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2018 Trial Examination

STUDENT NUMBER | | | | | | | | | Letter |

PHYSICS

Unit 2– Written examination

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

QUESTION & ANSWER BOOK

Structure of book

Section	*Area of Study*		*Number of questions*	*Number of questions to be answered*	*Number of marks*
A	1&3	Multiple Choice	15	15	15
B	1&3	Short Answer			55
			Number of options	*Number of options to be answered*	*Number of marks*
C	2	Options	12	1	20
					Total 90

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners and rulers, one A4 (double-sided) page of pre-written notes and one scientific calculator.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.

Materials supplied

- Question and answer book of 83 pages (including formula and data sheet).

Instructions

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

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic communication devices into the examination room.

SECTION A – CORE Multiple-choice questions

Instructions for Section A

Section A consists of 15 multiple-choice questions. Choose the response that is **correct** or that **best answers** the question. Write the letter corresponding to your chosen answer in the box at the end of each question.

- A correct answer is worth 1 mark, an incorrect answer scores 0.
- Marks will **not** be deducted for incorrect answers.
- No marks will be given if more than one answer is given for any question
- Take the value of g to be 9.8 m s^{-2}

Question 1

A child walks 5 metres west, then 4 metres south before turning and travelling another 2 metres west. What is the child's final displacement in regards to magnitude and angle?

A. 8.06 m S 30° W

B. 8.06 m S 60° W

C. 7 m W

D. 4 m S

Question 2

A car travels to Yarrawonga from Melbourne which is a distance of 275 km. The trip to Yarrawonga takes 3 hours, while the return journey back to Melbourne takes 3 hours 45 minutes. Which of the following statements is correct?

A. The total displacement for the trip is 550 km.

B. On averge the car travels 73 km h^{-1} during the trip to Yarrawonga and 92 km h^{-1} on the return journey

C. The average velocity for the entire trip is 23 m s^{-1}

D. The average speed for the entire trip is 81.5 km h^{-1}.

The following information refers to Questions 3 and 4

Figure 1 shows the velocity vs time graph for a child playing a game of tiggy.

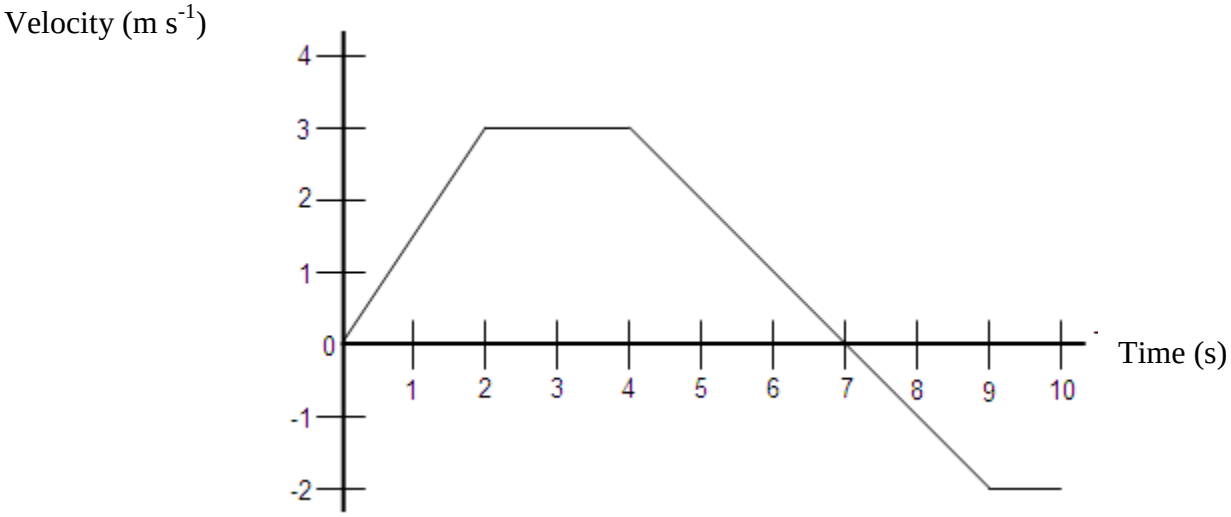


Figure 1

Question 3

Which of the following statements is **incorrect**?

A. The child has a maximum velocity of 3 m s^{-1}.
B. The child has a displacement of 13.5 m at time = 7 seconds
C. At time = 2 seconds the child is stationary
D. The child's maximum acceleration is 1.5 m s^{-2}

Question 4

The maximum displacement of the child at the end of the 10 seconds is;

A. 13.5 m
B. 4 m
C. 17.5 m
D. 9.5 m

Question 5

A car was initially travelling at 50 km h^{-1} accelerates to 80 km h^{-1} in 3 seconds. What is the acceleration of the car?

A. 10 m s^{-1}
B. 2.78 m s^{-1}
C. 8.33 m s^{-1}
D. 7.41 m s^{-1}

Question 6

Chris is applying a force to a 2 kg mass, causing it to acceleration at 10.0 ms^{-2}. When Chris applies the same force to a different object, its acceleration is 4.0 ms^{-2}. The mass of second object is

A. 10kg
B. 8.0kg
C. 5.0kg
D. 2.5kg

Question 7

A box is sitting on an incline plane which has an adjustable slope as shown in Figure 2.

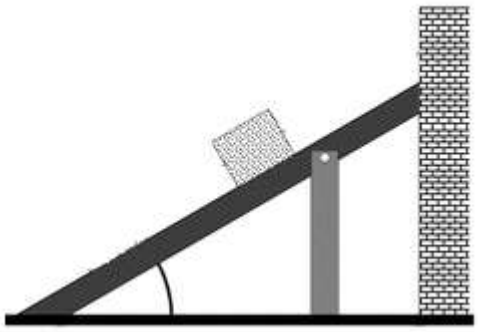


Figure 2

What changes occur to the normal reaction force of the object as the incline is made steeper?

A. It increases
B. It decreases
C. It stays the same
D. There is another change that is not specified above.

Question 8
An ice skater of mass 55 kg is standing stationary on an ice rink when she throws a 1.5 kg ball away from her with a velocity of 8 m s^{-1}.
Which of the following statements correctly describes the subsequent motion of the ice skater?

A. The ice skater moves off in the same direction as the ball with a velocity of 8 m s^{-1}
B. The ice skater moves off in the opposte direction as the ball with a velocity of 8 m s^{-1}
C. The ice skater moves off in the same direction as the ball with a velocity of 0.22 m s^{-1}
D. The ice skater moves off in the opposite direciton as the ball with a velocity of 0.22 ms $^{-1}$

Question 9
A rubber ball of mass 500 g is bounced off a wooden floor. It falls with a velocity of 6 m s^{-1} and rebounds with a velocity of 5 m s^{-1}. Its impact time with the floor is 20 ms. What force acts on the ball?

A. 275 N
B. 25 N
C. 25 000 N
D. 275 000 N

Question 10
Assuming 80% efficiency, how much energy must a person of mass 60 kg require to walk up a set of stairs that are 5 metres high?

A. 3675 J
B. 2940 J
C. 2352 J
D. 36.75 J

Question 11
A 500 kg roller coaster starts from rest at the top of a 10 metre high hill. The next hill it goes over has a height of 7.5 metres. What is its kinetic energy at the top of the second hill?

A. 49 000J
B. 36 750 J
C. 12 250 J
D. 85 750 J

SECTION A - continued

Question 12
A group of 5 Physics students use a stop watch to measure the time it takes for a ball to reach the floor by dropping it from a distance of 1 m. They each take independent measurements as shown in Table 1

Student	1	2	3	4	5
Time (s)	0.33	0.54	0.45	0.28	0.47

Table 1

The average time they obtain including uncertainty would be;

A. 0.414 ± 0.01 s
B. 0.414 ± 0.005 s
C. 0.41 ± 0.01 s
D. 0.41 ± 0.005 s

Question 13
In an experiment, the variable that is manipulated is called the

A. Dependent variable.
B. Measurement variable.
C. Independent variable.
D. Changeable variable

Question 14
Which of the following is **NOT** true when writing a hypothesis?

A. It can be tested
B. It is a prediction
C. It should restate the aim of the experiment
D. It should be based on reliable theorectical information

Question 15
Which of the following would cause a systematic errors are:

A. Worn out equipment
B. Variation in the results obtained on a spring balance due to the temperature
C. Two different people measuring the length of a string
D. Both A and B

END OF SECTION A
TURN OVER

SECTION B – CORE- Short-answer questions

Instructions for Section B

Section B consists of 4 questions. Answer all questions in the spaces provided.

- Your answers should be expressed correctly using appropriate physics terms.
- Numerical answers should be calculated fully and expressed with the appropriate number of significant figures.
- Where an answer box has a unit printed in it, give your answer in that unit.
- In questions where more than one mark is available, appropriate working should be shown
- Take the value of g to be 9.8 m s^{-2}

Question 1 (10 marks)

A child in a toy car is playing with friends at a traffic school shown in Figure 1. The child initially accelerates north from rest at a set of traffic lights to reach a speed of 20 km h^{-1} in 10 seconds.

Figure 1

He then travels at this constant velocity for a further 10 seconds before slowing to a stop in 5 seconds. At this point he sits and waits for his friends to catch up for 20 seconds before turning around and racing them back towards the starting line for a further 15 seconds reaching a maximum velocity of 7 m s^{-1} at the 15 second mark.

