KASH JOURNEY CONCLUDES IN THIS BOOK (Book 6)

Zolo King has sent an urgent request to prepare Physics Examination Paper for Zolo students.

Zolo Certificate of Education Examination, 2018 Physics

Total working time allowed: 3 hours **Reading time allowed: 10 minutes**

Structure of this paper

Section	Number of questions	Number of questions to be answered	**Suggested working time**	Marks available	Percentage of exam
One: Short Response	14	14	**50**	54	30
Two: Problem solving	7	7	**90**	90	50
Three: Comprehension	2	2	**40**	36	20
Total					**100**

When calculating numerical answers, show your working or reasoning clearly. Give final answers to **three significant figures** and **include appropriate units where applicable**.

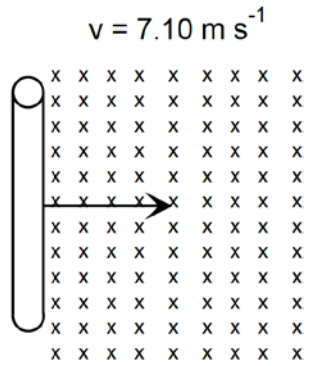
When estimating numerical answers, show your working or reasoning clearly. Give final answers to a maximum of **two significant figures** and **include appropriate units where applicable**.

You must be careful to confine your responses to the specific questions asked and to follow any instructions that are specific to a particular question.

Question 1 **(3 Marks)**

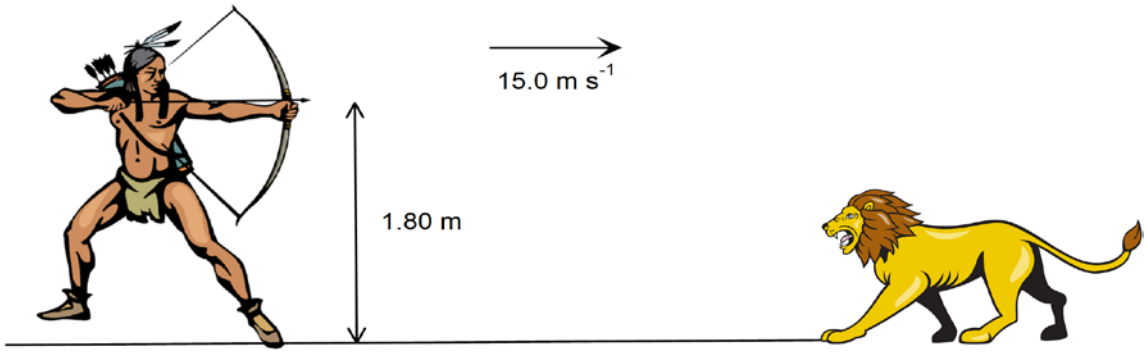
A 15.0 cm long piece of gold wire is moved at a constant velocity of 7.10 m s^{-1} through a magnetic field of 0.160 T.

Calculate the potential difference between the ends of the wire and indicate on the diagram which end of the wire is positive.



Question 2 **(3 Marks)**

The legendary Tarzan releases an arrow with a speed of 15.0 ms-1 horizontally from a height of 1.80 m from ground onto a charging lion to chase the lion (not to kill).

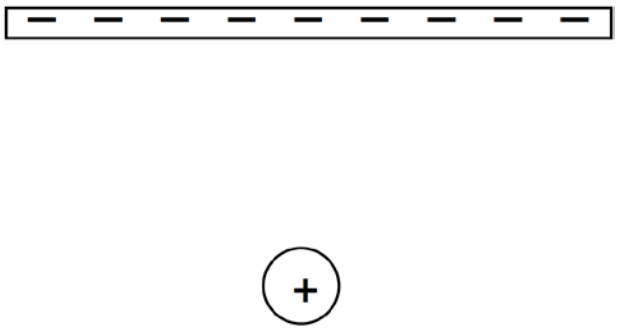


What is the maximum horizontal distance the arrow will travel before landing on the ground?

Question 3 **(4 Marks)**

a) Draw 5 electric field lines around equally charged two spheres placed closure to each other

b) A charged sphere is placed closure to a charged plate. Draw at least five electrical field lines



Question 4 **(4 Marks)**

Quarks are fundamental particles. All hadrons are composed of different combinations of quarks. Baryons and mesons are sub-groups of hadrons. Baryons are made from a combination of three quarks while mesons are made of one quark and one antiquark.

All quarks have a baryon number of $+\frac{1}{3}$ and all antiquarks have a baryon number of $-\frac{1}{3}$. All baryons have a baryon number of $+1$.

