TSSM
Creating VCE Success

2012 Trial Examination

STUDENT NUMBER

Figures										Letter
Words										

PHYSICS

Unit 3 – Written examination 1

Reading Time: 15 minutes
Writing Time: 1 hour and 30 minutes

QUESTION & ANSWER BOOK

Structure of Book

Section	*Number of Questions*	*Number of Marks*
A – Core Areas of Study		
1. Motion in one and two dimensions	20	43
2. Electronics and photonics	10	23
B – Detailed Studies		
1. Einstein's special relativity	12	24
OR		
2. Materials and their use in structures	12	24
OR		
3. Further electronics	12	24
	Total	90

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, and rulers, up to 2 pages of pre written notes and an approved **scientific calculator**.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape, graphics calculators

Materials supplied

- Question and answer book of 37 pages (including a multiple choice answer sheet for **Section B)**. Formula Sheet.

Instructions

- Print your name in the space provided on the top of this page.
- All written responses must be in English.

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 of the paper.
Assume **g** = 10 Nkg^{-1} , near the Earth's surface.

Area of Study 1 – Motion in one and two dimensions

Questions 1 to 3 refer to the following information

Figure 1 shows the velocity vs. time graph for a 150 g cart travelling along a rough surface. A motor provides a constant driving force of 120 N for the first 8 seconds, then the power source to the motor is disabled and the cart is allowed to come to rest.

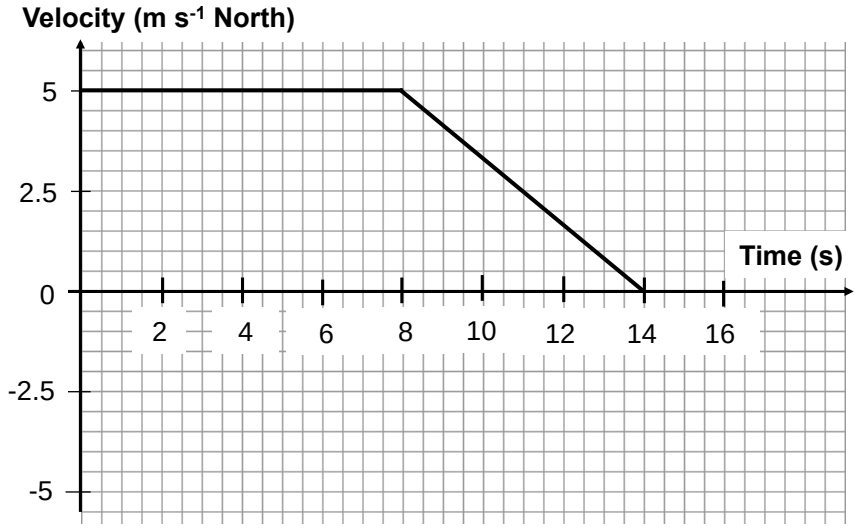


Figure 1

Question 1
Determine the size of the drag forces acting on the cart at t = 5 sec.

N

2 marks

Question 2
Determine the magnitude of the net force acting on the cart at t = 13 sec.

N

3 marks

SECTION A – Area of Study 1 – continued

Question 3
Determine the total distance covered by the cart from t = 0 until it comes to rest.

m

2 marks

The following information applies to Questions 4 to 6.

Figure 2 shows a truck and trailer moving down an inclined plane with a gradient of 10^o.
The truck has a mass of 7×10^3 kg and the trailer 3×10^3 kg. You may ignore the mass of the coupling joining the two.
The truck driver is applying the brakes such that the truck is decelerating at 2 m s^{-2}.
Friction forces equal to 15% of the truck and trailer weight are also acting on each, respectively (braking force not included).
There is a compression force in the coupling equal to 4000 N.

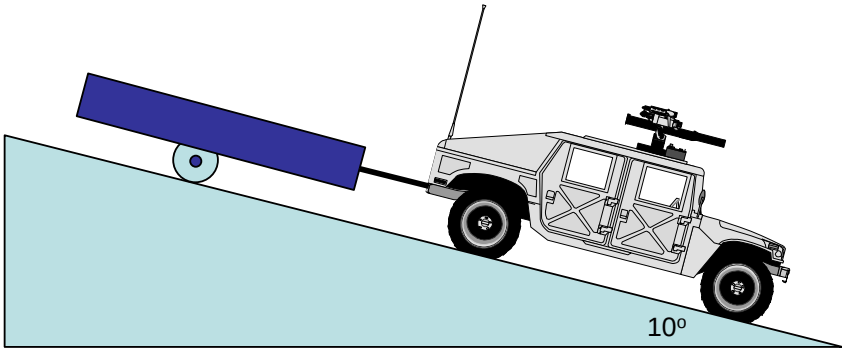


Figure 2

Question 4
Label the key forces acting on the truck.
Use the convention $\boldsymbol{F}_{\text{object A } \textbf{on} \text{ object B}}$.

2 marks

Question 5
Determine the net force acting on the truck.

N

2 marks

SECTION A – Area of Study 1 – continued
TURN OVER

Question 6
Determine the braking force required by the truck.

N

3 marks

The following information applies to Questions 7 to 9

Ivan the Physics Giant is pushing boxes along a rough carpet surface, just for fun.
There are two boxes:

- **Box A – 20 kg**
- **Box B – 10 kg**

At one point in the game, Ivan pushes the boxes at a constant speed.
Sliding friction of 50% of the weight is known to act on both boxes.
Figure 3 shows Ivan and the boxes.

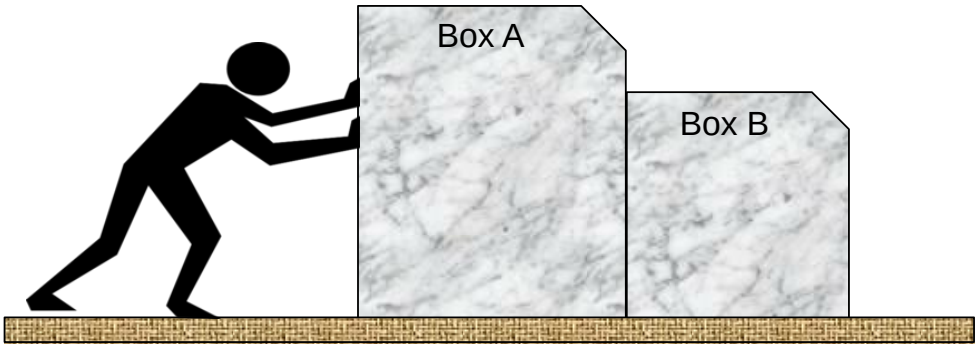


Figure 3

Question 7
Determine the size of $F_{\text{Ivan on Box A}}$.

N

2 marks

SECTION A – Area of Study 1 – continued

Question 8
Label the key forces (including sizes) acting on Box B. Use the convention $\boldsymbol{F}_{\text{object A on object B}}$.

2 marks

Question 9
Determine the size and direction of $\boldsymbol{F}_{\text{Box B on Box A}}$.

N	Direction:

3 marks

The following information applies to Questions 10 to 13

There is a new ride at the local playground which involves a rider sitting in a chair that is attached to a pole via a cable. The pole then rotates so that the rider moves in a circle, as shown in Figure 4.
An anxious parent observes their child excitedly sitting in the chair as it revolves around the central pole with a period of 3.1 sec.
The horizontal distance from the chair to the pole is 3.5 m.
The chair and child have a combined mass of 25 kg.

