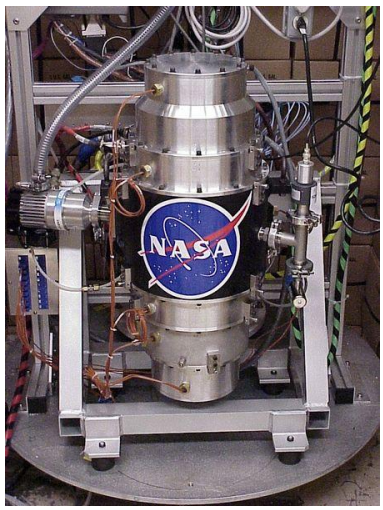
These notes cover the different methods that can be employed to store energy in various forms. These notes cover the storage of Electrical Energy, Kinetic Energy, and Pneumatic Energy. There are many methods, but here are an example of some:



- Batteries
- High value capacitors
- Pump storage power stations
- Coiled spring
- Flywheel storage

Electrochemical Cells & Batteries

Battery Characteristics

Electrochemical batteries allow electricity to be stored in a chemical form for an extended period of time. The electricity can then be released as DC (direct current) when required. There are many different types of batteries, all with their own characteristics. These characteristics make them useful for particular purposes.

Cells & Batteries

It is important to understand the distinction between Cells and Batteries. A Cell is simply an individual electrochemical element for the storage of electricity. A Battery is an arrangement of cells in series or parallel in order to develop the required output voltages or capacity. In general Cells are non-rechargeable and Batteries are rechargeable.

A list of some of the most common cell and battery types available on the market are shown below:

Primary Cells – non rechargeable	***Secondary Batteries – rechargeable***
Zinc Carbon	Lead-acid
Zinc Chloride	Nickel-cadmium (NiCd)
Silver Oxide	Nickel metal hydride (NiMH)
Lithium	Lithium Ion (Lion)
Mercury	Lithium Ion Polymer
Zinc-Air	
Zinc-Carbon	

Characteristics

There are a whole range of characteristics associated with each type of Cell or Battery technology. Some of these are:

Nominal Capacity (Amp/Hours Ah) – *The measurement of capacity for a given voltage*

Voltage or EMF (Volts) – *The nominal voltage that the battery will develop at its terminals*

Watts per Kilogram (W/Kg) – *The power released in relation to the mass of the battery*

Power Density (Watts/ Litre) – *The power released in relation to the volume of the battery*

Capacity

Batteries and Cells are supplied in a range of voltage and capacity ratings. It is important to be able to identify the correct battery or cell for the application.

The nominal voltage of the battery is the voltage you would expect to measure across the output terminals when fully charged. This voltage will drop as the battery discharges. The rate at which it discharges is dependant upon the capacity (Amp/Hours.)

For example a car battery may have the label:

12V, 100Ah

This means the battery is capable of supplying:

12Volts at 100 Amps for 1 Hour

or

12 Volts at 1 Amp for 100 Hours

Also

12 Volts at 10 Amps for 10 Hours

Etc.

Exercise 1.) If a 6V battery has a capacity of 7Ah, how long will it be able to maintain this voltage if the load current is 160mA?

Exercise 2.) If a 12V battery has a capacity of 36Ah, how long will it maintain its nominal output voltage if supplying an electric heater whose element has a resistive load of 10Ω?

Lead Acid

•These batteries use lead plates and a sulphuric acid electrolyte. They come in a range of sizes.

• They are commonly found in house alarm systems and as the power source for golf buggies and motorised wheelchairs.

• Advantages: Cheap, high capacity, can supply very high currents.

• Disadvantages: Very heavy, contain toxic lead.

Nickel Cadmium (Ni-Cad)

•These batteries contain Nickel and Cadmium. They are commonly used in household equipment, power tools etc. They come in a range of sizes.

•Advantages: Fairly cheap, light weight, high capacity, can supply large currents.

•Disadvantages: Contain toxic Cadmium .

Nickel Metal Hydride (NiMH)

•These are simililar to NiCads but have a number of advantages.

•Advantages: Fairly cheap, light weight, high a higher capacity and can supply higher currents than Ni-Cads, less toxic chemicals than Ni-Cads, long shelf life.

•Disadvantages: Longer charge time than Ni-Cads.

