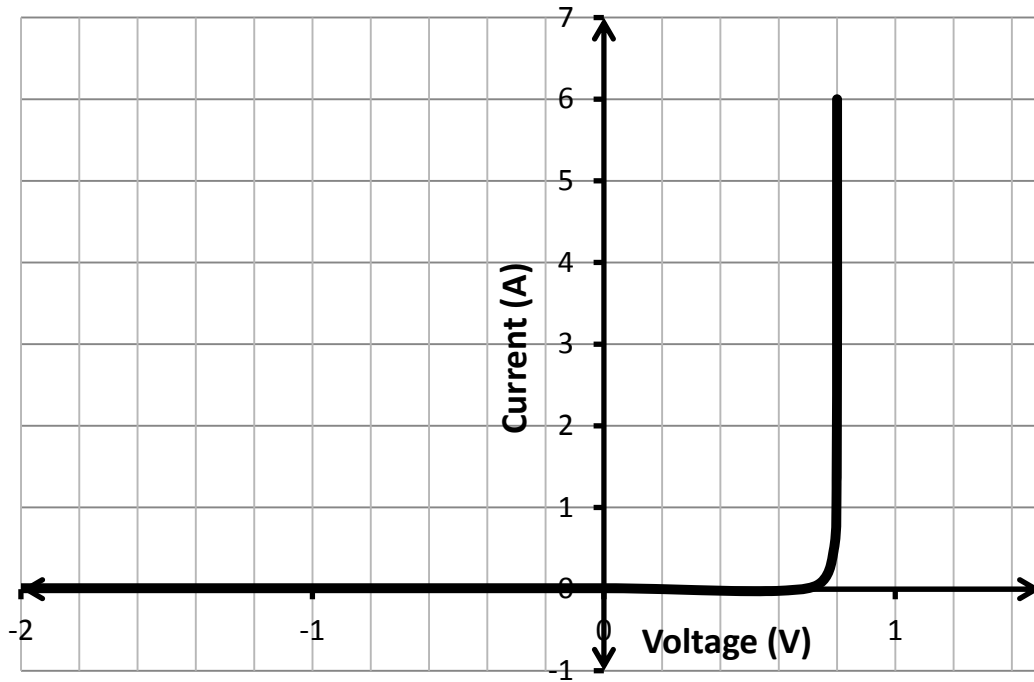


Figure 2

If $20 V_{\text{RMS}}$ is used as the AC input, what will be the magnitude of the DC output voltage?

- A. $20.0 V_{\text{RMS}}$
- B. $19.2 V_{\text{RMS}}$
- C. $12.0 V_{\text{RMS}}$
- D. $18.4 V_{\text{RMS}}$

Use the following information to answer Questions 4–6.

Patrick sets up a separate circuit to test a capacitor. With the circuit he can charge and discharge the capacitor with a 20 V DC power supply. He connects the circuit to a cathode ray oscilloscope as shown in Figure 3.

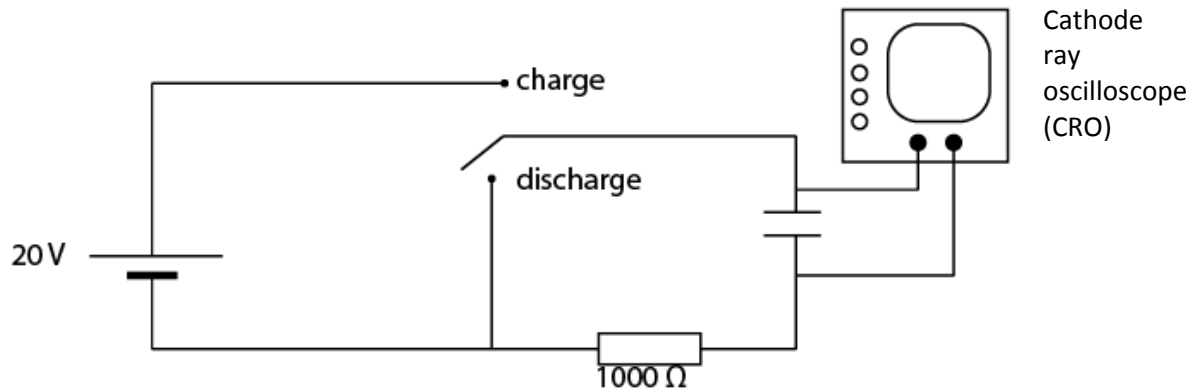


Figure 3

When he discharges the capacitor, he records the voltage as shown in Figure 4.

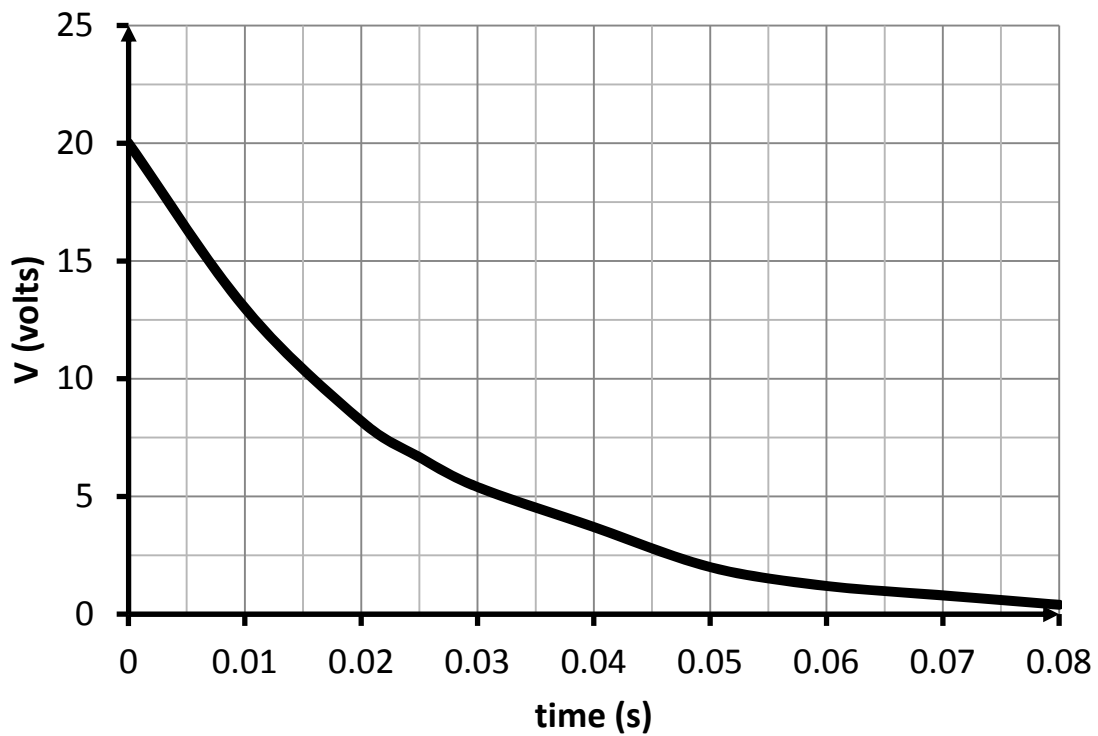


Figure 4

Question 4

What is the best value for the capacitance of the capacitor?

