71/76=93%

29.

$$F_G = \frac{Gm_Em_R}{r_E^2} + \frac{Gm_Mm_R}{r_M^2} = Gm_R\left(\frac{m_E}{r_E^2} + \frac{m_R}{r_M^2}\right)$$
$$= \left(6.67\times10^{-11}\frac{N\cdot m^2}{kg^2}\right)(1.2\times10^3 kg)\left(\frac{5.98\times10^{24}kg}{(3\times10^8 m)^2} + \frac{7.35\times10^{22}kg}{(8.4\times10^7)^2}\right) \cong 6.152N$$

The net gravitational force on the rocket from the earth and the moon is 6.152 N.

29. Given: m_E= 5.98 x 10^{24} kg
m_M= 7.35 x 10^{22} kg
m_R= 1200 kg
r_{ER}= 3.0 x 10^8 m
r_{MR}= (3.84 x 10^8) – (3.0 x 10^8) = 8.4 x 10^7

Solve: $\vec{F}_{Gnet} = \vec{F}_E + \vec{F}_M$

$$= \frac{Gm_Em_R}{r_{ER}{}^2} + \frac{Gm_Mm_R}{r_{MR}^2}$$

$$= (6.67 \times 10^{-11} Nm^2/kg^2)(1200kg)\left(\frac{5.98\ x\ 10^{24}kg}{(3.0x10^8 m)^2} + -\frac{(7.35x10^{22}kg)}{(8.4x10^7)^2}\right) = 4.48\ N \text{ or } 4.5\ N$$

2/4

30. a)

$$F_G = (12\ kg)\left(\frac{7.2\ m}{s^2}\right) = 86.4\ N$$

$$r^2 = \frac{\left(6.67\times10^{-11}\frac{N\cdot m^2}{kg^2}\right)(12\ kg)(5.98\times10^{24}\ kg)}{86.4\ N} \cong \left(80.04\times10^{-11}\ \frac{N\cdot m^2}{kg^2}\right)\left(0.069\times10^{24}\frac{kg}{N}\right)$$

$$r \cong 7.443\times10^6\ m$$

$$r_M = 7.443\times10^6\ m - r_E = 7.443\times10^6\ m - 6.38\times10^6 \cong 1.06\times10^6\ m$$

The meteor's height above the earth's surface is $1.06\times10^6\ m$. ✓

b)

$$F_G = (30\ kg)\left(7.2\frac{m}{s^2}\right) = 216\ N$$

The force that a 30 kg meteor will experience is 216 N. ✓

31. a)

$$r^2 = \frac{Gm_Sm_E}{F_G} = \frac{\left(6.67\times10^{-11}\frac{N\cdot m^2}{kg}\right)(5\times10^2\ kg)(5.98\times10^{24}\ kg)}{3\times10^3\ N} \cong 66.48\times10^{12}\ m^2$$

$$r \cong 8.16\times10^6\ m$$

The radius of the circular orbit is $8.16 \times 10^6\ m$. ✓

b)

$$v^2 = \frac{Gm_E}{r} = \frac{\left(6.67 \times 10^{-11} \frac{N \cdot m^2}{kg^2}\right)(5.98 \times 10^{24}\ kg)}{8.16 \times 10^6 m} = \frac{(6.67)(5.98)}{8.16} \times 10^{24-11-6} \frac{m^2}{s^2}$$
$$= 48.88 \times 10^7 \frac{m^2}{s^2}$$
$$v \cong 6991.47\ m/s$$

The speed of the satellite is $6991.47\ m/s$. ✓

c)

$$\vec{v} = \frac{\Delta d}{\Delta t} = \frac{2\pi r}{\Delta t}$$

$$\Delta t = \frac{2\pi r}{\vec{v}} = \frac{2\pi(8.16 \times 10^6\ m)}{6.99 \times 10^3\ m/s} \cong 7334.8\ s$$ ✓

The period of the orbit is $7334.8\ s$.

