STAV PUBLISHING

STAV Publishing 2010

Student name

PHYSICS
Unit 3
Trial Examination

QUESTION AND ANSWER BOOK

Total writing time: 1 hour 30 minutes

Structure of book

	Number of Areas of study	Number of Areas of study to be answered	Number of marks
Section A – Areas of study	2	2	64

	Number of Detailed studies	Number of Detailed studies to be answered	Number of marks
Section B – Detailed studies	3	1	26
		Total	**90**

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers, up to two pages (one A4 sheet) of pre-written notes (typed or handwritten) and one scientific calculator.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape, mobile phones and/or any other unauthorised electronic devices.

Materials supplied

- Question and answer book of 33 pages, with a detachable data sheet in the centrefold and detachable answer sheet for mutiple choice questions inside the front cover.

Instructions

- Detach the data sheet from the centre of this book, and the answer sheet for multiple choice questions, during reading time.
- Write your **name** on the top of this page and on the answer sheet for multiple choice questions.
- Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.
- All written responses must be in English.

At the end of the examination

- Place the multiple choice answer sheet inside the front cover of this book.

Published by STAV Publishing. STAV House, 5 Munro Street, Coburg VIC 3058 Australia.
Phone: 61 + 3 9385 3999 • Fax: 61 + 3 9386 6722 • Email: stav@stav.vic.edu.au Website: http://www.sciencevictoria.com.au/stavpublishing/

ABN 61 527 110 823

STAV Publishing
2010

PHYSICS
Unit 3 Trial Examination
MULTIPLE CHOICE ANSWER SHEET

STUDENT NAME:	

INSTRUCTIONS: **USE PENCIL ONLY**

- Write your name in the space provided above.
- Use a **PENCIL** for **ALL** entries. For each question, **SHADE** the box which indicates your answer.
- Marks will **NOT** be deducted for incorrect answers.
- **NO MARK** will be given if more than **ONE** answer is completed for any question.
- If you make a mistake, **ERASE** the incorrect answer – **DO NOT** cross it out.

SECTION B

Show the Detailed Study answered by shading one box.

Detailed Study:

- ☐ Detailed Study 1: Einstein's special relativity
- ☐ Detailed Study 2: Materials and their use in structures
- ☐ Detailed Study 3: Further electronics

Please write the Detailed Study name in the box below to confirm your chosen Detailed Study.

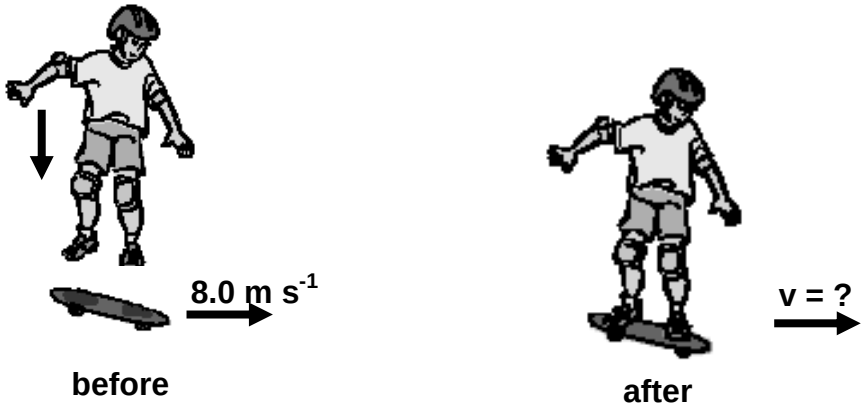
Detailed Study:

	ONE ANSWER PER LINE					ONE ANSWER PER LINE				
1	A	B	C	D	8	A	B	C	D	
2	A	B	C	D	9	A	B	C	D	
3	A	B	C	D	10	A	B	C	D	
4	A	B	C	D	11	A	B	C	D	
5	A	B	C	D	12	A	B	C	D	
6	A	B	C	D	13	A	B	C	D	
7	A	B	C	D						

AREA OF STUDY 1 – Motion in one and two dimensions

Questions 1 and 2 relate to the following information

Anutja is hanging from an overhead beam when he lets go and drops vertically on to a skateboard as it passes beneath him. The skateboard weighs 2.5 kg and is travelling at 8.0 m s^{-1} when Anutja, who weighs 45 kg, lands on it.



Question 1.

Calculate the speed of Anutja and his skateboard after this collision

m s^{-1}

[2 marks]

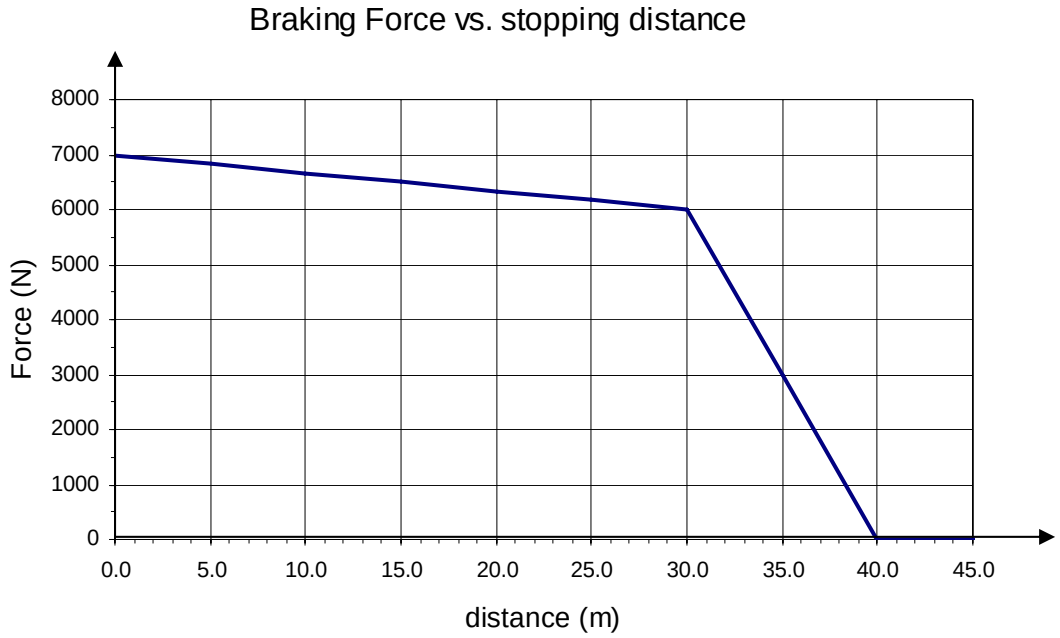
Question 2.

Prove, with calculations, that the collision between Anutja and the skateboard is inelastic.

[2 marks]

Questions 3 to 5 relate to the following information

Joffa is driving his car when he sees the traffic lights change to red. He applies the brakes and comes to rest safely at the lights. The graph below shows the force versus distance relationship for his vehicle from the moment he applied the brakes to the moment when he came to a stop. Joffa was travelling at 20 m s^{-1} when he applied the brakes.



Question 3.

Was Joffa breaking the 60 km per hour speed limit? Circle YES or NO below.
Show by calculation the justification for your answer.

YES NO *(Circle your answer)*

[2 marks]

Question 4.

Show by calculation that the work done by the brakes bringing Joffa's car to rest at the traffic lights is equal to 2.25×10^5 J.

[3 marks]

Question 5.

Assuming all the work done goes into changing the kinetic energy of Joffa and his car, what is the mass of Joffa and his car?

