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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 34 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.

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STAV Publishing
2009

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					

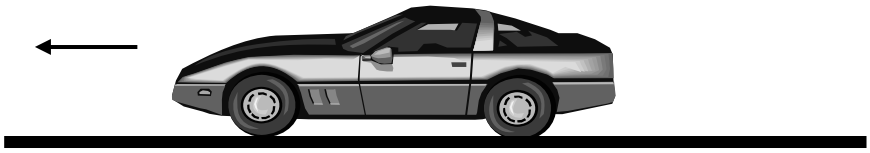
SECTION A

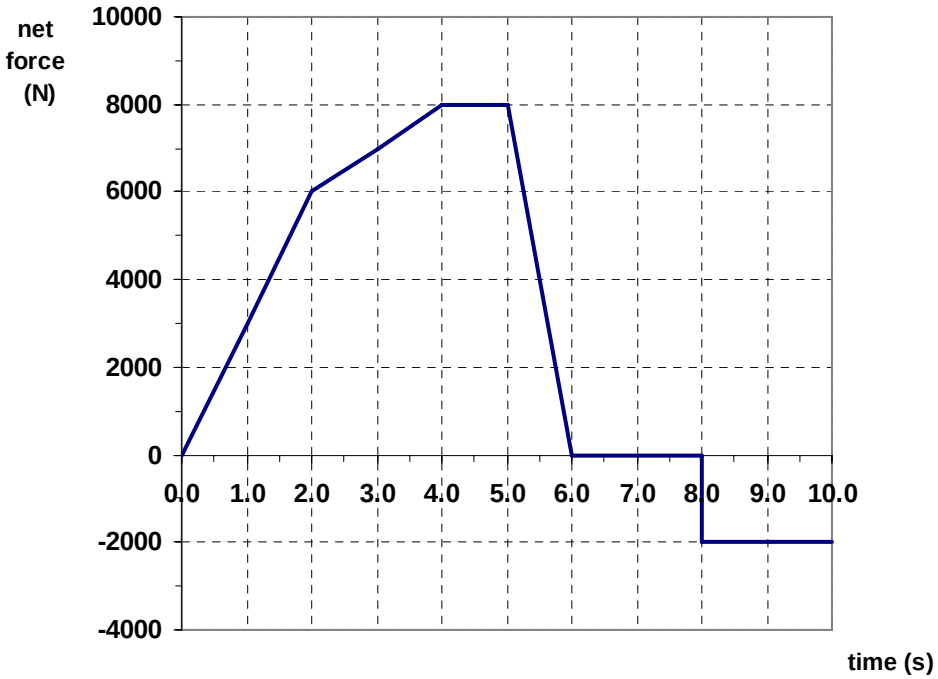
Instructions for Section A
Answer **all** questions **for both** Areas of study in this section in the spaces provided.
Where an answer box has a unit printed in it, give your answer in that unit.

AREA OF STUDY 1 – Motion in one and two dimensions

Questions 1 to 4 relate to the following information

A car starts from rest and then accelerates and travels in a straight line along a flat section of the highway. The graph below shows the **net force** acting on the car for the first 10 seconds of its motion along the highway. The car and occupants have a mass of 1000 kg.





Question 1.

At t = 2.0 s what is the magnitude of the acceleration of the car? Show working.

[2 marks] **m s^{-2}**

Question 2.

How fast is the car travelling at t = 7.0 s? Show working.

m s^{-1}

[4 marks]

Question 3.

What possible explanation can be given for the car's motion in the section t = 8.0 to 10.0 s?

[2 marks]

Question 4.

If the initial velocity of the car is taken to be in the positive direction in which of the following time intervals is the velocity negative?

A 0.0 s to 6.0 s

B 6.0 s to 8.0 s

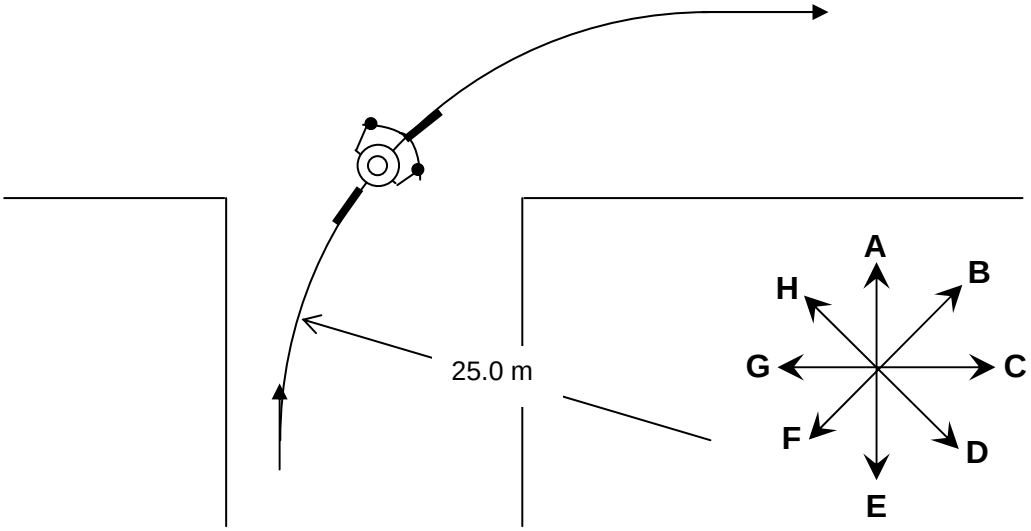
C 8.0 s to 10.0 s

D None of the above

[2 marks]

Questions 5 to 8 relate to the following information

Janette is riding her bicycle when she makes a 90^o right hand turn at an intersection. She takes 4.0 seconds to turn the corner on a radius of 25.0 m. She coasts around the corner at constant speed. The diagram below shows an overhead view of Janette in the middle of turning the corner. The mass of Janette and her bicycle is 75 kg.



Question 5.

What was Janette's constant speed as she travelled around the corner? Show working.

m s^{-1}

Question 6.

What was the magnitude of the net force acting on Janette and the bicycle as she travelled around the corner? Show working.

N

[2 marks]

Question 7.

Which of the arrows (**A – H**) shows the direction of the velocity of Janette in the middle of the corner as shown on the diagram?

[2 marks]

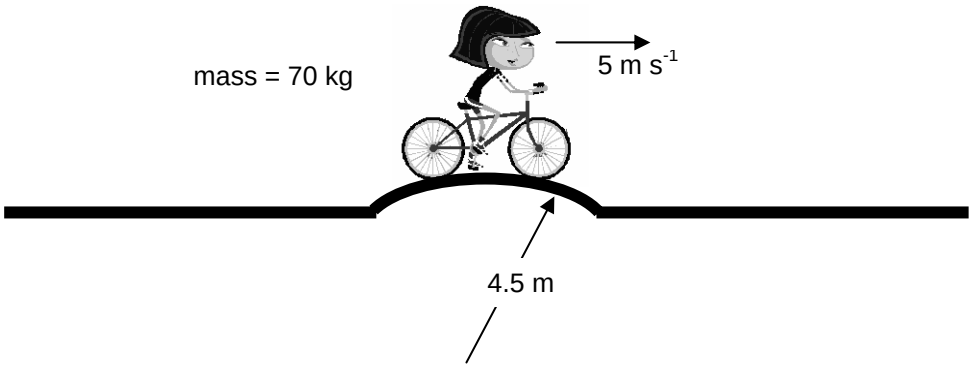
Question 8.

Which of the arrows (**A – H**) shows the direction of the sideways frictional force acting on the road by Janette and the bicycle in the middle of the corner as shown on the diagram?

[2 marks]

Question 9.

