Question 1.
The electrostatic force between two charges, Q₁ and Q₂ a separated by a distance D, is F₁. What is the force between them after they are moved to a distance 2D apart? (Give in terms of F₁)

*Force is inversely proportional to distance. Double the distance and the force goes down by a factor of 4*

Question 2.
An object of mass m is attached to a spring of spring constant k on a horizontal frictionless surface (which we take as the x-axis). Its position is x=0 when at equilibrium. It is then displaced by a distance +X and released, and we observe its movement. Answer all questions in terms of m, X and k.

a) What is its maximum magnitude of acceleration?

Max force is kX, F=ma, so max a=kX/m

b) What is its position when its velocity (magnitude) is largest?

When it is at x=0 all the energy is kinetic.

\[ x=0 \]

\[ v=X\sqrt{k/m} \]

c) What is the value of this maximum velocity?

Given by \[ 0.5mv^2 = 0.5kX^2 \]

\[ v=X\sqrt{k/m} \]

d) Where is it when exactly half of its energy is kinetic energy and half is potential energy?

When \[ 0.5kx^2 = 0.5(0.5kX^2) \]

\[ x=X/\sqrt{2} \]

Question 3
In this question, all batteries are 12Volt batteries (yes, TWELVE Volts), and we define the positive terminal of the battery to be at +12V, (that is the long line), and the negative terminal to be at 0V (that is the short line). Each resistor is 2 Ohms.

a) What is the current I, as shown by arrow?

Total $R = 2 + 2 = 4 \Omega$, and $V = IR$

b) Now the circuit has been changed. What is I now?

We’ve changed the circuit so that $R_2$ is short-circuited and is irrelevant. $V = IR$ again where $R = 2 \Omega$

6 Amps

c) We’ve changed the wires again. What is the current now?
The two resistors are in parallel.

d) We change it again. What is the Voltage at point A on the circuit?

\( I \) is now 3A again, so voltage drop over each resistor is 6V, and A is 6V above zero.
Question 4

Look at the following circuit (note that this battery is a 6 Volt battery). Each of the resistors is 3 Ohms. a) What is the current through ONE of the resistors?

The V across each resistor is 6V, so the current through one of them is given by V=IR and is 2A.

b) What is the power supplied by the battery? (remember units)
P=IV, each resistor uses 2x6 W, so all three use 36.

Question 5

A moving charge is moving in a magnetic field that is at right angles to it. Is there a force on the charge, and if so, in what direction? (6 choices: in the direction of motion, opposite to the direction of motion, in the direction of the magnetic field, opposite to the direction of the magnetic field, perpendicular to the direction of motion and the direction of the magnetic field, no force).

Perpendicular both to the direction of motion and the magnetic field.
12 points so far

Question 6
A light-bulb is rated at 60W. How much energy (in Joules), is required to light it for 1 minute?

\[ \text{Watts are Joules/second.} \]

3600 J

Question 7
Two balls, each of mass 1 kg, and each charged with a charge of +1 Coulomb, are a meter apart. Will they move together (attracted because of gravity), move apart (because of electrostatic repulsion), or will these two forces cancel? The electrostatic force is ginormously bigger than the gravitational one.

Pushed apart.

Question 8
Approximately what frequency of sound is the highest a human ear can hear? (Give answer in Hz, that is, cycles per second).

18000 Hz

Question 9
Three charges are in a row along the x axis.
The first is charge +Q and it is at x=0
The second is charge +2Q and it is at x=D
The third is charge -3Q and it is at x=2D
What is the force on the middle (+2Q) charge?

\[ \frac{8Q^2}{D^2} \]

The two forces both act in the positive direction. One is \( \frac{2Q^2}{D^2} \) and the other is \( \frac{6Q^2}{D^2} \)
16 points so far

**Question 10**
Which of the following will tend to decrease the magnetism of a “permanent” magnet? Circle the answer. It’s only a point if both parts are answered correctly.

- Dropping it  
  - yes
- Heating it  
  - yes

**Question 11**
The mains electricity we get from the power socket is “alternating current” rather than “direct current” which is what we get from a battery. Name ONE reason why it was decided that we should be given “alternating current”. (Please don’t give more than one, or I won’t know which to read!)

- It’s much easier to change voltage (using a transformer) with a.c.
- It’s natural to produce a.c. using a dynamo.

**Question 12**
A certain note on piano (A above middle C if you are interested) is 440 Hz (that is, f is 440 cycles per second). The speed of sound in air is around 330 m/s. What is the wavelength of the sound of this note?

\[ v = \lambda f \]

\[ \lambda = \frac{v}{f} = \frac{330}{440} = 0.75 \text{m} \]

**Question 13**
Three charges, all positive charge +Q are arranged in the form of an equilateral triangle of side length D. What is the magnitude of the force on one of them.

*We did this in class. The two forces act VECTORIZALLY.*

\[ F = \frac{\sqrt{3} Q^2}{D^2} \]