Exam number:

SHORE

PHYSICS Trial Examination 2021

General Instructions

- Reading time 5 minutes
- Working Time 3 Hours
- Write using black pen
- Draw diagrams using pencil
- Calculators approved by NESA may be used
- Answer Section A on the multiple choice answer sheet provided.
- Answer all other sections on the question Paper.
- Write your **Exam number in ALL spaces provided**

Section I: 20 marks

- Attempt question 1-20
- Allow about 35 minutes for this section

Section II: 80 marks

- Attempt questions 21- 35
- Allow about 2 hours and 25 minutes for this section

Note: Any time you have remaining should be spent revising your answers.

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Section I – 20 marks

Attempt Questions 1-20
Allow about 35 minutes for this part

Use the multiple-choice answer sheet provided for Questions 1-20

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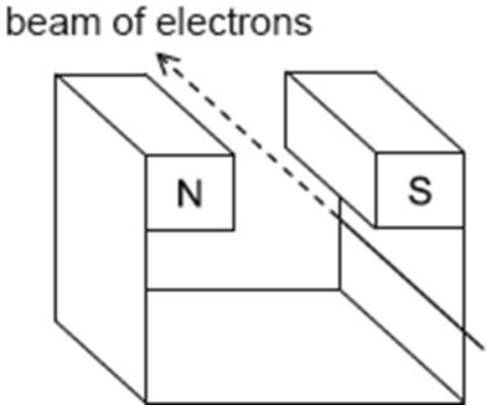
1. A beam of electrons moves between the poles of a magnet.



What is the direction in which the electrons will be deflected?

(A) Downwards

(B) Towards the N pole of the magnet

(C) Towards the S pole of the magnet

(D) Upwards

2. The concept of escape velocity can best be described as:

(A) the initial speed required so that an object will safely orbit the Earth.

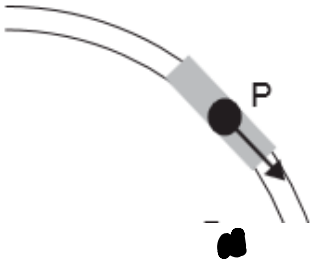
(B) the speed required for an object to be launched and fly through space forever.

(C) the speed necessary for a spacecraft to escape Earth's atmosphere.

(D) the velocity needed to provide an initial kinetic energy such that total mechanical energy is zero.

3. The speed limit for a train taking a curve on level ground is determined by the maximum safe sideways force applied to the rails.

The figure shows a train at position P taking a circular curve of radius 200 m on horizontal ground, at a constant speed of 60 kmh^{-1} which is the speed limit for this section of curved track. The radius of a curve track that has a speed limit 120 kmh^{-1} is:



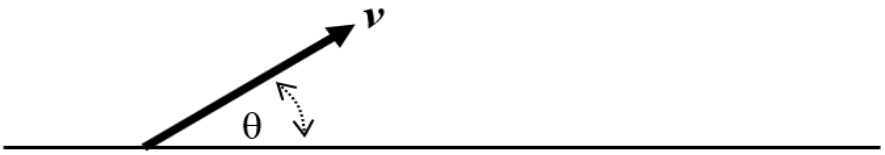
(A) 80 m

(B) 400 m

(C) 600 m

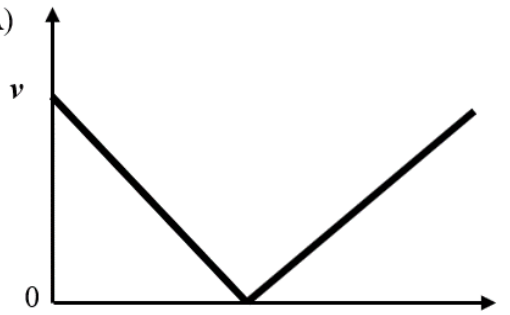
(D) 800 m

4. A projectile is launched with initial speed ***v*** at an angle θ to the horizontal, as shown.

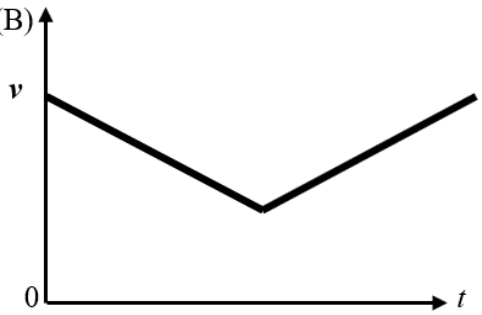


Which graph most closely represents the speed of the projectile during the entirety of its flight?

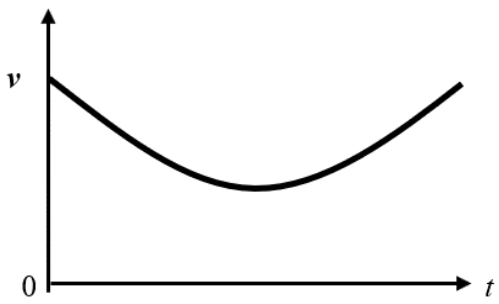
(A)



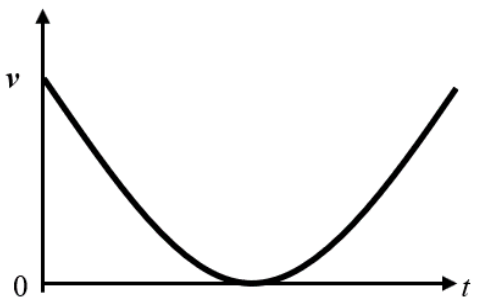
(B)



(C)



(D)



5. What is the magnitude of the gravitational force acting on a 3.50×10^3 kg satellite orbiting a planet when the satellite's orbital radius is 9.17×10^6 m and the satellite's orbital period is 1.50 hours?

(A) 4.34×10^4 N

(B) 5.63×10^{11} N

(C) 4.07 N

(D) 1.24×10^4 N

6. Which of the following was not a major contribution of James Clerk Maxwell?

(A) Proved that EMR exists beyond the visible spectrum.

(B) Unified the fields of Electricity, magnetism and light.

(C) Calculated the speed of light.

(D) Explained how EMR propagates.

7. A light bulb produces unpolarised light and has an intensity of 120 lumens at 0.5 m. Determine the intensity of the light from the bulb after it has passed through a polarising filter that is placed 3.0 m from the bulb.

(A) 6.9 lumens

(B) 12 lumens

(C) 1.7 lumens

(D) 3.3 lumens

8. An electron is accelerated from rest across a vacuum by a potential difference, reaching a velocity of 6.5×10^3 ms^{-1}. It then enters a perpendicular magnetic field of 2.4×10^{-3} T, following a circular path. What is the radius of that path?

