Name of the Student:_____
Max. Marks : 25 Marks **Time : 25 Minutes**

Mark Schemes

Q1.

(a) magnetic field direction: −*z* **(1)**

1

(b) direction changes meaning that velocity is not constant **(1)**

acceleration involves change in velocity
(or acceleration is rate of change of velocity) **(1)**

[**alternatively**

magnetic force on electron acts perpendicular to its velocity **(1)**
∴ force changes direction of movement causing acceleration **(1)**]

2

(c) (i) $BQv = \frac{mv^2}{r}$ **(1)** gives $v \left(= \frac{BQr}{m}\right)$

$= \frac{0.43 \times 10^{-3} \times 1.60 \times 10^{-19} \times 74 \times 10^{-3}}{9.11 \times 10^{-31}}$ **(1)** (= 5.59 × 10^6 m s^{-1})

2

(ii) angular speed $\omega \left(= \frac{v}{r}\right) = \frac{5.59 \times 10^6}{74 \times 10^{-3}}$ = 7.5(5) × 10^7 **(1)**

unit: rad s^{-1} **(1)** (accept s^{-1})

2

(iii) frequency of electron's orbit $f \left(= \frac{\omega}{2\pi}\right) = \frac{7.55 \times 10^7}{2\pi}$ **(1)**
(= 1.20 × 10^7 s^{-1})

number of transits min^{-1} = 1.20 × 10^7 × 60 = 7.2 × 10^8 **(1)**

[**alternatively**

orbital period $\left(= \frac{2\pi r}{v}\right) = \frac{2\pi \times 74 \times 10^{-3}}{5.59 \times 10^6}$ [**or** $\left(= \frac{2\pi}{\omega}\right) = \frac{2\pi}{7.55 \times 10^{-7}}$]

(= 8.32 × 10^{-8} s)

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number of transits min^{-1} = $\frac{60}{\quad} = 7.2 \times 10^{8}$ **(1)**]

2

[9]

Q2.

(a) (i) primary coil with more turns than secondary coil **(1)**

(wound around) a core **or** input is ac **(1)**

2

(ii) the mark scheme for this part of the question includes an overall assessment for the Quality of Written Communication

QWC	descriptor	mark range
good-excellent	Two causes of energy losses are clearly identified, correct measures to indicate how these two losses may be reduced are stated and a detailed physical explanation of why these measures are effective is given. eg **any two** from the following four 1 When a transformer is in operation, there are ac currents in the primary and secondary coils. The coils have some resistance and the currents cause **heating of the coils**, causing some energy to be lost. This loss may be reduced by using **low resistance wire** for the coils. This is most important for the high current winding (the secondary coil of a step-down transformer). Thick copper wire is used for this winding, because thick wire of low resistivity has a low resistance. 2 The ac current in the primary coil magnetises, demagnetises and re-magnetises the core continuously in opposite directions. Energy is required both to **magnetise and to demagnetise the core** and this energy is wasted because it simply heats the core. The energy wasted may be reduced by choosing a material for the core which is easily magnetised and demagnetised, ie a **magnetically soft material** such as iron, or a special alloy, rather than steel. 3 The magnetic flux passing through the core is changing continuously. The metallic core is being cut by this flux and the continuous change of flux induces emfs in the core. In a continuous core these induced emfs cause currents known as **eddy currents**, which heat the core and cause energy to be wasted. The eddy current effect may be reduced by laminating the core instead of having a continuous solid core; the laminations are separated by very thin layers of insulator. Currents cannot flow in a conductor which is discontinuous (or which has a very high resistance).	**5-6**

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	4 If a transformer is to be efficient, as much as possible of the magnetic flux created by the primary current must pass through the secondary coil. This will not happen if these coils are widely separated from each other on the core. **Magnetic losses** may be reduced by adopting a design which has the two coils close together, eg by **better core design**, such as winding them on top of each other around the same part of a common core which also surrounds them.	

modest-adequate	Up to two sources of energy losses are stated and there is an indication of how these may be minimised by suitable features or materials. There is no clear appreciation of an understanding of the physical principles to explain why these measures are effective.	**3-4**
poor-limited	Up to two sources of energy losses are given, but the answer shows no clear understanding of the measures required to minimise them.	**1-2**
incorrect, inappropriate or no response	There is no answer or the answer presented is irrelevant or incorrect.	**0**

Answers which address only **one** acceptable energy loss should be marked using the same principles, but to max 3.

6

(b) (i) power wasted internally (= $I\,V$) = 0.30 × 9.0 = 2.7 (W) **(1)**

1

(ii) input power $\left(= \frac{2.7}{0.90}\right)$ = 3.0 (W) **(1)**

mains current $\left(= \frac{3.0}{230}\right)$ **(1)** (= 1.30×10^{-2} A)

2

(iii) energy wasted per year (= $P\,t$) = $3.0 \times 0.80 \times 3.15 \times 10^{7}$
= $7.5(6) \times 10^{7}$ (J) **(1)**

1

(iv) energy wasted = $\frac{7.56 \times 10^{7}}{3.6 \times 10^{6}}$ = 21.0 (kWh) **(1)**

cost of wasted energy = 21.0 × 20 = 420p (£4.20) **(1)**

2

(c) answers should refer to:

an advantage of switching off **(1)**

- cost saving, saving essential fuel resources, reduced global warming etc

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a disadvantage of switching off **(1)**

- inconvenience of waiting, time taken for computer to reboot etc
- risk of computer failure increased by repeated switching on and off
- energy required to reboot may exceed energy saved by switching off

2

[16]

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