Worked Solutions by Kyli Layden

1. A particle's position is given by $\vec{x}(t) = \left(3\frac{m}{s}t - 2\frac{m}{s^2}t^2\right)\hat{x} + \left(2m + 1m\sin\left(\pi\frac{1}{s}t\right)\right)\hat{y}$.
   a. What is the velocity at t=2s? What is the speed?
   b. What is the acceleration at t=3s? If the particle has a mass of 2kg, what is the magnitude of the force it experiences?
   c. What is the angle between the position and acceleration vectors at t=0.5s?
   d. If the particle has a mass of 3kg, what is the rate at which its kinetic energy is changing at t=1.5s?

a) $\frac{d}{dt}\vec{x}(t) = \vec{v}(t)$

$\vec{v}(t) = (3-4t)\hat{x} + (\pi\cos(\pi t))\hat{y}$

$\vec{v}(2) = -5\hat{x} + \pi\hat{y}\ [\frac{m}{s}]$

b) $\frac{d}{dt}v(t) = \vec{a}(t)$

$\vec{a}(t) = -4\hat{x} + (-\pi^2\sin(\pi t))\hat{y}$

$\vec{a}(3) = -4\hat{x}\ [\frac{m}{s^2}]$

$\vec{F} = m\vec{a} = (2)(-4\hat{x}) = -8\hat{x}[N]$

c) $\vec{x}(0.5) = 2.5\hat{x} + 3\hat{y}$

$\vec{a}(0.5) = -4\hat{x} - \pi^2\hat{y}$

$\cos\theta = \frac{\vec{a}\cdot\vec{b}}{|\vec{a}||\vec{b}|} \Rightarrow \frac{\vec{x}\cdot\vec{a}}{|\vec{x}||\vec{a}|} = -0.953$

$\theta = \cos^{-1}(-0.953)$
$= 162.45$

d) $KE = \frac{1}{2}mv^2$
$= \frac{1}{2}m(v(1.5)^2)$

$v(1.5) = -3\hat{x}$

$KE = 13.5J$

2. A particle's velocity is given by $\vec{v}(t) = 2\frac{m}{s}\hat{x} + \left(1\frac{m}{s} - 3\frac{m}{s^3}t^2\right)\hat{y}$.
   a. What is its displacement between t=2s and t=3s?
   b. What is its acceleration at t=1s?
   c. What is its kinetic energy at t=0.5s if it has a mass of 1kg?

a) $\vec{x}(t) = \int \vec{v}(t)\,dt = (2t)\hat{x} + (t - t^3)\hat{y}\Big|_2^3$

$= [(6\hat{x}) + (3-27)\hat{y}] - [4\hat{x} + (2-8)\hat{y}]$

$= 2\hat{x} - 18\hat{y}$ $\quad |\Delta\vec{x}| = 36m$

b) $\vec{a}(t) = -6t\hat{y}$

$a(1) = -6\hat{y}$

c) $KE = \frac{1}{2}mv^2$ $\quad v(0.5) = 2\hat{x} + 0.25\hat{y}$ $\quad |v| = 2.02 \Rightarrow KE = 2.03J$

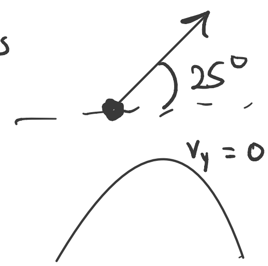
3. A particle moves only along the x-axis, and is subject to a force towards the origin of magnitude kx^3. If the particle moves from x_1 to x_2 how much work does this force do on it? (Consider the case $x_1 < x_2$). If this were a *conservative* force, what would the change in potential energy be?

$F = kx^3$

$$W = \int \vec{F} \cdot d\vec{r}$$
$$= \int kx^3 \cdot dx$$
$$= \frac{k}{4} x^4 \Big|_{x_1}^{x_2}$$
$$= \frac{k}{4}(x_2^4 - x_1^4)$$

4. A 2kg particle is launched at a speed of 30m/s at an angle of 25 degrees above the horizontal.
   a. How far does it travel over level ground?
   b. If it lands 2m above the launch point how long would that take?
   c. If it lands 2m below the launch point how long would that take?
   d. How long does it take to reach the top of its flight?
   e. What is the maximum height it reaches?
   f. What is the kinetic energy when launched?
   g. What is the kinetic energy at the top of the flight?
   h. What is the gravitational potential energy at the top of the flight?
   i. Make sure you can do this kind of problem for other input numbers.

