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2010 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 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	17	17	37
2. Electronics and photonics	11	11	27
B – Detailed Studies			
1. Einstein's special relativity	13	13	26
OR			
2. Materials and their use in structures	13	13	26
OR			
3. Further electronics	13	13	26
			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 41 pages (including a multiple choice answer sheet for **Section B**)

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.

Areas of study **Page**

SECTION A - continued

Area of Study 1 – Motion in one and two dimensions

Questions 1 and 2 refer to the following information

During the filming of a new action film, a stuntman hangs from a cable beneath a rising elevator, as depicted in Figure 1.
The elevator is accelerating upwards at a rate of 4 m s^{-2}.
The mass of the stuntman is 85 kg.

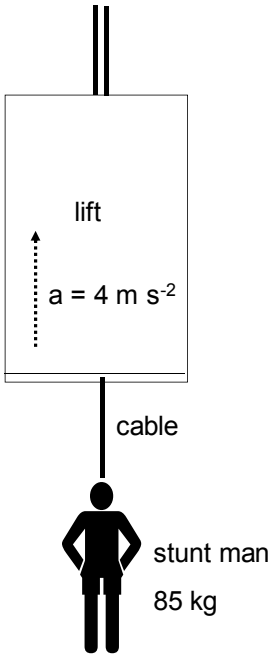


Figure 1

Question 1
Determine the magnitude of the net force acting on the stunt man. You must show your working.

N

2 marks

SECTION A – Area of study 1 - continued
TURN OVER

Question 2
Determine the size of the tension in the cable that attaches the stuntman to the rising elevator.
You must show your working.

	N

2 marks

Questions 3 to 5 refer to the following information

A student swings a ball (mass 0.1 kg) on a string in a clockwise vertical circle at a constant speed, as shown in Figure 2. At the instant shown, the ball is at the bottom of a revolution. Each revolution is known to take 0.8 sec and the string remains under tension at all times. The radius of revolution is 0.85 m.

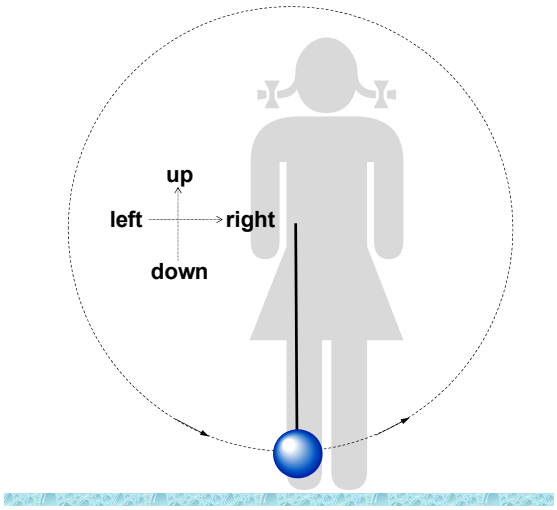


Figure 2

Question 3
Carefully label Figure 2, showing the forces acting on the tennis ball.

2 marks

SECTION A – Area of study 1 - continued

Question 4
In the box below, specify the direction of the net force acting on the ball. Use the key provided in Figure 2 to orient your answer.

1 mark

Question 5
Based on the information provided and for the position shown in Figure 2, determine the size of the tension force in the string. You must show your working.

N

3 marks

Questions 6 to 8 refer to the following information

A small rabbit is launched from a horizontal ledge to a shelf which is 2.7 m above. The rabbit reaches the shelf and lands such that it has no vertical velocity.
The rabbit starts 4 m horizontally from the vertical wall.
The path is depicted in Figure 3. Air resistance may be ignored.

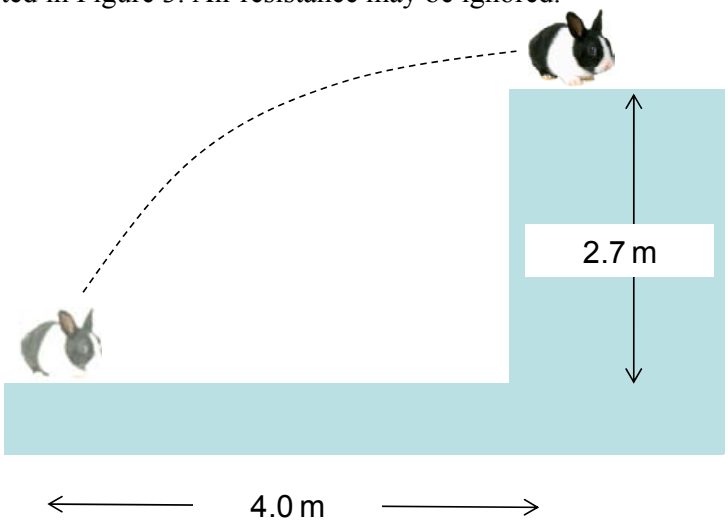


Figure 3

Question 6
Determine the vertical component of the velocity required for the rabbit to complete the path described. You must show your working.

m s^{-1}

2 marks

Question 7
Determine the horizontal component of the velocity required by the rabbit. You must show your working.

m s^{-1}

2 marks

SECTION A – Area of study 1 - continued

Question 8
Calculate the launch angle required for the rabbit and the overall speed of launch. Show your working.

Angle:	Speed: m s^{-1}

2 marks

Questions 9 to 11 refer to the following information

Initially travelling at 12 m s^{-1} west, a car collides with a solid granite wall. The car rebounds with a velocity of 3 m s^{-1} in an easterly direction. The collision takes place in 0.24 s.
The car has a mass of 1500 kg.
Figure 4 shows a simplified diagram of the collision.

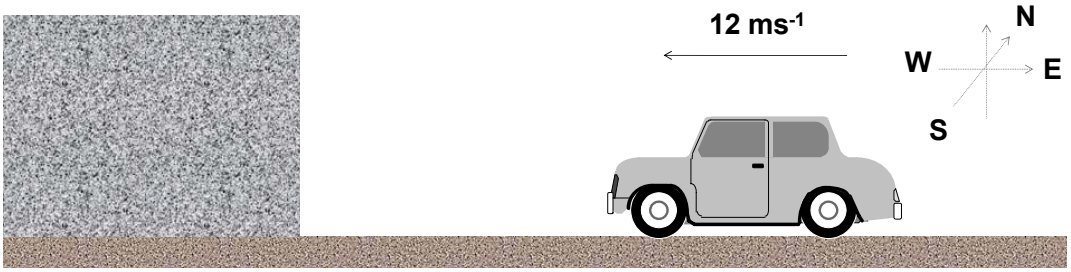


Figure 4

Question 9
Determine the change in momentum of the car. Include a direction in your answer. You must show your working.

kg m s^{-1}	Direction:

3 marks

SECTION A – Area of study 1 – continued
TURN OVER

Question 10
Determine the net force acting on the car. Include a direction in your answer and show your working

N	Direction:

2 marks

Question 11
State whether the collision is isolated and justify your answer.

2 marks

Questions 12 to 14 refer to the following information

Max has developed a new game, which involves throwing a 5 kg medicine ball over a high bar. He has placed a rubber mat on the other side of the bar for the ball to land on, as shown in Figure 5.
Max's best throw is launched at 7 m s^{-1} from ground level and clears the bar by a considerable margin.
The rubber mat is 0.5 m thick when at rest, but when the ball lands on it is compressed to a thickness of 0.2 m.

