Ignore air friction in all problems.

Please give complete responses to all questions including units and theoretical justification for responses.

You must show ALL of your work to receive full credit!

Useful values and formulas:

1 km = 0.62 miles = 3280.8 feet

1 m = 39.37 inches

1 kg = 2.2 lbs

101 kPa = 760 mg Hg

ρ_{water} = 1 g/cm^3 = 1000 kg/m^3

1 Cal = 4.18 Joules

c_{water} = 1.0 kcal/kg °C

(8)

1. (X pts) What is the electric force felt between an electron and a +2.5 nC charge, that are separated by 2 mm? Is it attractive or repulsive? How do you know?

(2) $F = \frac{K q_1 q_2}{d^2}$

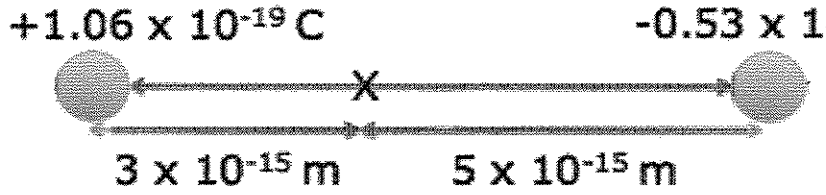
(2) $= \frac{\left(9 \times 10^9 \frac{Nm^2}{C^2}\right)(2.5 \times 10^{-9} C)(-1.6 \times 10^{-19} C)}{\left[2 mm \left(\frac{1 m}{1000 mm}\right)\right]^2}$

(2) $F = -9 \times 10^{-13} N$

(2) attractive b/c "−" sign - also b/c between + and − charge, opposites attract

15

2. ~~(X pts)~~ What magnitude and direction of electric field is felt at the point marked with an X in the image below?



(1) $E_{@x} = E_{\text{due to L}} + E_{\text{due to R}}$, (2) $E = \frac{kq}{d^2}$

$$E_{\text{due to L}} = \frac{\left(9\times10^{9}\ \frac{N m^2}{C^2}\right)(1.06\times10^{-19} C)}{(3\times10^{-15}\ m)^2}$$

(4) (1)

$= 1.06\times10^{20}$ N/C, pointing to the right, away from the ⊕ charge

$$E_{\text{due to R}} = \frac{\left(9\times10^{9}\ \frac{N m^2}{C^2}\right)(0.53\times10^{-19} C)}{(5\times10^{-15}\ m)^2}$$

(4) (1)

$= 1.91\times10^{19}$ N/C, pointing to the right, or to the ⊖ charge

Since both point to the R @ the x, they add to give you the total E field @ x (2) +11

(4) $E_{TOT} = (1.06\times10^{20}) + (1.91\times10^{19})$ N/C (2) R

$= 1.25\times10^{20}$ N/C, to the right

(8)

3. ~~(X pts)~~ A mammoth is trapped in the La Brea tar pits. If it becomes fully submerged, what is the buoyancy force acting on the mammoth? You can approximate a mammoth as a sphere of radius 5 feet, and assume the density of tar is 1.153 g/cm^3.

(2) $F_b = \rho V g$, where $\rho = \rho_{tar}$, V = vol of tar displaced by mammoth

(2) $F_b = \left(1.153 \frac{g}{cm^3}\right)\left(\frac{1\,kg}{1000\,g}\right)\left(\frac{100\,cm}{1\,m}\right)^3 \left(\frac{4}{3}\pi\left[5\,ft\left(\frac{12\,in}{1\,ft}\right)\left(\frac{1\,m}{39.37\,in}\right)\right]^3\right)\left(9.8\frac{m}{s^2}\right)$

$1153\ kg/m^3$ (2) $(1.50\,m)^3$

$F_b = 159{,}741.5\ N$

(2) or $166{,}216.74$ if use $(1.52\,m)^3$

(10)

4. ~~(X pts)~~ A circuit has 3 resistors connected in parallel: one 150 Ω, one 975 Ω, one 4.7 kΩ. ~~If each resistor is to have 12.5 A of current flowing through it, what is the voltage needed to power this circuit?~~ The total V is 120 V,

b a) What I_{TOT}? b) What I in 150 Ω?

(6) a) (2) $V_{TOT} = I_{TOT} R_{TOT}$

(2) $R_{TOT} = \frac{1}{\frac{1}{150} + \frac{1}{975} + \frac{1}{4.7\times10^3}} = 126.5\ \Omega$

(2) $I_{TOT} = \frac{120\,V}{126.5\,\Omega} = 0.95\ A$

(4) b) (2) $V = IR$

(2) $I = \frac{120\,V}{150\,\Omega} = 0.80\ A$

(5)

5. (X pts) In 2012, James Cameron completed a record breaking dive, reaching 6.8 miles (11 km) below the surface of the Pacific Ocean. His dive vehicle needed to be able to withstand the pressures felt at that depth. Calculate that pressure, where the density of seawater is 1030 kg/m^3.

(3) $P = \rho g h$

$= \left(1030 \frac{kg}{m^3}\right)\left(9.8 \frac{m}{s^2}\right)\left(11 \text{ km} \cdot \frac{1000 \text{ m}}{1 \text{ km}}\right)$

(2) $= 111,034,000.0 \quad \frac{kg}{m\,s^2} \} \quad \frac{N}{m^2} \} \text{ Pa}$

(1.1×10^8)

(10)

6. (X pts) A fishermans scale stretches 3.9 cm when a 1.8 kg fish hangs from it. If the fish is pulled down and released so that the spring vibrates up and down, what is the spring constant? What is the frequency of vibration?

→ a)

(2) $F = kx$

(2) $k = \frac{(1.8 \text{ kg})(9.8 \text{ m/s}^2)}{3.9 \text{ cm}\left(\frac{1 \text{ m}}{100 \text{ cm}}\right)} = 452.31 \frac{kg}{s^2}$

b)

(2) $T = 2\pi\sqrt{\frac{m}{k}}$, and $T = \frac{1}{f}$

(2) $T = 2\pi\sqrt{\frac{1.8 \text{ kg}}{452.31 \text{ kg/s}^2}} = 0.39 \text{ s}$

(2) $f = \frac{1}{T} = 2.56 \text{ Hz}$

(10)

7. (X pts) Describe each of

6 a. ~~What are~~ the three ways in which heat is transferred?

4 b. Why is a vacuum liner used in a thermos bottle to provide insulation?

a) (2) 1 conduction: collisions of molecules
needs ΔT
rate depends on material, size + shape of object

(2) 2 convection: mass movement of molecules (ie draft of air)

(2) 3 radiation: waves of energy, doesn't require matter

b) vacuum = no molecules, so no heat loss due to conduction or convection

(4)