(a) Kaon, K is a meason. Determine the baryon number of kaon.

(b) Baryon number must be conserved in all reactions. By applying baryon number, determine whether the following reactions can occur (show working)

proton and neutron are baryons and π^+ and π^- are mesons.

(i) $\mathbf{p} + \mathbf{p} \rightarrow \mathbf{p} + \mathbf{p} + \pi^+ + \pi^0$

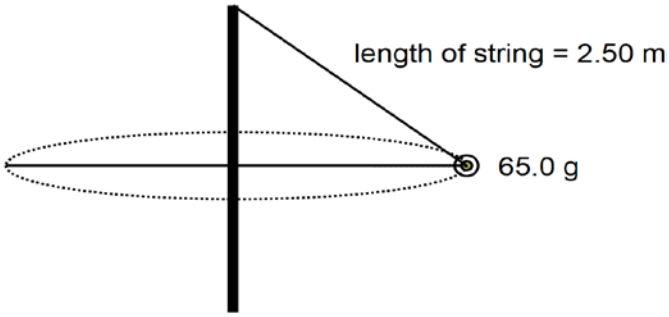
(ii) $\mathbf{p} + \mathbf{p} \rightarrow \mathbf{p} + \mathbf{p} + \mathbf{n}$

(iii) For reaction to occur, charge must also be conserved. Will reaction one can occur? Justify by showing working.

π^+ : + 1 charge π^0 : 0 charge

Question 5 **(4 Marks)**

A ball of mass 65.0 g undergoes a circular motion. At a particular speed, the string makes an angle of 50.0^0 to the horizontal.

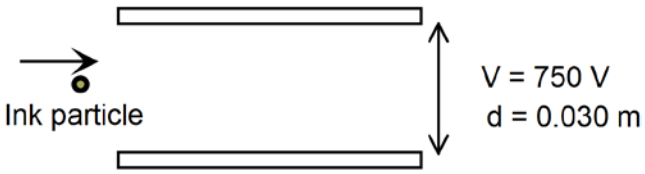


(a) Show the forces acting on the ball.

(b) Calculate the number of circles the ball will make around a vertical post in 5.00 minutes.

Question 6 **(3 Marks)**

A charged ink particle enters the electric field generated between two metal plates that have a potential difference of 750 V.

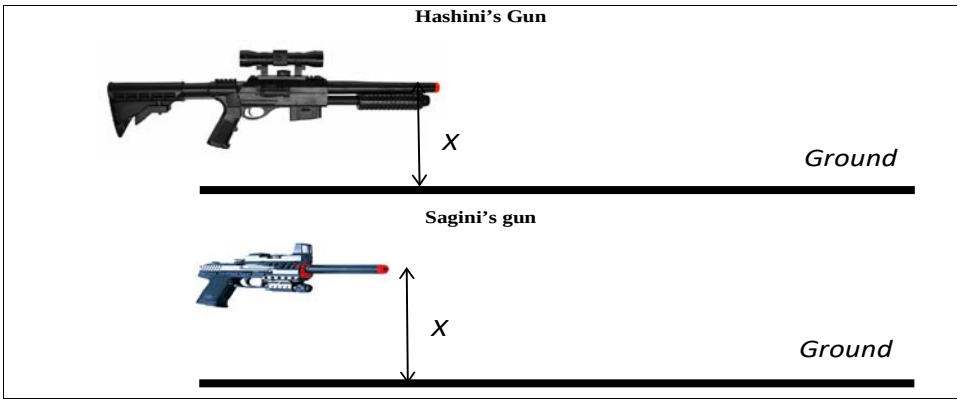


(a) Calculate the electric field intensity between the plates if the plates are separated by 0.030 m.

(b) Calculate the charge on ink particle that will cause the particle experience a force of 1.65×10^{-7} N

Question 7 **(2 Marks)**

Hashini and her little sister Sagini are playing with their recently bought toy guns. Hashini's gun **is bigger and fires a large rubber projectile at a faster speed** than Sagini's gun.



If both guns shoot their projectiles horizontally at the same time from same height (x) from the ground, **explain which projectile (if any) will hit the ground first**. Assume air resistance is negligible.