- A. 0.025 F
- B. 2.5 μF
- C. 25 μF
- D. 0.25 μF

Question 5

The time constant for the charging cycle is much smaller than the discharging time constant when the capacitor is placed in this arrangement.

What is the best explanation for this?

- A. The capacitor has a built-in bias that favours charging over discharging.
- B. The power supply resists the discharge cycle.
- C. The resistance of the circuit when charging is much lower than when discharging.
- D. The time constant is measured differently during discharge.

Question 6

How long does it take for the capacitor to fully discharge?

- A. 0.125 s
- B. 0.025 s
- C. 0.25 s
- D. 0.05 s

Use the following information to answer Questions 7 and 8.

Patrick tests a zener diode in an arrangement shown in Figure 5. The diode conducts at 6.5 V and is rated at 2.0 W. The load in this case is a variable resistor.

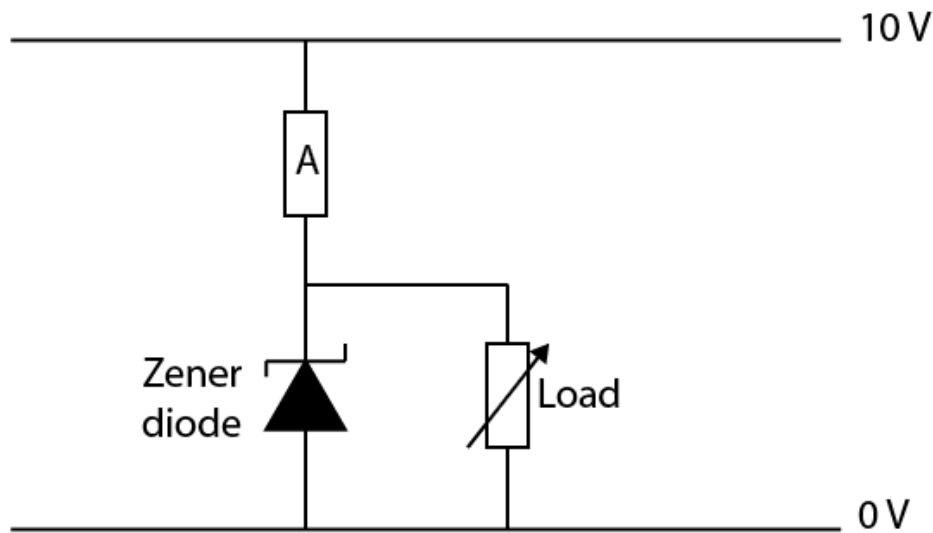


Figure 5

Question 7

What is the best value for R_A if current through the load is to be maximised?

- A. 3000 Ω
- B. 150 Ω
- C. 30 Ω
- D. 15 Ω

Question 8

Consider the following quantities:

- I_A – current through resistor A
- I_l – current through the load
- I_z – current through zener diode
- V_A – voltage across resistor A
- V_l – voltage across the load
- V_z – voltage across zener diode

If the supply voltage momentarily increased to 12 V, which of the quantities would also increase?

- A. I_A, I_z, V_A
- B. I_A, I_l, V_A
- C. I_A, I_l, I_z, V_A
- D. $I_A, I_l, I_z, V_A, V_l, V_z$

Patrick now tests his circuit. He begins with just a transformer and a working full-wave bridge rectifier as shown in Figure 6.

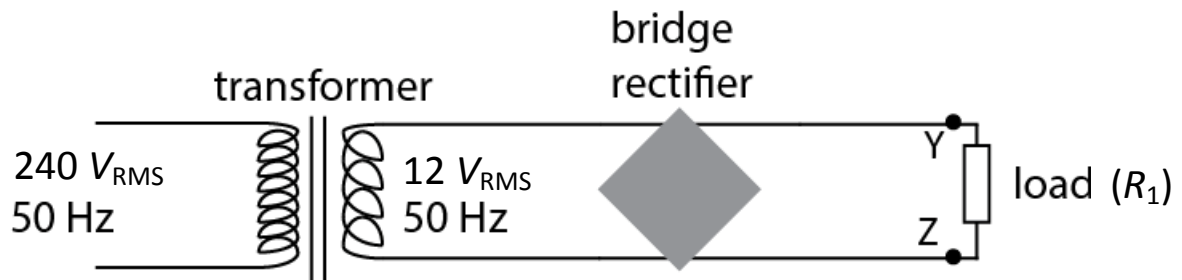
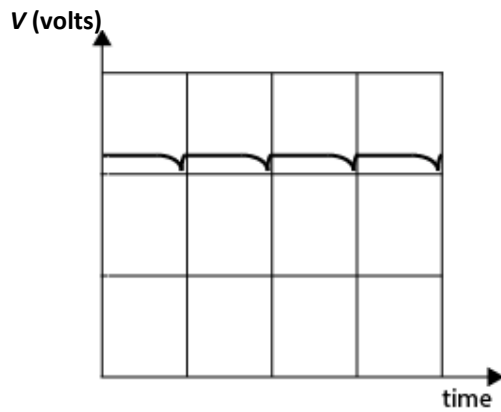


Figure 6

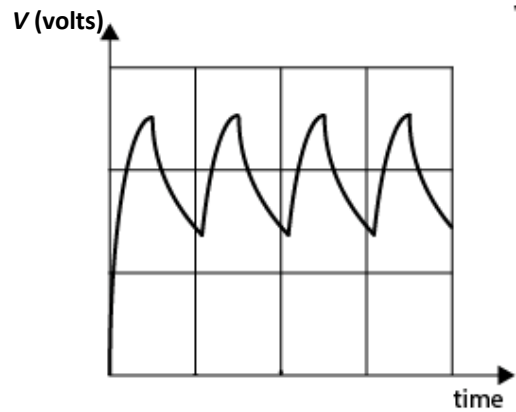
Question 9

When Patrick connects his cathode ray oscilloscope to points Y and Z, which of the following traces will he observe?

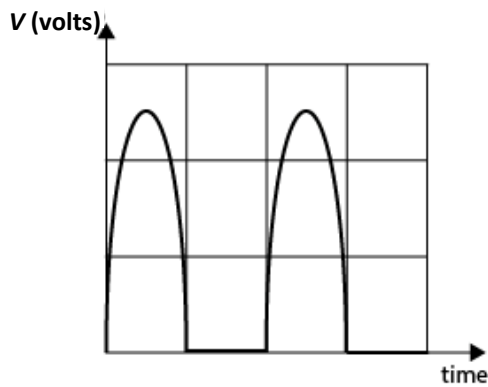
A.



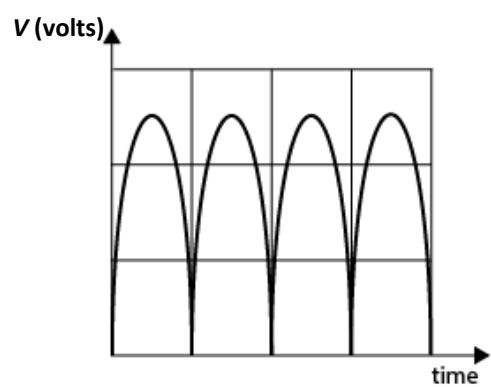
B.



