Student Number ___________________

Caringbah High School

Physics: HSC Course

Trial Exam 2022

General Instructions

- *Reading time – 5 minutes*
- *Working time – 3 hours*
- *Write using black or blue pen*
- *Draw diagrams and graphs using pencil*
- *NESA approved calculators may be used*

Total marks: 100

This paper has two parts, Part A and Part B

***Part A** – 20 marks*

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

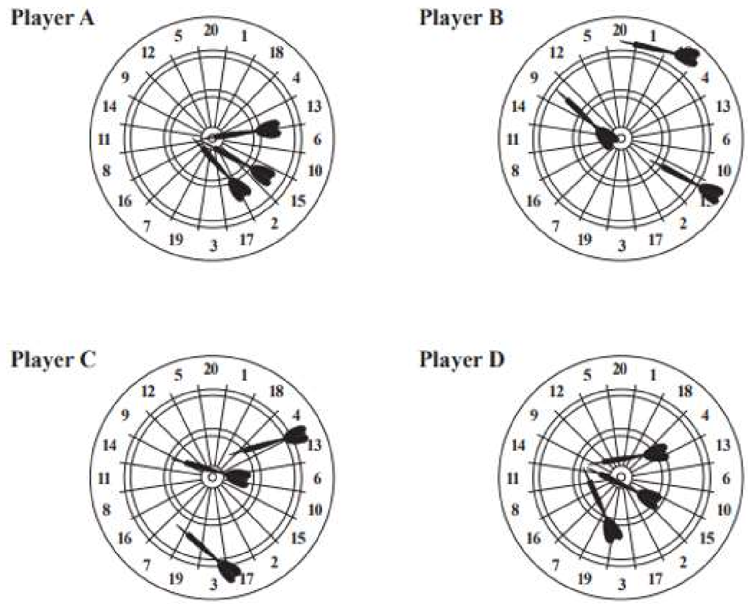
***Part B** – 80 marks*

- *Attempt Questions 21-39*
- *Allow about 2 hours and 25 minutes for this part*

OUTCOME	*MARK*
Knowledge and Understanding	*/78*
Working Scientifically *Q1, Q11, Q25, Q27, Q34, Q37*	*/22*
Total	*/100*

PART A: Circle the letter of the BEST answer on the grid (20 marks)

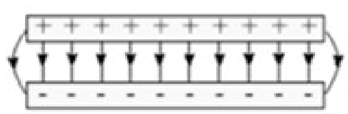
1. *The aim of darts is to hit the bullseye at the centre of a dartboard. Four darts players (A, B, C and D) each threw three darts. The results of their throws are shown below.*

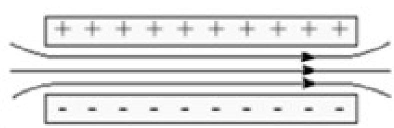


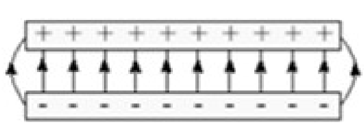
Which one of the players produced a set of attempts that could be described as being precise but innaccurate?

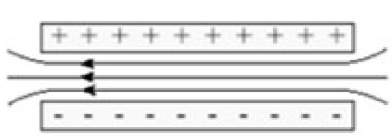
A. Player A
B. Player B
C. Player C
D. Player D

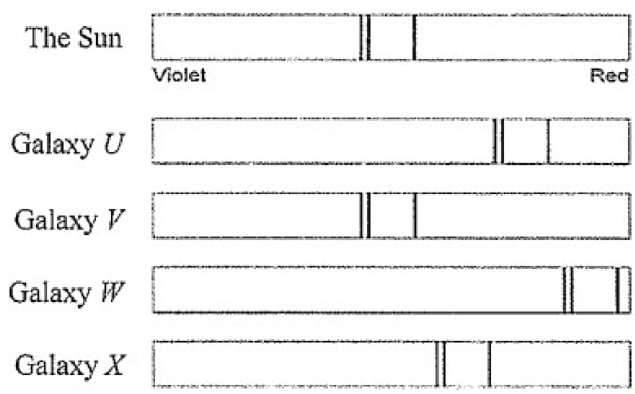
2. *Which diagram shows the electric field between a pair of charged parallel plates?*

A. 

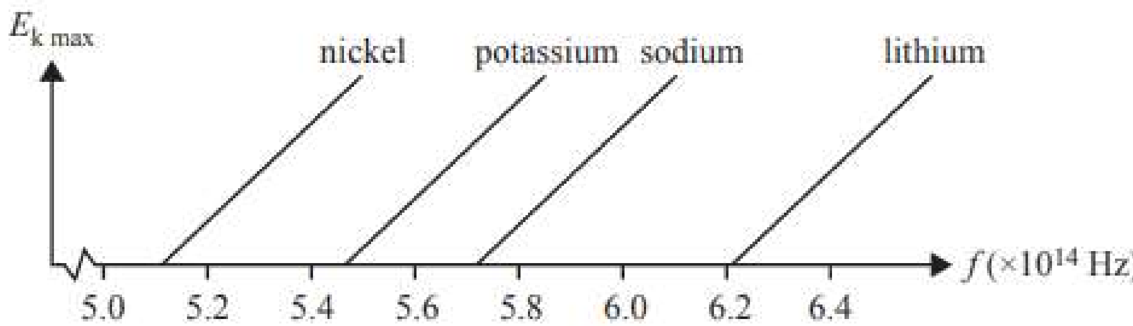
B. 

C. 

D. 

