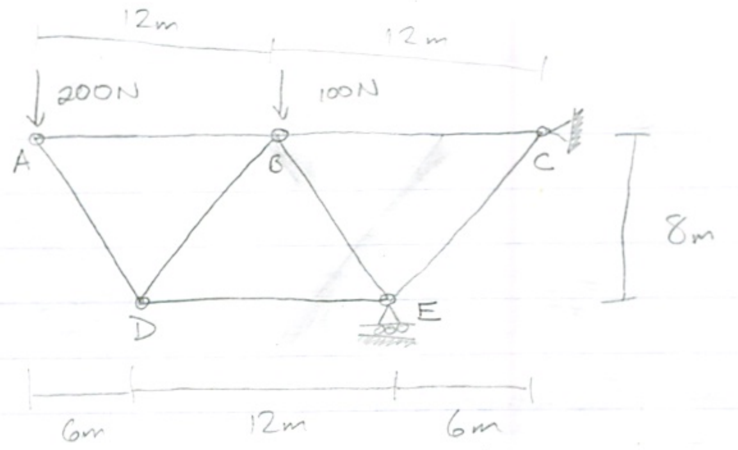
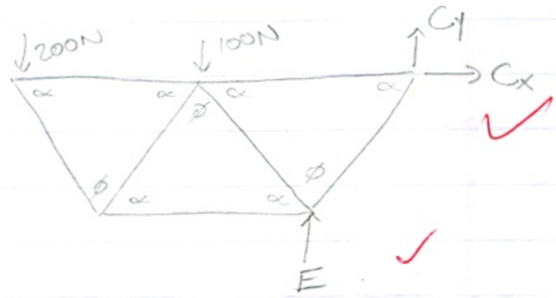
(1)



(1)



$\Sigma F_x = C_x = 0$

$C_x = 0\ N$

$\Sigma F_y = E + C_y - 200 - 100 = 0$

$E + C_y = 300\ N$

$\Sigma M_C = 200(24) + 100(12) - E(6) - C(0) = 0$

$4800 + 1200 - 6E = 0$

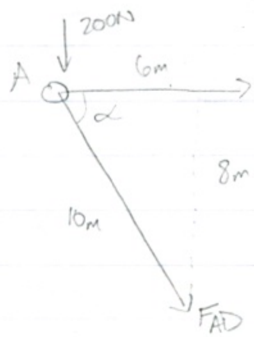
$E = 1000\ N$

$E + C_y = 300$

$C_y = 300 - E$

$C_y = -700\ N$

nice concept



$\Sigma F_x = F_{AB} + F_{AD}\cos\alpha = F_{AB} + \frac{3}{5}F_{AD} = 0$

$F_{AB} = -\frac{3}{5}F_{AD}$

$\boxed{F_{AB} = 150\ N}$

$\Sigma F_y = -F_{AD}\sin\alpha - 200 = 0$

$-\frac{4}{5}F_{AD} = 200$

$\boxed{F_{AD} = -250\ N}$

(3)

$$\Sigma F_y = F_{DA}\sin\alpha + F_{DB}\sin\alpha = 0$$

$$\tfrac{4}{5}F_{DA} + \tfrac{4}{5}F_{DB} = 0$$

$$\tfrac{4}{5}F_{DA} = -\tfrac{4}{5}F_{DB}$$

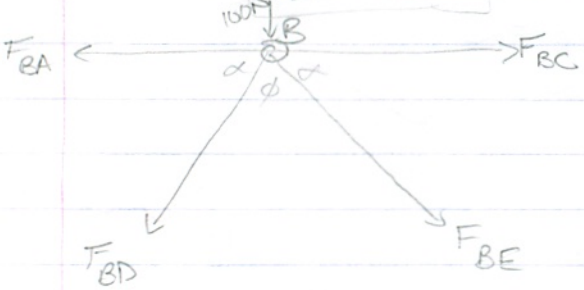
$$F_{DA} = -F_{DB} = 250\text{ N}$$

$$\boxed{F_{DB} = 250\text{ N}}$$

$$\Sigma F_x = F_{DA}\cos\alpha + F_{DB}\cos\alpha + F_{DE} = 0$$

$$F_{DE} = -\tfrac{3}{5}F_{DA} - \tfrac{3}{5}F_{DB} = -\tfrac{3}{5}(250) - \tfrac{3}{5}(250) = -300$$

