
NESA STUDENT NUMBER

2023

Year 12 Physics

Trial Examination

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.
- A data sheet, formulae sheet and Periodic Table are provided.

Total marks: 100

Section 1 – **Multiple Choice** **20 marks**
- Attempt Questions 1–20

Section 2A – **Written Response** **20 marks**
- Attempt Questions 1–4

Section 2B – **Written Response** **20 marks**
- Attempt Questions 1–4

Section 2C – **Written Response** **40 marks**
- Attempt Questions 1–6

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Section 1

20 marks

- Attempt Questions 1–20.
- Use the multiple-choice answer sheet at the **back of Section 2A** to answer the multiple-choice questions for Section 1.

S1

Question 1 (1 mark)

Three identical balls are thrown off the edge of a cliff with the same speed. Ball **X** is thrown vertically upward, ball **Y** is thrown horizontally, and ball **Z** is thrown vertically downward.

If the base of the cliff is flat and air resistance is negligible, which ball will hit the ground with the highest speed?

(A) Ball **X**.

(B) Ball **Y**.

(C) Ball **Z**.

(D) All three balls will hit the ground with the same speed.

Question 2 (1 mark)

How did Newton's particle theory of light explain refraction?

(A) Gravitational attraction to the more densely arranged particles changed the direction of travel of the light particles.

(B) The light particles slowed down as they enter the denser medium.

(C) Newton theorised that the impurities in the poor-quality glass of the time caused errors in the measurements that he made.

(D) The light particles scattered in the medium because the medium particles were closer together than the air particles.

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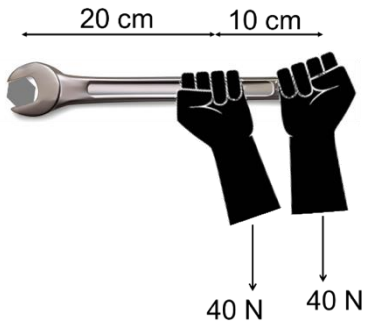
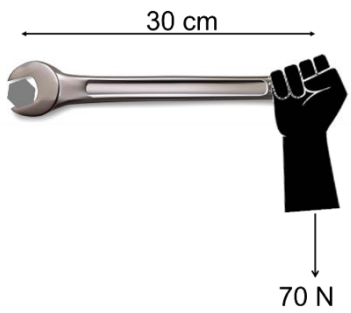
Question 3 (1 mark)

Identify the situation in which the greatest torque is being applied to the 30 cm spanner.

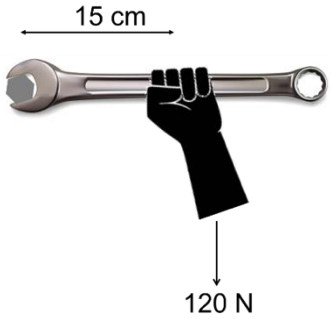
(A)



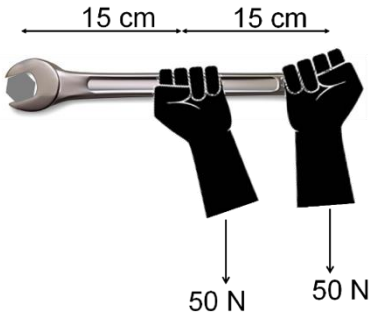
(B)



(C)



(D)



Question 4 (1 mark)

A radioactive source is placed 1 cm from a Geiger-Muller tube, and various absorbers are placed between them, one at a time.

For each material, a one-minute count is taken of the total number of decays (measured in counts per minute), and this is repeated several times. The table shows the average results of the experiment.

Material	Radiation counts (counts per minute)
None	1043
0.1 mm paper	1040
1 mm aluminium	497
1 cm lead	6

Prior to starting the experiment, the average background radiation measured is 5 counts per minute.

What nuclear radiation do the results suggest the source was emitting?

(A) Alpha only

(B) Beta only

(C) Alpha and beta

(D) Alpha, beta and gamma

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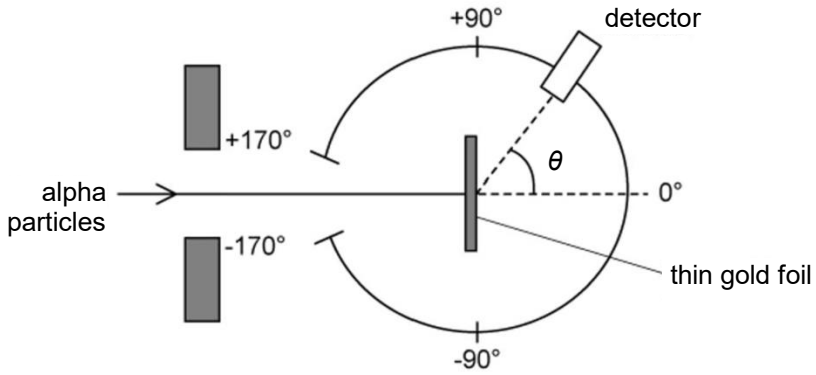
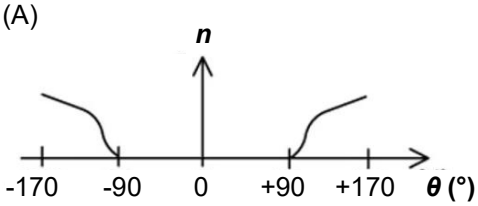
Question 5 (1 mark)

Michael set up an alpha particle scattering experiment, as shown in the diagram below, to determine the number of α-particles incident per unit time on a detector held at various angles, θ.

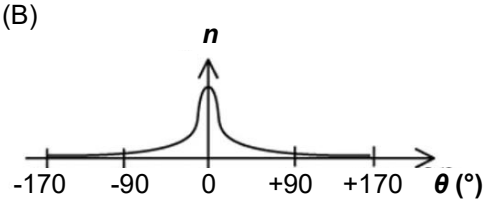


Which of the following graphs best represents the number of α-particles detected per unit time with θ?

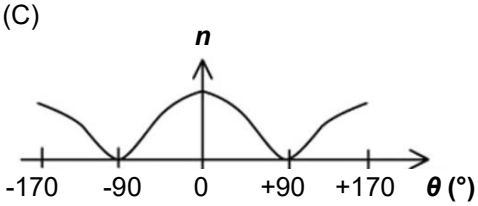
(A)



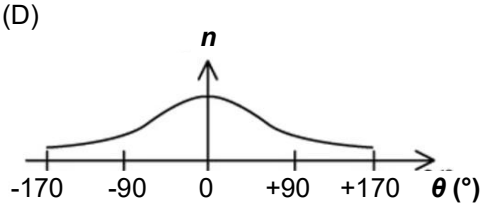
(B)



(C)



(D)



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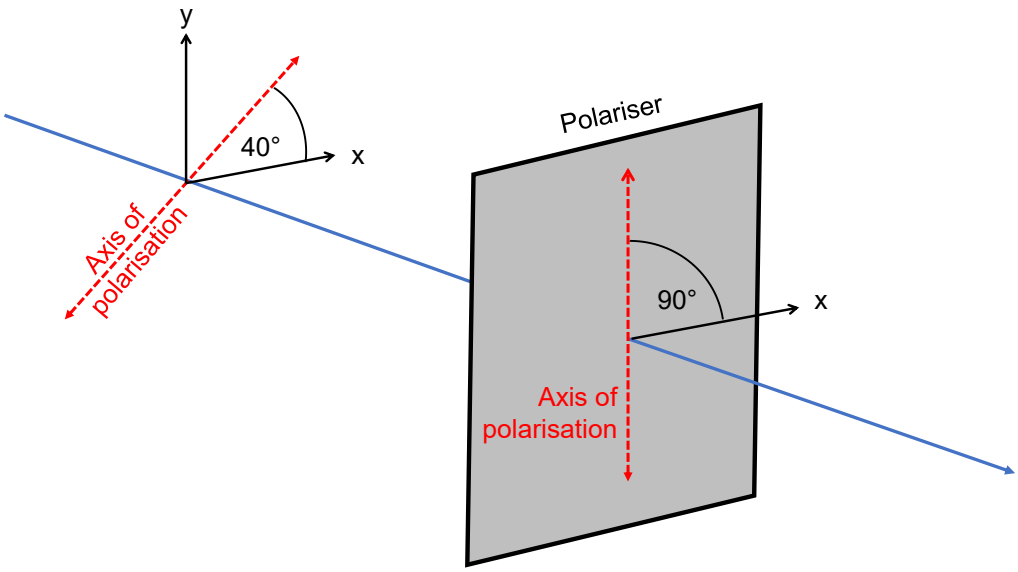
Question 6 (1 mark)

A polarised light source is entering a polarising filter as shown below.



What adjustment would produce the greatest reduction in light intensity?

(A) Rotating the light source clockwise by 60°.

(B) Rotating the light source counter-clockwise 50°.

(C) Rotating the filter clockwise by 130°.

(D) Rotating the filter counter-clockwise by 200°.

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Question 7 (1 mark)

The muon decay experiment served a part of the evidence for Einstein's theory of special relativity.

