Chemistry Coursework.

What Factors Influence the Energy Change When Metals Are Added to a Metal Salt Solution.

Skill P Planning Experimental Procedures.

Aim.

I am trying to find out what factors influence the energy change when metals are added to a metal salt solution.

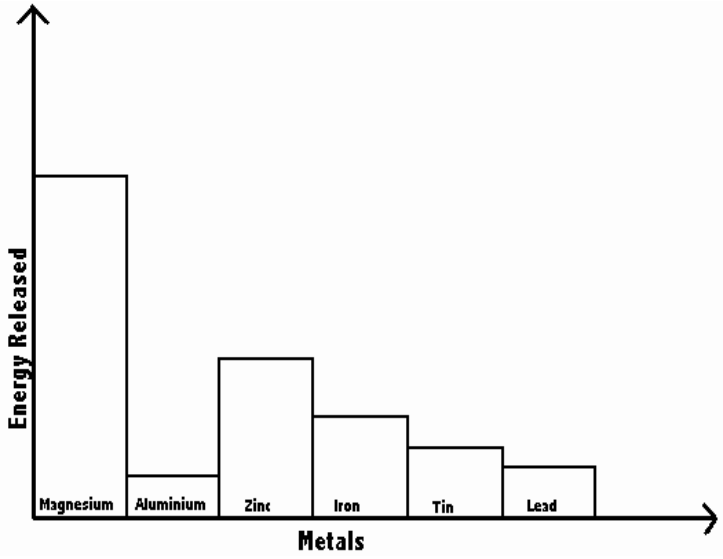
Introduction.

The energy released when one metal displaces another can be used in industry, for example in the reaction of aluminium with iron oxide to weld rails together. Your task is to devise a plan to show how the temperature rise, and hence the energy change, is affected by adding different metals to copper sulphate solution. A suitable metal would be iron, which reacts according to the equation

$(Fe_{(s)} + CuSO_{4(aq)} \rightarrow FeSO_{4(aq)} + Cu_{(s)})$

Prediction.

Prediction Graph.



I predict that when we put a metal from the reactivity series, the higher it will be, the larger amount of energy will be given off. If the metal is very reactive, eg: magnesium, the temperature will rise more than zinc because the further away the electrons are from the nucleus and therefore the more reactive the metal is because the more unstable the metal is and it will give off more electrons more easily and therefore release more energy. In aluminium's case, it should be more reactive than zinc.

Variables.

Dependent Variable*: My dependent variable is going to be the temperature because that is what I am going to measure throughout the experiment. It is going to change when copper sulphate reacts with the metal, with some, it is going to rise a lot, with some, not at all.*
Independent Variable: *My independent variable is going to be the metals themselves, because I am going to change them throughout the experiment, each is going to react with copper sulphate solution ang give off energy.*
Control Variables: *Control variables are the ones that need to be always constant, slight change would have an effect on the results, so to prevent the results from being anomalous, the following must be kept constant:*

1) *The temperature of copper sulphate, if it isn't constant, then the results gained won't be 100% accurate therefore we have to make sure that it is constant.*
2) *Amount used of copper sulphate, if it is too much or more that the previous one, it is yet again won't be that accurate because the more copper sulphate there is, the less energy it will give off when metal is added on to it.*
3) *Amount of the metal used, if the mass used is bigger than the previous one, the result will be different because if there is more metal, then the temperature rise will be more because there will be more energy to be given off so therefore, the amount of metal used should also be kept constant.*
4) *The debris from the 1st experiment because if it wasn't washed properly, the mass would be bigger therefore this would effect the results.*
5) *The temperature of the room, if you start off the experiment in the middle of the room, then throughout the experiment change the place where you were before and move somewhere near the radiator, this would also change the results.*
6) *You should also measure everything accurately to prevent stupid mistakes and anomalous results.*

7) *Also, you should clean up the polystyrene cup after being used so next time when you use that cup, the debris won't affect the results.*

My independent variable is going to be metal. The me tals that I am going to use are: Magnesium, Aluminium, Zinc, Iron, Tin, Lead. I will use change them after each experiment, say if I started off with magnesium, after I added it to copper sulphate solution and got the result, I will get rid of it, wash the polystyrene cup, the small test tubes and then add the next metal. The apparatus that I am going to use to measure the change is the electronic scales, and the way that I am going to measure it is simple, place the empty test tube on the scales, then add the metal powder in the test tube and stop when the needed amount is reached.