3.	*The physics underpinning Kepler's second law of planetary motion is:* *A. a planet losing kinetic energy as it moves closer to the central body.* *B. a planet's orbit not being a perfect circle.* *C. a planet's orbital radius being proportional to its period.* *D. a planet losing gravitational potential energy as it moves closer to the central body.*	
4.	*Which statement about the Michelson-Morley experiment is correct?* *A. It was a valid experiment because it tested the principle of relativity.* *B. It was a valid experiment because it took into account the known properties of light.* *C. It was an invalid experiment because it did not take into account the particle nature of light.* *D. It was an invalid experiment because the speed of Earth through the aether was not taken into account.*	
5.	*The diagram shows three identically spaced lines on light spectra from our Sun and four galaxies.*  *Based on this information, which galaxy is closest to us?* *A. U* *B. V* *C. W* *D. X*	
6.	*An ideal transformer has an input DC voltage of 240 V, 2000 turns in the primary coil and 80 turns in the secondary coil.* *The output voltage is closest to* *A. 0 V* *B. 9.6 V* *C. 6.0×10^3 V* *D. 3.8×10^7 V*	

7. *The diagram below shows a plot of maximum kinetic energy, $E_{k\ max}$, versus frequency, f, for various metals capable of emitting photoelectrons.*



Which one of the following correctly ranks these metals in terms of their work function, from highest to lowest in magnitude?

A. sodium, potassium, lithium, nickel
B. nickel, potassium, sodium, lithium
C. potassium, nickel, lithium, sodium
D. lithium, sodium, potassium, nickel

8. *Jupiter's moon Ganymede is its largest satellite.*
Ganymede has a mass of 1.5×10^{23} kg and a radius of 2.6×10^{6} m.
Which one of the following is closest to the magnitude of Ganymede's surface gravity?

A. 0.8 ms^{-2}
B. 1.5 ms^{-2}
C. 3.8 ms^{-2}
D. 9.8 ms^{-2}

9. *Which statement about the spectra of incandescent and laser lights is correct?*

A. Both laser light and incandescent light have a very narrow spectrum.

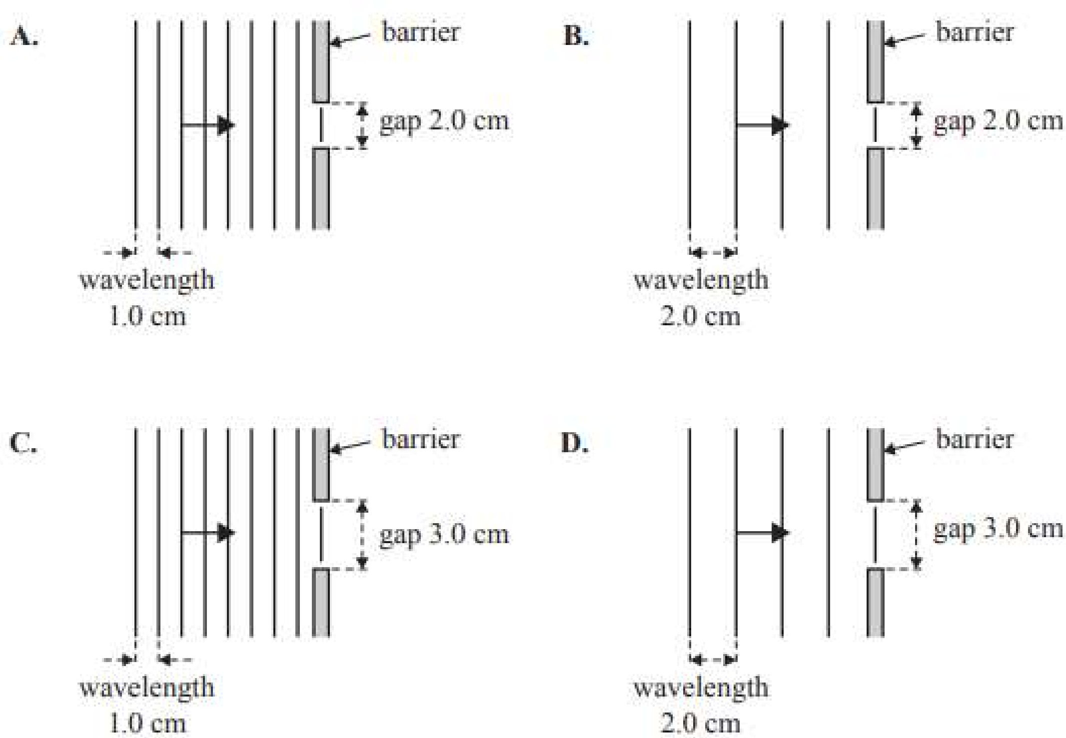
B. Laser light has a very wide spectrum concentrated in the infra-red, incandescent has a very narrow spectrum.

C. Laser light has a continuous spectrum, incandescent light has a spectrum concentrated in the yellow region.

D. Laser light has a spectrum specific to its narrow frequency range, incandescent light has a continuous spectrum.

10. *Students are investigating the diffraction of waves using a ripple tank. Water waves are directed towards barriers with gaps of different sizes, as shown below.*

In which one of the following would the greatest diffraction effects be observed?



11. *Which one of the following statements about systematic and random errors is correct?*