C.



D.



Question 10

Patrick now connects a $50 \mu\text{F}$ capacitor as shown in Figure 7. The bridge rectifier and transformer are unchanged. The load resistance R_1 is 600Ω .

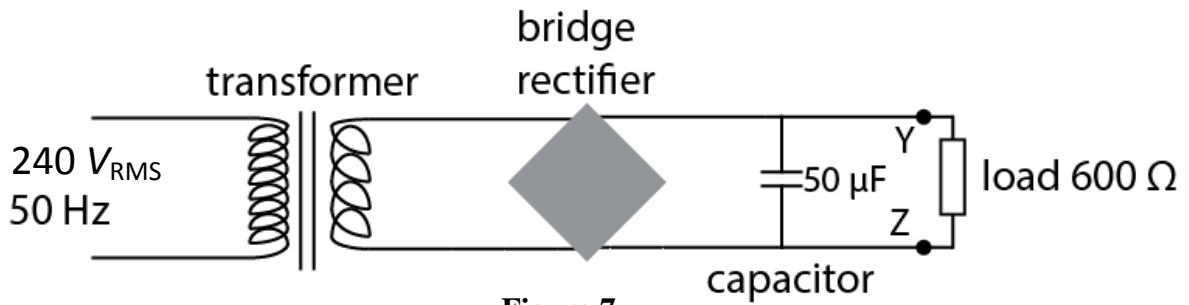
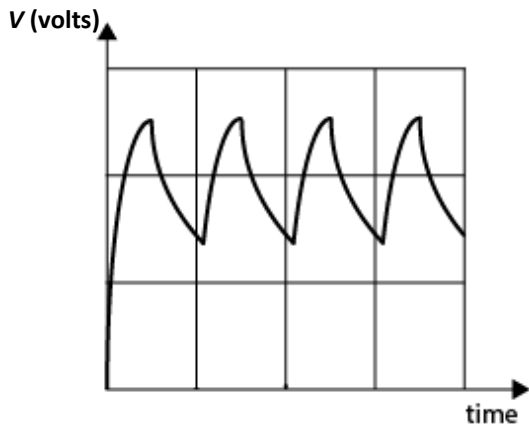


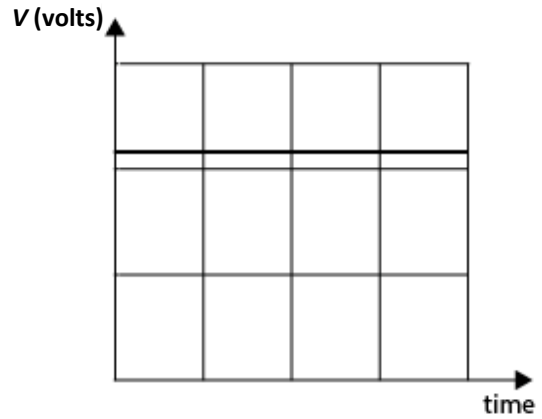
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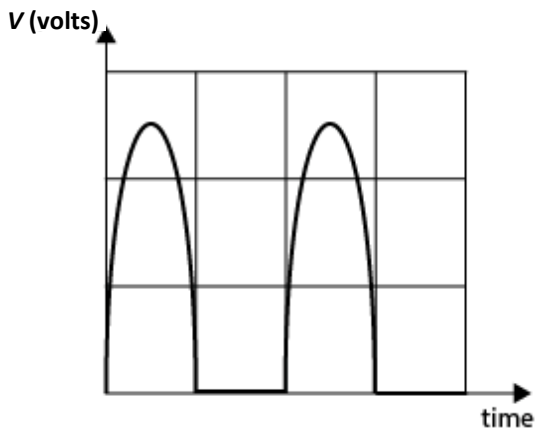
A.



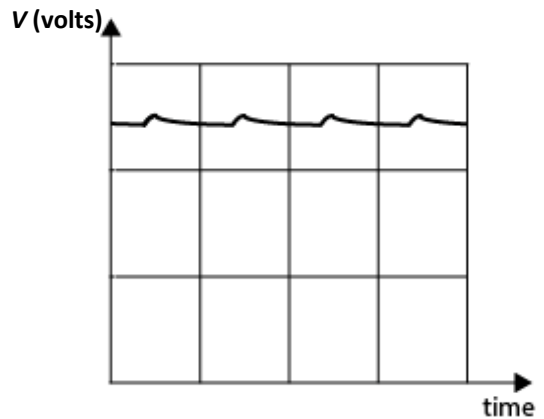
B.



C.



D.



Question 11

Patrick now connects a 6.5 V zener diode as shown in Figure 8. The other components remain unchanged.

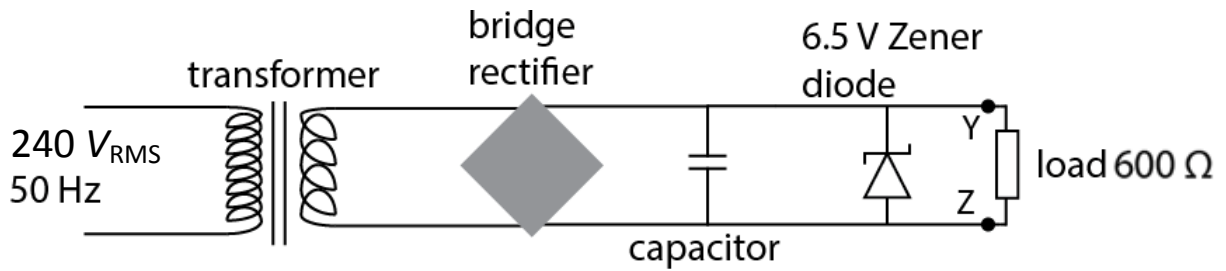
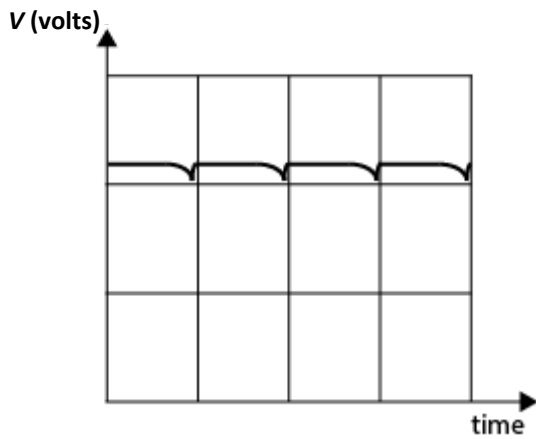