Christine is also out cycling when she crosses over a speed hump which consists of a section of a circle of radius 4.5 m. Christine and the bicycle have a mass of 70 kg. She passes over the top of the hump at a speed of 5.0 m s^{-1}.
What was the magnitude of the total normal reaction force acting on the bicycle as she passed over the very top of the speed hump? Show working.



N

[3 marks]

Questions 10 & 11 relate to the following information

In a movie stunt the hero in pursuit of the villain drives a car off the end of an incomplete motorway. The car has a mass of 1500 kg and leaves the motorway surface with a horizontal velocity of 36 ms^{-1}. The car continues on and crashes into the ground 25 m vertically below. Of course the hero, defying all logic and the laws of physics, continues on and drives off after the villain!

Question 10.

What is the impact speed of the hero's car with the ground? Show working.

m s^{-1}

[3 marks]

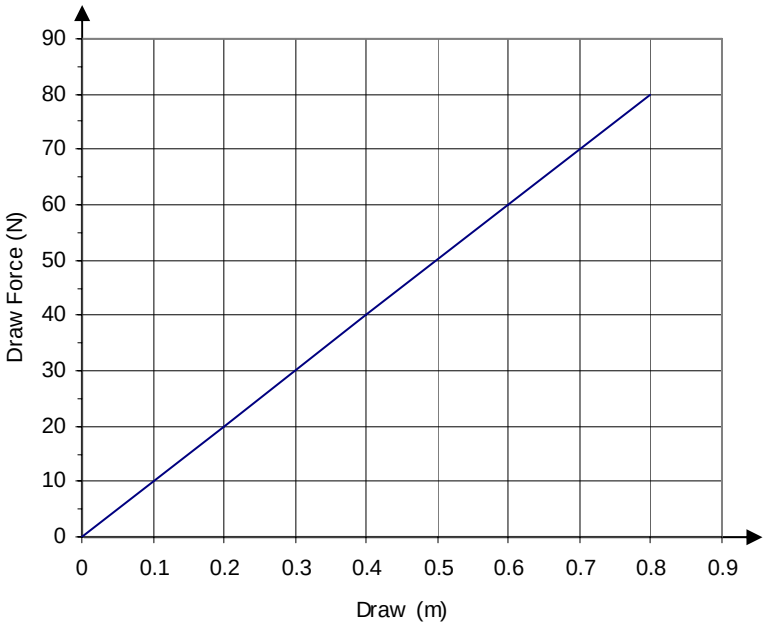
Question 11.

How far does the hero's car travel horizontally before impacting with the ground? Show working.

[3 marks]

Questions 12 & 13 relate to the following information

An arcade game, commonly known as a pin ball machine, relies on a spring to fire a metal ball to start the game. The player can decide how fast to launch the 'pin ball' into the game field by adjusting how far they draw back the spring loaded plunger. A particular machine has a spring loaded plunger with the following draw force – draw distance relationship.



Question 12.

What is the spring constant of this machine?

N m^{-1}

[2 marks]

Question 13.

The pin ball has a mass of 25 g. What is the velocity of the ball as it enters the playing field if the plunger is drawn back a distance of 30 cm? Show working.

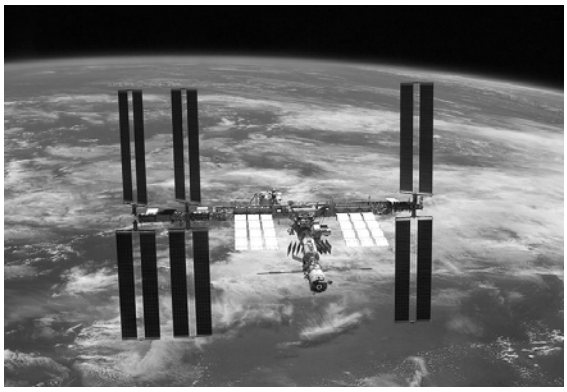
m s^{-1}

[3 marks]

Questions 14 & 15 relate to the following information

The International Space Station (ISS) currently has a mass of 227 tonne (it is still being built!).

The ISS orbits the Earth at an average **altitude** of 354 kilometres.



Question 14.

What is the period of the ISS in minutes?

minutes

[3 marks]

Question 15.

An astronaut is deployed to do some repairs to the heat shield. As he is floating outside the ISS he experiences apparent weightlessness. Explain this concept and include in your answer a calculation of the value of 'g' acting on the astronaut.

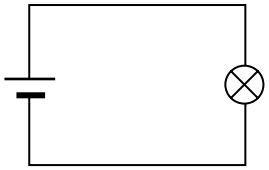
[3 marks]

g = **N kg^{-1}**

AREA OF STUDY 2 – Electronics and photonics

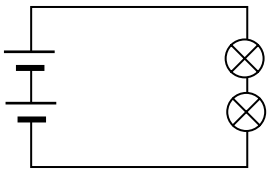
Questions 1 & 2 relate to the following information.

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

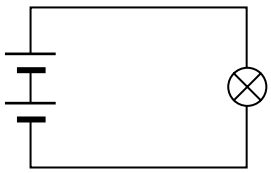


Use the following choices A – E to answer Questions 1 and 2.

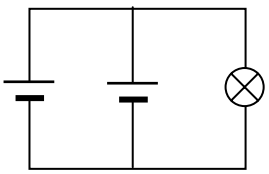
A



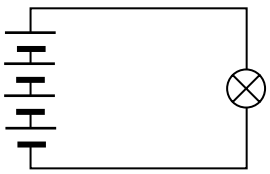
B



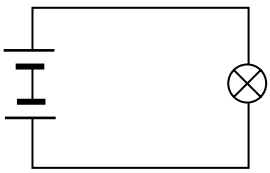
C



D



E



Question 1.

Which **one or more** of the above circuits would have the light or lights operating at normal brightness.

[2 marks]

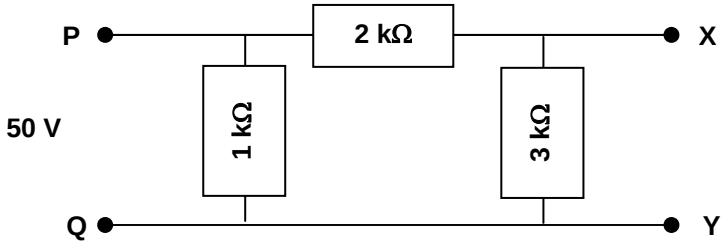
Question 2.

Which **one or more** of the above circuits would have the light or lights operating brighter than normal?

[2 marks]

Question 3.

A 50 V DC voltage is applied across the terminals P - Q.
What is the voltage across the terminals X - Y?

