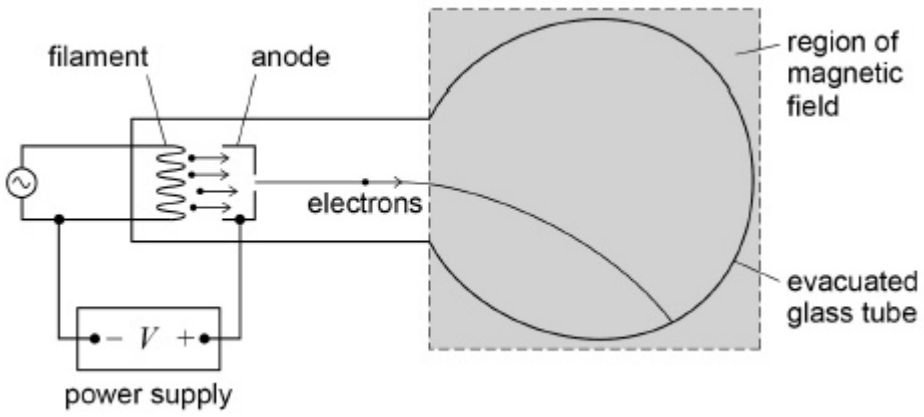
3 The diagram shows apparatus which can be used to determine the specific charge of an electron.



Electrons are emitted from the filament and accelerated by a potential difference between the filament and anode to produce a beam. The beam is deflected into a circular path by applying a magnetic field perpendicular to the plane of the diagram.

(a) Describe the process that releases the electrons emitted at the filament.

(3)

(b) The table shows the data collected when determining the specific charge of the electron by the method shown in the diagram.

potential difference V that accelerates the electrons	320 V
radius r of circular path of the electrons in the magnetic field	4.0 cm
flux density B of the applied magnetic field	1.5 mT

Show that the specific charge of the electron is given by the expression $\frac{2V}{B^2r^2}$

(2)

(c) Using data from the table, calculate a value for the specific charge of the electron.
Give your answer to an appropriate number of significant figures.

specific charge of the electron = _____ C kg^{-1}

(2)

(d) At the time when Thomson measured the specific charge of the particles in cathode rays, the largest specific charge known was that of the hydrogen ion.

State how Thomson's result for the specific charge of each particle within a cathode ray compared with that for the hydrogen ion and explain what he concluded about the nature of the particles.

_____

_____

_____

_____

_____

_____

_____

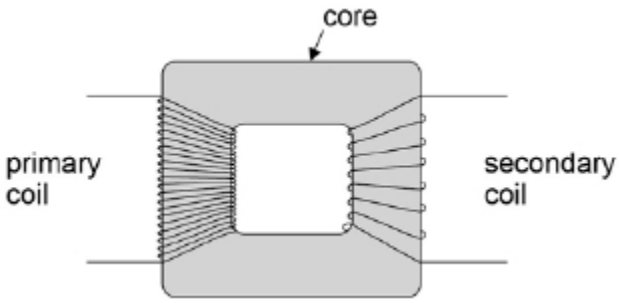
_____

(2)

(Total 9 marks)

6 **Figure 1** shows a step−down transformer used in a laptop power supply.

Figure 1



(a) Explain the purpose of the core in the transformer.

_____

_____

(1)

(b) Describe and explain **two** features of the core that improve the efficiency of the transformer.

1. _____

_____

_____

2. _____

_____

_____

(2)

(c) Explain why transformers only work continuously when supplied with an alternating current.

_____

_____

_____

_____

(1)

(d) The primary coil of the transformer is connected to a 230 V_{rms} ac supply. The current in the primary coil is 0.30 A_{rms}. The secondary coil has 300 turns and provides an output of 20 V_{rms} and a power of 65 W.

Calculate the number of turns on the primary coil.

number of turns on primary =_____

(1)

(e) Calculate the efficiency of the transformer.

efficiency _____

(2)

(Total 7 marks)

7 Two charged particles, $\mathbf{P}_1$ and $\mathbf{P}_2$, follow circular paths as they move at right angles to the same uniform magnetic field. Both particles are travelling at the same speed.