The observations made in this experiment suggested that:

(A) the time experienced by the muons to make their journey is dilated so their half-life increases.

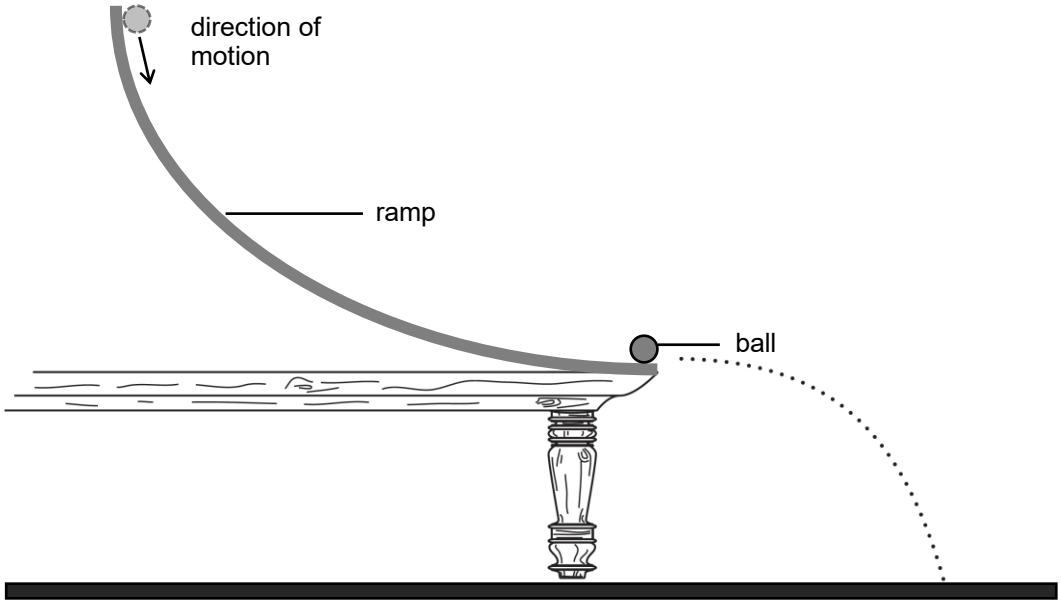
(B) due to their extremely high velocity muons have a shorter half-life than they would in a laboratory.

(C) the length of the muons contracts according to observers on Earth so that the distance they need to travel from the upper atmosphere to the Earth's surface appears to be relatively longer.

(D) the muons experience a journey of shorter distance from the upper atmosphere to the Earth's surface than is observed from Earth's rest frame.

Question 8 (1 mark)

A ball is rolled down a ramp as shown in the diagram below.



Question 8 continues on the next page

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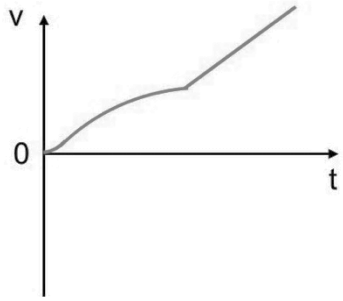
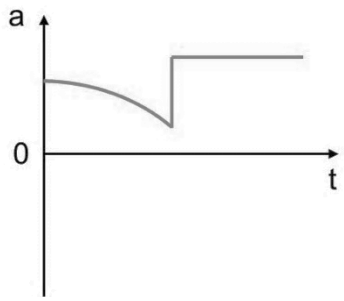
Question 8 continued…

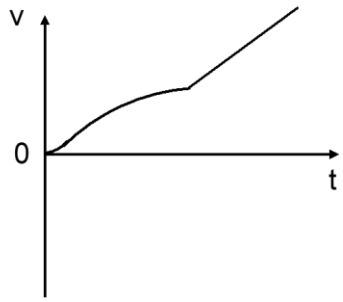
Which of the following pairs of graphs below best describes the velocity and acceleration of the ball as a function of time?

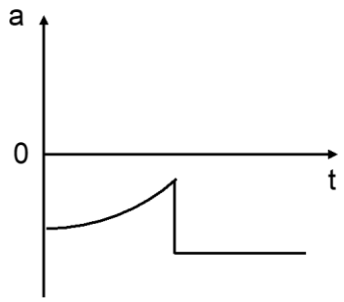
(A)



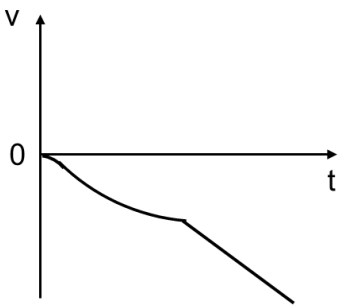


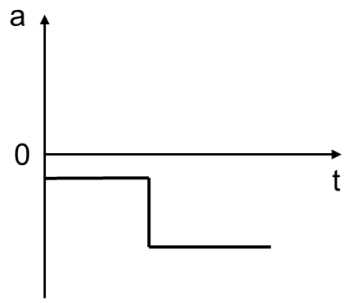
(B)



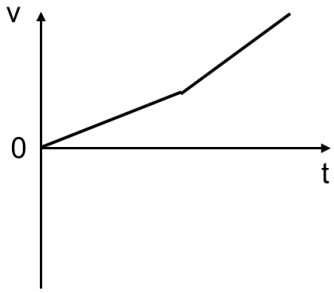


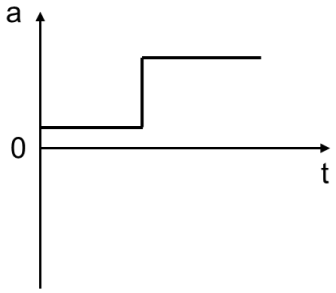
(C)





(D)





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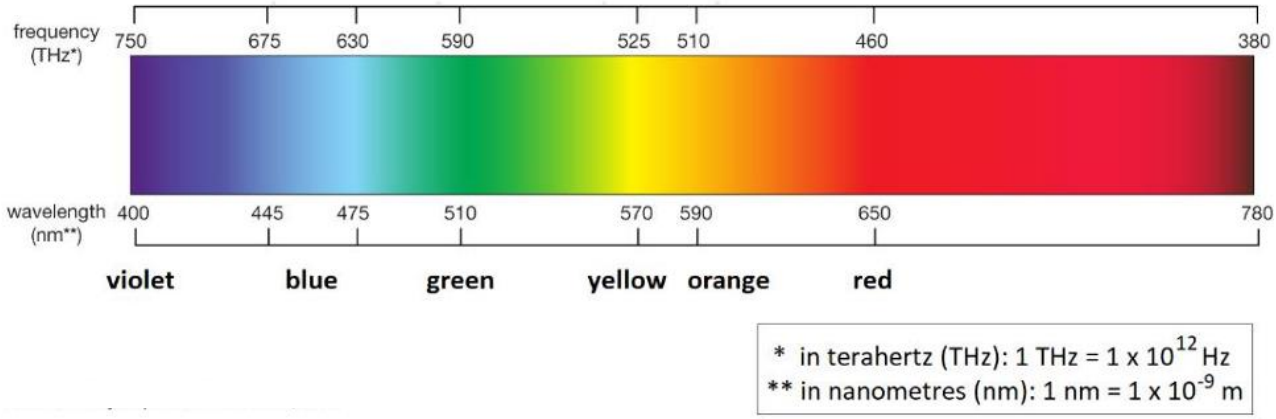
Question 9 (1 mark)

The star CX-234 can be considered an ideal black body. It has a surface temperature of about 6400 K.



Using the above diagram and any relevant calculations, determine the colour of CX-234 is most likely to have in the night sky.

(A) Red

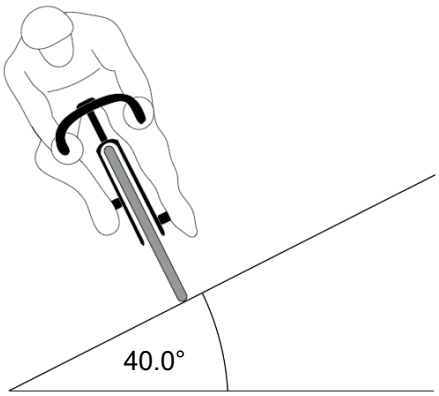
(B) Yellow

(C) Blue

(D) Invisible to the naked eye (ultraviolet)

Question 10 (1 mark)

A speedy Physics teacher is riding a bike along a section of a cycling track where sharper turns are made. The section of the track has a horizontal radius of 20.0 m and is banked at 40.0° to the horizontal.



Calculate the speed he can travel at to maintain a horizontal radius of 20.0 m without the use of friction.