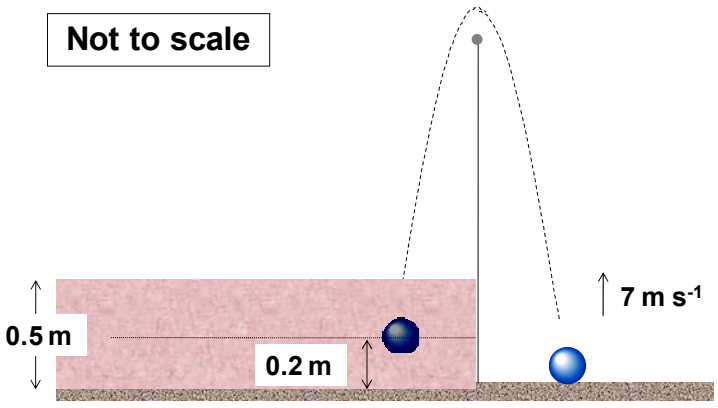


Figure 5

SECTION A – Area of study 1 - continued

Question 12
Determine the maximum height achieved by the ball.

m	2 marks

Question 13
Determine the speed at which the ball is travelling when it reaches the mat (that is, at a height of 0.5 m). You must show your working.

$m\ s^{-1}$	2 marks

Question 14
Determine the spring coefficient of the mat required to bring the ball to rest at a height of 0.2 m. You must show your working.

$N\ m^{-1}$	3 marks

SECTION A – Area of study 1 – continued
TURN OVER

Questions 15 and 16 refer to the following information

A rogue satellite is hurtling towards an asteroid deep in outer space.
The satellite has a mass of 650 kg and is presently located 400 km from the surface of the asteroid, moving at 450 m s^{-1}. The asteroid has no atmosphere.

- Figure 6 shows a diagram of the situation.
- Table 1 shows some key data about the asteroid.
- Graph 1 shows a plot of the gravitational field strength of the asteroid with respect to distance from its centre. Co-ordinates should be used in your calculations

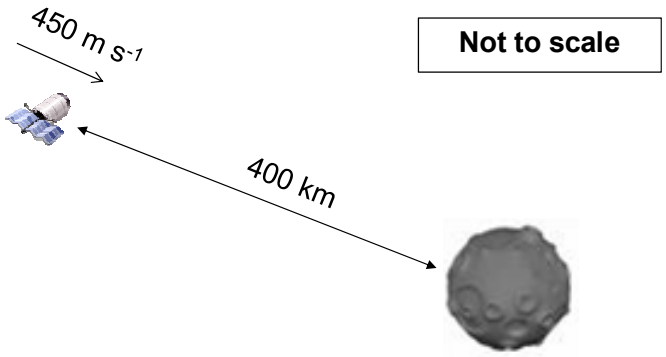
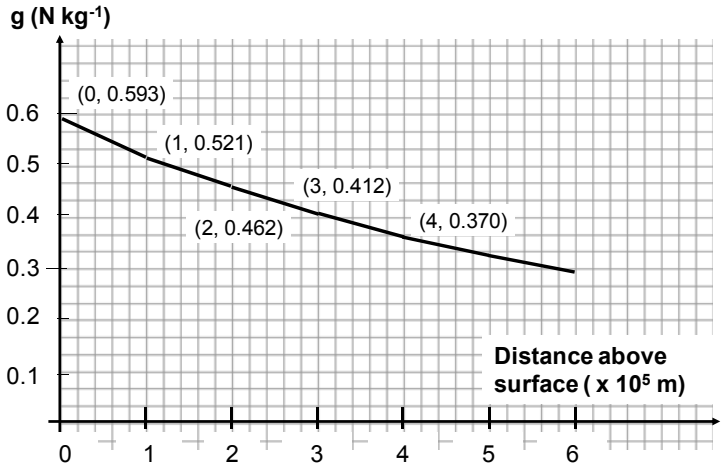


Figure 6

Table 1 – Asteroid Data

Mass	Radius of body	Radius of orbit	Period of revolution	Period of rotation
2 x 10^{22} kg	1.5 x 10^{6} m	5.9 x 10^{12} m	7.82 x 10^{9} s	2.1 x 10^{4} s



Graph 1

SECTION A – Area of study 1 - continued

Question 15
Estimate the speed at which the satellite will hit the surface of the asteroid. You must show your working.

	m s^{-1}

3 marks

In a mission to determine the fate of the first satellite, a research team led by Professor Marcus launches a second probe to enter into a geostationary orbit around the asteroid.

Question 16
Determine the radius required for a geostationary orbit around the asteroid. You must show your working.

	m

2 marks

SECTION A – Area of study 1 – continued
TURN OVER

Jim the cat sits on top of a descending elevator as shown in Figure 7.
Jim's mass is 8 kg and the elevator has an acceleration of 3 m s^{-2} down.
Take g = 10 N kg^{-1}.

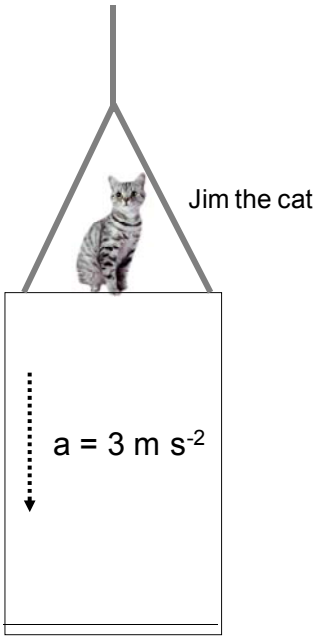


Figure 7

Question 17
Determine Jim's apparent weight. You must show your working.

N

2 marks

END OF AREA OF STUDY 1
SECTION A - continued

Area of Study 2 – Electronics and Photonics

Questions 1 and 2 refer to the following information

A temperature monitoring circuit is set up, with the key component a thermistor.
The circuit diagram and characteristic curve for the thermistor are shown in Figure 1 and Figure 2 respectively.
The circuit is intended to give a minimum output voltage of 2.25 V and a maximum of 4.5 V.

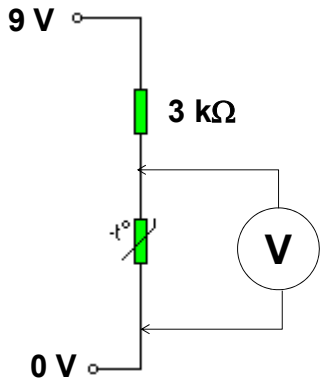


Figure 1

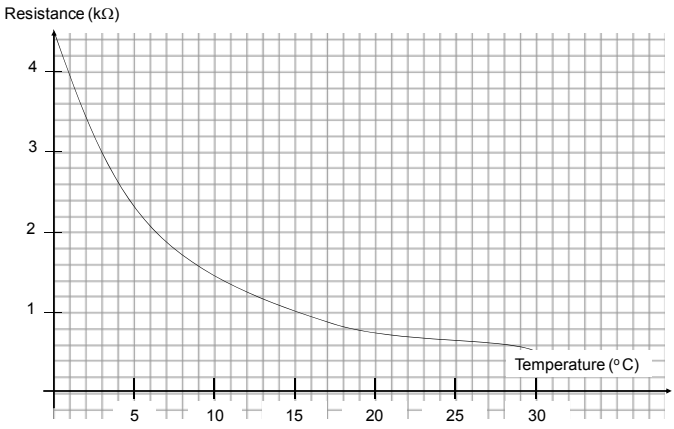


Figure 2

SECTION A – Area of study 2 – continued
TURN OVER

Question 1
Determine the corresponding temperature range that would yield an output voltage range of 2.25 – 4.5 V. You must show your working.

degrees

3 marks

A student wishes to increase the minimum operating voltage to 3 V.

Question 2
Which of the following changes would be most appropriate to achieve an increase in output voltage?
A. Increase value of the fixed resistor
B. Decrease the value of the fixed resistor
C. Decrease the input voltage
D. Switch the positions of the fixed resistor and the thermistor

2 marks

Figure 3 shows a simplified circuit diagram for a basic shop entry circuit. Circuit A is positioned on one side of a door and Circuit B on the other.

