

**Q12 [Faraday's law]** A beating heart produces a changing magnetic field; just outside the chest the maximum rate of change of this field is  $10^{-10} \text{ T s}^{-1}$ . Suppose that a small coil with  $10^5$  turns and a cross-sectional area of  $10^{-2} \text{ m}^2$  is placed just outside the chest with the magnetic field produced by the heart perpendicular to the plane of the coil. What is the maximum magnitude of the EMF induced in this coil by the beating heart? (You may assume that the wire is so thin that all the turns enclose the same area and take the magnetic field to be constant over the area of the coil.) Pencil across one cell in row 12.

KEY for Q12

- |  |                       |
|--|-----------------------|
| A $10^{-9} \text{ V}$                                  | E $10^{-1} \text{ V}$ |
| <input checked="" type="radio"/> B $10^{-7} \text{ V}$ | F $10 \text{ V}$      |
| C $10^{-5} \text{ V}$                                  | G $10^3 \text{ V}$    |
| D $10^{-3} \text{ V}$                                  |                       |

**Q13 [Lenz's law]** A solenoid carrying a steady current is passed through a conducting loop (Figure 2). An observer located on one side of the loop observes that the current through the solenoid is in a clockwise sense (as shown in Figure 2). The solenoid is initially on the side of the loop closest to the observer; it is then pushed through the loop till it is on the far side. Which of the descriptions in the key best describes the current induced in the loop by the solenoid, as described by the observer? Pencil across one cell in row 13.

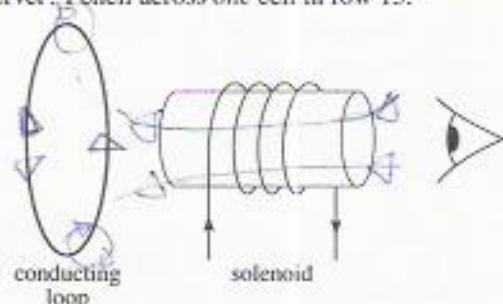


FIGURE 2

KEY for Q13

- A Clockwise throughout
- ☒ B Anticlockwise throughout
- C Clockwise till the solenoid is half-way through, then anticlockwise
- ☒ D Anticlockwise till the solenoid is half-way through, then clockwise

**Q14 [Electromagnetic radiation]** The key for this question contains six statements about electromagnetic radiation. Five of these statements are correct and one is false. Select the false statement. Pencil across one cell in row 14.

KEY for Q14

- A The speed of an electromagnetic wave in a vacuum is independent of its frequency, wavelength or amplitude.
- ☒ B In an electromagnetic wave, the electric and magnetic fields oscillate in phase with one another.
- ☒ C A radio frequency of 100 MHz corresponds to a wavelength of about 3 m.
- ☒ D Accelerating charged particles generate electromagnetic radiation.
- ☒ E The electric field vector, the magnetic field vector and the direction of propagation are mutually perpendicular in an electromagnetic wave propagating in empty space.
- ☒ F When unpolarized microwaves are passed through a grid of vertical conducting wires, the majority of the radiation emerging on the far side of the grid is polarized with the electric field vector oscillating in a vertical direction.

$$c = f\lambda$$

anti

$$T = \frac{2\pi R}{V} = \frac{2\pi m}{qB} = \frac{2\pi m}{qB}$$

$$V = -N \frac{d\phi}{dt} = -10^5 \times 10^{-2} \times 10^{-10} = 10^{-7}$$