(A) 0.154 m

(B) 5.93 m

(C) 1.54×10^{-5} m

(D) 5.93×10^7 m

9. One application of step-up transformers is in the transmission of electrical energy over long distances.

A doubling of voltage in a long distance transmission line while maintaining the same power being transmitted results in:

(A) half the amount of power being lost as heat.

(B) a doubling in the current being transmitted.

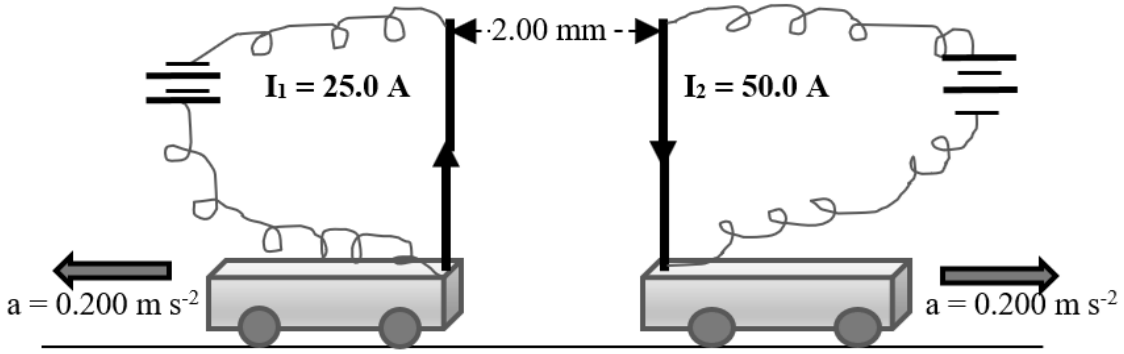
(C) more heat generated in the transmission lines.

(D) a 75% reduction in energy wasted due to the resistance in the transmission lines.

10. Two parallel wires, both 2.00 m long, are placed vertically on two identical frictionless trolleys on a horizontal surface.

When the current is switched on in both wires, the trolleys move away in opposite directions from each other with initial accelerations of 0.200 m s^{-2}.

DIAGRAM NOT TO SCALE



The mass of each trolley is:

(A) 0.625 kg

(B) 1.25 kg

(C) 2.50 kg

(D) 5.00 kg

11. In an investigation into the photoelectric effect, yellow light was shone onto the surface of the cathode.

Which of the following changes would result in an increase in the emitted photo electrons' maximum kinetic energy?

(A) Changing the cathode material to a metal with a lower work function.

(B) Changing yellow light to red light.

(C) Increasing the intensity of the incident yellow light.

(D) Decreasing the distance between the cathode and the anode.

12. Schrodinger's advancement of atomic theory:

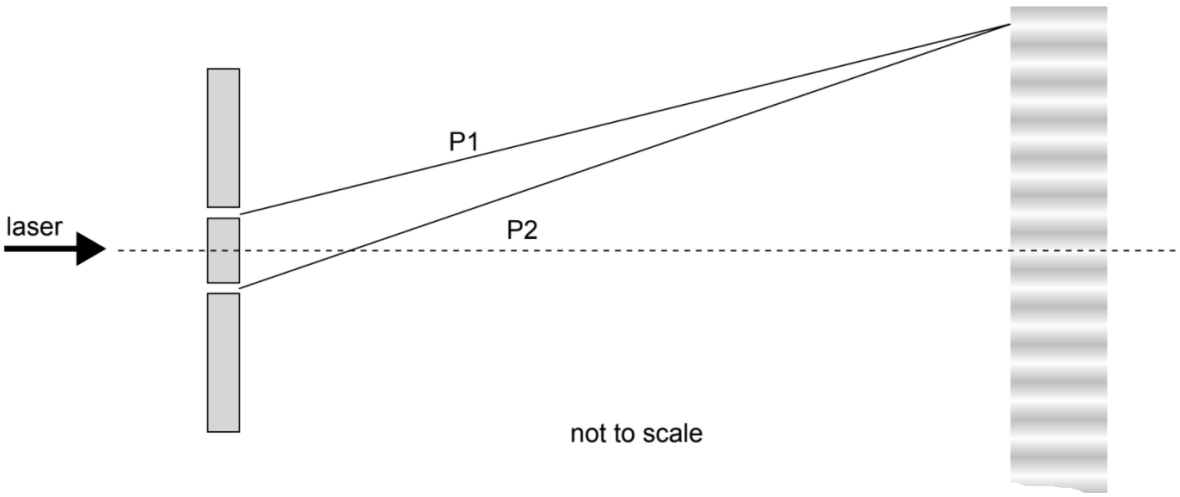
(A) removed the certainty about the position of electrons in their orbits.

(B) provided certainty regarding the position of electrons in their orbits.

(C) showed that electrons are waves.

(D) showed that electrons are not particles.

13. The image below is that seen when observing a demonstration of Young's double slit experiment.



If the laser was changed from green with a wavelength of 532 nm to a red laser of 633 nm wavelength the pattern on the wall would do what?

(A) Stay the same.

(B) The alternating bands of bright light would become brighter.

(C) The alternating bands of bright light would become closer together.

(D) The alternating bands of bright light would become more separated.

14. Two moons of Jupiter, Io and Europa, have respective orbital periods of 1.77 days and 3.55 days. Calculate the orbital radius of Io if Europa has an orbital radius of 671 000 km.