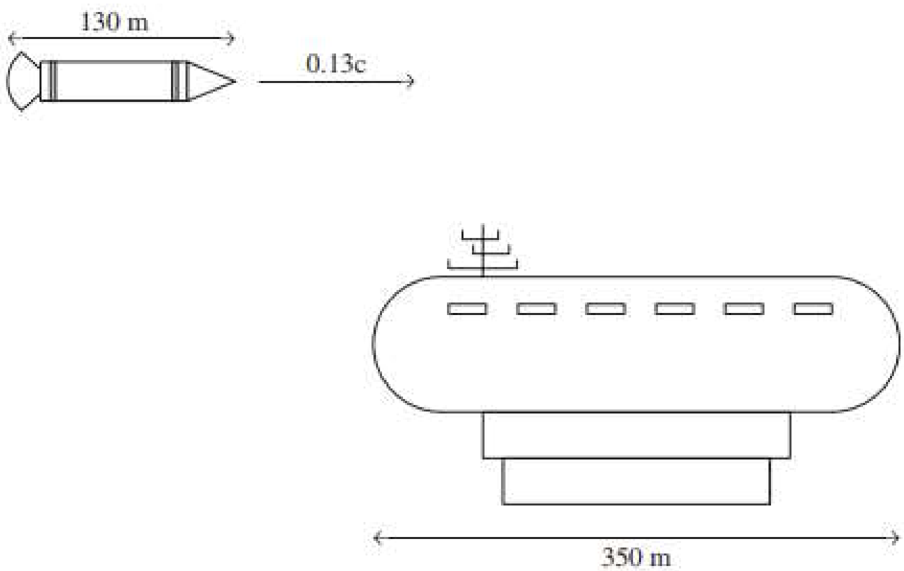
A. Random errors can be reduced by repeated readings.
B. Both random and systematic errors can be reduced by repeated readings.
C. Systematic errors can be reduced by repeated readings.
D. Neither systematic nor random errors can be reduced by repeated readings.

12. *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.

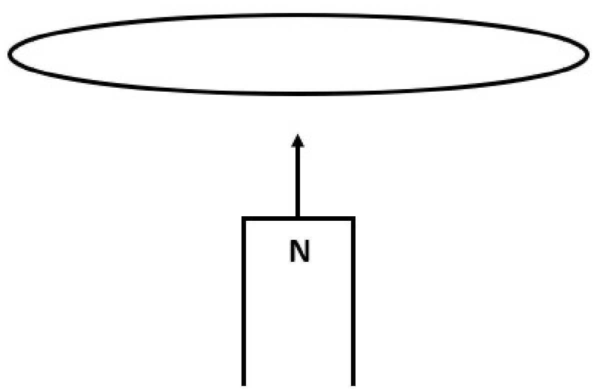
13. *An astronaut is travelling aboard a spacecraft. The spacecraft has a length of 130 m and is flying at a speed of 0.13c. The spacecraft travels past a space station that has a length of 350 m, as shown in the diagram.*



Which of the following correctly shows the length of the space station as perceived by the astronaut?

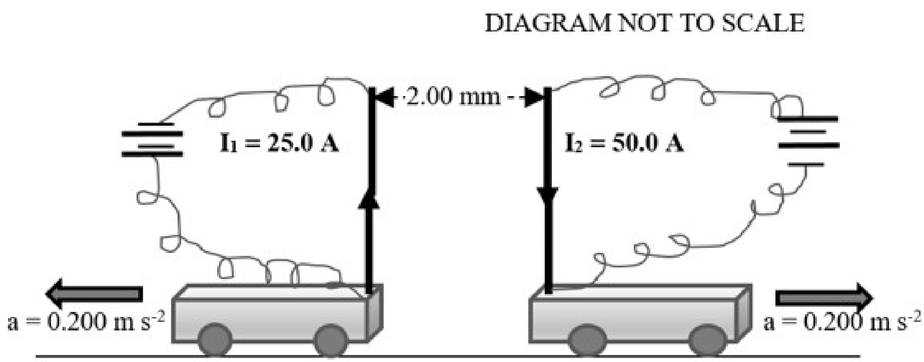
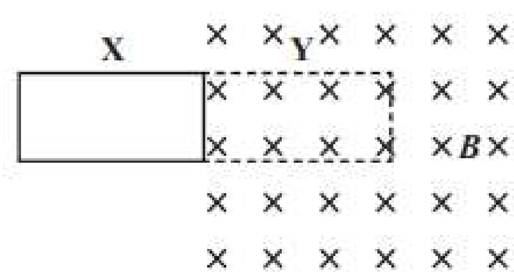
A. 347 m
B. 349 m
C. 350 m
D. 353 m

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

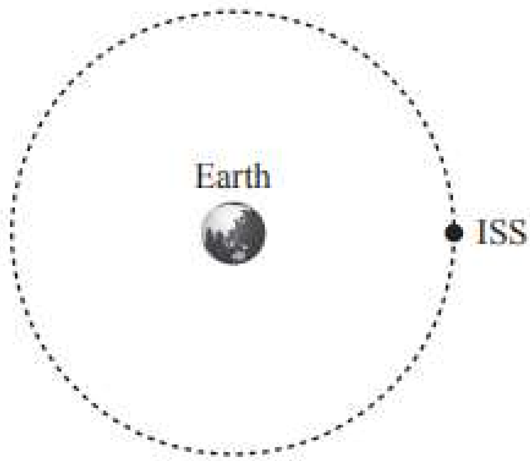


Which of the following statements is correct?

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. When viewed from above, the induced current in the coil will flow perpendicular to the movement of the magnet.
D. There will be no induced current in the coil.

15.	*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}.*  *The mass of each trolley is:* *A. 0.625 kg* *B. 1.25 kg* *C. 2.50 kg* *D. 5.00 kg*	
16.	*What is the magnitude of the gravitational force acting on a 3.50 x 10^3 kg satellite orbiting a planet when the satellite's orbital radius is 9.17 x 10^6 m and the satellite's orbital period is 1.50 hours?* *A. 4.07 N* *B. 1.24 x 10^4 N* *C. 4.34 x 10^4 N* *D. 5.63 x 10^{11} N*	
17.	*A single loop of wire moves into a uniform magnetic field B of strength 3.5 × 10^{-4} T over time t = 0.20 s from point X to point Y, as shown in the diagram below. The area A of the loop is 0.05 m^2.*  *The magnitude of the average induced EMF in the loop is closest to* *A. 0 V* *B. 3.5 x 10^{-6} V* *C. 8.8 X 10^{-3} V* *D. 8.8 x 10^{-5} V*	