The radius of the path travelled by $\mathbf{P}_1$ is twice the radius of the path travelled by $\mathbf{P}_2$.

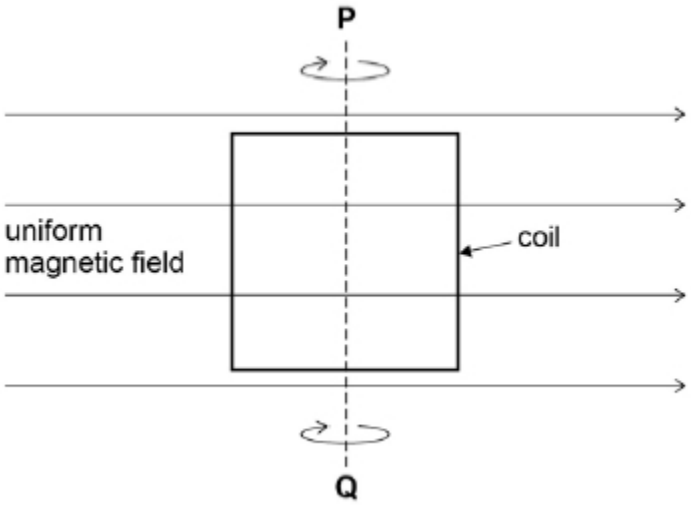
The mass of $\mathbf{P}_1$ is m and its charge is q.

What is the mass of $\mathbf{P}_2$ and the charge of $\mathbf{P}_2$?

	Mass of $\mathbf{P}_2$	**Charge of $\mathbf{P}_2$**	
A	$2m$	q	⬭
B	$2m$	$2q$	⬭
C	$\sqrt{2}\,m$	$\sqrt{2}\,q$	⬭
D	m	$2q$	⬭

(Total 1 mark)

8 A rectangular coil of area A has N turns of wire. The coil is in a uniform magnetic field of flux density B with its plane parallel to the field lines.



The coil is then rotated through an angle of 30° about axis **PQ**.

What are the correct initial value and correct final value of the magnetic flux linkage?

	Initial magnetic flux linkage	**Final magnetic flux linkage**	
A	0	$\frac{1}{2}BAN$	⬭
B	0	BAN	⬭
C	BAN	$\frac{1}{2}BAN$	⬭
D	BAN	BAN	⬭

(Total 1 mark)

9 Charged particles, each of mass m and charge Q, travel at a constant speed in a circle of radius r in a uniform magnetic field of flux density B.
Which expression gives the frequency of rotation of a particle in the beam?

A $\frac{BQ}{2\pi m}$ ⬭

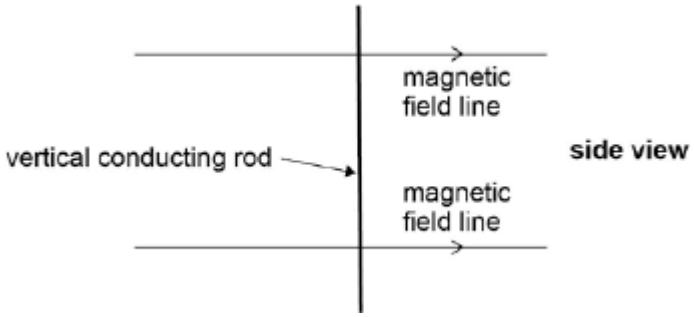
B $\frac{BQ}{m}$ ⬭

C $\frac{BQ}{\pi m}$ ⬭

D $\frac{2\pi BQ}{m}$ ⬭

(Total 1 mark)

10 A vertical conducting rod of length l is moved at a constant velocity v through a uniform horizontal magnetic field of flux density B.



Which of the rows gives a correct expression for the induced emf between the ends of the rod for the stated direction of the motion of the rod?

	Direction of motion	Induced emf	
A	Vertical	$\frac{B}{lv}$	⬭
B	Horizontal at right angles to the field	Blv	⬭
C	Vertical	Blv	⬭
D	Horizontal at right angles to the field	$\frac{B}{lv}$	⬭

(Total 1 mark)