(A) 334 555 km

(B) 421 909 km

(C) 643 618 km

(D) 751 030 km

15. Which investigation or development allowed the mass of the electron to be found?

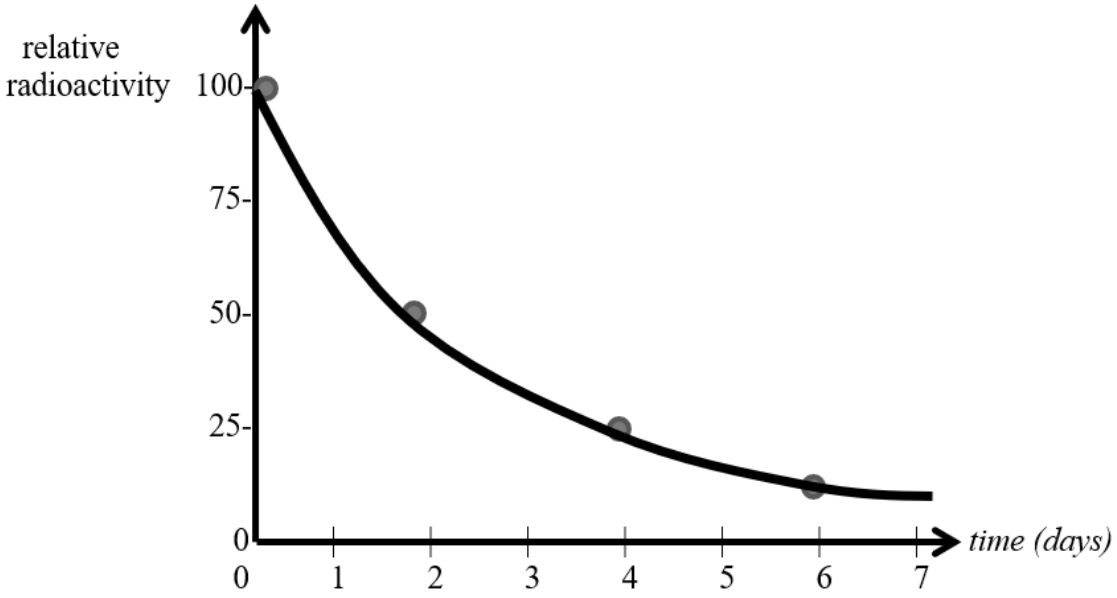
(A) The charge of the proton was found.

(B) The mass of the helium nuclei was found.

(C) Millikan's oil drop experiment.

(D) Rutherford's atomic model was developed.

16. A graph of the decay of a radioactive sample is shown.



The decay constant for this sample is closest to:

(A) $0.34\ s^{-1}$

(B) $4 \times 10^{-6}\ s^{-1}$

(C) $2.0\ s^{-1}$

(D) $6.0\ s^{-1}$

17. In a hypothetical different universe, the Hubble constant is smaller than in our universe.

This implies that the hypothetical universe:

(A) is not sufficiently dense to form stars.

(B) is more compacted than out universe.

(C) did not commence with a Big Bang.

(D) is older than our universe.

18. A nucleus moving at 10 m s^{-1} possesses 1.00 x 10^{-24} J of kinetic energy.

The same nucleus within an electric field of strength 1.00 V m^{-1} experiences an acceleration of 4.79 x 10^{7} m s^{-2}.

How many protons are in this nucleus?

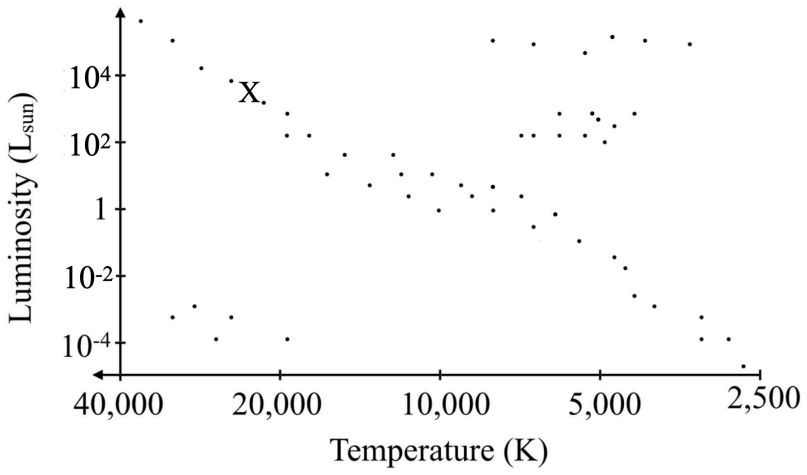
(A) 6

(B) 3

(C) 12

(D) 28

19. The following HR diagram has a star indicated with an X



What is the most likely dominant nucleosynthesis reactions occurring in the core of star X.

(A) Proton-proton with a small amount of CNO

(B) CNO and a small amount of Proton-proton

(C) Proton-proton with a small amount of Triple Alpha

(D) CNO with a small amount of Triple Alpha

20. Given the mass of a helium nucleus is 4.002602 amu, and the Sun produces

3.85×10^{26} W of radiant power, how many helium nuclei are produced in the Sun each second?

(A) 4.278×10^{9}

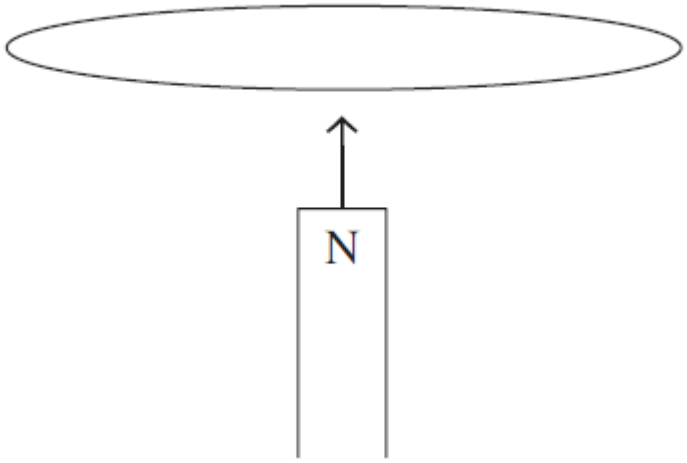
(B) 8.97×10^{37}

(C) 4.3678×10^{-29}

(D) 3.85×10^{26}

Extra Question

21. The North pole of a magnet is moved upwards towards a stationary horizontal coil, as shown in the diagram.



Which of the following statements is correct?

(A) When viewed from above, the induced current in the coil will flow anti-clockwise.

(B) When viewed from above, the induced current in the coil will flow clockwise.

(C) There will be no induced current in the coil.

(D) When viewed from above, the induced current in the coil will flow perpendicular to the movement of the magnet.

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Exam number:

Section II – 80 marks

Attempt Questions 21–35

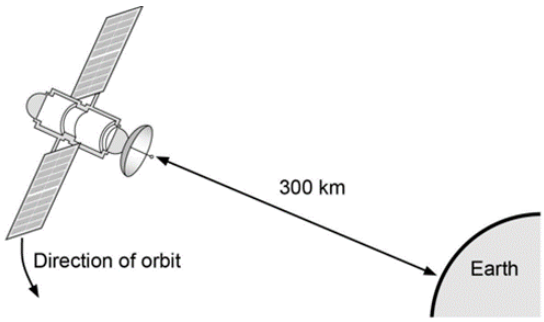
Allow about 2 hours and 25 minutes for this part

Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.

Show all relevant working in questions involving calculations.

Question 21 (7 marks) **Marks**

A 100 kg satellite is placed into a near circular orbit with an average path radius of 6.671×10^6 m around the Earth.