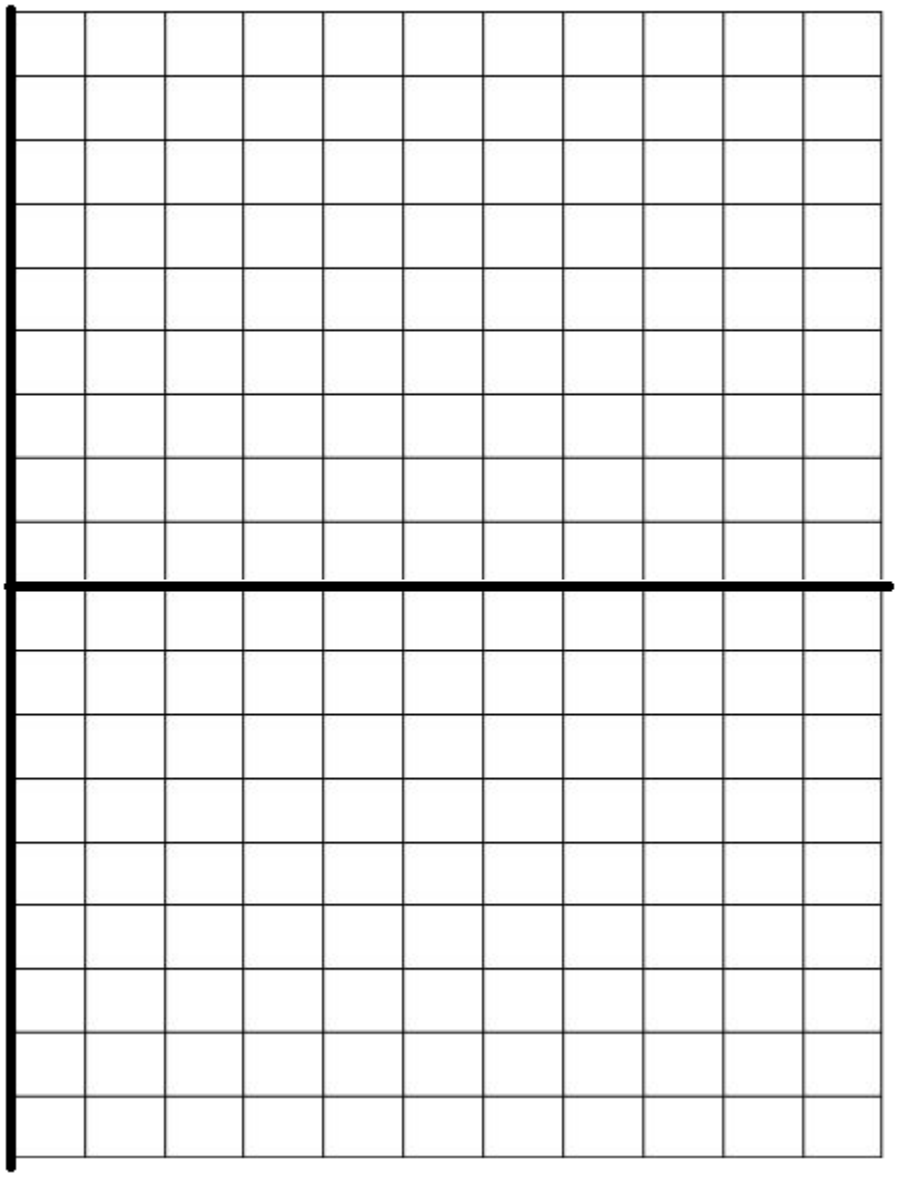
a. What was the child's initial acceleration in the first 10 seconds?

2 marks

m s^{-2}

SECTION B – continued

b. Draw a velocity time graph to show the motion of the child over his entire journey.



3 marks

SECTION B – continued
TURN OVER

c. What was the final displacement in both magnitude and direction of the child?

3 marks

m

d. What was the maximum acceleration of the child?

2 marks

m s^{-2}

Question 2 (7 marks)

Sally is playing the game of softball as shown in Figure 2.

Figure 2

A 150 g ball is thrown horizontally towards her bat with a velocity of 10 m s^{-1}, she strikes the ball and it leaves her bat with a velocity of 15 m s^{-1} also in a horizontal direction.

SECTION B – continued

a. If the impact time between the bat and the ball was 10 ms, what force did the bat provide to the ball?

2 marks

N

The ball then struck the ground 0.55 seconds later.

b. How high off the ground was Sally's bat when she struck the ball?

2 marks

m

c. What was the final velocity of the ball as it hit the ground?

3 marks

m s^{-1}

SECTION B – continued

TURN OVER

Question 3 (5 marks)

A train of mass 500 kg accelerates from rest with three carriages attached, as shown in Figure 3. Each carriage has a mass of 200 kg and the train uses 4000 N to pull the carriages. There is a frictional force of 1500 N on the train and 600 N on each carriage.

Figure 3

a. What is the acceleration of the train?

3 marks

m s^{-2}

b. What is the tension in the coupling between the train and the first carriage?

2 marks

N

SECTION B – continued

Question 4 (6 marks)

A forklift of mass 1 tonne accelerates from rest at the top of an 15° incline as shown in Figure 4. There is a frictional force acting between the incline surface and the wheels of the forklift.

Figure 4

a. on Figure 4, label the forces acting on the fork lift.

2 marks

b. After 10 seconds the forklift has a speed of 3 m s^{-1}, determine the frictional force acting on the forklift.

4 marks

N

SECTION B – continued

TURN OVER

Question 5 (5 marks)

In a recent movie, a stunt man is involved in a scene where a worker is lifted off the ground by a falling crate of bricks attached to a pulley as shown in Figure 5. The stuntman has a mass of 80 kg and the crate has a mass of 110 kg.

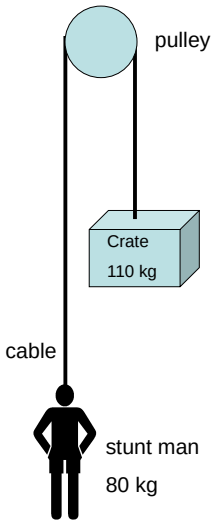


Figure 5

a. Determine the magnitude of the acceleration on the stunt man.

3 marks

m s^{-2}

b. What is the tension in the cable?

2 marks

N

SECTION B – continued

Question 6 (7 marks)

Two boxes are being pushed along a rough carpet surface, as shown in Figure 6
Box A has a mass of 30 kg and Box B has a mass of 15 kg. The boxes are being pushed with constant speed and encounter a frictional force of 25 % of their weight force

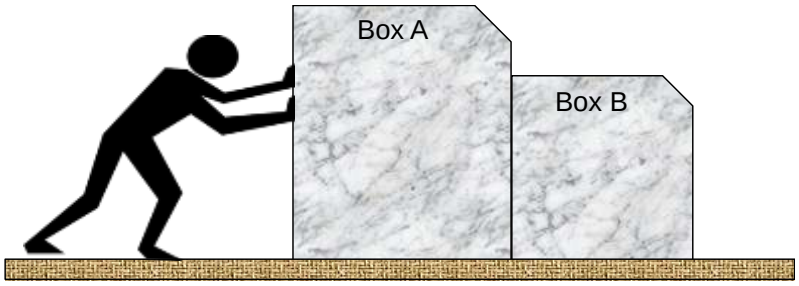


Figure 6

a. Determine the size of the force on Box A

2 marks

N

b. Label and calculate the size of each of the key forces acting on Box B. Use the convention $F_{\text{object A on object B}}$. 2 marks

c. Determine the size and direction of $F_{\text{Box B on Box A}}$.

3 marks

N

SECTION B – continued
TURN OVER

Question 7 (15 marks)

In a practical experiment a group of physics students were asked to investigate conservation of momentum and kinetic energy with two carts as shown in Figure 8.

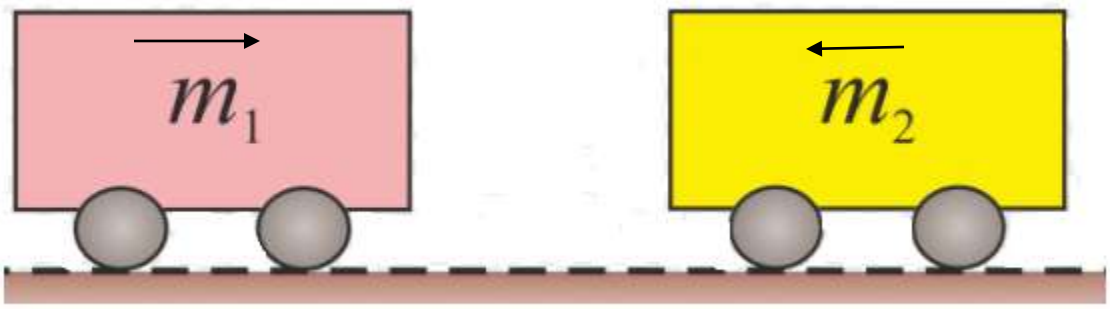


Figure 8

The students set up an experiment so that Cart m_1 has a mass of 2.5 kg and is initially moving with a velocity of 5 m s^{-1}, while Cart m_2 has an unknown mass and is 8 m s^{-1} to the left. The students were told by their teacher the final velocity of the locked carts should be 2.1 m s^{-1} to the left

a. Write a suitable hypothesis for this experiment.

3 marks

b. Identify the independent, dependent and control variables in this experiment

3 marks

SECTION B – continued

c. Find the mass of Cart m_2 based on the initial calculations of the students and the information given to them by their teacher.

2 marks

kg

d. The students then analysed their results and calculated a final locked velocity of 1.5 m s^{-1} to the left. Calculate the final momentum of the system and determine if momentum has been conserved or lost. If momentum has in fact been lost account for possible discrepancies

2 marks

e. Determine if the collision is elastic or inelastic

3 marks

f. Identify other possible systematic and random errors within this experiment different to your response in part **d**.

2 marks

END OF SECTION B
TURN OVER

SECTION C: Options

Instructions for Section C

Select **ONE** Option and answer **all** questions within that Option.

Option 2.1: What are stars?

Question 1

A group of stars that are in close proximity to each other are called:

A. a constellation.

B. a galaxy.

C. a nebula.

D. a cluster.

Questions 2 and 3 relate to the following information.

The diagram in Figure 1 shows the four visible hydrogen emission spectrum lines in the Balmer series as observed under laboratory conditions.

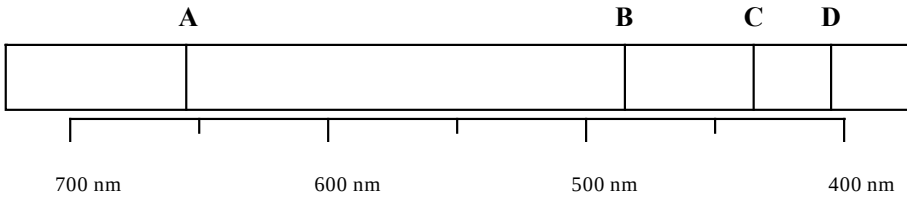


Figure 1

Question 2

Which one of the four spectral lines, **A** – **D**, is in the red part of the visible spectrum?