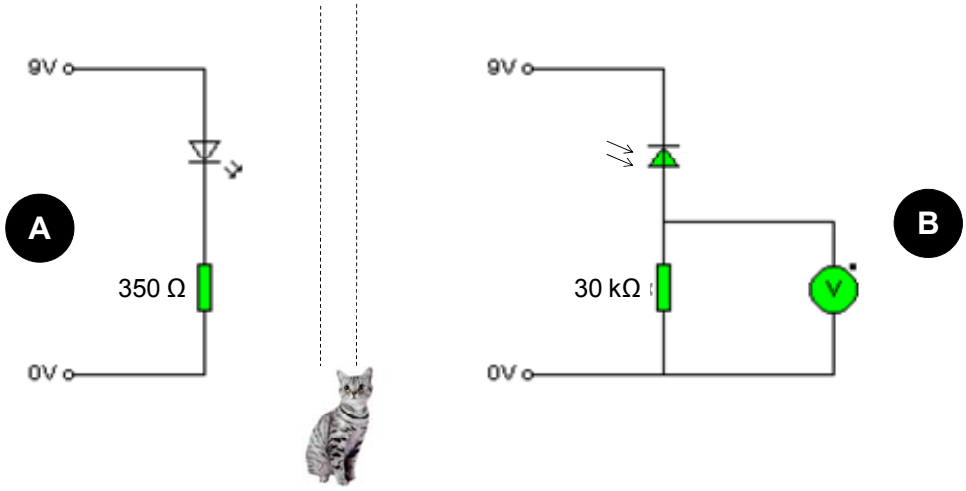


Figure 3

Question 3
Explain what happens to the output voltage ($V_{30\ k\Omega}$) in Circuit B when Jim the cat strolls through the detection zone.

3 marks

SECTION A – Area of study 2 – continued
TURN OVER

Figure 4 is a characteristic curve for the photodiode used in the previous circuit system.

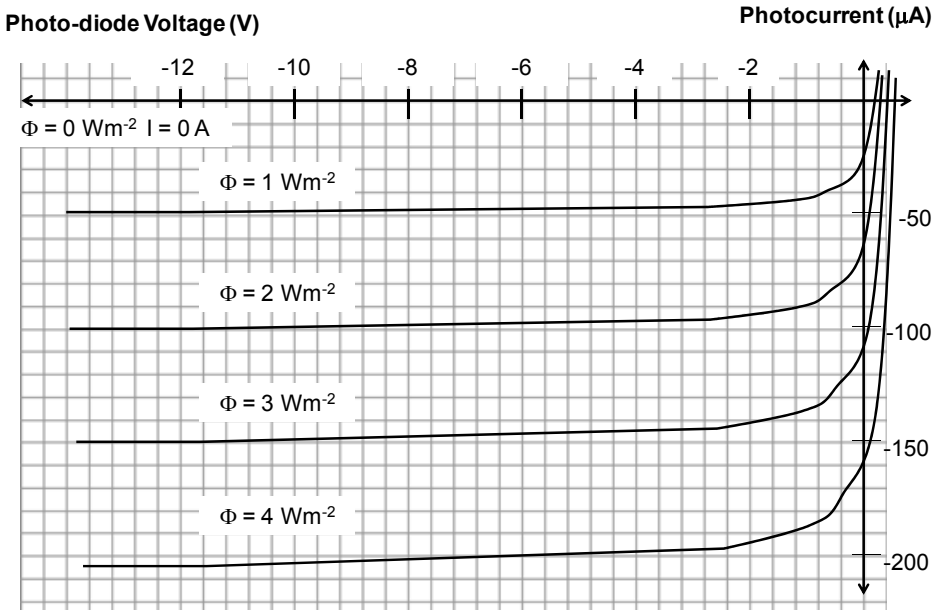


Figure 4

Question 4
Determine the brightness of the light source if the voltage across the 30 kΩ resistor ($V_{30\,k\Omega}$) is 3 V.

W m^{-2}

2 marks

SECTION A – Area of study 2 - continued

The 350 Ω resistor in Circuit A is replaced with a 250 Ω resistor.
Figure 5 shows the characteristic curve for the LED.

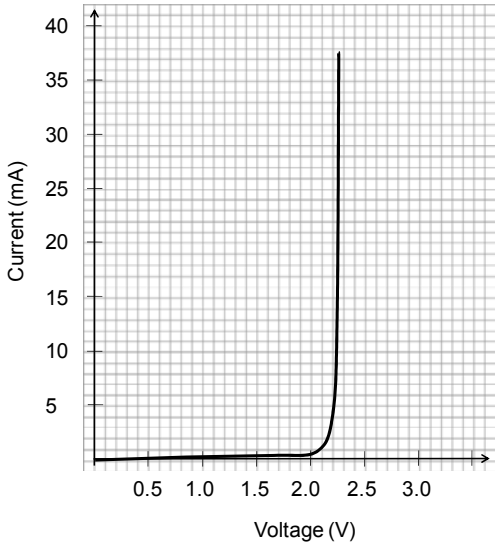


Figure 5

Question 5
Which of the following effects would be observed for the LED?

Option	Voltage	Current	Brightness
A	Increased	Decreased	Unchanged
B	Unchanged	Decreased	Increased
C	Unchanged	Increased	Increased
D	Decreased	Unchanged	Decreased

2 marks

Question 6
State the type of transducer used in Circuit B.

1 mark

SECTION A – Area of study 2 - continued
TURN OVER

Figure 6 shows an information signal which is to be modulated for transmission.
The carrier wave to be used has a frequency of 200 Hz

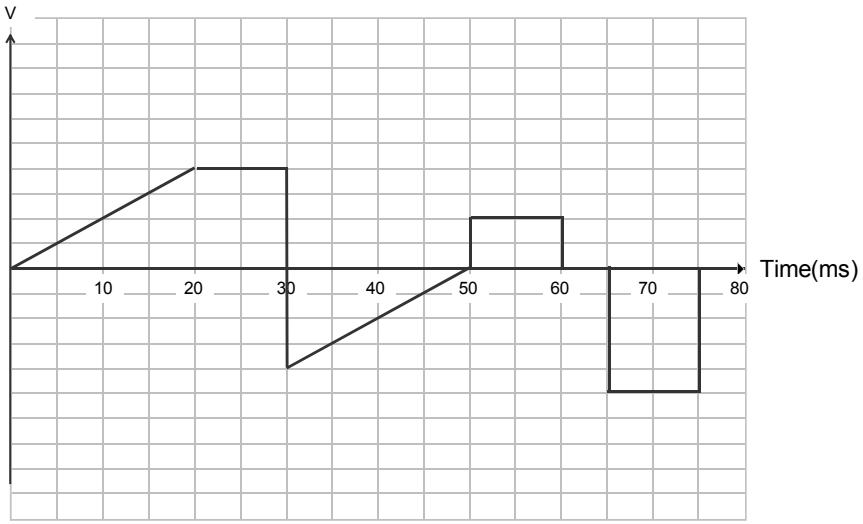
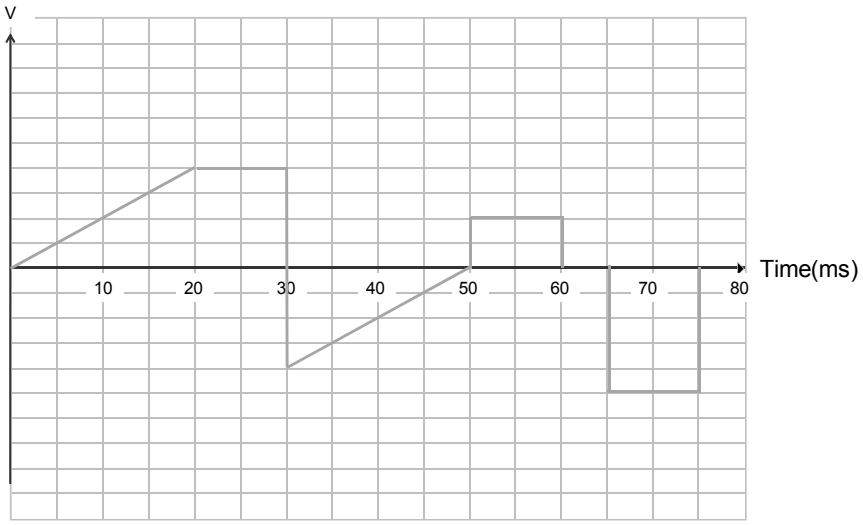


Figure 6

Question 7
Draw the modulated signal on the axes provided. The original signal has been provided to assist you.