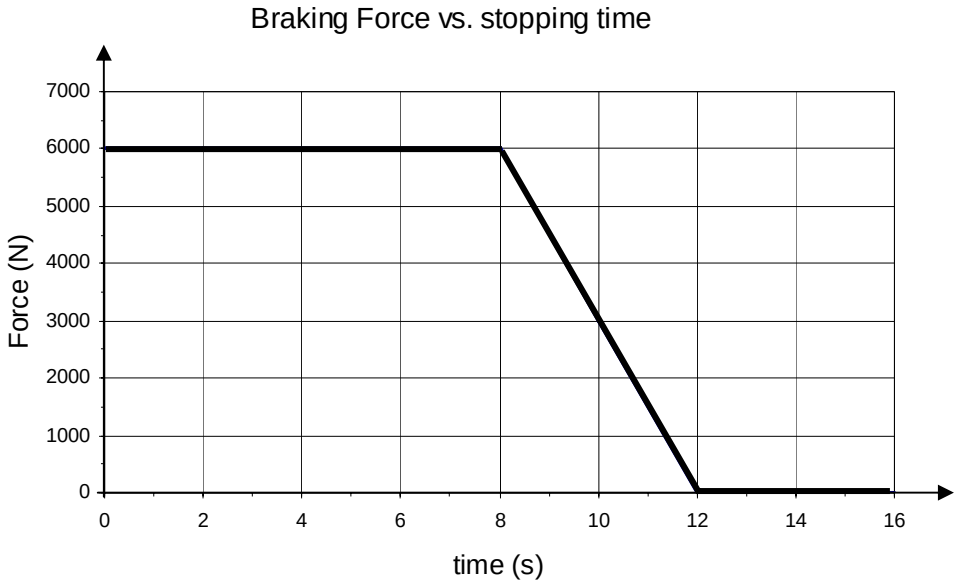
kg

[3 marks]

Questions 6 & 7 relate to the following information

George is towing his trailer behind his car and the total mass of the car and trailer is 2200 kg

At a set of lights George brakes and brings the car and trailer to rest. The following graph shows the force versus time graph for this action.



Question 6.

How fast was George travelling before he applied the brakes?

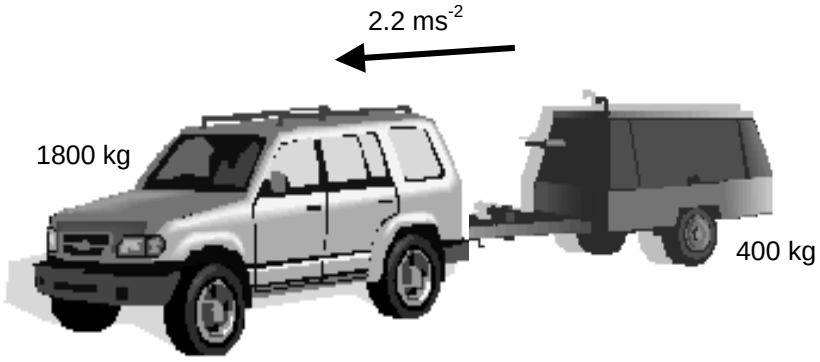
m s^{-1}

[3 marks]

Question 7.

George is driving along a straight level road. The car weighs 1800 kg and the trailer is very lightly loaded and weighs 400 kg. The car and trailer are accelerating forward at 2.2 ms^{-2}.

The friction force acting on the car is 350 N and on the trailer another 250 N.



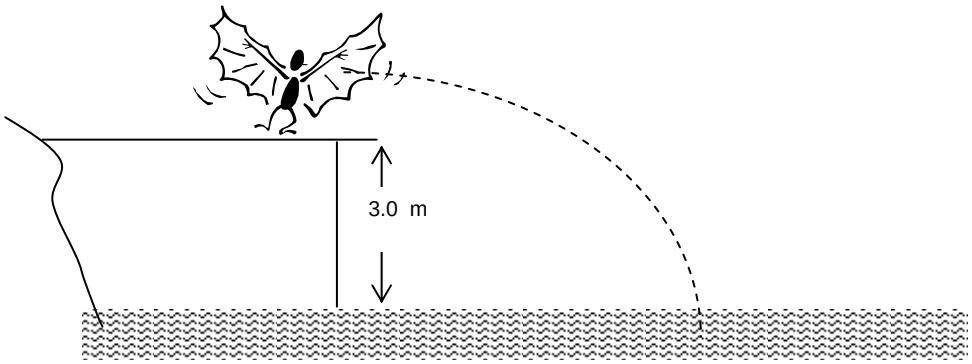
What is the magnitude of the tension in the tow bar connecting the trailer to the car?

N

[2 marks]

Questions 8 & 9 relate to the following information

In the Moomba "Birdman" Event participants run off a horizontal platform and launch themselves into space to "fly" into the waters of the Yarra River 3.0 metres below them
The amount of "lift" supplied by their apparatus varies from zero to not very much.



Question 8.

One of the "flyers" launches into space at a speed of 4.5 m s^{-1} horizontally. They are only in it for fun and their equipment consists of "fairy wings" supplying no lift. They plummet to the water. How far from their launch point do they travel horizontally?

m

[3 marks]

Question 9.

Another competitor who, with his equipment, weighs in at a beefy 88 kg also runs off the launch platform at a speed of 4.5 m s^{-1} horizontally. He travels a total distance horizontally of 22.0 m. What was the magnitude of the average vertical force acting on this competitor during his "flight"?

N

[3 marks]

Question 10.

Christine is bouncing on her trampoline. At her maximum bounce height the bottom of her feet are 1.5 m **above** the level of the unstretched trampoline surface. At the lowest point of her bounce the bottom of her feet are 0.4 m **below** the unstretched level of the trampoline surface.
Christine weighs a bouncy 48.0 kg.

From this information what is the best estimate of the spring constant of the trampoline?

N m^{-1}

[3 marks]

Questions 11 & 12 relate to the following information

An open wheeler race car and driver travelling at 60 m s^{-1} turn into a corner of radius 230 m. The car and driver weigh 750 kg. The driver does not use his brakes and maintains his speed through the corner.

Question 11.

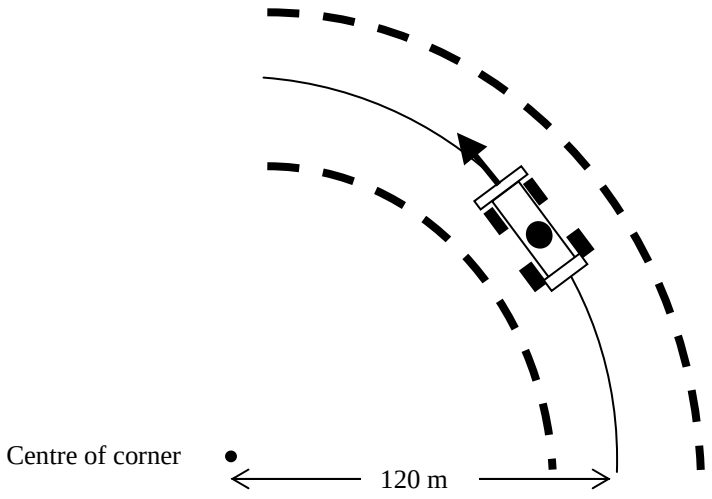
What is the magnitude of the average sideways grip from **each** of the **four** tyres keeping the car on the track?

N

[2 marks]

Question 12.