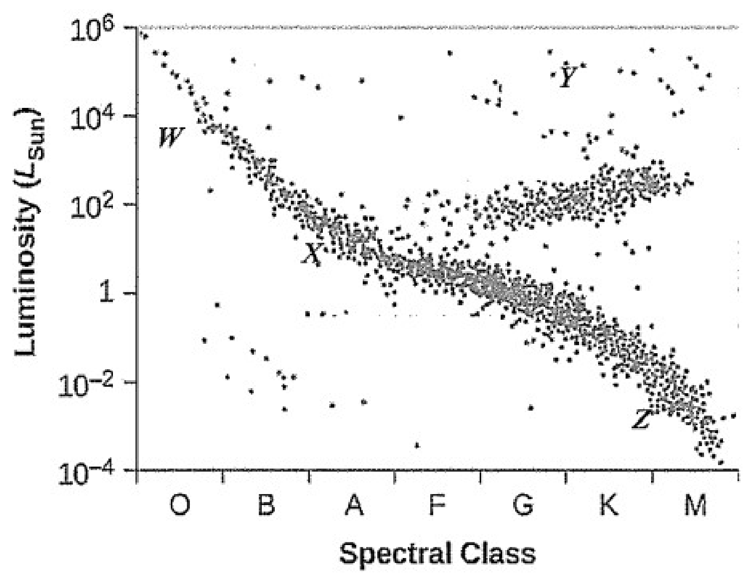
18. *The International Space Station (ISS) is travelling around Earth in a stable circular orbit, as shown in the diagram below.*



Which one of the following statements concerning the momentum and the kinetic energy of the ISS is correct?

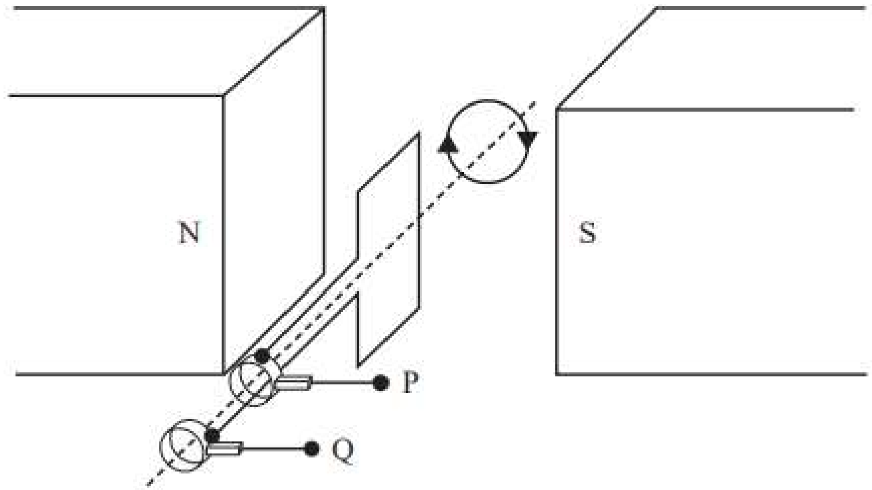
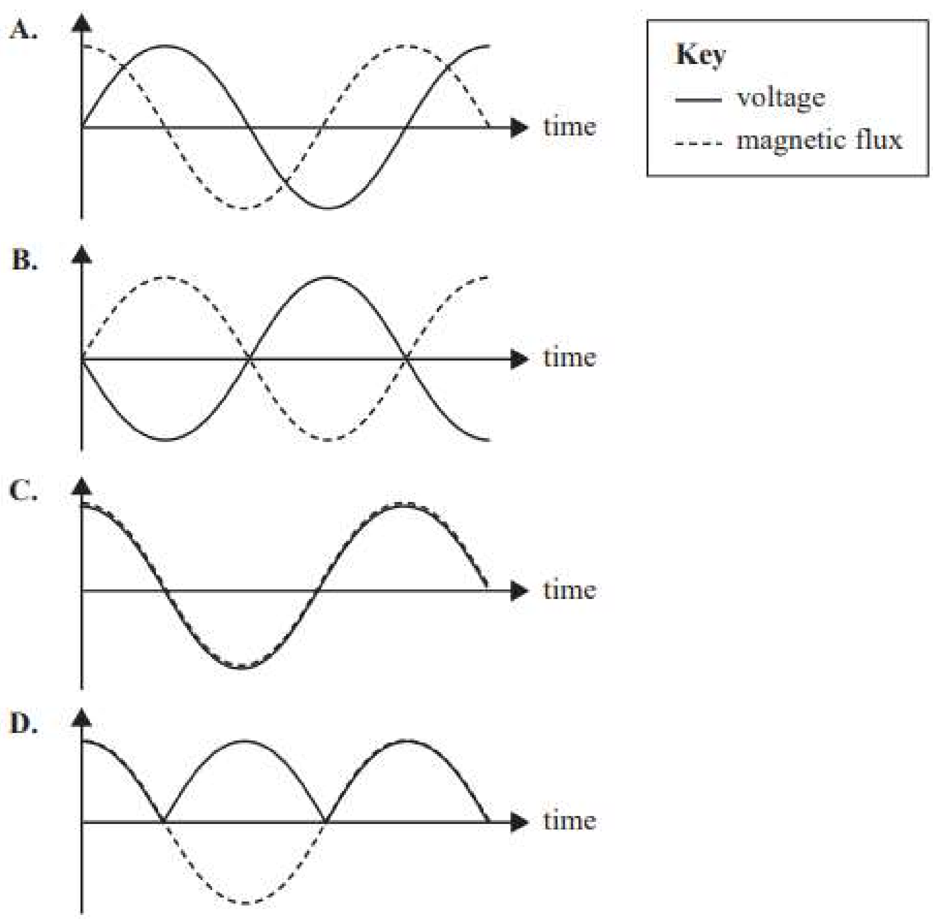
A. Both the momentum and the kinetic energy vary along the orbital path.
B. Both the momentum and the kinetic energy are constant along the orbital path.
C. The momentum is constant, but the kinetic energy changes throughout the orbital path.
D. The momentum changes, but the kinetic energy remains constant throughout the orbital path.