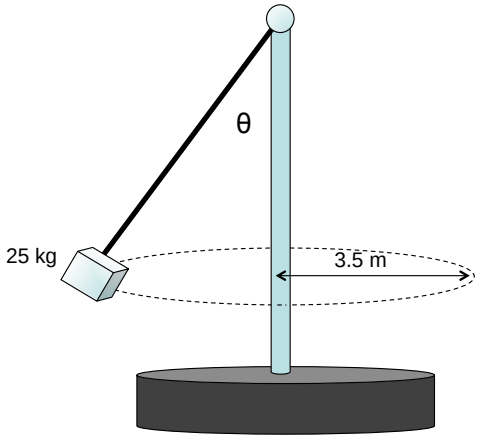


Figure 4

SECTION A – Area of Study 1 – continued
TURN OVER

Question 10
Determine the speed of the child.

m s^{-1}

1 mark

Question 11
Determine the net force acting on the child and chair (as a combined mass).

N

2 marks

Question 12
Calculate the size of the tension force in the cable connecting the chair and the central pole.

N

3 marks

The parent now increases the speed of the ride and carefully observes the effect on the chair and child.

Question 13
Which **one or more** of the following would occur?

A. The period would increase.
B. The radius (horizontal distance from chair to central pole) would increase.
C. The net force on the chair and child would increase.
D. The angle that the cable makes with the central pole (shown as θ in Figure 4) would increase.

2 marks

SECTION A – Area of Study 1 – continued

The following information applies to Questions 14 to 16.

Bored with theoretical discussions about gravitation, a physics class launches a manned orbiter around nearby planet Tritonus. Known data for the planet and the orbiter is shown below:

- **Mass of orbiter: 7.2 x 10^3 kg**
- **Mass of Tritonus: 2.9 x 10^{23} kg**
- **Radius of Tritonus: 2.4 x 10^6 m**

At a particular orbit, the force of Tritonus on the orbiter is known to be 2.06 x 10^4 N.

Question 14
Determine the altitude of the orbiter above the surface of Tritonus.

m

2 marks

Question 15
Determine the period of orbit for the craft. State your answer to the nearest minute.

mins

2 marks

SECTION A – Area of Study 1 – continued
TURN OVER

Class observers based at Mission Control on Earth are discussing the effect of gravity on the occupants of the orbiter.

- Carrie asserts that the occupants are weightless as their circular orbit effectively means they are in freefall around Tritonus. All gravitational forces are simply acting on the orbiter alone.
- Bill disagrees and says that the occupants would feel weightless, but that the magnitude of the weight force acting on them remains constant and definitely not zero.

Question 16
Discuss the accuracy of Carrie and Bill's statements, referring to appropriate physics concepts to support your answer.

2 marks

The following information applies to Questions 17 and 18

Consider a projectile launched from ground level to a raised shelf, as shown in Figure 5.
The shelf is 16.2 m above the ground and an observer notes that the projectile is launched at an angle of 35^o and reaches its top with only horizontal velocity.
The trajectory takes 1.8 sec and air resistance can be ignored during your calculations.

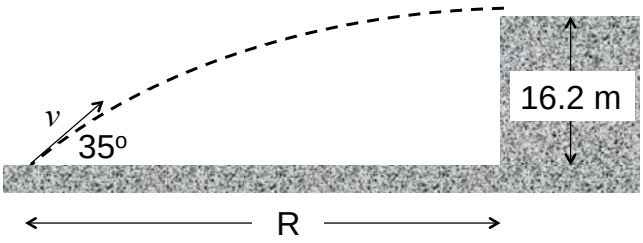


Figure 5

Question 17
Determine the speed of the projectile at launch, *v*.

m s^{-1}

2 marks

Question 18
Determine the distance from the launch point to the based of the shelf (shown as **R** in Figure 5).

m

2 marks

SECTION A – Area of Study 1 – continued
TURN OVER

The following information applies to Questions 19 and 20

Two carts are positioned on what can be assumed to be a frictionless air-track, as shown in Figure 6. A magnet is fixed to the end of each cart with the like poles facing each other (ie. so a repulsive force is experienced).
The carts are brought together, then released from rest at t = 0 sec.
The following data may be used:

- Mass of Cart A: 0.35 kg
- Mass of Cart B: 0.20 kg

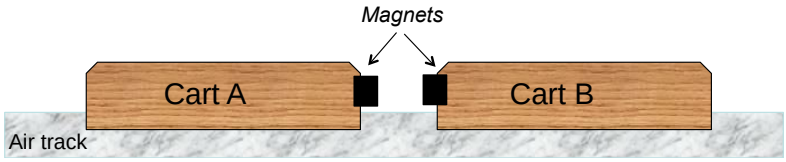
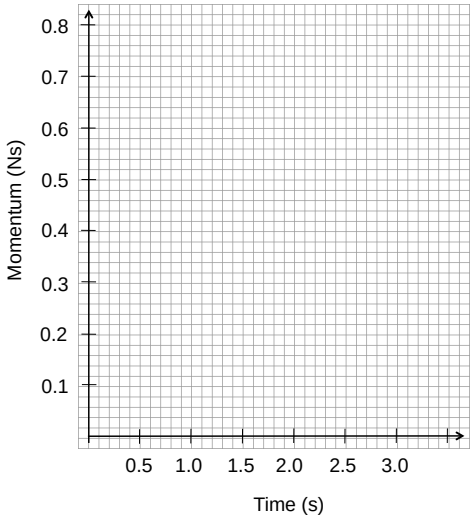


Figure 6

Question 19
Draw a graph showing the momentum of the system over time.



2 marks

Cart A is measured with a velocity of 1.3 m s^{-1} as it moves away after being released.

Question 20
Determine the kinetic energy of Cart B.

J

2 marks

END OF AREA OF STUDY 1
SECTION A — continued

Area of Study 2 – Electronics and Photonics

Questions 1 to 3 refer to the following information.

A 9 V DC supply is connected to six 3 Ω resistors, as shown in Figure 1.
The switch at B is initially open.

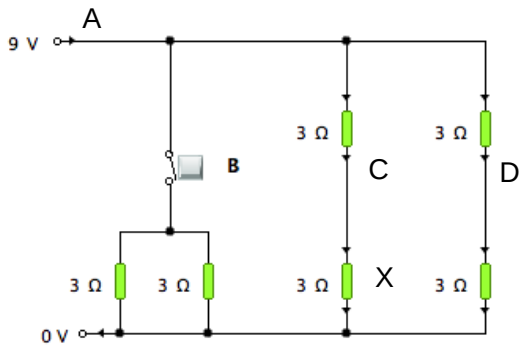


Figure 1

Question 1
With the switch at B still open, determine the total current in the circuit.

A

2 marks

Switch B is now closed, allowing current to flow through the two remaining resistors.

Question 2
Using Table 1, describe the effect on the following circuit parameters.
Indicate with the appropriate term: INCREASED, DECREASED, UNCHANGED

Parameter	Effect
Current at A	
Current at C	
Current at D	

3 marks

SECTION A – Area of Study 2 – continued
TURN OVER

Question 3
With Switch B still closed, calculate the power disipated by resistor **X**

	W

2 marks

The following information applies to Questions 4 and 5.

Two LEDs, a 40 Ω and a 50 Ω resistor are connected to a 9 V supply as shown in Figure 2. The operating voltage for the LEDs is 2.1 V.