(a) Calculate the period of the satellite. **2**

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(b) Calculate the speed of the satellite. **2**

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Question 21 continues on the next page

Question 21 (continued) **Marks**

(c) Explain why a satellite of 1000 kg with the same distance from the centre of the Earth would have the same period. **3**

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Question 22 (3 marks)

The carbon-oxygen-nitrogen (CNO) cycle occurs in stars that are at least 1.3 times heavier than the Sun. The first step in the cycle can be represented by the nuclear fusion equation.

$$^{12}_{6}C + ^{1}_{1}H \rightarrow ^{13}_{7}N + \gamma$$

The exact masses of these isotopes are shown in the table.

Isotope	Exact mass (u)
$^{12}_{6}C$	12.000
$^{1}_{1}H$	1.0078
$^{13}_{7}N$	13.057

Using the equation, calculate the energy released during of the first step of the CNO cycle in joules. **3**

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Exam number:

Question 23 (6 marks) **Marks**

Einstein needed to make two assumptions in his development of the special relativity theory. They are his postulates:

- the speed of light in a vacuum is an absolute constant
- all inertial frames of reference are equivalent

Discuss how the discovery of muons (0.99c) at the Earth's surface is supporting evidence that the postulates are true. The half-life of a muon at rest is 2.2×10^{-6} s. **6**

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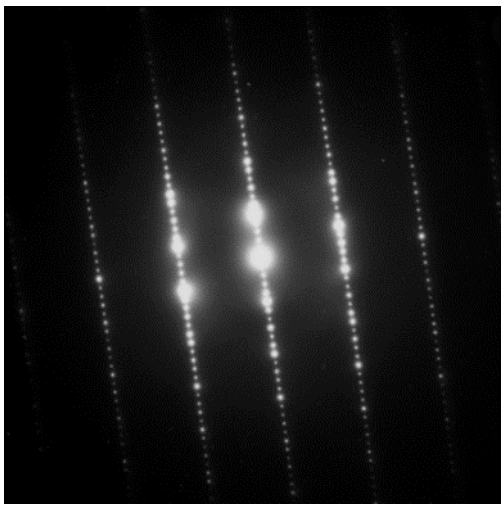
Exam number:

Question 24 (6 marks) **Marks**

The image below shows a typical pattern obtained in a transmission electron microscope and is produced by a parallel beam of high-speed electrons interacting with a crystalline substance.



(a) Discuss the implications of this pattern for the failure of classical physics to explain the properties of the electron. **3**

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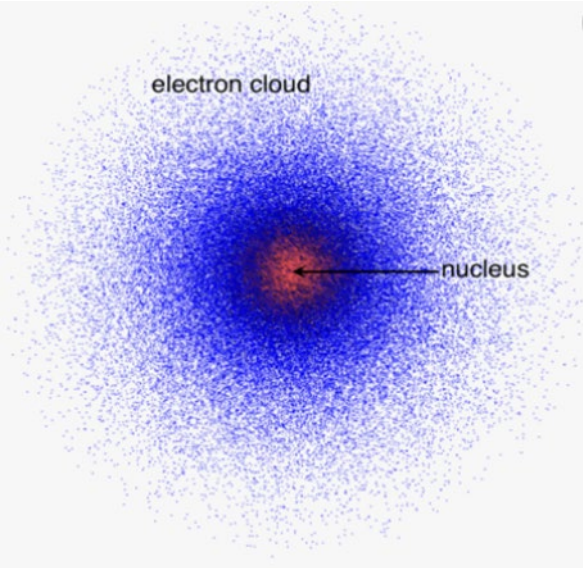
Question 24 continues on the next page

Exam number:

Question 24 (continued) **Marks**

(b) The image below shows a representation of the Schrodinger model of the atom.



Analyse Schrodinger's contribution to this advanced understanding of the model of the atom. **3**

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Exam number:

Question 25 (5 marks) **Marks**

Fred is playing tennis. He services the ball so that it leaves the racket 3.2 *m* above the ground. The ball leaves the racket at an angle of 8 degrees to the horizontal as shown. At its maximum height the ball has a speed of 20 ms^{-1}.

(a) At what speed, relative to the ground, did the ball leave Fred's racket? **1**

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(b) At what horizontal distance from the point where the ball leaves the racket will it hit the ground? **4**

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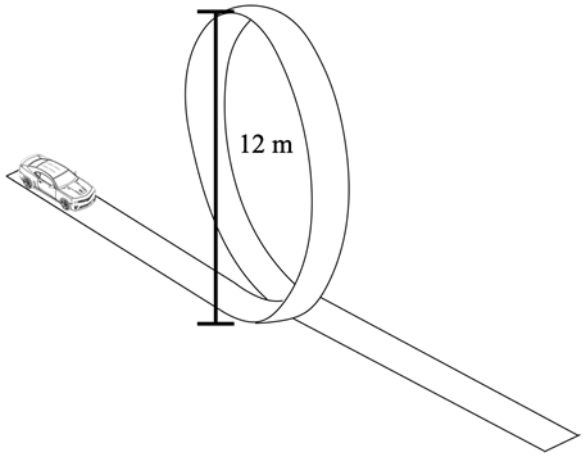
Exam number:

Question 26 (3 marks) **Marks**

A 1100 *kg* car with a 75 *kg* driver are attempting a loop de loop at a stunt car rally. If the diameter of the loop is 12 *m* as shown in the diagram, what speed must the car travel so that the driver feels a normal force, at the peak of the loop, equivalent to his weight force.



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Exam number:

Question 27 (8 marks) **Marks**

(a) Describe how a transformer works and explain how the iron core increases efficiency. **4**

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(b) A transformer is supplied with 20 000 V and 100 A. The voltage output of the transformer is 12 400 V. If the transformer has an efficiency of 90%, determine the output current. **4**

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Exam number:

Question 28 (4 marks) **Marks**

Compare Back emf to the current produced in a generator. **4**

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Question 29 (4 marks)

Explain how a star's translational velocity can be deduced. **4**

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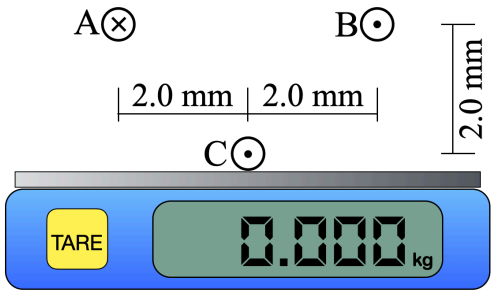
Exam number:

Question 30 (5 marks) **Marks**

Three conductors are set up so that their cross sections are shown below. Conductor A and B are fixed, and conductor C is fixed to the surface of a tarred scales. All three conductors run parallel to each other for 10 cm.