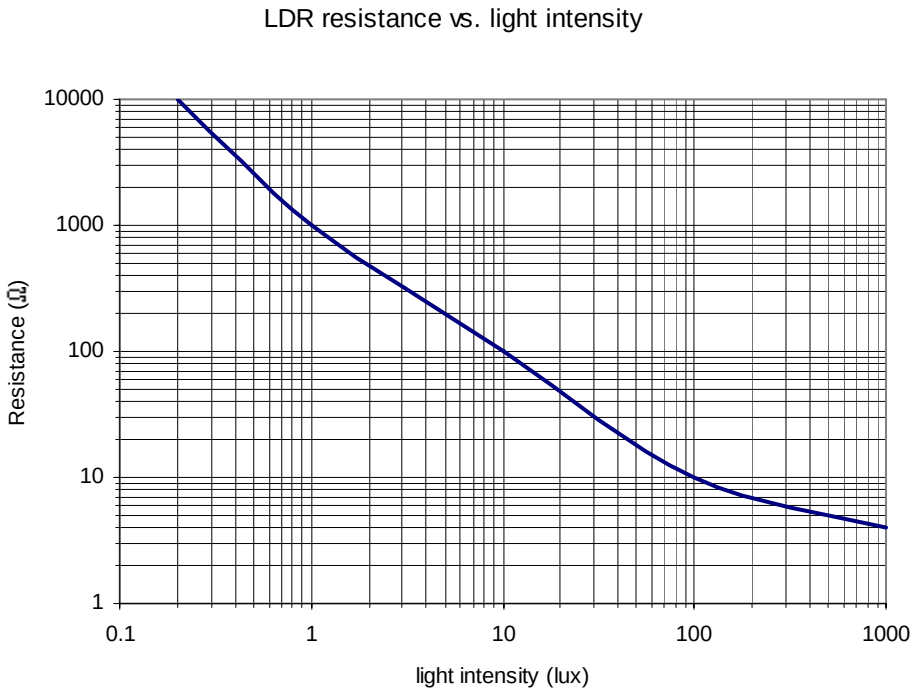


V

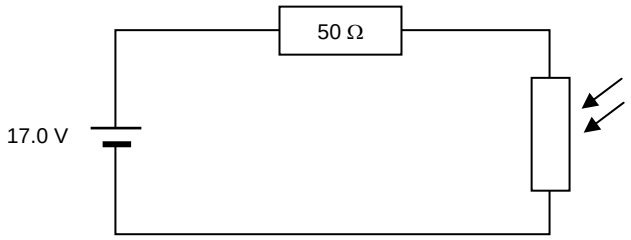
[2 marks]

Question 4.

The graph below shows the characteristics of a Light Dependent Resistor.



The LDR is placed in a circuit on the right.



The current in the circuit is measured to be 68 mA. What is the light intensity incident on the surface of the LDR? Show working.

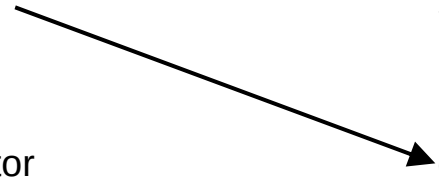
lux

[3 marks]

Question 5.

Draw arrows clearly joining the component to the corresponding energy transformation.
The battery is given as an example. (One energy transformation will be unmatched).

Component	Energy Transformation
Battery	sound → electrical
LED	light → electrical
Thermistor	chemical → electrical
LDR	electrical → light
	heat → electrical



[3 marks]

Question 6.

What is meant by the term "modulation" in the context of electronic communication systems?

[2 marks]

Question 7.

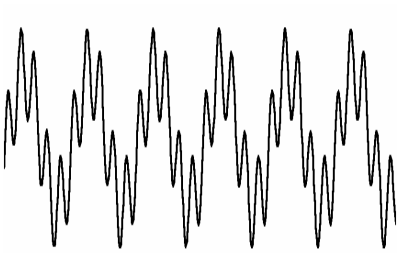
Why is it necessary to use a modulated carrier wave in the transmission of a radio signal?

[2 marks]

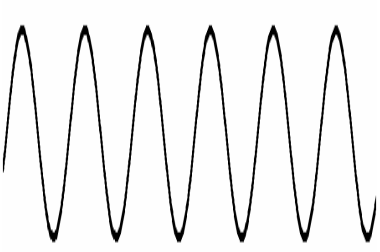
Questions 8 to 10 relate to the following information.

Use the following choices (A – D) to answer the next three questions

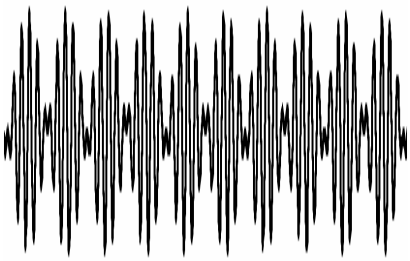
A



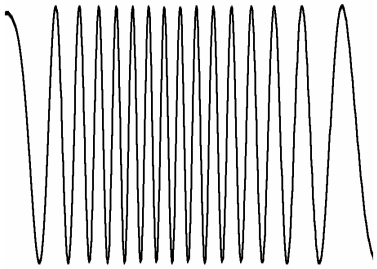
B



C



D



Question 8.

Which of the choices (A-D) is an example of Amplitude modulation?

[2 marks]

Question 9.

Which of the choices (A-D) is an example of Frequency Modulation?

[2 marks]

Question 10.

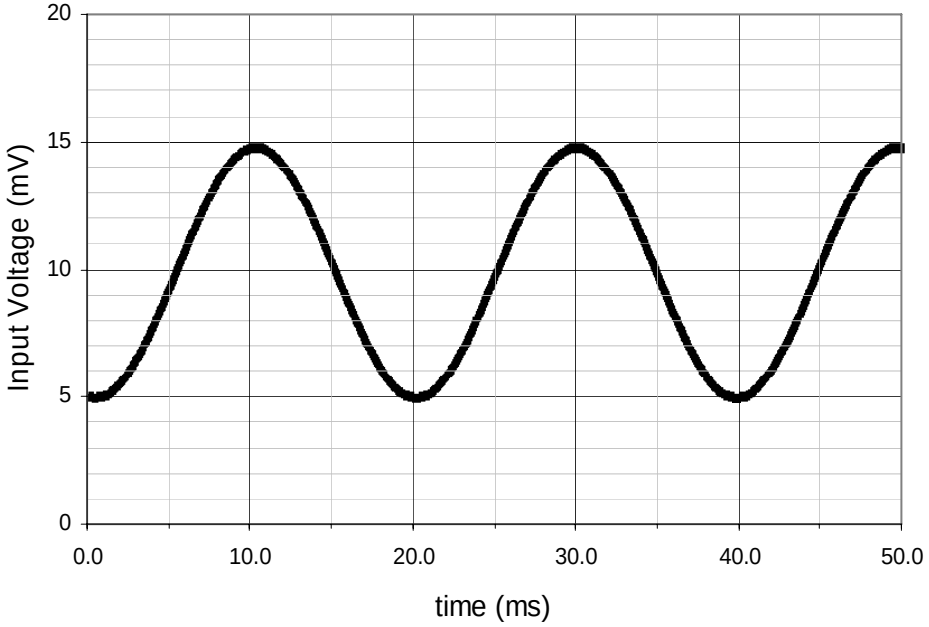
Which of the choices (A-D) is could be used as a carrier wave?

[2 marks]

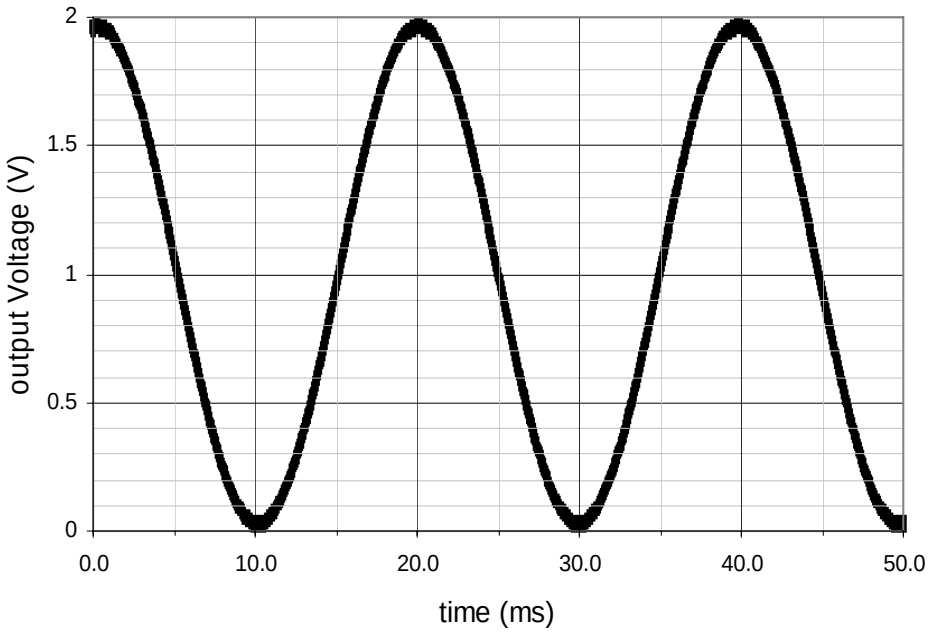
Questions 11 & 12 relate to the following information.