19. *The Hertzsprung-Russell diagram for the nearby stars has four stars, marked W, X, Y and Z.*



Which statement about these four stars is correct?

A. Star Y is the largest and hottest of the four.
B. Star X is a relatively small, yellow star, similar to our Sun.
C. Star W is the hottest, largest and most massive of the four.
D. Star Z is the smallest and has the longest remaining lifespan.

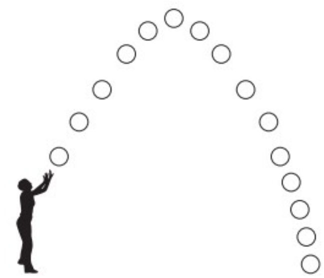
20.	*An electrical generator is shown in the diagram below. The generator is turning clockwise.*  *The voltage between P and Q and the magnetic flux through the loop are both graphed as a function of time, with voltage versus time shown as a solid line and magnetic flux versus time shown as a dashed line. Given the starting position illustrated above, which one of the following graphs best shows the relationships for this electrical generator?* 	

PART A: Answer the multiple choice questions HERE. Circle the letter of the BEST answer.

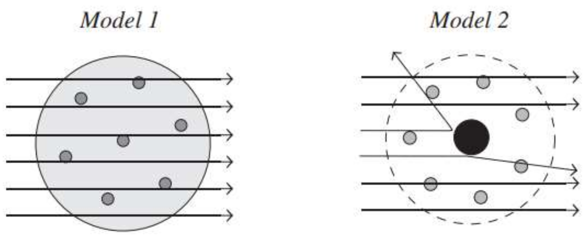
Do NOT detach this page from the rest of the exam.

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

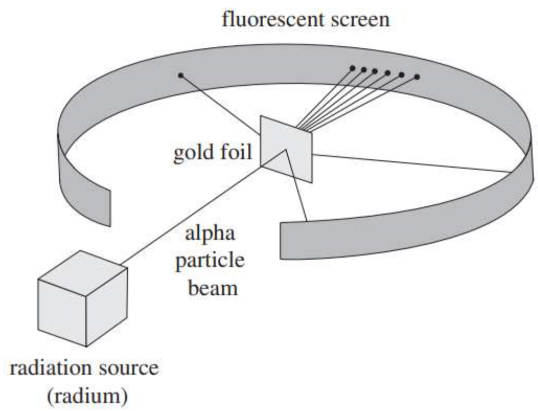
PART B: Longer Answers (80 marks)

21.	*Compare the motion of charged particles in electric fields to the motion of projectiles in gravitational fields.* ……………………………………………………………… ……………………………………………………………… ……………………………………………………………… ……………………………………………………………… ……………………………………………………………… ………………………………………………………………	**2**
22.	*The diagram represents a time-lapse video of a person throwing a basketball into the air. A camera was used to record the video at five frames per second. The first frame was taken the moment the basketball left the person's hands.*  *Calculate the maximum height the ball reaches above the ground.* ……………………………………………………………… ……………………………………………………………… ……………………………………………………………… ……………………………………………………………… ………………………………………………………………	**2**
23.	*The production of electromagnetic radiation in the radio waveband relies on the movement of electrons within the transmitting antenna.* *Describe how Maxwell's electromagnetic theory is compatible with this method used to produce radio waveband electromagnetic radiation.* ……………………………………………………………… ……………………………………………………………… ……………………………………………………………… ……………………………………………………………… ……………………………………………………………… ……………………………………………………………… ……………………………………………………………… ………………………………………………………………	**3**

24.	*The following schematic diagrams represent two models of the atom, one of which was proposed by JJ Thomson (Model 1) and the other by Ernest Rutherford (Model 2). The diagrams show what is predicted to happen if positively charged alpha particles are fired towards each model of the atom.*	**3**



Geiger and Marsden were asked by Rutherford to test Thomson's model of the atom. The experiment, with the observed results, is shown in the diagram below. The experiment was carried out in a vacuum.



Explain how the results of the Geiger and Marsden gold foil experiment changed scientific understanding of the atom from Model 1 to Model 2.

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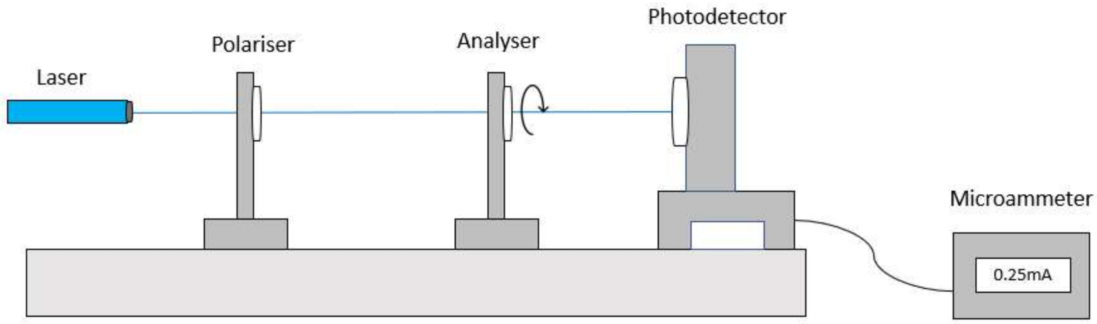
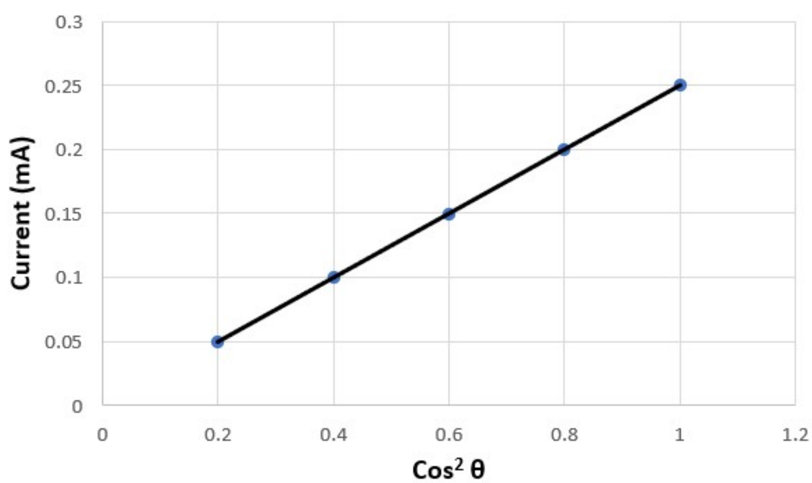
25. *A student used the following equipment to investigate Malus's Law.*