$|v| = 30\,m/s$



a) $x_y(0) = 0$

$x_0 = 0$

$$\vec{x}(t) = \vec{x}_0 + \vec{v}_0 t + \tfrac{1}{2}\vec{a}t^2$$
$$\vec{v}(t) = \vec{v}_0 + \vec{a}t$$

$$\vec{v}(t) = 30(\cos 25^\circ \hat{i} + \sin 25 \hat{j}) + (-9.8\hat{j})t$$
$$\vec{x}(t) = (27.2\hat{i} + 12.68\hat{j})t + \tfrac{1}{2}(-9.8\hat{j})t^2$$

$\hat{j}\ \vec{x}(t)$: $0 = 12.68t - 4.9t^2$

$t = 2.59s$

$\hat{i}$: $\vec{x}(t)_{\hat{i}} = 27.2(2.59) - 4.9(2.59)^2$

$= 70.4m$

b) $x_y = 2m = 12.68t - 4.9t^2$

$t = 0.17s$

$t = 2.42s$

c) $x_y = -2m \Rightarrow t = 2.74s$

d) $V_y = 0 = 12.68 - 9.8t$

$t = 1.29s$

e) $x_y(1.29) = 8.2m$

f) $KE = \tfrac{1}{2}mv^2$

$= 900J$

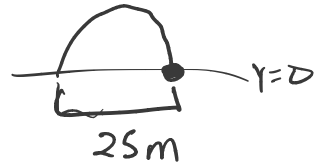
g) $V_x(1.29) = 27.2$

$KE = 739.84J$

h) $PE_g = mgh$

$= 160.72J$

5. A 3kg object is launched at an angle of 35 degrees above the horizontal.
   a. It travels 25m over level ground, what is its launch speed?
   b. It hits a tree 5m tall and 10m away. What was the launch speed?



a) $|\vec{V}_0| = ?$ $\quad \vec{x}(t) = \vec{V}_0 t + \frac{1}{2}\vec{a}t^2$

$\hat{\imath}$: $25\text{m}\,\hat{\imath} = V_0 \cos 35\, t$ (1)

$\hat{\jmath}$: $x_y = 0 = V_0 \sin 35\, t - 4.9t^2$

$t = \frac{V_0 \sin 35}{4.9}$ (2)

$V_0 = 16.15\text{ m/s}$

b) $V_0 = ?$

$X_x = 10\text{m}$

$\hat{\imath}$: $10 = V_0 \cos 35\, t$

$V_f = 0$

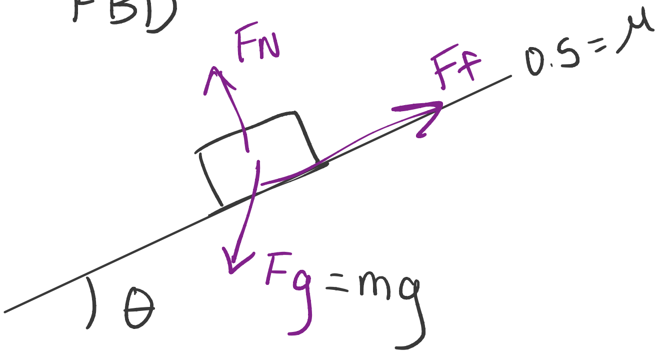
$0 = V_0(\cos 35\,\hat{\imath} + \sin 35\,\hat{\jmath}) - 9.8t\,\hat{\jmath}$

$\hat{\jmath}$: $t = \frac{V_0 \sin 35}{9.8}$

$V_0 = 14.4\frac{\text{m}}{\text{s}}$

6. A block sits on a plane with which it has a coefficient of friction of 0.5. What is the maximum angle that the plane can make with the horizontal before the block starts to slip?