$$\boxed{F_{DE} = -300\text{N}}$$



$$\Sigma F_y = -100 - F_{BD}\sin\alpha - F_{BE}\sin\alpha = 0$$

$$\tfrac{4}{5}F_{BE} = -\tfrac{4}{5}F_{BD} - 100$$

$$F_{BE} = -F_{BD} - 125 = -250 - 125$$

$$\boxed{F_{BE} = -375\text{ N}}$$

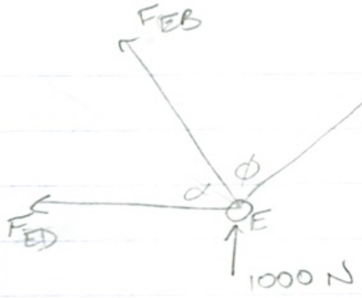
$$\Sigma F_x = -F_{BA} - F_{BD}\cos\alpha + F_{BE}\cos\alpha + F_{BC} = 0$$

$$F_{BC} = -F_{BE}\left(\tfrac{3}{5}\right) + F_{BD}\left(\tfrac{3}{5}\right) + F_{BA}$$

$$F_{BC} = -225 - 150 - 150 = -525\text{ N}$$

$$\boxed{F_{BC} = -525\text{N}}$$

✓

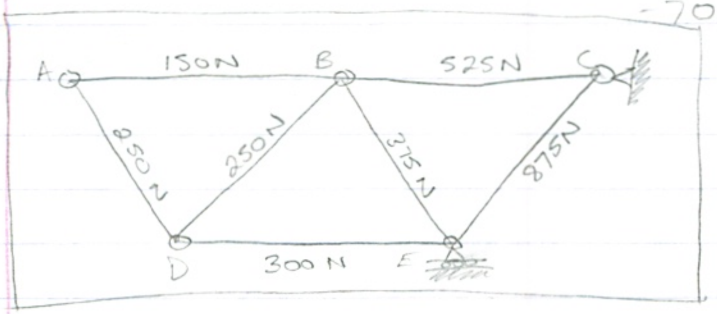


$$\Sigma F_y = F_{EB}\sin\alpha + F_{EC}\sin\alpha + 1000 = 0$$
$$= \tfrac{4}{5}F_{EB} + \tfrac{4}{5}F_{EC} + 1000 = 0$$
$$F_{EC} = -F_{EB} - 1250$$
$$F_{EC} = 375 - 1250$$
$$\boxed{F_{EC} = -875\ N}$$

$$\Sigma F_x = -F_{EB}\cos\alpha + F_{EC}\cos\alpha - F_{ED} = 0$$
$$-\tfrac{3}{5}F_{EB} + \tfrac{3}{5}F_{EC} - F_{ED} = 0$$
$$225 - 525 = F_{ED}$$
$$\boxed{F_{ED} = -300\ N}$$

$$\Sigma F_x = -F_{CB} - F_{CE}\cos\alpha = 0$$
$$-F_{CB} - \tfrac{3}{5}F_{CE} = 0$$
$$-525 + 525 = 0 \checkmark$$

$$\Sigma F_y = -700 - F_{CE}\sin\alpha = 0$$
$$-700 - \tfrac{4}{5}F_{CE} = 0$$
$$-700 + 700 = 0 \checkmark$$