The photodetector converts light into electricity and the current reading on the microammeter is proportional to the intensity of the light incident upon the photodetector.

The student shone an unpolarized blue laser through both the polariser and analyser onto the photodetector and recorded the current measured on the microammeter. The student then continued rotating the analyser and recording the current before graphing their results below.



When the polariser and analyser were removed, and the blue laser was shone directly onto the photodetector, a current of 0.50mA was recorded on the microammeter.

a. Assess the accuracy of this investigation. **3**

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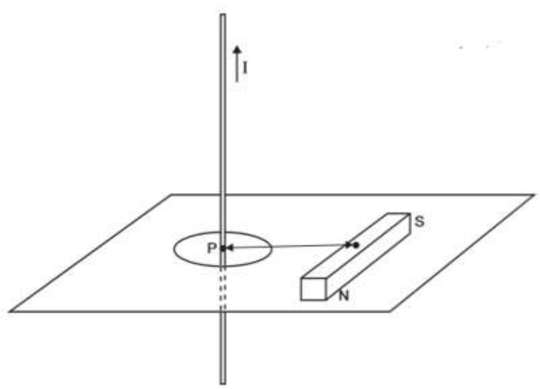
	A second student tried to repeat the investigation with an unpolarized red laser and could not get a current reading regardless of polariser and analyser orientation. *b. Explain why there was no current.* …………………………………………………………………………………… …………………………………………………………………………………… …………………………………………………………………………………… …………………………………………………………………………………… …………………………………………………………………………………… …………………………………………………………………………………… …………………………………………………………………………………… …………………………………………………………………………………… ……………………………………………………………………………………	**2**
26.	*A vertical wire carrying a current I is placed opposite the centre of a permanent bar magnet as shown in the figure. The magnet is fixed in its position.*  *Explain what will happen to the wire when the current is switched on.* …………………………………………………………………………………… …………………………………………………………………………………… …………………………………………………………………………………… …………………………………………………………………………………… …………………………………………………………………………………… …………………………………………………………………………………… …………………………………………………………………………………… …………………………………………………………………………………… …………………………………………………………………………………… …………………………………………………………………………………… ……………………………………………………………………………………	**3**

27. *The data shown in the table was shared by the Hubble Space Telescope.*

Galaxy	***Distance from earth (Mpc)***	***Recessional Velocity (kms^{-1})***
Alpha	*11*	*850*
Beta	*14*	*1050*
Omega	*32*	*1900*
Lambda	*51*	*3150*
Delta	*62*	
Zeta	*98*	*6200*

a. Graph the recessional velocity vs distance on the grid below **4**

b. Use your graph to determine recessional velocity of Delta. **1**

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c. Hubble's law can be expressed as

$$v = H_0 r$$

v = recessional velocity
H_0 = Hubble constant
r = distance

Describe what this means in practical terms. **1**

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d. Use the gradient of your graph to determine the value of the Hubble constant including units. **2**

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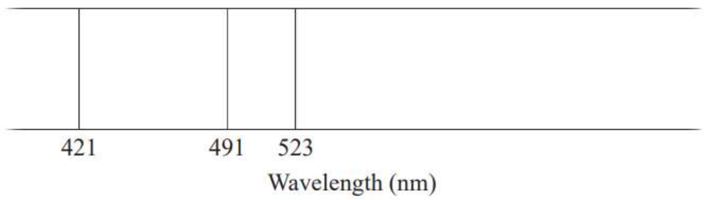
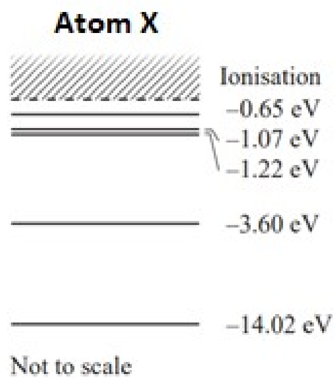
28. *A physicist has identified the emission spectrum of an unknown atom.*



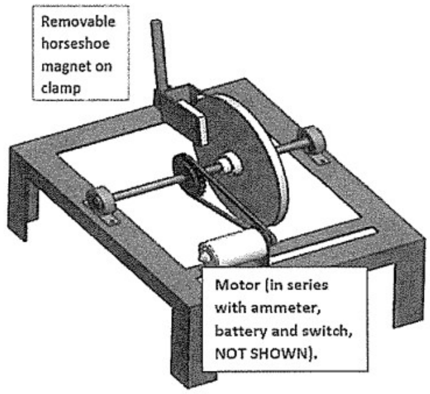
The physicist suspects the emission spectrum belongs to Atom X. The diagram below shows the atomic energy levels for Atom X.



a. Determine if Atom X is the unknown atom. Use calculations to support your response. **3**

b. Explain how such an emission spectrum is produced. **3**

29.	*A student set up an aluminium disc which is able to rotate in a vertical plane. The axle of the disc has a pulley wheel turned by a motor in series with an ammeter, battery and switch. A clamp with a horseshoe magnet can be attached so that a horizontal magnetic field passes through one part of the disc. (NOTE the magnet does not touch the disc).*	**6**



The student observes the current and the speed of disc rotation, before and after the magnet is attached with its magnetic field passing through the disc. When the magnet is in place, the current through the ammeter increases ***and*** *the speed of rotation of the disc decreases.*

Explain these TWO observations.