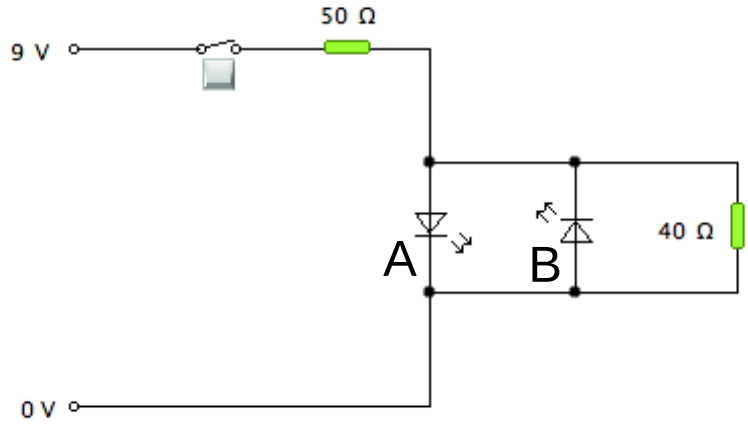


Figure 2

Question 4
Determine the power disipated through each LED.

LED A:	W	LED B:	W

2 + 2 = 4 marks

SECTION A – Area of Study 2 – continued

Question 5
Explain the effect on LED A if the 50 Ω resistor were replaced with a connecting wire of negligible resistance.

2 marks

A communications engineer is designing a circuit to convey a signal along an optic fibre. The electro-optical transducer he has chosen is an LED and the electrical input that must be sent as an amplitude modulated signal is shown in Figure 3.
The engineer is using a carrier signal of 1250 Hz.

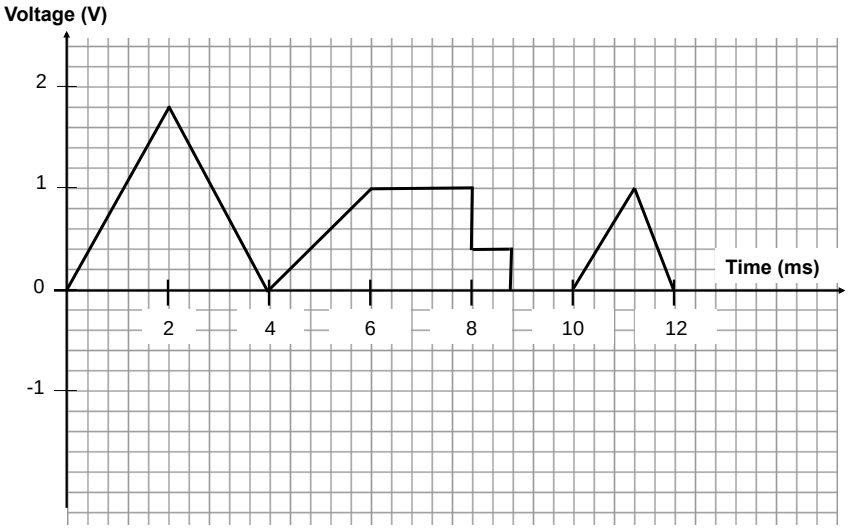
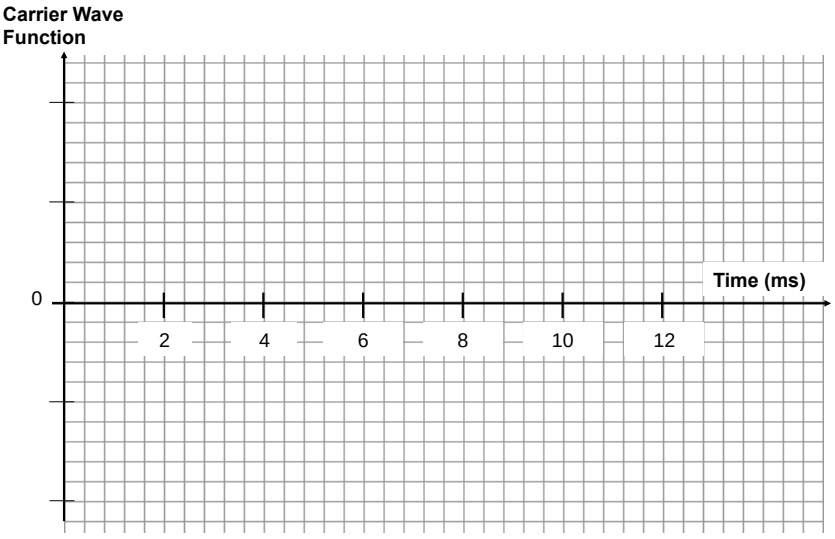


Figure 3

Question 6
Using the axes provided, sketch the modulated carrier signal.



2 marks

SECTION A – Area of Study 2 – continued
TURN OVER

The following information applies to Questions 7 and 8.

Barry is investigating the performance of an amplifier.
Through careful experimentation, he applies a series of input voltages, and completes a plot of Output Voltage vs. Input Voltage, as shown in Figure 4.

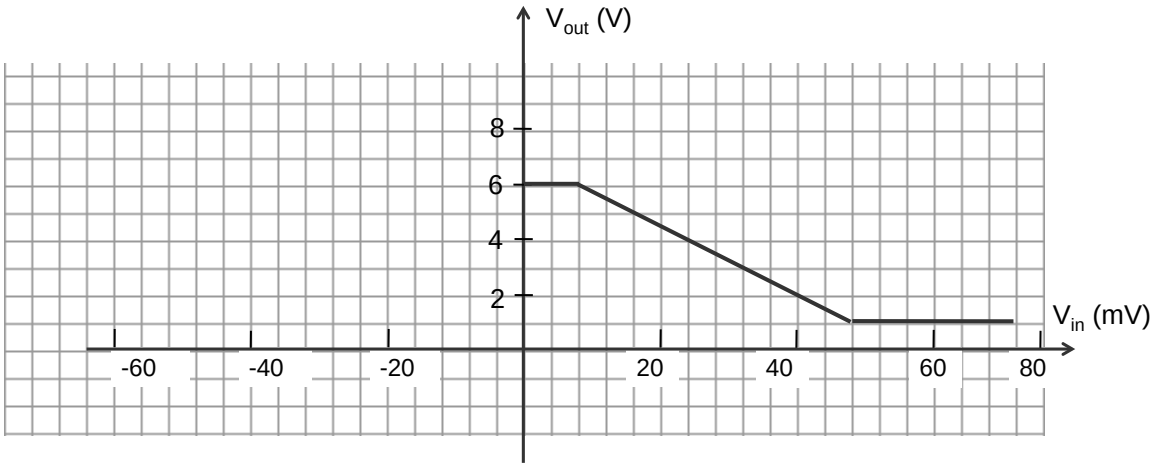


Figure 4

Question 7
Determine the magnitude of the gain of the amplifier and state whether it is inverting or non-inverting in nature.

Gain:	Inverting / Non-inverting

2 marks

SECTION A – Area of Study 2 – continued

Barry now connects a new input signal to the amplifier and observes the output signal on a CRO. He knows that the input signal has an amplitude of 20 mV and is initially positive, but is not biased correctly.
Figure 5 shows the output signal as displayed on the CRO.