The flowing graphs give the input voltage wave form and the output voltage waveform of a single stage amplifier.

INPUT



OUTPUT



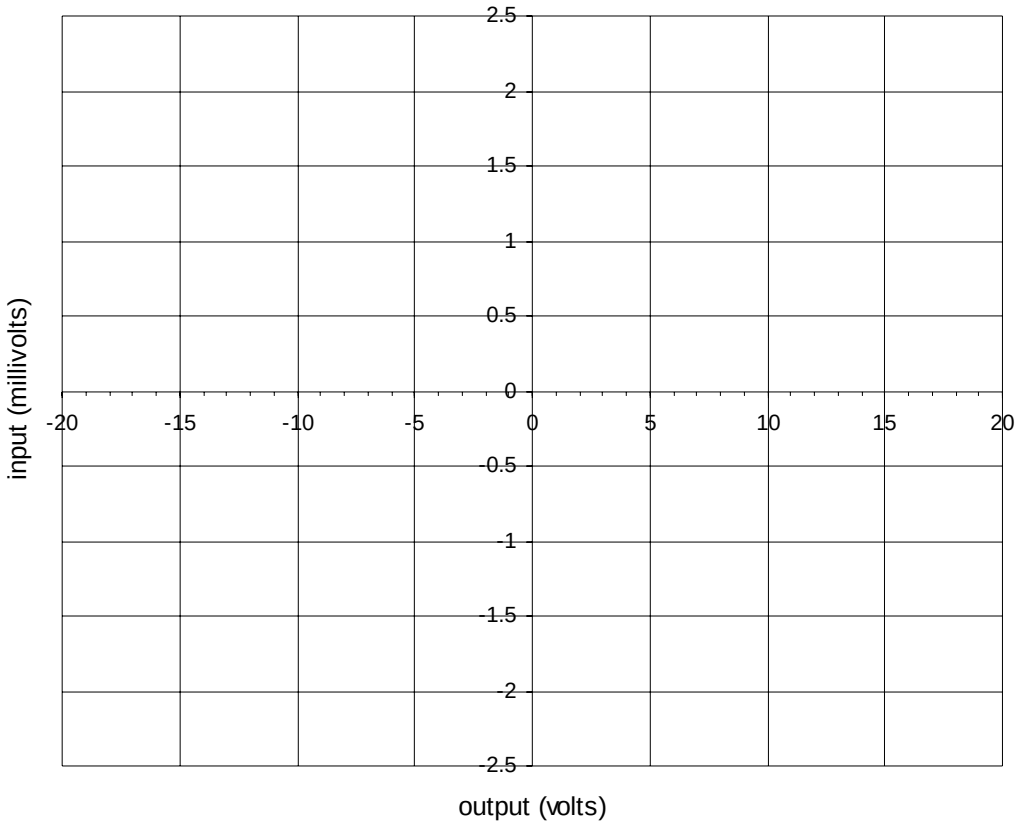
Question 11.

What is the linear voltage gain of this amplifier?

[2 marks]

Question 12.

Use the axes provided to draw the voltage characteristic of this amplifier.



[2 marks]

SECTION B – Detailed studies

Instructions for Section B

Select **one** Detailed study.
Answer **all** questions from the Detailed study, in pencil, on the answer sheet provided for multiple-choice questions.
Write the name of your chosen Detailed study on the multiple-choice answer sheet **and** shade the matching box.
Choose the response that is **correct** for the question.
A correct answer scores 2 marks, an incorrect answer scores 0.
Marks will **not** be deducted for incorrect answers.
No marks will be given if more than one answer is completed for any question.
You should take the value of g to be 10 ms^{-2}.

Detailed study **Page**

PHYSICS
Unit 3 Trial Examination

DATA SHEET

Directions to students

Detach this data sheet before commencing the examination.
This data sheet is provided for your reference.

1	velocity; acceleration	$v = \frac{\Delta x}{\Delta t}; \quad a = \frac{\Delta v}{\Delta t}$
2	equations for constant acceleration	$v = u + at$ $x = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2ax$ $x = \frac{1}{2}(v + u)t$
3	Newton's second law	$F = ma$
4	circular motion	$a = \frac{v^2}{r} = \frac{4\pi^2 r}{T^2}$
5	Hooke's law	$F = -kx$
6	elastic potential energy	$\frac{1}{2}kx^2$
7	gravitational potential energy near the surface of the Earth	mgh
8	kinetic energy	$\frac{1}{2}mv^2$
9	Newton's law of universal gravitation	$F = G\frac{M_1 M_2}{r^2}$
10	gravitational field	$g = G\frac{M}{r^2}$
11	stress	$\sigma = \frac{F}{A}$
12	strain	$\varepsilon = \frac{\Delta L}{L}$
13	Young's modulus	$E = \frac{\text{stress}}{\text{strain}}$
14	transformer action	$\frac{V_1}{V_2} = \frac{N_1}{N_2}$
15	AC voltage and current	$V_{\text{RMS}} = \frac{1}{2\sqrt{2}}V_{\text{p-p}} \quad I_{\text{RMS}} = \frac{1}{2\sqrt{2}}I_{\text{p-p}}$
16	voltage; power	$V = RI \qquad P = VI$

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	$\gamma = \left(1 - \frac{v^2}{c^2}\right)^{-\frac{1}{2}}$
21	time dilation	$t = t_o \gamma$
22	length contraction	$L = L_o / \gamma$
23	relativistic mass	$m = m_o \gamma$
24	acceleration due to gravity	$g = 10 \text{ m s}^{-2}$
25	universal gravitational constant	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
26	mass of Earth	$M_E = 5.98 \times 10^{24} \text{ kg}$
27	radius of Earth	$r_E = 6.37 \times 10^6 \text{ m}$
28	mass of the electron	$m_e = 9.1 \times 10^{-31} \text{ kg}$
29	charge on the electron	$q_e = -1.6 \times 10^{-19} \text{ C}$
30	speed of light	$c = 3.0 \times 10^8 \text{ m s}^{-1}$

Prefixes/Units

p = pico = 10^{-12}

n = nano = 10^{-9}

μ = micro = 10^{-6}

m = milli = 10^{-3}

k = kilo = 10^3

M = mega = 10^6

G = giga = 10^9

1 tonne = 10^3 kg

END OF DATA SHEET

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DETAILED STUDY 1 – Einstein's special relativity

Question 1.

Maxwell's equations, predicting the speed of light, rely only on knowing:

A the speed of the source of light.

B the speed of the observer.

C the speed of separation of the relative frames of reference of the source and observer.

D the electrical and magnetic properties of the medium the light is travelling through.

Question 2.

Michelson and Morley in 1887 discovered:

A that Maxwell's equations are only relevant at speeds close to the speed of light.

B that the Earth moves relative to the aether.

C that the speed of light is dependent on the frame of reference.

D that the aether does not exist.

Question 3.

A scientist measures a standard kilogram mass on the Earth prior to leaving on an interstellar voyage. Sometime later on the voyage, when the space craft is travelling at 0.4*c*, he re-measures the standard mass. He finds that:

A the mass has increased to 1.091 of what it was on Earth.

B the mass has decreased by a factor of 0.909.

C the mass cannot be determined without knowing the gravitational field.