A current of 120 A is run through conductor A into the page whilst a current of 80 A is run through conductor B and C out of the page.

Determine the reading on the scale. **5**

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Exam number:

Question 31 (9 marks) **Marks**

Discuss how three historical experiments that probed the atom were made possible by known scientific principles and ideas. **9**

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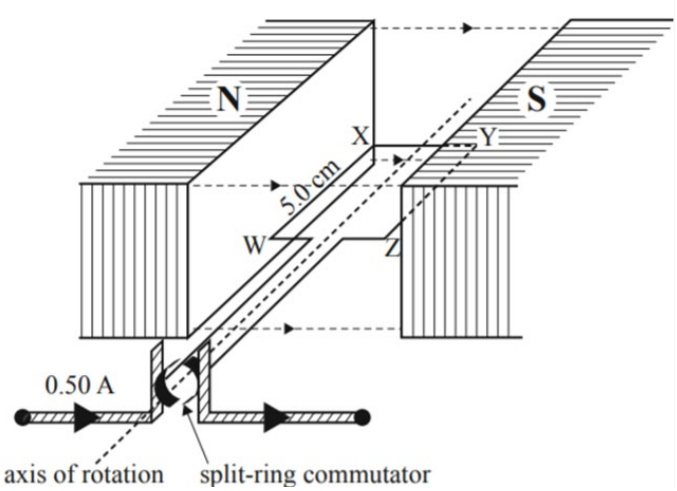
Exam number:

Question 32 (6 marks) **Marks**

A model representing a motor is shown below.



(a) Describe what would happen to the motor if it was connected to an AC supply. **3**

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(b) What modification would be required to turn the motor into an AC motor? **1**

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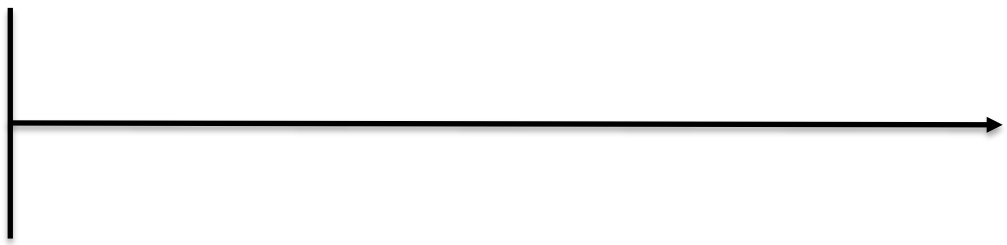
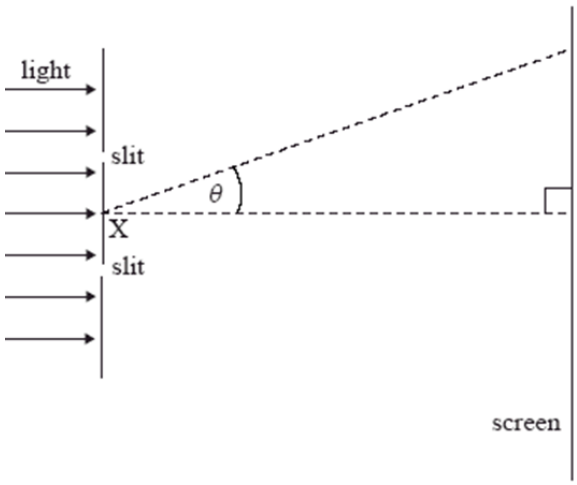
(c) On the axis below, draw the output voltage that would be displayed on an oscilloscope screen by rotating the motor coil through three full turns at a constant speed **starting from a position which is 90º from that shown in the diagram.** **2**



Exam number:

Question 33 (6 marks) **Marks**

Monochromatic, coherent light is incident on two narrow parallel slits whose widths are small compared to their separation. After passing through the slits the light is brought to a focus on a screen producing interference fringes. Point X is the midpoint of the slits.



The angular position of a point on the screen is determined by the angle θ.

(a) Explain why the intensity of light at $\theta = 0$ will be a maximum. **2**

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(b) The wavelength of light is 6.80×10^{-7} m and the separation of the slits is 1.13×10^{-4} m. Show that for the first order maximum $\theta = 6.02 \times 10^{-3}$ rad. **1**

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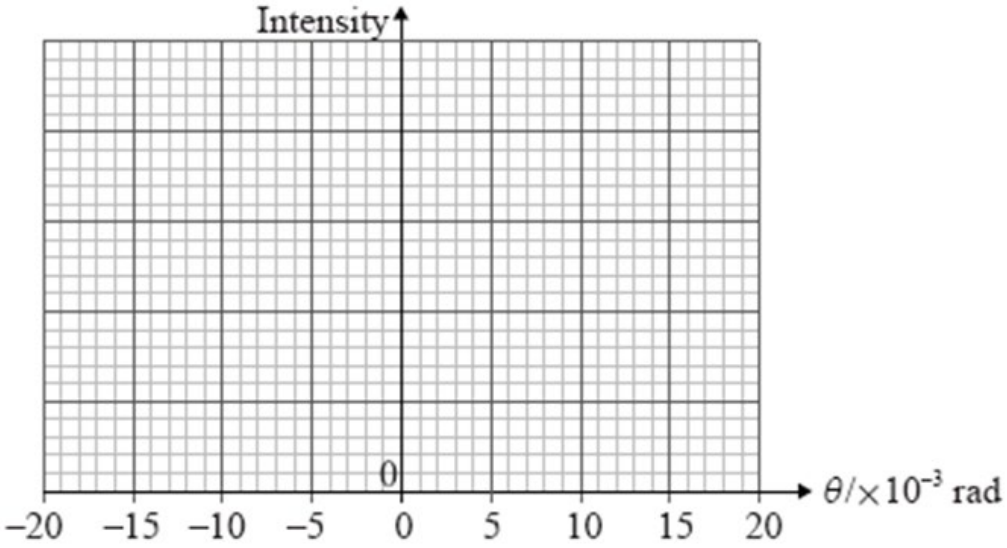
Question 33 continues on the next page

Exam number:

Question 33 (continued) **Marks**

(c) On the axes below draw a graph to show how the intensity of light observed on the screen varies with angle θ. (You do not have to put numbers on the vertical axis.) **3**



Question 34 (3 marks)

Light takes 4.3 years to reach the Earth from the star Alpha Centauri. A space probe is to be sent from the Earth to the star to arrive 5.0 years later, according to observers on Earth. **3**

Assuming that the speed of the probe is constant, calculate the time taken for this journey, in years, that would be registered by a clock on the space probe.