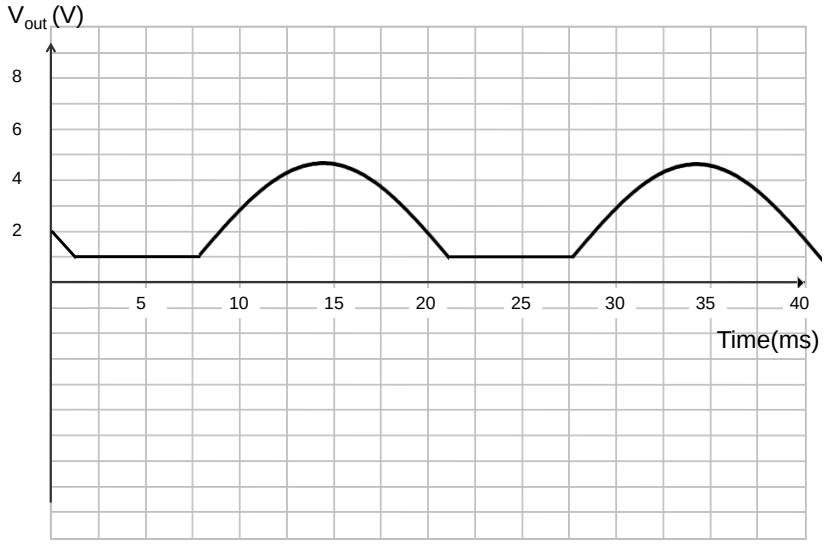
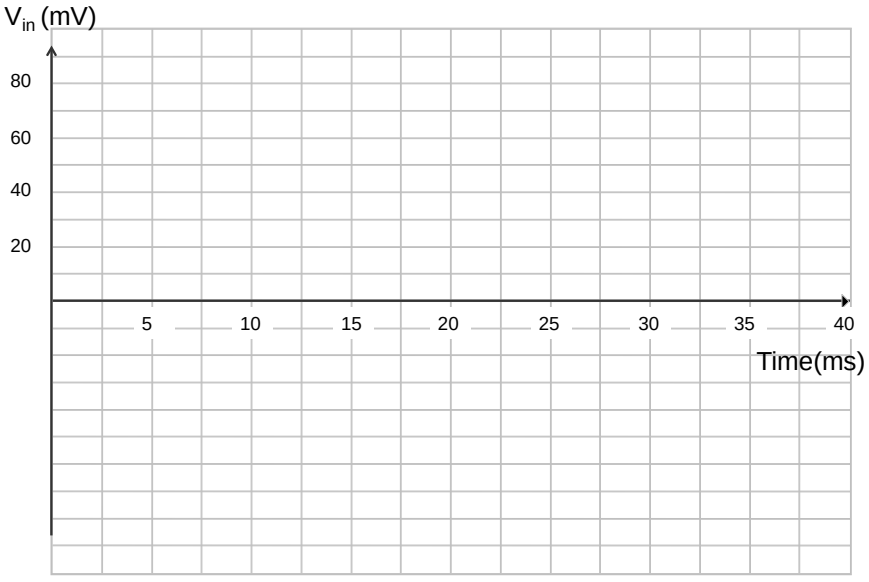


Figure 5

Question 8
Use the axes provided below to sketch the input signal. Include a horizontal and a vertical scale.



2 marks

SECTION A – Area of Study 2 – continued
TURN OVER

A circuit is built to demonstrate the operation of a photodiode, as shown in Figure 6.
Vincent measures the voltage across the photodiode under both light and dark conditions, yielding the following results:

LIGHT: $V_{photodiode} = 0.6$ V
DARK: $V_{photodiode} = 9.0$ V

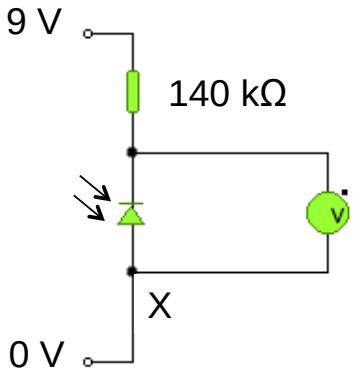


Figure 6

Question 9
Determine the size of the current at Point X under both light and dark conditions

Light: A	**Dark**: A

2 marks

SECTION A – Area of Study 2 – continued

The photodiode circuit is now modified to include an LDR and new resistor, R, as shown in Figure 7.
The circuit is to be used to detect increased light intensity and trigger a secondary circuit if ambient light becomes too bright.
The output voltage across the LDR must be less than 1V to trigger a secondary circuit.

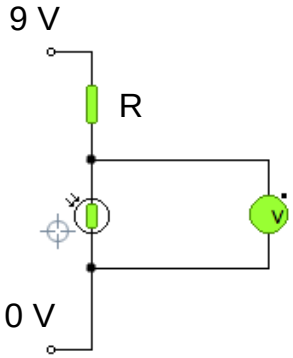


Figure 7

Question 10
Explain, whether a user of this circuit would need to increase or decrease the value of R to make the circuit **less** sensitive to bright light. That is, a brighter source is required to trigger the secondary circuit.

2 marks

END OF SECTION A
TURN OVER

SECTION B – Detailed Studies

Instructions for Section B

Choose **one** of the following **Detailed Studies**. Answer **all** the questions on the detailed study you have chosen and record your answer on the accompanying answer sheet.
Each question is worth 2 marks.

Detailed Study 1 – Einstein's Special Relativity

A proton has a known rest mass of 1.6726×10^{-27} kg.
In a laboratory experiment a proton is accelerated until it acquires a total energy of 2.4×10^{-10} J.

Question 1
Which one of the following best approximates the relativistic mass of the moving proton?

A. 2.67×10^{-27} kg
B. 4.34×10^{-27} kg
C. 8×10^{-19} kg
D. 4.34 kg

Question 2
Which one of the following best approximates the energy of an electron travelling at 0.7c, given the rest mass of the electron is 9.11×10^{-31} kg?

A. 3.96×10^{-15} J
B. 2.34×10^{-14}
C. 3.28×10^{-14} J
D. 1.15×10^{-13} J

A high speed particle, travelling at 0.75c falling vertically towards the surface of the earth detects a mountain to be of height 4000m.

Question 3
Which one of the following is the best approximation for the height of the mountain as measured by a static earth observer?

A. 2600 m
B. 4000 m
C. 5300 m
D. 6000 m

SECTION B – Detailed Study 1 – continued

A neutron (m_o = 1.67 x 10^{-27} kg) is accelerated by work totalling 6 x 10^{-11} J. The initial γ value for the neutron is 1.10.

Question 4
Which one of the following best describes the new γ value for the neutron?

A. 0.70
B. 1.10
C. 1.20
D. 1.50

The following information applies to Questions 5 to 8.

Two asteroids (Xenon and Yammer) are moving towards an observer on Planet Zephod, as shown in Figure 1.
Xenon is moving at 0.6c and Yammer 0.4c, both relative to Zephod.
At a pre-determined time, when both asteroids are exactly 2.6 light years from Zephod, they emit a burst of electromagnetic radiation as a warning signal to the observer on Zephod.

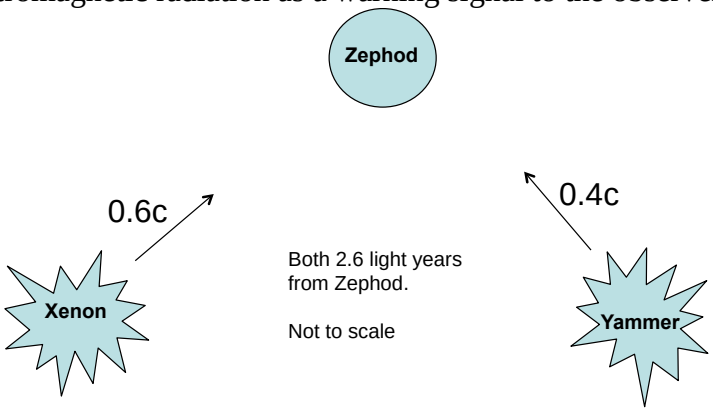


Figure 1

Question 5
From the point of view of the observer, which one of the following statements is correct?