32.

$$F = ma = m\left(\frac{4\pi^2 r}{T^2}\right) = m\left(\frac{2\pi^2 r}{\left(\frac{\Delta d}{\vec{v}}\right)^2}\right) = m\left(\frac{4\pi^2 r}{\left(\frac{2\pi r}{\vec{v}}\right)^2}\right) = m\left(\frac{\vec{v}^2}{r}\right) = (70\ kg)\left(\frac{(30\ m/s)^2}{150\ m}\right) = 450\ N$$

The bathroom scale will give the astronaut a reading of $450\ N$. ✓

33. a)

$$\overrightarrow{F_{13}} = \frac{kq_1q_2}{r_{13}} = \frac{\left(9 \times 10^9 \frac{N \cdot m^2}{C^2}\right)(2 \times 10^{-5}\ C\ [N])(3 \times 10^{-5}\ C\ [N])}{(2\ m)^2} = 1.35\ N\ [N]$$
$$\overrightarrow{F_{12}} = \frac{kq_1q_2}{r_{13}} = \frac{\left(9 \times 10^9 \frac{N \cdot m^2}{C^2}\right)(2 \times 10^{-5}\ C\ [E])(3 \times 10^{-5}\ C\ [E])}{(2\ m)^2} = 1.35\ N\ [E]$$
$$F_{net} = \sqrt{2(1.35\ N)^2} \cong 1.91\ N$$
$$\tan(\theta) = \frac{1.35\ N\ [N]}{1.35\ N\ [E]} = 1$$
$$\theta = 45°$$
$$\overrightarrow{F_{net}} = 1.91\ N\ [E\ 45°\ N]$$

The net force on charge 1 is $1.91\ N\ [E\ 45°\ N]$. ✓

b)

$$\overrightarrow{\varepsilon_{net}} = \frac{\overrightarrow{F_{net}}}{q_1} = \frac{1.91\ N\ [E\ 45°\ N]}{2\times10^{-5}\ C} \cong 9.55\times10^4\ \frac{N}{C}\ [E\ 45°\ N]$$

The net electric field acting on charge 1 is $9.55\times10^4 \frac{N}{C}\ [E\ 45°\ N]$. ✓

✓

34. a)

$$\overrightarrow{F_G} = ma = (0.15kg)\left(9.8\ \frac{m}{s^2}\ [Down]\right) = 1.47\ N\ [Down]$$
$$\overrightarrow{F_T} = (1.47\ N\ [Down])\cos(40°\ [Right]) \cong 1.13\ N\ [Down\ \ 40°\ Right]$$

The tension in the thread is $1.13\ N\ [Down\ 40°\ Right]$.

1.92N

1/2

b) Since the charge of Charge 1 is negative, there is either a negative plate pushing Charge 1 towards a weaker negative charge or Charge 2 is positive and is attracting Charge 1. Since Charge 1 is being attracted to Charge 2, then Charge 2 must be positive. They do not touch because the length of the string, which Charge 1 is attached to, is not long enough.

b. $\vec{F}_E = \frac{kq_1q_2}{r^2} = \vec{F}_T sin\theta$

$$\frac{\left(\frac{9.0x10^9 Nm^2}{C^2}\right)(q^2)}{(0.40m)^2} = (1.919N)(sin40°)$$

q_2= 4.68 x 10^{-6}C = 4.7 x 10^{-6} C

Particle 2 must be positive in order to attract charge 1, which is positive according to the Law of Electric Charges

2/4

35. a)

$$\vec{a} = \frac{\vec{F}}{m} = \frac{\left(4\times10^2\frac{N}{C}\right)(-1.6\times10^{-19}\ C)}{9.11\times10^{-31}\ kg\ [Up]} \cong 0.702\times10^{14}\ \frac{m}{s^2}\ [Down]$$

The acceleration of the electron between the plates is $0.702\times10^{14} \frac{m}{s^2}\ [Down]$.