✓

② $F - drag = m\dot{v} = F_0 - \frac{F_0^2 v}{4P_p} - drag$

$\frac{dv}{dt} = \frac{F_0}{m} - \frac{F_0^2 v}{4mP_p} - \frac{drag}{m}$ — $-F_f$ $\quad drag = \frac{\rho A C_d v^2}{2}$

$A = \frac{F_0}{m}$

$B = \frac{F_0^2}{4mP_p}$

$C = \frac{\rho A c_d}{2m}$

$\frac{dv}{dt} = A - Bv - Cv^2$

$\int \frac{dv}{A - Bv - Cv^2} = \int dt$

$u = A - Bv - Cv^2$

$du = (-B - 2Cv)\,dv$

cannot integrate

(3)

use MATLAB

at $v = v_p$ $\quad \frac{dv}{dt} = 0 \therefore A - Bv_p - Cv_p^2 = 0$

$$v_p = \frac{B \pm \sqrt{B^2 - 4CA}}{2C} = \frac{\frac{F_0^2}{4mP_p} - \sqrt{\frac{F_0^4}{16m^2P_p^2} + 2\rho\frac{Ac_dF_0}{m^2}}}{-\rho\frac{Ac_d}{m}} = \frac{\frac{F_0^2}{4P_p} - \sqrt{\frac{F_0^4}{16P_p^2} + 2\rho A c_d F_0}}{-\rho A c_d}$$

but v_p is a point, not a function

$vdot = \frac{F_0}{m} - \frac{F_0^2 v}{4mP_p} - \frac{drag}{m} - \frac{F_f}{m}$

$\frac{F_0}{m} - \frac{F_0^2 v}{4mP_p} = vdot + \frac{drag}{m} + \frac{F_f}{m}$

$\frac{v}{4mP_p} F_0^2 - \frac{1}{m} F_0 + \left(vdot + \frac{drag}{m} + \frac{F_f}{m}\right) = 0$

$\frac{v_p}{4mP_p} F_0^2 - \frac{1}{m} F_0 + \left(\frac{drag}{m} + \frac{F_f}{m}\right) = 0$ b/c $vdot = 0$ @ $v_{peak} = v_p$

$$F_0 = \frac{\frac{1}{m} + \sqrt{\frac{1}{m^2} - 4\left(\frac{v_p}{4mP_p}\right)\left(\frac{drag}{m} + \frac{F_f}{m}\right)}}{\frac{v_p}{2mP_p}}$$

☆ I attempted this homework on my own with the result of functions lasthw and lasthw2. These functions did not function correctly, so I asked Lauryn Berretta for help. The result of that is lasthw3, which I understand. Using this knowledge, I created lasthw4. This did not work because I could not find a function of F_0, only a value. I couldn't follow Lauryn's method at all, and therefore did not employ it. As a result, I believe the answer to 2c is $F_0 = 8994.75$ N (the output value of lasthw4).

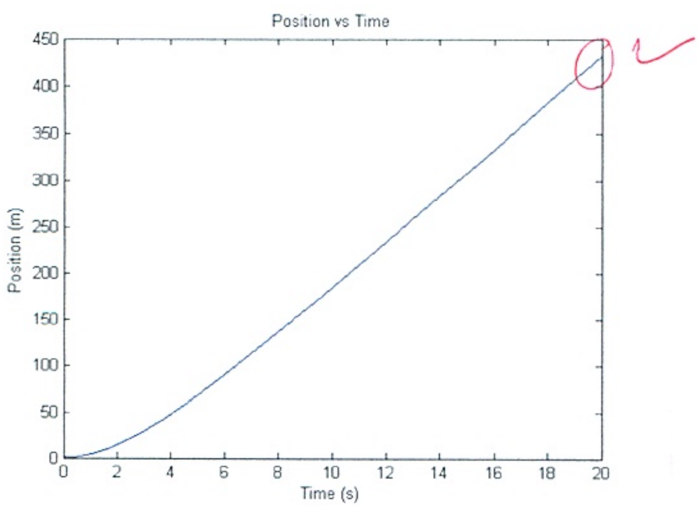
My answers:
2a → lasthw3.m
2b → lasthw4.m
2c → 8994.75 N