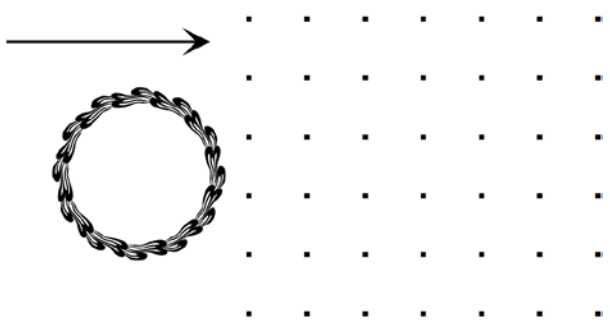
Question 8 **(4 Marks)**

(a) An electron with a deBrogile wavelength of 2.65 x 10^{-1} nm travels inside of an electron microscope. Calculate the speed of electron (ignore any relativistic effect on mass)

(b) If a proton travels at a speed of 25% of the speed of light, what would be the relativistic momentum of the proton?

Question 9 **(4 Marks)**

A circular metal ring of radius 15.0 cm enters a uniform magnetic field density of 1.50 W m^{-2} which is directed out of page.



a) Calculate the maximum flux that can pass through the ring

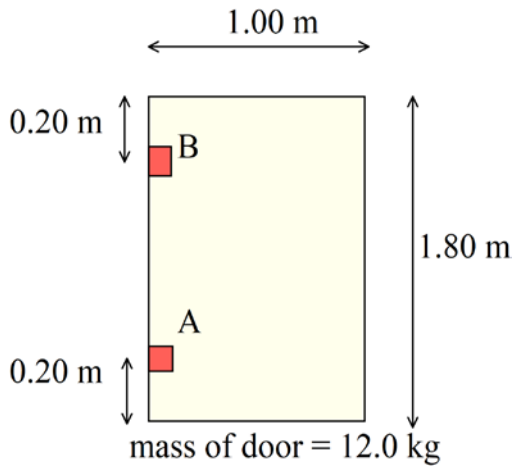
b) What is the direction of induced current when the ring leaves the magnetic field region? State by circling the correct answer below.

i) Clockwise ii) Anticlockwise

c) Explain why current is induced, incorporating relevant physics laws, in your description.
[take note that mentioning the name(s) of laws alone is insufficient]

Question 10 **(5 marks)**

A uniform door of length 1.80 m and width of 1.00 m is supported by 2 hinges A and B as shown in the diagram below. Each hinge supports half the weight of the 12.0 kg door.



a) Show the direction of the horizontal force acting on each hinge in the above diagram.
(Hint: Take A as pivot point)

b) Calculate the horizontal force acting on hinge B
(Hint: Take A as pivot point)

c) Show the direction of reaction force acting on hinge B.

Question 11 **(3 marks)**

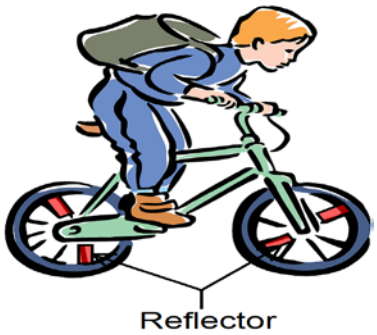
Two spaceships, Z-10 and Z-50, enter the planet Zolo form opposite directions as shown below.

If the speed of Z-10 relative to Zolo is 0.95c and the speed of Z50 relative to Z-10 is 0.90 c, calculate the speed of Z-50 relative to planet Zolo.

Question 12 **(6 marks)**

The bicycle in the picture has safety reflectors attached to its spikes.

Jonathan riding his bicycle on a straight road at a constant speed.



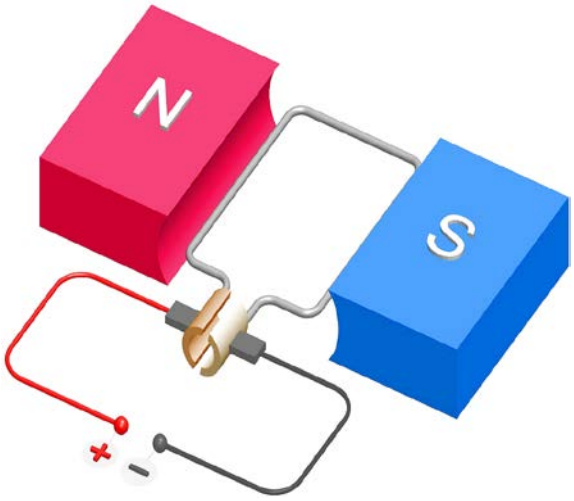
a) Explain why the safety reflector is accelerating even though the bicycle travels at a constant speed.

b) Jonathan has to lean when travelling along a circular bend to avoid falling. Explain why this is so.

c) At what minimum angle, Jonathan should lean **to the horizontal** if he is riding along a circular bend of radius 15.0 m at a speed of 10.0 m s^{-1}?