(A) 3.6 km h^{-1}

(B) 12.8 km h^{-1}

(C) 45.9 km h^{-1}

(D) 46.2 km h^{-1}

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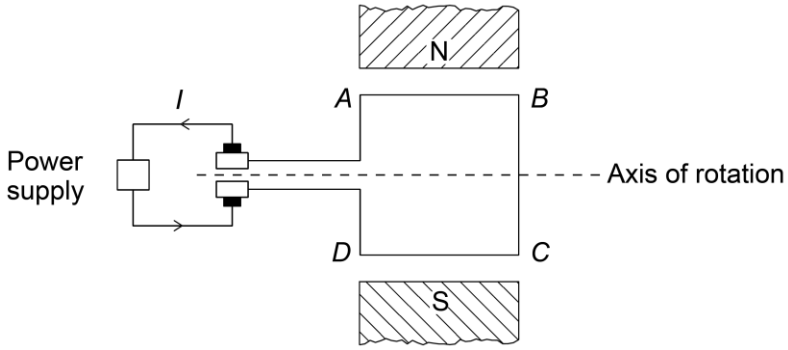
Question 11 (1 mark)

A simple DC motor is connected to a battery. The armature of the motor consists of 50 turns of wire which forms a square loop. It rotates within an external magnetic field produced by radial magnets of strength 350 mT.



It was noted that the current reached a constant value of 0.25 A when no load was attached to the motor. The sides perpendicular to the magnetic field each experience a force of magnitude 0.275 N.

Determine the magnitude of the torque produced by the motor.

(A) 0.006 Nm

(B) 0.017 Nm

(C) 0.069 Nm

(D) 0.275 Nm

Question 12 (1 mark)

A spaceship travelling at 0.95*c* passes close by a stationary observer in a space-station. The pilot of the spaceship is applying as much thrust as his ship can produce and his instruments tell him he is getting faster.

Which of the following statements is true?

(A) As the ship approaches the speed of light, the sensor in the pilot's seat records that his mass is increasing towards infinity.

(B) The pilot experiences no change in the ship's length or mass, and thus observes the ship's velocity to increase without limit.

(C) As the ship's engine applies more thrust, the stationary observer measures the velocity of the ship to continue increasing and its momentum to approach infinity.

(D) To the stationary observer the ship's length contracts and approaches zero as it approaches the speed of light, thus to the observer the mass of the ship also approaches zero.

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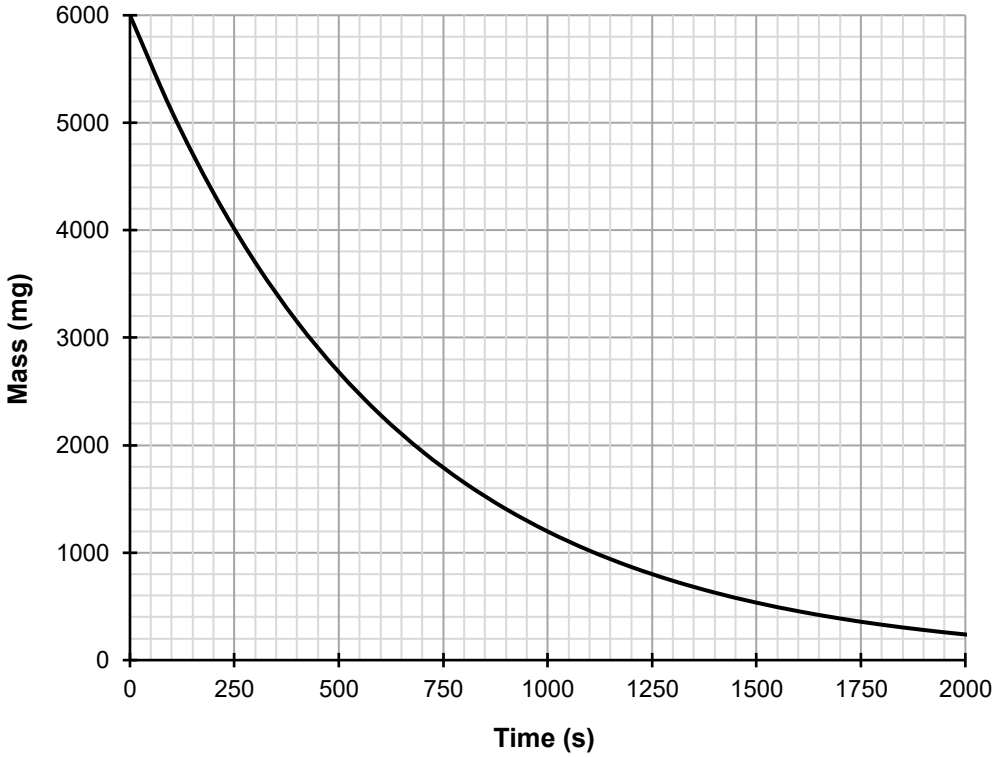
Question 13 (1 mark)

The graph below shows the decay of a radioactive isotope.



An experiment requires no less than 100 mg of the isotope to be placed in a reactor. A scientist acquires a 4.00 g sample of the isotope.

How much time does she have, to add the sample to the reactor, to ensure there is 100 mg of the isotope remaining?

(A) 430 s

(B) 2290 s

(C) 2540 s

(D) 2660 s

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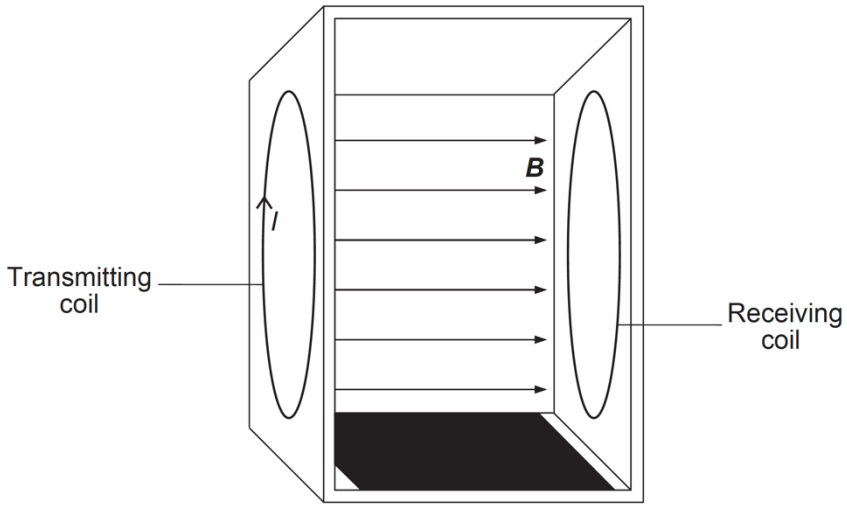
Question 14 (1 mark)

A simplified diagram of an airport security gate is shown below.



The transmitting coil on the left-hand side of the security gate produces a magnetic field as a result of a varying current.

The receiving coil of radius 60.0 cm consists of 25 turns experiences an induced emf of magnitude 32.5 mV.

What is the rate at which magnetic flux density changes inside the receiving coil required to induce the stated emf?

(A) 1.15×10^{-3} Wb s^{-1}

(B) 1.30×10^{-3} Wb s^{-1}

(C) 2.17×10^{-3} Wb s^{-1}

(D) 2.87×10^{-2} Wb s^{-1}

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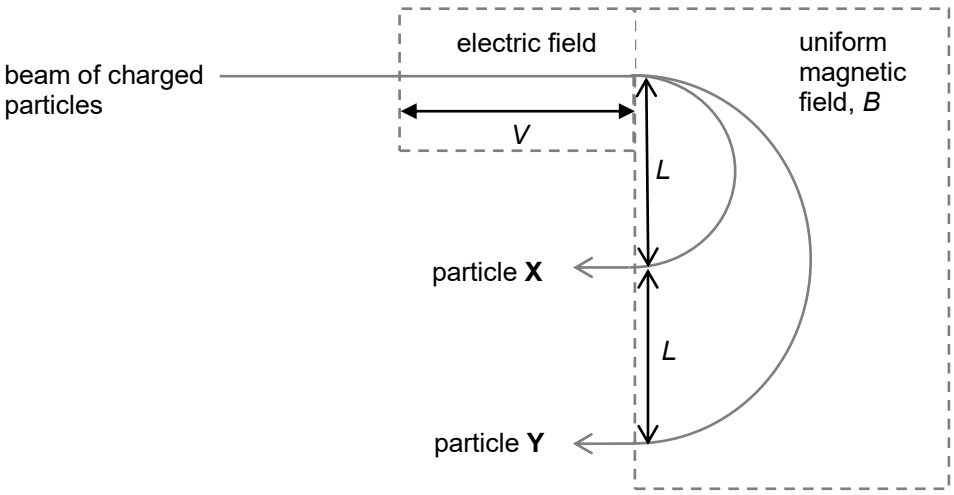
Question 15 (1 mark)

A beam consists of two different particles **X** and **Y**. Initially of negligible energy, they are both accelerated through the same potential difference *V* before entering a region with uniform magnetic field of strength *B*. Particles **X** and **Y** exit from the magnetic field at distance *L* and *2L* from the entry point respectively.



The *q*:*m* ratio of:

(A) **X** is larger than that of **Y** by a factor of 2.

(B) **Y** is larger than that of **X** by a factor of 2.

(C) **X** is larger than that of **Y** by a factor of 4.

(D) **Y** is larger than that of **X** by a factor of 4.

