# PROBLEM SET #3 Answer Key

The first question asks you to find supply and demand equilibrium, with consumers' and producers' surplus.

Part 1)
The demand function is given by: q=100-2p, if we write this as q+2p=100, we can use a simple plotting tool to plot the relationship.

```
> Demand1:=q+2*p=100;
```

$$Demand1 := q + 2\,p = 100$$

Similarly, instead of writing the supply curve as q=2p, we get q-2p=0

```
> Supply1:=q-2*p=0;
```

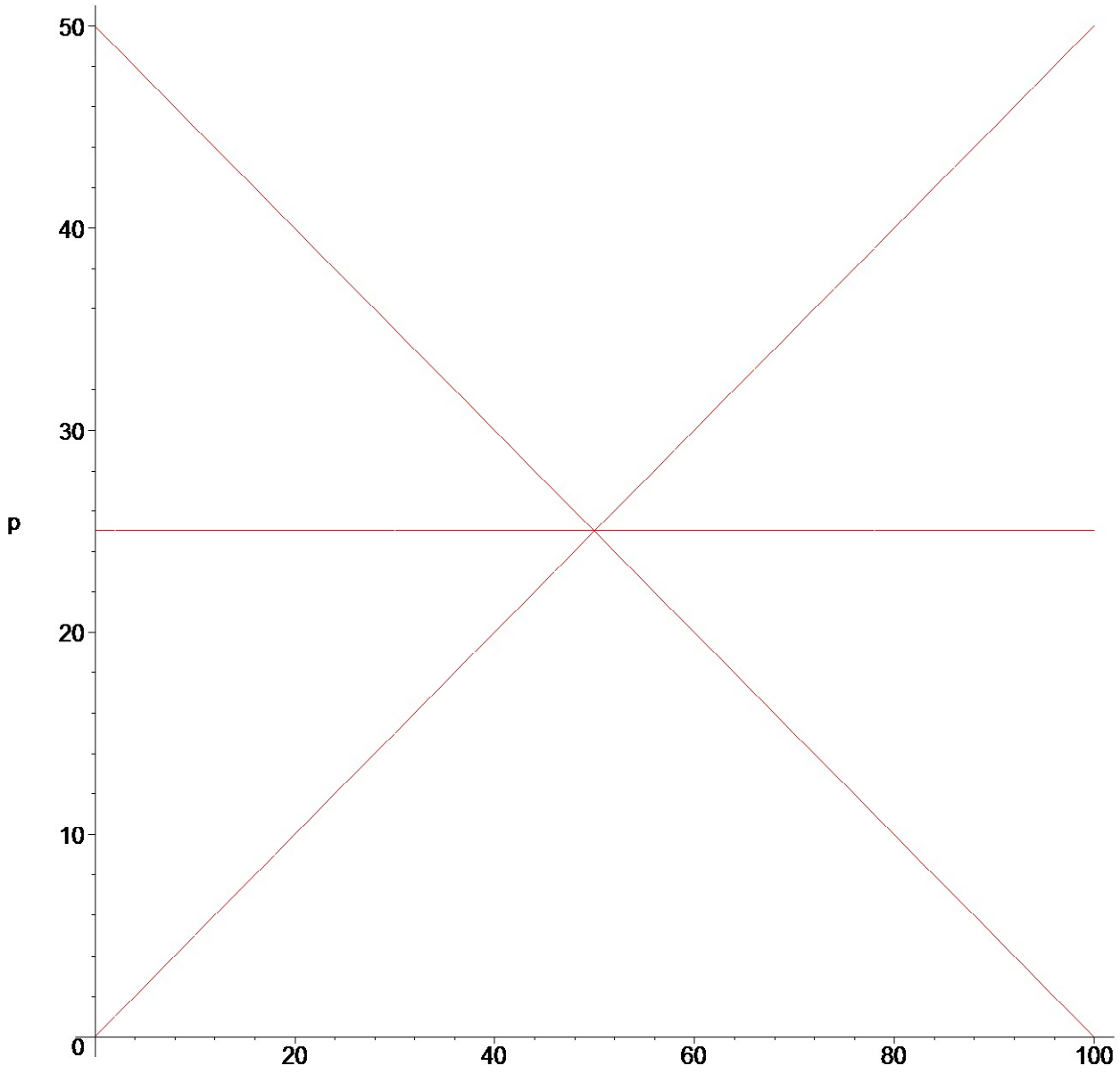
$$Supply1 := q - 2\,p = 0$$

Let's draw the diagram first, so we get an idea how it works (for those Maple buffs out there, this is a good way to learn how to use the implicit plot command!)
I've also inserted the equilibrium price after the fact.
Note the axes.

```
> with(plots);
Warning, the name changecoords has been redefined
```

[*animate, animate3d, animatecurve, arrow, changecoords, complexplot, complexplot3d, conformal, conformal3d, contourplot, contourplot3d, coordplot, coordplot3d, cylinderplot, densityplot, display, display3d, fieldplot, fieldplot3d, gradplot, gradplot3d, graphplot3d, implicitplot, implicitplot3d, inequal, interactive, listcontplot, listcontplot3d, listdensityplot, listplot, listplot3d, loglogplot, logplot, matrixplot, odeplot, pareto, plotcompare, pointplot, pointplot3d, polarplot, polygonplot, polygonplot3d, polyhedra_supported, polyhedraplot, replot, rootlocus, semilogplot, setoptions, setoptions3d, spacecurve, sparsematrixplot, sphereplot, surfdata, textplot, textplot3d, tubeplot*]

```
> implicitplot({Demand1,Supply1,p=25},q=0..100,p=0..50);
```




Market equilibrium is obtained by solving the two equations simultaneously, so we have:

```
> solve({Demand1,Supply1},{q,p});
```

$$\{q = 50, p = 25\}$$

which looks about right given our diagram. Consumer's surplus is now the area of the upper triangle, from market price up to the point at which the demand function crosses the p axis. We this triangle has area (50-p)*q/2, or 25*50/2:

```
> CS1:=25*50/2;
```

$$CS1 := 625$$

Similarly, producers' surplus is the lower triangle, which has area p*q/2:

```
> PS1:=25*50/2;
```

$$PS1 := 625$$

Part 2:

Basically the same. Here we have:

```
> Demand2:=q+200*p=10000;
```

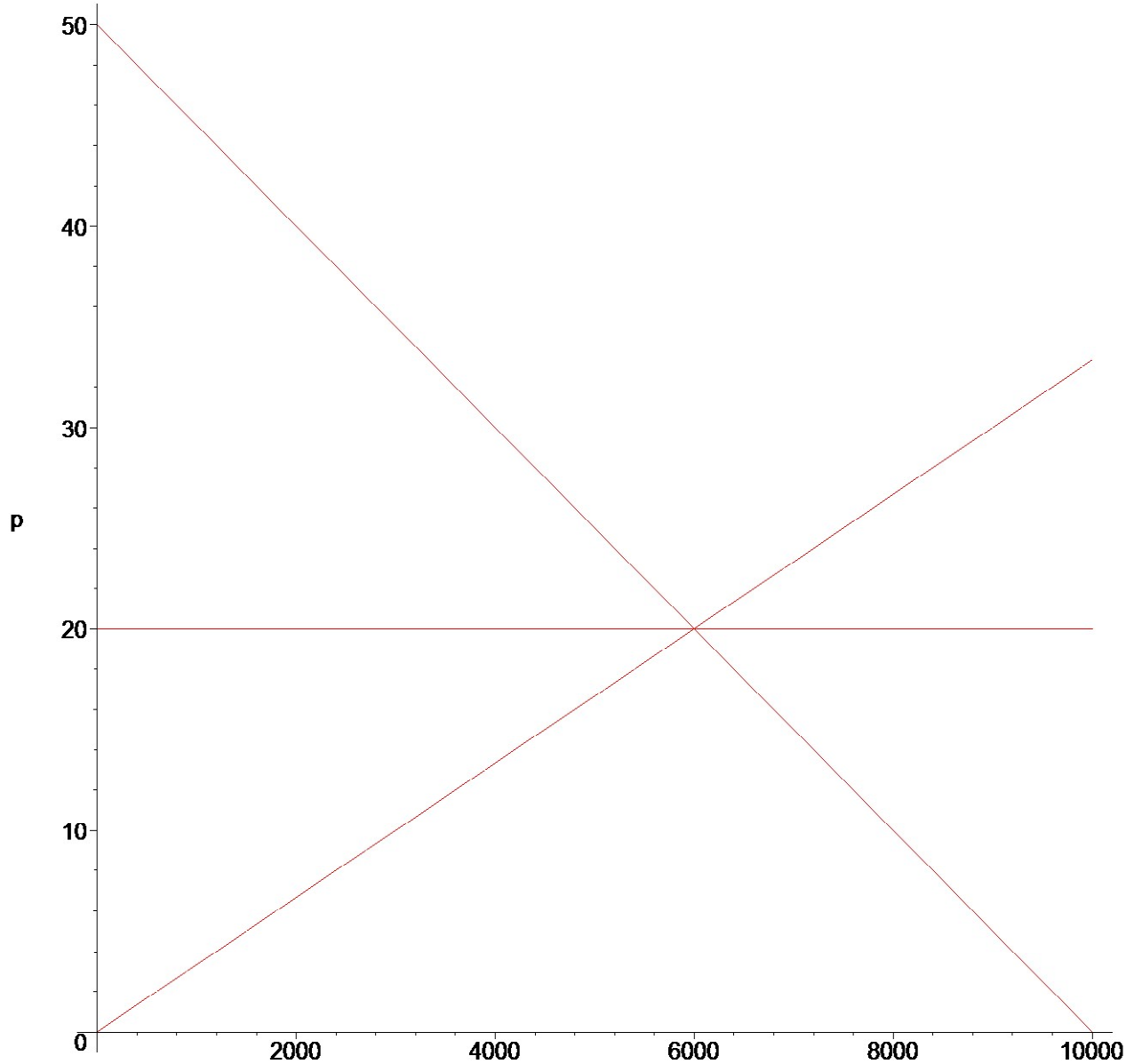
$$Demand2 := q + 200\,p = 10000$$

```
> Supply2:=q-300*p=0;
```

$$Supply2 := q - 300\,p = 0$$

The plot is as follows (I've again included the price...this will help us later):

```
> implicitplot({Demand2,Supply2,p=20},q=0..10000,p=0..100);
```




The equilibrium price is obtained as before, by solving demand and supply for price and quantity:

```
> solve({Demand2,Supply2},{p,q});
```

$$\{p = 20,\ q = 6000\}$$

Consumer's surplus in this case is given by

```
> CS2:=(50-20)*6000/2;
```

$$CS2 := 90000$$

```
> PS2:=20*6000/2;
```

$$PS2 := 60000$$

II. Tax incidence. In this case, we are asked to find the equilibrium prices and quantities after we insert a tax. How does this change the problem? Well, now we effectively have the following

equations to solve:

q=100-2pc,
q=2ps,
with pc=ps+5.

I'll write these as follows:

```
> Demand1a:=q+2*pc=100;
```

$$Demand1a := q + 2\,pc = 100$$

```
> Supply1a:=q-2*ps=0;
```

$$Supply1a := q - 2\,ps = 0$$

If we substitute in our tax, which puts a $5 wedge between the two prices, we have:

```
> pc:=ps+5;
```

$$pc := ps + 5$$

Now, we can simply solve the equations:

```
> solve({Demand1a,Supply1a},{q,ps});
```