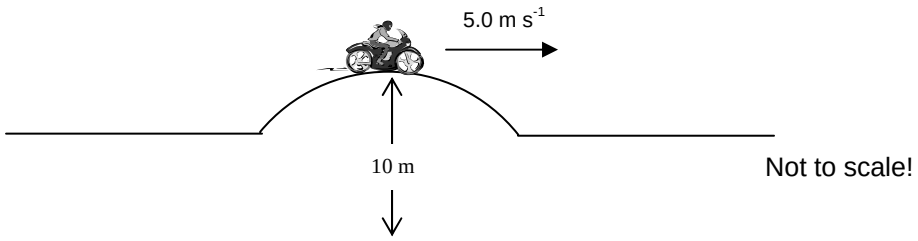
As he drives into the next corner the driver finds that he is travelling too fast to maintain his direction around the corner and he applies the brakes and reduces his speed. On the diagram below draw an arrow that best indicates the direction of the net horizontal force acting on the car as he goes around the corner and applies the brakes. The arrow shows the direction of travel of the car and driver.



[2 marks]

Question 13.

A motorcyclist passes over a railway track at a speed of 5.0 m s^{-1}. The track is raised up so that it has a curve of radius 10 m.



The motorcyclist weighs 76.0 kg.
What is his apparent weight as he passes over the top of the railway track at this speed?

N

[3 marks]

Questions 14 & 15 relate to the following information

The space shuttle is in orbit at an **altitude** of 370 km.

Mass of the Earth = 5.98×10^{24} kg

Radius of the Earth = 6.37×10^{6} m

G = 6.67×10^{-11} N m^2 kg^{-2}

Question 14.

The shuttle captain has a mass of 78 kg. In this orbit he is floating freely in the cabin of the shuttle. What is the magnitude of his weight force?

N

[2 marks]

Question 15.

What is the speed of the shuttle?

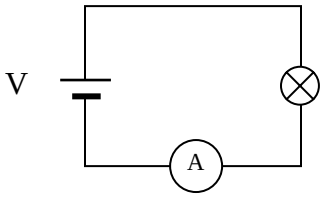
m s^{-1}

[3 marks]

AREA OF STUDY 2 – Electronics and photonics

Questions 1 to 4 relate to the following information.

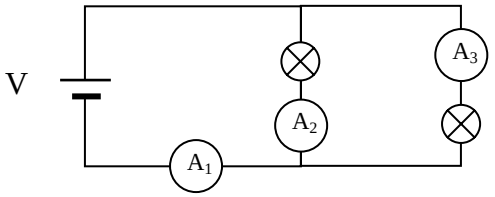
A simple circuit composed of a light globe and a one cell battery is shown on the right. This is considered to be the normal circuit.



In this circuit the battery voltage is 4.5 volts and the current in the ammeter is 0.4 A.

Question 1.

The battery and light globes are the same as in the 'normal' circuit. What is the current in each of the ammeters A_1, A_2 and A_3 in the circuit on the right?

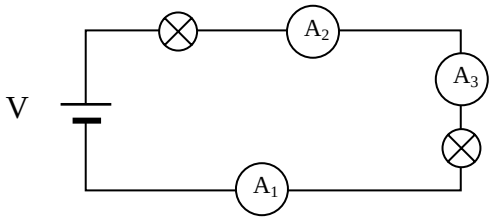


A_1	**A**
A_2	**A**
A_3	**A**

[3 marks]

Question 2.

The battery and light globes are the same as in the 'normal' circuit. What is the current in each of the ammeters A_1, A_2 and A_3 in the circuit on the right?

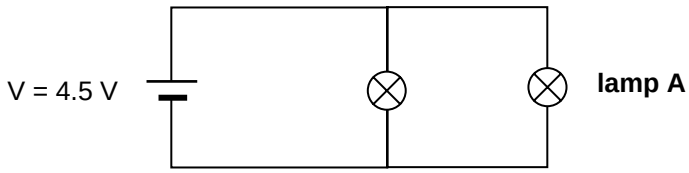


A_1	**A**
A_2	**A**
A_3	**A**

[2 marks]

Question 3.

What is the power dissipated in **lamp A** in the following circuit?

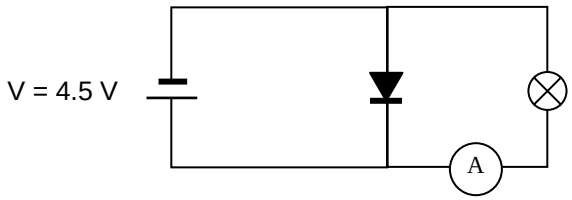


W

[2 marks]

Question 4.

What is the current in the ammeter in the following circuit?

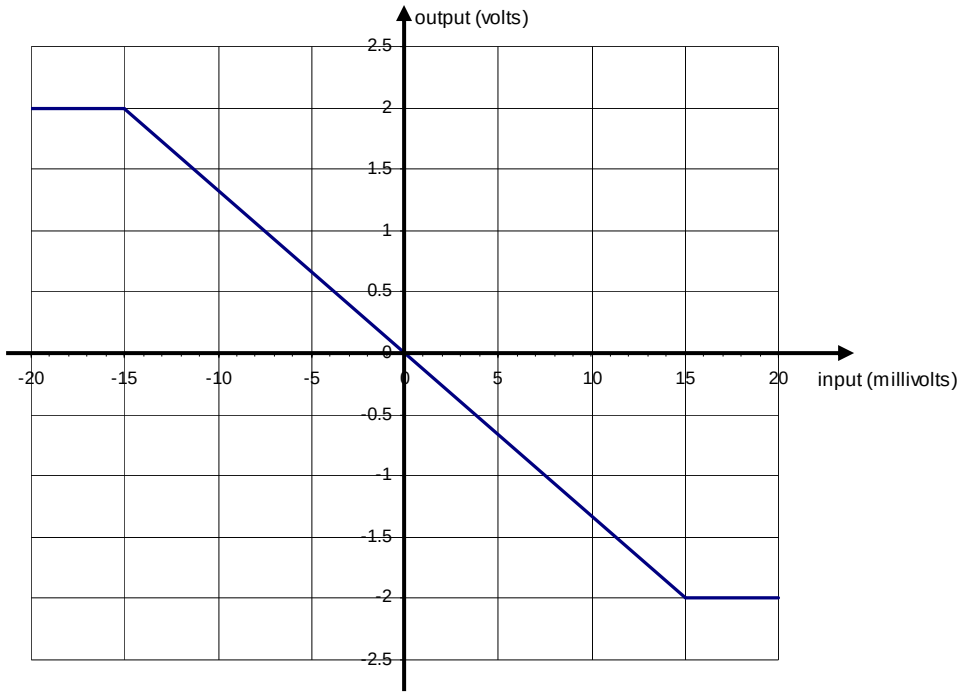


A

[2 marks]

Questions 5 to 8 relate to the following information.

The characteristic of a single stage amplifier are given below.



Question 5.

This type of characteristic indicates that the amplifier is an inverting amplifier.
Explain this statement by referring to the amplifier characteristic given above.