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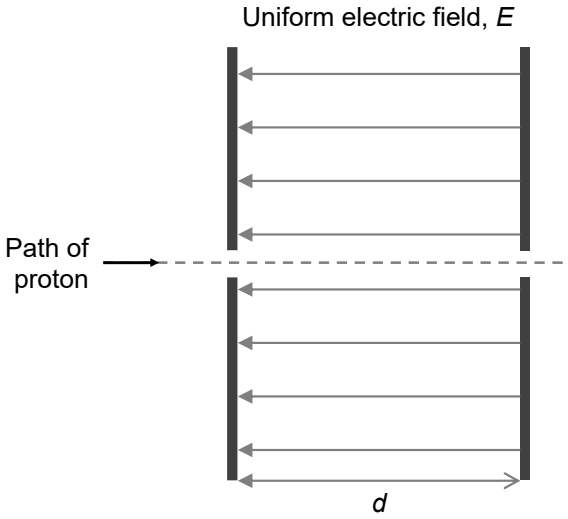
Question 16 (1 mark)

A proton of mass m and charge q travels through a uniform electric field of field strength, E. It enters the field with velocity v and then travels a distance d in a direction opposite to the field, as shown.



What will be its speed when leaving the field?

(A) $v-\sqrt{\frac{qEd}{m}}$

(B) $v+\sqrt{\frac{qEd}{m}}$

(C) $\sqrt{v^2-\frac{qEd}{m}}$

(D) $\sqrt{v^2+\frac{qEd}{m}}$

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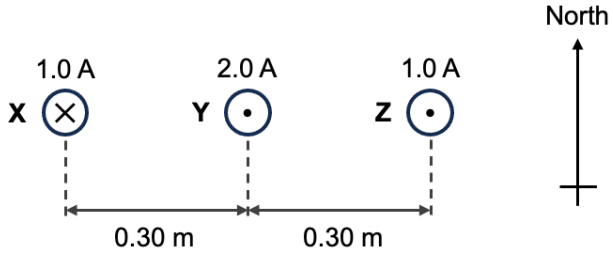
Question 17 (1 mark)

Three long vertical wires **X**, **Y** and **Z** are carrying currents 1.0 A, 2.0 A and 1.0 A, respectively.

The diagram shows the top view of the wires with the directions of their currents and the distances between them. The component of the Earth's magnetic field that is parallel to the Earth's surface is 2.0×10^{-5} T.

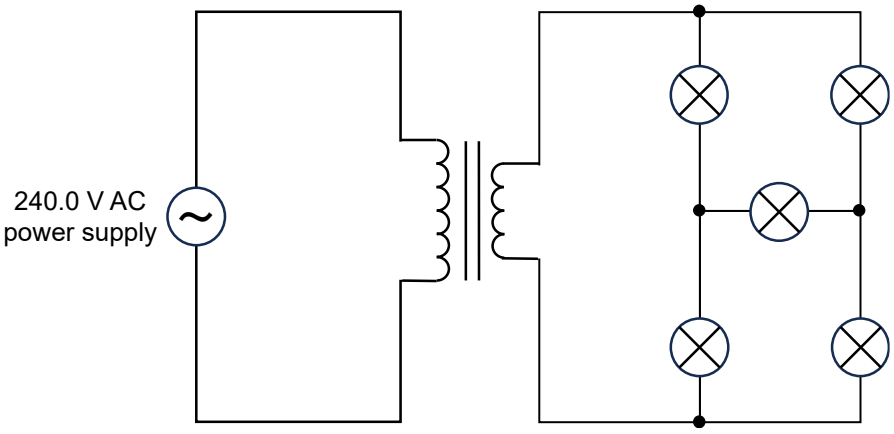


What is the magnitude and direction of the force per unit length acting on wire **Y**?

	Magnitude of force per unit length on Y (N m^{-1})	Direction
(A)	1.3×10^{-6}	East
(B)	2.7×10^{-6}	East
(C)	1.9×10^{-5}	West
(D)	3.7×10^{-5}	West

Question 18 (1 mark)

A transformer is connected to a 240.0 V AC power supply in the primary coil and outputs 12.0 V AC in the secondary coil. Five identical lamps are connected to the secondary coil as shown below.



The lamps are rated 6.00 V and 12.0 W and are operating at normal brightness.

Given that the transformer is ideal, determine the current drawn from the mains in the primary circuit.

(A) 0.20 A

(B) 0.40 A

(C) 2.00 A

(D) 4.00 A

Question 19 (1 mark)

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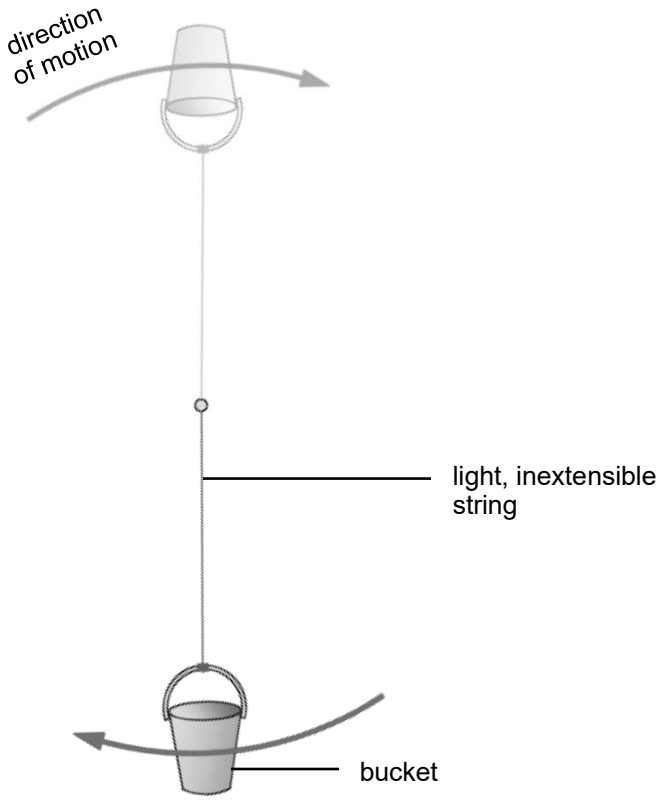
A 1.20 kg bucket is held by a light, inextensible string and whirled in a vertical circle. The radius of the circle is 1.50 m. The speed of the bucket is 12.1 m s^{-1} at the bottom of the loop and subsequently, the bucket reached the top of the circle.



What is the difference in the tension in the string at these two positions?

(A) 58 N

(B) 71 N

(C) 129 N

(D) 187 N

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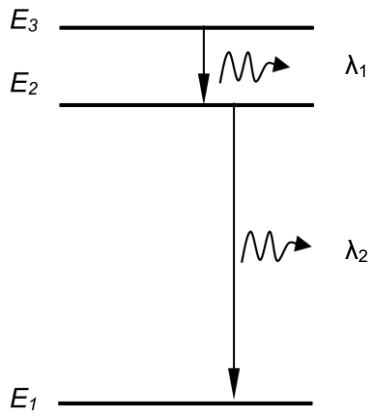
Question 20 (1 mark)

The diagram below shows a simplified representation of three electron energy levels in an atom of element **X**.



Cool vapour of **X** at low pressure is bombarded with electrons accelerated from rest across a potential difference of V. Two possible transitions which result in the emission of photons of wavelengths $\lambda_1 = 6.22 \times 10^{-7}$ m and $\lambda_2 = 1.78 \times 10^{-7}$ m are observed.

What is the minimum value of V for the above transitions to occur?

(A) 1.56 V

(B) 2.80 V

(C) 7.00 V

(D) 9.00 V

END OF SECTION 1

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S2A

2023

Year 12 Physics

Trial Examination

Section 2A (20 marks)

Questions 1–4

- Write using a black pen.
- Draw diagrams using pencil.
- Show all relevant working in questions involving calculations.
- NESA approved calculators may be used.

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Section 2A

20 marks

- Attempt Questions 1–4.
- If you use the extra space provided at the back of this section, clearly indicate which question you are answering.

Marks

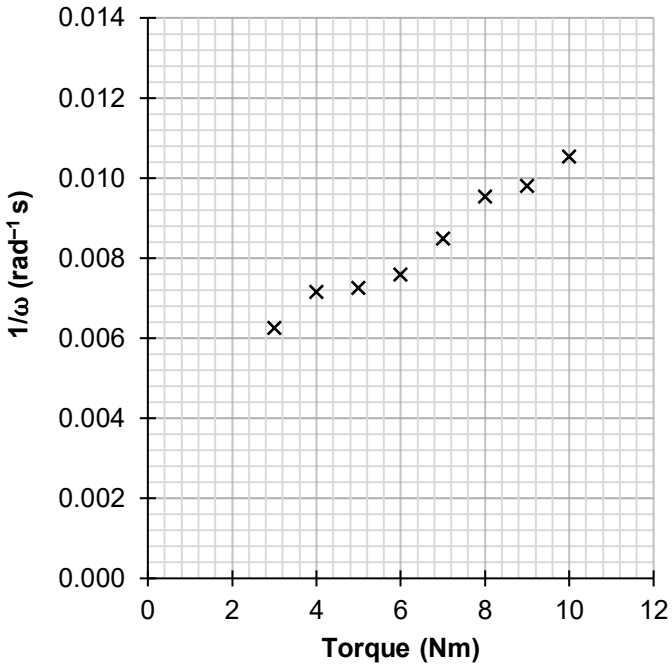
Question 1 (3 marks)

A motor with 30.0% efficiency is connected to 240 V power supply. It was recorded that as the angular velocity of this motor increases, the torque decreases.