Question 13 **(6 marks)**

The diagram below show a simple motor.



a) Label the split ring commutator and carbon brushes and explain the function of these two parts.

b) Show the direction of torque by circling the correct answer.

i) Clockwise ii) Anticlockwise

c) Calculate the length of a square coil of a motor that will generate a maximum torque of 3.00 Nm, if the number of turns in the coil is 25, current to the coil is 2.00 A and the magnetic field strength due to magnets is 1.50 T.

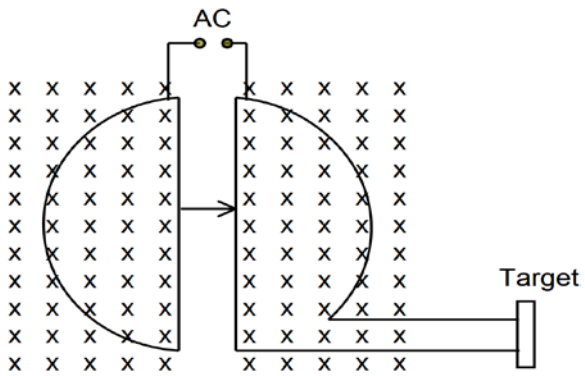
Question 14 **(3 marks)**

Calculate the period of a stable satellite orbiting the planet Zolo, if the mass of Zolo is 0.700 times of the mass of Earth and the radius of Zolo is 5.98×10^6 m. The altitude of the satellite from the surface of Zolo is 30.0×10^3 km.

End of Section One

Question 15 **(10 Marks)**

A deuterium ion with **a single positive charge** (m = 3.34 x 10^{-27} kg) enters from one dee to other as shown by line and arrow head in the diagram. Magnetic field strength perpendicular to each dee is 1.15 T and directed into the page.



Calculate the kinetic energy of the charged particle when it leaves the cyclotron, if the diameter of cyclotron is 25.0 cm.

a) Calculate the kinetic energy of the charged particle when it leaves the cyclotron.

b) Show the path of the charged particle in the above diagram until it hits the target.

c) Explain why the charge particle gains kinetic energy when it moves across the dee each time.

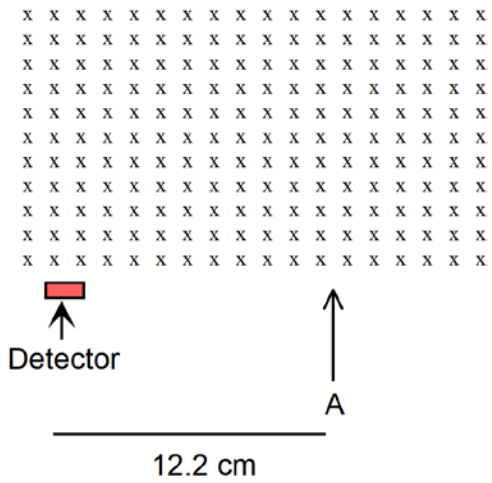
d) Cyclotron can fail if speed of charged particle inside a cyclotron reaches a relativistic speed. Explain why.

e) With suitable equation(s), explain why the radius of the charged particle is independent of the period of the charge particle when spiralling inside the cyclotron.

Question 16 **(14 marks)**

The path that a charged particle takes in a magnetic field is used to determine the mass of the particle.

A particle with a charge of 3.20×10^{-19} C enters a magnetic field of magnitude 0.150 T with a velocity of 4.35×10^{5} m s^{-1} that is perpendicular to the magnetic field. The charged particle travels in a semicircle and is detected at a distance of 12.2 cm from the injection point as shown below.



a) Draw the path of the charged particle in the magnetic field.

b) State whether the particle is positively or negatively charged by circling the correct answer.

i) Positively charged ii) Negatively charged

c) Calculate the force exerted on the charged particle when it is in the magnetic field region.

d) Explain why charged particles move with **uniform circular motion** when they enter a magnetic field with a velocity that is perpendicular to the magnetic field.

