Practice Question Set For A-Level
Subject : Physics
Paper-2 Topic: Fields And Their Consequences(Magnetic Field)

Name of the Student:____
Max. Marks : 21 Marks **Time : 21 Minutes**

Mark Schemes

Q1.

(a) Core – idea that it provides greater linkage/increases linkage of magnetic flux/field (from the primary coil to the secondary coil compared to an air core) ✔$_1$ OWTTE

✔$_1$ This can be expressed using terms such as "channels/directs/concentrates/focuses/funnels".

In MP1 the reference to an air core can be inferred.

Condone " links all/most flux".

Secondary coil – (a conductor) has a varying/alternating/changing magnetic flux/field passing through/linking with it ✔$_2$ OWTTE

✔$_2$ 'varying' is important for this mark.

✔$_3$ errors may cancel this mark eg 'this increases the power output', will not gain this mark.

Producing an induced emf / <u>induces an emf</u> that is determined by the number of turns in (the primary and) the secondary coils ✔$_3$ OWTTE

Do not allow reference to "induced voltage" or "induced current" in MP3.

When no other mark awarded, MAX 1 for "this is a step-up transformer/the voltage is less on the primary than on the secondary because there are more secondary turns than primary turns"

3

(b) MAX 3

Design feature 1 ✔$_{1a}$

Link to efficiency ✔$_{1b}$

Design feature 2 ✔$_{2a}$

Link to efficiency ✔$_{2b}$

Award ✔$_a$ only once for "thin sheets/ laminations of iron are used".

For each example ✔$_b$ is contingent on ✔$_a$

Example A

*✔$_a$ The (sheets) of material **M** / laminations are made from insulator/high resistivity material*

✔$_b$ reduces/limits (eddy) currents or charge flowing in the core.

Example B:

✔$_a$ thin sheets/ laminations of iron are used

✔$_b$ so smaller emf's are induced in the core

Example C:

✔$_a$ thin sheets/ laminations of iron are used

✔$_b$ so resistance is high causing lower (eddy) currents

If no other marks awarded, give 1 MAX for

✔ Iron is used which magnetises and demagnetises easily

OR

✔ Eddy currents produce a magnetic field that opposes the magnetic field supplied to the core

3 Max

(c) If the voltage is lower/33 kV then power is transmitted at high current. So energy/power is wasted/lost in the cable by (I^2R) heating. ✔$_1$ OWTTE

These two points can be expressed the other way round. They could state why the voltage needs to be high and then why it should not be low.

Do not accept 'changes affect the resistance (of the cable)'.

If the voltage is made too high this will create major insulation/isolation difficulties. ✔$_2$ OWTTE

In ✔$_2$ accept "taller pylons", "transformers that have better insulation against spark/flash over", "more expensive equipment"

2

(d) Use of efficiency $\eta = \frac{\text{power}_{out}}{\text{power}_{in}}$ once ✔^{1}

Correct use of $I = P/V$ with their values once at any point ✔$_2$

✔$_1$ examples could be:

power at 132 kV = 72 / 0.98 = 73.5 MW

OR

at transmission line start = 73.5 / 0.94 = 78.2 MW

OR

at 25 kV = 78.2 / 0.98 = 79.8 MW

OR

in single stage

Power at 25 kV = 72 / (0.94 × 0.98^2) = 79.8 MW)

✔$_2$ eg at consumers I = 72 × 10^6 / 11 × 10^3 = 6545 A

✔$_1$ examples could be:

I = 3200 (A) (correct answer only, no ecf) ✔$_3$

(Calculator value: 3190.16 A)

3

[11]

Q2.

(a) Force due to uniform <u>magnetic</u> field (is constant and always) at 90º to direction of travel ✔

Identifies this force as the centripetal force for circular/semicircular motion ✔

Reference to velocity will be taken as the velocity of the proton

2

(b) (1 electron through 10 kV = 10000 eV
14 MeV by 10000 eV)
= 1400 (times) ✔

1

(c) $F = Bev$ AND $F = m_p v^2/R$ ✔

Equates forces giving $v = eBR/m_p$ ✔

$E_k = ½m_p v^2 = ½m_p(eBR/m_p)^2$ ✔

$E_k = e^2B^2R^2 / 2m_p$

1st mark for either or both

2nd mark for expression for v

3rd mark for substituting in $½m_p v^2$

Condone use of Q or q for E

3

(d) Uses = $\frac{e^2B^2R^2}{2m_p}$ to calculate E_k for any one cyclotron in J or eV ✔ Calculates E_k for 3 cyclotrons or argues that as **X** is just OK, **Y** will be greater and Z will be less than 11 MeV ✔
<u>So</u> reasoned choice of **X** ✔

cost/$11.7^{1.5}$ = £2.3 million/$10^{1.5}$
cost = £2.9 million ✔

*For **X** $E_k = \frac{(1.6 \times 10^{-19})^2 \times 1.3^2 \times 0.38^2}{2 \times 1.67 \times 10^{-27}}$*

$= 1.87 \times 10^{-12}$ J or 11.7 MeV

*For **Y** $E_k = 2.32 \times 10^{-12}$ J or 14.5 MeV **or** **Y** must have higher energy because BR and hence B^2R^2 must be greater*

*For Z $E_k = 6.89 \times 10^{-13}$ J 4.3 MeV **or** by inspection B^2R^2 will be too low to give 11 MeV*

Or other appropriate method

4

[10]