Nickel Metal Hydride (NiMH)

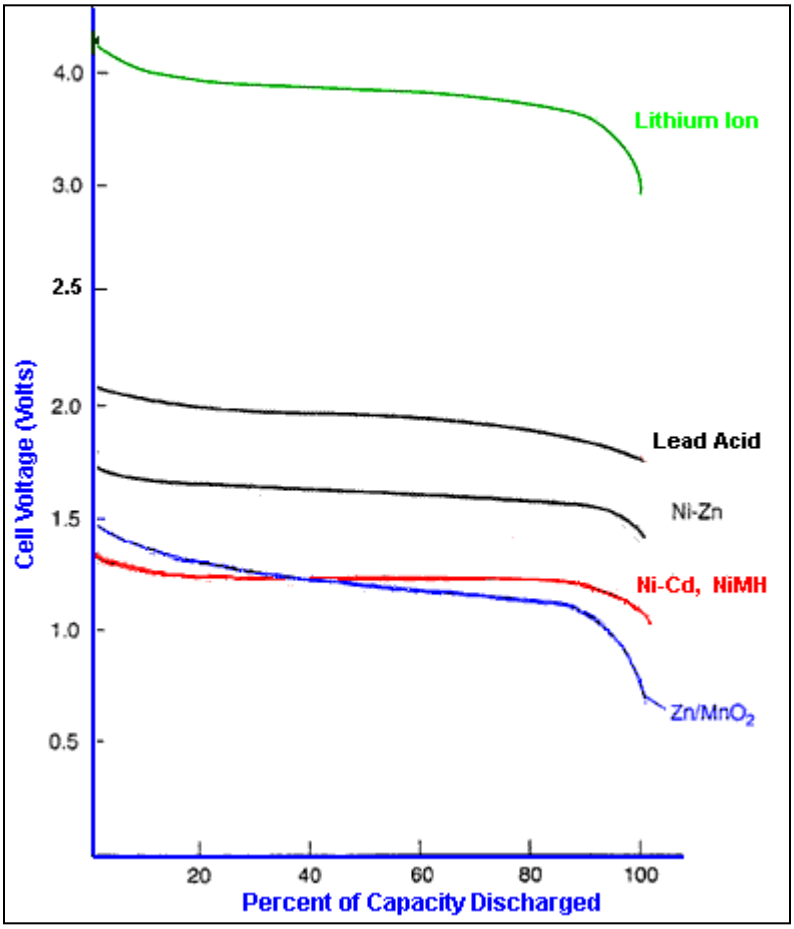
•These batteries are used extensively in modern portable equipment such as laptops and mobile telephones. They are very compact and can store a lot of energy for their size.

•Advantages: Very light weight, high capacity, low self discharge rate so good for standby operation.

•Disadvantages: Contain toxic Lithium .

Electrochemical Cells and Batteries
Battery Characteristics

Type	Temp. Range (oC)	Max. Charge Cycles	Energy Density By Mass. (Wh/Kg)	Energy Density By Vol. (Wh/L)	Self Discharge (%/Month)	Uncharged Shelf Life (Months)	Relative Cost	Standard Charge Time (Hours)
Lead Acid	-15 to 50	180+	35	27	5	6	Low	12
Ni-Cad	-20 to 65	500+	50	140	15 to 20	6	Med	4 to 10
Ni-MH	-10 to 60	500+	55	180	20 to 30	12	Med	12 to 36
Li-Ion	-10 to 60	500+	90	210	5 to 10	12	High	



Common discharge curves of common batteries

1.) Describe why a Li-Ion battery might be used rather than a Lead Acid battery in mobile phone applications. Relate your answer to the characteristics of the respective types.

2.) Explain why Ni-MH batteries are considered to be superior to Ni-Cads.

4.) A middle range remote control car needs a battery to supply power to the motors. The motors relatively high peak current supply.

5.) A bank has central server computers that are used to process the transactions made by their national ATM machines. A system is required to ensure that the power to the servers are not interrupted if mains power is interrupted (non-interruptible power supply –UPS). Such a system will have a very high current consumption and in normal operation will be in the standby condition for extended periods of time.

6.) An engineer is designing a portable remotely operated vehicle, used for identifying hidden packages under vehicles. The powerful drive motors draw a high current when the vehicle is in motion. Justify which battery you believe to be most suitable for use in the design.