The way I am going to measure the temperature is also simple, all I need is the thermometer and measure the solution after the metal is being added in the copper sulphate solution and when it is mixed, it is going to give off heat, but before measuring the temperature rise, I will have to measure the room temperature first so I know what is the rise of the temperature by itself, without the room temperature.

Range.

Reactivity series:

Potassium
Sodium
Calcium
Magnesium
Aluminium
Zinc
Iron
Tin
Lead
Copper
Silver
Gold
Platinum

Most Reactive

Least Reactive

Reliability

I predict that this experiment will be quite reliable, I am going to repeat each experiment three times with the same metal under the same conditions to make it a more accurate result, then I am going to add them all up and divide by three to find out the average.

Safety

1. *Wear lab coats at all times, to stop copper sulphate getting on clothes*
2. *Handle copper sulphate with care, as it can potentially irritate skin*

Apparatus List:

Beaker, polystyrene cup, thermometer, weigh bottles, lead, zinc, magnesium, aluminium, iron, tin

Method.

1) *Firstly, I am going to find out the molar masses of the metals I am going to use. To do so, we just look at the periodic table at the top number of the element, that is the molar mass, so we do that for each metal.*
2) *Secondly, I am going to find the mass of the each metal used and to do so, I am going to use the following formula:*
   (Mass of the metal = moles ∗ molar mass of metal)
3) *Then, when I got the masses of the metals, I measured them on electronic scales.*
4) *After I got the needed masses of the metals, I got the measuring cylinder and added 25 cm^3 of Copper Sulphate.*
5) *I chose to start the experiment with the more reactive metals such as magnesium and move towards the least ones.*
6) *I got the polystyrene cup and filled it up with 25c^3 of Copper Sulphate and added the metal powder to it. If it was a reactive metal, then, the reaction would take place straight away, and the sign of it being reacted is not often clear, but in magnesium's case, the bubbles occurred which indicated that the reaction is taking place.*
7) *After I dropped the metal powder in, I started stirring it with a thermometer and measuring the temperature, I continued doing that until the temperature stops rising.*
8) *Then, I recorded the result I got, and did the same with the same metal three times to make my results more accurate.*
9) *I did the same with the rest of the metals, going from most reactive, down to least reactive.*

Skill O Obtaining Evidence

Table of results.

	Beginning temperature of $CuSO_4$				*When the metals were added*		
Metals	*(^oC)*	*(^oC)*	*(^oC)*		*(^oC)*	*(^oC)*	*(^oC)*
Magnesium	*23*	*23*	*23*		*49*	*45*	*44*
Aluminium	*23*	*23*	*23*		*23*	*23*	*23*
Zinc	*23*	*23*	*23*		*36*	*36*	*37*
Iron	*23*	*23*	*23*		*29*	*27*	*28*
Tin	*23*	*23*	*23*		*23.5*	*23.5*	*23.5*
Lead	*23*	*23*	*23*		*23.9*	*23*	*24.1*

Metals	*Joules*	*Average temperature*	*Temperature change*	*Energy change*
Magnesium	*483000*	*46*	*23*	*2415*
Aluminium	*0*	*23*	*0*	*0*
Zinc	*279300*	*36.3*	*13.3*	*1396.5*
Iron	*105000*	*28*	*5*	*525*
Tin	*25000*	*23.5*	*0.5*	*52.5*
Lead	*12600*	*23.6*	*0.6*	*63*

Skill A Analysing Evidence

Analysis.