FBD

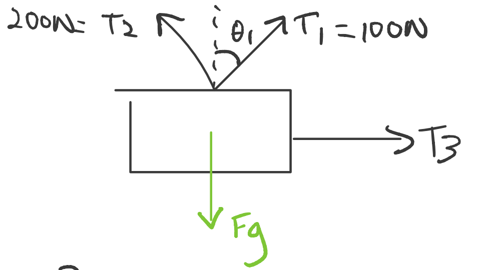


$\Sigma F_x = 0 = -F_N \sin\theta + F_f \cos\theta$

$\theta = 26.6°$

7. A mass is held up by 3 ropes. One has a tension of 100N and makes an angle of 25 degrees to the right of vertical, one has a tension of 200N and makes an angle of 45 degrees to the left of vertical, and one is horizontal.
   a. What is the suspended mass?
   b. What is the direction of the force the third rope exerts? (left or right)
   c. What is the tension in this third rope?

FBD



c)

a) $m = ?$

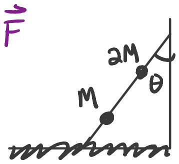
$\Sigma F_y = 0 \Rightarrow m = \dfrac{T_1 \cos\theta_1 + T_2 \cos\theta_2}{g}$

$m = 23.7\,kg$

b) $\Sigma F_x = 0 \Rightarrow T_3 = 99.1\,N$ If pos $\Rightarrow$ correct dir

8. A massless ladder of length L has a mass M one-third of the way up, and a mass 2M two-thirds of the way up. It leans against a frictionless wall. The feet of the ladder have a coefficient of static friction of 0.6 with the ground. What is the biggest angle the ladder can make with the wall before the ladder slips?

$\tau = \vec{r} \times \vec{F}$



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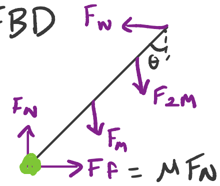


$\Sigma F = 0$

$\Sigma \tau = 0$

$\Sigma F_x = 0 = -F_W + F_f \Rightarrow F_W = \mu F_N = \mu 3Mg$

$\Sigma F_y = 0 = F_N - Mg - 2Mg$

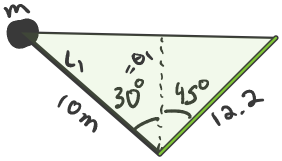
$F_N = 3Mg$

$\Sigma \tau = 0 = -\sin\theta \frac{L}{3} Mg - \frac{4L}{3} \sin\theta Mg + F_W L \cos\theta$

$\tan\theta = \dfrac{9\mu}{5}$

$\theta = 47.2°$

9. A massless beam of length 10m makes an angle 30 degrees to the left of vertical. It supports a 10kg mass at its top end. The top end is also supported by a horizontal rope which connects to the top of a uniform 12.2m long beam which makes an angle 45 degrees to the right of horizontal. The bottoms of both beams are fixed in place by a pin. What is the mass of the 12.2m beam?



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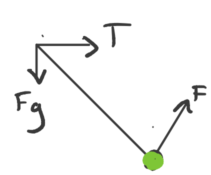

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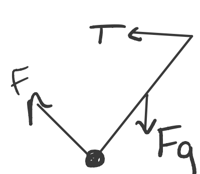


$\Sigma \tau = 0 = T L_2 \cos\theta_2 - Mg \frac{L_2}{2} \sin\theta_2$

$M = 11.55\,kg$

$\Sigma F = 0$

$\Sigma \tau = 0$

$\Sigma \tau = 0 = -T L_1 \cos\theta_1 + F_g L_1 \sin\theta_1$

$T = mg \tan\theta_1 = 56.6\,N$

10. A spring with spring constant k=100N/m supports a 5kg mass against gravity.
    a. By how much is the spring stretched?
    b. What was the increase in the potential energy in the spring compared with then the mass was not attached?
    c. What was the decrease in gravitational potential energy of the mass as it goes down to the equilibrium position?

a)