2 marks

SECTION A – Area of study 2 - continued

Questions 8 and 9 refer to the following information

Figures 7 and 8 show input and output voltage curves for an amplifier circuit.

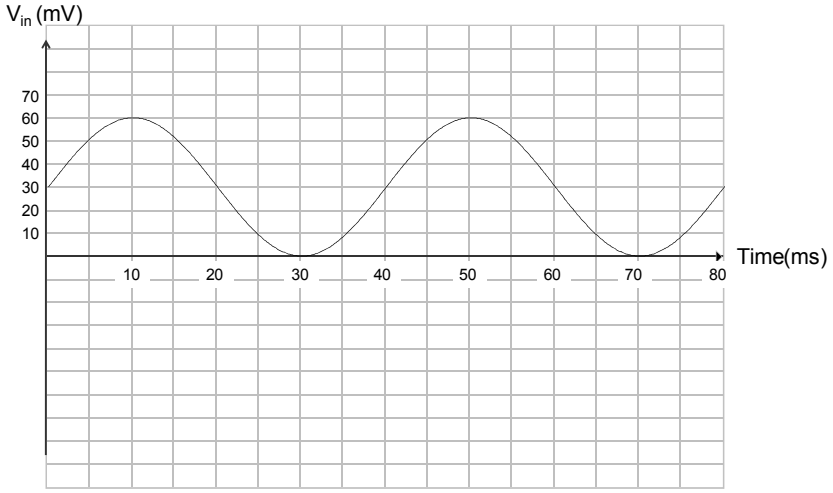


Figure 7

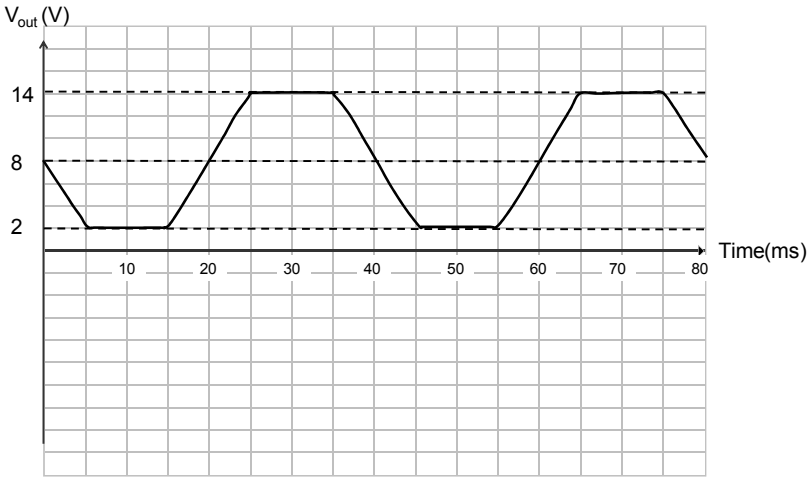


Figure 8

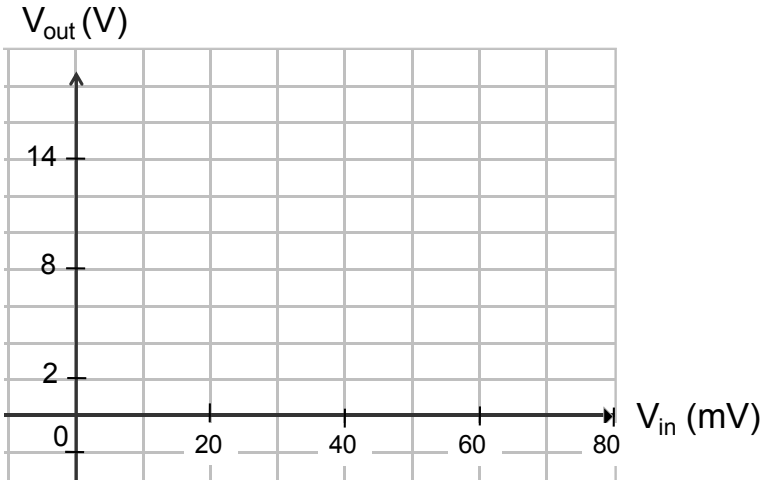
Question 8
Calculate the gain for the amplifier and specify whether it is inverting or non-inverting.

Gain:	Inverting / Non-inverting

2 + 1 = 3 marks

SECTION A – Area of study 2 – continued
TURN OVER

Question 9
Sketch a possible transfer curve for the amplifier on the axes provided.



3 marks

Questions 10 to 12 refer to the following information

Figure 9 shows a DC circuit consisting of three identical 4 Ω constant resistance globes (labelled X, Y & Z) connected to a 6 V source.

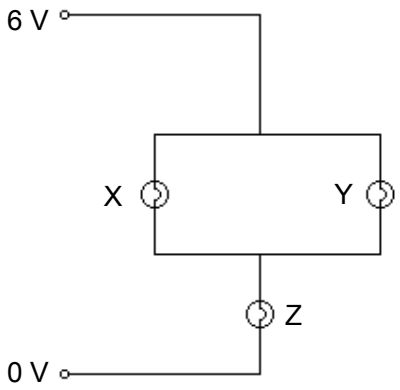


Figure 9

Question 10
Determine the voltage across Globe Z. You must show your working.

V

2 marks

SECTION A – Area of study 2 - continued

Question 11
Which of the following best describes the scale of the brightness for Globes X, Y & Z?

Option	Globe X	Globe Y	Globe Z
A	Dim	Dim	Bright
B	Bright	Bright	Bright
C	Dim	Dim	Dim
D	Bright	Bright	Dim

2 marks

A fourth identical globe (Globe W) is now added, as shown in Figure 8.

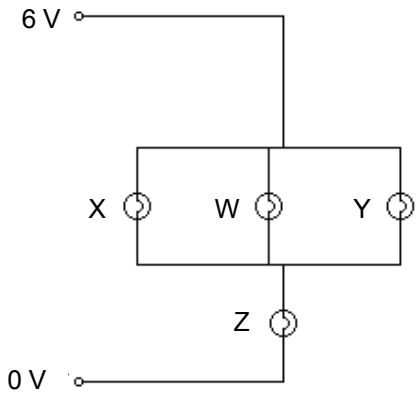


Figure 8

Question 12
Describe what happens to the brightness of Globe Z when Globe W is connected. You must explain your answer.

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.

Areas of study **Page**

SECTION B –continued

Detailed Study 1 – Einstein's Special Relativity

Question 1
Which of the following can be considered to be an inertial reference frame?
A. Rotating merry-go-round ride at a circus
B. Satellite travelling at a constant velocity through space
C. Elevator moving upwards with an acceleration of 2 m s^{-2}
D. The Earth orbiting the Sun.