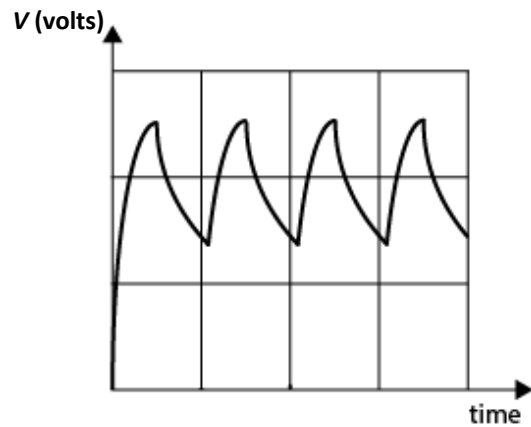
Figure 8

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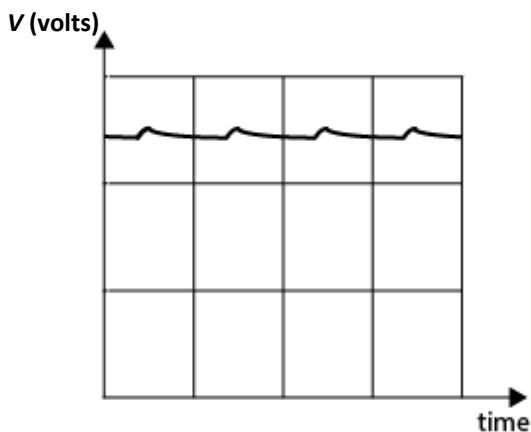
A.



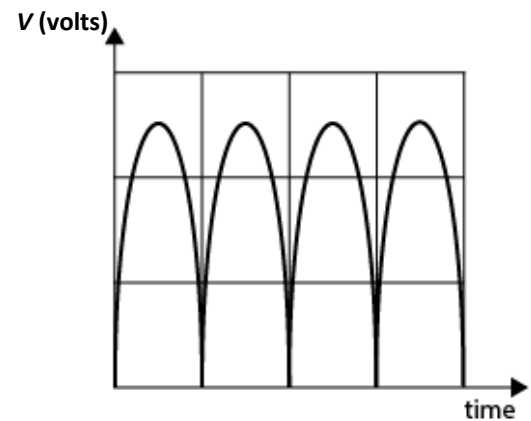
B.



C.



D.



**End of Detailed study 3
SECTION B – continued
TURN OVER**

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Detailed study 4 – Synchrotron and its applications**Question 1**

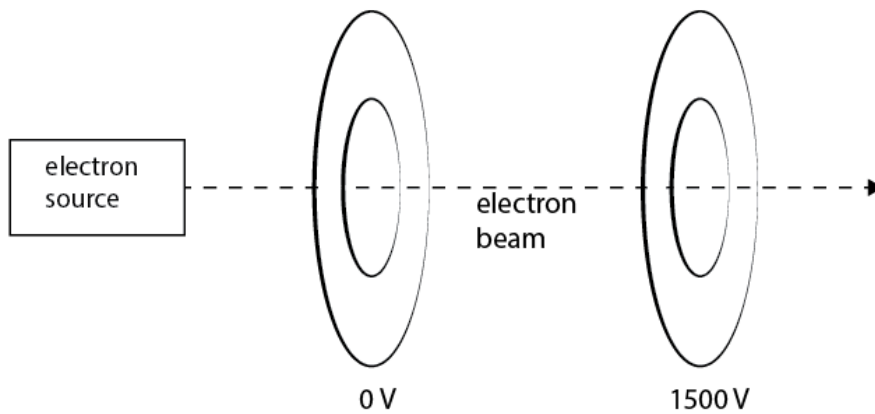
Synchrotrons are a very useful source of X-ray radiation for researchers but they are not the only source of X-rays.

What feature of synchrotron radiation makes it more useful than X-ray lasers or X-ray tubes?

- A.** Synchrotron radiation has lower collimation than other sources.
- B.** It is more cost effective than other sources.
- C.** A wider range of frequencies is available than from other sources.
- D.** It is less harmful to humans than other sources.

Question 2

An electron gun takes electrons with effectively zero kinetic energy and accelerates them between two plates with potential difference as shown in Figure 1.

**Figure 1**

What speed do the electrons have when released from this gun?

- A. $5.7 \times 10^{16} \text{ m s}^{-1}$
- B. $1.6 \times 10^7 \text{ m s}^{-1}$
- C. $2.3 \times 10^7 \text{ m s}^{-1}$
- D. $5.3 \times 10^{14} \text{ m s}^{-1}$

Use the following information to answer Questions 3 and 4.

Electrons from a linear accelerator are fired into a strong magnetic field at a uniform velocity of $2.0 \times 10^6 \text{ m s}^{-1}$ as shown in Figure 2. Four detectors are placed every 0.5 m either side of the electron beam. Each detector is 10 cm wide.

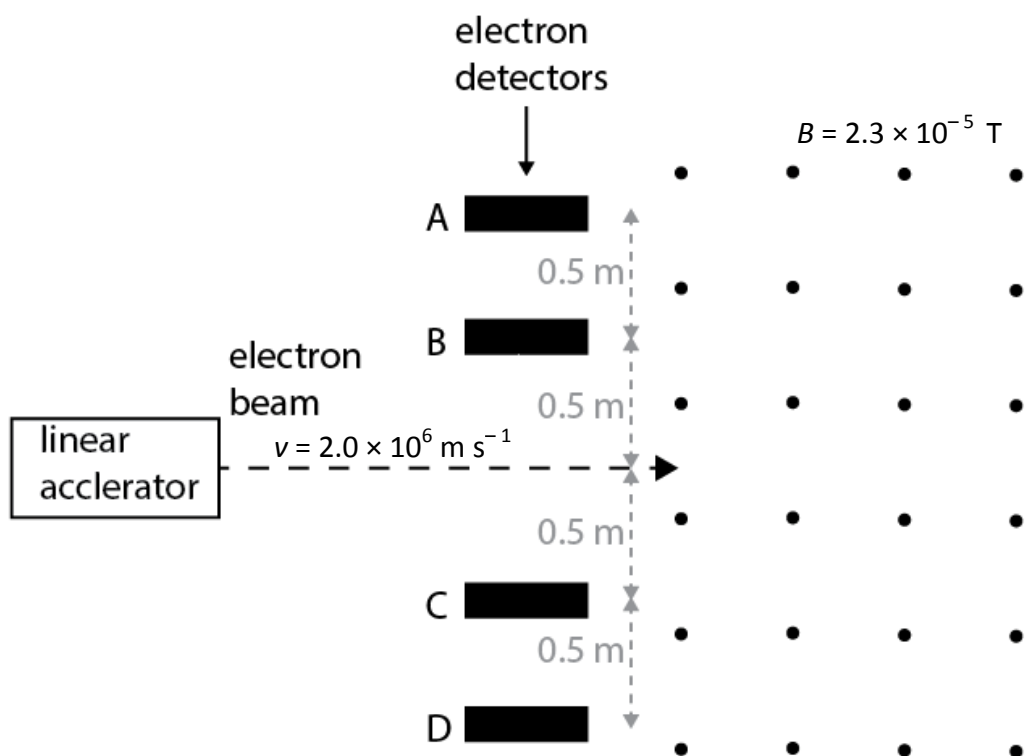


Figure 2

Question 3

Which of the following will detect the electrons?