FBD

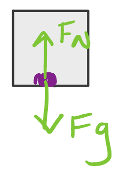
$$\Sigma F_y = 0 = -F_g + F_s$$
$$Mg = F_s = k\Delta x$$
$$\Rightarrow \Delta x = 0.49\,m$$

b) $\Delta PE = PE_f - PE_i$
$$= \frac{1}{2}k|\Delta x_f|^2 - 0$$
$$= 12J$$

c) $\Delta PE_g = mg(h_f - h_i) = mg\Delta x = 24\,J$

11. A mass of 3kg sits on a scale in an elevator. The scale measures the normal force between the mass and the floor of the elevator. What is the reading when
    a. The elevator is stationary?
    b. The elevator rises at a constant speed of 2m/s?
    c. The elevator descends at a constant speed of 2m/s?
    d. The elevator accelerates upwards at $2m/s^2$?
    e. The elevator accelerates downwards at $2m/s^2$?

$\vec{F} = m\vec{a}$



a) $\Sigma F = 0 = -F_g + F_N \Rightarrow 29.4N = F_N$

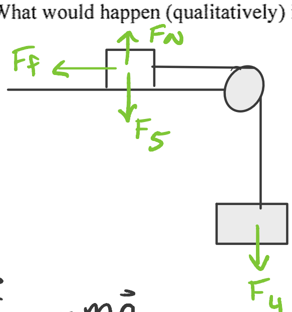
b) v = const $a = 0$ $F_N = 29.4N$

c) same as a,b

d) $\vec{F}_{net} = m(2m/s^2) = \vec{F}_N - \vec{F}_g$
$$2\frac{m}{s^2} \cdot m = F_N - mg$$
$$F_N = m(2 + 9.81)$$

e) $F_{net} = m\left(-2\frac{m}{s^2}\right) = F_N - mg$
$$F_N = 23.4N$$

12. A 5kg mass sits on a horizontal surface with which it has a coefficient of friction of 0.2. It is attached via a rope which goes over a massless, frictionless pulley, to a 4kg mass.
    a. What is the acceleration of the 5kg mass?
    b. What is the tension in the rope?
    c. What would happen (qualitatively) if the pulley were not massless?



b) $T = 26.1N$

$F_f \leq \mu F_N$
$\Sigma F_y = 0$
$F_N = m_5 g$

c) $\tau = I\alpha$
$$I = mr^2$$

a) 5: $\vec{F}_{net} = m\vec{a}$
$$T\uparrow - F_f\uparrow + F_N\uparrow - F_5\uparrow = m_5 a\uparrow$$
$$\Rightarrow T + (-m_5\mu g) = m_5 a \quad (1)$$

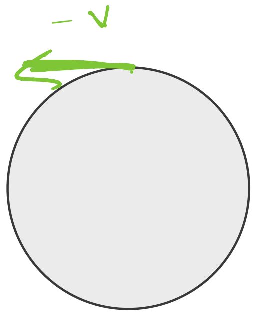
4: $\vec{F}_{net} = m\vec{a}$
$$T\uparrow - F_4\uparrow = m_4(-a)\uparrow$$
$$\Rightarrow T - m_4 g = -m_4 a \quad (2)$$
$$T = -m_4 a + m_4 g$$

$$\Rightarrow -m_4 a + m_4 g - \mu m_5 g = m_5 a$$
$$a = \frac{m_4 g - \mu m_5 g}{m_4 + m_5}$$
$$= 3.3\,m/s^2$$

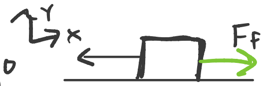
13. A car goes into a curve of radius R at speed V. The coefficient of friction between the car and the road is 0.7.
   a. If the curve is not "banked" and R=50m, what is the biggest V such that the car won't skid?
   b. If the curve is banked at an angle of 20 degrees, and R=50m, what value of V will result in no frictional force on the car?
   c. If the curve is not banked and the driver is going at speed V described in part a, what will happen when the drive touches the brakes? Why?

