# Answers to the Lecture Exercises

**<u>Lecture Exercise 1:</u>**

1. (a) False
   (b) False
   (c) False
   (d) False
   (e) True in 2 dimensions, False in 3 dimensions
   (f) False
   (g) True
   (h) True
   The total flux through each of the shapes is 0
2. Charge for E(a) : +1Q
   E(b) : -1Q
   E(c) : +2Q
   E(d) : +6Q
   Charge for surface charge: $R_1$(inner) : -1Q
   $R_2$(inner) : +1Q
   $R_3$(inner) : -2Q

   $R_1$(outer) : -1Q
   $R_2$(outer) : +2Q
   $R_3$(outer) : +6Q

**Lecture Exercise 2:**

1. Note that the marks are in "cm" while the graph lists the axes in "m"
2. PE=q*V, V(x) = 20kV, PE(x) = 0.02J
   V(y) = -20kV, PE(y) = 0.04J
   V(z) ≈ -9kV, PE(z) = -0.027J
5. W=q*ΔV = q*(V(z)-V(y)) = q*(-9kV-(-20kV)) = 0.044J
6. W = q*(V(x)-V(y)) = q*(20kV-(-20kV)) = q* 40kV = 0.2J
7. W = q*(V(x)-V(i)) = q*(20kV-15kV) = q*5kV = 0.015J
8. Done in class
9. Strong E-field: For example (14cm,12cm)
   E=0: For example (5cm,19cm) or (17cm,9cm)
   Weak E-field: For example (22cm,22cm)
10. F = q*E, |E|= |ΔV/Δx| = 0/Δx = 0 → F=0N
11. |E| = |ΔV/Δx|
    For ΔV take the two closest points around "i" in the direction where the field is the steepest (perpendicular to the equipotential lines). This is the direction of the field which is the same direction for the force on a positive charge. Thus the force points to the WEST. The magnitude of the force is:
    F = q*(20kV-10kV)/0.02m = 8E-14N
12. As #11 however, the field points to the NW and the force on the negative charge points to the SE. The closest points for the derivative are located at (20cm,6cm) and (22cm,4cm) with potentials of –14kV and –6kV, respectively. The distance for this ΔV is sqrt(0.02m^2 + 0.02m^2)
    F = q*(14kV-6kV)/sqrt(0.0008)m = 9E-14N