Name of the Student:_____
Max. Marks : 23 Marks **Time : 23 Minutes**

Mark Schemes

Q1.

(a) $N = \frac{\Phi}{AB}$ Or $N = \frac{1.5 \times 10^{-3}}{2.5 \times 10^{-2} \times 5.0 \times 10^{-4}}$

N = 120 (turns) ✔$_2$

✔$_1$ *N must be the subject of the equation for the mark.*

✔$_2$ *A correct answer gains both marks.*

If no mark is awarded a single mark can be given for Φ = BAN cos 30° being used to find

N = 139.

2

(b) Φ(= NAB cosθ = 1.5 × 10^{-3} cos 30°)

Flux linkage = 1.3 × 10^{-3} (Wb turns) ✔

1

(c) $f = \frac{1}{T} = \frac{1}{0.25}$ = 4.0 (Hz) or ω = 25.1 or 8π (rad s^{-1}) ✔$_1$

Peak emf (= $BAN\frac{2\pi}{T} = 1.5 \times 10^{-3} \times \frac{2\pi}{0.25}$)

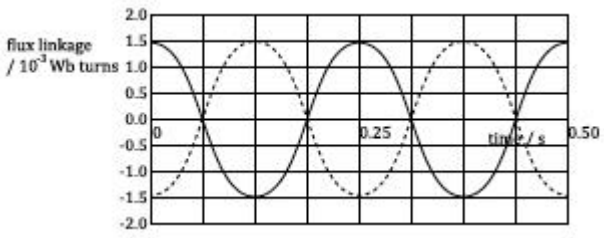
✔$_1$ *Condone using 1 sig fig for f but not ω or T.*

The mark can be gained from seeing f or ω or T given explicitly or from a substitution in the peak emf equation in the second mark.

✔$_2$ *A correct answer gains both marks.*

2

(d)



Either solid or dashed line gains mark ✔

The mark is dependent on the exact crossing of the time axis which has a tolerance of ± 1 small square.

The vertical axis figures is not expected.

Also ignore errors in height and the exact positions of the peaks.

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Only a rough sinusoidal shape is expected. A triangular shape with very slightly rounded edges would be acceptable.

1

[6]

Q2.

(a) The direction of the induced emf (when there is a change of flux linkage) is such that it will (try) to oppose the change (of flux) that is producing it ✔ owtte

A reference to emf is needed rather than induced current as this is dependent on a circuit. Ignore reference to current if emf is given.

1

(b) (The reading shows a dc) current flow which then becomes zero (when the magnet stops moving) ✔

The reading does not have to be steady. So reading increasing or pulsing up before falling to zero is okay. There should be no hint that the reading changes direction.

1

(c) (The induced current produces) a north pole on the right hand side of the coil ✔

which opposes the motion of the bar magnet

OR

and the two north poles repel each other

OR

to try to maintain the (small) magnetic field as the magnet approaches the coil (without this the magnet would increase the magnetic field beside the coil) ✔

The polarity of the coil may be shown on the diagram.

The two marks are independent but the second mark does not stand completely alone as it has to be said in context. EG 'Two North poles repel' on its own will not gain a mark.

2

(d) (Use of $\varepsilon = Blv$ as the straight leading edge of the coil is the only conductor that cuts the magnetic flux lines. Also using $v = s / t$)

$t = Bls/\varepsilon$ ✔

(There must be some evidence of use for the mark but the mark can come from substituting numbers, eg $t = 0.38 \times 0.032 \times 0.032 / 2.9 \times 10^{-4}$)

$t = 1.3(4)$ (s)✔

OR

(Using $\varepsilon = (-)N\,\Delta\varphi/\Delta t$ then $\Delta t = \Delta(BA)/\varepsilon$)

$t = BA/\varepsilon$ ✔

(There must be some evidence of use for the mark but the mark can come from substituting numbers, eg. $t = 0.38 \times .032^2 / 2.9 \times 10^{-4}$)

$t = 1.3(4)$ (s) ✔

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Useful numbers BA = 3.89 × 10^{-4}

Although the first mark can come from substituting numbers the equation mark may be lost if it is obvious that the equation is not understood by the way substitutions are made (this does not include a simple AE slip). This loss of a mark is directed at the candidate who quotes several equations and happens to hit on the correct equation but fails to use it properly.

Failure to square the side length is a PE.

Answer only gains 2 marks.

2

(e) (using $\varepsilon = BAN\omega \sin \omega t$ which give a maximum value of $\varepsilon_{max} = BAN\omega$)

ω (= ε_{max} /*BAN*) = 5.1 × 10^{-3} /(0.38 × $(0.032)^2$. ✔

ω = 13(.1) (rad s^{-1}) ✔

Candidates who cannot maximise/remove sin ωt gain no marks.

{may see ω = 5.1 × 10^{-3} /3.9 × 10^{-4}}.

2

[8]

Q3.

(a) Filament / metal is heated due to the current through it ✔

OR

Temperature of the filament rises due to the current through it

(Free / conduction) electrons gain sufficient/enough (kinetic) energy to leave (the metal surface)

OR

Work function (defines work function) ≤ energy supplied to an electron/electron energy ✔

Thermionic emission ✔

Not

Electrons are heated

Not heated due to the pd across it

Allow

By electrical power or electrically heated

Not allowed

Reference to electrons leaving <u>atoms</u> or ionisation

Allow

Energy supplied sufficient to overcome the work function

3

(b) Use one of $\frac{1}{2}mv^2 = eV$ and $r = \frac{mv}{Be}$ or $\frac{mv^2}{r} = Bev$

To arrive at

$\frac{Ber}{m} = v$ or $v = \sqrt{\frac{2eV}{m}}$ or $v^2 = \frac{2eV}{m}$

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or $\frac{e}{m} = \frac{v}{}$ or $\frac{e}{} = \frac{v^2}{}$ ✔

Substitution in the other equation and manipulates correctly and clearly to give $\frac{e}{m} = \frac{2V}{B^2r^2}$ ✔

Condone q for e

Substitution in other equation and correct manipulation

NB this is a show that so mark is not simply for stating the equation given

I presented such that v (velocity) and V (voltage) are indistinguishable in manipulation then award only first mark

2

(c) Correct substitution $\frac{e}{m} = \frac{2 \times 320}{(1.5 \times 10^{-3})^2 \times 0.040^2}$

And answer 1.8×10^{11} ✔

Answer to 2 sig figs ✔

Allow for incorrect answer following incorrect substitution in equation

As answer is on the data sheet must see correct substitution with all correct powers of ten

2

(d) The specific charge of the cathode rays/the particles was(much) larger/greater than the hydrogen ion/proton ✔

This provided evidence that cathode rays were composed of electrons/particles which have a (very) small mass / have a high (negative) charge

OR

Mass (much) smaller than the mass of a hydrogen (ion)/proton ✔

Not higher

If mark 1 not given then 0 for the question

Not lightest as substitute for mass

2

[9]

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