_____

_____

_____

[2 marks]

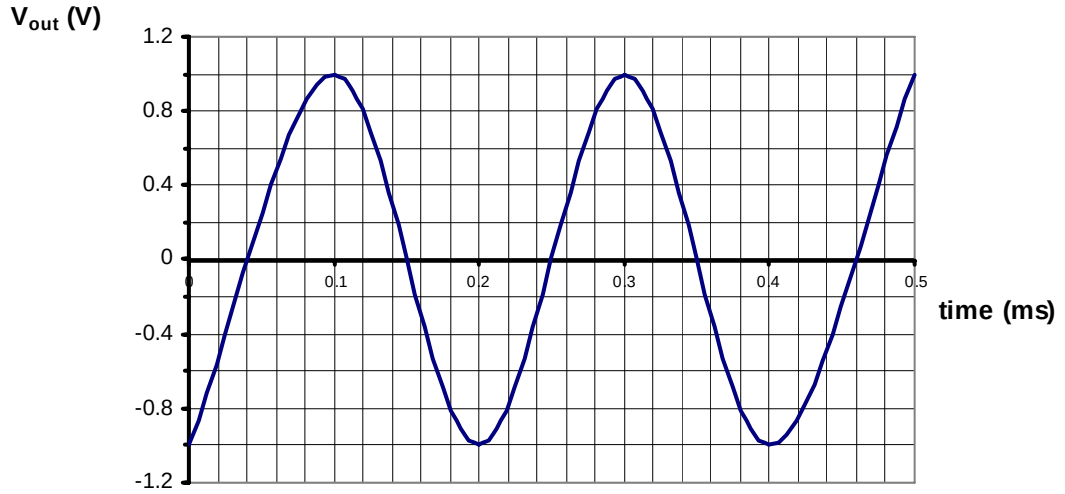
Question 6.

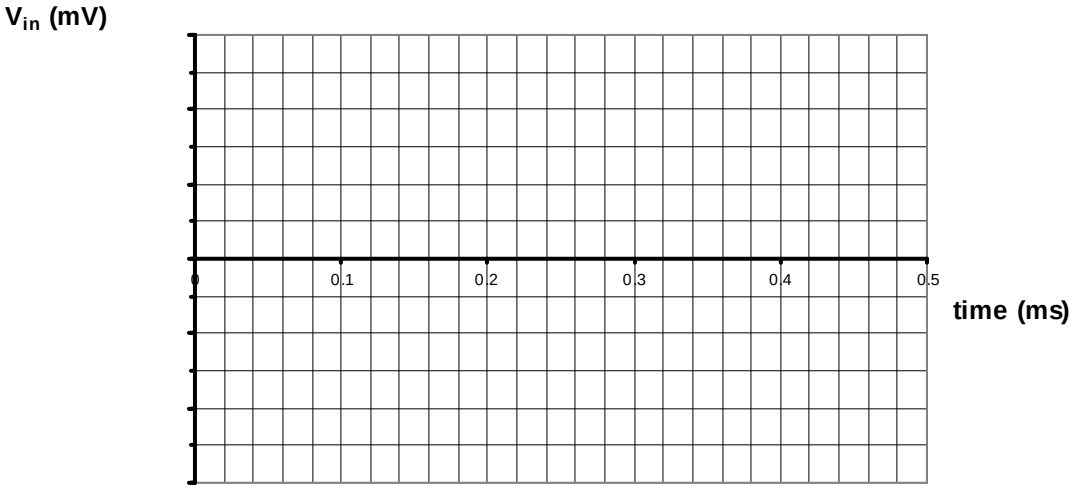
What is voltage gain of this amplifier?

[2 marks]

Question 7.

The output signal is shown on the first set of axes below. On the second set of axes provided draw in the corresponding input signal. Assign a scale for the input voltage axis.





[3 marks]

Question 8.

For any amplifier what is the value of the following ratio?

$$\frac{\text{frequency of the input voltage}}{\text{frequency of the output voltage}}$$

[2 marks]

Questions 9 to 11 relate to the following information.

The characteristics of a Light Dependent Resistor (LDR) are shown below.

Question 9.

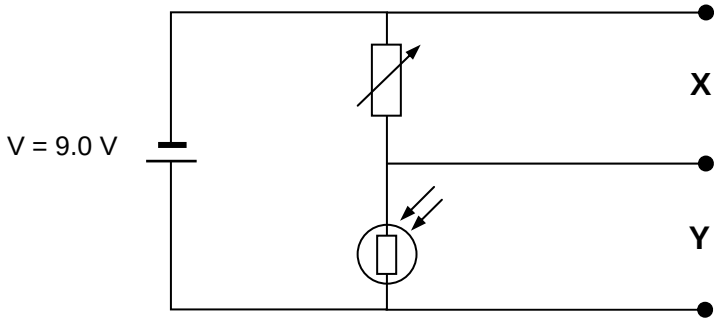
What is the resistance of the LDR when the light intensity is 3 lux?

Ω

[2 marks]

Question 10.

The LDR is incorporated into a circuit to control a security light system at a school. The circuit is shown below. An electronic switch activates the lights when the voltage across the switch falls below 6.0 V and turns the lights off when the voltage is equal to or above 6.0 V.



The security lights need to come on when the light intensity as measured by the LDR drops below 10 lux. In which of the positions **X** or **Y** should the switch be placed for the system to operate correctly?

(Circle your choice) **X** **Y**

Explain your choice.

[3 marks]

Question 11.

At what resistance should the variable resistor be set for the system to operate correctly?

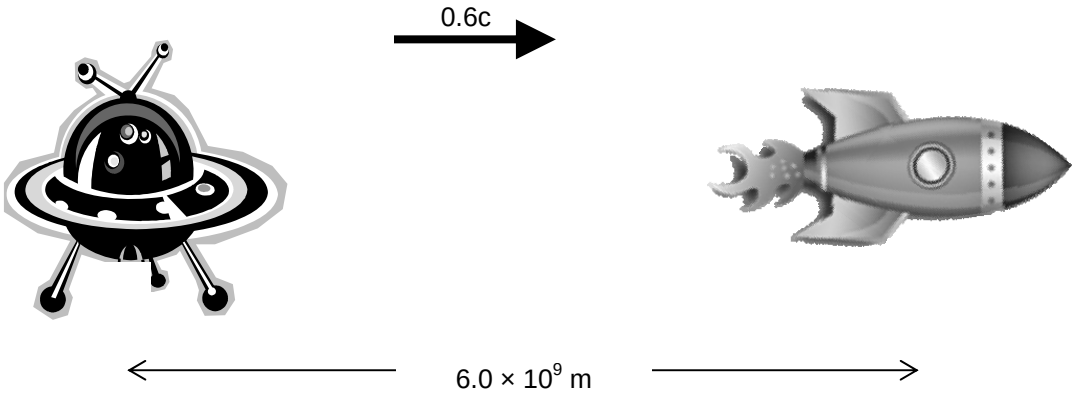
Ω

[3 marks]

DETAILED STUDY 1 – Einstein's special relativity

Questions 1 and 2 relate to the following information.

Two interstellar space ships are travelling towards Alpha Centauri in convoy, both at a speed of 0.6c and a separation of 6.0×10^9 m.



Question 1.

The alien in the front ship shines a light back at the trailing ship. The alien in the rearward ship measures the speed of the light beam from the forward ship to be:

A 0.4c **B** 0.6c

C 1.0c **D** 1.6c

Question 2.

How long does the beam take to travel from the front ship to the rear ship?

A 12.5 s **B** 20 s

C 33.3 s **D** 50 s

Question 3.

A passenger on a spaceship knows her spaceship was 50 m long when measured at the space docking station. How long is the spaceship, as measured by the passenger, now that her spaceship is travelling at 0.4c.

A 45.8 m **B** 50.0 m

C 54.6 m **D** 59.5 m

Question 4.

Which of the following quantities is not affected by travel at speeds close to the speed of light when measured by both stationary and moving observers?

A Mass in kg

B Length in m

C Velocity in ms^{-1}

D Speed of light in "c"

Question 5.

An electron is accelerated to 0.9c in a particle accelerator. What is the value of γ (gamma) for this particular speed?

