Questions 1–5: A hypothetical mathematical closed surface (in this case a box) is sketched in a region where there is a uniform electric field to the right as shown in Figure 1. Note that the electric at all locations on the back side of the box is the same as the front side and the electric at all locations on the bottom side is the same as the top side.

1. The electric flux through the left side of the box is
   (a) positive
   (b) negative
   (c) zero

2. The electric flux through the right side of the box is
   (a) positive
   (b) negative
   (c) zero

3. The electric flux through the top side of the box is
   (a) positive
   (b) negative
   (c) zero

4. The electric flux through the bottom side of the box is
   (a) positive
   (b) negative
   (c) zero

5. The electric flux through the front side of the box is
   (a) positive
   (b) negative
   (c) zero

6. The electric flux through the back side of the box is
   (a) positive
   (b) negative
   (c) zero
7. The net electric flux through the box is
   (a) positive
   (b) negative
   (c) zero

8. The total amount of charge inside the box, according to Gauss’s Law, is
   (a) positive
   (b) negative
   (c) zero

9. If a charged particle with charge $q$ is placed outside of this box, does the pattern of electric field everywhere in space change?
   (a) yes
   (b) no

10. If a charged particle with charge $q$ is placed outside of this box, does the total electric flux through the box change
    (a) yes
    (b) no

A bar magnet is held with its south end facing a current loop as shown in Figure 2. The loop is not connected to a battery or anything else.

![Figure 2](image)

11. As the bar magnet is held at rest, in what direction does current flow around the loop?
    (a) out of the page at the top, and into the page at the bottom
    (b) into the page at the top, and out of the page at the bottom
    (c) no current is induced in the loop

12. As the bar magnet is toward the loop, in what direction does current flow around the loop?
    (a) out of the page at the top, and into the page at the bottom
    (b) into the page at the top, and out of the page at the bottom
    (c) no current is induced in the loop
A charged plate with dimensions 40 cm x 40 cm is shown in Figure ?? (not drawn to scale). A Gaussian surface shaped like a box is drawn near the middle of the plate where the electric field is uniform and perpendicular to the plate. The dimensions of this imaginary box are 10 cm long, 2 cm tall, and 3 cm deep. The electric field at the ends of the box is 1000 N/C.

![Figure 3:](image)

13. What is the net electric flux through this Gaussian surface (i.e. the box)?

14. What is the total charge enclosed by the box?

15. If the entire plate has the same charge per unit area, how much charge would be on the entire plate?

16. How many excess electrons or excess protons are on the plate?
My dad has a pacemaker to regulate the beating of his heart. The pacemaker sometimes has to be adjusted. Since there nobody wants wires hanging out of his chest or to have surgery in order for the doctor to adjust a resistor in the pacemaker, electromagnetic induction is used. The pacemaker has a coil on the inside of the patient’s chest. To adjust the pacemaker, a coil is placed external to the chest. A current through this “primary” coil is used to induce a current in the “secondary” coil inside the chest.

A simple model is shown in Figure ???. The primary coil (on the left) is connected to a variable power supply that is used to adjust the current through this coil. The secondary coil, in this model, is not connected to anything.

![Figure 4:](image)

In this model, assume that the magnetic field through the secondary coil is uniform through the plane of the coil.

17. If the current in the primary coil flows out of the top and in at the bottom, what is the direction of the magnetic field at the location of the secondary coil?

18. If the voltage across the primary coil is increased so that the current through this coil increases, in what direction will current flow in the secondary coil?
1. (b) 7. (c)
2. (a) 8. (c)
3. (c) 9. (a)
4. (c) 10. (b)
5. (c) 11. (c)
6. (c) 12. (a)

13. $flux = 2EA = 1.2V \, m$
14. $q_{inside} = 1.062 \times 10^{-11} \, C$
15. 
   $$q_{total} = \frac{A_{total}}{A_{surface}} q_{inside} = 2.83 \times 10^{-9} \, C$$
16. $1.77 \times 10^{10}$ protons
17. The magnetic field at the location of the secondary loop is to the right.
18. The current in the secondary coil flow in at the top and out at the bottom.