D the mass is unchanged.

Question 4.

Unstable particles known as muons are produced in the Earth's atmosphere by cosmic rays from outer space. The Muon's are travelling at 0.99c as observed by a stationary Earth bound observer. These unstable muons have a half life of 1.56×10^{-5} s. During this period of time they are measured to travel 4.62×10^{3} m by the Earth bound observer.

How far would an infinitesimal observer travelling aboard the muon see the muon travel?

A 7.09 m

B 3.28×10^{4} m

C 652 m

D 2.32×10^{5} m

Question 5.

An observer on the Earth's surface sees a UFO fly past. He notes that the UFO appears to be 20.0 m long. Meanwhile Zoogle, the pilot of the UFO, knows the real length of his spaceship to be 27.0 m long. How fast was Zoogle flying as measured by the observer on the Earth?

A 1.35×10^{8} m s^{-1}

B 2.02×10^{8} m s^{-1}

C 2.22×10^{8} m s^{-1}

D 5.47×10^{8} m s^{-1}

Questions 6 and 7 relate to the following information.

Two spaceships are approaching Earth from diametrically opposed directions. The Enterprise is travelling at 0.6*c* and the Voyager is travelling at 0.7*c* as observed from the Earth.

Question 6.

According to Newton's Laws of Motion what is the speed of the Voyager as observed by the Captain of the Enterprise?

A 1.3*c* **B** 0.6*c*

C 0.7*c* **D** 0.1*c*

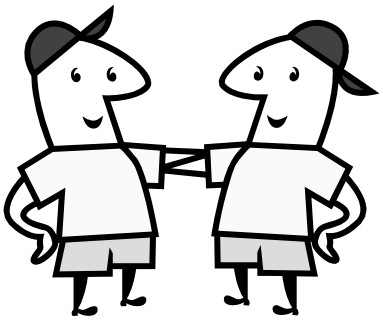
Question 7.

According to Einstein's model of the Universe what is the speed of the Voyager as observed by an observer on the Earth?

A 1.3*c* **B** 0.5*c*

C 0.7*c* **D** 0.1*c*

Questions 8 and 9 relate to the following information.



Twin's William and Benjamin are both astronauts. William sets out on a trip to Alpha Centauri at a speed of 0.866*c* while Benjamin stays behind on Earth. The distance to Alpha Centauri is 4.45 light years. When he arrives William realises he left his toothbrush behind so immediately sets out to return to Earth. Assume that the spaceship attains full speed of 0.866*c* immediately on departure.

Question 8.

As measured from the Earth how long does William's whole journey take?

A 2.57 years **B** 5.14 years

C 10.28 years **D** 20.56 years

Question 9.

As measured from the spaceship how long does the whole journey take?

A 2.57 years **B** 5.14 years

C 10.28 years **D** 20.56 years

Question 10.

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 6.74×10^{-31} kg **B** 9.1×10^{-31} kg

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

Question 11.

What is the total mass–energy of a body with rest mass m_o travelling at a speed v?

A γm_o **B** $\gamma m_o v$

C $\gamma m_o c^2$ **D** $m_o c^2$

Question 12.

What is the magnitude of the **momentum** of a neutron of rest mass 1.675×10^{-27} kg travelling at $0.3c$.

A 1.436×10^{-19} kg m s^{-1} **B** 1.580×10^{-19} kg m s^{-1}

C 1.654×10^{-19} kg m s^{-1} **D** 1.800×10^{-19} kg m s^{-1}

Question 13.

What is the **kinetic energy** of a neutron of rest mass 1.675×10^{-27} kg travelling at $0.3c$.

A 7.278×10^{-12} J **B** 5.025×10^{-19} J

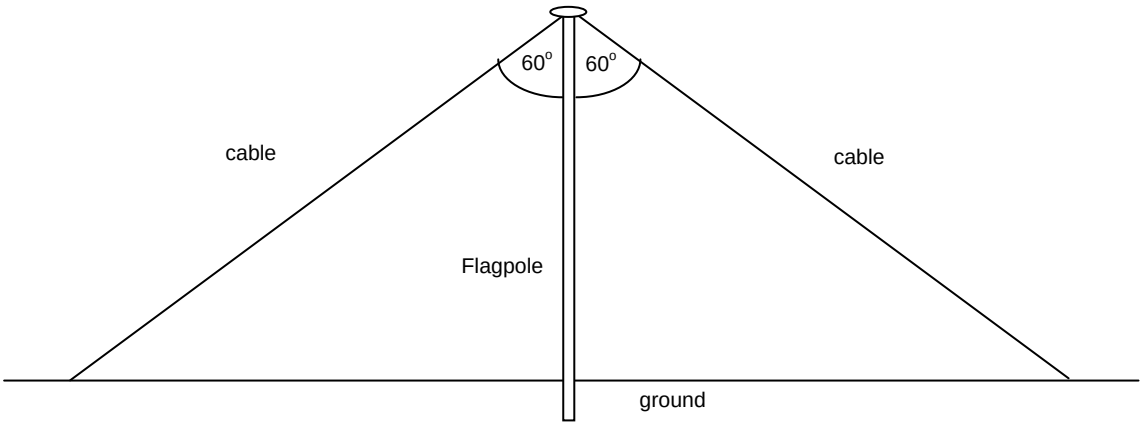
C 2.412×10^{-20} J **D** 6.784×10^{-12} J

END OF EXAMINATION

DETAILED STUDY 2 – Materials and their use in structures

Questions 1 and 2 relate to the following information.

A flagpole is supported by two cables that are attached to the top and staked to the ground as shown in the diagram below. The tension in each cable is 2×10^4 N.



Question 14.

The flagpole is under which of the following external forces?

A Tension

B Compression

C Shear

D All of the above

Question 15.

The total force exerted by both cables on the flagpole is:

A 2×10^4 N upwards

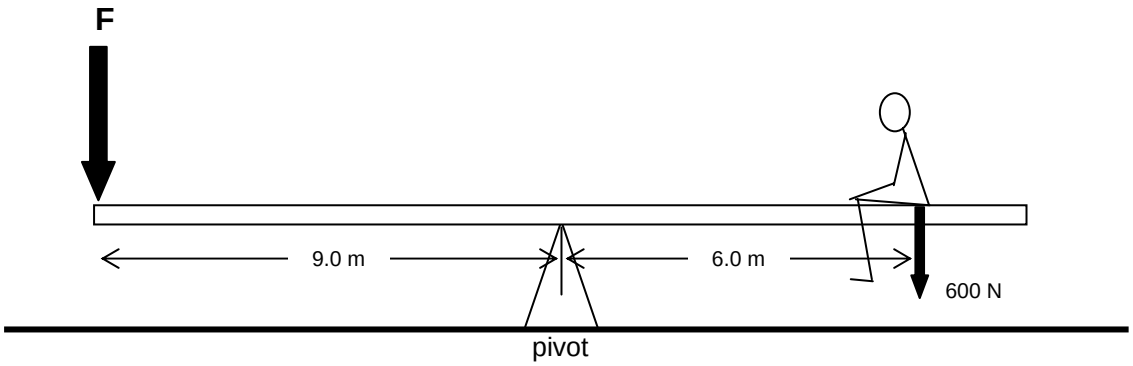
B 4×10^4 N upwards

C 3×10^4 N upwards

D 2×10^4 N downwards

Question 16.

A boy of weight 600 N sits on a see-saw 6.0 m from the pivot as shown below.



What force is required at F to balance the see-saw?

A 200 N **B** 400 N

C 600 N **D** 900 N

Question 17.

The Young's modulus for copper is 1.3×10^{11} Pa. A length of copper wire is 1.5 m long and has a cross sectional area of 0.40 mm^2. The copper is measured carefully and found to be extended by 2.50 mm when placed under tension by a mass suspended vertically from the end of the wire? What mass must be suspended from the end to cause this extension?