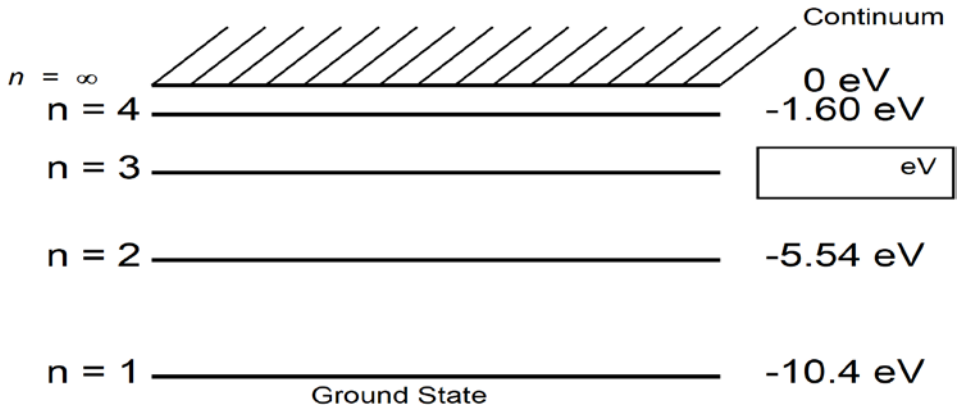
e) Derive the expression, $r = \frac{mv}{qB}$, for the radius r of the circular path of a particle that is moving with speed v at right angles to a uniform magnetic field of magnitude B. The particle has charge q and mass m.

f) Calculate the mass of the charged particle.

g) If deuterium ion with two positive charge and mass of 2.34×10^{-27} kg enters the magnetic field region at the same injection point, draw the path of this ion using dotted line in the diagram given above and label clearly.

Question 17 **(12 marks)**

The diagram below shows some of the energy states of a mercury atom.



a) Electron falls from a high energy level to energy level 2. Draw the transition using line with arrow head to represent the transition that will give the largest wavelength in the above diagram.

b) If the photon released has a frequency of 5.14×10^{14} Hz, when electron moves from energy level 3 to 2, calculate the **energy of energy level 2 in eV** and enter this vale in the diagram (inside the box).

c) Calculate the ionisation energy in J.

d) Low pressure mercury vapour in a gas discharge tube produce coloured lines when see through spectroscope. Describe the physics process involved.

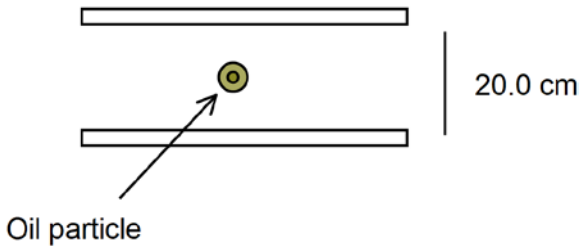
Question 18 **(14 marks)**

A Teltron tube is a device used to accelerate electrons using potential difference between two parallel plates. Electrons are deflected when they enter the region between two parallel plates where potential difference has been applied.

a) Explain why electrons will experience an electric force of constant magnitude when they are between two very long parallel plates to which a constant potential difference has been applied.

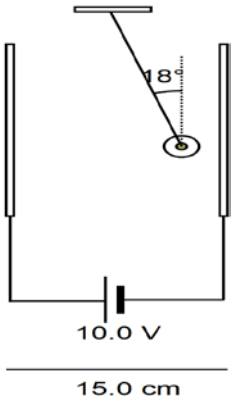
b) An uncharged oil droplet is negatively charged by adding 100 electrons. The charged oil particle is placed between two parallel plates and a potential difference of 1.60 kV is applied. The distance between the parallel plates is 20.0 cm.

If the charged oil particle **remains stationary**, calculate the mass of the charged oil particle. Ignore the effect of friction.



c) A charged ball is hanged between two parallel plates that are separated by a distance of 15.0 cm and a potential difference of 10.0 V is applied between plates as shown below. The ball makes an angle of 18.00 to the vertical.

i) Calculate the electric field between the plates



ii) Calculate the mass of the ball if the ball has a positive charge of 0.012 C.

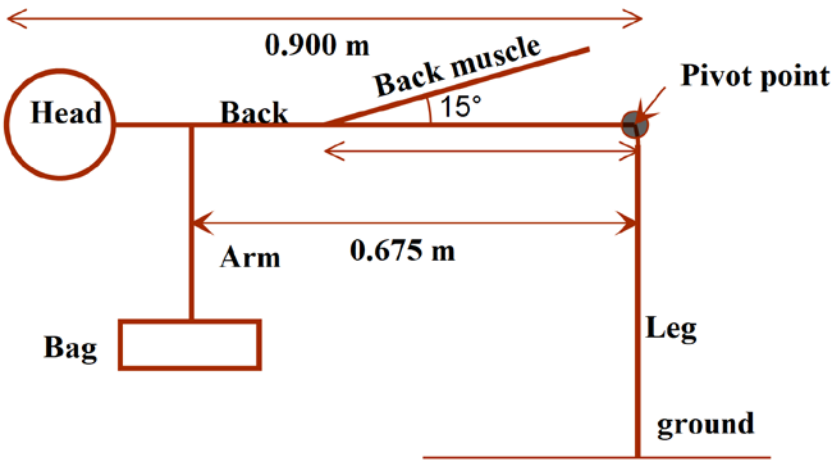
iii) Explain why the ball moved to the right.

iv) Show the forces acting on the charged ball in the above diagram.