My results were what I expected, and matched my prediction. This was due to the fact that the higher the metal in the reactivity is, the greater the energy will be released, We did however receive one anomalous results, that didn't match the actual results I got during the experiment. It was aluminium, it is covered with the oxide coating which prevents it from reactive. It is so reactive that it has already reacted with oxygen therefore it can't react any further, and that is why it is so useful to us when it has reacted with oxygen. The rest of my prediction graph matched the actual graph that I got after the experiment. By looking at the prediction graph, we can see that there isn't that much difference between iron and tin and lead, but in the real graph, there is quite a lot of difference, but most importantly, I got the pattern right. But the rest seems to have matched my prediction of what I thought is going to happen. From the graph, we can see that as we select a more reactive metal, the amount of energy produced or released increases, just as I stated in my prediction. The biggest energy gap however was between magnesium and aluminium and it is obviously due to the oxide coating as I said. The gap between zinc and magnesium is however small, and by looking at the graph, we see that they are both very reactive and release similar amounts of energy. Compared to the other metals, these two produce significantly higher delta energy levels. The way I found out the masses of the metals is pretty simple, I firstly found out the moles, I used the equation:

(Moles = mass/molar mass)

But to find out the molar mass of the metal is very easy, all you need is the periodic table and the molar mass is the top number of the metal and it is also the biggest number. But to find out the mass of the metal used, I used the other equation:

(Mass = moles ∗ molar mass of the metal)

To find out the energy change, we use the equation:

*(Energy Change = Temp. difference * 4.2 *25)*

To find the joules each metal produced, we use the equation:

Skill E Evaluating Evidence

Evaluation.

In my opinion, I think that the experiment I did was quite fair because I kept all the factors that may have affected the results constant, with a few exceptions of course, such as the debris left at the bottom of the cup that wasn't very easy to wash out, plus the test tubes which we kept the metal powder in after each reading needed to be washed out, but when the next portion was added do this test tube, the bits of powder stuck in the test tube leading to the experiment with less metal powder than required. I obviously could have prevented this, but we were short of time so we had to rush it and that is why I couldn't prevent that happening, but if I had more time, then I would have let the test tube dry first before proceeding. My results were accurate enough to draw firm conclusions from. The experiment must have achieved something, as it matched my prediction. To further the experiment, we could have used more metals from the reactivity series, therefore giving us a wider range of results. We could also have tried different types of substances, like alkaline, acid etc. to find out what happens to metals when in contact with an acid, for example if we want t see how strong the metal is, which didn't react with copper sulphate solution, whether it is strong enough to avoid reacting with an acid, so we could have got all sorts of results, gain more information etc. we could have also had the top on the polystyrene cup so avoid the energy escaping, or use a different material rather than polystyrene, to see how it keeps the heat energy in. Our experiment however did have flaws, such as the residue being left in the bottom of the test tube after each different metal, meaning that this may have interfered with the results in our next experiment. We also had the problem of measuring our copper sulphate solution exactly, as we laid down a straight measurement of 25cm^3, but often it was impossible to gain exactly 25cm^3, as the means of measuring out the copper sulphate solution was not very accurate. Energy was also lost through the lack of a lid being present, which meant delta energy would have been lost, that should have been included in our readings. The temperature readings, weren't exactly accurate. They were accurate enough, but give the opportunity again, I would have used a much more accurate level, meaning that I would have used other techniques trying to avoid the change in any of the control variables and this would have made our results much more accurate as a consequence. As it happened, these factors didn't effect our results, as they were kept constant at the levels that we set down before the experiment all the way through. It was consequently possible to draw firm conclusions from our

results, as they matched our prediction, that when the higher the metal in the reactivity series is, the more energy will be released when reacted with copper sulphate solution.