A 8.7 N **B** 87 N

C 8.7 kg **D** 87 kg

Question 18.

The Yield strength of mild steel is 2.5×10^8 Pa. What is the minimum diameter of mild steel rod that can support a 75 kg man with a safety factor of 3 before yielding?

A 9.0×10^{-6} m^2 **B** 3.0×10^{-6} m^2

C 3.4 mm **D** 1.7 mm

Question 19.

Chipboard or particle board is a widely used composite material in modern homes for both the building structure and the furniture within the building.

Chipboard is classed as a composite material because:

A it is cheap because it is made up of waste material from solid lumber production.

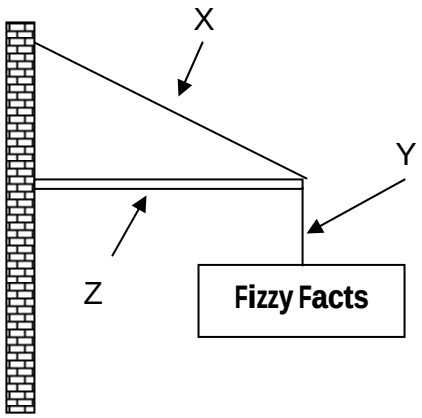
B it comes in big sheets and can span bigger gaps.

C it can be molded into a variety of shapes for ease of use combined with strength.

D it is made up of wood chips and polymer glues.

Question 20.

A sign is suspended from a shop front wall.



Which of the following statements is correct?

A Cable X and Rod Z are in tension.

B Cable Y and Rod Z are in tension.

C Cable X and Rod Z are in compression.

D Cable X is tension and Rod Z in compression.

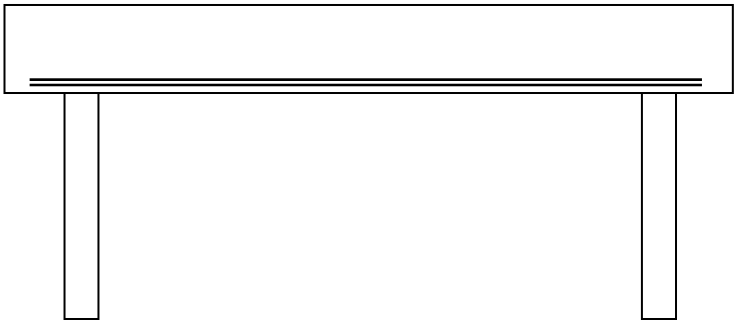
Question 21.

The floor in a new building is to be made from reinforced concrete. The floor is to be suspended between two supporting piers. Which of the following diagrams best shows how the reinforcing steel should be embedded in the concrete?

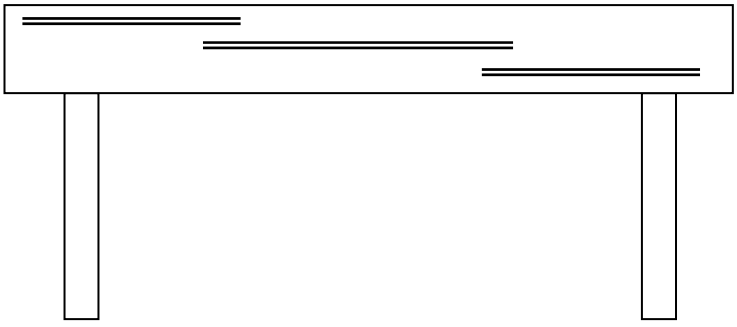
A

B

C

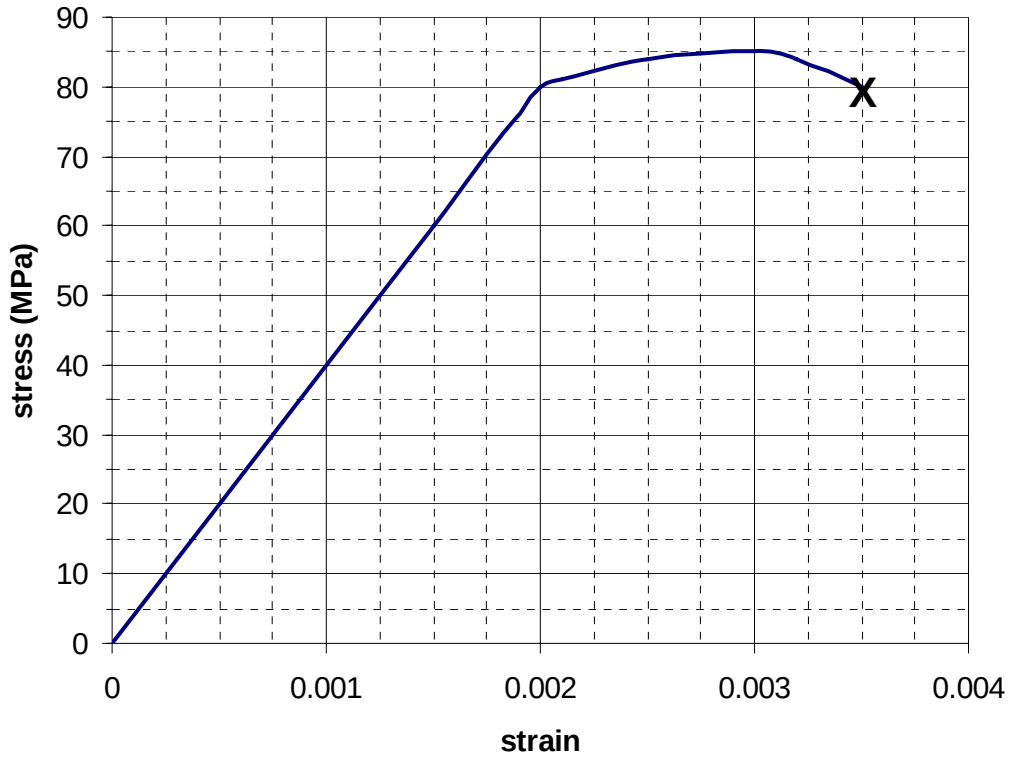


D



Questions 9 and 10 relate to the following information.

A sample of wire cable is tested to failure and the following stress strain graph is obtained. The piece of test cable is 2.0 m long and has a cross sectional area of 2.5×10^{-4} m^2.



Question 22.

How much potential energy is stored in the cable when the strain is 0.002?

A 40 J **B** 80 J

C 1.6×10^5 J m^{-3} **D** 0.16 MJ

Question 23.

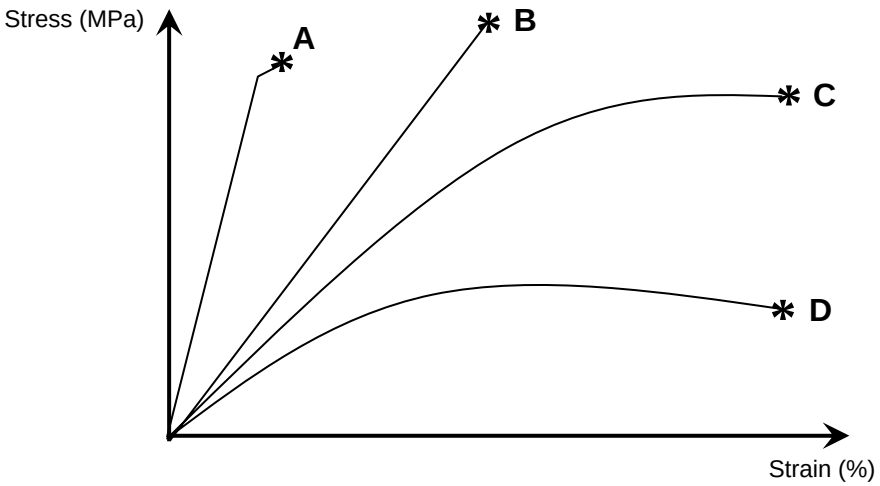
What is the potential energy per unit volume stored in the cable up to the point of failure of this material?