A. The warning messages would arrive at the same time.
B. The warning message from Xenon would arrive first.
C. The warning message from Yammer would arrive first.
D. Both asteroids would beat the warning message to Planet Zephod.

Question 6
From the point of view of a Zephod observer. Which one of the following is closest to the time taken for the signal from Xenon to arrive at Zephod?

A. 1.25 years
B. 2.08 years
C. 2.60 years
D. 3.25 years

Question 7
According to a hitchhiker taking measurements aboard asteroid Xenon, what is the distance from Xenon to Zephod?

A. 1.25 light years
B. 2.08 light years
C. 2.60 light years
D. 3.25 light years

Question 8
According to a hitchhiker taking measurements aboard asteroid Xenon, what is the time elapsed from the point shown in Figure 1 to its arrival at Zephod?

A. 3.47 years
B. 2.08 years
C. 2.60 years
D. 4.33 years

Question 9
An observer approaching a field of dimensions 400 x 400 m **from the north** with a γ value of 1.2 would observe the field to be closest to which one of the following dimensions? Use Figure 2 below to aid your decision.

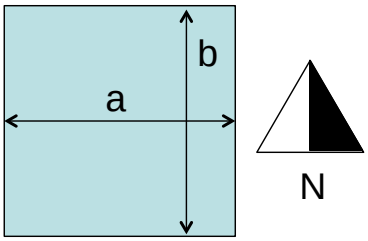


Figure 2

A. **a** = 333 m, **b** = 333 m
B. **a** = 400 m, **b** = 333 m
C. **a** = 400 m, **b** = 400 m
D. **a** = 400 m, **b** = 480 m

Question 10
Which one of the following best describes the term proper time?

A. The time as measured by an atomic clock
B. The time when measured by any observer at the same location
C. The time when measured at rest relative to the event
D. The time when measured whilst moving at a constant speed away from the event

Question 11
Which one of the following situations would NOT be suitable for confirming Newton's Laws of Motion?

A. Travelling through deep space at a constant speed of 0.95c
B. At rest in a craft in deep space
C. Inside the shell of a rotating craft in deep space (radius of 100 m, period of rotation of 4 sec.)
D. In space travelling at a constant speed of 0.1c

Question 12
Which one of the following statements concerning the aim of the Michelson-Morely experiment is FALSE?

A. To verify experimentally whether time taken by light to travel a distance in a direction parallel to the aether is the same as the time taken to travel the same distance perpendicular to the aether
B. To detect and "aether wind" due to the motion of the Earth using an interferometer
C. To detect the presence of the "luminiferous aether" medium required by light
D. To detect the presence of the aether through changes in the frequency of light.

END OF DETAILED STUDY 1
SECTION B — continued
TURN OVER

Detailed Study 2 – Materials and their use in structures

Questions 1 to 7 refer to the following information

Figure 1 shows the tensile stress-strain characteristic curve for a new building material, creatively named Material C.

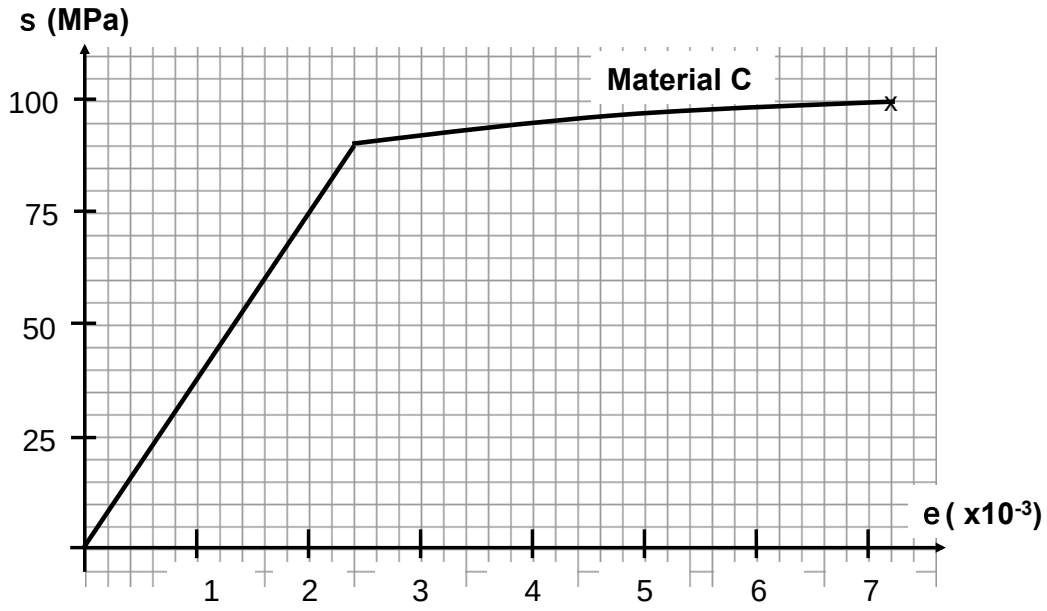


Figure 1

Question 1
Which one of the following best approximates Young's Modulus for Material C?

A. 90 MPa
B. 3.75 GPa
C. 2 x 10^{-3} GPa
D. 37.5 GPa

Question 2
Which one of the following is the best estimate for the Ultimate Tensile Strength of Material C?

A. 90 MPa
B. 100 MPa
C. 37.5 GPa
D. 7.2 MPa

When loaded by a force of 126 kN, a sample of Material C with circular cross-section experiences a stress of 40 MPa

Question 3
Which one of the following best approximates the diameter of the sample?

A. 13 cm
B. 6.3 cm
C. 13 mm
D. 6.3 mm

A circular cross-section sample of Material C with diameter 4 cm and length 2.5 m is subjected to a stress of 60 MPa.

Question 4
Which one of the following best approximates the change in length of the sample?

A. 1.56 mm
B. 4 mm
C. 40 mm
D. 4 m

Question 5
Which one of the following best estimates the total strain energy stored in Material C at a stress of 60 MPa? Assume the sample remains at 2.5 m with a diameter of 4 cm.

A. 4.8×10^4 J m^{-3}
B. 9.6×10^4 J m^{-3}
C. 1.5 J
D. 150 J

Question 6
What would be the best estimate of the quantitative value of toughness for the sample in Question 5?

A. 4.8×10^4 J m^{-3}
B. 9.6×10^4 J m^{-3}
C. 5.3×10^5 J m^{-3}
D. 1.7×10^3 J

Question 7
Which of the following best describes the failure mode of Material C?

A. Brittle, because there is extensive plastic deformation prior to fracture at X.
B. Brittle, because there is extensive elastic deformation prior to fracture at X.
C. Ductile, because there is extensive elastic deformation prior to fracture at X.
D. Ductile, because there is extensive plastic deformation prior to fracture at X.

The following information applies to Questions 8 and 9

An angled cable (AC - ignore mass) and horizontal rod (CD) support a 15 kg vertical member (CB) as shown in Figure 2.
A tension of 200 N is applied to the cable (AC).
The support at B is only capable of providing a vertical reaction force.