✓

b)

$$\overrightarrow{\Delta d} = \frac{1}{2}\vec{a}\Delta t^2$$

$$\Delta t = \left|\sqrt{\frac{2\vec{a}}{\overrightarrow{\Delta d}}}\right| = \left|\sqrt{\frac{2(2\times10^{-2}\ m\ [Down])}{0.702\times10^{14}\frac{m}{s}\ [Down]}}\right| \cong 2.387\times10^{-6}s$$

$$\overrightarrow{\Delta d} = \vec{v}\Delta t = \left(4\times10^{6}\frac{m}{s}\ [Right]\right)(2.387\times10^{-6}\ s) \cong 9.55\ m\ [Right]$$

The horizontal distance travelled by the electron when it hits the plate is $9.55\ m\ [Right]$. ✓

c)

$$\overrightarrow{v_{fy}} = \sqrt{2\vec{a}\Delta\vec{d}} = \sqrt{2\left(0.702\times10^{14}\frac{m}{s^2}\ [Down]\right)(2\times10^{-2}\ m)} \cong 1.68\times10^{6}\frac{m}{s}\ [Down]$$

$$\overrightarrow{v_{fx}} = 4\times10^{6}\frac{m}{s}\ [Right]$$

$$v_f = \sqrt{\left(4\times10^{6}\frac{m}{s}\right)^2 + \left(1.68\times10^{6}\frac{m}{s}\right)^2} \cong 4.34\times10^{6}\frac{m}{s}$$

$$\tan\theta = \frac{1.68}{4} = 0.42, \qquad \theta \cong 23°$$

$$\overrightarrow{v_f} = 4.34\times10^{6}\frac{m}{s}\ [Right\ 23°\ Down]$$

The velocity of the electron as it strikes the plate is $4.34\times10^{6}\frac{m}{s}\ [Right\ 23°\ Down]$. ✓

36. a)

$$E_E = \frac{kq_1q_2}{r_{12}} + \frac{kq_1q_3}{r_{13}} + \frac{kq_2q_3}{r_{23}}$$
$$= \left(9\times10^{9}\frac{N\cdot m^2}{C^2}\right)\left(\frac{(3\times10^{-4}C)(-3\times10^{-4}C)}{3\ m} + \frac{(3\times10^{-4}\ C)^2}{6m}\right.$$
$$\left. + \frac{(-3\times10^{-4}\ C)(3\times10^{-4})}{3\ m}\right) = -405\ J$$

The total electric potential energy for the charge distribution is $-405\ J$. ✓

b)

$$V = \frac{kq_1}{r_1} + \frac{kq_2}{r_2} + \frac{kq_3}{r_3} = k\left(\frac{q_1}{r_1} + \frac{q_2}{r_2} + \frac{q_3}{r_3}\right)$$
$$= \left(9\times10^{9}\frac{N\cdot m^2}{C^2}\right)\left(\frac{3\times10^{-4}\ C}{4.24\ m} + \frac{-3\times10^{-4}\ C}{3\ m} + \frac{3\times10^{-4}\ C}{4.24\ m}\right) \cong 3.74\times10^{5}\ V$$

The total electric potential at point Z is $3.74\times10^{5}\ V$. ✓

37.

$$\overrightarrow{p_T} = \overrightarrow{p_T}'$$
$$m_1\overrightarrow{v_1} + m_2\overrightarrow{v_2} = (m_1 + m_2)\vec{v}'$$
$$(0.8\ kg)\left(12\frac{m}{s}[E]\right) + (0.4\ kg)\left(8\frac{m}{s}\ [W]\right) = 6.4\ N\cdot s\ [E]$$
$$6.4\ N\cdot s\ [E] = (0.8\ kg + 0.4\ kg)\vec{v}' = (1.2\ kg)\vec{v}'$$
$$\vec{v}' = 5.\bar{3}\frac{m}{s}\ [E]$$

$$\frac{1}{2}(m_1v_1^2 + m_2v_2^2) = \frac{kq_1q_2}{r} + \frac{1}{2}(m_1 + m_2)v'^2$$
$$\frac{1}{2}\left((0.8\ kg)\left(12\frac{m}{s}\right)^2 + (0.4\ kg)\left(8\frac{m}{s}\right)^2\right)$$
$$= \frac{\left(9\times10^9\frac{N\cdot m^2}{C^2}\right)(3\times10^{-4}\ C)^2}{r} + \frac{1}{2}(0.8\ kg + 0.4\ kg)\left(5.\bar{3}\frac{m}{s}\right)^2$$
$$70.4\ J = \frac{(81\times10\ N\cdot m^2)}{r} + 17.0\bar{6}\ J$$
$$r \cong 15.12\ m$$

The minimum separation of the two pucks is 15.12 m.