Question 2
Which of the following was one of Einstein's postulates for his special theory of relativity?
A. The speed of light varies depending on the relative speed of the observer
B. The speed of light is relative to the medium known as aether
C. The laws of magnetism and light were not the same in all inertial reference frames
D. The speed of light is constant for all observers

Question 3
The Michelson-Morley result surprised scientists primarily because it showed that
A. The time that the light took to reach the detector depended on the direction that the detector moved through the aether
B. Rotation of the detector caused a significant change in the observed pattern due to the change in light speed
C. No evidence of change in speed was observed, regardless of the direction that the detector was moving through the aether
D. The light travelled more slowly than expected and created previously unseen interference patterns

Questions 4 to 9 refer to the following information

A spacecraft passes an observer on Earth at a relative speed of 0.85c ($\gamma = 1.90$) The captain of the craft measures its length to be 250 m.

Question 4
The length of the spacecraft as measured by the observer on Earth would be closest to
A. 132 m
B. 250 m
C. 278 m
D. 294 m

According to the captain's clock, it takes 4 hours to reach his destination

Question 5
How long would the Earth observer perceive the craft to take to reach its destination?
A. 2.1 hrs
B. 3.4 hrs
C. 4.0 hrs
D. 7.6 hrs

Question 6
Which of the following is the best estimate for the distance from Earth to the craft destination, as measured by an Earth observer?
A. 6.98×10^9 km
B. 6.98×10^6 km
C. 3.67×10^9 km
D. 1.93×10^9 km

Question 7
If the captain of the spacecraft turned on the headlights, what would be the speed of the light emitted by them?
A. 0.15c
B. 0.85c
C. 1.00c
D. 1.85c

The spacecraft and its payload have a rest mass of 1.5×10^4 kg

Question 8
Which of the following is the best estimate of the work that must be done to increase the craft from rest to 0.85c ?
A. 1.215×10^{21} J
B. 2.565×10^{21} J
C. 8.55×10^{12} J
D. 3.915×10^{21} J

Question 9
Which of the following is the best estimate of the mass of the craft at 0.85c, if it could be measured by the Earth observer?
A. 1.5×10^4kg
B. 1.5×10^2 kg
C. 7.9×10^4 kg
D. 2.9×10^4 kg

Scientific observations of short living muons travelling at 0.6c have shown that, over a distance of around 2000m, fewer decay than would be expected.

Question 10
The best reason for this observation would be
A. The length perceived by the moving muons is considerably longer than for relatively stationary observers
B. The length perceived by the moving muons is considerably shorter than for relatively stationary observers
C. The muons mass would be much less as observed by the scientists, making them decay more slowly
D. Time travels faster for the muons from their reference point, so they decay more readily

Question 11
Which of the following is the best estimate of the mass increase of an electron that is accelerated from rest using 8 GeV of energy?
A. 1.42 kg
B. 1.42×10^{-18} kg
C. 1.42×10^{-29} kg
D. 1.42×10^{-26} kg

Question 12
Which of the following is the best definition for proper time?
A. Proper time is the time measured by an Earth observer
B. Proper time is the time measured by an official watch on Earth that has been calibrated for special relativity
C. Proper time is the time measured in the reference frame at rest with respect to the event
D. Proper time is the time measured by an observer who is moving the fastest with respect to the event

Question 13
According to Maxwell, which of the following observers would see light travelling the slowest?
A. An observer moving towards a light source stationary in the aether
B. An observer moving away from a light source stationary in the aether
C. An observer who is at rest relative to a light source stationary in the aether
D. An stationary observer, who see a light source moving towards him in the aether

END OF DETAILED STUDY 1
SECTION B – continued
TURN OVER

Detailed Study 2 – Materials and their use in structures

Questions 1 to 6 refer to the following information

Consider two Materials, A and B.
Their tensile stress vs. strain properties are shown in Figure 1.

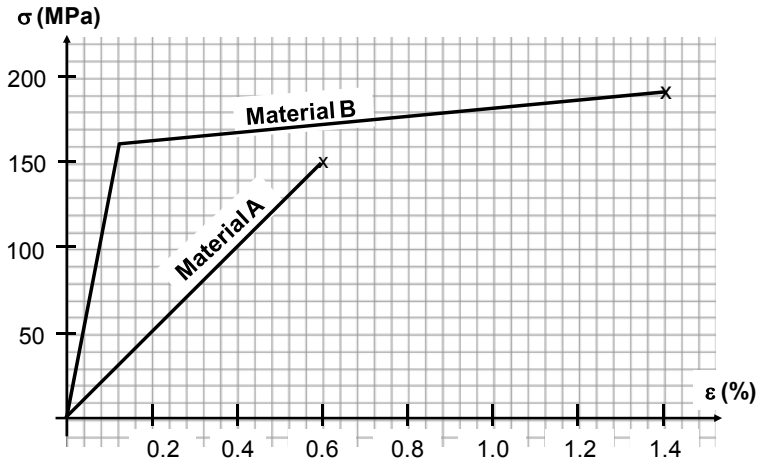


Figure 1

Question 1
Young's modulus for the elastic region of Material A would be closest to:
A. 0.04 GPa
B. 2.5 GPa
C. 25 GPa
D. 25 MPa

Question 2
Which material(s) could be described as brittle?
A. Material A
B. Material B
C. Both materials
D. Neither material

A tensile force of 66 kN is applied to a sample of Material B, which has a rectangular cross section as shown in Figure 2.

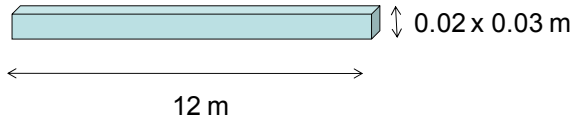


Figure 2

Question 3
Which of the following is closest to the stress on the sample?
A. 11 MPa
B. 6.6 MPa
C. 66 MPa
D. 110 MPa

Question 4
What type of deformation is most likely occurring in the sample of Material B?
A. Plastic
B. Ductile
C. Elastic
D. Yield

Question 5
Which of the following is the best estimate for the change in length for the sample?
A. 0.96 mm
B. 0.96 cm
C. 9.6 cm
D. 9.6 m

Question 6
Which of the statements is true of the two materials?
A. Material A is tougher than Material B, but less ductile
B. Material A is tougher than Material B and more ductile
C. Material B is tougher than Material A, but less stiff
D. Material B is tougher than Material A and more stiff

Use the following information to aid with your answers to Questions 7 and 8

Concrete Strength and Properties:

- *Elastic Modulus: 40 GPa*
- *Compressive Strength: 42 MPa*
- *Tensile Strength: 4 MPa*

Tim is working with a small cylindrical sample of concrete, 6 cm in diameter and 20 cm in length.

Question 7

Which of the following would be closest to the minimum compressive force required to fracture the concrete sample?

A. 119 kN
B. 297 kN
C. 475 N
D. 475 kN

Question 8

Based on the concrete information provided, which of the following applications would non-reinforced concrete be most suitable for?

A. A 15 m bridge span
B. A 300 mm diameter, 10 m long column
C. Simple underground house foundations
D. Second floor slab for a house.

A beam is to be designed to span between two simple supports and extend as a cantilever, as shown in Figure 3.
The loading pattern is shown with arrows.
A structural engineering student is considering a reinforced concrete design, but is debating the best place for the steel reinforcement which is to be laid within the concrete beam.