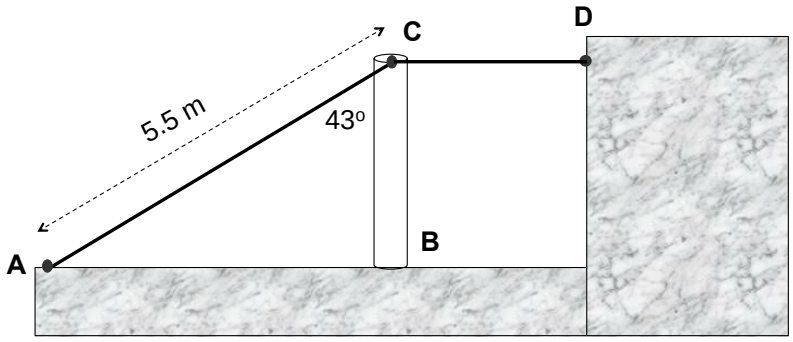


Figure 2

Question 8
Which of the following best approximates the size of the vertical reaction force at B?

A. 146 N
B. 150 N
C. 4 N
D. 296 N

Question 9
Which of the following best approximates the size and type of force in the horizontal rod (CD)?

A. 200 N Tension
B. 136 N Compression
C. 136 N Tension
D. 146 N Tension

A long bolt joins three members, as shown in Figures 3a and 3b.
Forces are applied as indicated in Figure 3b.

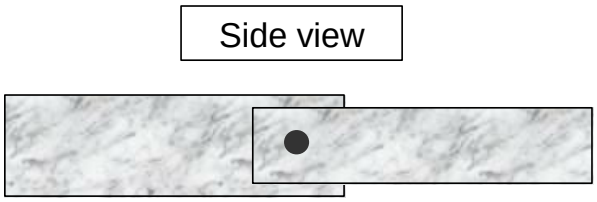


Figure 3a

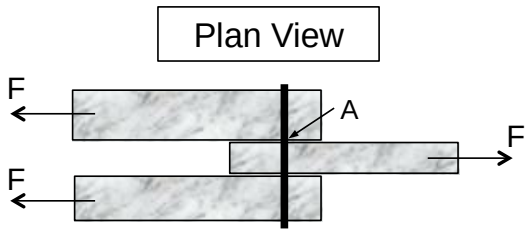


Figure 3b

Question 10
Which of the following best describes the primary type of force applied to the bolt at Point A (Figure 3b)?

A. Shear
B. Torsion
C. Compression
D. Tension

SECTION B – Detailed Study 2 – continued
TURN OVER

The following information applies to Questions 11 and 12.

A simply supported concrete beam of mass 2000 kg m^{-1} is loaded with two heavy boxes as indicated in Figure 4.

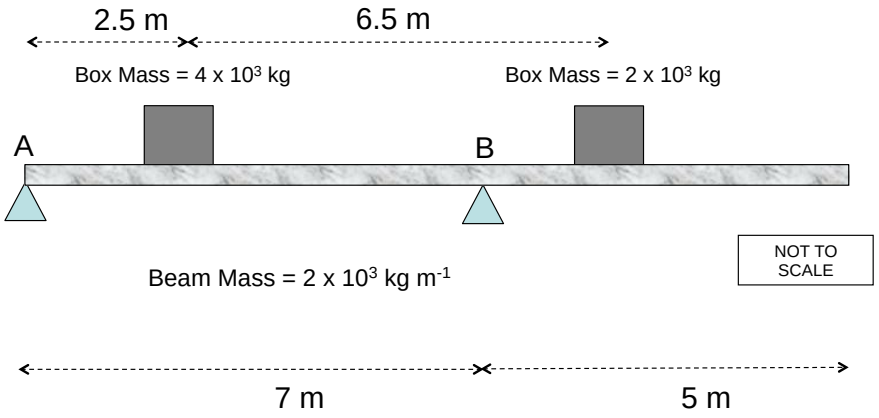


Figure 4

Question 11
Which of the following is the best estimate for the size of the reaction force at support A?

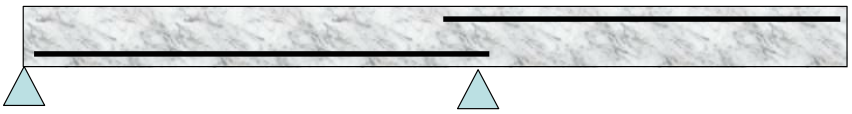
A. 23 kN
B. 54 kN
C. 300 kN
D. 246 kN

Question 12
Still referring to the example in Question 11, which of the following diagrams indicates the most appropriate location for the primary steel reinforcement to provide added strength to the concrete beam?

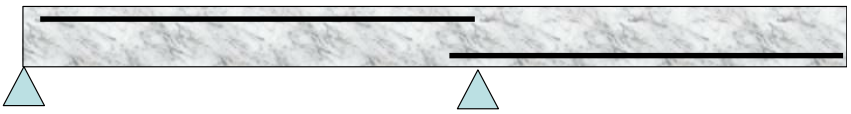
A.

B.

C.



D.



END OF DETAILED STUDY 2
SECTION B — continued
TURN OVER

Detailed Study 3 – Further Electronics

Questions 1 to 5 refer to the following information

Figure 1 shows a basic AC to DC power supply system.
The switch adjacent to the transformer is initially open.

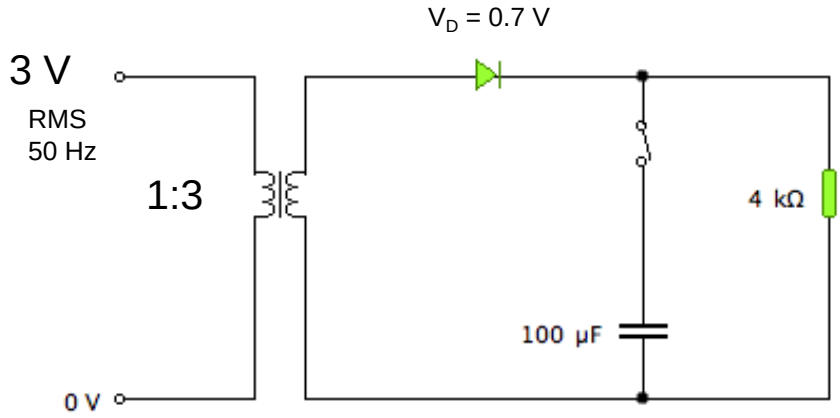


Figure 1

Question 1
Which one of the following best approximates V_{peak} across the secondary side of the transformer?

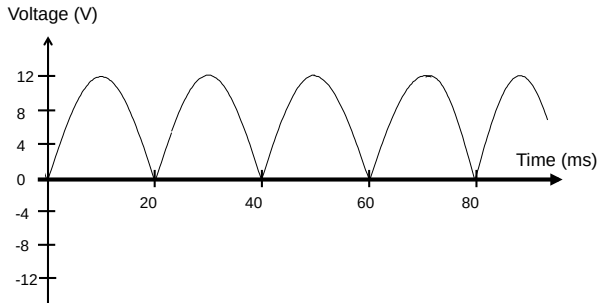
A. 1 V
B. 1.4 V
C. 9 V
D. 12.7 V

Question 2
Which one of the following is the best estimate for the time constant of the system?