FBD

$\Rightarrow F_N = mg$



a) $\theta = 0^\circ$



$F_c = ma$

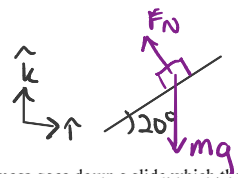
$F_c = m\frac{v^2}{R} = ma$

$\Sigma F_x = 0 = -F_c + F_f$

$F_c = F_f$

$\frac{mv^2}{R} = \mu mg \Rightarrow v = \sqrt{r\mu g} = 18.5\,m/s$

b)



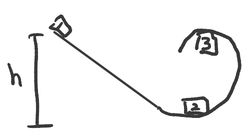
$F_{net\,y} = ma_y = F_N\cos\theta - mg = 0 \Rightarrow F_N = \frac{mg}{\cos\theta}$

$F_{net\,x} = ma_x \Rightarrow F_N \sin\theta = \frac{mv^2}{R}$

$V = 13.35\frac{m}{s}$

14. A 1kg mass goes down a slide which then puts it into a loop-the-loop of radius 1m.
   a. At the top of the loop, the normal force on the mass is 5N. How high did it start?
   b. At the top of the loop the normal force is 5N, what is the normal force at the bottom?
   c. Suppose that instead the 1kg mass was a ball ($I=2/5\,M\,R^2$) which rolled without slipping. What would the answers for a and b be in this case?

a)



① $W_{net} = mgh$ ← energy conservation

② $W_{net} = \frac{1}{2}mv_2^2$

$\Rightarrow v_2 = \sqrt{2gh}$

③ $F_{net} = ma$

$-mg - F_N = -m\frac{v_3^2}{R}$

$v_3 = \sqrt{14.8}$

Energy conservation between 2 : 3

$\frac{1}{2}\cancel{m}v_2^2 = \frac{1}{2}\cancel{m}v_3^2 + \cancel{m}g(2R)$

$v_2^2 = v_3^2 + 4Rg$

$v_2^2 = 54$

$54 = 2gh$

$h = 2.76\,m$

b) ② $F_{net} = ma$

$F_{N_2} - mg = m\frac{v_2^2}{R}$

$F_{N_2} = \frac{m(2gh)}{R} + mg$

$F_{N_2} = 63.8N$

c) $I = \frac{2}{5}MR^2$

① → ②

$mgh = \frac{1}{2}mv_2^2 + \frac{1}{2}I\omega^2$

$\omega = \frac{|v|}{r}$

$\Rightarrow \cancel{m}gh = \frac{1}{2}\cancel{m}v_2^2 + \frac{1}{2}\left(\frac{2}{5}\right)\cancel{m}\cancel{R^2}\frac{v_2^2}{\cancel{R^2}}$

$v_2^2 = \frac{gh10}{7}$

② → ③

$\frac{1}{2}mv_2^2 + \frac{1}{2}I\omega_2^2 = \frac{1}{2}mv_3^2 + \frac{1}{2}I\omega_3^2 + mg(2R)$

$\frac{1}{2}\cancel{m}v_2^2 + \frac{1}{2}\left(\frac{2}{5}\right)\cancel{m}\cancel{R^2}\frac{v_2^2}{\cancel{R^2}} = \frac{1}{2}\cancel{m}v_3^2 + \frac{1}{2}\left(\frac{2}{5}\right)\cancel{m}\cancel{R^2}\frac{v_3^2}{\cancel{R^2}} + \cancel{m}g2R$

$\sqrt{v_2^2} = \frac{10}{7}\left(\frac{1}{2}(14.8) + \frac{1}{5}(14.8) + g2R\right)$

$h = \frac{7}{10g}\left(\frac{10}{7}\left(\frac{14.8}{2} + \frac{14.8}{5} + 2Rg\right)\right) = 7.2$

$F_{N_2} = 101.154N$

17. A 2kg mass traveling at 10m/s along the x-axis hits a 5kg mass initially at rest. The collision is elastic.
    a. What is the velocity of the 5kg mass after the collision?
    b. What is the velocity of the 2kg mass after the collision?
    c. What is the change in momentum of the 5kg mass?
    d. What is the final momentum of the 2kg mass?