38. a) The type of charge that is on the sphere is positive since the top plate is negative and the bottom plate is positive. The sphere would be positive since the bottom repels it upwards and the negative attracts it upwards. This causes the electric field to be directed upwards (positive to negative or bottom to top) allowing the sphere to go in the opposite direction of gravity.

b)

$$F_E = F_G$$
$$q\frac{\Delta V}{r} = ma$$
$$q\frac{265.4\ V}{0.005\ m} = (2.6\times10^{-15}\ kg)\left(9.8\ \frac{m}{s^2}\right)$$
$$q = \frac{(2.6\times10^{-15}\ kg)\left(9.8\frac{m}{s^2}\right)(0.005\ m)}{265.4\ V} \cong 4.8\times10^{-19}\ C✓$$

c)

$$Ne = q$$
$$N = \frac{4.8\times10^{-19}\ C}{1.6\times10^{-19}\ C} = 3✓$$

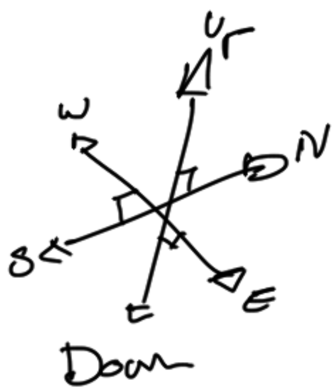
39. a)

$$\overrightarrow{F_M} = qvB = (1.6\times10^{-19}\ C)\left(5\times10^6\frac{m}{s}\ [N]\right)(2\times10^{-2}\ T\ [Up]) = 1.6\times10^{-14}\ N ✓[E]$$

b)

$$F_M = m\left(\frac{v^2}{r}\right)$$

$$r = \frac{mv^2}{F_M} = \frac{(9.11\times10^{-31}\ kg)\left(5\times10^{6}\frac{m}{s}\right)^2}{1.6\times10^{-14}\ N} = 1.42\times10^{-3}\ m$$



40. a)

$$\overrightarrow{F_M} = (2\ A\ [W])(4\ m)(1.4\ T\ [N]) = 11.2\ N\ [Down]$$

b) i) The direction of the magnet would change with respect to the change in the direction of the wire. Also, the direction of the magnetic field would not change since its perpendicular to the rotation.

ii) If the current is doubled, then the magnetic force would be doubled as well.

iii) If the direction of the magnetic field is reversed, then the direction of the magnetic force and velocity of the electrons would also be reversed as well.

41. a) The particle accelerator in the diagram shown works by releasing electrons (negatively charged) into a synchrotron. The initial portion is a linear accelerator which accelerates the electrons using positively charged electromagnets to attract and then changing them to negatively charged electromagnets to repel them away as they move past the electromagnet. The electrons then enter the portion which is a synchrotron. Here, the particles are accelerating in a closed circuit to accelerate them to the maximum speed the synchrotrons radius will offer.

b) If the magnetic field in the magnetic field was too weak, the velocity of the particles in the accelerator would go down. This can be found in the equation: $v = \frac{rqB}{m}$. Since r, m, and q would all be constants in this context, therefore B is the only variable; which is decreasing. Hence there should be a direct proportional relation between the magnetic field and the velocity of the particle.

c) As the particles gain energy, they move at a faster velocity; as shown through kinetic energy. Since the velocity is increasing, then the one change to the electric field would be that it would have to increase as to allow the velocity to increase without the radius having to increase. This is also the same case for the magnetic field – the one change being that the magnetic field would have to increase to allow the velocity to increase without the radius having to increase. ✓