A. Line A.

B. Line B.

C. Line C.

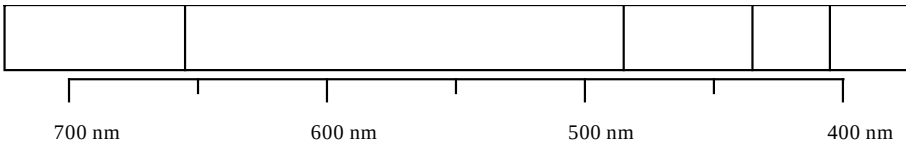
D. Line D.

SECTION C – continued

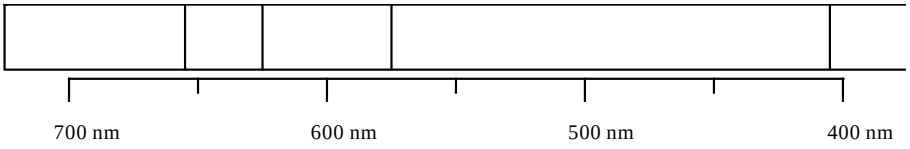
Question 3

What would the hydrogen emission spectrum look like for a galaxy that is travelling towards us?

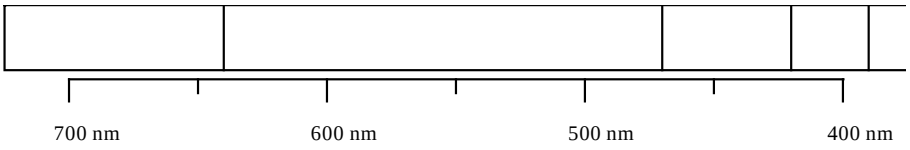
A.



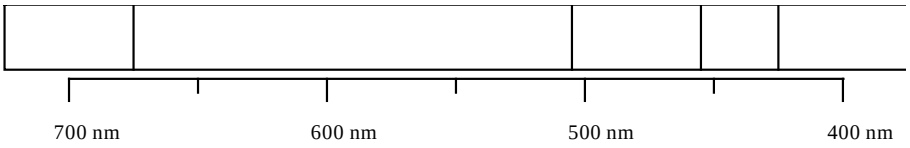
B.



C.



D.



Question 4

The final stage of a star's existence is determined by its mass. The most massive stars will end their lives as;

A. Supergiants
B. Neutron stars
C. White dwarfs
D. Black holes

Question 5

Suppose you were inside Schwarzschild radius of a black hole. If you were to shine a blue light to a companion exterior to the black hole your companion would see;

A. Red light
B. Blue light
C. Violet light
D. No light

SECTION C – continued
TURN OVER

Question 6 (9 marks)
The night sky as we observe is made up of many stars.

a. Define what is meant be the term star?

2 marks

b. Stars have the ability to generate their own light. Outline this process

2 marks

c. The absolute brightness and the apparent brightness are two ways in which stars are classified. Explain what is meant by each term and how they differ from each other.

2 marks

SECTION C – continued

d. Stars are held together by 2 main forces during their stablifetime. Describe the two main forces and how they act to keep the star stable

3 marks

Question (6 marks)

The Hertz sprung –Russell diagram is a valuable tool in classifying stars. An example of a Hertz sprung – Russell diagram is shown in Figure 2.

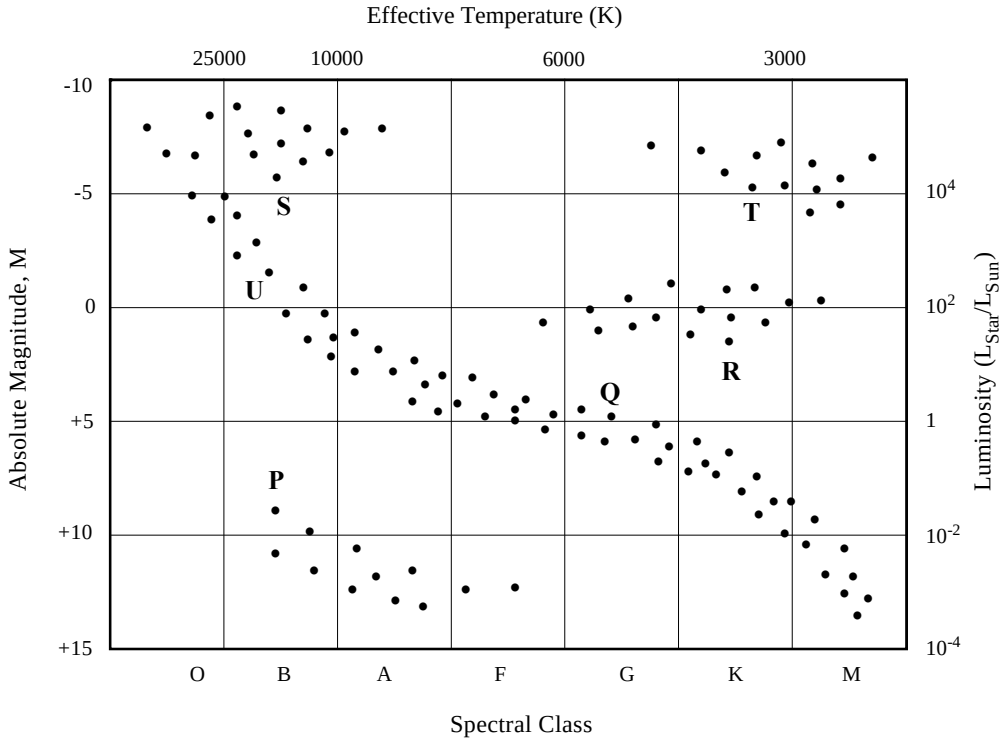


Figure 2

SECTION C – continued
TURN OVER

a. What information does the H-R diagram give astronomers?

2 marks

b. What are the characteristics of a star located in the upper right portion of the diagram?

2 marks

c. A low mass star expands and cools becoming more luminous as it evolves from the main sequence stage to the giant phase. In which directions will it move on the H-R diagram? Explain.

3 marks

END OF EXAMINATION

SECTION C: Options

Instructions for Section C

Select **ONE** Option and answer **all** questions within that Option.

Option 2.2: If there life beyond the solar system?

Question 1
Which condition is necessary for a *habitable zone* to exist around a star?

A. The star must situated in very close proximity to its parent star
B. The star must situated in a large distance from its parent star
C. The star must have several moons orbiting it
D. The star must be a suitable size and temperature

The following information refers to Questions 2 and 3

An astronomer is viewing a distant star. He perceives it to be emitting a wavelength of 390.4 nm. However he knows the star is actually producing a wavelength of 397.2 nm.

Question 2
Using the Doppler Effect the astronomer will be able to determine what characteristic of this star?

A. Its age
B. If its moving towards Earth
C. If its moving away from Earth
D. Its size

Question 3
The astronomer then calculates the speed at which it is moving; he calculates it to be:

A. 3×10^{8}m s^{-1}
B. 5.2×10^{6} m s^{-1}
C. 5.1×10^{6} m s^{-1}
D. 180 m s^{-1}

Question 4
The Drake Equation tries to predict;

A. The total number of aliens in our galaxy
B. The number of possible communications we have received via radiotelescopes
C. How long ago the Big Bang occurred
D. The number of advanced civilisations in our galaxy

Question 5
The Sun's observed visible light spectrum shows

A. A continuum with dark emission lines
B. A continuum with bright emission lines
C. A continuum with dark absorption lines
D. A continuum with bright absorption lines

Question 6 (9 marks)
Spectroscopy is a tool used to investigate light from our stars and it provides a wealth of information.

a. Identify and describe three factors that spectroscopy allows to be identified from the spectrum of a star.

3 marks

SECTION C – continued

Figure 1 shows simplified versions of three different spectra

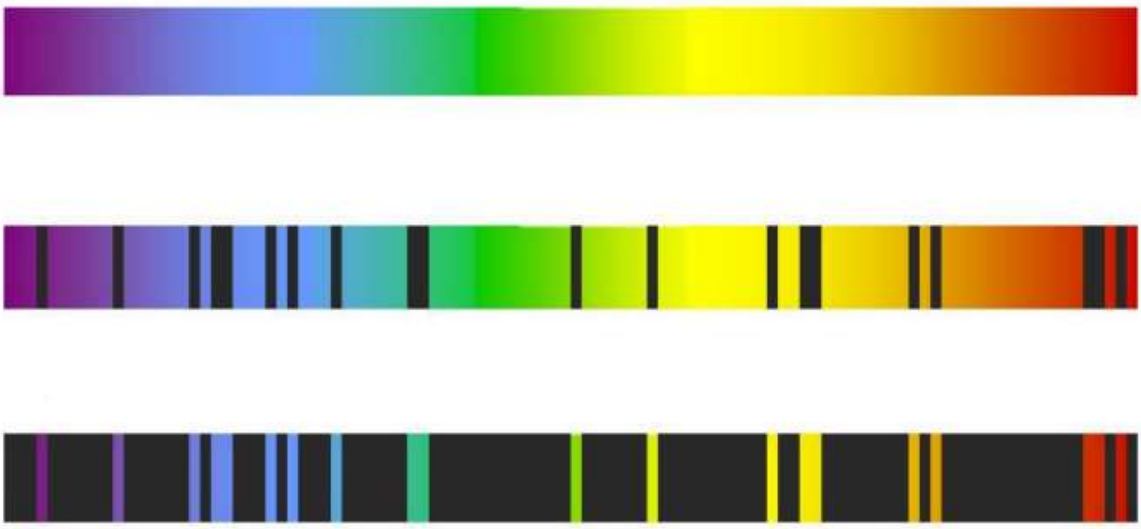


Figure 1

b. Identify the three different spectra and explain how they are formed.

3 marks

SECTION C – continued
TURN OVER

Figure 2 shows the spectra obtained from the same star at two different times.

Figure 2

c. Identify the differences in the spectra and explain why these differences occur.