a) $$\left.\begin{aligned} m_1 v_{1i} + m_2 v_{2i} &= m_1 v_{1f} + m_2 v_{2f} \\ \tfrac{1}{2} m_1 v_{1i}^2 + \tfrac{1}{2} m_2 v_{2i}^2 &= \tfrac{1}{2} m_1 v_{1f}^2 + \tfrac{1}{2} m_2 v_{2f}^2 \end{aligned}\right] \text{elastic}$$

$$v_{1f} = \left(\frac{m_1 - m_2}{m_1 + m_2}\right) v_{1i} + \left(\frac{2m_2}{m_1+m_2}\right) v_{2i}$$

$$v_{2f} = \left(\frac{2m_1}{m_1+m_2}\right) v_{1i} + \left(\frac{m_2 - m_1}{m_1+m_2}\right) v_{2i}$$

$$v_{2f} = \frac{4}{7}(10) = \frac{40}{7} \text{ m/s} \uparrow$$

b) $$v_{1f} = \frac{-3}{7}(10) = \frac{-30}{7} \text{ m/s} \uparrow$$

c) $$\Delta p = m_1(v_{1f} - \cancel{v_{1i}}^{\,0})$$
$$= \frac{200}{7} \frac{\text{m kg}}{\text{s}}$$

d) $$p_{f_1} = -\frac{60}{7} \frac{\text{m}}{\text{s}} \text{kg}$$

18. A ring of radius 1.2m and mass 2kg rolls without slipping along a flat surface.
    a. The ring moves at 6m/s. What is its angular speed?
    b. What is the total kinetic energy?
    c. What is the tangential speed of any point along the surface of the ring?

a) $$\omega = \frac{v}{R} = \frac{6}{1.2} = 5 \frac{\text{rad}}{\text{s}}$$

b) $$\tfrac{1}{2} m v^2 + \tfrac{1}{2} I \omega^2 = KE$$
$$\tfrac{1}{2}(2)(6)^2 + \tfrac{1}{2}(5)^2 (m r^2) = KE$$
$$KE = 72$$

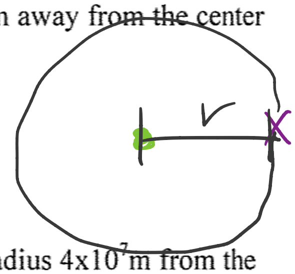
19. A disk of radius 0.2m rotates 6 times each second.
    a. What is its angular speed?
    b. What is the tangential speed on a point on the edge of the disk?

a) $$\omega = 6 \text{ rps} \cdot 2\pi = 12\pi \frac{\text{rad}}{\text{s}}$$

b) $$v = \omega r = 0.2 \cdot 12\pi = 2.4\pi \text{ m/s}$$

20. A satellite of mass 600kg orbits in a circle at a distance of $2x10^7$ m away from the center of a planet of mass $2.4x10^{24}$kg.

$m_1 = \text{sat.}$



a. What is the period of this orbit?
b. What is the speed of this satellite?
c. What is the force that the satellite experiences?
d. What is the satellite's kinetic energy?
e. What is the satellite's potential energy?
f. What is the period of an object that moves in a circle of radius $4x10^7$m from the planet?

a) $T = \frac{2\pi r}{v}$ $\quad F = \frac{G m_1 m_2}{R^2}$ $\quad F = ma = m\frac{v^2}{R}$

$\Rightarrow v = \frac{2\pi R}{T} \longrightarrow \frac{\cancel{m_1} v^2}{R} = \frac{G \cancel{m_1} m_2}{R^2}$

$T = \frac{2\pi r^{3/2}}{\sqrt{G m_2}} = 44417.7s$

b) $v = \frac{2\pi r}{T} = 2829.1 \frac{m}{s}$

c) $F = \frac{m_1 m_2 G}{r^2} = 240.12N$

d) $KE = \frac{1}{2} m v^2 = 2.4MJ$

e) $PE = -\frac{G m_1 m_2}{r} = -4.8MJ$

f) $T = \frac{2\pi r^{3/2}}{\sqrt{G m_2}}$

$= 125{,}632s$

21. A $-5x10^{-3}$C charge is at the origin, a $4x10^{-3}$C charge is at $1m\hat{x}$, and a $6x10^{-3}$C charge is at $-1m\hat{x} + 1m\hat{y}$.

a. What is the force on the charge at the origin?
b. What is the electric potential energy of the charge at the origin?
c. What is the electric field at the origin?
d. How much work would you have to do on the charge at the origin to move it to $5m\hat{x}$?