A 2.294 **B** 1.2345

C 0.810 **D** 0.436

Question 6.

The experiment of Rossi and Hall in 1941, measuring the behaviour of muons in the atmosphere, was important in providing experimental evidence of:

A time dilation.

B the non-existence of the aether.

C the constant speed of light in all frames of reference.

D the conversion of mass to energy according to Einstein's equation, $E = mc^2$.

Question 7.

Protons measured in a physics laboratory have a rest mass of 1.67×10^{-27} kg. When accelerated to a speed of 0.3c the mass of the protons as measured by an observer in the laboratory would be:

A 1.52×10^{-27} kg **B** 1.59×10^{-27} kg

C 1.75×10^{-27} kg **D** 1.84×10^{-27} kg

Question 8.

In another experiment a proton of rest mass of 1.67×10^{-27} kg is accelerated and given an energy of 8.4 GeV. What is the relativistic **change** in mass of the proton?

A 4.47×10^{-15} kg **B** 4.48×10^{-18} kg

C 1.49×10^{-23} kg **D** 1.49×10^{-26} kg

Question 9.

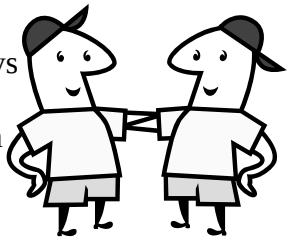
An electron of mass 9.1×10^{-31} kg is accelerated across a potential of 100 MeV.
In Newtonian physics what is the speed of this electron?

A 5.93×10^{9} m s^{-1} **B** 4.69×10^{18} m s^{-1}

C 1.35×10^{11} m s^{-1} **D** 3.52×10^{19} m s^{-1}

Questions 10 and 11 relate to the following information.

Twins William and Benjamin are both astronauts. William sets out on a trip into deep outer space while Benjamin stays behind on Earth. When William returns to Earth it is found that in space William has aged 20 years while Benjamin on Earth has aged 23.1 years.



Question 10.

What was the average speed of William's space craft?

A 0.25c **B** 0.50c

C 0.75c **D** 0.99c

Question 11.

On returning to Earth William decides to go off on another space trip. This time his craft travels at an average speed of 0.7c and he returns to Earth after 2 years have passed for him. On his return to Earth, what distance has he travelled as measured in his moving frame of reference?

A 1.40 light years **B** 1.71 light years

C 2.80 light years **D** 3.36 light years

Question 12.

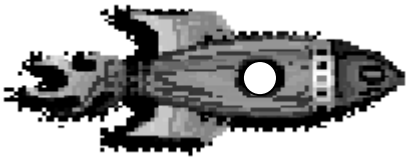
In a laboratory an electron is accelerated to a speed of 2.0×10^{8} m s^{-1}. What is the mass of the electron travelling at this speed as measured by an observer in the laboratory?

A 6.78×10^{-31} kg **B** 9.1×10^{-31} kg

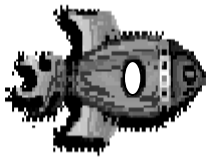
C 6.10×10^{-31} kg **D** 1.22×10^{-30} kg

Question 13.

A spaceship has a circular window in its side. An observer sees the spaceship fly past going very quickly. The observer notices that the window as viewed by him is no longer circular but now oval shaped with the length half the width.



At rest



Speed = v

How fast is the space ship travelling?

A v = 0.25c **B** v = 0.50c

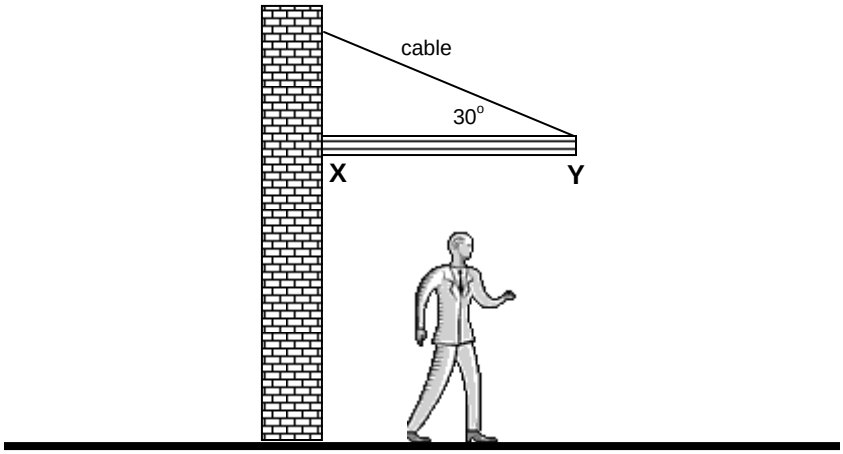
C v = 0.75c **D** v = 0.87c

END OF DETAILED STUDY 1

DETAILED STUDY 2 – Materials and their use in structures

Questions 1 and 2 relate to the following information.

A beam (**X – Y**) forms a roof on the front of a shop. It is fixed to the shop front wall and also supported by a cable as shown in the diagram below. The cable makes an angle of 30^o to the beam.



Question 1.

The beam (**X – Y**) is under which of the following external forces?

A Tension

B Compression

C Shear

D Both Tension and Compression

Question 2.

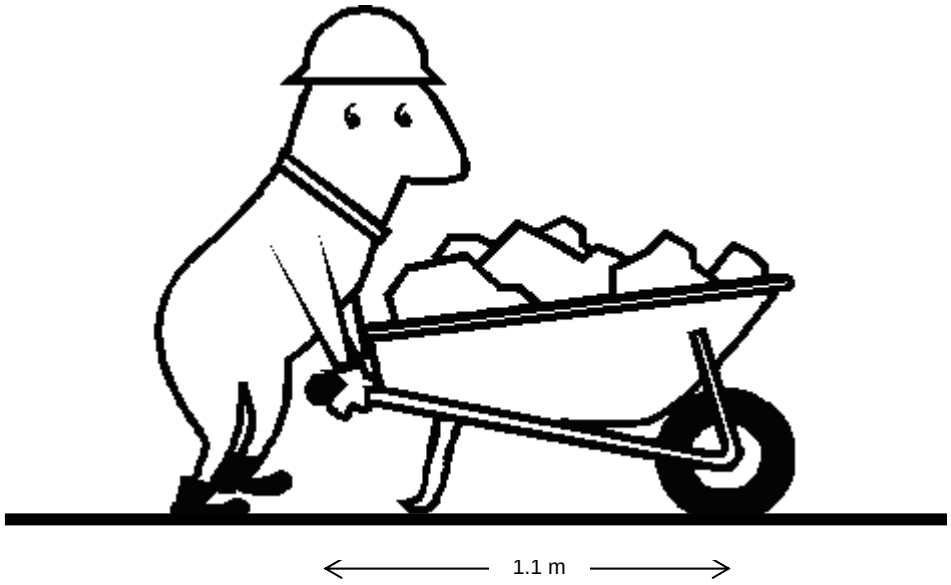
The mass of the beam (**X – Y**) is 250 kg and it is 3.0 m long.
The **best** estimate of the magnitude of the tension in the cable is:

A 1.25×10^2 N **B** 2.5×10^2 N

C 1.25×10^3 N **D** 2.5×10^3 N

Questions 3 and 4 relate to the following information.

A wheelbarrow has a load of 90 kg of rocks in it. The wheelbarrow itself has a mass of 25 kg. The length of the wheel barrow handle to the centre of the wheel is 1.1 m.



Question 3.