3 marks

SECTION C – continued

Question 2 (6 marks)

Does life exist beyond our planet? This is an issue that scientists have debated for an extended period of time.

a. What is the first thing scientists look for to find life outside Earth? Explain its significance.

2 marks

b. What controls a planet's surface temperature and how does this determine is its habitable?

2 marks

c. There are another two properties scientists look for in determining if a planet is habitable.What are they and why are they important?

2 marks

END OF EXAMINATION

SECTION C: Options

Instructions for Section C

Select **ONE** Option and answer **all** questions within that Option.

Option 2.3: How do forces act on the human body?

Question 1

The elbow is an example of a:

A. second class lever
B. system of movement that is not based on any lever system
C. third class lever
D. first class lever

Question 2

Kristina is performing an exercise that requires her to left her arms above her head. What happens to Kristina's centre of mass of a human body as she raises her arms?

A. It will move up
B. It will move down
C. It won't change
D. It will move to the left

Question 3

In a game of volleyball Amber is serving the ball using the overhead technique. To do this Amber tosses the ball into the air and hits it with her hand so it passes over the net. When analyzing the forces acting on her forearm there is a gravitational force on her arm which is 7.9N and acts 11cm from her elbow and the gravitational force on her hand which is 3.2 N and acts at a total distance of 17.4cm from her elbow as shown in **Figure 1.**

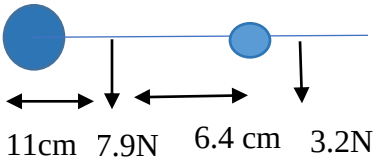


Figure 1

The distance from her elbow to the center of mass during the serve, in centimetres, is:

A. 12.9
B. 13.6
C. 17.4
D. 6.4

Question 4

While playing a game of netball, Rachel falls over and exerts a force of 2250 N on her ankle ligament. If the ligament has a cross sectional area of 2.5 cm^2, what is the stress on the ligament.

A. 0.5625 Pa
B. 900 Pa
C. 5625 Pa
D. 9×10^6 Pa

SECTION C – continued
TURN OVER

Question 5

Figure 2 shows a typical stress-strain curve for human skin as it is stretched

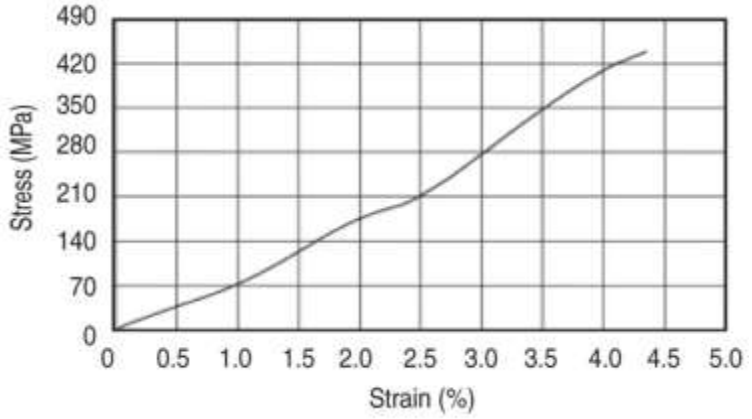


Figure 2

The maximum strain energy that this human skin is able to absorb per unit of volume when stretched by 2.5% is closest to

A. 7 J m^{-3}
B. 2.45×10^{8} J m^{-3}
C. 2.45×10^{6}J m^{-3}
D. 245 J m^{-3}

SECTION C – continued

Question 6 (12 marks)

Figure 3 shows Amy who has a mass of 50kg completing a tricep push up.

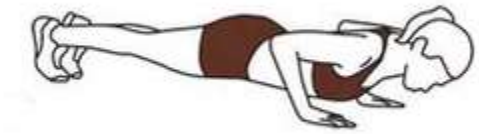


Figure 3

The distance between Amy's feet and her shoulders is 1.5m and there is 85 cm between her feet and her centre of mass.

a. Calculate the force exerted on Amy's hands by the floor.

3 marks

N

b. The triceps can be thought of as effective levers with a length of 1.5cm. If Amy exerts a force on the floor 25cm from her elbows, calculate the force in each of her tricep muscles.

3 marks

N

c. Calculate the total upwards force is being exerted by the floor on Amy toes.

1 mark

N

SECTION C – continued
TURN OVER

After completing her push up, Amy changes her exercise so she is now jumping a distance of 2m onto a hard concrete floor. As she lands, her knees compress a distance of 1 cm.

d. Find the amount of force applied to her knees during landing.

3 marks

N

e. If the area of her knee joints is 3.3 cm^2 find the amount of stress applied to one joint.

2 marks

Question 7 (3 marks)

Table 1 shows a variety of different materials uses for prosthesis within the body. Complete the table.

Material	Location of Use	Properties that make it suitable
Aluminum		
Silicon joints		
Ultrahigh molecular weight polyethylene		

3 marks

END OF EXAMINATION

SECTION C: Options

Instructions for Section C

Select **ONE** Option and answer **all** questions within that Option.

Option 2.4: How can AC electricity charge a DC device?

The following information refers to Questions 1 and 2

A current of 4.5A flows in the primary coil of an ideal transformer when it is connected to 240V, AC. The number of turns on the secondary coil is 8 times the primary coil.

Question 1
What is the voltage across the secondary coil?

A. 30 V
B. 240 V
C. 1920 V
D. 2040 V

Question 2
What current flows through the secondary coil?

A. 0.22 A
B. 0.56 A
C. 4.5 A
D. 36 A

Question 3

Figure 1 shows the characteristics of a diode

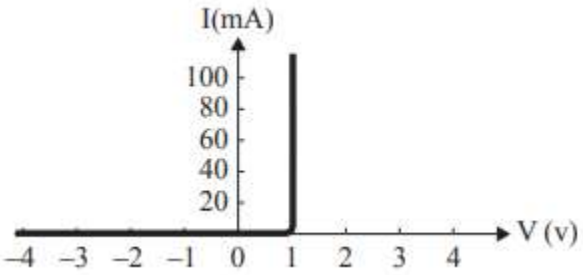


Figure 1

The diode is placed in the circuit shown in Figure 2

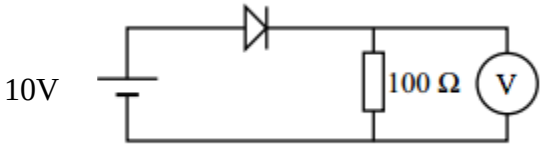


Figure 2

What is the voltage on the voltmeter?

A. 11 V
B. 10 V
C. 9 V
D. 8 V

SECTION C – continued

Question 4
Figure 3 shows a basic demonstration circuit for a 5 V zener diode.

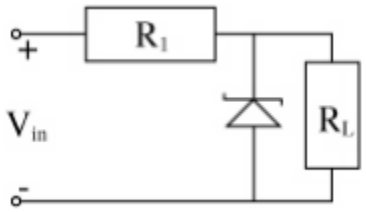


Figure 3

V_{in} is 10 V, R_1 is 50 Ω, the breakdown voltage of the Zener diode is 5 V and it has a current of 40 mA passing though it

Which of the following best estimate for the magnitude of the resistor, R_L?

A. 8 Ω
B. 83 Ω
C. 833 Ω
D. 83 kΩ

Question 5
Which of the following is true about the bridge rectifier circuit?

A. The capacitor discharges for a longer time to make the voltage more constant
B. The capacitor discharges for a shorter time to make the voltage more constant
C. The capacitor discharges for a longer time and then made to discharge for a shorter time to make the voltage more constant
D. The capacitor discharges for a shorter time and then made to discharge for a longer time to make the voltage more constant

SECTION C – continued
TURN OVER

Question 6 (6 marks)

A thermistor is used to trigger a circuit for a refrigeration unit. The graph in Figure 4 shows the temperature characteristics for the thermistor.

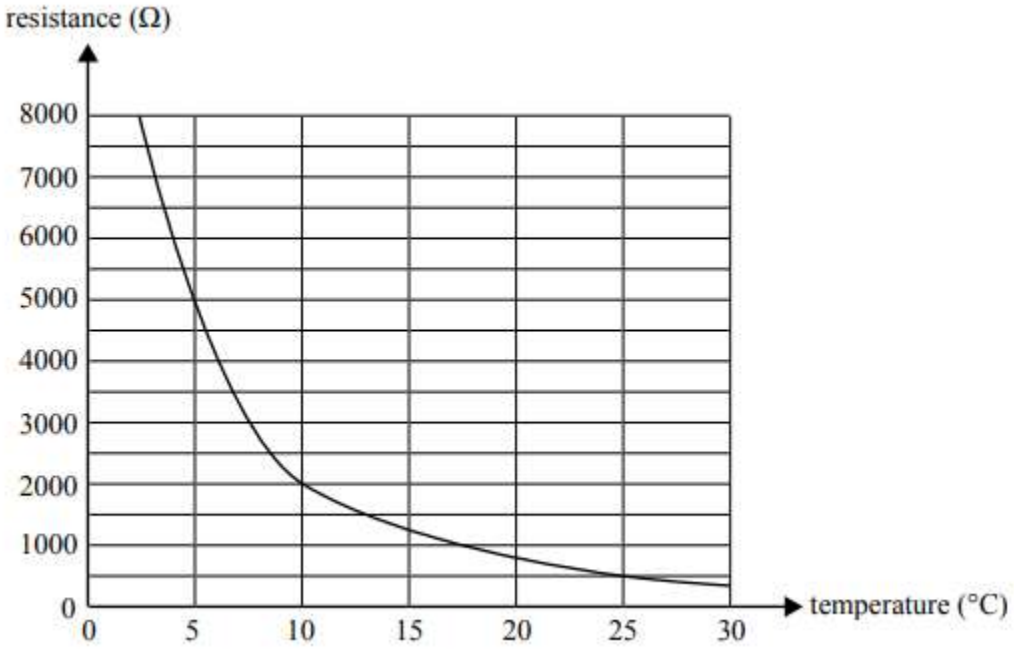


Figure 4

a. What is the resistance of the unit when the thermistor records a temperature of 25°C?