- A. detector A
- B. detector B
- C. detector C
- D. detector D

Question 4

What is the magnitude of the magnetic force acting on a single electron from this source as it passes through this field?

- A. The force changes as the direction of the electron changes.
- B. $7.4 \times 10^{20} \text{ N}$
- C. $7.4 \times 10^{-8} \text{ N}$
- D. $7.4 \times 10^{-18} \text{ N}$

Question 5

Beamline radiation is produced when

- E. electrons change direction in the storage ring.
- F. electrons are slowed down in the storage ring.
- G. electrons are fired down the beamline from the storage ring.
- H. electrons collide in the storage ring.

Question 6

A straight section of a storage ring contains an insertion device known as a wiggler. Six magnetic poles produce an alternating magnetic field that causes the electrons to deviate from their path.

In another section of the same storage ring is a larger wiggler containing 18 pairs of magnetic poles.

How does the intensity of light from the larger wiggler compare with the smaller one?

- A. The larger wiggler produces radiation of the same intensity as the smaller wiggler.
- B. The larger wiggler produces radiation twice the intensity of the smaller wiggler.
- C. The larger wiggler produces radiation three times the intensity of the smaller wiggler.
- D. The larger wiggler produces radiation nine times the intensity of the smaller wiggler.

Question 7

Another type of insertion device is the undulator. Undulators differ from wigglers because

- A. the magnetic poles in an undulator all point in the same direction.
- B. an undulator uses more powerful magnets than a wiggler.
- C. an undulator produces radiation that is less collimated than that from a wiggler.
- D. an undulator produces light that is reinforced at particular wavelengths.

Question 8

X-ray photons are directed onto a sample under investigation. The scattered X-ray photons from the sample have a larger wavelength than the incident photons.

This is an example of

- A. Bragg scattering.
- B. the photoelectric effect.
- C. Thompson scattering.
- D. Compton scattering.

Use the following information to answer Questions 9 – 11.

X-rays from a synchrotron beamline are tuned to a wavelength of 0.378 nm and shone onto a crystalline sample with interatomic spacing of 0.612 nm. Angles from 0° to 90° are used.

Question 9

At what angle will peaks in the Bragg diffraction pattern be observed?

- A. 47.6° and 38.1°
- B. 38.1° and 67.9°
- C. 11.9° and 18.0°
- D. 18.0° and 36.0°

Question 10

When investigating another sample with the same wavelength of light, a diffraction peak is observed at 52.1°. Scientists use this data to deduce a value for d , the interatomic spacing of the sample.

What other angle should they check to confirm their conclusion about the value of d ?

- A. 26.1°
- B. 17.4°
- C. 23.2°
- D. no other angle possible

Question 11

The beamline is now tuned so that higher-energy X-rays are incident on the sample.

What effect will this have on the Bragg diffraction peaks?

- A. The first-order peak will occur at a smaller angle.
- B. The first-order peak will occur at a larger angle.
- C. The first-order peak will no longer occur at any angle.
- D. The first-order peak will occur at the same angle.

End of Detailed study 4
SECTION B – continued
TURN OVER

SECTION B**Instructions for Section B**

Select **one** Detailed study and answer **all** questions within that Detailed study in pencil on the answer sheet provided for multiple-choice questions.

Show the Detailed study you are answering by shading the matching box on your multiple-choice answer sheet and writing the name of the Detailed study in the box provided.

Choose the response that is **correct** for 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.

Detailed study 5 – Photonics**Question 1**

A coherent light source is best described as

- A. a light source that emits light in discrete wavelengths.
- B. a light source that emits light due to thermal motion.
- C. a light source where all waves are of the same amplitude.
- D. a light source where all waves have the same frequency and phase.

Question 2

Sodium vapour lamps are commonly used as streetlights. They produce a yellow light with a wavelength of 589 nm.

What is the best value for the energy level transition that produces this light?

- A. 3.37×10^{-19} J
- B. 3.37×10^{-28} J
- C. 2.11 J
- D. 2.11×10^{-9} J

Question 3

A particular LED has characteristics as shown in Figure 1. Electrons being conducted by this LED experience a 2.1 eV loss of electrical potential energy. What colour LED is this?

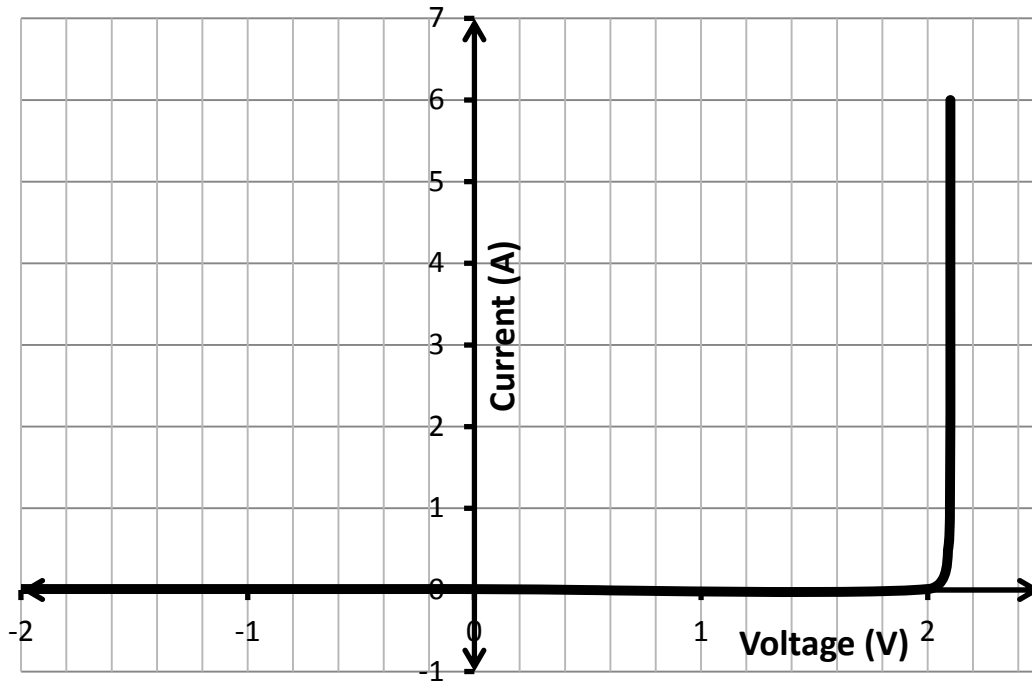
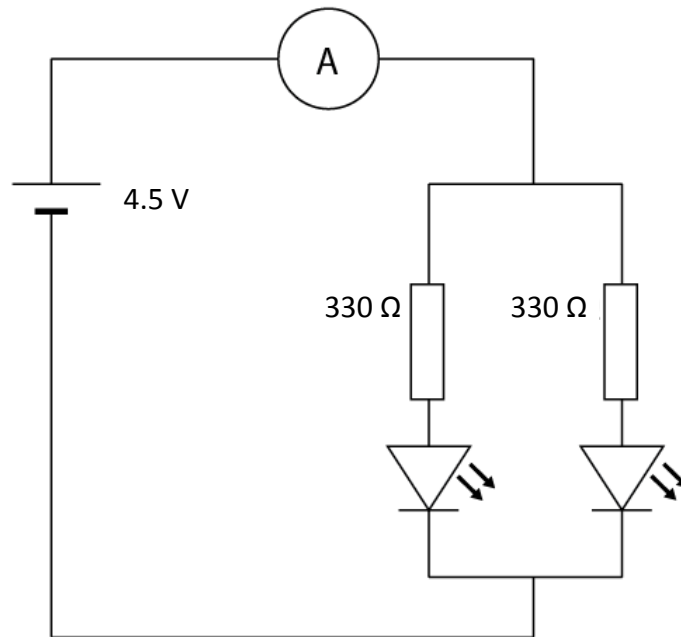