Question 19 **(12 marks)**

The schematic diagram below represents a lady of mass 55.0 kg bends over and raise a 10.0 kg bag. Her back is in horizontal position. **The back muscle is attached to the body half way from the upper body**. **Length of upper body is 0.900 m**. **The angle between the spine and muscle is 15^0**. The shoulders are three fourth of the way along the upper body.

Assume the weight of bag is vertically below the shoulder and her centre of mass (when not lifting the bag) is located where back muscle attached to the spine. **Distance from pivot point to shoulder is 0.670 m.**



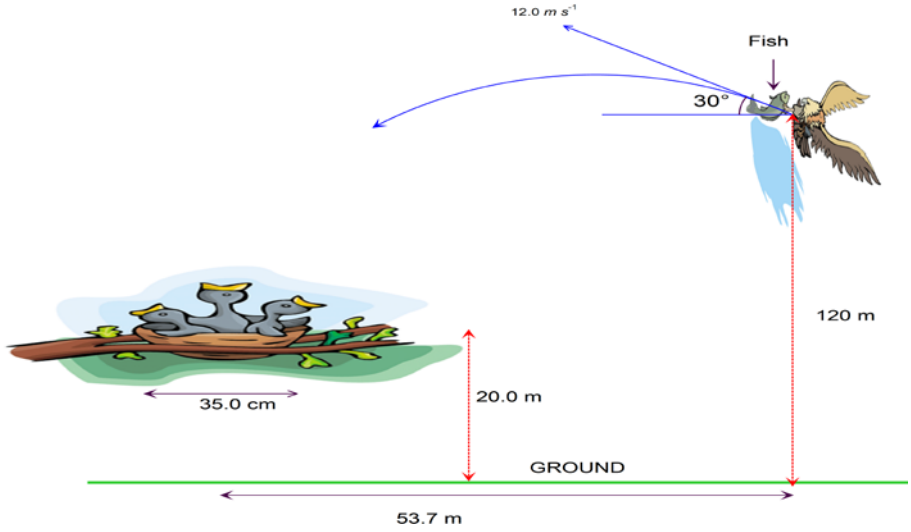
a) Show all the forces acting on the back in a free body diagram.

b) Calculate the magnitude of tension in the back muscle.

c) Back muscle will be injured if the tension in the back muscle exceeds 3000 N. Calculate the maximum mass the lady can lift without injuring her back muscle.

Question 20 **(12 marks)**

A cockatoo is carrying a fish to the chicks in its nest. The cockatoo is flying at a speed of 12.0 m s^{-1} at an angle of 30^0 to the horizontal. The fish wriggles free and falls when the cockatoo is 120 m above the ground and 53.7 m horizontally from the nest. The height of the nest from the ground is 20.0 m and the diameter of the nest is 35.0 cm.



(a) Determine the horizontal and vertical components of the **initial velocity of the fish**.

(b) How long does it take the fish to travel the vertical distance to the cockatoo's nest?

(c) Will the fish land in the cockatoo's nest? Justify your answer with suitable calculation/s.

Question 21 **(16 marks)**

The data below relates to the five moons of Saturn. Each moon has a period denoted by *T* and a distance from **Saturn's** centre denoted by R.

Table 1:

Name of Moon	Orbital Radius, R (km)	Period, T (Days)	R^3 (x 10^{25}) m^3 (x)	T^2 (x10^{10}) sec^2 (y)
Mimas	185 539	0.94	**0.64**	**0.66**
Enceladus	238 020	1.37	**1.35**	**1.40**
Tethys	294 619	1.89		
Dione	377 396	2.74		
Rhea	527 108	4.52	**14.65**	**15.25**

a) Using appropriate equations provided in the datasheet, establish Kepler's 3rd law equation that give the relationship between orbital radius of a star, mass of a planet orbiting the star and orbital period.

b) The linear graph that relates the period squared against distance cubed of Kepler's equation can be used to calculate the mass of the star.