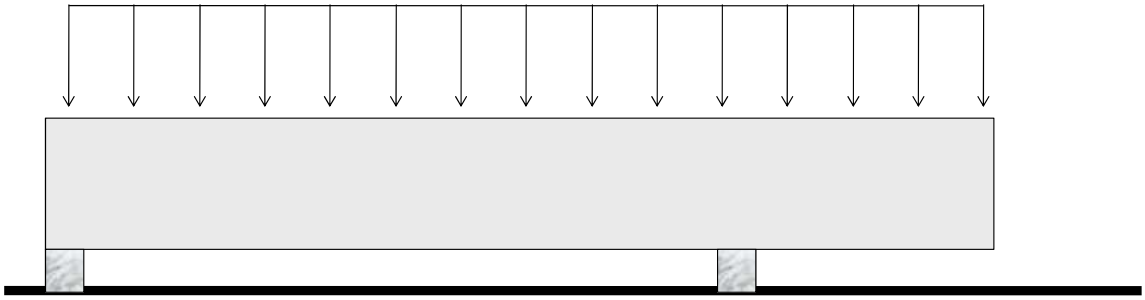
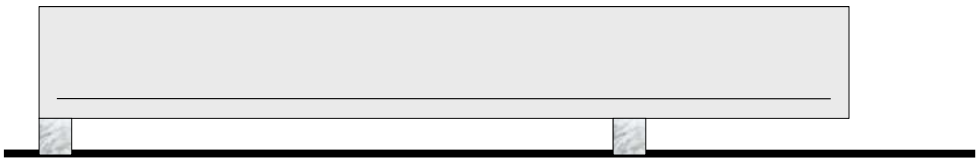


Figure 3

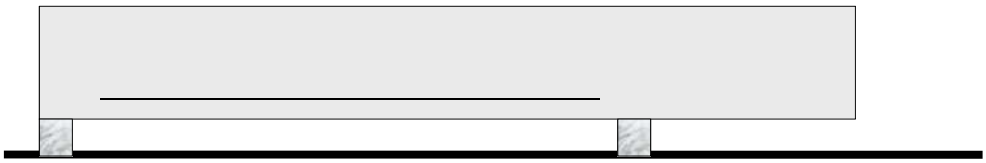
Question 9
Which of the following designs would be most suitable?

A.

B.



C.



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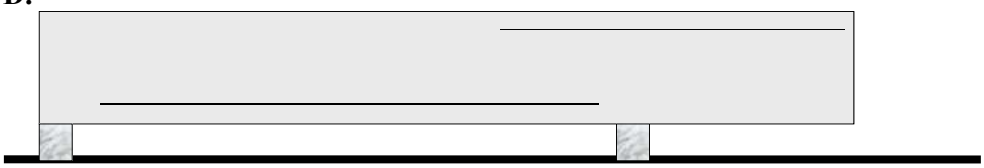


SECTION B – Detailed study 2 – continued
TURN OVER

Questions 10 and 11 refer to the following information

Michael is modelling the behaviour of a beam using a structural analysis programme.
His simplified model is shown in Figure 4.
Note the beam has a mass of 4 x 10^2 kg, which can be assumed to be uniformly distributed along its length.

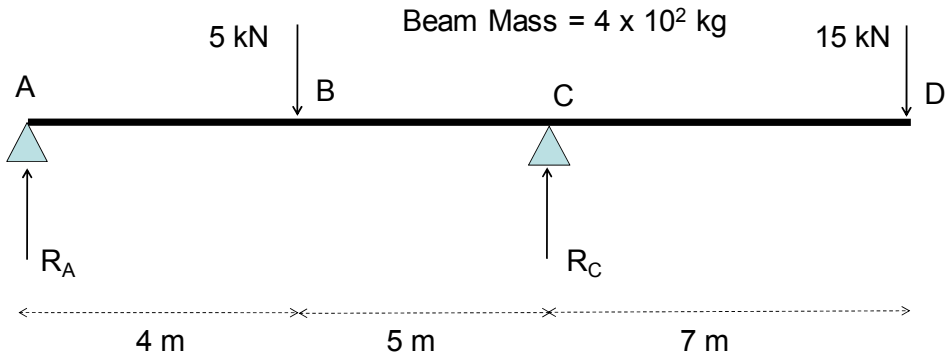


Figure 4

Question 10
Which of the following best describes the magnitude and direction of the torque due to the 15 kN load about Point A.
A. 15 kNm, anticlockwise
B. 15 kNm, clockwise
C. 240 kNm, clockwise
D. 240 kNm, anticlockwise

Question 11
Which of the following is closest to the reaction force at C?
A. 30 kN
B. 32 kN
C. 75 kN
D. 292 kN

Questions 12 and 13 refer to the following information

Consider a 4 kg mass, suspended via two cables, as shown in Figure 5.

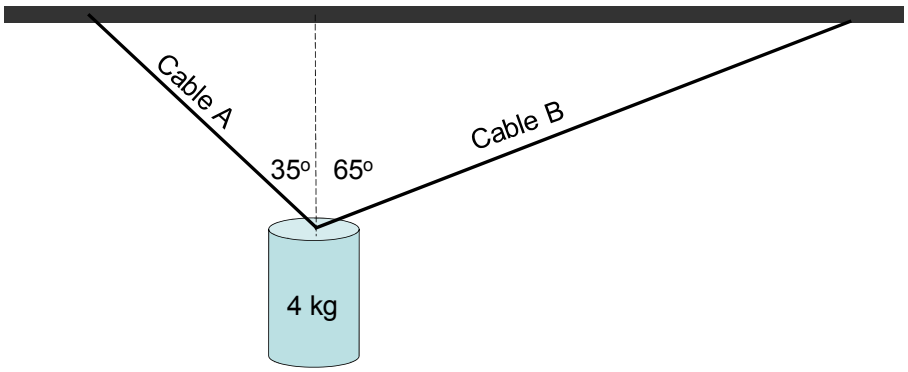


Figure 5

Question 12
Which of the following is closest to the tension force in Cable A?
A. 2 N
B. 3.7 N
C. 29 N
D. 37 N

Question 13
Which of the following is closest to the tension force in Cable B?
A. 4 N
B. 23 N
C. 30 N
D. 36 N

END OF DETAILED STUDY AREA 2
SECTION B – continued
TURN OVER

Detailed Study 3 – Further Electronics

Questions 1 and 2 refer to the following information

Consider a step down transformer, as depicted in Figure 1.
The primary coil is an AC supply measured at 25 V RMS, with a power output of 100 W.
The secondary coil has a load resistor and ammeter attached, giving a reading of 20 A RMS.

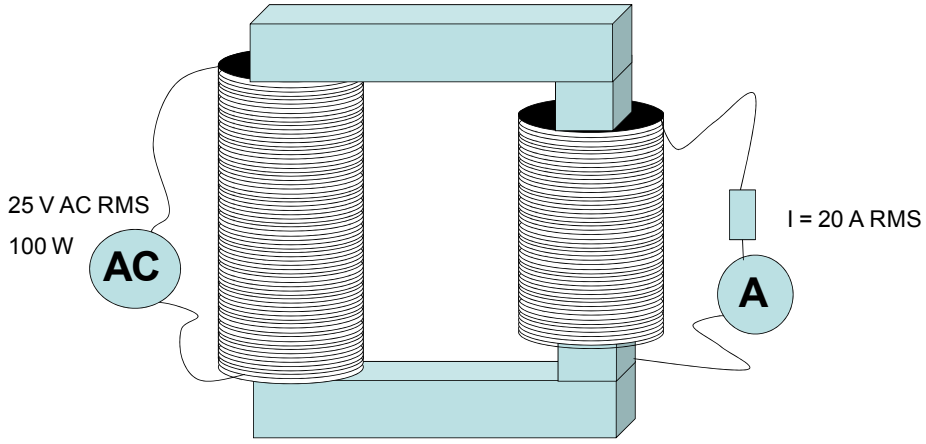


Figure 1

Question 1
Which of the following is closest to the peak - peak value of the primary voltage?
A. 35 V
B. 50 V
C. 71 V
D. 100 V

Question 2
Which of the following best matches the transformer turns ratio (*primary : secondary*)
A. 1 : 4
B. 25 : 20
C. 100 : 20
D. 600 : 150

Questions 3 to 6 refer to the following information

Emily uses another AC supply as the starting point for a smoothing circuit, as depicted in Figure 2. Switch A is initially closed, whilst Switch B remains open.