Figure 1

- A. red (640–700 nm)
- B. orange (605–620 nm)
- C. yellow (585–595 nm)
- D. green (525 nm)

Question 4

Two of the LEDs described in Question 3 are installed in a circuit as show in Figure 2.

**Figure 2**

What is the value of the current as measured by the ammeter?

- A. 7.3 mA
- B. 15 mA
- C. 27 mA
- D. 0.9 mA

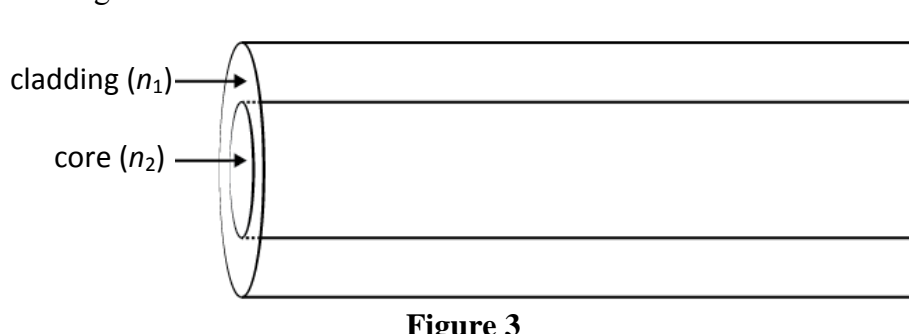
Question 5

The word 'laser' is an acronym of

- A. Light Amplification by Spontaneous Emission of Radiation
- B. Light Amplification by Stimulated Excitation of Radiation
- C. Light Amplification by Stimulated Emission of Radiation
- D. Light Absorption by Simultaneous Excitation of Radiation

Question 6

An optical fibre is constructed from two materials with difference refractive indices (n_1 and n_2) as shown in Figure 3.

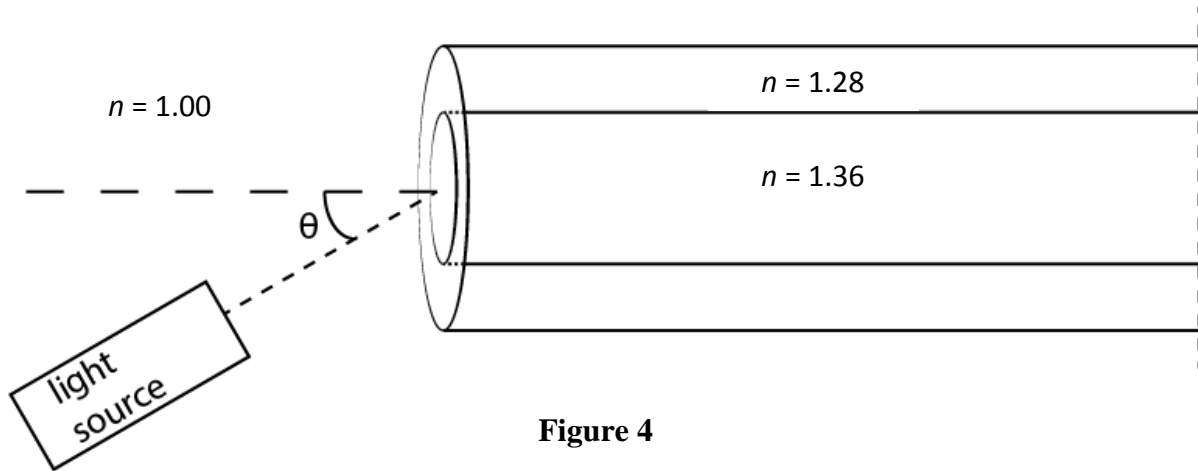
**Figure 3**

When constructing an optical fibre, which of the following statements is true?

- A. The difference in refractive indices must be LARGE so that the critical angle will be SMALL.
- B. The difference in refractive indices must be SMALL so that the critical angle will be SMALL.
- C. The difference in refractive indices must be LARGE so that the critical angle will be LARGE.
- D. The difference in refractive indices must be SMALL so that the critical angle will be LARGE.

Use the following information to answer Questions 7–9.

A step-index fibre has a core with a refractive index of 1.36 and cladding with a refractive index of 1.28, as shown in Figure 4. Light is shone into the fibre at angle θ .



Question 7

What is the critical angle for this fibre?

- A. 70°
- B. 27°
- C. 1.2°
- D. 20°

Question 8

What is the numerical aperture for this fibre?

- A. 0.28
- B. 0.21
- C. 0.75
- D. 0.46

Question 9

The fibre is now immersed in water ($n = 1.33$).

What is the maximum value for θ to ensure total internal reflection?

- A. 27°
- B. 20°
- C. 70°
- D. 78°

Question 10

A step-index optical fibre has an attenuation of 10 dB km^{-1} .

If 5.0 mW from a laser diode is input into a 1.2 km length of this cable, what is the power output?

- A. 32 mW
- B. 3.2 mW
- C. 320 mW
- D. 0.32 mW

Question 11

Modal dispersion is a phenomenon that adversely affects signal propagation in fibre-optic cables.

Which of the following lists shows the three main cable types in order of LEAST modal dispersion to MOST modal dispersion?

- A. step-index, graded-index, single-mode
- B. graded-index, step-index, single-mode
- C. single-mode, graded-index, step-index
- D. single-mode, step-index, graded-index

End of Detailed study 5
SECTION B – continued
TURN OVER

SECTION B**Instructions for Section B**

Select **one** Detailed study and answer **all** questions within that Detailed study in pencil on the answer sheet provided for multiple-choice questions.

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Detailed study 6 – Sound

In this section, the speed of sound is assumed to be 340 m s^{-1} unless otherwise stated.

Use the following information to answer Questions 1–5.

Marcus is playing his bass guitar through an amplifier in the middle of a school oval, practising for a concert. He produces a sound of 100 Hz.

Question 1

Which of the following statements correctly describes how the sound energy travels?

- A. Air particles move away from Marcus at 340 m s^{-1} .
- B. Air particles vibrate 100 times per second perpendicular to the direction of energy propagation.
- C. Air particles vibrate 100 times per second in the direction of the energy propagation.
- D. Air particles vibrate at 340 m s^{-1} about their rest position.