	Ω

1 mark

SECTION C – continued

The control circuit for the thermistor is shown below in Figure 5

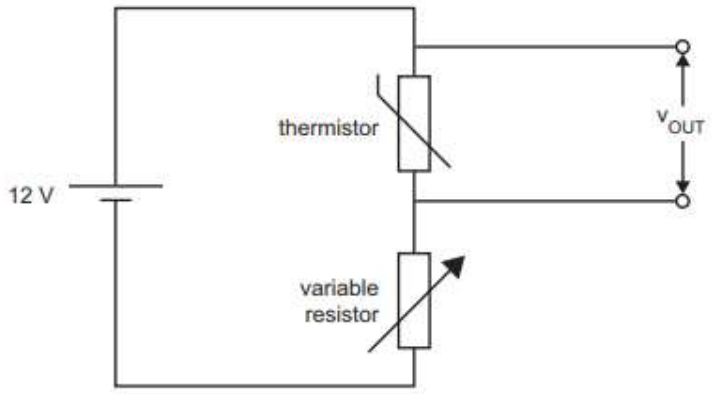


Figure 5

The unit is designed to turn the air conditioner on with a voltage output of 5 V across the thermistor when the temperature reaches 10 ℃

b. Calculate the value of variable resistor in order to achieve this.

2 marks

Ω

c. It is decided that the temperature is too warm when the unit turns on at, and as a result, adjustments are to be made so that the unit turns on at 5℃ instead. In order to achieve this, should the resistance of the variable resistor be increased or decreased? Explain.

3 marks

SECTION C – continued
TURN OVER

Question 7 (9 marks)

A 400 μF is charged using the circuit shown in **Figure** 6. To charge the capacitor the switch S is closed

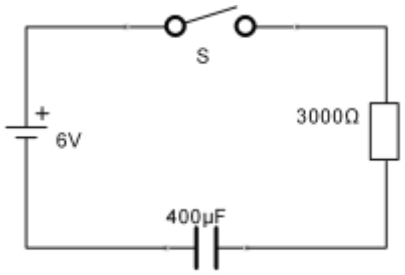


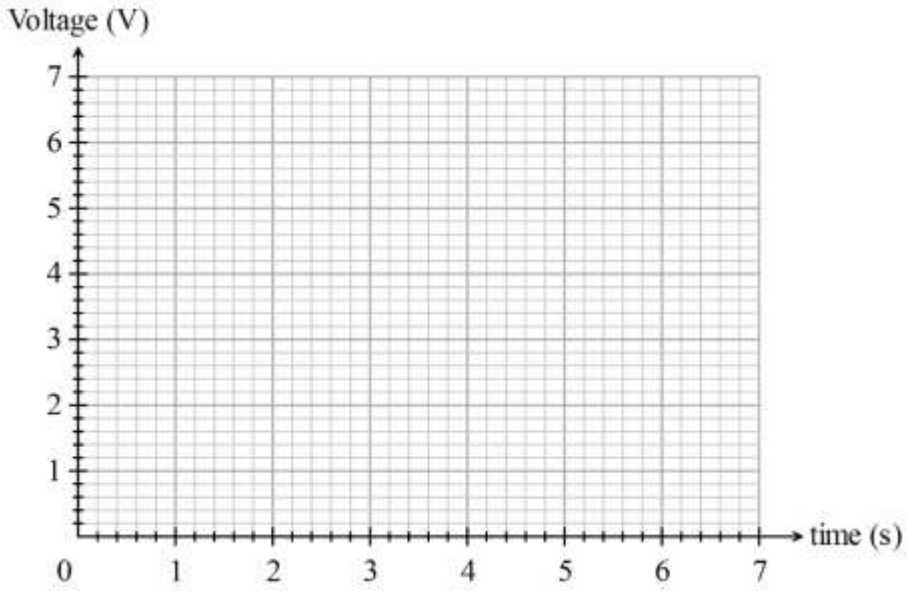
Figure 6

a. What is the time constant, τ for this circuit?

2 marks

s

b. On the axes below draw a labelled graph to show the amount of charge vs. time for the capacitor to charge over five time constants.



2 marks

SECTION C – continued

c. What would be the voltage drop across the 3000 Ω resistor 1.2 seconds after S is closed and the charging process commences.

3 marks

V

d. After the capacitor is fully charged, the switch S is then opened. On the same set of axes as used in part **b.**, draw a labelled graph to show the discharge of the capacitor over 5 time constants.

2 marks

END OF EXAMINATION

SECTION C: Options

Instructions for Section C

Select **ONE** Option and answer **all** questions within that Option.

Option 2.5: How do heavy things fly?

Question 1

There are four main forces important in the aerodynamics of flight. Which combination below is not considered as reaction forces as conveyed in Newton's Third Law of Motion?

A. Weight and Thrust
B. Thrust and Drag
C. Weight and Lift
D. Lift and Drag

Question 2

A pilot flying a small plane makes a small increase in the angle of attack on a wing, the effect that this will have on the plane is?

A. There will be an increase in the drag
B. There will be an increase in the lift
C. There will be an decrease in the drag
D. There will be an decrease in the lift

The following information refers to Questions 3 -5

An aeroplane flying at an altitude of 39,000 feet with a constant velocity of 750 km h^{-1}. The aeroplane has a mass of 500, 000 kg and experiences a drag force of 80,000 N.

Question 3

The thrust force exerted by the engine is:

A. 8×10^3 N
B. 8×10^4 N
C. 8×10^5 N
D. 0 N

Question 4
What will be the lift force on the aeroplane?
A. 4.9×10^4 N
B. 4.9×10^5N
C. 4.9×10^6N
D. 4.9×10^7N

Question 5
What power is required by the engine to overcome the resistance forces?

A. 1.67×10^7W
B. 6×10^7W
C. 6×10^5W
D. 1.67×10^3W

Question 6 (10 marks)
Figure 1 shows a diagram of an aerofoil.

Figure 1

In order to generate lift a wing relies in part on Bernoulli's principle.

a. Draw the motion of the air over the aerofoil, also labelling lift and angle of attack on Figure 1

3 marks

SECTION C – continued
TURN OVER

b. Explain how lift is generated according to Bernoulli's principle.

2 marks

c. What is the angle of attack and how does it assist in lift.

2 marks

d. There are two major types of aerodynamic drag that act on a plane during its flight. Identify them and explain how they contribute to aerodynamic drag.

3 marks

SECTION C – continued

Question 7 (5 marks)

The Skybird shown in Figure 2 is flying at a height of 8000 m with a constant speed of 520 km h^{-1}. It has a mass of 13 155 kg and on take-off provides a thrust of 100 000 N and has a drag force of 75 550 N

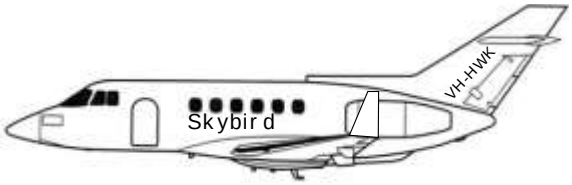


Figure 2

a. Find the acceleration of the plane on take-off.

2 marks

m s^{-2}

In order to stabilize the load passenger's luggage, the rear fuel tank of the Skybird has had fuel added to it.

b. If the luggage in placed in the cargo hold which is located 2.4m in front of the centre of mass and has a mass of 500 kg, how much fuel needs to be added to the rear fuel tank which is located 4.5m behind the centre of mass?

3 marks

L

END OF EXAMINATION

SECTION C: Options

Instructions for Section C

Select **ONE** Option and answer **all** questions within that Option.

Option 2.6: How do fission and fusion compare as viable energy sources?

Question 1

How many protons, neutrons and nucleons does an atom of $^{235}_{92}U$ have?

A. 92 protons, 143 neutrons and 235 nucleons.

B. 143 protons, 92 neutrons and 92 nucleons.

C. 143 protons, 92 neutrons and 235 nucleons.

D. 92 protons, 235 neutrons and 92 nucleons.

Question 2

The following equation shows a typical fission reaction

$$^{1}_{0}n + \ ^{235}_{92}U \ \rightarrow \ ^{A}_{Z}X + \ ^{140}_{55}Cs + 4\,^{1}_{0}n$$

What are the missing atomic and mass numbers?

A. atomic number 92, mass number 37

B. atomic number 37, mass number 92

C. atomic number 37, mass number 95

D. atomic number 95, mass number 37

Question 3

In a particular nuclear fission explosion, 2.5×10^{34} eV of energy was released. The change in mass of the nuclear particles in this reaction was, therefore, equivalent to:

A. 2.5×10^{34} kg

B. 4.0×10^{15}kg

C. 2.8×10^{17}kg

D. 0.044 kg

SECTION C – continued

Question 4

The primary fuel for a nuclear fusion reactor is:

A. Plutonium
B. Hydrogen
C. Helium
D. Uranium

Question 5

The process by which two lighter nuclei travelling at high speeds fuse together to form a single heavier nuclei is called:

A. A nuclear chain reaction
B. A nuclear fission reaction
C. A nuclear fusion reaction
D. Radioactive decay

Question 6 (5 marks)

There are two methods in which energy could be produced within nuclear power

a. What are these methods and outline the differences between them in regard to fuels and processes.

3 marks

SECTION C – continued
TURN OVER

b. Which of the methods is the more viable source of energy production presently? Explain why this is the case.

2 marks

Question 7 (10 marks)

Figure 1 shows what can happen when the nucleus of a uranium atom absorbs a neutron.

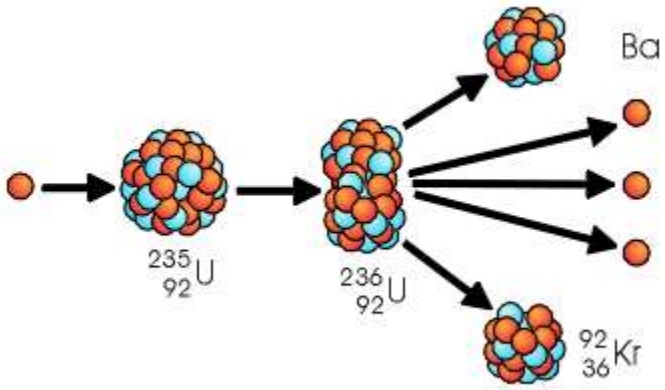


Figure 1

a. What is the name given to the process above?