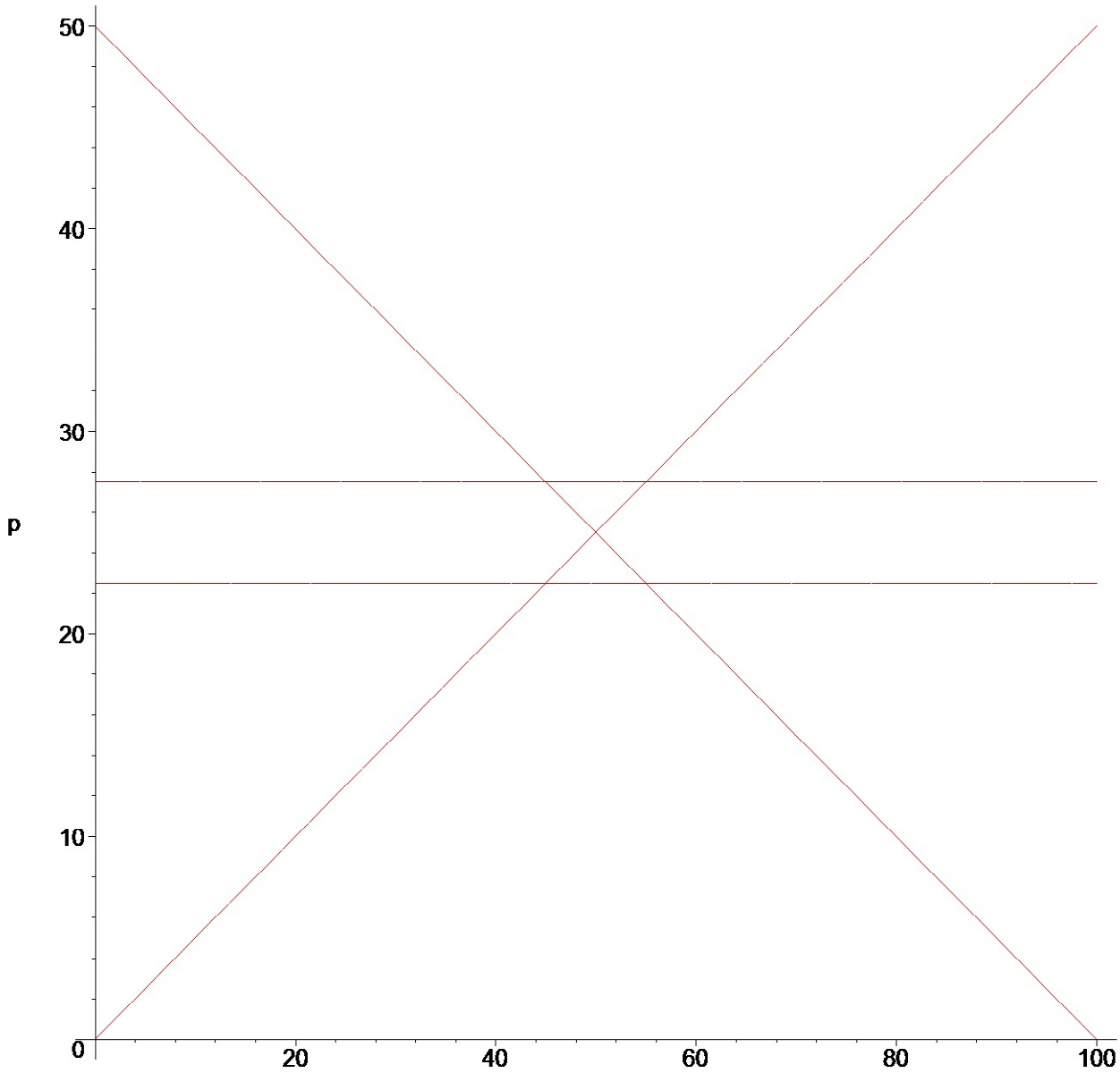
$$\{ps = \frac{45}{2}, q = 45\}$$

Then, we have our consumer price as: 45/2+5=55/2.

