Problems from A16.1: Vector Forces

F = ma $\quad E = \frac{F}{q} \quad g = \frac{F}{m}$

1. An electron is in a 2310 N/C electric field to the West. What is its acceleration? Look up the charge and mass in your data packet. (4.06×10^{14} ms^{-2} East)
2. A proton accelerates North at 3.80×10^{12} ms^{-2}. What is the electric field? (3.97×10^{4} N/C North)
3. There is a upward force of 0.0120 N on a charge inside a downward electric field of 450. N/C. What is the charge? Is it positive or negative? (-2.67×10^{-5} C, negative)
4. The planet Xzarr exerts a force of 67.0 N on a 4.50 kg mass. What is the gravitational field strength? (14.9 N/kg)
5. A region in space has a gravitational field strength of 1.40 N/kg. What mass would experience a force of 780. N. (557 kg)

$E = \frac{F}{q} \quad g = \frac{F}{m} \quad E = -\frac{\Delta V_e}{\Delta r}$ (Electrical force upwards = Gravitational force downwards)

6. A 0.310-gram object with a charge of -1.80 μC is suspended against gravity between two horizontal parallel plates. The plates have a voltage of 150. V across them, what is their separation? Which plate is the positive plate? (8.88 cm, top)
7. A 0.980-gram object with a charge of +0.780 μC is suspended against gravity between two horizontal parallel plates that are 3.80 cm apart. What voltage does this require, and which plate is the positive plate? (468 V, bottom)
8. A 0.450-gram object is suspended against gravity between two horizontal parallel plates that are 1.50 cm apart. What charge does the object have if this requires 13.0 V to accomplish? If the top plate is negative, is the charge positive or negative? (5.09 μC, positive)
9. An object with a charge of +4.50 μC is suspended against gravity between two horizontal parallel plates that are 1.4 cm apart. What mass does the object have if this requires 260. V to accomplish? Which plate is positive, the top or the bottom? (8.52 g, bottom)
10. A 2.30 gram object is suspended against gravity between two horizontal parallel plates that are 3.80 cm apart. What charge does the object have if this requires 75.0 V to accomplish? If the positive plate is on the top, is the charge positive or negative? (11.4 μC (1.14×10^{-5} C), negative)

$F_G = G\frac{m_1 m_2}{r^2} \quad F_E = k\frac{q_1 q_2}{r^2}$ - Inverse square force laws

11. At what distance from the center of a 3.40 μC charge is there a force of 7.80 N on a 1.10 μC charge? Is it attracted or repelled? (6.57 cm, repelled)
12. A -3.80 μC charge is attracted with a force of 45.0 N to another charge that is 56.0 cm away. What is the other charge? Is it positive or negative? (413 μC(4.13×10^{-4} C), positive)
13. At what distance from the center of a 5.97×10^{24} kg planet is the force of attraction on a 6.00 kg mass 23.0 N (1.02×10^{7} m)
14. On the surface of a 7.30×10^{6} m radius planet, there is a 57.0 N force on a 5.10 kg mass. What is the planet's mass? (8.93×10^{24} kg)
15. Two point charges have a force of attraction of 140. N when they are 12.0 m away from each other. What is their force of attraction when they are 17.0 m away from each other? (69.8 N)
16. The force of gravity between two spherical masses is 5.90×10^{-12} N when their centers are separated by 1.80 m. If they are moved so that the force of attraction is 7.80×10^{-12} N, what is their new separation? (1.57 m)
17. Two point charges have a force of repulsion of 56.0 N when they are 45.0 cm from each other. At what separation is the force 98.0 N? (34.0 cm)
18. The force of gravity between two spherical masses is 6.00×10^{-11} N when their centers are separated by 1.10 m. If they are moved so that their separation is 3.20 m, what is the force of attraction? (7.09×10^{-12} N)
19. Two point charges have a force of attraction of 160. N when they are 2.50 m apart. If they are moved so their new force of attraction is 240. N, what is their separation? (2.04 m)
20. Two point masses are attracted by a force of 1.20×10^{-12} N when they are 45.0 cm apart. If they are moved so that they are 150.0 cm apart, what is their new force of attraction? (1.08×10^{-13} N)