Question 2

Helen is standing 5 m away from Marcus. Marcus' amplifier has a power output of 100 W when he turns it up to full volume.

What is the maximum sound intensity that Helen could be exposed to? Treat the amplifier as a point source and ignore reflections.

- A. 0.95 W m^{-2}
- B. 0.32 W m^{-2}
- C. 4.8 W m^{-2}
- D. 20 W m^{-2}

Question 3

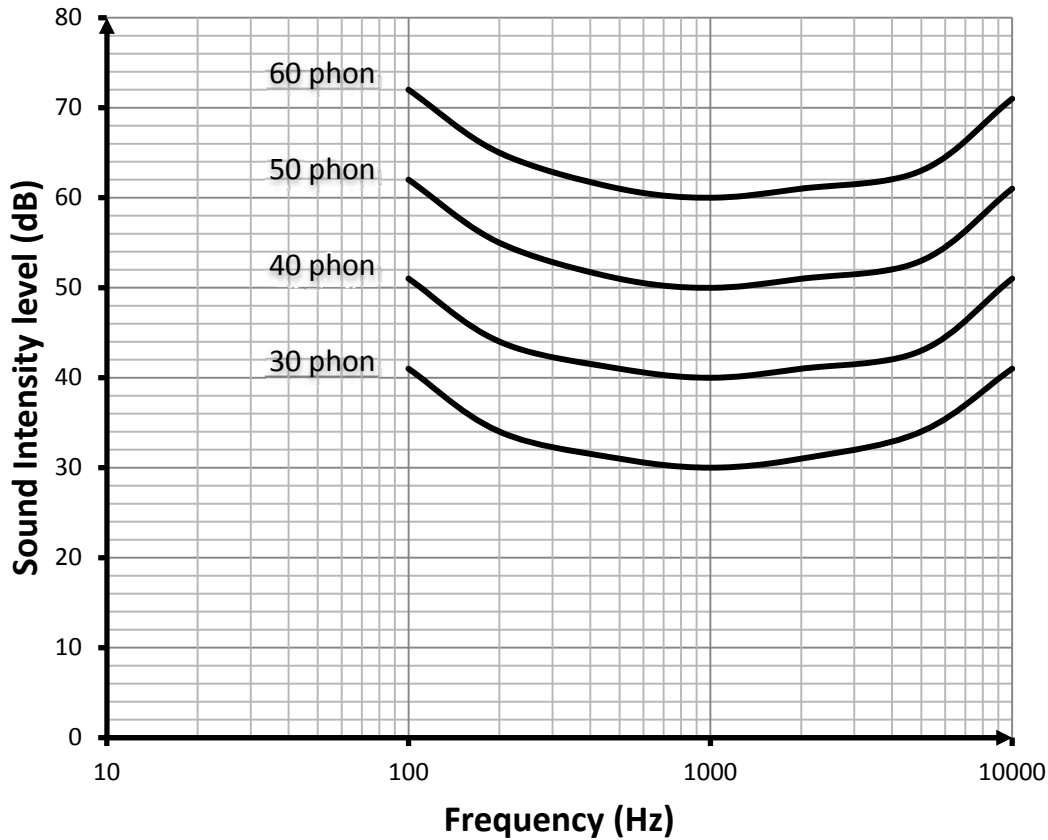
Marcus adjusts his amplifier until it is 105 dB as measured from 5 m away. For the concert, the audience will be 10 m away.

What sound level will the audience be exposed to?

- A. 102 dB
- B. 90 dB
- C. 99 dB
- D. 100 dB

Question 4

Helen's hearing has been tested at a range of frequencies and decibel levels. The results are summarised in the graph of phon curves in Figure 1.

Phon Curves**Figure 1**

Helen is standing some distance away holding a sound level meter. When Marcus plays a 100 Hz note, Helen's sound level meter measures it as being 50 dB.

Which of the following best describes Helen's experience of the sound?

- A. 39 dB
- B. 62 dB
- C. 50 dB
- D. 30 dB

Question 5

The graph of phon curves shows which of the following to be true?

- A. The human ear is least sensitive to mid-range frequencies (1000–5000 Hz).
- B. The human ear is most sensitive to high frequencies (above 5000 Hz).
- C. The human ear is most sensitive to low frequencies (below 1000 Hz).
- D. The human ear is most sensitive to mid-range frequencies (1000–5000 Hz).

Use the following information to answer Questions 6 and 7.

Evie has a slide whistle. She blows into the top and can adjust the length of the pipe (see Figure 2). The top of the whistle can be treated as an open end; the bottom is a closed end. Take the speed of sound as 340 m s^{-1} .

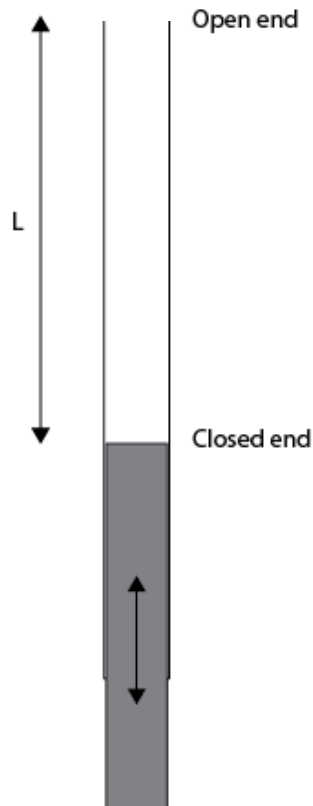


Figure 2

Question 6

If Evie wants to play ‘middle C’ (262 Hz) as the fundamental frequency, how long should she make the tube?

- A. $L = 1.3 \text{ m}$
- B. $L = 0.33 \text{ m}$
- C. $L = 0.65 \text{ m}$
- D. $L = 0.98 \text{ m}$

Question 7

Evie moves the slide so that $L = 0.9 \text{ m}$.

Besides the fundamental frequency of 94 Hz, which of the following frequencies will she also produce?