The torque, τ, produced by the motor is given by $\tau = \frac{VI\eta}{\omega}$, where:

- τ = torque (Nm)
- V = voltage (V)
- I = current (A)
- η = efficiency
- ω = angular velocity (rad s^{-1})

The graph of torque against $\frac{1}{\omega}$ is given below:



Using an appropriate line of best fit, calculate the power generated by this motor. **3**

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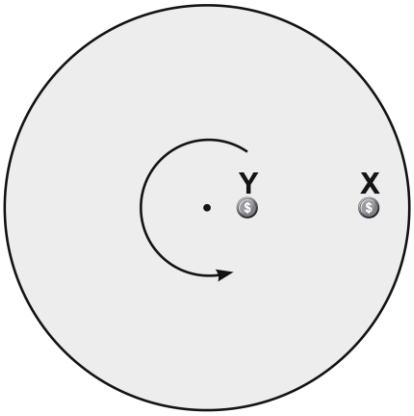
Marks

Question 2 (5 marks)

Two identical coins, **X** and **Y**, are placed on a rotating disc. The centre of the Coin **X** is three times as far away from the centre of the disc as that for Coin **Y**. The disc begins to rotate.



NOT TO SCALE

(a) Compare the angular and instantaneous velocities of Coin **X** with those of Coin **Y**. **2**

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(b) When the frequency of rotation reaches 2.00 Hz, Coin **X** flies off the disc. **3**

Calculate the frequency of rotation when Coin **Y** flies off.

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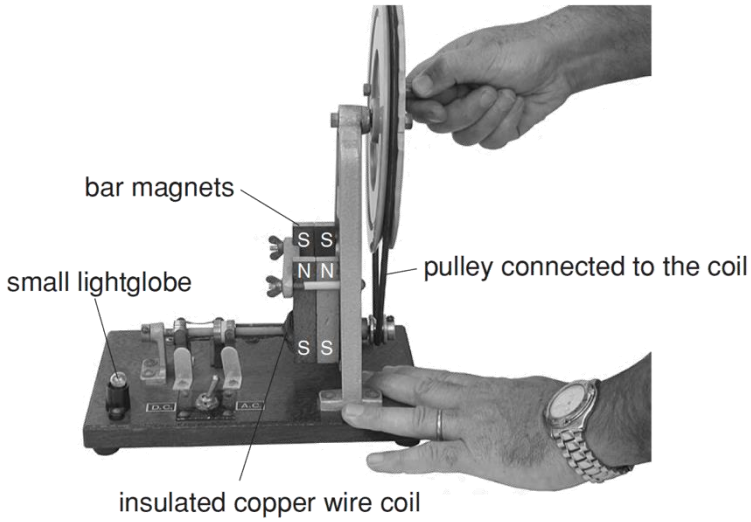
Marks

Question 3 (4 marks)

A hand generator is shown in the photograph below. Often these hand generators can be set to generate either AC or DC current as the commutator can be switched between a slip-ring commutator or a split-ring commutator.



Question 3 continues on the next page

Question 3 continued…

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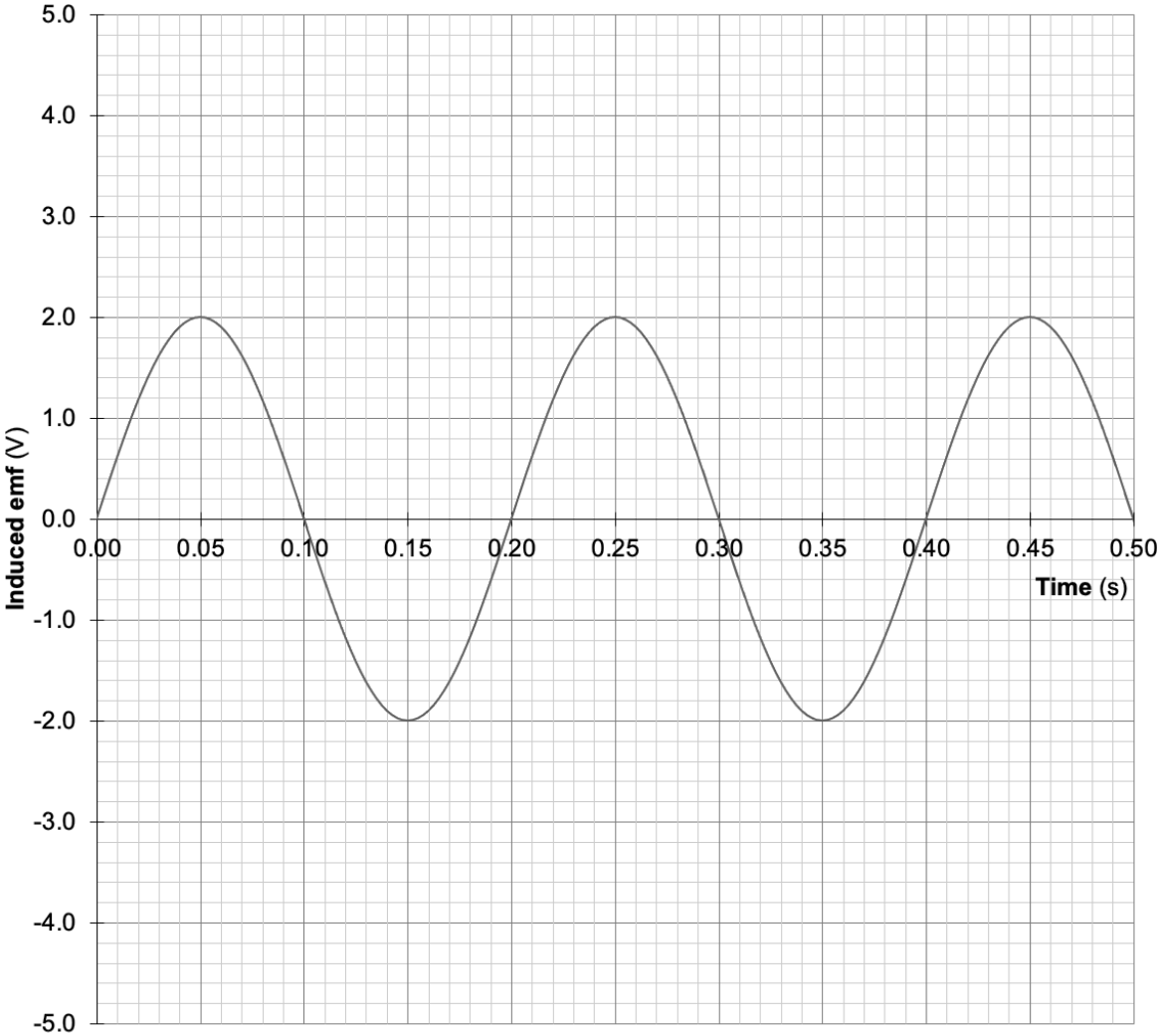
Marks

A Physics teacher connected the hand generator to a cathode ray oscilloscope to show the variation of induced emf over time.



(a) On the axes above, sketch the output that is likely when the speed of rotation is halved. **2**

(b) Determine whether the split-ring commutator or the slip-ring commutator was used by the teacher. Justify your answer. **2**

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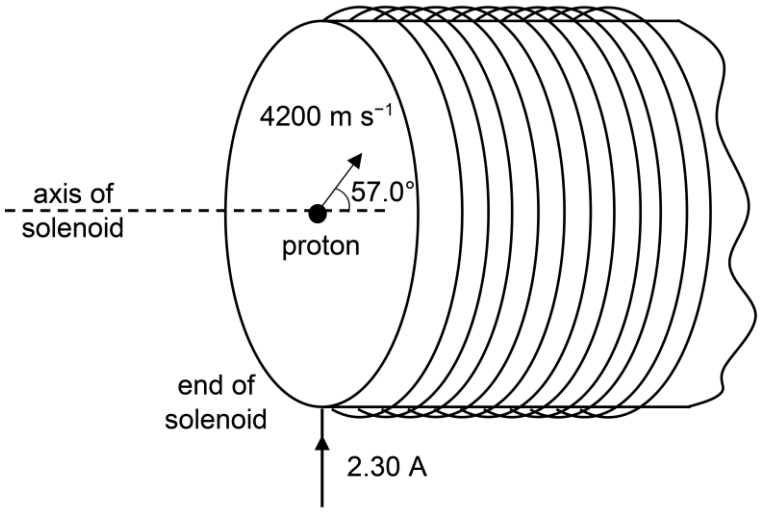
NESA STUDENT NUMBER

Marks

Question 4 (8 marks)

Leo placed a solenoid of length 0.35 m and 400 turns in a vacuum and passed a current of 2.30 A through it.