A 2.1 J **B** 2.1×10^5 J

C 2.1×10^5 J m^{-3} **D** 3.2×10^5 J m^{-3}

Questions 11 to 13 relate to the following information.

The following graph shows the stress vs strain relationships for four materials (A – D)



Question 24.

Which of the materials (A – D) has the highest Young's modulus?

Question 25.

Which of the materials (A – D) is the most brittle?

Question 26.

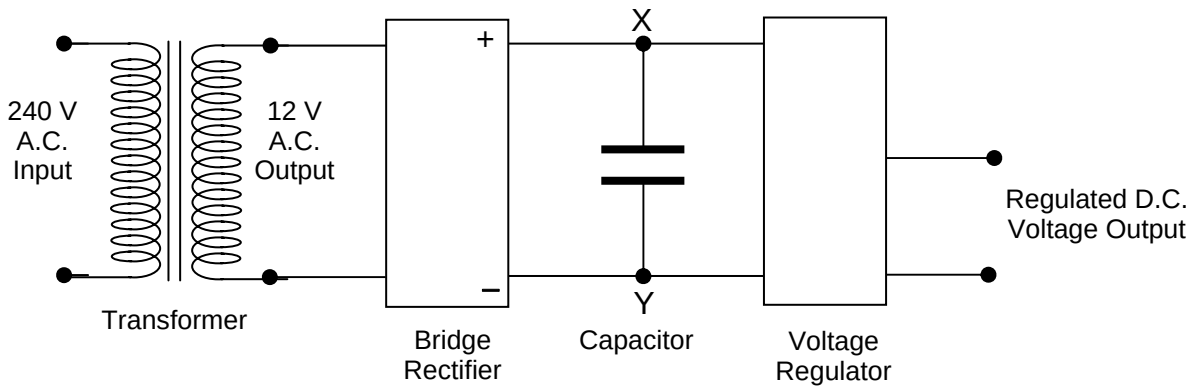
Which of the materials (A – D) is the toughest?

END OF EXAMINATION

DETAILED STUDY 3 – Further electronics

Questions 1 to 4 relate to the following information.

A regulated DC power supply circuit is shown below. The input voltage is from a 12 V RMS AC supply. The AC power supply has as its input a normal household supply of 240 V RMS. A transformer is used to reduce the voltage from 240 V RMS to 12 V RMS.



Question 27.

The primary (input) side of the transformer has 360 coils wrapped around the soft iron core. How many turns are there on the secondary side of the transformer?

A 18 **B** 36

C 180 **D** 720

Question 28.

The current flowing into the primary coil is 0.05 A. What is the maximum possible power supplied to the bridge rectifier?

A 6 W **B** 8.5 W

C 12 W **D** 17 W

Question 29.

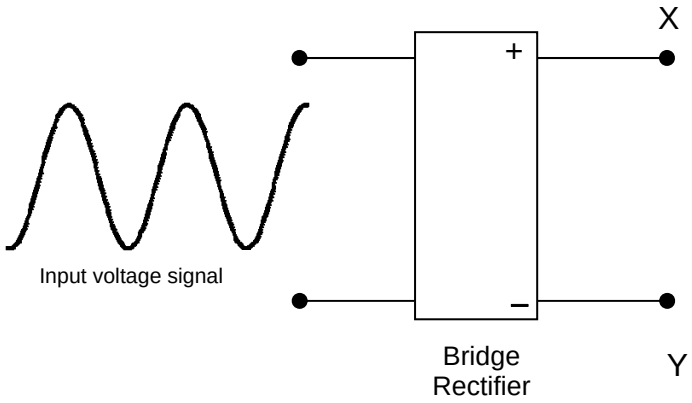
What is the peak voltage supplied to the bridge rectifier?

A 12 V **B** 17 V

C 240 V **D** 339 V

Question 30.

For the given input signal which of the following is the output voltage signal as measured at the points **XY**, the output of the bridge rectifier.



A

B

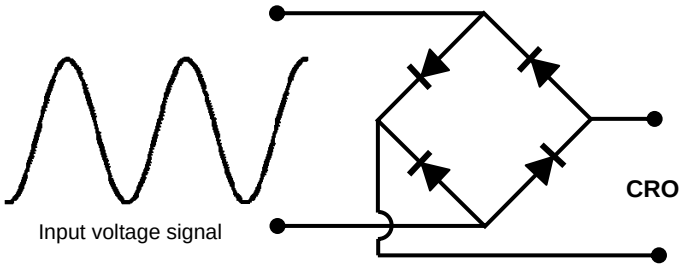
C

D

Question 31.

Janette is assembling a bridge rectifier using four individual diodes. She solders the diodes together. Janette then tests the circuit by using an AC input voltage while looking at the output on a cathode ray oscilloscope (CRO).

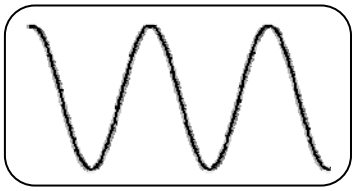
Below is her assembled circuit.



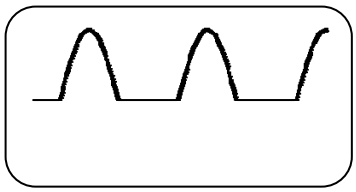
What is the output that would be seen on the CRO for Janette's circuit?

A

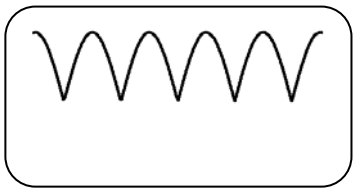
B



C



D



Questions 6 and 7 relate to the following information.

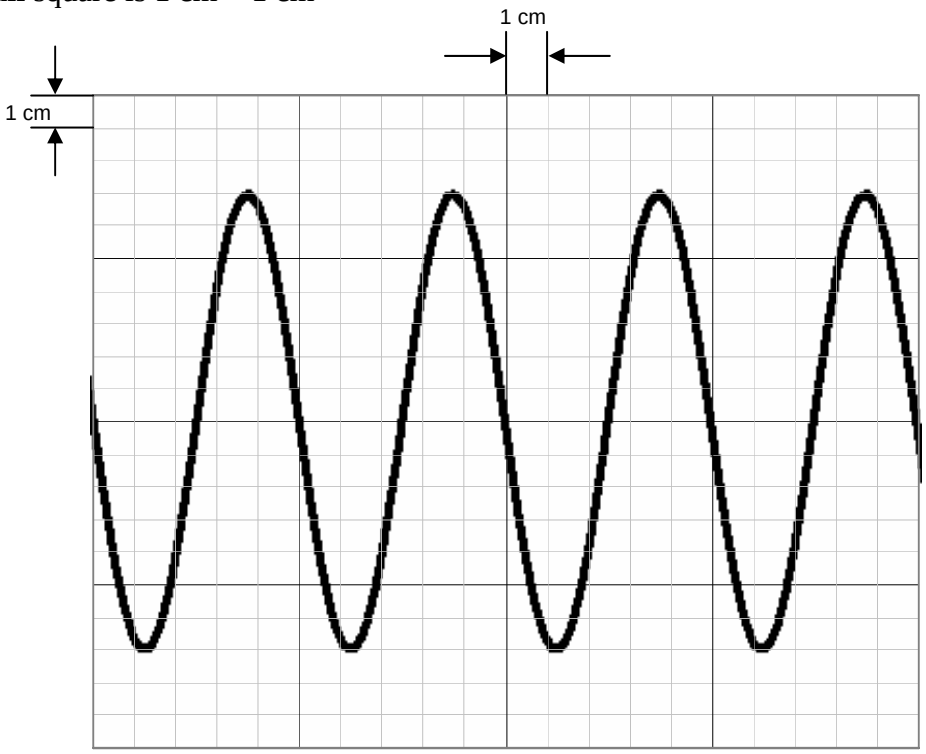
A cathode ray oscilloscope (CRO) has been set with the following scales:

X axis → 10 ms per cm

Y axis → 50 mV per cm.

