CASE STUDY QUESTION 04

Read the following and answer any four questions from (i) to (v)

A solenoid is a long helical coil of wire through which a current is run in order to create a magnetic field. The magnetic field of the solenoid is the superposition of the fields due to the current through each coil. It is nearly uniform inside the solenoid and close to zero outside and is similar to the field of a bar magnet having a north pole at one end and a south pole at the other depending upon the direction of current flow. The magnetic field produced in the solenoid is dependent on a few factors such as, the current in the coil, number of turns per unit length etc.

The following graph is obtained by a researcher while doing an experiment to see the variation of the magnetic field with respect to the current in the solenoid. The unit of magnetic field as given in the graph attached is in milli-Tesla (mT) and the current is given in Ampere.

(i) What type of energy conversion is observed in a linear solenoid?
(a) Mechanical to Magnetic
(b) Electrical to Magnetic
(c) Electrical to Mechanical
(d) Magnetic to Mechanical

A "Linear Solenoid" is an electromagnetic device that converts electrical energy into a mechanical pushing or pulling force or motion.

Ans: (c) Electrical to Mechanical
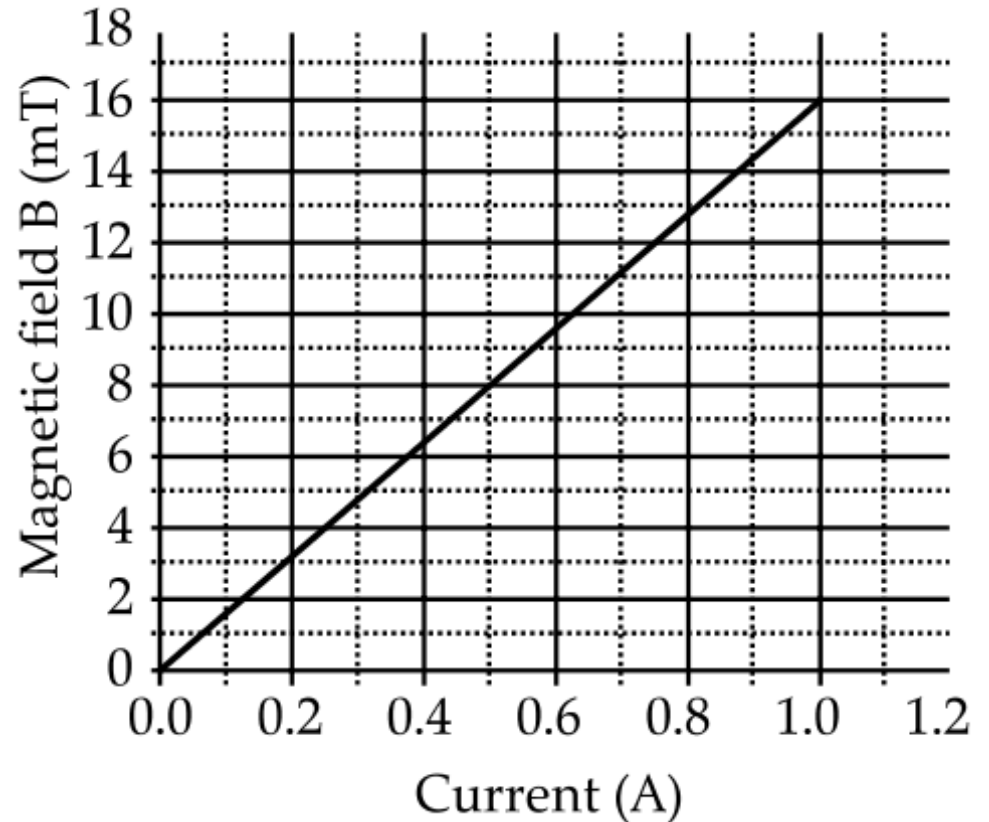
(ii) What will happen if a soft iron bar is placed inside the solenoid?
(a) The bar will be electrocuted resulting in short-circuit.
(b) The bar will be magnetised as long as there is current in the circuit.
(c) The bar will be magnetised permanently.
(d) The bar will not be affected by any means.

The magnetic field around a current carrying solenoid is similar to the magnetic field produced by a bar magnet.
When a soft iron bar is introduced inside a current carrying solenoid, the magnetic field inside the solenoid will increase.

**Ans:** (b) The bar will be magnetised as long as there is current in the circuit.

(iii) The magnetic field lines produced inside the solenoid are similar to that of …
(a) a bar magnet   (b) a straight current carrying conductor
(c) a circular current carrying loop   (d) electromagnet of any shape

Ans: (a) a bar magnet

(iv) After analysing the graph a student writes the following statements.