A proton enters the solenoid at a speed of 4200 m s^{-1}, at an angle of 57.0°, as shown in the diagram below. The proton moves in a helical path of constant radius inside the solenoid. It exits the other side of the solenoid.



(a) Explain why the proton will move in a helical path inside the solenoid. **2**

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Question 4 continues on the next page

NESA STUDENT NUMBER

Marks

Question 4 continued…

(b) Calculate the number of complete cycles of the helix. **4**

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(c) When the proton exits the solenoid, it moves in a spiral with increasing radius. **2**
Explain why this occurs.

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END OF SECTION 2A

NESA STUDENT NUMBER

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If you use this space, clearly indicate which question you are answering.

NESA STUDENT NUMBER

2023

NBHS Year 12 Physics Trial Examination

NESA STUDENT NUMBER

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

A ○ B ● C ○ D ○

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A ● B ⊗ C ○ D ○

If you change your mind and have crossed out what you consider to be the correct answer, then indicate this by writing the word *correct* and drawing an arrow as follows:

correct

A ⊗ B ⊗ ← C ○ D ○

1	A ○	B ○	C ○	D ○
2	A ○	B ○	C ○	D ○
3	A ○	B ○	C ○	D ○
4	A ○	B ○	C ○	D ○
5	A ○	B ○	C ○	D ○
6	A ○	B ○	C ○	D ○
7	A ○	B ○	C ○	D ○
8	A ○	B ○	C ○	D ○
9	A ○	B ○	C ○	D ○
10	A ○	B ○	C ○	D ○
11	A ○	B ○	C ○	D ○
12	A ○	B ○	C ○	D ○
13	A ○	B ○	C ○	D ○
14	A ○	B ○	C ○	D ○
15	A ○	B ○	C ○	D ○
16	A ○	B ○	C ○	D ○
17	A ○	B ○	C ○	D ○
18	A ○	B ○	C ○	D ○
19	A ○	B ○	C ○	D ○
20	A ○	B ○	C ○	D ○

NESA STUDENT NUMBER

S2B

2023

Year 12 Physics

Trial Examination

Section 2B (20 marks)

Questions 1–4

- Write using a black pen.
- Draw diagrams using pencil.
- Show all relevant working in questions involving calculations.
- NESA approved calculators may be used.

NESA STUDENT NUMBER

Section 2B

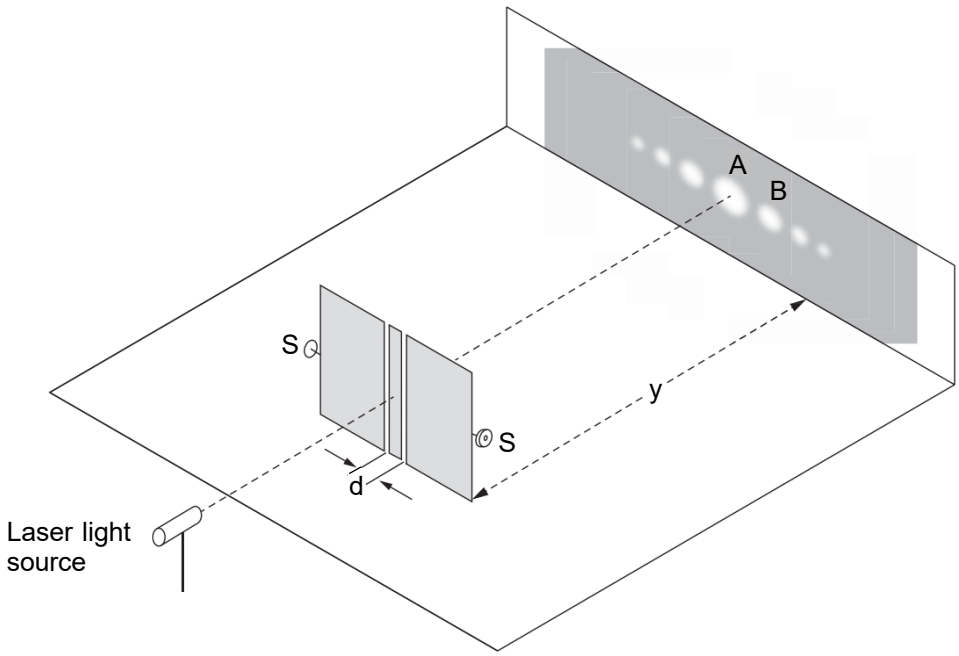
20 marks

- Attempt Questions 1–4.
- If you use the extra space provided at the back of this section, clearly indicate which question you are answering.

Marks

Question 1 (2 marks)

The following apparatus is used to investigate light interference using a double slit.



The distance, y, from the slits to the screen can be varied. The adjustment screws (S) vary the distance, d, between the slits. The wavelength of the laser light can be varied across the visible spectrum. The diffraction pattern shown is for a specific wavelength of light. **2**

Explain ONE way in which the distance between the maxima at A and B could be increased.

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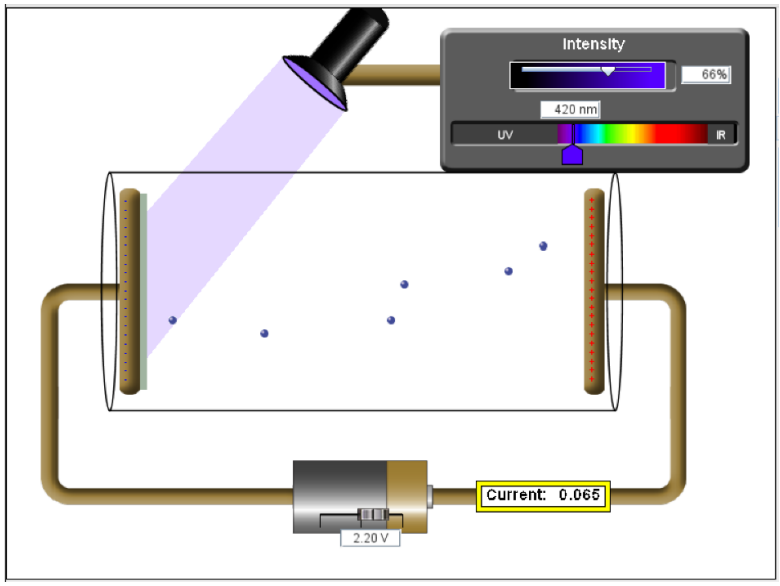
NESA STUDENT NUMBER

Marks

Question 2 (6 marks)

Bill and Phil are conducting experiments to investigate the photoelectric effect. They are shining light onto a potassium plate and measuring the photocurrent generated as they vary the wavelength and the intensity of the light.



(a) In their first experiment, they vary the wavelength of the light while keeping the intensity constant. They find that they require light with a wavelength of 540 nm or less to generate a photocurrent. **2**

Describe what this observation demonstrates about the nature of light.

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(b) Determine the work function for potassium. **2**

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Question 2 continues on the next page

NESA STUDENT NUMBER

Marks

Question 2 continued…

(c) In their second experiment, the wavelength is set at 420 nm and the intensity of the light is changed. **2**

Describe how the photocurrent will respond as the intensity is increased and explain why.

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NESA STUDENT NUMBER

Marks

Question 3 (6 marks)

A dishonest spaceship salesman is delivering a second-hand spaceship, that is capable of reaching close to light-speed, to a customer on Jupiter. However, he doesn't want to do too much distance or he won't get paid as much for the spaceship. Hence, he plans to go very fast in order to use length contraction to his advantage.

(a) The distance to Jupiter is 7.77×10^{11} m, but the salesman only wants the spaceship's computer to measure a distance of 1.00×10^{11} m. **2**

Identify the proper distance (l_0) of the journey and justify your answer.

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(b) The customer, who is waiting on Jupiter, observes that the trip takes one hour. **2**

Determine how long the trip takes according to the salesman.