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30.	*A 100 kg satellite is placed into a near circular orbit with an average path radius of 6.671 x 10^6 m around the Earth.* *At what altitude would a 200kg satellite have an orbital period twice that of this 100 kg satellite?* ……… ……… ……… ……… ……… ……… ……… ……… ……… ……… ……… ……… ………	**3**
31.	*Muons are particles which are produced by the interaction of cosmic ray particles with molecules in the upper atmosphere of the Earth.* *Describe how the detection of muons at the Earth's surface provides evidence for special relativity.* ……… ……… ……… ……… ……… ……… ……… ……… ……… ……… ……… ……… ……… ………	**3**

32.	*Using Huygens' wave model of light as an example explain how models are developed and validated in science.* ……………………………………………………………………………………………… ……………………………………………………………………………………………… ……………………………………………………………………………………………… ……………………………………………………………………………………………… ……………………………………………………………………………………………… ……………………………………………………………………………………………… ……………………………………………………………………………………………… ……………………………………………………………………………………………… ……………………………………………………………………………………………… ……………………………………………………………………………………………… ……………………………………………………………………………………………… ……………………………………………………………………………………………… ………………………………………………………………………………………………	**4**
33.	*A rocket is in orbit a distance R from the centre of the Earth. At this height it has gravitational potential energy (U) equal to -4E Joules. The rocket is then boosted to an orbit where its gravitational energy is -E Joules.* *a. Complete the table below to show the missing values.*	**2**

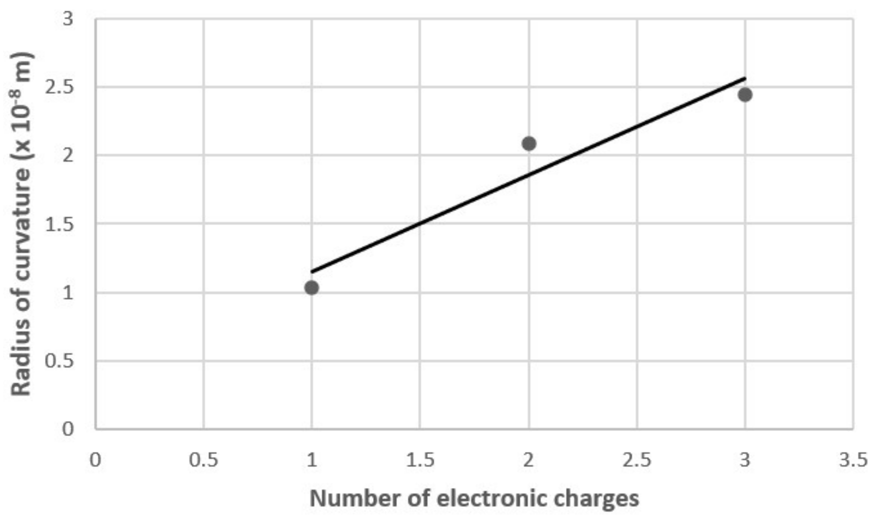
	Gravitational potential energy (J)	***Orbital Kinetic Energy (J)***	***Total Energy (J)***
Initial position	*-4E*		
Final position	*-E*		

	b. Justify the change in kinetic energy of the rocket by deriving the relationship between velocity of an orbiting object and the radius of its orbit. ……………………………………………………………………………………………… ……………………………………………………………………………………………… ……………………………………………………………………………………………… ……………………………………………………………………………………………… ………………………………………………………………………………………………	**2**

34. *Using a mass spectrometer, some students did an experiment to determine the relationship between the charge on a particle and its radius of curvature in a magnetic field. They used 3 atomic nuclei of varying charge to conduct their investigation. The results are shown in the table below.* **4**

Atomic Nuclei	***Atomic Mass (amu)***	***Charge of nuclei (Number of electronic charges)***	***Radius of curvature of path ($\times 10^{-8}$ m)***
Hydrogen	*1*	*+1*	*1.04*
Helium	*4*	*+2*	*2.09*
Lithium	*7*	*+3*	*2.44*

The students plotted their results, shown on the graph below, and concluded that the radius of curvature of a charge in a magnetic field is proportional to the magnitude of the charge.



Evaluate their conclusion and identify any problems with their method.

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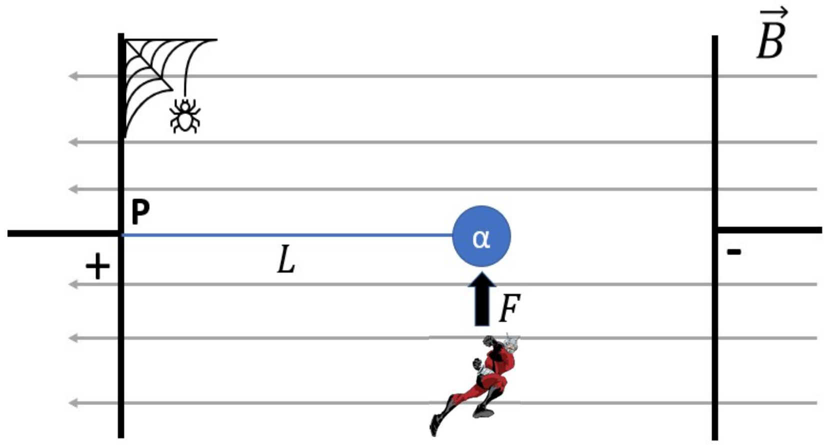
35. *A quantum spider has managed to catch an alpha particle with a single thread of quantum spider silk of length (L) 2.2 x 10^{-11} m. Quantum spider silk is incredibly strong and massless. The spider silk is fixed at point* **P**, *allowing the alpha particle to be at rest within both an electric and magnetic field (pictured below). The electric field strength is 50V/m, magnetic field strength is 0.25T and the effects of gravity are neglible.*