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Exam number:

Question 35 (5 marks) **Marks**

(a) Calculate the energy of a photon of wavelength 415nm. **2**

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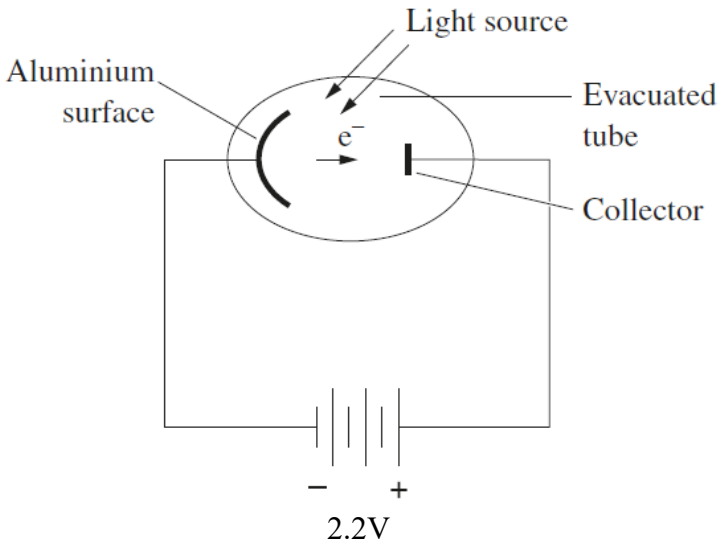
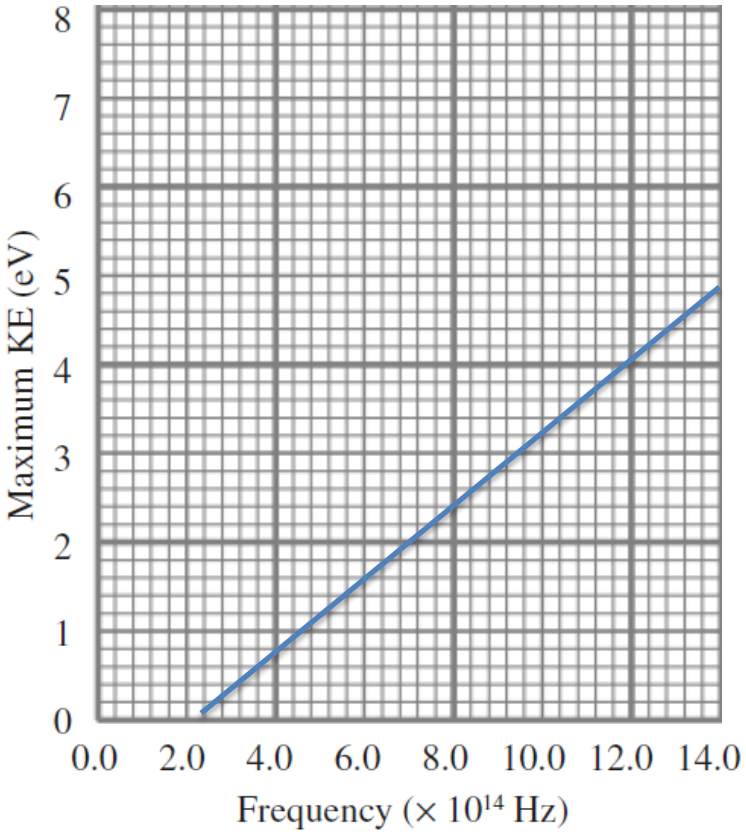
(b) An experiment was conducted using a photoelectric cell as shown in the diagram.



Question 35 continues on the next page

Question 35 (continued) **Marks**

The graph plots the maximum kinetic energy of the emitted photoelectrons against radiation frequency for the aluminium surface.



The experiment is planned to be repeated using a voltage of 0.0V

(i) Draw a line on the graph to show the predicted results of the planned experiment. **2**

(ii) The voltage was then reset to 2.2V. Determine the radiation frequency which would produce photoelectrons with a maximum kinetic energy of 1.2 eV. **1**

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Exam number:

END OF EXAM

SHORE PHYSICS

2021 TRIAL

ANSWERS AND SUGGESTED MARKING SCHEME

Section I – 20 Marks

QUESTION	1	2	3	4	5	6	7	8	9	10
ANSWER	D	D	D	C	A	B	C	C	D	B

QUESTION	11	12	13	14	15	16	17	18	19	20
ANSWER	A	A	D	B	C	B	D	A	B	B

Section II – 20 Marks

Question 21a (2 marks)

Criteria	Marks
A correct calculation	2
A partially correct calculation	1

Sample answer

$$\frac{r^3}{T^2} = \frac{GM}{4\pi^2}$$

$$T = \sqrt{\frac{r^3 \; x \; 4 \; \pi^2}{GM}}$$

$$T = \sqrt{\frac{(6.671 \; x \; 10^6)^3 \; x \; 4 \; \pi^2}{6.67 \; x \; 10^{-11} \; x \; 6.0 \; x \; 10^{24}}}$$

T = 5412 s

Question 21b (3 marks)

Criteria	Marks
Equates centripetal force and gravitational force experienced by the satellite Demonstrates the cancellation of common factors Recognises the implication that v is independent of mass	3
Equates centripetal force and gravitational force experienced by the satellite Demonstrates the cancellation of common factors	2
Equates centripetal force and gravitational force experienced by the satellite	1

Sample answer

The satellite can be assumed to be in circular motion and the centripetal force experienced by the satellite can be equated to the gravitational force experienced by the satellite.

Therefore

$$\frac{m_{sat}\, v^2}{r_{sat}} = \frac{G\, m_{sat}\, M_{Earth}}{r_{sat}^2}$$

cancelling the mass of the satellite that appears on both sides of the equation and multiplying both sides of the equation by r_{sat} leads to

$$v^2 = \frac{GM_{Earth}}{r_{sat}}$$

or

$$v = \sqrt{\frac{G\, M_{Earth}}{r_{sat}}}$$

thus, the velocity of the satellite is independent of the mass of the satellite. Therefore, since the velocity at attitude r_{Sat} is independent of mass, satellites at attitude r_{Sat} most also have the same period of orbit.

