Exemplar Materials: Unit 12 Electrons in Action

Exemplar Portfolio Work Assignment (Work is in Note Form)	Commentary on Mark Allocation
(Work could be presented in a folder) Front cover (e.g.): **Report to Council** **Scooters for Shopping Centre** **Recommendations 2006**	
A survey was carried out in June 2006 to see what power sources are already used for scooters. The survey involved asking actual users of scooters and using the internet. For each power source, information such as the method of use and the cost were found. The results are displayed in the following table. [*table of survey results*]	1 mark in Mark Band 1 could be awarded for the completed survey table. Three types of cell mean that Mark Bands 2 and 3 are available.
Three possibilities were looked at in more detail. These were:- Batteries non rechargeable Batteries rechargeable Fuel cells	
<u>Non rechargeable batteries</u> A diagram showing their construction is below. {diagram} The materials used are:- Zinc Ammonium chloride Manganese dioxide Carbon	Details of method of obtaining these materials and a rough estimate of cost and effect on the environment would be needed if Mark Band 3 is to be awarded.
Zinc produces the ions $Zn \rightarrow Zn^{2+} + 2e$ A reduction reaction	This detail is adequate in depth for Mark Band 2 if three cells are considered.
When the battery is working, these electrons rush round to the carbon electrode (so producing an electric current) At the carbon electrode in the dry cell this reaction happens $2NH_4^+ + 2e \rightarrow 2NH_3 + H_2$ An oxidation reaction.	Effect on environment should include: Emission products/disposal of cells/for MB3 information on materials used in the cell construction and energy usage.

The hydrogen is then oxidised by the manganese dioxide to water. The ammonia dissolves in the water. The maximum voltage that can be produced is 1.5v so if a higher voltage is required, cells have to be joined together in series. The ammonium chloride is acidic and so attacks the zinc walls of the battery. The zinc walls of the battery become thin as the zinc ionises so the battery leaks and produces a nasty sticky mess. These batteries are really only good when a small current is needed . They have a limited life. Batteries are usually disposed into land fill sites where the chemicals will gradually be absorbed into the land. There have been improvements in this type of battery. Such batteries last longer and produce higher potential voltages Examples of such batteries are Zinc/carbon/manganese(IV) oxide with an electrolyte of potassium hydroxide. These are alkaline batteries and are marketed as long life. Such batteries can be used where a high continuous current is needed. They are more expensive. <u>Rechargeable batteries</u>. The most familiar type of rechargeable battery is the lead accumulator which is in cars. A diagram showing its construction is below. {diagram} The materials used are:- Lead Sulphuric acid Lead accumulator Electrons are produced in the lead accumulator by the reaction $PbSO_4 + 2H_2O \text{ ---> } PbO_2 + SO_4^{2-} + 4H^+ + 2e^-$ Thus reaction occurs when the battery is in use. When the battery is recharged, electrons have to be added. The reaction is $PbO_2(s) + 4H^+(aq) + SO_4^{2-}(aq) + 2e^- \text{ ---> } PbSO_4(aq) + 2H_2O(l)$ The accumulator is bulky and heavy. The voltage supplied is approximately 2 volts per cell.	Cost effectiveness to include: Expected working life-time of cell. Whether cell maintains its output of energy over time. Details of method of obtaining these materials and a rough estimate of cost and effect on the environment would be needed if Mark Band 3 is to be awarded. This detail is brief. Reference to the diagram and the equations to explain the functioning of the accumulator both on charging and discharging needed for Mark

Lead from accumulators that no longer function efficiently is recycled. The recycling of old accumulators is organised through garages. Most old accumulators recycled.	Band 2. Mark Band 2 only given if three different types of cells are considered.
Other rechargeable batteries have been developed. One example is the Nickel /cadmium cell alkaline electrolyte Reaction is $2NiOOH + Cd + 2H_2O \rightarrow 2Ni(OH)_2 + Cd(OH)_2$	Two types of commercial cells with a description can be awarded up to 4 marks in Mark Band 1.
Left to right is discharging. Right to left is charging. $Cd \rightarrow Cd^{2+}$ Oxidation Voltage for the cell is 1.2v Disposal of these batteries needs care as cadmium is carcinogenic	A description of other rechargeable cells together with relevant equations gives the possibility of Mark Band 3.
<u>Fuel Cells</u> The basic chemical reaction in a fuel cell is $2H_2 + O_2 \rightarrow 2H_2O$ This reaction occurs in two stages in different parts of the fuel cell. The two stages are: $2H_2 \rightarrow 4H^+\_ +4e$ $O_2 + 4H^+ + 4e \rightarrow 2H_2O$. A diagram of a fuel cell is shown below {diagram} The materials in a fuel cell are not disclosed as fuel cells are in a state of development. However a catalyst of platinum is used. A continuous flow of oxygen and hydrogen are needed for the fuel cell to operate. Both are gases and therefore occupy large volumes Hydrogen is explosive. Waste product is water which will not harm the environment. Only able to produce 0.7v	This detail is adequate in depth for Mark Band 2 if three cells are considered.

<u>Conclusion</u> To include a summary of the advantages and disadvantages of the three types of cell in actual use considering safety, ease of use and cost both financially and to the environment. A suitable recommendation should be included.	Summary must be detailed and consideration given to all aspects if Mark Band 3 is to be awarded.