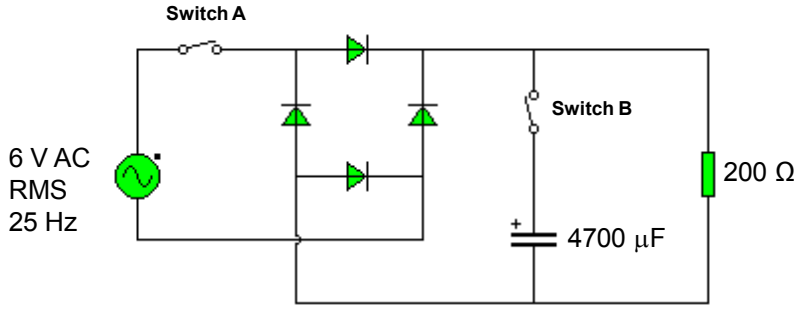
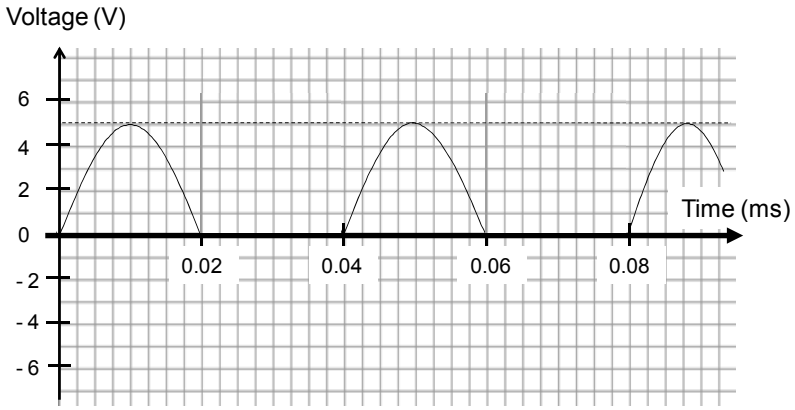


Figure 2

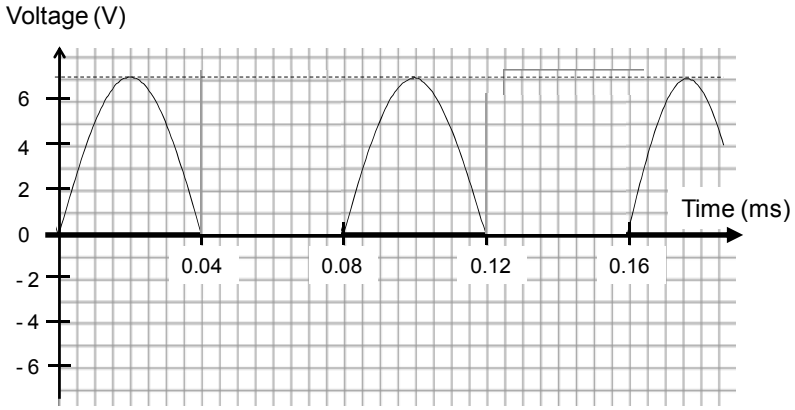
Question 3

Which of the following plots best represent the voltage across the 200Ω resistor?

A.

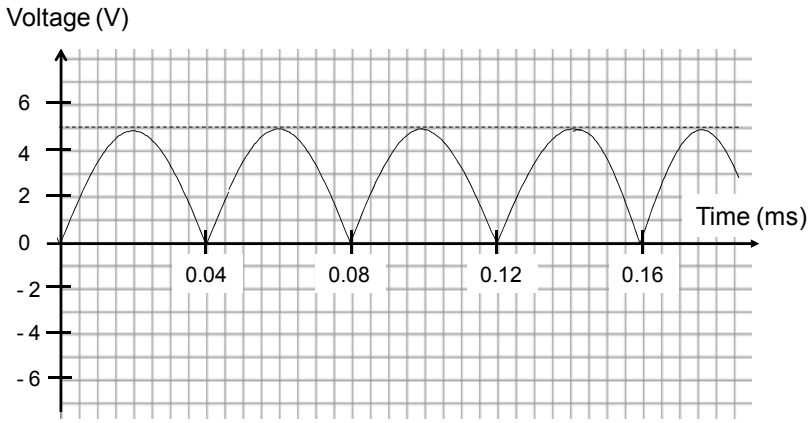


B.

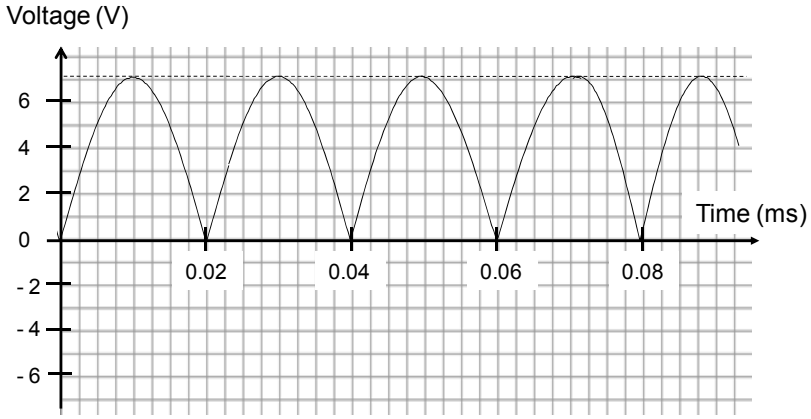


SECTION B – Detailed study 3 – continued
TURN OVER

C.



D.



Switch B is now also closed.

Question 4

Which of the following statements best describes the operation of the 4700 μF device?

A. The component is a capacitor that charges when the rail above it is higher in voltage and discharges when it is lower in voltage, providing additional voltage and current to give a smoother overall supply to the load resistor.

B. The component is a zener diode that charges when the rail above it is higher in voltage and discharges when it is lower in voltage, providing additional voltage to give a smoother overall supply to the load resistor.

C. The component is a capacitor that charges when the rail above it is lower in voltage and discharges when it is higher in voltage, providing additional voltage and current to give a smoother overall supply to the load resistor.

D. The component is a capacitor that fully charges once the switch is closed and only discharges when the AC supply is disconnected, providing an emergency backup supply to the resistor.

Question 5
Given the specifications of the circuit in Figure 2, which of the following statements best describes the degree of smoothing provided once both switches are closed?
A. No smoothing – completely ineffective
B. Minimal smoothing – virtually no smoothing observed.
C. Some smoothing, but overall ripple voltage would be large
D. Extensive smoothing – only a small ripple would remain.

Question 6
Which of the following combinations of changes would best minimise the ripple voltage across the load?

Option	Load resistor	Capacitor	Supply voltage
A	Increase	Increase	Decrease
B	Decrease	No change	Increase
C	No change	Decrease	Increase
D	Decrease	Decrease	No change

Questions 7 and 8 refer to the following information

A student is investigating the performance of a DC circuit with a capacitor, as shown in Figure 3.
Initially, Switch A is closed & Switch B is open.

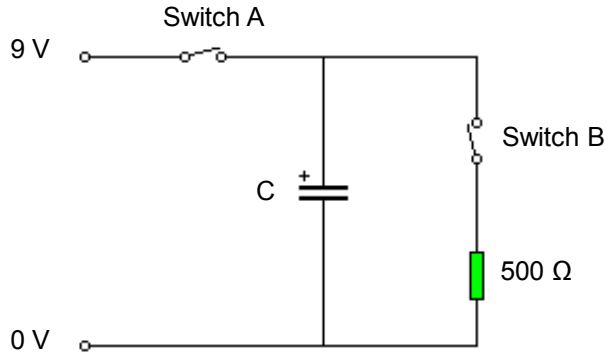


Figure 3

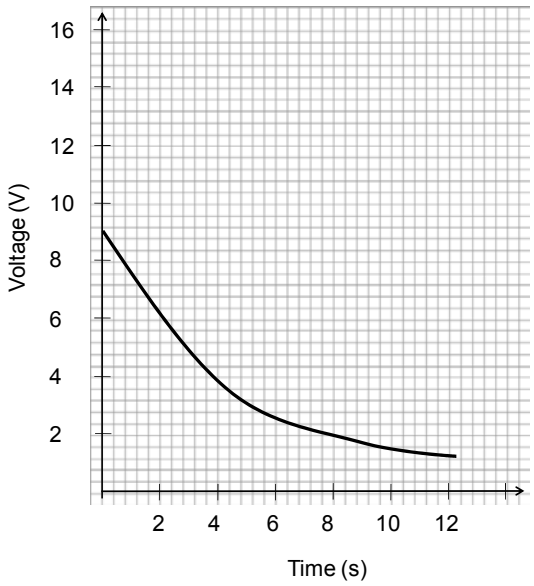
Switch A is now opened, then at time t = 0, Switch B is closed. After 5 sec, a voltmeter across the capacitor reads approximately 3.3 V.