1 mark

SECTION C – continued

b. Write out the reaction equation from the information provided.

2 marks

c. Explain how this process can lead to a chain reaction

2 marks

d. A critical mass of a nuclear fuel is required so that a chain reaction can be established. What two factors determine the critical mass?

2 marks

SECTION C – continued
TURN OVER

e. Using the information provided in Table 1 calculate the energy provided for each reaction.

Mass of neutron = 1.6745×10^{-27}kg	Mass of Barium-144 = 2.38992×10^{-25}kg
Mass of Uranium-235=3.90305×10^{-25}kg	Mass of Krypton-89=1.47653×10^{-25}kg

Table 1

3 marks

J

END OF EXAMINATION

SECTION C: Options

Instructions for Section C

Select **ONE** Option and answer **all** questions within that Option.

Option 2.7: How can radiation maintain human health?

Question 1

Magnetic Resonance Imaging (MRI) uses a large magnetic field to cause the alignment of atoms within the body. Which of the following types of atoms found in the body will align themselves with the external magnetic field?

A. Oxygen atoms.

B. Carbon atoms.

C. Hydrogen atoms.

D. Calcium atoms.

Question 2

Technetium-99 is radioactive and has a half-life of 6 hours. This isotope can be used to detect bone disease. A sample of Technetium needs to be delivered to hospital 30 hours away. When it arrives it must have an activity of 0.5 MBq. The amount of Technetium that needs to be produced will be closest to;

A. 0.001 MBq

B. 1000 Bq

C. 16 MBq

D. 16 Bq

Questions 3 to 5 relate to the following information.

Positron emission tomography (PET) is a nuclear medical imaging technique that can be used to produce a three-dimensional image or picture of functional processes inside the body.

Question 3

The radioactive isotope that is injected into the patient decays by positron emission. A positron is:

A. identical to an electron, but has a positive charge.
B. identical to a neutron, but has a positive charge.
C. a particle with the mass of an electron, but has the charge of a neutron.
D. a particle with the mass of an electron and the charge of a neutron.

Question 4

Very soon after it is emitted a positron will meet an electron and be annihilated with it. This means that:

A. the positron and electron form a nucleus and gamma rays are emitted.
B. the positron and electron are destroyed and gamma rays are emitted.
C. the positron and electron combine with the isotope to produce fluorine 18.
D. the positron and electron combine with the isotope to produce oxygen 18

Question 5

Which of the following statements is a correct description of the two gamma rays that are emitted following the annihilation of a positron and an electron?

A. They are absorbed by the radioactive isotope.
B. They are absorbed by the body tissue.
C. They are emitted at 180^{o} to each other.
D. They are emitted in the same direction.

Question 6 (5 marks)

The data in **Table 1** gives information about a variety of radioactive isotopes, some of which can be used as diagnostic tools in medicine

Isotope	Radiation Emitted	Half-life
Fluourine-18	β^+	109.77 minutes
Strontium-90	β	28.8 years
Carbon-14	β	5730 years
Technetium-99	γ	6 hours
Cobalt - 60	γ	5.27 years

Table 1

a. Describe the properties that make a radioactive isotope useful for medical imaging.

3 marks

b. Using the information provided in **Table 1** justify which isotope(s) would be suitable for diagnostic imaging

2 marks

SECTION C – continued
TURN OVER

Question 7 (10 marks)

Figure 1 shows an X-Ray image of a hand

Figure 1

a. Explain how an x-ray machine produces x-rays

2 marks

b. Explain how the image is produced.

2 marks

SECTION C – continued

c. Why do X-rays give good images of bones compared with soft tissue?

2 marks

d. X-rays can be classified as *hard* or *soft*. Explain how hard x-rays differ to soft x-rays and why they are preferred for imaging the human body.

2 marks

e. CAT scans provide more information than X-rays, so they should be used whenever possible. Discuss this statement.

2 marks

END OF EXAMINATION

SECTION C: Options

Instructions for Section C

Select **ONE** Option and answer **all** questions within that Option.

Option 2.8: How do particle accelerators work?

Question 1
Which of the following is not a particle accelerator?

A. Cloud chamber
B. Cyclotron
C. Storage ring collider
D. Microtron

Question 2
The primary purpose of a particle accelerator is to;

A. Make small particles go very fast
B. Make small particles achieve a large acceleration
C. Create particles and study their behaviour
D. Produce energy for commercial use

Question 3
In the electron gun of a particle accelerator electrons are accelerated by a voltage of 8000V. Which of the following gives the speed of the electrons

A. $2.8 \times 10^{15} ms^{-1}$
B. $5.3 \times 10^{7} ms^{-1}$
C. $3 \times 10^{8} ms^{-1}$
D. $8.0 \times 10^{3} ms^{-1}$

Question 4

Which of the following is not a characteristic of light produced from a particle accelerator

A. Highly polarised
B. High brightness
C. Consists of a single wavelength
D. Tuneable

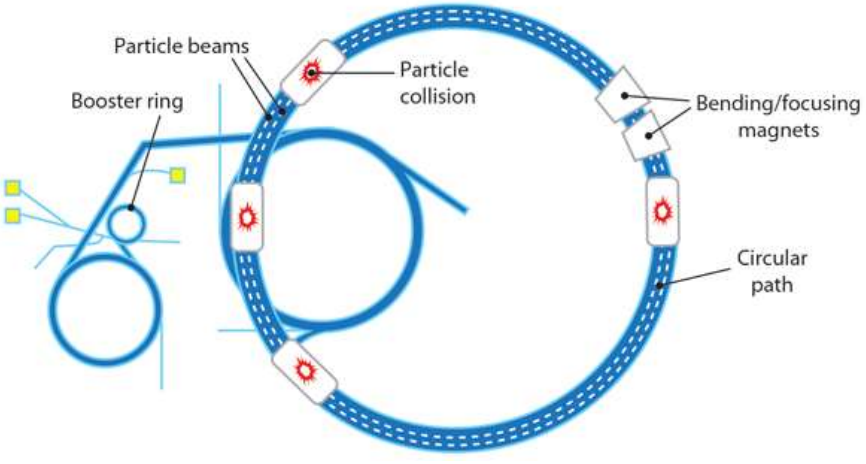
Question 5

Which of the following is **not** an application of particle accelerators?

A. Implanting ions in silicon chips.
B. Proton therapy in cancer treatment.
C. Production of radioisotopes.
D. Operation of LEDs

Question 6 (9 marks)

Figure 1 shows a diagram of a particle accelerator called a synchrotron



a. Explain the basic principles behind how a particle accelerator generates radiation

2 marks

b. Once generated, how is the electron beam:

Stored?

2 marks

SECTION C – continued

Accelerated?

2 marks

c. There are many different characteristics of the Synchrotron radiation that make it useful as a research tool. Outline 3 of these.

3 marks

Question 7 (6 marks)

Over recent decades particle accelerators have detected hundreds of new baryons and mesons as well as quarks. They have also detected particles called gauge bosons.

a. What is a gauge boson?

2 marks

SECTION C – continued
TURN OVER

b. Why have these machines been significant in the detection of these particles?

2 marks

c. Particle accelerators have also allowed scientists to confirm the standard model of particle physics with the confirmation of a particle called the Higgs Boson. What is the Higgs Boson, why is it hard to detect and why was it important in confirming the standard model?

2 marks

END OF EXAMINATION

SECTION C: Options

Instructions for Section C

Select **ONE** Option and answer **all** questions within that Option.

Option 2.9: How can human vision be enhanced?

Question 1

A light ray travels from air into a medium with a refractive index of 1.58. If the light ray enters at an angle of 40˚, the angle of refraction would be;

A. 29°
B. 24°
C. 40°
D. 50°

Question 2

A long sighted person cannot see objects nearer to his eye than 50cm. To enable him to read a book 25 cm away, he should use spectacle lenses whose power in diopters is:

A. -6
B. -4
C. +6
D. +4

Question 3

What is the image distance of an image formed by an object placed 10 cm from a convex mirror with a focal length of -20 cm?

A. 6.67 cm
B. -6.67 cm
C. -10cm
D. 10 cm

Question 4

A student who is sitting at the back of a classroom is able to read what is written on the board at the front of the room but not his text book that is on the table in front of him. Which of the following statements is correct?

A. The near point of his eyes has receded away.
B. The near point of his eyes has come closer to him
C. The far point of his eyes has come closer to him
D. The far point of his eyes has receded away.

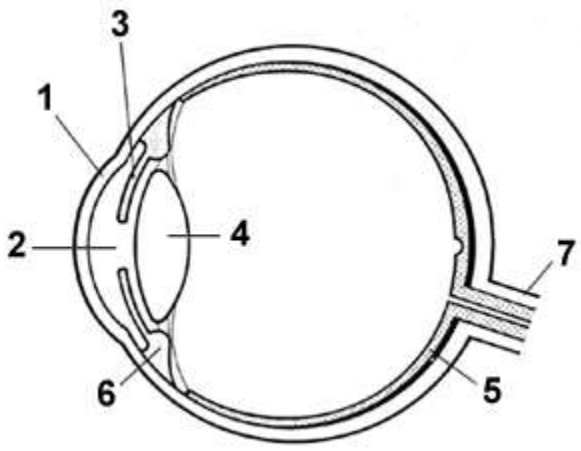
Question 5

At a recent optometrist appointment Lachlan had his near and far points measured. The optometrist determined that Lachlan's eyes had a near point of 100 cm and a far point of infinity, then

A. Lachlan has myopia and needs eye glasses with a convex lens
B. Lachlan has myopia and needs eye glasses with a concave lens
C. Lachlan has hyperopia and needs eye glasses with a convex lens
D. Lachlan has hyperopia and needs eye glasses with a concave lens

Question 6 (6 marks)

Figure 1 shows a diagram of the human eye.



a. Fill in the names for each section labelled 1- 7

3 marks

SECTION C – continued
TURN OVER

b. Describe how an image is obtained by the eye, include a diagram in your answer.