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(c) Determine the speed that he must travel as a fraction of the speed of light. **2**

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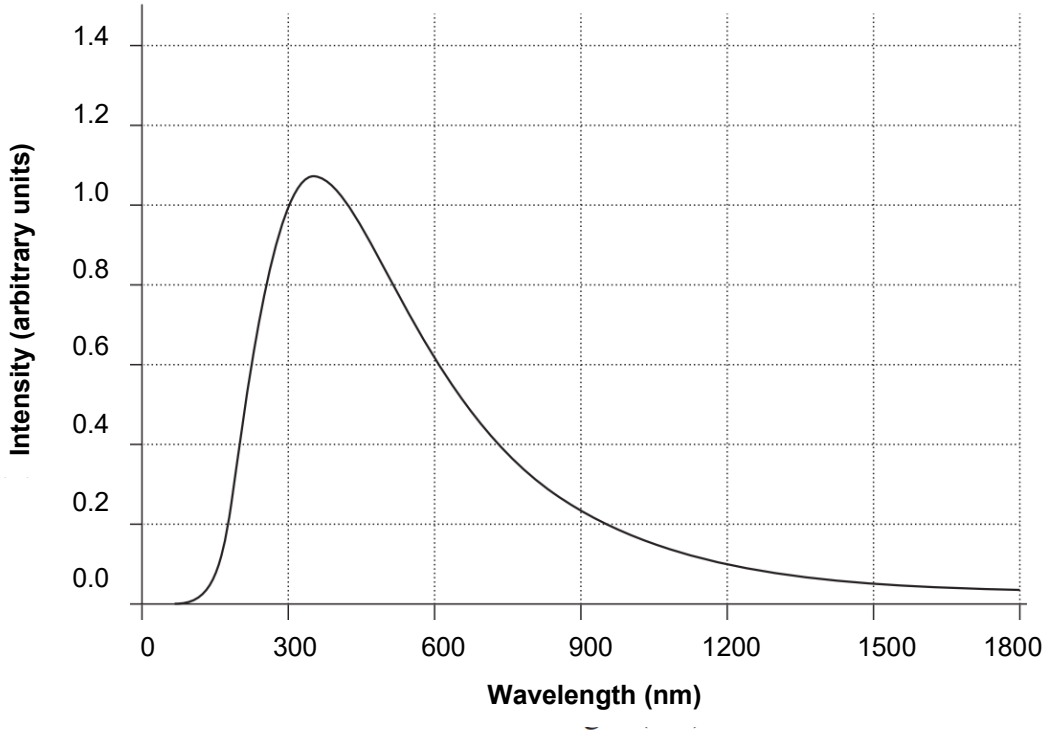
NESA STUDENT NUMBER

Marks

Question 4 (6 marks)

The graph below shows the distribution of wavelengths of radiation emitted by a star.



(a) Explain how a change in the understanding of the nature of light led to the development of this model. **1**

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(b) Determine the surface temperature of the star. **2**

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Question 4 continues on the next page

Question 4 continued…

NESA STUDENT NUMBER

Marks

(b) The Sun has a surface temperature of 5800 K. **3**

Sketch the curve for the Sun on the graph on the previous page and explain the difference between the curves.

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END OF SECTION 2B

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S2C

2023

Year 12 Physics

Trial Examination

Section 2C (40 marks)

Questions 1–6

- Write using a black pen.
- Draw diagrams using pencil.
- Show all relevant working in questions involving calculations.
- NESA approved calculators may be used.

NESA STUDENT NUMBER

Section 2C

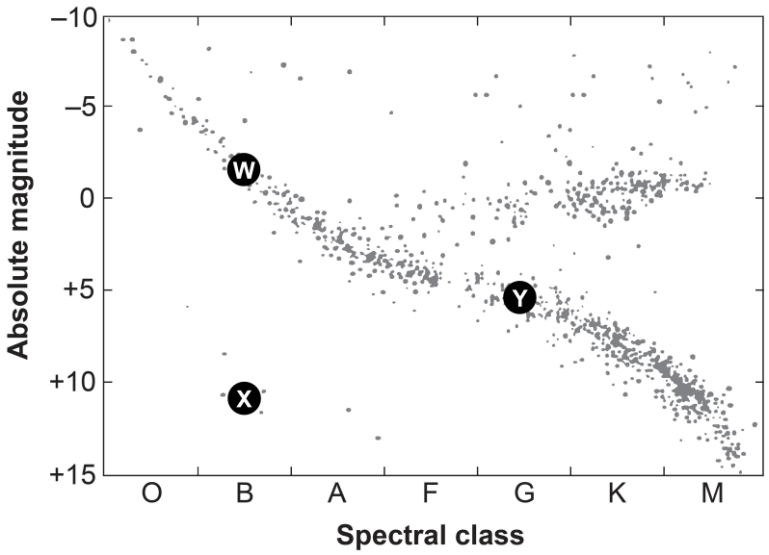
40 marks

- Attempt Questions 1–6.
- If you use the extra space provided at the back of this section, clearly indicate which question you are answering.

Marks

Question 1 (7 marks)

Hertzsprung-Russell diagrams can be used to deduce the properties of stars. The positions of three stars, **W**, **X** and **Y**, are shown.



(a) Identify which of the three stars **W**, **X** and **Y** are Main Sequence stars. **1**

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(b) Outline the energy production processes that occur in stars **W, X** and **Y**. **3**

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Question 1 continues on the next page

NESA STUDENT NUMBER

Marks

Question 1 continued…

(c) Describe and account for the relationship between the masses of Main Sequence stars with their luminosities AND lifetimes. **3**

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Marks

Question 2 (9 marks)

A group of HSC Physics students performed an investigation relating to projectile motion.

Figure 1 shows the vertical displacement of a projectile throughout its trajectory and **Figure 2** shows the variation of the projectile's kinetic energy.

It was noted that the range of the projectile is 0.620 m. Assume that air resistance is negligible.

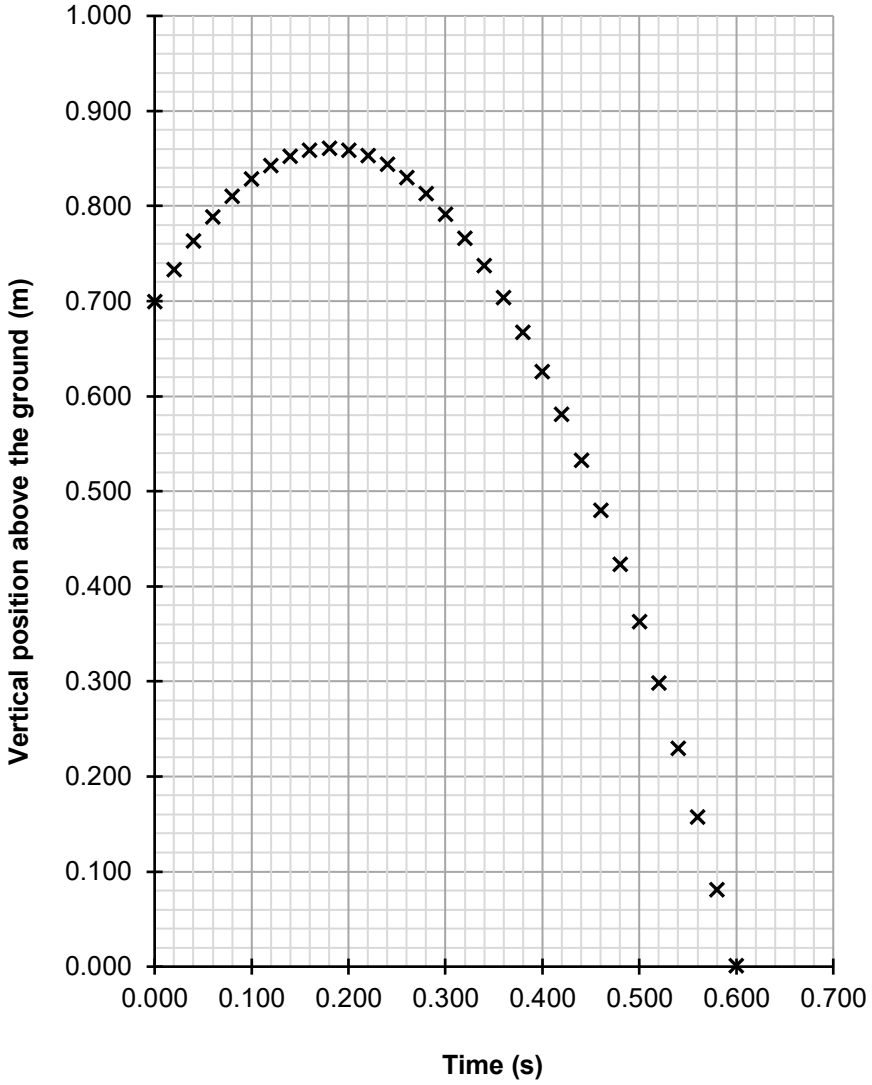

Figure 1 – The vertical displacement of a projectile throughout its trajectory

Question 2 continues on the next page

Question 2 continued…

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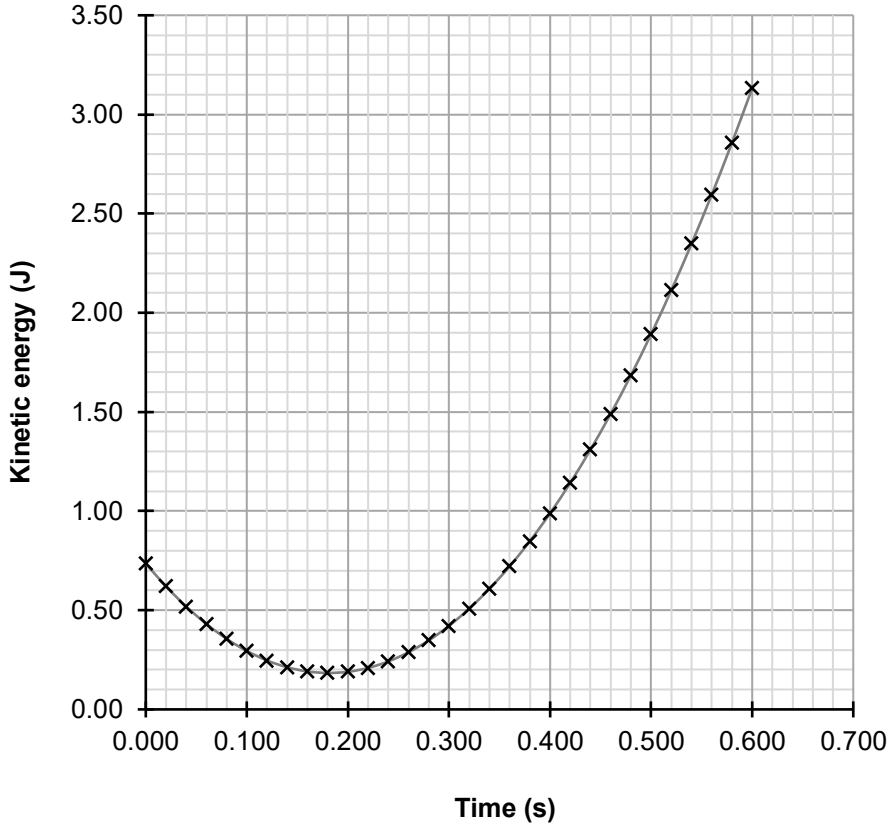