a) $F_{q_1q_2} = \frac{k q_1 q_2}{r_{12}^2} \hat{r}_{12} = 180kN \uparrow$

b) $U = \frac{k q_1 q_2}{r_{12}} + \frac{k q_1 q_3}{r_{13}}$

$F_{q_1q_3} = \frac{k q_1 q_3}{|\vec{r}_3 - \vec{r}_1|^2} \hat{r}_{13} = 135kN \left(-\frac{1}{\sqrt{2}}\uparrow + \frac{1}{\sqrt{2}}\uparrow\right)$

c) $\vec{F} = q\vec{E}$

$F_{net} = F_{q_1q_2} + F_{q_1q_3}$

$\vec{E} = \frac{\vec{F}_{net}}{q_1}$

d) $W = \vec{F} \cdot d\vec{x} = F_{net} \cdot 5 =$

22. A 5x10^{-4}C charge is fixed at the origin. A -4x10^{-4}C charge of mass 1kg is initially at $2m\hat{x}$. It initially has a velocity of $40\frac{m}{s}\hat{x}$.

a. What is the maximum separation between these charges?
b. What is the speed of the negative charge when it is at $4m\hat{x}$?
c. What is the potential difference between where the negative charge started and where it "turns around"?

a) $E_i = KE_i + U_{r_i} = U(r_{max})$

$$\frac{1}{2}mv_{2i}^2 + k\frac{q_1q_2}{2} = \frac{kq_1q_2}{r_{max}}$$

$$r_{max} = \frac{kq_1q_2}{\left(\frac{1}{2}mv_{2i}^2 + \frac{kq_1q_2}{2}\right)} = \frac{-1800}{-100} = 18m$$

b) $$\frac{1}{2}mv_1^2 + \frac{kq_1q_2}{2} = \frac{kq_1q_2}{4}, \quad V_2 = 0$$

$$V = 30\,m/s$$

c) $$\Delta U = \frac{kq_1q_2}{r_{max}} - \frac{kq_1q_2}{2} = kq_1q_2\left(\frac{1}{18} - \frac{9}{18}\right) = \frac{-8}{18}kq_1q_2$$

23. A 3.2x10^{-19}C ion with mass 2.6x10^{-25}kg travels at an initial velocity of $\vec{v} = 2000\frac{m}{s}\hat{x}$ in a region where there is a uniform magnetic field of $0.35T\,\hat{z}$.

a. It moves in a circle; what is the radius of that circle?
b. Where is the center of the circle?

a) $\vec{F}_B = q\vec{v}\times\vec{B}.$

$$F_B = ma = \frac{mv^2}{R} = q\vec{v}\times\vec{B}$$

$$\vec{V}\times\vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2000 & 0 & 0 \\ 0 & 0 & 0.35 \end{vmatrix} = -700$$

$$R = \frac{mv^2}{q\vec{v}\times B} = \frac{(2.6\times10^{-25})(2000)^2}{(3.2\times10^{-19})(-700)} = 0.0046m$$

24. An ion of mass 5.2x10^{-25}kg and charge 4.8x10^{-19}C starts at rest in a region where the electric field is $1000\frac{V}{m}\hat{x}$. When it has moved $\Delta\vec{x} = 2m\,\hat{x}$ it enters a region were there is *also* a constant magnetic filed.

a. What speed will the ion be moving at when it enters the magnetic field?
b. Assuming that the magnetic field is in the z direction, describe qualitatively what happens to the ion.
c. Given that the magnetic field is in the z direction, what is the magnitude such that an ion might experience no force (for a speed as given in 'a') and what direction must the ion be travelling?

a) $V_0 = 0 \quad V_f = ?$

$\vec{F} = q\vec{E} = 4.8\times10^{-16}\,\hat{i}$

$W = \vec{F}\cdot\Delta\vec{x} = 4.8\times10^{-16}\,\hat{i}\cdot 2\hat{i} = 9.6\times10^{-16}$

$W = \Delta KE = \frac{1}{2}m(V_f^2 - \cancel{V_0^2})$

$V_f = 60764\ m/s$

b) $\vec{B} = B\hat{z} = B\hat{k} \quad \vec{F} = q\vec{v}\times\vec{B}$

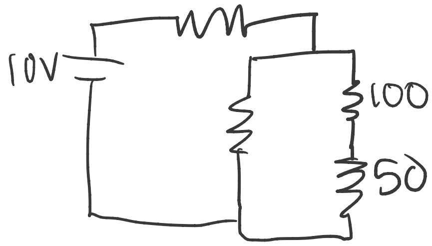
Magnetic Force on ion will be perp to the magnetic field.