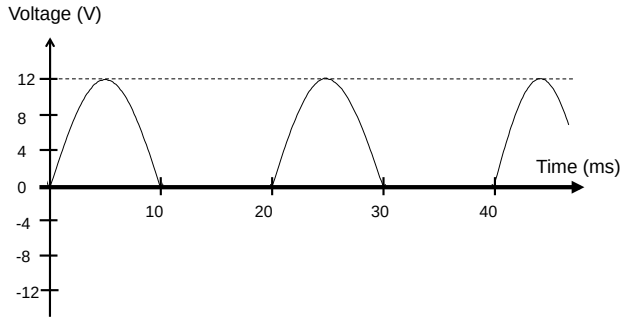
A. 0.4 s
B. 4 s
C. 0.004 s
D. 4×10^7 s

Question 3

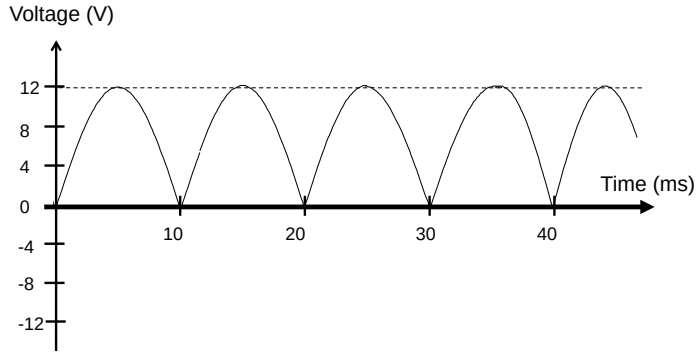
Which one of the below graphs would best match the voltage vs. time plot for the 4 kΩ resistor? (Note: the switch remains open)



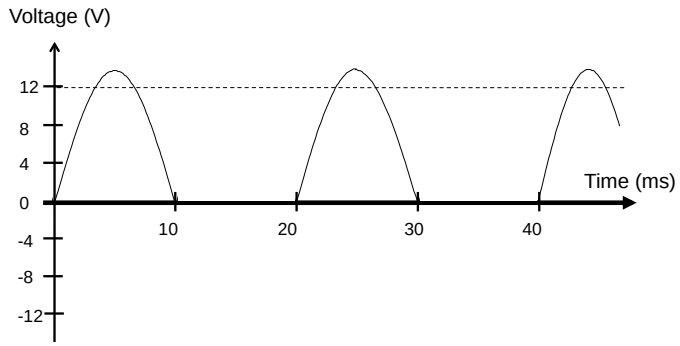
Graph A



Graph B



Graph C



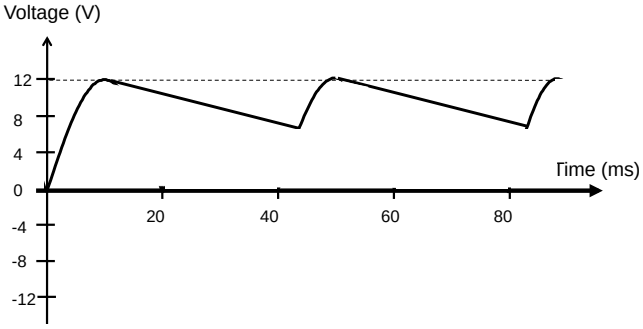
Graph D

SECTION B – Detailed Study 3 – continued
TURN OVER

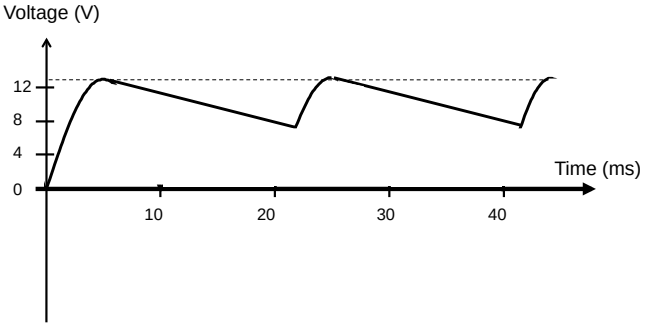
Question 4

The switch is now closed.

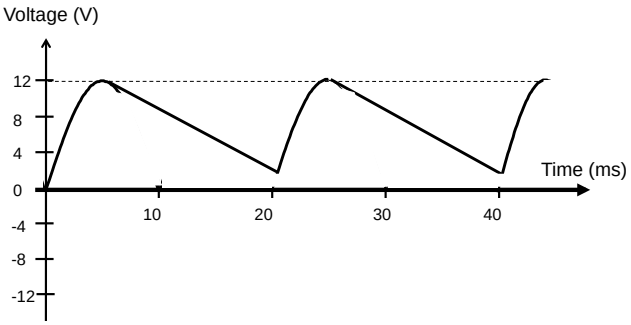
Which one of the below graphs would now best match the voltage vs. time plot for the 4 kΩ resistor?



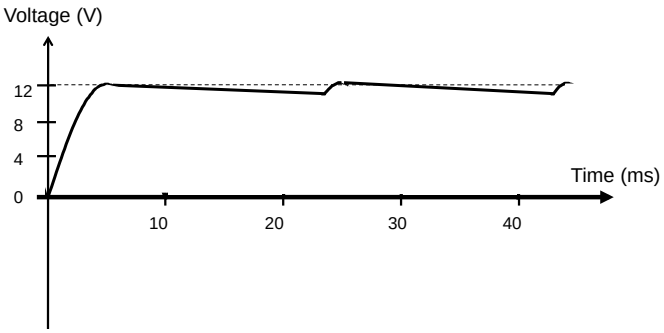
Graph A



Graph B



Graph C



Graph D

SECTION B – Detailed Study 3 – continued

Question 5
Which of the following is the best estimate for the power across the primary coil of the transformer?

A. 36 W
B. 3 mW
C. 20 mW
D. 36 mW

Figure 2a shows a circuit diagram for a zener diode.
Figure 2b shows the characteristic curve for the zener diode.

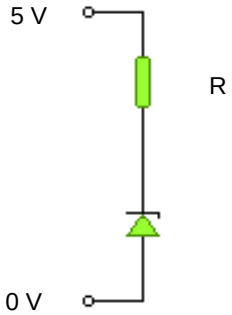


Figure 2a

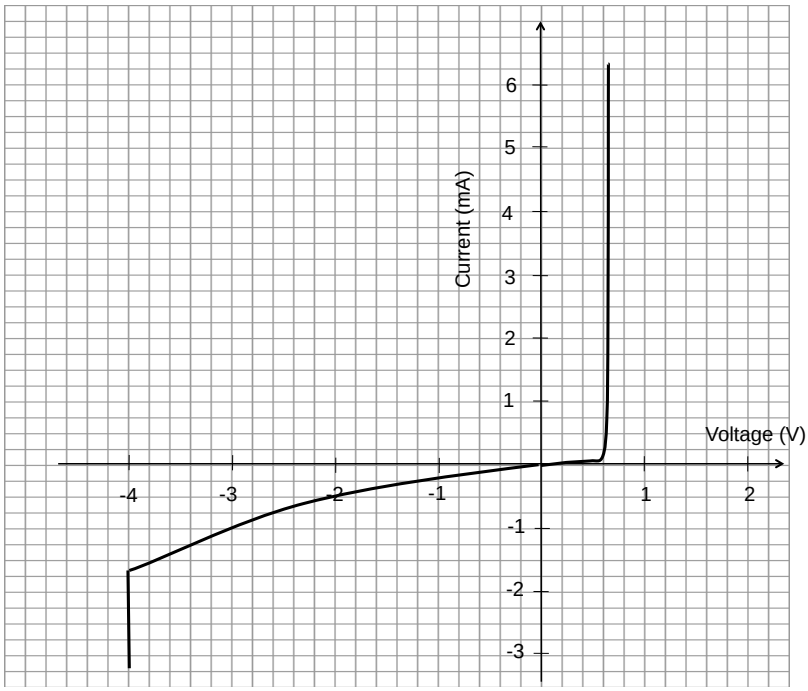


Figure 2b

Question 6
Which of the following best matches the maximum resistance, **R**, required for the zener diode to function correctly?