What is the best estimate of the size of the minimum lifting force that needs to be applied by the worker to get the wheelbarrow's legs just off the ground?

A 58 N **B** 115 N

C 575 N **D** 1150 N

Question 4.

What is the best estimate of the size of the force between the ground and the wheel barrow's tyre when the wheelbarrow's legs are just off the ground?

A 58 N **B** 115 N

C 575 N **D** 1150 N

Questions 5 and 6 relate to the following information.

The Young's modulus for glass is 1.0×10^{11} Pa. A length of glass rod is 0.75 m long and has a cross sectional area of 3.5 cm^2. The glass rod is measured carefully and found to be extended by 0.20 mm when placed under tension by a mass suspended vertically from the end of the rod?

Question 5.

What is the strain energy stored in the stretched glass rod?

A 1.87 J

B 0.93 J

C 9.3×10^3 J

D 1.87×10^3 J

Question 6.

What is the major assumption you have made when answering the previous question?

A The cross section of the glass was circular.

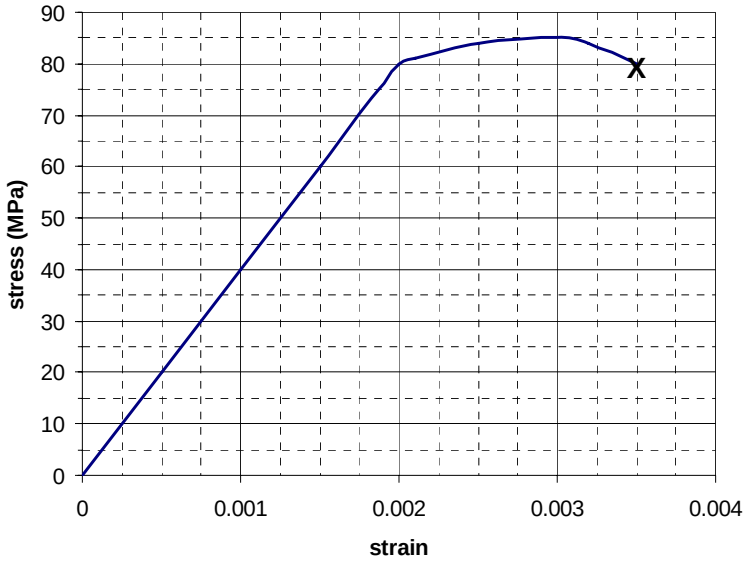
B The glass rod was ductile.

C The glass rod was malleable.

D That extension of the glass rod was within the elastic limit for this type of glass.

Questions 7 to 9 relate to the following information.

The following graph shows the stress - strain relationship for a material.



Question 7.

Question 14. From the graph Young's modulus is:

A 4.0×10^4 Pa **B** 4.0×10^{10} Pa

C 4.0×10^7 Pa **D** 400 GPa

Question 8.

The material is stretched to a point when the strain is 0.003. On releasing the stretching force the material will:

A return to its original length.

B be permanently deformed and stay at a strain of 0.003.

C be permanently deformed and return to a strain of 0.0009.

D be permanently deformed and return to a strain of 0.001.

Question 9.

The point **X** on the graph indicates:

A An unknown quantity.

B The ductile region of the material.

C The elastic limit.

D The point of fracture.

Question 10.

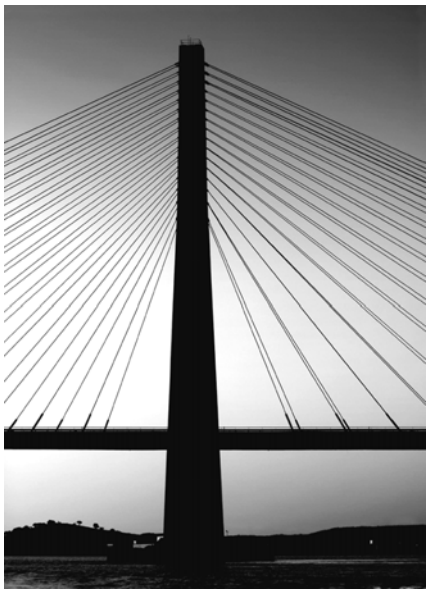
For the bridge pictured on the right which of the following choices (A-D) is correct?

A The cables are in tension and the central column is in compression.

B The cables are in compression and the central column is in compression.

C The cables are in compression and the central column is in tension.

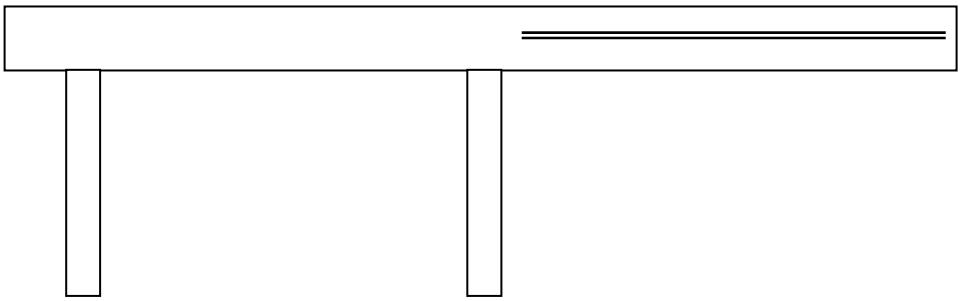
D The cables are in tension and the central column is in tension.



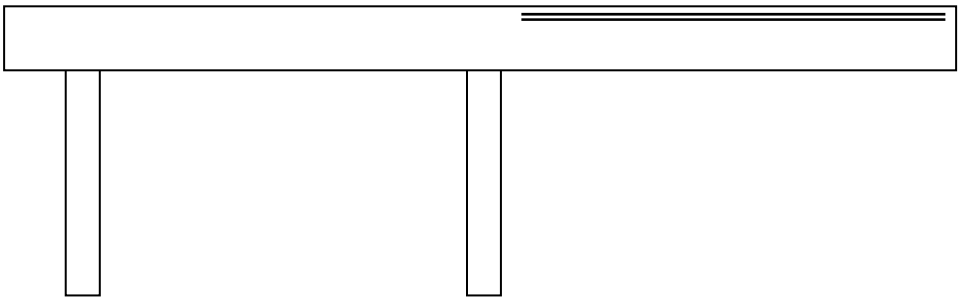
Question 11.

The floor in a new building is to be made from reinforced concrete. The floor is to be extended to form a viewing deck. Which of the following diagrams best shows how the reinforcing steel should be embedded in the concrete of the **viewing deck**?