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

i) Complete the missing data in the Table 1 provided above.

ii) Plot a graph and establish a line of best fit.

iii) Determine the gradient of the graph using the line of best fit.

iv) Estimate the mass of Saturn.

v) If the actual mass of Saturn is 5.68×10^{26} kg, calculate the percentage of error.

END OF SECTION 2

Question 22 **(18 Marks)**

The energy quantization of electromagnetic radiation in general, and of light in particular, is expressed in the Plank's relation, $E = h\frac{c}{\lambda}$ where E is the energy of the radiation, f is its frequency, and h is Planck's constant (6.63×10^{-34} Js)

Its validity is based on solid experimental evidence, most notably the *photoelectric effect*. The basic physical process underlying this effect is the emission of electrons in metals exposed to light.

Consider the conduction electrons in a metal to be bound in a well-defined potential. The energy required to release the most loosely held outer most electron is called the *work function* W0 of the metal.

Experimental evidence shows that light frequency should exceed a threshold *frequency* ft for an electron to be emitted.

The photoelectric equation involves;

$$hf = E_{K\,max} + W_0 \qquad \text{(Eq. 1)}$$

Where:

- h = the Plank constant (6.63×10^{-34} J s)
- f = the frequency of the incident light in hertz (Hz)
- W_0 = the work function in joules (J)
- $E_{k\,max}$ = the maximum kinetic energy of the emitted electrons in joules (J)

The energy of a photon of light = hf.

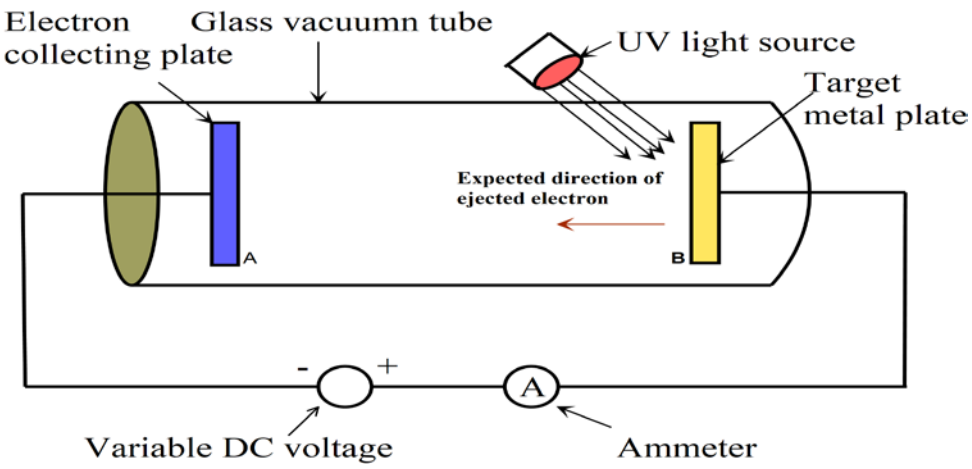
The photoelectric current in a typical setup is extremely small, and making a precise measurement is difficult. However, we can apply a reverse voltage to the anode; this reverse voltage repels the electrons and prevents them from reaching the anode. The minimum required voltage is called the *stopping potential* Vs, and the "stopping energy" of each electron is therefore qVs, Where q is the charge of an electron.

Equation 1 can be rewritten as equation 2 by substituting qVs into $E_{K\,Max}$.

$$V_s = \frac{hf}{q} - \frac{W_0}{q} \qquad (Eq\ 2)$$

Eq. (2) shows a linear relationship between the stopping potential Vsand the light frequency f, with slope $\frac{h}{q}$ and vertical intercept $-\frac{W_0}{q}$. If the value of the electron charge q is known, then this equation provides a good method for determining Planck's constant h and work function W_0 of a metal.

Sayalee and her group of students carried out an experiment to determine the work function of an unknown metal and Plank's constant. The experimental setup is shown in the diagram below.



The data collected is provided in Table 1.

Frequency of incident UV light (x 10^{15} Hz)	V_{stop} (V)
1.1	0.10
1.3	0.75
1.5	1.6
1.7	2.5
2.0	3.7

a) Light has the properties of particles and waves, called particle wave duality of light.

i) Name the property of light is demonstrated in this experiment.

ii) Explain how the experiment supports only one of the two properties and not the other.

b) What is the purpose of using vacuum tube?