A. 6 Ω
B. 240 Ω
C. 600 Ω
D. 2400 Ω

SECTION B – Detailed Study 3 – continued
TURN OVER

Figure 3 shows a basic rectification circuit, designed to convert 2 V RMS 20 Hz signal to useable DC across terminals X and Y.
The voltage drop across the diodes in the 4-way bridge is 0.7 V per diode.
The 4 V zener diode is initially isolated from the circuit by Switch A.

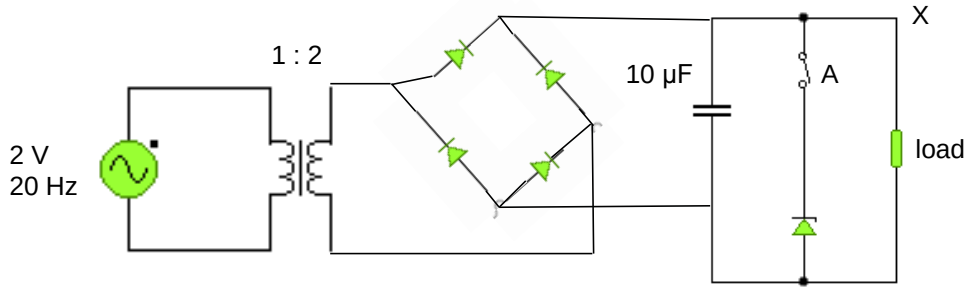


Figure 3

Question 7
Which of the following is closet to V_{MAX} at terminal X?

A. 4 V
B. 2.6 V
C. 5.6 V
D. 4.2 V

Question 8
Which of the following adjustments would decrease the size of the ripple voltage across the load?

A. Increase the size of the input RMS voltage
B. Decrease the frequency of the AC supply voltage
C. Replace the 4-way bridge with a single diode
D. Increase the size of the capacitor

Switch A is now closed, including the zener diode in the circuit.

Question 9
Which of the following best explains why the zener diode will unlikely act to smooth the voltage to a constant 4 V?

A. V_{MAX} at X is too large
B. The time constant for the circuit is too long
C. The time constant for the circuit is too short
D. The frequency of the signal is too short

Figure 4 shows a charging and discharging circuit for a 200 μF capacitor.
The capacitor is initially discharged and the switch is in position B.
The switch is then moved from position B to A, as shown in Figure 4.

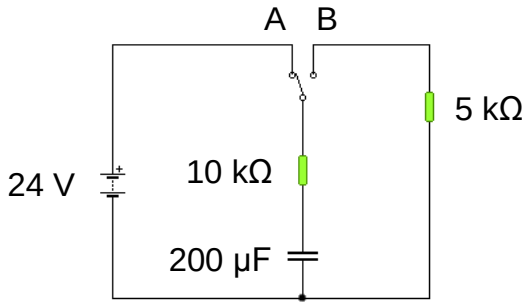


Figure 4

Question 10
Which of the following best approximates the time taken for the voltage across the 10 kΩ resistor to reach 9 V?

A. 1 sec
B. 2 sec
C. 5 sec
D. 10 sec

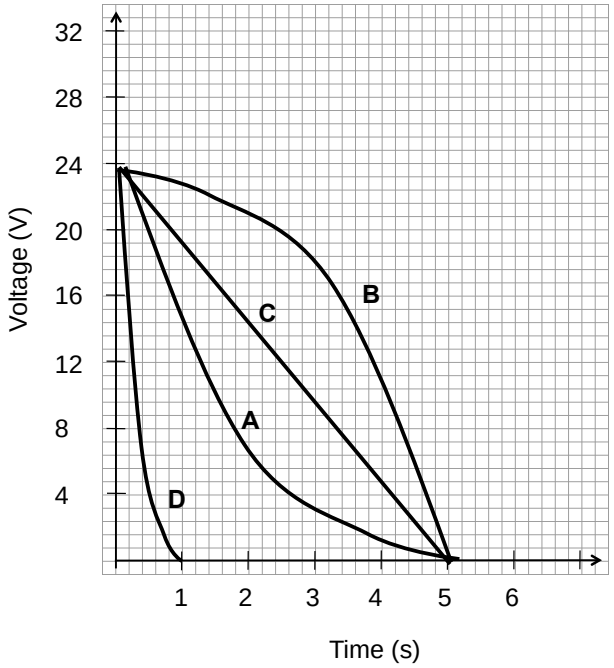
After some time, the switch is now moved from position A to B.

Question 11
After an initial change, which of the following best approximates the time taken for the voltage across the 5 kΩ resistor to return to 0 V?

A. 1 sec
B. 2 sec
C. 5 sec
D. 10 sec

Question 12

Which of the following plots **(A-D)** best matches the voltage vs. time curve across the 5 kΩ during the discharging process?



END OF QUESTION AND ANSWER BOOK

Data Sheet

1	Velocity, acceleration	$v = \frac{\Delta x}{\Delta t}\ a = \frac{\Delta v}{\Delta t}$
2	Equations for constant acceleration	$v = u + at$ $x = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$ $x = \frac{1}{2}(u + v)t$
3	Newton's second law	$F = ma$
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	$F = \frac{GM_1M_2}{r^2}$
10	Gravitational field	$g = \frac{GM}{r^2}$
11	Stress	$\sigma = \frac{F}{A}$
12	Strain	$\varepsilon = \frac{\Delta L}{L}$
13	Young's modulus	$E = \frac{stress}{strain}$
14	Transformer action	$\frac{V_1}{V_2} = \frac{N_1}{N_2}$
15	AC voltage and current	$V_{RMS} = \frac{1}{2\sqrt{2}}V_{p-p},\ I_{RMS} = \frac{1}{2\sqrt{2}}I_{p-p}$
16	Voltage, power	$V = IR,\ P = VI$
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	$\gamma = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$
21	Time dilation	$t = t_0\gamma$
22	Length contraction	$L = L_0 / \gamma$
23	Relativistic mass	$m = m_0\gamma$
24	Universal gravitational constant	$G = 6.67 \times 10^{-11}$ N m^2 kg^{-2}
25	Mass of Earth	$M_E = 5.98 \times 10^{24}$ kg
26	Radius of Earth	$R_E = 6.37 \times 10^6$ m
27	Mass of the electron	$m_e = 9.1 \times 10^{-31}$ kg
28	Charge on the electron	$q = -1.6 \times 10^{-19}$ C
29	Speed of light	$c = 3.0 \times 10^8$ ms^{-1}

Prefix/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

SECTION B – DETAILED STUDY ANSWER SHEET

Detailed Study Attempted – Please tick appropriate box

1. Einstein's Special Relativity	
2. Materials and their use in structures	
3. Further Electronics	

Answers – Circle ONE of A-D for each of the 12 multiple choice questions.

Question	Answer			
1	**A**	**B**	**C**	**D**
2	**A**	**B**	**C**	**D**
3	**A**	**B**	**C**	**D**
4	**A**	**B**	**C**	**D**
5	**A**	**B**	**C**	**D**
6	**A**	**B**	**C**	**D**
7	**A**	**B**	**C**	**D**
8	**A**	**B**	**C**	**D**
9	**A**	**B**	**C**	**D**
10	**A**	**B**	**C**	**D**
11	**A**	**B**	**C**	**D**
12	**A**	**B**	**C**	**D**