3 marks

Question 7 (5 marks)

Rebecca has a far point located at 210 cm from her eyes as shown in Figure 2

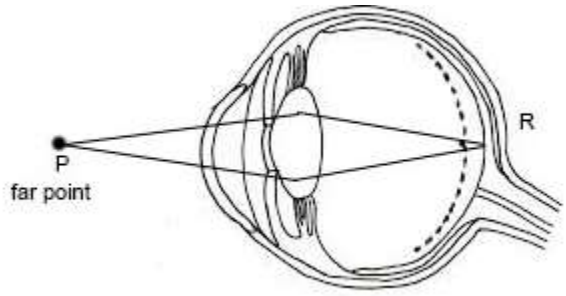


Figure 2

a. What eye condition does Rebecca have

1 mark

SECTION C – continued

b. Rebecca decides to get contact lenses to assist her is seeing objects clearly. Determine the focal length of contact lenses she requires.

2 marks

m

c. What is the power of these lenses.

2 marks

SECTION C – continued
TURN OVER

Question 8 (4 marks)

One of the leading causes of blindness in the world is cataract blindness.

A. Explain what cataract blindness is

2 marks

B. How is cataract blindness treated?

2 marks

END OF EXAMINATION

SECTION C: Options

Instructions for Section C

Select **ONE** Option and answer **all** questions within that Option.

Option 2.10: How do instruments make music?

The following information refers to Questions 1 and 2

Rick is listening to a clarinet being played on a stage 10 m away and he records the sound level reading to be 76 dB.

Question 1

How is the sound of the clarinet being transmitted to Rick's ears?

A. Transverse waves.
B. Longitudinal waves.
C. Electromagnetic waves.
D. Pressure waves.

Question 2

What is the sound level at a distance of 2 m?

A. 76 dB
B. 90 dB
C. 84 dB
D. 62 dB

Question 3

A pipe shown in **Figure 1** is closed at one end and open at the other. It has a length of 0.5m.

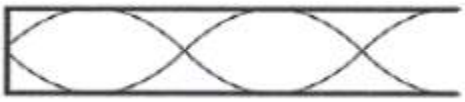


Figure 1

The pipe is filled with air. What is the resonant frequency corresponding to the mode of vibration shown in **Figure 1.** Assume the speed of sound is 340 ms^{-1}.

A. 170 Hz
B. 227 Hz
C. 340 Hz
D. 850 Hz

Question 4

Lucas is standing at the far side of a theatre. On stage he can see a tuba and a trombone being played. The musical director informs Lucas the tuba is being played with a frequency 70 Hz while the trombone plays a note of 275 Hz. Both are playing at exactly the same volume and sound intensity. Lucas can clearly hear one of the instruments but not the

Which of the following statements best describes why this is the case?

A. Lucas can hear the trombone louder than the tuba because of diffraction of the two sounds
B. Lucas can hear the trombone louder than the tuba because of refraction of the two sounds
C. Lucas can hear the tuba louder than the trombone because of diffraction of the two sounds
D. Lucas can hear the tuba louder than the trombone because of refraction of the two sounds

Question 5

Figure 2 shows a set of phon curves for a standard human ear.

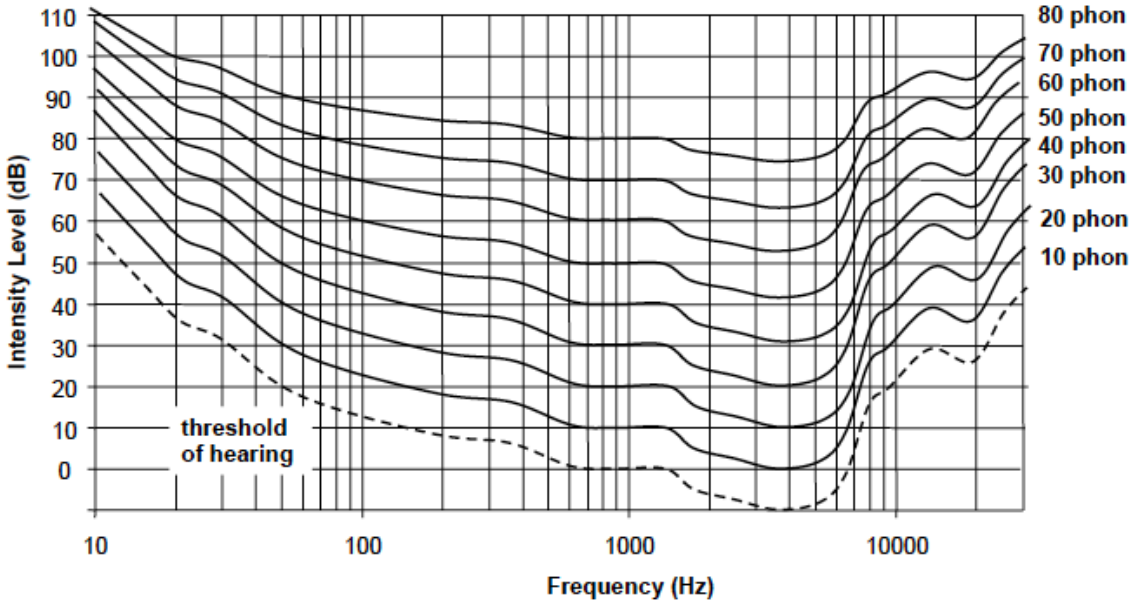


Figure 2

Which of the following sounds would appear louder than 300 Hz at 65 dB?

A. 50 Hz at 70 dB
B. 100 Hz at 70 dB
C. 3000 Hz at 63 dB
D. 20 Hz at 80 dB

SECTION C – continued
TURN OVER

Question 6 (6 marks)

A guitar string has a length of L m and plays a fundamental frequency of 250 Hz. The speed of the wave in the guitar string was measured at 400 m s^{-1}.

a. Explain how a standing wave is formed

2 marks

b. Calculate the length of the guitar string

2 marks

m

c. Find the 5^{th} harmonic produced by this guitar string

2 marks

Hz

SECTION C – continued

Question 7 (6 marks)

Lucy is playing a clarinet which can be modelled as a closed pipe. The clarinet has a length of 0.8 m. (Assume speed of sound is 340 m s^{-1})

a. Calculate the fundamental frequency Lucy obtained on her clarinet.

2 marks

Hz

b. Calculate the next two frequencies Lucy could also play.

2 marks

Hz

Hz

c. Briefly explain resonance in terms of the behaviour of the sound waves in a tube closed at one ends.

2 marks

SECTION C – continued
TURN OVER

Question 8 (3 marks)

Two speakers are set up on a school oval, a distance of 3 m apart as shown in Figure 3.

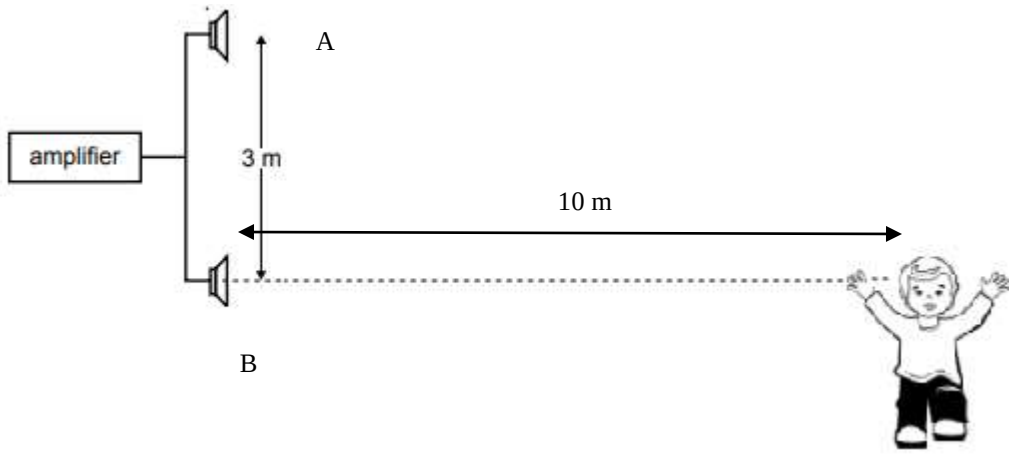


Figure 3

The frequency produced by the speakers is 386 Hz and a student's ear is located at a distance of 10 m directly in front of speaker B.

Assuming the speed of sound in air is 340 m s^{-1}, describe what this student will hear standing at this position.

3 marks

END OF EXAMINATION

SECTION C: Options

Instructions for Section C

Select **ONE** Option and answer **all** questions within that Option.

Option 2.11: How can performance in ball sports be improved?

The following information refers to Questions 1 to 3

Two billiard balls, each with a mass of 140 g are travelling towards one another when they collide during a game of billiards. After the collision one ball stops and the other keeps moving.

Question 1

The first ball was initially travelling with a velocity of 8.5 ms^{-1} east. Its initial momentum is:

A. 1190 kg m s^{-1} east
B. 11.90 kg m s^{-1} west
C. 1.19 kg m s^{-1} east
D. 0.119 kg m s^{-1} west

Question 2

The second ball was travelling at 6.5 m s^{-1}. In order for it to make contact with the first ball, its momentum would be:

A. 0.91 kg m s^{-1} east
B. 0.91 kg m s^{-1} west
C. 910 kg m s^{-1} east
D. 910 kg m s^{-1} west

Question 3

The final velocity of the ball that keeps moving after the collision would be:

A. 2 m s^{-1} west
B. 15 m s^{-1} west
C. 15 m s^{-1} east
D. 2 m s^{-1} east

SECTION C – continued
TURN OVER

Question 4

The Magnus effect supports the concept that a ball with "top spin" will have a lift force;

A. Downwards
B. Upwards
C. Towards the left
D. Towards the right

Question 5

A soccer ball with a radius of 10.5 cm rotates with an angular velocity of 8 revolutions per second. Its linear velocity is closest to;

A. 0.84 m s^{-1}
B. 8 m s^{-1}
C. 84 m s^{-1}
D. 10.5 m s^{-1}

Question 6 (9 marks)

A ball is dropped from a 15m high balcony onto the ground below. The coefficient of restitution between the ball and the ground is 0.85.

a. What is the velocity of the ball as it strikes the ground?

2 marks

m s^{-1}

b. How high will the ball bounce after it initially rebounds?

2 marks

m

SECTION C – continued

c. What velocity will it leave the ground at?