Question 7
Which of the following best approximates the value of the capacitor, C?

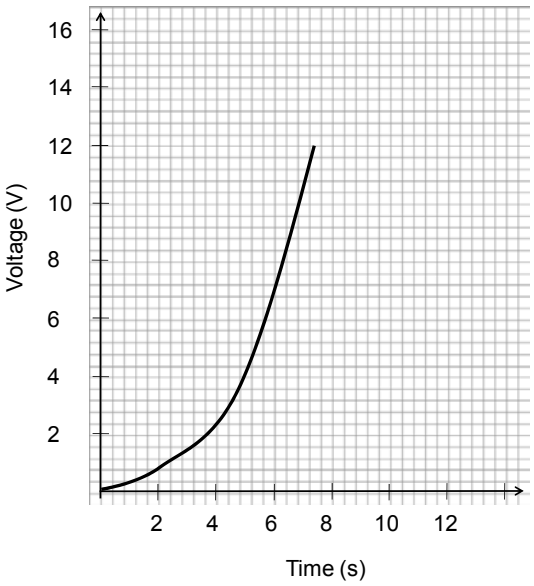
A. 10 μF
B. 100 μF
C. 10 mF
D. 0.01 mF

Question 8
Which of the following best represents a voltage vs. time graph for the capacitor from t = 0?

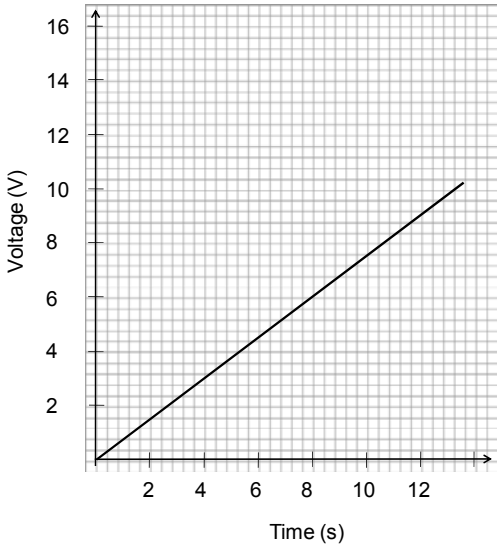
A.



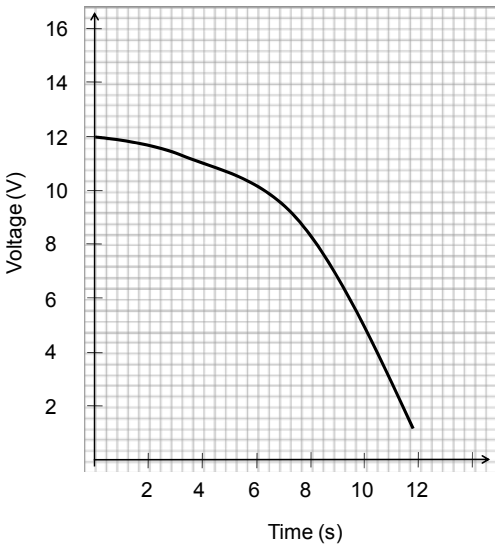
B.



C.



D.



SECTION B – Detailed study 3 - continued

Question 9
Which of the following statements is true about measuring current in a DC circuit with a multimeter?

A. When measuring current, the multimeter must be connected in parallel. In this mode, its resistance is very high to ensure it does not interfere significantly with the circuit.
B. When measuring current, the multimeter must be connected in series with the other components. In this mode, its resistance is very high to ensure it does not interfere significantly with the circuit
C. When measuring current, the multimeter must be connected in series. In this mode, its resistance is very low to ensure it does not interfere significantly with the circuit
D. When measuring current, the multimeter must be connected in parallel. In this mode, its resistance is very low to ensure it does not interfere significantly with the circuit

Questions 10 to 12 refer to the following information

A zener diode circuit is constructed as shown in Figure 4.
The characteristic curve for the zener diode is shown in Figure 5.

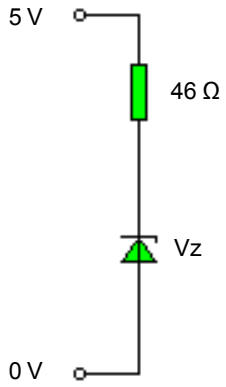


Figure 4

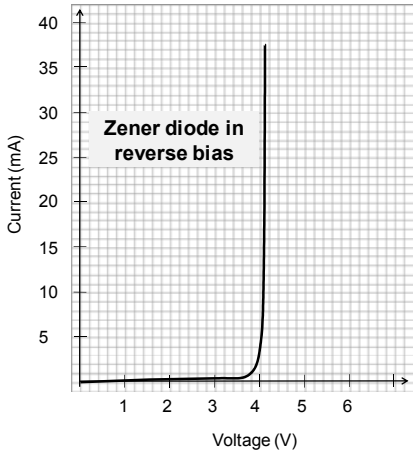


Figure 5

Question 10
Which of the following is the closest to the voltage across the resistor?

A. 5 V
B. 4 V
C. 1 V
D. 0 V

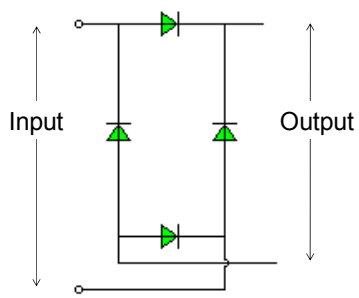
Question 11
Which of the following is the closest to the current through the resistor?
A. 46 mA
B. 22 mA
C. 1 mA
D. 0.02 mA

The voltage is now decreased to 3 V

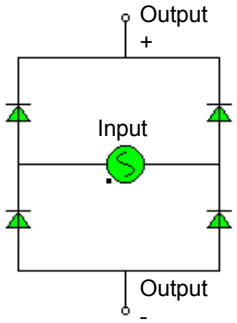
Question 12
Which of the following is the closest to the current through the zener diode?
A. 0 mA
B. 22 mA
C. 46 mA
D. 1 A

Question 13
Which of the following does NOT represent an effective arrangement of four diodes for full wave rectification?

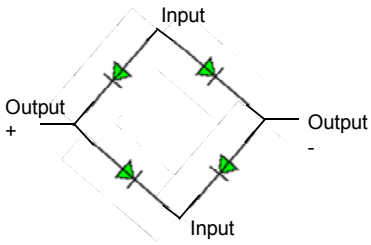
A.



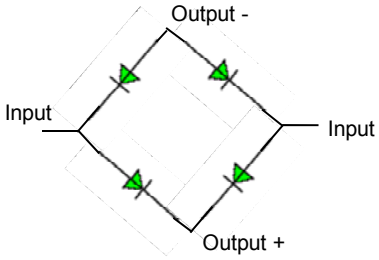
B.



C.



D.



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 thirteen 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
13	A	B	C	D