[redacted]
12/03/09
ENGRI 1170
TA: Justin Fishbone

sorry. I had to

```
function lasthw3
v_0 = 0;
x_0 = 0;
z_0 = [v_0 x_0];

[t z] = ode23(@myfn,[0 20],z_0);

v = z(:,1);
x = z(:,2);

plot(t,x)
title('Position vs Time')
xlabel('Time (s)')
ylabel('Position (m)')
end

function zdot=myfn(t,z)
v=z(1);
x=z(2);
m   =  1000; %total mass of car  (1000 kg)
P_p =  74569.9872; % 100 hp=74569.9872watts
rho =  1; %density of air   (1 kg/m^3)
A   =  2; %cross sectional area   (2 m^2)
%v   =  present speed of car (variable)
c_d =  1.0; %drag coefficient  (1.0)
F_f =  1000; %constant friction force   (1000 N)
F_0 =  10000; %force at wheel if the car is still (depends on gear ratio)
%v_f =  speed of car when motor supplies  no torque
drag = (rho * A * c_d * v ^2)/2;
vdot = (F_0/m)-((F_0^2*v)/(4*m*P_p))-(drag/m)-(F_f/m);
xdot = v;
zdot = [vdot xdot]';
end
```

EDU>> lasthw3



3

[redacted]
12/03/09
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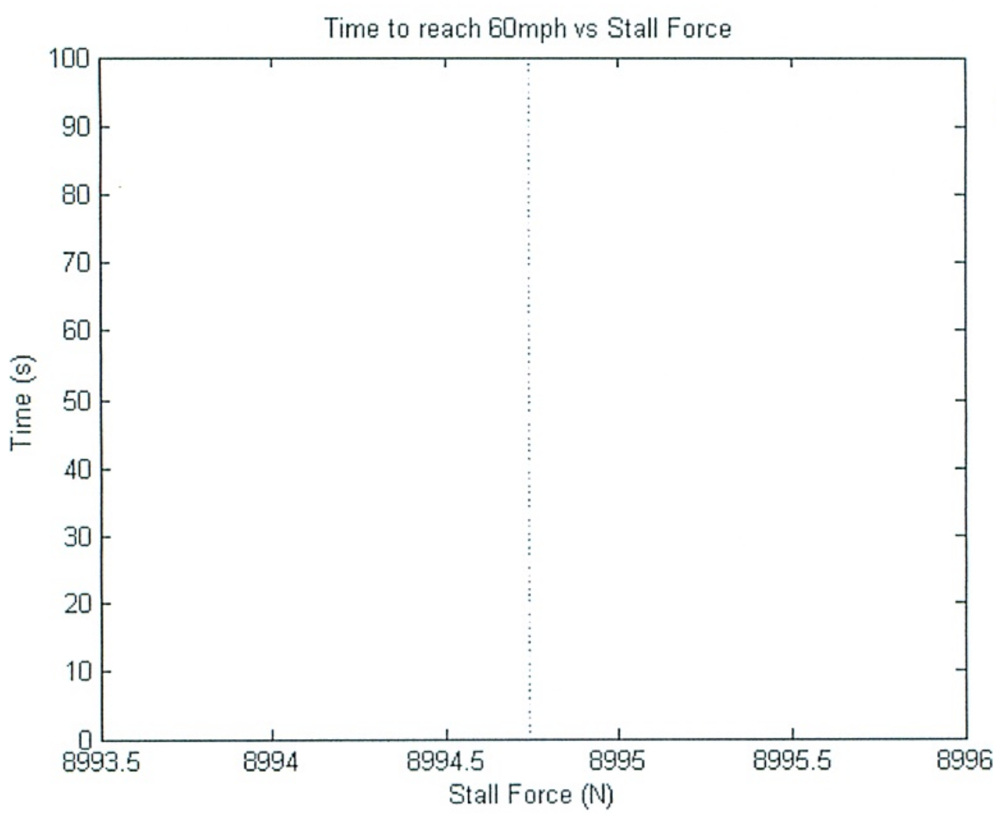
```
function lasthw4

m   =  1000; %total mass of car  (1000 kg)
P_p =  74569.9872; % 100 hp=74569.9872watts
rho =  1; %density of air   (1 kg/m^3)
A   =  2; %cross sectional area   (2 m^2)
v   =  26.8224; %present speed of car (60mph=26.8224 m/s)
c_d =  1.0; %drag coefficient  (1.0)
F_f =  1000; %constant friction force   (1000 N)
%F_0 = force at wheel if the car is still (depends on gear ratio)(variable)
%v_f =  speed of car when motor supplies  no torque

drag = (rho * A * c_d * v ^2)/2;

F_0 = ((1/m)+sqrt(1/m^2-4*v/(4*m*P_p)*(drag/m+F_f/m)))/(v/(2*m*P_p));
t = linspace(0,100,100);
plot(F_0,t)
title('Time to reach 60mph vs Stall Force')
xlabel('Stall Force (N)')
ylabel('Time (s)')
end
```