2 marks

m s^{-1}

d. If the ball keeps bouncing, how many times will it pass a height of 8 m off the ground?

3 marks

SECTION C – continued
TURN OVER

Question 7 (6 marks)

Julia is playing soccer and she kicks the 400 g ball along the ground as shown in Figure 1.

Figure 1

a. If the friction coefficient is 0.45 and Julia kicks the ball with a horizontal force of 150 N, find the amount of kinetic friction acting on the ball just after she kicked it.

2 marks

N

b. The initial velocity of the ball was measured to be 2.75 m s^{-1}. How long did it take to begin rolling?

2 marks

s

c. How fast was it going when it began to roll?

2 marks

m s^{-1}

END OF EXAMINATION

SECTION C: Options

Instructions for Section C

Select **ONE** Option and answer **all** questions within that Option.

Option 2.12: How does the human body use electricity?

Question 1

Neurons communicate with each other sending electrical impulses called

A. Depolarisation
B. Neurotransmission
C. Action potential
D. Resting potential

Question 2

Which of the following currents is considered dangerous in the human body?

A. 1 mA
B. 30 mA
C. 50 mA
D. 0.2 A

Question 3

Hyperpolarisation is

A. A sudden change within a cell during which the cells undergoes a dramatic electrical change.
B. Opposite to depolarisation, it causes a change in the cell's membrane potential making it more negative
C. The same as depolarisation, it causes a change in the cell's membrane potential making it more postive
D. An influx of charged potassium (K^+) ions within the cell.

The following information refers to Questions 4 and 5

A 100 μF capacitor, an unknown resistor and 15 V supply are connected as shown in Figure 1a. When the switch is closed, the voltage versus time across the capacitor is recorded and shown in Figure 1b.

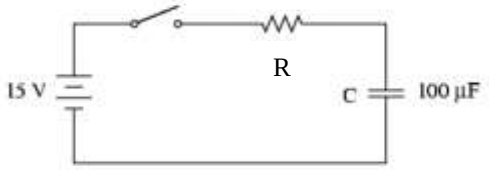
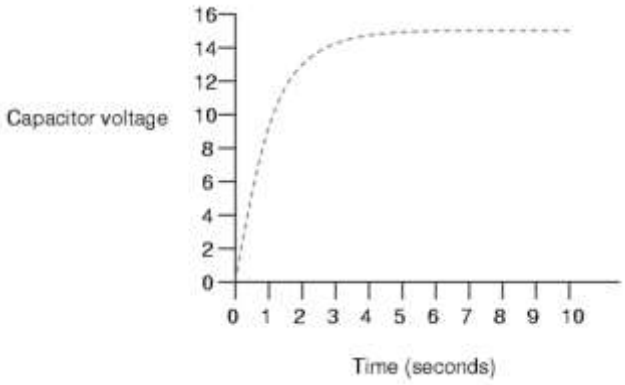


Figure 1a



Question 4

Which of the following is the best estimate for the time constant of the circuit?

A. 10 sec
B. 9.45 sec
C. 1 sec
D. 3 sec

Question 5

Which of the following is the best estimate for the value of **R**?

A. 100 Ω
B. 1000 Ω
C. 10 kΩ
D. 150 kΩ

SECTION C – continued

Question 6 (7 marks)
Figure 2 shows the key components of the heart's electrical system.

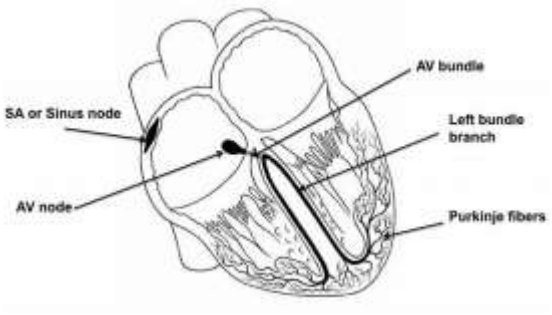


Figure 2

a. Explain how the heart generates an electrical signal.

2 marks

Figure 3 shows an electrocardiogram diagram taken to examine the function of the heart

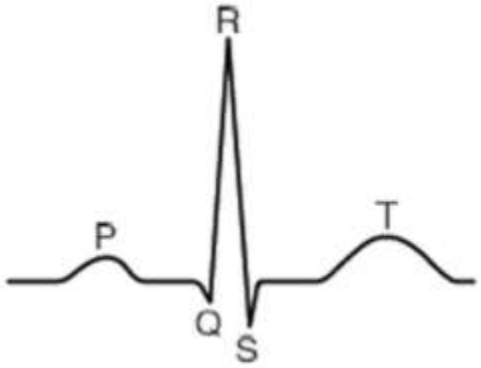


Figure 3

SECTION C – continued
TURN OVER

b. How does an ECG work?

2 marks

c. What do the waves P, QRS and T represent?

3 marks

SECTION C – continued

Question 7 (8 marks)

Figure 4 shows a diagram on a neuron. Some of the key parts of the neuron are represented by the arrows

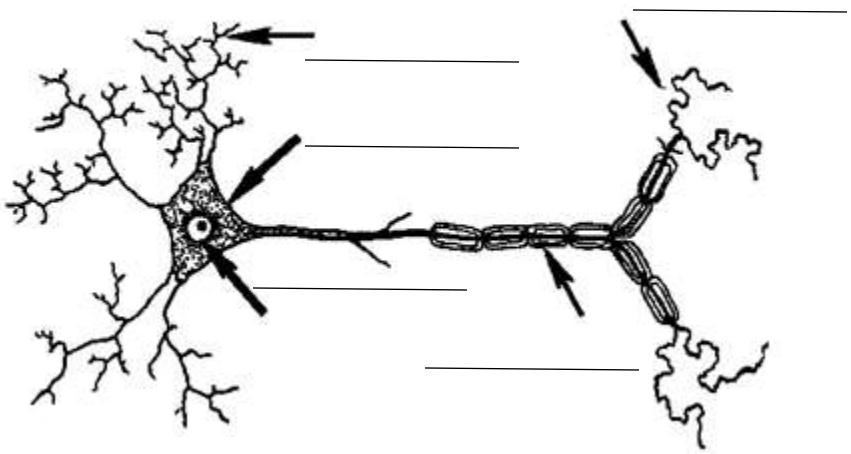


Figure 4

a. Label Figure 4 with the correct components of the neuron

2 marks

b. Where are neurons found?

1 mark

c. Explain how the signal transmitted through the neuron.

2 marks

SECTION C – continued
TURN OVER

d. Neurons are responsible for conveying information in our bodies. There are three types of neurons as listed below. Explain the function of each.

Sensory Neuron

_____

Motor Neuron

_____

Interneuron

_____

3 marks

END OF EXAMINATION

Formula and Data Sheet

Velocity; acceleration	$v = \frac{\Delta s}{\Delta t};\ a = \frac{\Delta v}{\Delta t}$
Equations for constant acceleration	$s = ut + \frac{1}{2}at^2$ $s = vt - \frac{1}{2}at^2$ $s = \frac{1}{2}(u+v)t$ $v = u + at$ $v^2 = u^2 + 2as$
Newton's second law	$a = \frac{F_{net}}{m}$
Torque	$\tau = r_{\perp}F$
Gravitational potential energy changes near the surface of the Earth	$E_g = mg\Delta h$
Force in springs	$F = -k\Delta x$
Elastic potential energy	$E_s = \frac{1}{2}k\Delta x^2$
Kinetic energy	$E_k = \frac{1}{2}mv^2$
Mechanical work	$W = Fd$
Efficiency of energy transfer	$\eta = \frac{\text{useful energy out}}{\text{total energy in}}$
Power	$P = \frac{W}{t}$
Momentum; impulse	$p = m\Delta v;\ I = F\Delta t$
Gravitational field strength near the surface of the Earth	$g = 9.8\ \text{N kg}^{-1}$

Electric power	$V = IR; \quad P = VI$

Speed of light	$c = 3.0 \times 10^8 \text{ m s}^{-1}$
Wave speed	$v = f\lambda$
Doppler shift	$\frac{\Delta\lambda}{\lambda_0} = \frac{v}{c}$
Mass-energy equation	$E = mc^2$
Centre of mass	$x_m = \frac{x_1 m_1 + x_2 m_2 + \ldots + x_n m_n}{m_1 + m_2 + \ldots + m_n}$
Stress	$\sigma = \frac{F}{A}$
Strain	$\varepsilon = \frac{\Delta L}{L}$
Young's modulus	$E = \frac{\sigma}{\varepsilon}$
Transformer	$\frac{N_1}{N_2} = \frac{V_1}{V_2}$
Time constant	$\tau = RC$
Capacitance	$C = \frac{Q}{V}$
Bernoulli's equation	$P_1 + \rho v_1^2 A = P_2 + \rho v_2^2 A$
Lift	$F_L = \frac{1}{2} C_L \rho v^2 A$
Drag	$F_D = \frac{1}{2} C_D \rho v^2 A$
Power	$P = Fv$
Electron volt	$1 \text{ eV} = 1.602\,176 \times 10^{-19} \text{ J}$

Absorbed dose	$\text{absorbed dose} = \dfrac{\text{energy absorbed}}{\text{mass}}$
Equivalent dose	$\text{equivalent dose} = \text{absorbed dose} \times \text{quality factor}$

Snell's law	$n_1 \sin(\theta_1) = n_2 \sin(\theta_2)$
Image position	$\dfrac{1}{f} = \dfrac{1}{u} + \dfrac{1}{v}$
Image size	$\dfrac{H_i}{H_o} = \dfrac{v}{u}$
Sound intensity	$I = \dfrac{P}{4\pi d^2}$
Sound intensity level	$L = 10 \log_{10}\left(\dfrac{I}{1 \times 10^{-12}}\right)$
Coefficient of restitution	$e = \dfrac{v - V}{U - u}$
Linear and angular speed	$v = r\omega$
Rolling friction	$F_k = \mu N$

Metric prefixes

giga- (G)	10^9
mega- (M)	10^6
kilo- (k)	10^3
milli- (m)	10^{-3}
micro- (μ)	10^{-6}
nano- (n)	10^{-9}
pico- (p)	10^{-12}