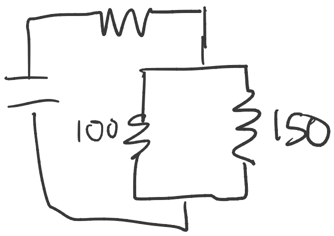
c) $\vec{F} = q\vec{v}\times\vec{B} = 0$

velocity would be parallel to B.

$$\vec{v}\times\vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & v \\ 0 & 0 & B \end{vmatrix} = 0$$

25a) $\frac{1}{R_{eq}} = \frac{1}{R_5} + \frac{1}{R_4}$ $\quad R_{eq\,4,5} = 50$





$\frac{1}{R_{eq}} = \frac{1}{150} + \frac{1}{100}$

$R_{eq} = 60$

$R_{eq} = 160\,\Omega$

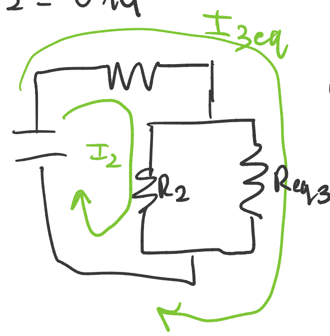
$I = \frac{10}{160} = 0.0625$

b) $P = \frac{V^2}{R} = I^2 R$

c)

$P_1 = 0.391$ $\quad P_3 = 0.0625$ $\quad P_4 = 0.0156$

$P_2 = 0.14$ $\quad P_5 = 0.0156$



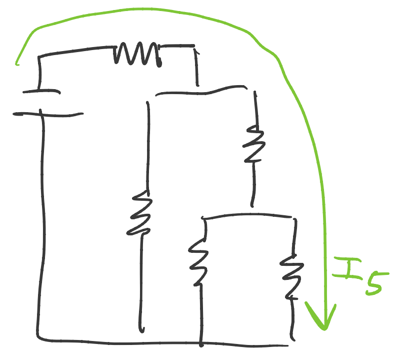
$0 = V - I_1R_1 - I_2R_2$

$I_2 = \frac{V - I_1R_1}{R_2}$

$= 0.0375$

$0 = V - I_1R_1 - I_3R_{3eq_{3}}$

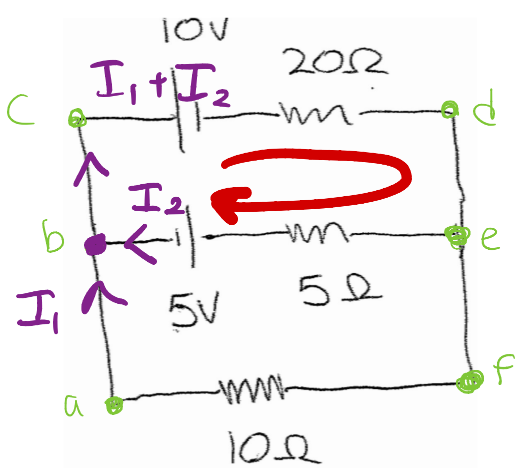
$I_3 = 0.025$



$0 = V - I_1R_1 - I_3R_3$
$- I_5R_5$

$I_5 = 0.0125$

26)



$V = IR$

$\Sigma I_{in} = \Sigma I_{out}$

$I_1 + I_2 = I_{out}$

Closed loop:

$\Sigma V = 0$

$\Sigma V = 0 = -10V + 20(I_1 + I_2) + 10(I_1)$ (1)

$\Sigma V = 0 = -10V - 5V + 20(I_1 + I_2) + 5(I_2)$ (2)

$I_1 = -0.14A$

$I_2 = 0.714A$