] F_0 is what this expression

EDU>> lasthw4

2



X

[redacted]
12/03/09
ENGRI 1170
TA: Justin Fishbone

```
function lasthw
[t xarray] = ode23(@myrhs2,[0 20], 0);
plot(t,xarray)
xarray(end)
end

function xdot=myrhs2(t,x)
[t varray]=ode23(@myrhs,[0 20],0);
xdot=[t varray]';
end

function vdot =myrhs(t,v)
m    =  1000; %total mass of car  (1000 kg)
P_p =  100; % hp
rho =  1; %density of air   (1 kg/m^3)
A   =  2; %cross sectional area   (2 m^2)
%v   =  present speed of car (variable)
c_d =  1.0; %drag coefficient  (1.0)
F_f =  1000; %constant friction force   (1000 N)
F_0 =  10000; %force at wheel if the car is still (depends on gear ratio)
%v_f =  speed of car when motor supplies  no torque
drag = (rho * A * c_d * v ^2)/2;
vdot = (F_0/m)-((F_0^2*v)/(4*m*P_p))-(drag/m)-(F_f/m);
end
```

```
EDU>> lasthw

??? Error using ==> odearguments at 113

MYRHS2 must return a column vector.



Error in ==> ode23 at 172

[neq, tspan, ntspan, next, t0, tfinal, tdir, y0, f0, odeArgs, odeFcn, ...



Error in ==> lasthw at 2

[t xarray] = ode23(@myrhs2,[0 20], 0);
```

[redacted]
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TA: Justin Fishbone

```
function lasthw2
[t varray] = ode23(@myrhs,[0 20], 0);
plot(t,varray)
varray(end)
end

function F_0 =myrhs(t,v)
m    =  1000; %total mass of car  (1000 kg)
P_p =  100; % hp
rho =  1; %density of air   (1 kg/m^3)
A    =  2; %cross sectional area   (2 m^2)
%v    =  present speed of car (variable)
c_d =  1.0; %drag coefficient  (1.0)
F_f =  1000; %constant friction force   (1000 N)
%F_0 =  force at wheel if the car is still (depends on gear ratio)
v_f =  26.8224; %speed of car when motor supplies  no torque (60mph)
drag = (rho * A * c_d * v ^2)/2;
F_0 = ((1/m)+sqrt(1/m^2-4*v_f/(4*m*P_p)*(drag/m+F_f/m)))/(v_f/(2*m*P_p));
end
```

EDU>> lasthw2

Warning: Imaginary parts of complex X and/or Y arguments ignored

> In lasthw2 at 3

ans =

1.6888e+002 +1.3777e-001i