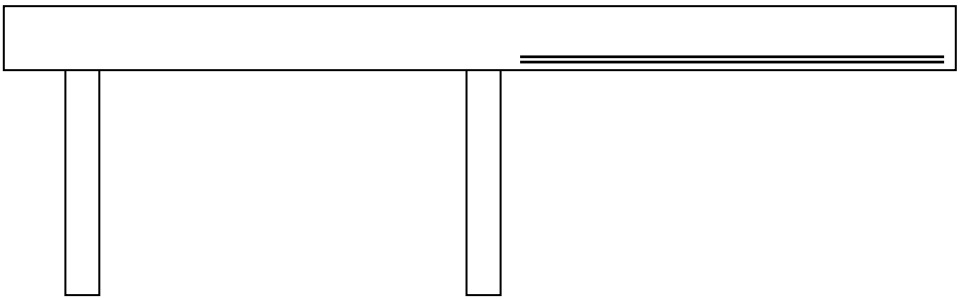
A



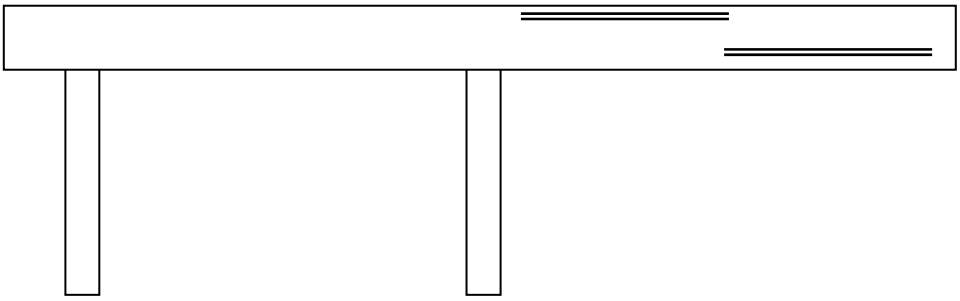
B



C

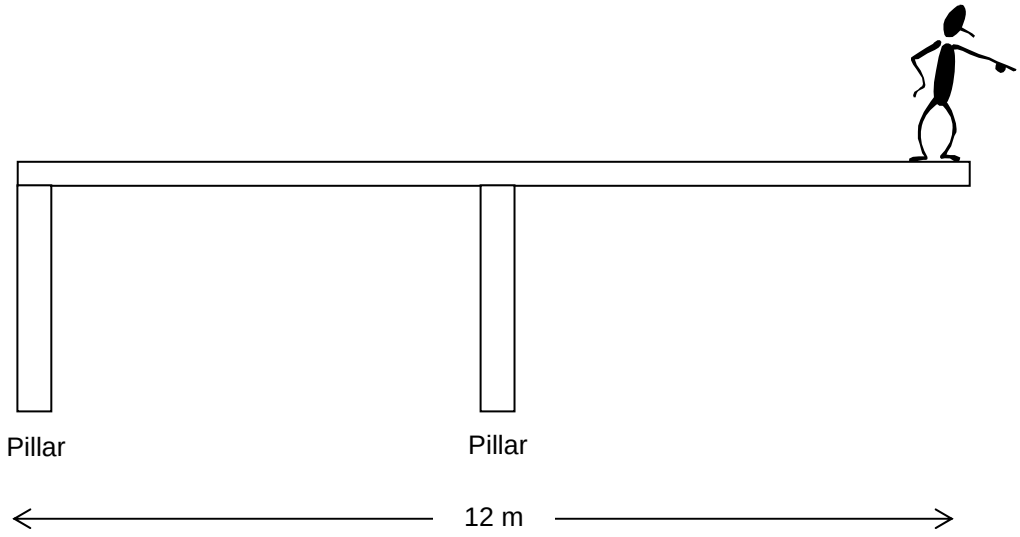


D



Question 12.

A beam is supported on two pillars A and B. Pillar A is at the left hand edge of the beam and pillar B is in the middle of the beam. The beam is 12 m in length and weighs 900 kg. A man, of mass 85 kg is standing on the extreme right hand edge of the beam.



Which of the following is the best estimate of the force on pillar A?

A 85 N down

B 850 N up

C 85 N up

D 850 N down

Question 13.

The stone arches used in the Roman aqueduct on the right rely on what primary property for their strength?

A The mortar between the stones 'glues' the stones together.

B Stone is strong under tension and weaker under compression.

C The shape of the arch places each of the stones in compression.

D The extended base of each arch supports the tension in the arch.

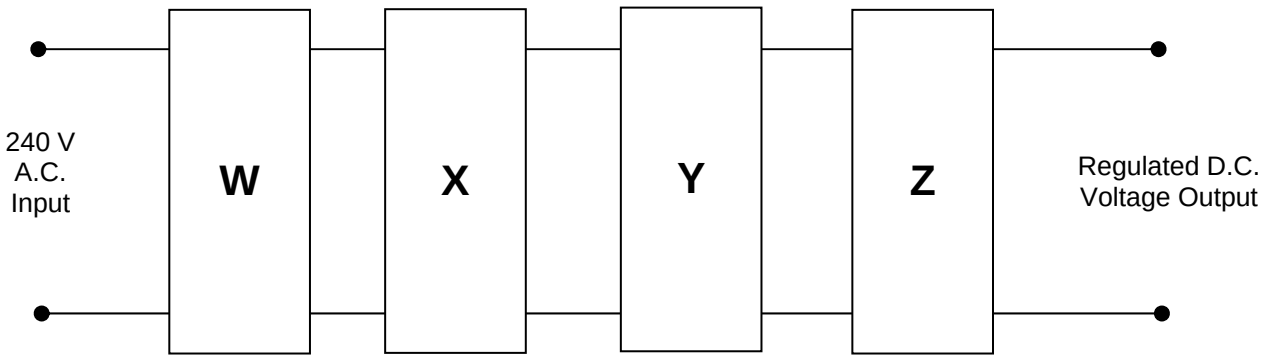
END OF DETAILED STUDY 2

DETAILED STUDY 3 – Further electronics

Questions 1 to 8 relate to the following information.

A regulated DC power supply circuit is shown below. The AC power supply has as its input a normal household supply of 240 V RMS.

The components of the regulated power supply are shown below as **W, X, Y** and **Z**.



Question 1.

Component **W** is which of the following devices?

A Voltage regulator **B** Capacitor

C Transformer **D** Bridge Rectifier

Question 2.

Component **Y** is which of the following devices?

A Voltage regulator **B** Capacitor

C Transformer **D** Bridge Rectifier

Question 3.

Component **Z** is which of the following devices?

A Voltage regulator **B** Capacitor

C Transformer **D** Bridge Rectifier

Question 4.

Component **X** is which of the following devices?

A Voltage regulator **B** Capacitor

C Transformer **D** Bridge Rectifier

Question 5.

The purpose of the capacitor in this regulated DC power supply is to:

A Stop the flow of DC current.

B To smooth the output of the voltage regulator.

C To release charge to the load during the charging cycle and to store charge during the discharging cycle.

D To smooth the output of the bridge rectifier.

Question 6.

The secondary or output side of the transformer is rated as 10 V AC. This is an RMS value. What is the Peak to Peak output voltage of the transformer?

A 12.0 V **B** 14.1 V

C 7.1 V **D** 28.3 V

Question 7.

The current flowing into the bridge rectifier is measured to be 1.5 A RMS. What is the best estimate of the RMS electrical power supplied to the primary coils of the transformer?

A 1.5 W **B** 21.2 W

C 15 W **D** 10.6 W

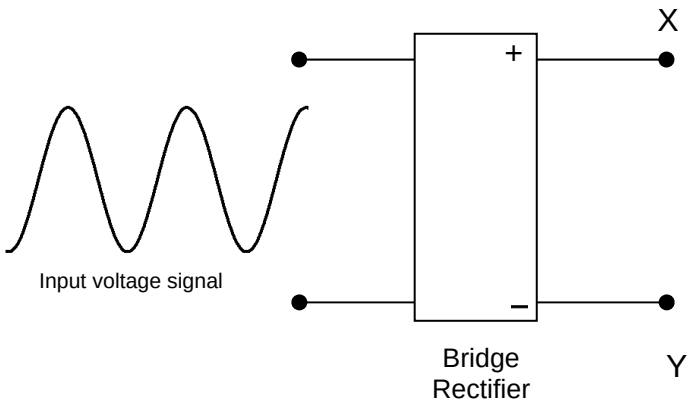
Question 8.

If the current going into the bridge rectifier is 1.5 A RMS then what is the peak current supplied to the bridge rectifier?