Upon entering the quantum world, Antman collides with the alpha particle applying a force on the particle and displacing it from its rest position. This force is pictured below and is applied up the page causing the alpha particle to rotate around point **P** *with a radius of 1.5 x 10^{-11}m.*



a. Calculate the speed of the alpha particle. Show your working. **3**

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b. Describe the motion of the alpha particle if the spider silk was cut while the alpha particle was rotating. **2**

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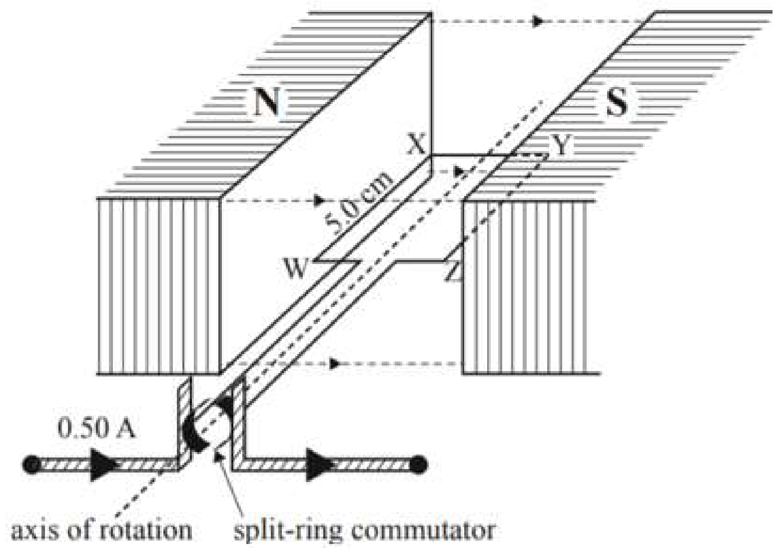
36. *A model representing a single coil motor is shown below.*



a. If the field strength between the magnets is 0.3 T and the maximum torque generated by the motor is 1.8×10^{-4} Nm, calculate the length X-Y of the loop. **2**

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b. Explain what would happen if the motor was connected to an AC supply. **2**

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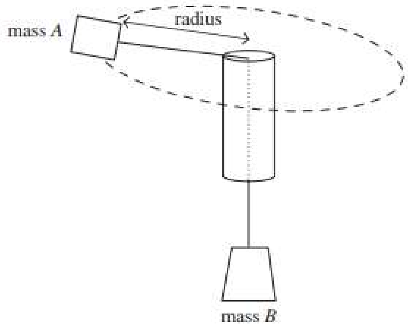
37. *A student conducted several tests on circular motion. In the tests, mass A was swung on a circular path. Mass B provided the necessary force to balance mass A, resulting in a known radius as shown in the diagram.*



The student varied the masses and radius for each test. They measured the time for mass A to make 10 rotations three times for each mass and radius, then averaged the three results to produce the table shown.

Test	*Mass of A (g)*	*Mass of B (g)*	*Radius of circle (m)*	*Time for 10 rotations (s)*
1	50	50	0.125	10
2	50	50	0.200	13
3	50	50	0.250	14
4	50	50	0.375	17
5	50	75	0.125	8
6	50	100	0.125	7
7	50	200	0.125	5
8	125	50	0.125	16
9	250	50	0.125	22
10	750	50	0.125	27

a. Write a suitable aim that tests 1-4 were trying to address. **1**

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b. For tests 5,6 and 7, identify the dependent variable and one controlled variable. **2**

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c. Assuming there are no frictional forces derive an equation for the radius of mass A in terms of v (velocity) and g (gravity). **2**

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38. *A laser light is incident on two slits, S1 and S2, that are 4.0×10^{-4} m apart, as shown in Figure 11a. Rays from the slits meet on a screen 2.00 m from the slits to produce an interference pattern. Point C is at the centre of the pattern. Figure 11b shows the pattern obtained on the screen.*

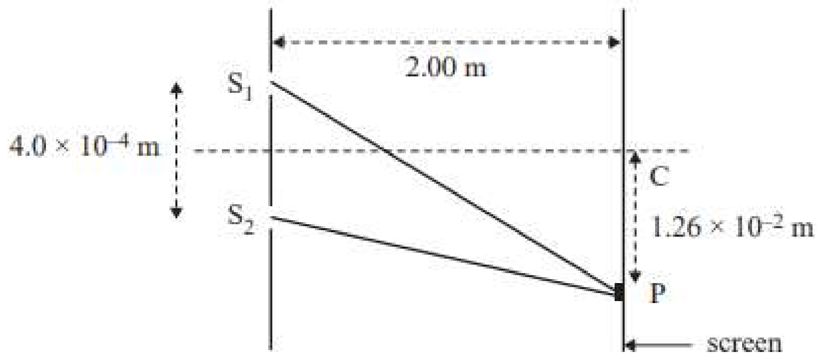

Figure 11a

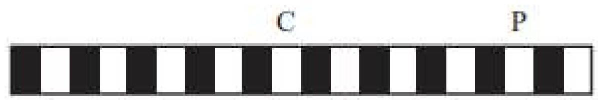

Figure 11b

a. There is a bright fringe at point P on the screen. Explain how this bright fringe is formed. **2**

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b. The distance from the central bright fringe at C to the bright fringe at point P is 1.26×10^{-2} m. Calculate the wavelength of the laser light. **2**

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39.	*Analyse how Planck's investigation of black body radiation contributed to our understanding of matter and light.*	**6**