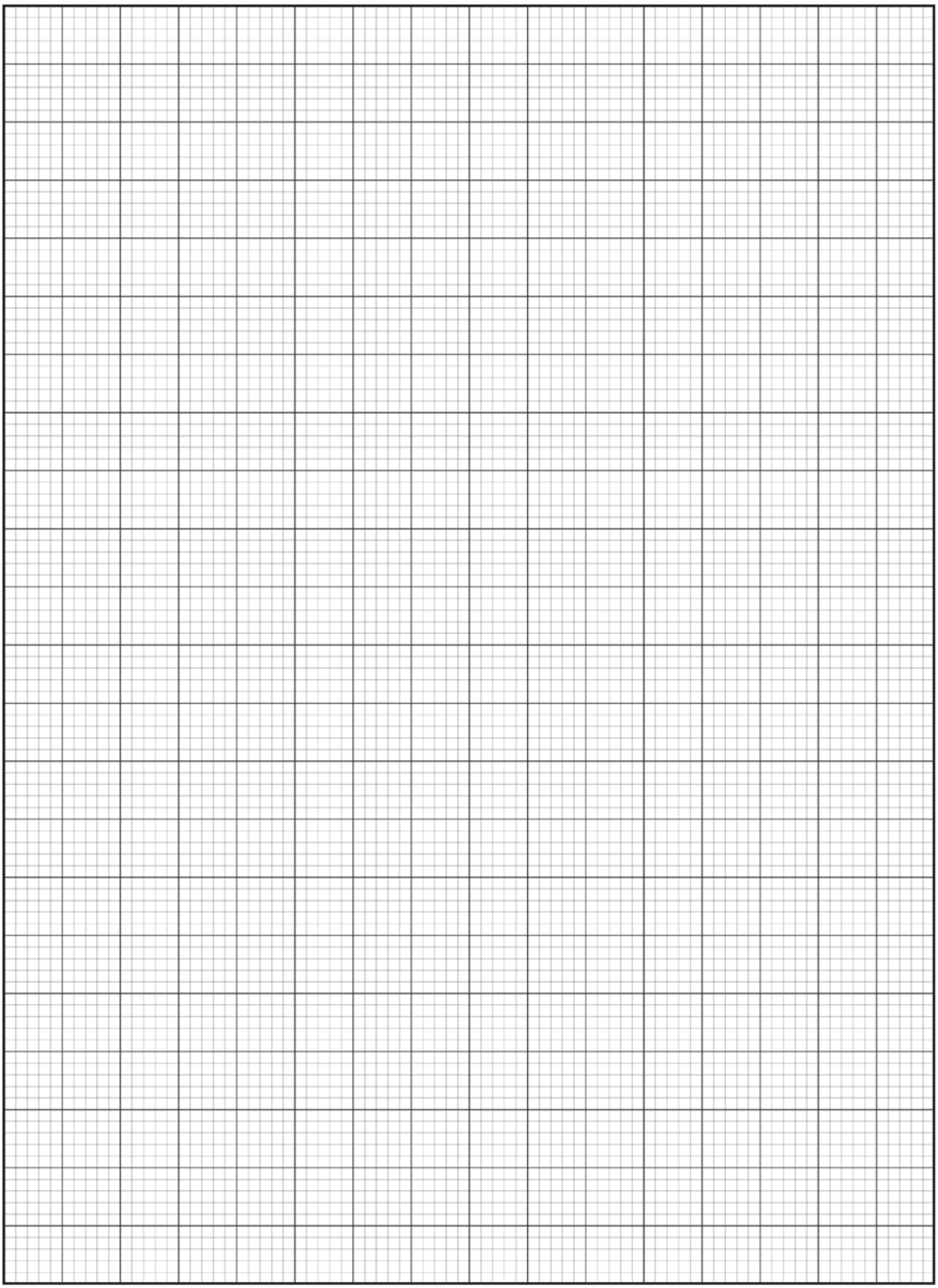
c) Name the electron collecting plate by circling the correct answer

(I) Anode (II) Cathode

d) Name the target metal plate by circling the correct answer

(I) Anode (II) Cathode

e) Draw a graph and establish a line of best fit in the graph paper provided below.



f) Calculate Plank's constant

g) Calculate the work function of the target metal.

h) Describe an experiment that supports a wave nature of light.

i) Photons with a wavelength of 500 nm is shone into an unknown metal found in planet Zolo. If the stopping voltage is 5.25 V, calculate the maximum kinetic energy of the ejected electron and the work function of the metal in eV.

E_K Max in eV	**Work function in eV**

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