Question 22 (2 marks)

Criteria	Marks
Correctly calculation of mass defect and energy released in Joules.	**2**
One error of logic/substitution	**1**

$\Delta m = initial\ mass - final\ mass = (12.000 + 1.0078) - (13.057) = 0.0021$ u

Hence, this is equivalent to

$E = \Delta mc^2 = 0.0021 \times 931.5 = 1.956$ MeV $= 1.956 \times 10^6 \times 1.602 \times 10^{-19} = 3.1 \times 10^{-13} J$

Question 23 (5 marks)

Criteria	Marks
Detailed analysis of muons as supporting evidence to Einstein's postulates with comprehensive relevant calculations	5
Analysis of muons as supporting evidence to Einstein's postulates with relevant calculations	4
Explains relevant information about muons OR Einstein's postulates with some relevant calculations	3
Limited analysis of relevant information about muons OR Einstein's postulates **OR** Limited analysis using relevant calculations	2
Outlines relevant information about muons OR Einstein's postulates	1

Sample answer

The Earth is constantly bombarded by energetic radiation from space, known as cosmic radiation. These rays collide with the upper atmosphere, producing particles known as muons. The average lifetime of a muons in the laboratory is 2.2×10^{-6} s. Given the speed at which they travel and the distance they travel through the atmosphere, the vast majority of muons would decay before they hit the ground.

Without relativistic time dilation, the muon would have travelled a distance (as measured by ground observers) of only $0.99 \times 3 \times 10^8 \times 2.2 \times 10^{-6}$ m = 0.653 km before decaying. Therefore, the muon would not be detected at ground level.

However, because of relativistic effects, muon are able to reach the ground before decaying. At a speed of 0.99c, the lifetime of the muon as measured by the ground observer is

$$time\ interval = \frac{\text{proper time}}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{2.2 \times 10^{-6} s}{\sqrt{1 - 0.99^2}} = 1.56 \times 10^{-5} s$$

In this time the muon travels a distance (as measured by ground observers) of

$$0.99 \times 3 \times 10^8 \times 1.56 \times 10^{-5} \text{ m} = 4.63 \text{ km}$$

A similar argument could be made for length contraction from the frame of the muon.

This means that the muon reaches the surface of the Earth before decaying due to time dilation and length contraction. That muons do make it to the surface of the Earth is evidence in support Einstein's theory of Special Relativity.

Question 24 (3 marks)

Criteria	Marks
Identifies the features of the Schrödinger model Describes the implications of the model for locating an electron around a nucleus	3
Identifies the features of the Schrödinger model **OR** Describes the implications of the model	2
Identifies relevant information about Schrödinger model	1

Sample answer

The Schrödinger model assumes that the electron is a wave and tries to describe the regions in space, or orbitals, where electrons are most likely to be found. Instead of trying to tell us where the electron is at any time, the Schrödinger model describes the probability that an electron can be found in a given region of space at a given time. This model no longer tells us where the electron is but it tells us where it might be. Where the cloud is most dense in the figure, the probability of finding the electron is greatest, and conversely, the electron is less likely to be in a less dense area of the cloud.

Question 25a (2 marks)

Criteria	Marks
Correctly equation and substitution to calculate photon energy (in J OR eV)	2
One error of logic/substitution	1

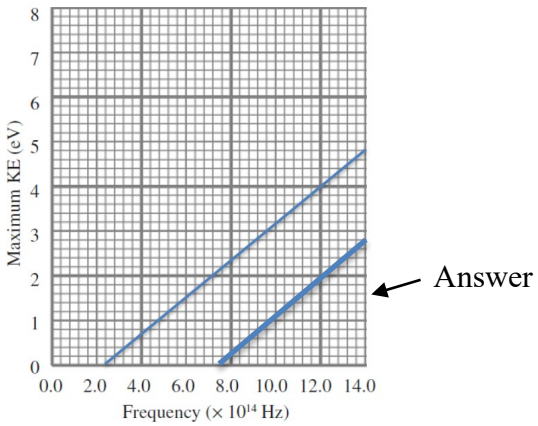
Sample Answer

$$E = \frac{hc}{\lambda} = \frac{6.626\times10^{-34}\times3\times10^{8}}{415\times10^{-9}}$$
$$= 4.79\times10^{-19}\,J$$

Question 25b(i) (2 marks)

Criteria	Marks
Correct slope AND correct intercept (7.6 x 10^{14}Hz – accept 7.2 – 8.0)	2
Correct slope OR correct intercept	1

Sample Answer



Question 25b(ii) (1 mark)

Criteria	Mark
Correct answer (accept 4.8 – 5.2 x 10^{14}Hz)	**1**

Sample Answer

$5.0\times10^{14}\,Hz$

Section III – 30 Marks

Question 26a (1 mark)

Criteria	Mark
Correct calculation Provides relevant working	1

Sample answer

$$cos\, 8^0 = \frac{20}{v}$$

$$v = \frac{20}{cos\, 8^0} = 20.2\, ms^{-1}$$

Question 26b (3 marks)

Criteria	Marks
Correct answer Provides relevant and correct working	3
Provides relevant and correct working with a calculation error	2
Provides some relevant and correct working	1

Sample answer

$a_y = -9.8\, ms^{-2}$
$y = -3.0\, m$
$u_y = 20 \times\ tan\, 8^0 = 2.81\, ms^{-1}$

$v_y^2 = u_y^2 + 2ay = (2.81)^2 + 2 \times (-9.8) \times -3.0 = 66.7$

$v_y = \sqrt{66.7} = \ -8.17\, ms^{-1}$

Time of flight

$$t = \frac{v_y - u_y}{a} = \frac{-8.17 - (2.81)}{-9.81} = 1.12\, s$$

$Range = u_x\, t = 20 \times 1.12 = 22.4\, m$

Question 27 (4 marks)

Criteria	Marks
Correctly calculates the value on the scales in kg.	4
Calculates the y components of the two forces **OR** Calculates correctly the forces applied by A and B	3
Identifies correct formula and correctly substitutes correct values into formula	2
Correctly calculates distance between wires	1

Sample answer:

$F_{ACy} = \frac{\mu_0}{2\pi}\frac{I_1 I_2}{r} l \sin\theta$

$F_{ACy} = 2 \times 10^{-7} \times \frac{120 \times 80}{0.003} \times 0.1 \sin 45$

$F_{ACy} = 0.048 \text{ N}$

$F_{BCy} = \frac{\mu_0}{2\pi}\frac{I_1 I_2}{r} l \sin\theta$

$F_{BCy} = 2 \times 10^{-7} \times \frac{80 \times 80}{0.003} \times 0.1 \sin 45$

$F_{BCy} = 0.032 \text{ N}$

$F_c = 0.048 - 0.032$

$F_c = 0.016 \text{ N}$

Therefore, the reading on the scales would be 0.002 kg

Question 28 (7 marks)

Criteria	Marks
Describes in detail three experiments and fully explains the necessity of scientific principles or ideas for three historical experiments that probed the atom.	7
Describes three experiments and explains the necessity of scientific principles or ideas for historical experiments that probed the atom.	5-6
Limited description of three experiments and explains some of the necessity of scientific principles or ideas for historical experiments that probed the atom.	3-4
Identifies experiments and provides some explanation of the necessity of scientific principles.	1-2

Sample answer:

J.J. Thompson conducted an experiment to measure the charge to mass ratio of an electron using the ideas developed by Faraday and Lorentz. He passed a cathode ray through an electric field and a magnetic field that were perpendicular to each other. The two fields in this arrangement caused deflection of the ray in opposite directions. By adjusting the strength of the two fields the forces acting on the ray were brought into equilibrium and the ray was not deflected. Thompson was able to then equate the known scientific principles of electric field strength and the force on a moving charged particle in a magnetic field. By further introducing the principle of centripetal force he was able to derive a value for the charge to mass ratio and definitively confirm the particulate nature of cathode rays.