I. The magnetic field produced by the solenoid is inversely proportional to the current.
II. The magnetic field produced by the solenoid is directly proportional to the current.
III. The magnetic field produced by the solenoid is directly proportional to square of the current.
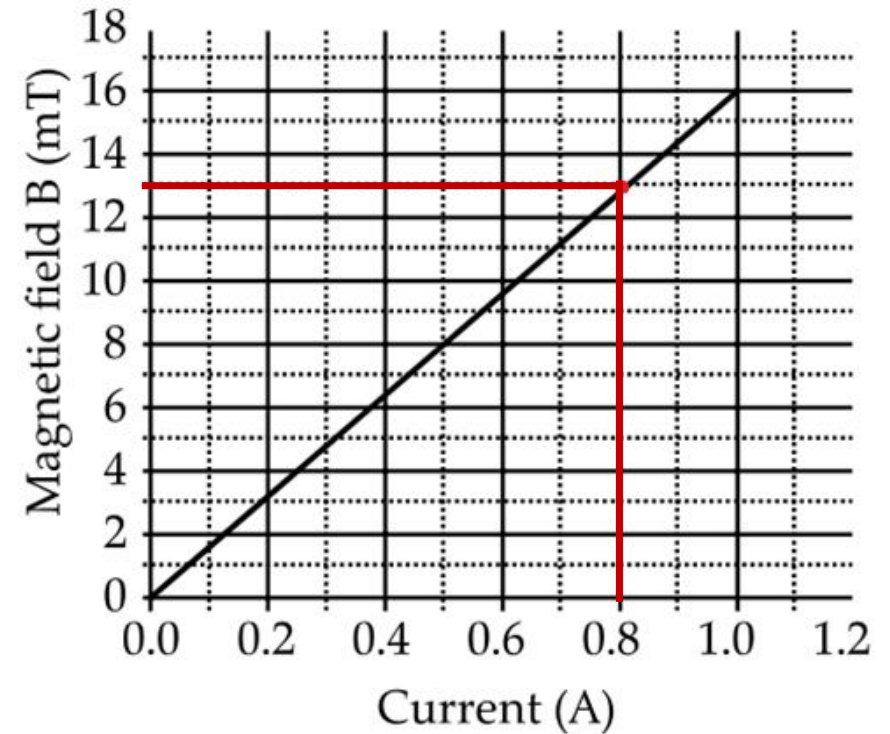IV. The magnetic field produced by the solenoid is independent of the current.
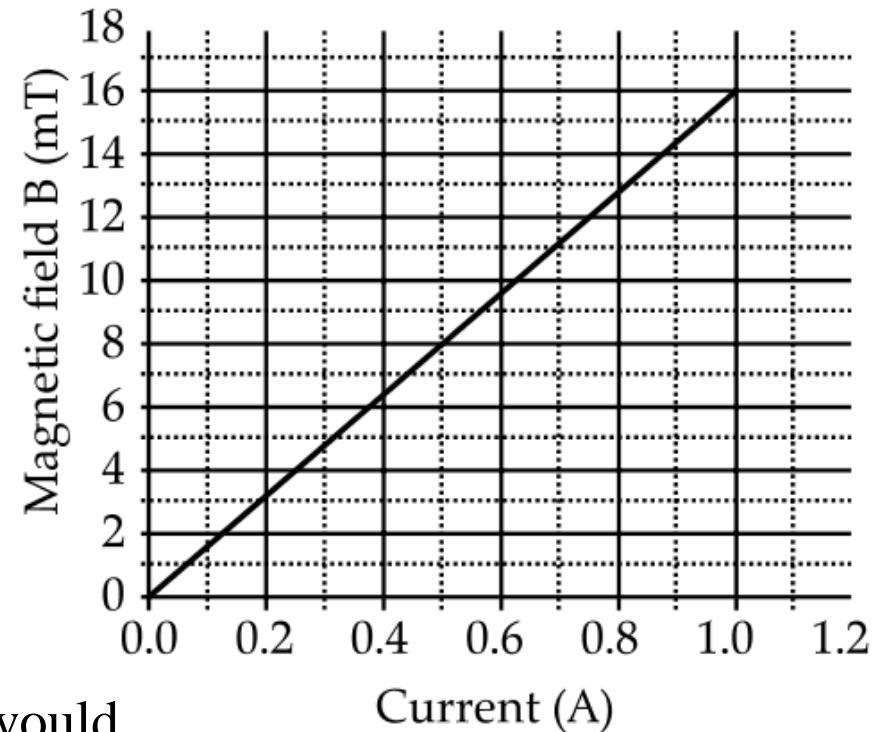
Choose from the following which of the following would be the correct statement(s).

(a) Only IV   (b) I and III and IV
(c) I and II   (d) Only II

Ans: (d) Only II

(v) From the graph deduce which of the following statements is correct.
(a) For a current of 0.8A the magnetic field is 13 mT
(b) For larger currents, the magnetic field increases non-linearly.
(c) For a current of 0.8A the magnetic field is 1.3 mT
(d) There is not enough information to find the magnetic field corresponding to 0.8A current.

(a) For a current of 0.8A the magnetic field is 13 mT