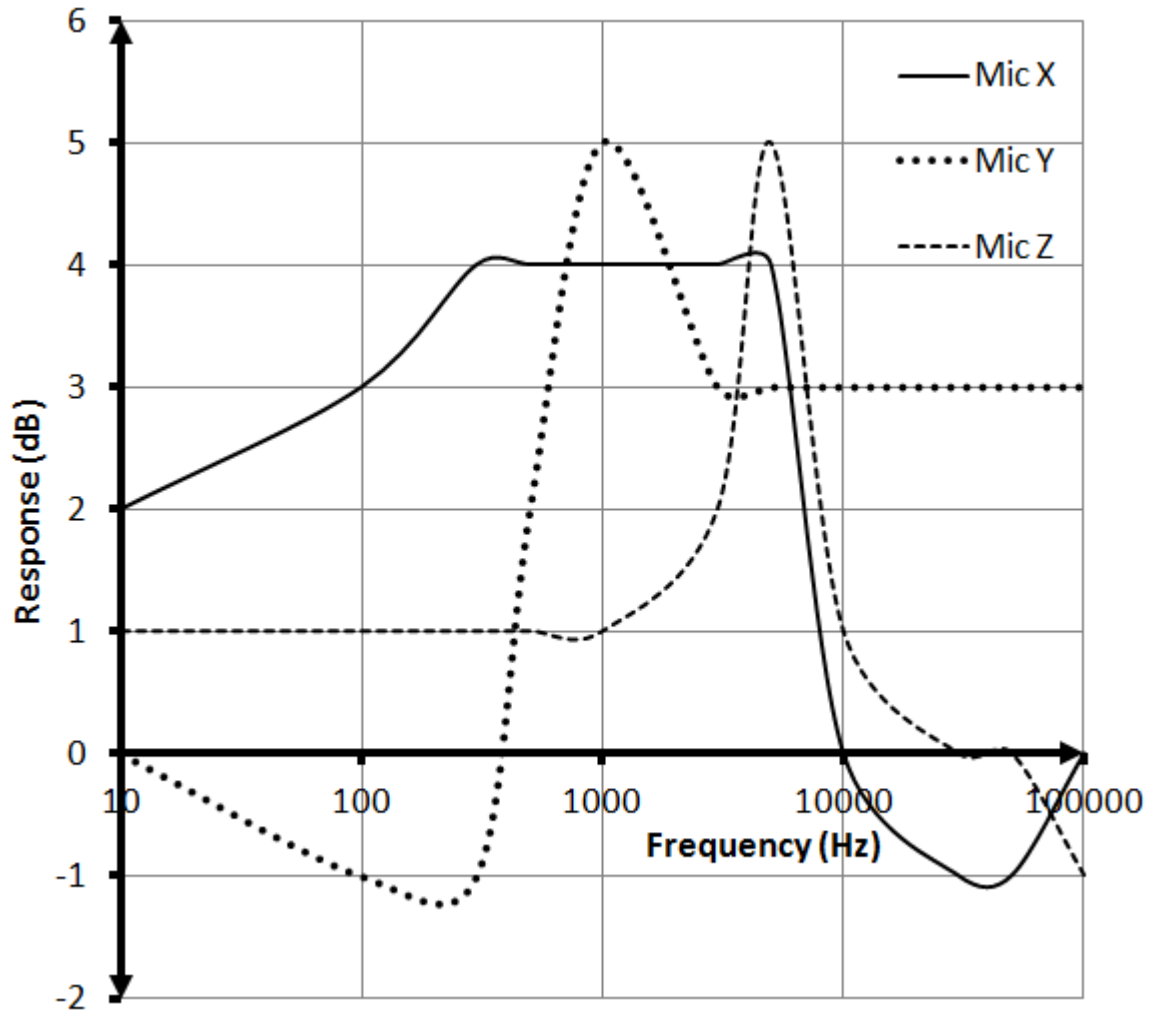
- A. 188 Hz and 376 Hz
- B. 47 Hz and 24 Hz
- C. 283 Hz and 472 Hz
- D. 378 Hz and 756 Hz

SECTION B – Detailed study 6 – continued
TURN OVER

CONTINUES OVER PAGE

Question 8

Foley artists recreate sound effects for the soundtracks to motion pictures. A foley artist on a low-budget film has only three microphones to work with. The frequency response of the three microphones is displayed in Figure 3.

**Figure 3**

One particular scene requires a low-frequency ‘thud’, a high-frequency ‘tinkle’ of broken glass and mid-range human voices.

If the foley artists are aiming for maximum fidelity, which microphone should they use for which sound effect?

	Thud	Tinkle	Voices
A.	Mic X	Mic Y	Mic Z
B.	Mic X	Mic Z	Mic Y
C.	Mic Z	Mic Y	Mic X
D.	Mic Y	Mic Z	Mic X

Question 9

Which of the following correctly describes the principles by which an electret-condenser microphone operates?

- A. A moving diaphragm creates a varying current when a coil is moved through a magnetic field.
- B. A moving diaphragm with a permanent electric charge creates a varying current by changing the capacitance in a metal plate.
- C. A moving diaphragm creates a varying current when a small crystal experiences pressure.
- D. A moving diaphragm creates a varying current by changing the resistance of a sample of carbon granules.

Question 10

Adam and Brian are standing outside a rock concert. Between them and the band is a tall stone wall as shown in Figure 4. Brian stands much closer to the wall than Adam.

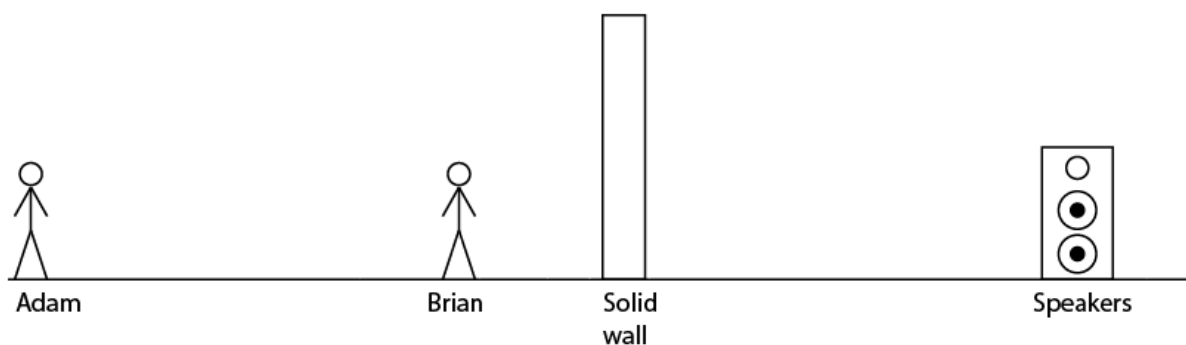


Figure 4

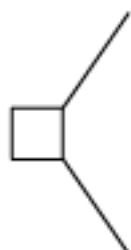
When comparing their experiences later, they find they heard the music differently.

Which of the following correctly explains this difference?

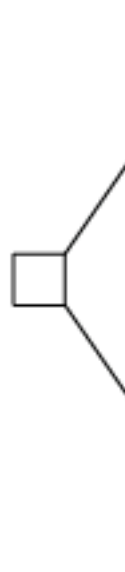
- A. Brian heard music dominated by bass tones as these diffract more than treble tones.
- B. Brian heard music dominated by shorter wavelengths as these diffract more than longer wavelengths.
- C. Brian heard music dominated by higher frequencies as these diffract more than longer wavelengths.
- D. The only difference between Adam and Brian was volume.

Question 11

Haylee is building a speaker. The instructions call for the speaker cone to be placed in a baffle board like that shown in Figure 5.



Speaker cone without baffle



Speaker cone with baffle

Figure 5

The reason for this is that the baffle

- A. stops sound waves from going backwards.
- B. stops sound waves being created by the back of the cone.
- C. allows the delicate components at the back of the speaker to be protected from the sound waves being created at the front.
- D. minimises destructive interference between sound from the back of the cone and sound from the front.

END OF DETAILED STUDIES