What does the diagram look like? Well, I'll also insert the equilibrium producers' price and the equilibrium consumers' price.

We then have:

```
> implicitplot({Demand1,Supply1,p=45/2,p=55/2},q=0..100,p=0..100);
```




Let's go ahead and figure out surplus and all that stuff now.

```
> CS1a:=evalf((50-55/2)*45/2);
```

$$CS1a := 506.2500000$$

```
> PS1a:=evalf((45/2*45)/2);
```

$$PS1a := 506.2500000$$

Tax revenue is given by:

```
> TR1:=5*45;
```

$$TR1 := 225$$

The deadweight loss is then the difference between the sum of CS1a, PS1a, and TR1, and the sum of CS1 and PS1.

```
> SW1:=CS1+PS1;
```

$$SW1 := 1250$$

```
> SW1a:=CS1a+PS1a+TR1;
```

$$SW1a := 1237.500000$$

```
> DW:=SW1-SW1a;
```

$$DW := 12.500000$$

In the second problem, we have the following:

```
> Demand2a:=q+200*pc=10000;
```

$$Demand2a := q + 200\ ps + 2000 = 10000$$

```
> Supply2a:=q-300*ps=0;
```

$$Supply2a := q - 300\ ps = 0$$

If we substitute in our tax, which puts a $5 wedge between the two prices, we have:

```
> pc:=ps+10;
```

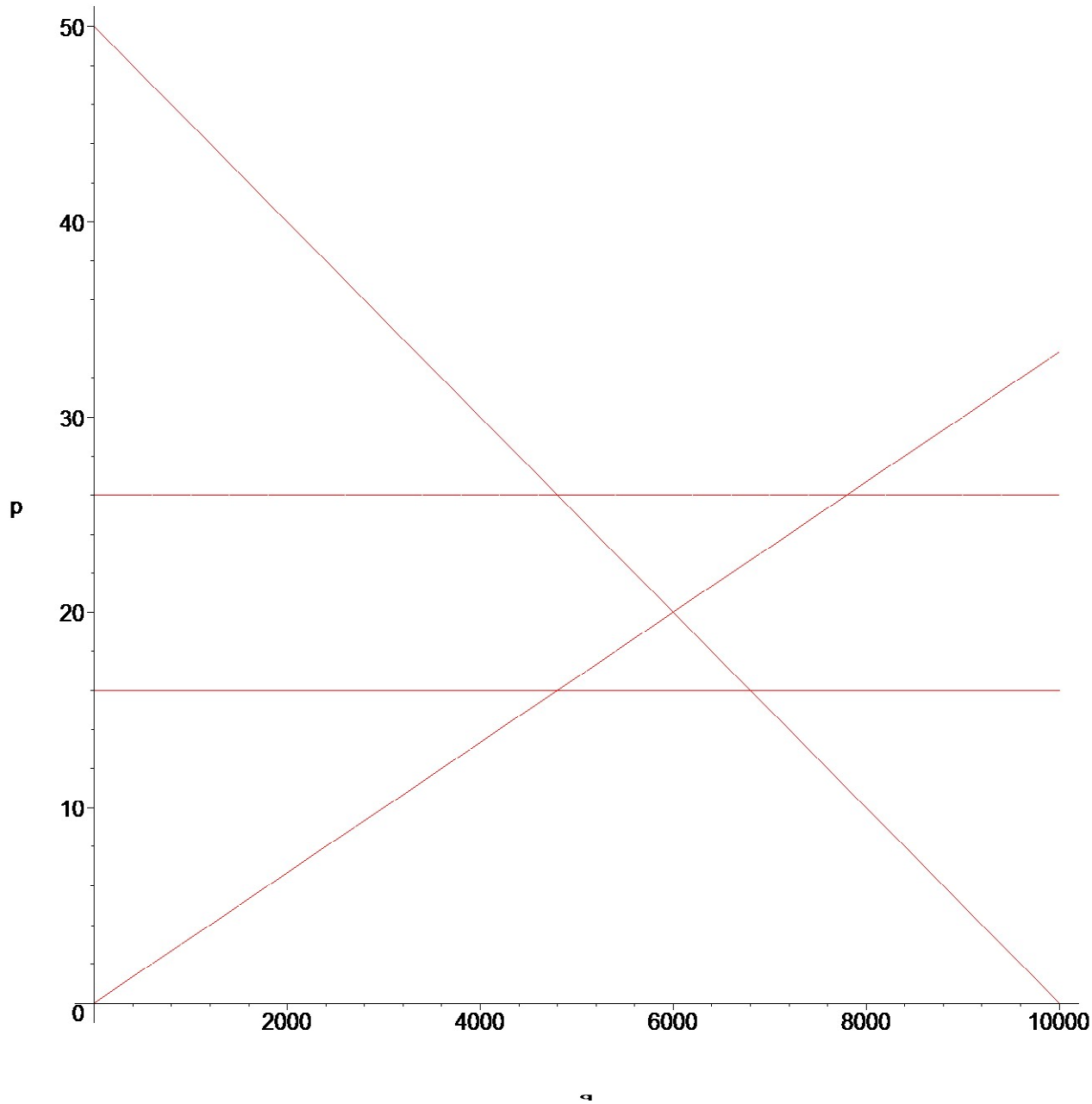
$$pc := ps + 10$$

```
> solve({Demand2a,Supply2a},{q,ps});
```