Robert Millikan used the known scientific principles of Lorentz and Newton to calculate the charge of an electron. He introduced oil drops between two charged metal plates. Using the known oil density, mass of the droplets was determined from their observed radii. Charged drops became suspended between plates when the force of gravity was equal to the electric force between the plates. By equating the known force of an electric field developed by Lorentz, and the force of gravity developed by Newton, Millikan was able to produce an expression for the charge of the drops. The charge on a drop was always a multiple of 1.6×10^{-19} C.

James Chadwick conducted an experiment to reveal the properties of neutrons based on work developed by Curie, Bothe and Becker, and the Joliots. Chadwick bombarded Beryllium with alpha particles to cause unstable nuclei to emit radiation (neutrons). The radiation passed through Hydrogen rich paraffin, ejecting protons. The protons kinetic energy was measured. Using the scientific principle of the law of conservation of momentum Chadwick deduced that the radiation was particles with no charge and a similar mass to protons.

Question 29a (3 marks)

Criteria	Marks
Identifies the motor coil will not rotate Describes that the motor would vibrate and heat energy would result	3
Identifies the motor coil will not rotate **OR** Describes that the motor would vibrate and heat energy would result	2
Identifies relevant information about the motor	1

Sample answer

The motor would not rotate at all and would start humming and would create vibrations, as a torque produced by positive and negative cycle of the AC would cancel out each other. DC motor would be heated up.

Question 29b (1 mark)

Criteria	Mark
Statement that the split ring commutator must be replaced with a pair of slip rings	1

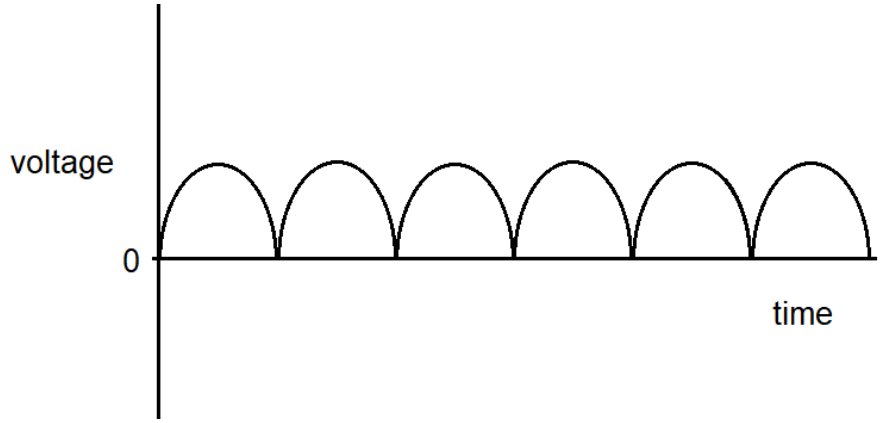
Sample answer

The replacement of the split ring commutator with a pair of slip rings.

Question 29c (2 marks)

Criteria	Marks
Correct shaped commencing at 0 V output with correct number of crests	2
Correct shaped wave	1

Sample answer



Question 30a (2 marks)

Criteria	Marks
Light from slit 1 and slit 2 has travelled the same distance Light will arrive in phase and constructively interfere causing a maximum	2
Light from slit 1 and slit 2 has travelled the same distance	1

Sample Answer
At $\vartheta = 0$, the light from slit 1 and slit 2 have travelled the same distance they will incident on the screen in phase. Therefore, will constructively interfere and a maximum will be observed on the screen.

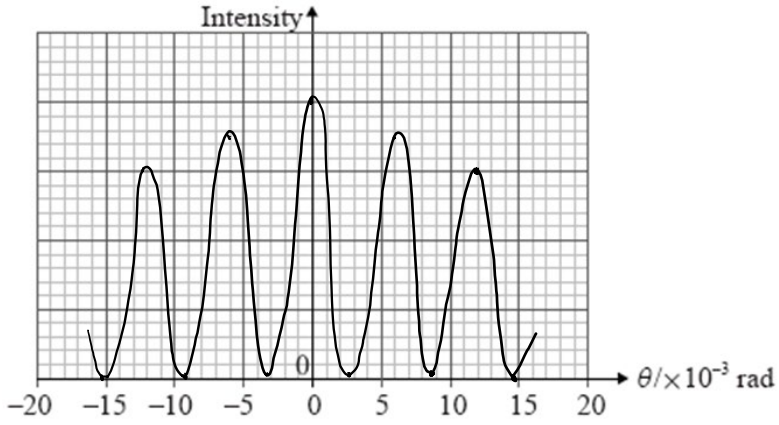
Question 30b (1 mark)

$d \sin\theta = n\lambda$

$$\theta = sin^{-1}\left(\frac{1 \times 6.8 \times 10^{-7}}{1 \cdot 13 \times 10^{-4}}\right) = 0 \cdot 344^{0} x \frac{\pi}{180} = 6.02 \times 10^{-3} rad$$

Question 30c (3 marks)

Criteria	Marks
Correct max intensities at correct angles **AND** decreasing intensities **AND** symmetrical around $\theta = 0$	3
Any TWO: max intensities at correct angles **OR** decreasing intensities **OR** symmetrical around $\theta = 0$	2
Any ONE: max intensities at correct angles **OR** decreasing intensities **OR** symmetrical around $\theta = 0$	1



Question 31 (3 marks)

Criteria	Marks
Calculates the correct time in years	**3**
Identifies proper time AND Correctly calculates the velocity of the space probe	**2**
Calculates the velocity of the space probe	**1**

$t = 5.0\ yr, \quad d = 4.3\ ly$

$$v = \frac{d}{t} = \frac{4.3}{5.0} = 0.86c$$

$$t_0 = t\sqrt{1 - \frac{(0.86c)^2}{c^2}} = 5.0\sqrt{1 - (0.86)^2} = 2.55\ yr$$