A voltage signal is shown in the following CRO picture.

Each **small** square is 1 cm × 1 cm



Question 32.

What is the peak to peak voltage as measured on this CRO?

A 0.7 V **B** 2.4 V

C 120 mV **D** 14 V

Question 33.

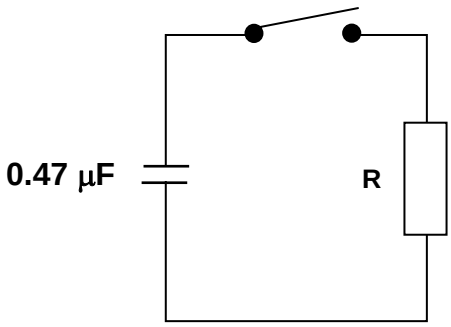
What is the frequency of the input voltage as measured on this CRO?

A 50 ms **B** 50 Hz

C 20 Hz **D** 200 ms

Question 34.

The circuit on the right contains a resistor, a switch and a 0.47 μF capacitor.



Initially the switch is open and the capacitor is fully charged.

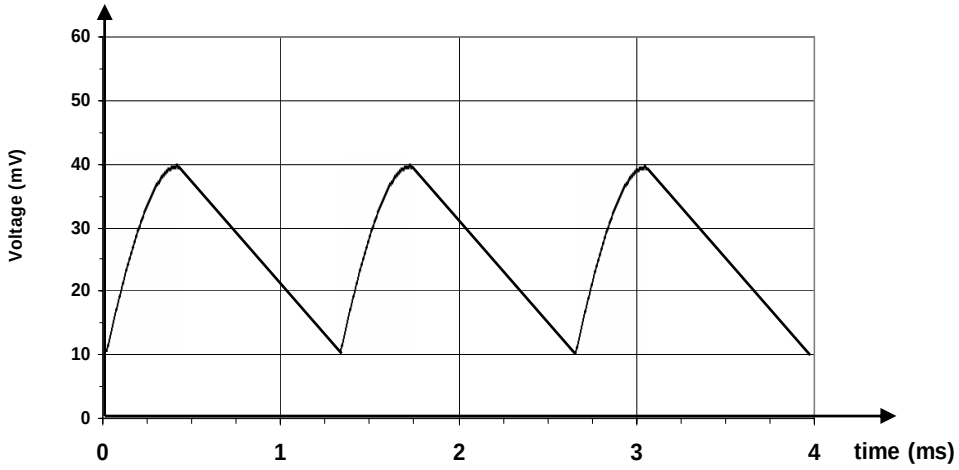
When the switch closes it takes 2.35 seconds to fully discharge the capacitor.
What is the size of the resistor?

A 10.0 kΩ **B** 100 kΩ

C 1.00 MΩ **D** 10.0 MΩ

Question 35.

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



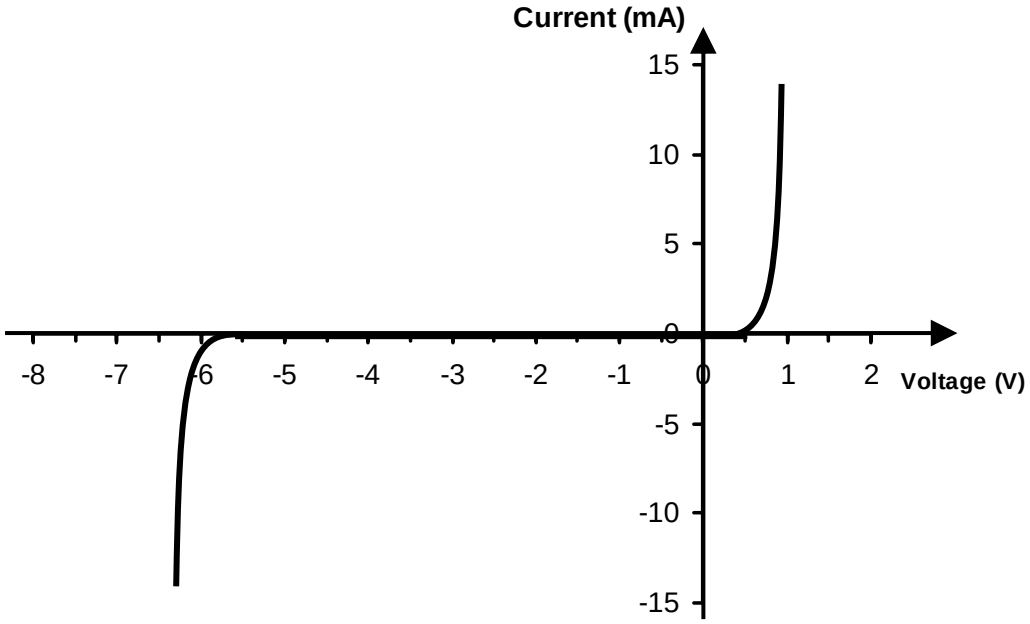
What is the ripple voltage of this signal?

A 0.30 V **B** 25 mV

C 40 mV **D** 30 mV

Question 36.

A zener diode is to be used to regulate an unregulated DC power supply. The zener diode has the following current-voltage characteristic. The input voltage to this voltage regulator is 18 V.



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

A 1.0 V **B** 6 V

C 12 V **D** 18 V

Questions 11 and 12 relate to the following information.

A laptop computer power supply converts the 240 V AC mains supply into a 10 V regulated DC supply. This charges the laptop battery at a power rating of 15 Watts.

Question 37.

What is the DC current supplied by the regulated DC voltage supply?

A 15 mA **B** 67 mA

C 0.67 A **D** 1.5 A

Question 38.

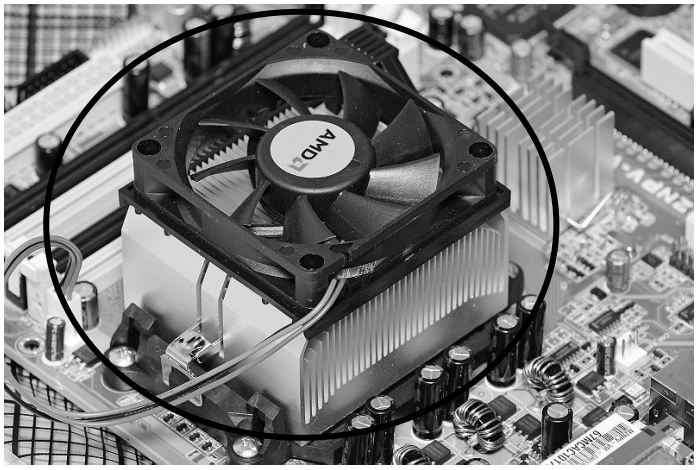
What is the effective resistance of the battery being charged?

A 0.15 Ω **B** 6.7 Ω

C 15 Ω **D** 67 Ω

Question 39.

What is the purpose of the object circled in the following photograph?



A It operates as a heat trap.

B To dissipate heat from the underlying circuit.

C To shield the underlying electronic circuit from external heat sources.

D To prevent stray magnetic and electric fields from interfering with the operation of the circuit.

END OF EXAMINATION