$$\{ps = 16, q = 4800\}$$

Apparently, in this case the consumer price is 18+10=28. The graph is as follows;

```
> implicitplot({Demand2,Supply2,p=16,p=26},q=0..10000,p=0..100);
```



And it seems as though consumers bear a much heavier tax burden. We then can write

```
> CS2a:=(50-26)*4800/2;
```

$$CS2a := 57600$$

```
> PS2a:=16*4800/2;
```

$$PS2a := 38400$$

```
> TR2:=10*4800;
```

$$TR2 := 48000$$

Our welfare comparison proceeds as before:

```
> SW:=PS2+CS2;
```

$$SW := 150000$$

```
> SWa:=CS2a+PS2a+TR2;
```

$$SWa := 144000$$

So the deadweight loss is given by:

```
> DW2:=SW-SWa;
```

$$DW2 := 6000$$

III. International Trade

Here, we are given that demand is:
q=50-p,
while supply is given by:
q=4p;
also, the international price is given at pw=5. Let's write supply and demand out as before:

```
> Demand3:=q+p=50;
```

$$Demand3 := q + p = 50$$

```
> Supply3:=q-4*p=0;
```

$$Supply3 := q - 4\,p = 0$$

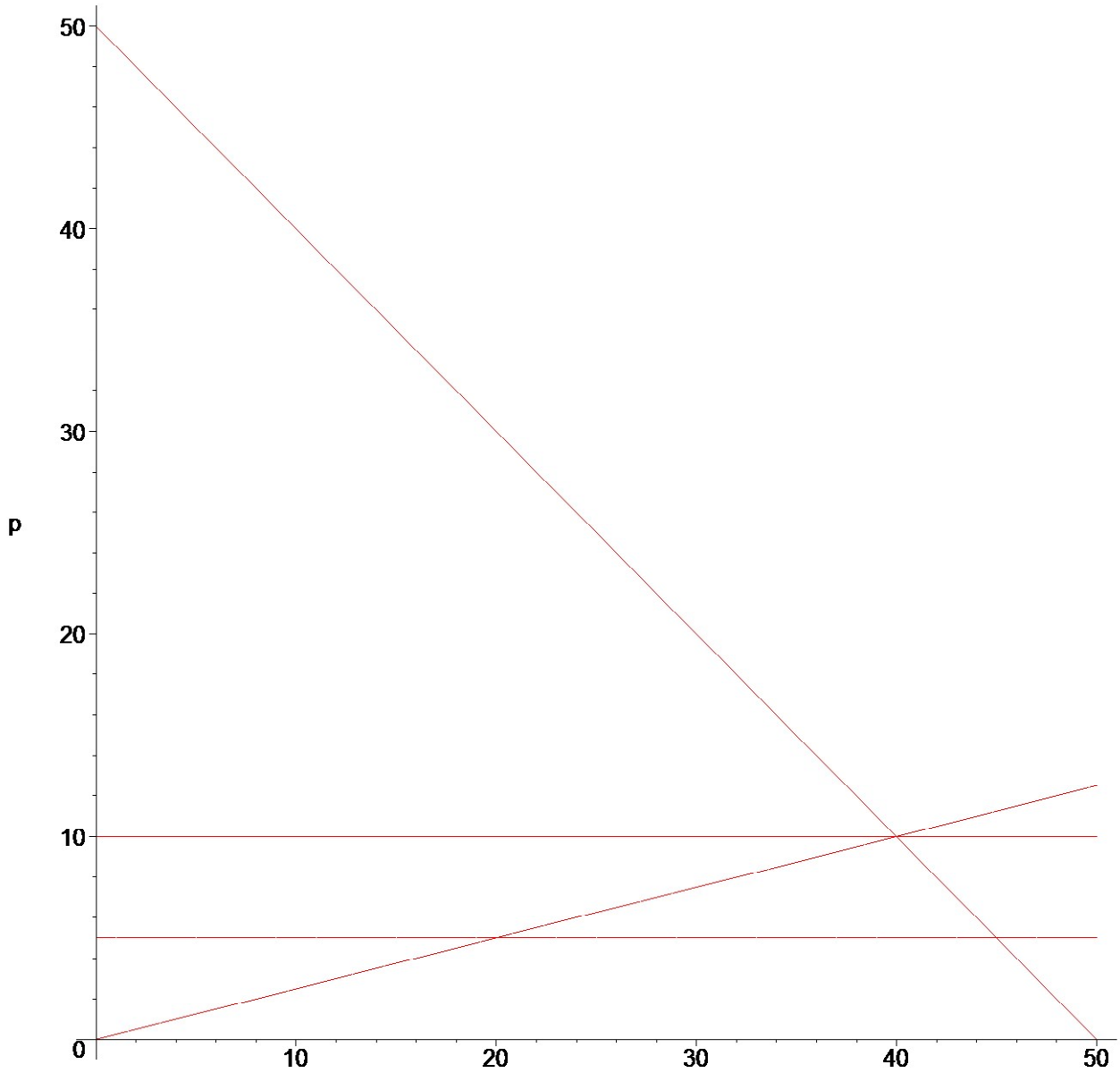
If we solve the two equations, we get:

```
> solve({Demand3,Supply3},{q,p});
```

$$\{p = 10, q = 40\}$$

and the whole graph (where I have included the international price) is as follows:

```
> implicitplot({Demand3,Supply3,p=10,p=5},q=0..50,p=0..50);
```




The lower, horizontal line is the world price. We can find domestic supply by finding out how much suppliers bring to the market at the international price (5). This gives:

```
> DomesticSupply:=4*5;
```

$$DomesticSupply := 20$$

Which looks just about right on the diagram; this is where the lower horizontal line intersects supply.

What are imports? At this price, consumers demand:

```
> DomesticDemand:=50-5;
```

$$DomesticDemand := 45$$

So imports are given by:

```
> Imports:=DomesticDemand-DomesticSupply;
```

$$Imports := 25$$

A $2 tariff raises the price of the product to 7 dollars. Here, we have domestic supply of :

```
> DomesticSupplyt:=4*7;
```

$$DomesticSupplyt := 28$$

```
> DomesticDemandt:=50-7;
```

$$DomesticDemandt := 43$$

```
> Importst:=DomesticDemandt-DomesticSupplyt;
```

$$Importst := 15$$

The tariff revenues are given by:

```
> TariffRevs:=15*2;
```

$$TariffRevs := 30$$