21. Linear Arrays:

A. Find the net force and direction on the charges (A: 72.4 N right, B: 111 N left, C: 39.0 N right)

A (-17.0 μC) — 23.0 cm — B (+18.0 μC) — 35.0 cm — C (+45.0 μC)

B. Find the net force and direction on the charges: (A: 12.2 N left, B: 91.1 N right, C: 78.9 N left)

A (+11.0 μC) — 18.0 cm — B (+12.0 μC) — 42.0 cm — C (-89.0 μC)

C. Find the net force and direction on the masses: (A: 39.2 N right, B: 3.10 N left, C: 36.1 N left)

A (9.80×10^6 kg) — 5.90 m — B (1.10×10^6 kg) — 3.10 m — C (2.30×10^6 kg)

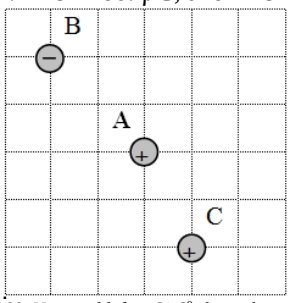
D. Find the net force and direction on the masses: (A: 10.5 N right, B: 11.9 N right, 22.4 N left)

A (1.40×10^6 kg) — 6.50 m — B (3.50×10^6 kg) — 9.70 m — C (7.90×10^6 kg)

22. Non-Linear Arrays:

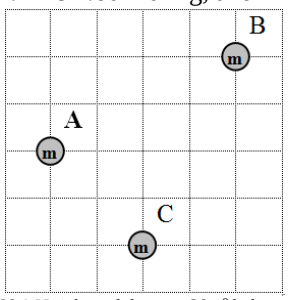
Each grid line is a meter. **Calculate the force on object A**. Draw the force vector and label its magnitude and direction.

A. A is +160. μC, and B is -110. μC, and C is +630. μC.



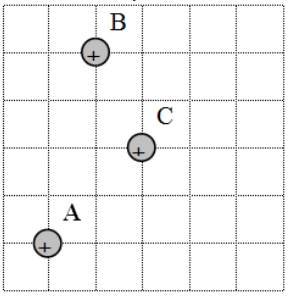
(200. N up and left at 61.6° above the x-axis)

B. A is 1.60×10^6 kg, and B is 2.10×10^6 kg, and C is 6.30×10^6 kg.



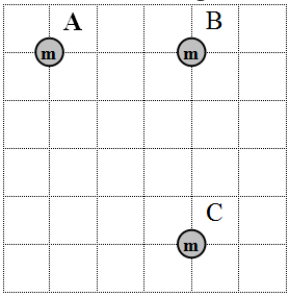
(88.2 N right and down at 38.1° below the x-axis)

C. A is +560. μC, and B is +780. μC, and C is +450. μC.



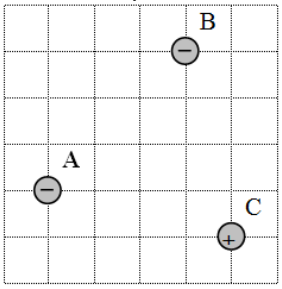
(496 N down and left at 58.9° below the x-axis)

D. A is 3.50×10^6 kg, and B is 2.20×10^6 kg, and C is 8.10×10^6 kg.



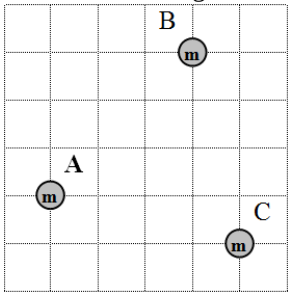
(119 N right and down at 30.6° below the x-axis)

E. A is -680. μC, and B is -890. μC, and C is +670. μC.



(273 N left and up at 85.8° above the x-axis)

F. A is 1.50×10^6 kg, and B is 7.30×10^6 kg, and C is 5.10×10^6 kg.



(61.6 N right and up at 20.3° above the x-axis)