A 1.1 A **B** 1.5 A

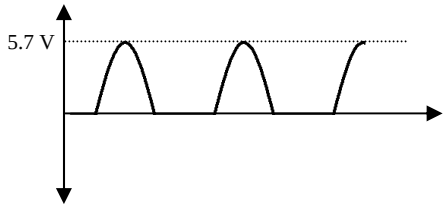
C 2.12 A **D** 3.0 A

Question 9.

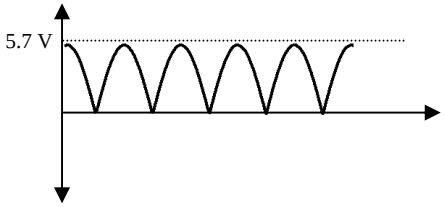


If a peak voltage, measured to be 7.1 volts, is supplied to a bridge rectifier, which of the following gives the best estimate of the voltage signal across the terminals X-Y?

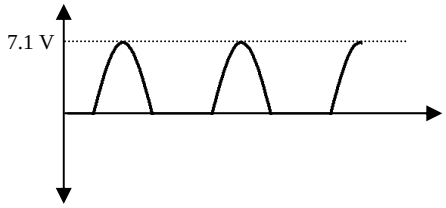
A



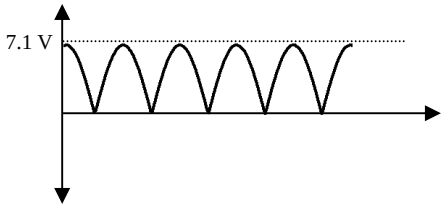
B



C



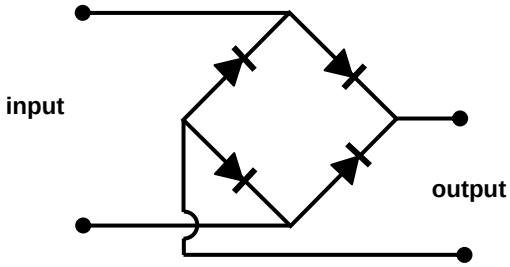
D



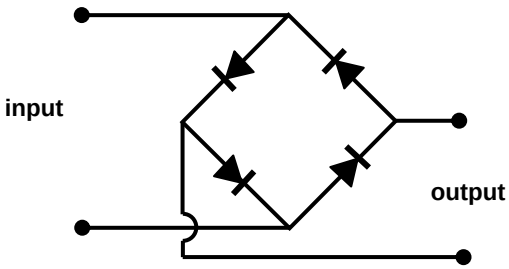
Question 10.

A student is assembling a bridge rectifier using four individual diodes. Which of the following diode arrangements will work as a bridge rectifier?

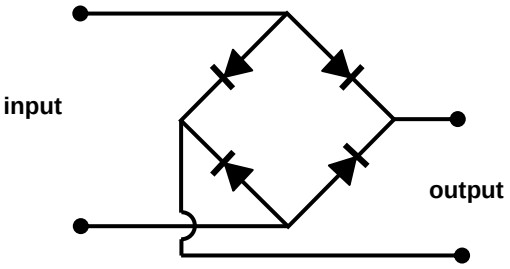
A



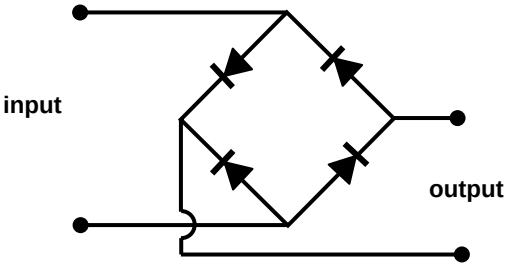
B



C

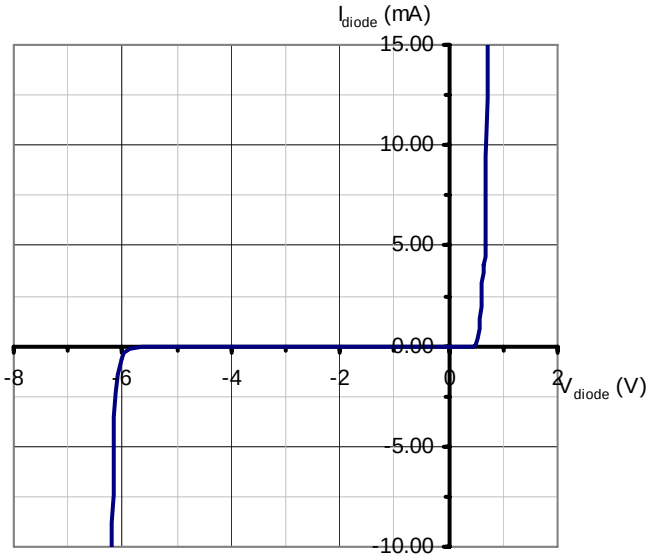


D

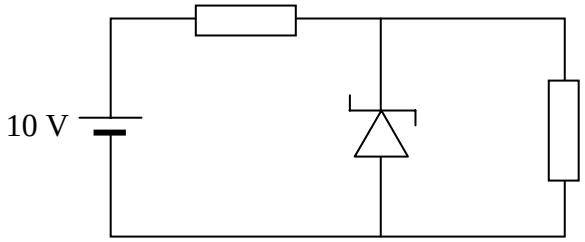


Question 11.

The voltage characteristics of a zener diode are shown on the right.



The zener diode is used in the following circuit.



What is the best estimate of the **zener voltage** for this diode?

A 0.7 V

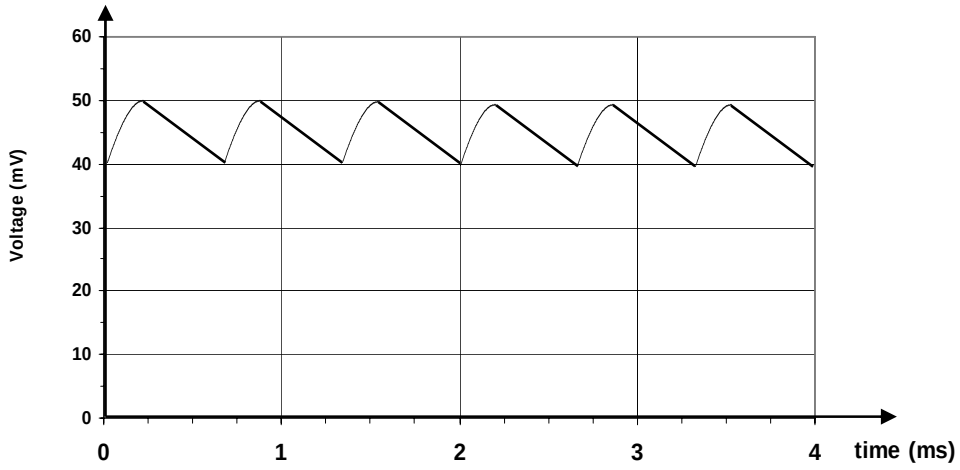
B 6.1 V

C 0.0 V

D cannot be determined without resistance values

Questions 12 and 13 relate to the following information.

A voltage is measured using a CRO. This signal is shown below.



Question 12.

What is the ripple voltage of this signal?

A 0.001 V **B** 10 mV

C 40 mV **D** 50 mV

Question 13.

What is the frequency of this signal?

A 1500 Hz **B** 500 Hz

C 167 Hz **D** 6.7×10^{-4} s

END OF DETAILED STUDY 3

END OF EXAMINATION