Figure 2 – The kinetic energy of a projectile throughout its trajectory

(a) Calculate the initial velocity of the projectile. **4**

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Question 2 continues on the next page

Question 2 continued…

NESA STUDENT NUMBER

Marks

(b) Calculate the mass of the projectile. **2**

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(c) Using the graph, explain why the kinetic energy of the projectile varies between its launch, its maximum height and when it lands. **3**

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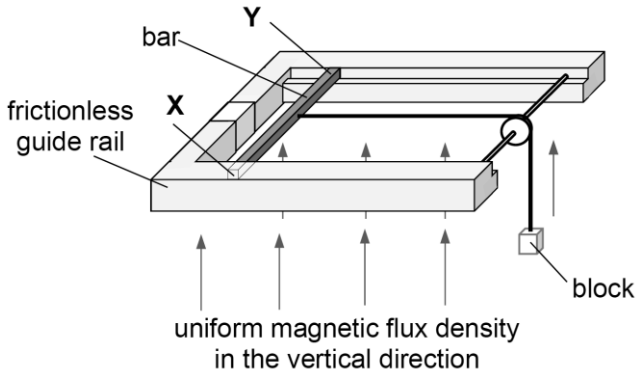
Marks

Question 3 (6 marks)

A uniform conducting bar **XY** is pulled horizontally across long parallel frictionless conducting guide rails by a light inextensible string. The string passes over a frictionless pulley and is attached to a hanging block. The guide rails are placed in a vertical magnetic field of uniform magnetic flux density as shown in the figure below. **6**



The block is released from rest at time t = 0 s, and the bar starts to move until it achieves constant motion. It then continues to move at a constant motion until it reaches the pulley.

Using appropriate Physics principles, explain the subsequent motion of the bar.

Include a sketch of a graph to show the variation with time t of the acceleration of the rod from t = 0 to time reaches the pulley to support your response.

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Question 3 continues on the next page

Question 3 continued…

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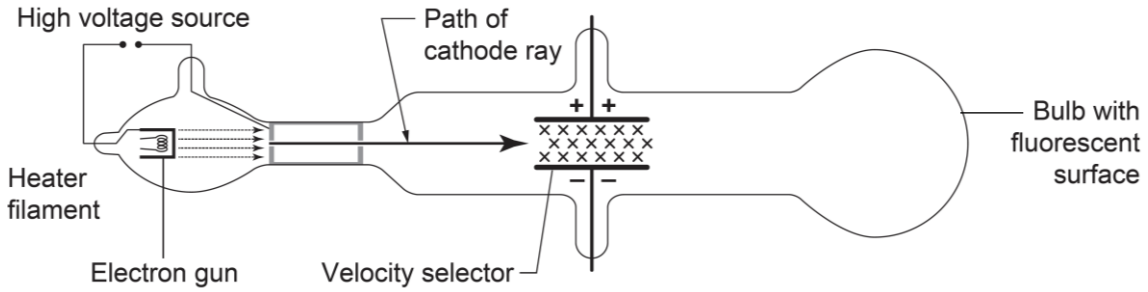
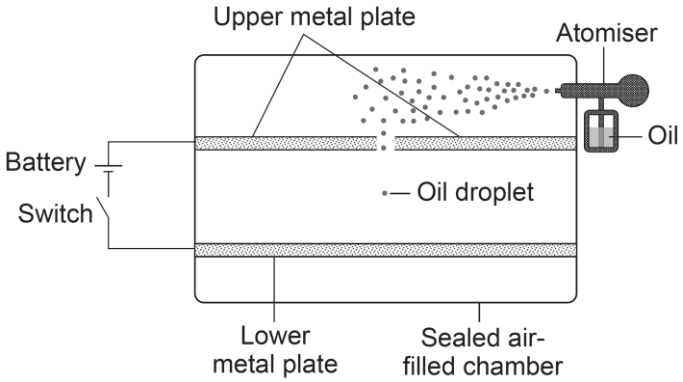
Question 4 (7 marks)

The following apparatus, shown below, have been used to determine properties of the electron. **7**





With reference to the apparatus shown, relevant equations and derivations, explain how scientists used fields to determine properties of the electron.

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Question 4 continued…

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Question 5 (4 marks)

In the 1920s, the first measurements of spectra from galaxies beyond the Milky Way were made. Wavelengths of spectral lines were observed to be shifted and Hubble discovered a correlation between the shift in the spectral line and the distance to the galaxy.

The graphs below show plots for data collected in 1929 **(Figure 1)** and 1931 **(Figure 2)**.

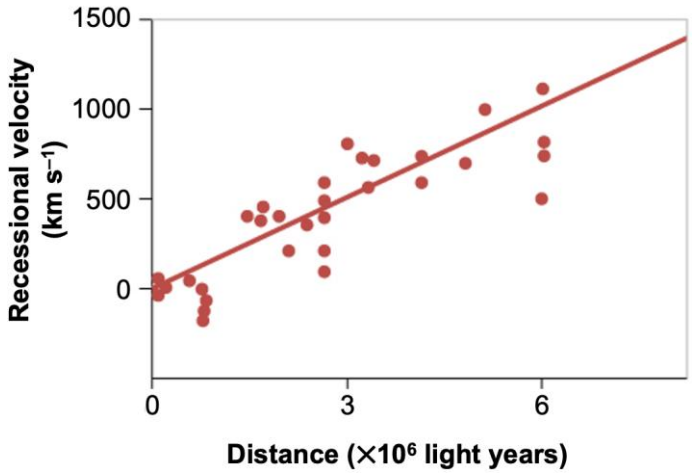

Figure 1 – Data collected by Hubble in 1929

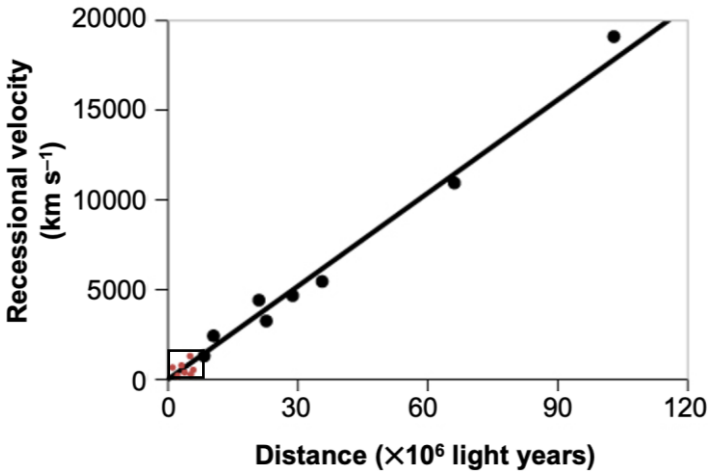

Figure 2 – Data collected by Hubble and Humason in 1931

The data used by Hubble for his 1929 plot **(Figure 1)** is contained within the rectangle close to the origin of the 1931 plot **(Figure 2)**.

Question 5 continues on the next page

Question 5 continued…

NESA STUDENT NUMBER

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Explain how Hubble's observations support the conclusion that the universe is expanding and assess the accuracy of this conclusion based on Hubble's original 1929 data. **4**

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Question 6 (7 marks)

A nitrogen-14 nucleus, initially at rest, collides with an alpha particle travelling at 3.0×10^7 m s^{-1} resulting in a nuclear reaction. The masses of the atoms involved are shown in atomic mass units (u).

$$^{14}_{7}\text{N} + ^{4}_{2}\text{He} \longrightarrow ^{17}_{8}\text{O} + ^{1}_{1}\text{H}$$

13.9993 u 4.0015 u 16.9947 u 1.0073 u

(a) By considering mass difference, Δm, calculate the minimum kinetic energy needed by the alpha particle to cause the nuclear reaction. **3**

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Question 6 continues on the next page

NESA STUDENT NUMBER

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Question 6 continued…

(b) Using calculations and appropriate Physics principles, account for the motion of the oxygen-17 and hydrogen-1 nuclei following the nuclear reaction, where relativistic effects do not need to be considered. **4**

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END OF SECTION 2C

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