University of Mumbai
Energy Storage
MCQ

Q1	
1	Which of the following storage method has working similar to the cycle of a Gas turbine Power plant?
Option A:	SMES
Option B:	Flywheel
Option C:	Pumped Hydroelectric
Option D:	**Compressed Air Energy Storage**
2	**Which of the following is not used as storage material for sensible TES system?**
Option A:	Rock
Option B:	Reinforced Concrete
Option C:	**Ice**
Option D:	Mineral oil
3	**What are the factors that determine the amount of energy stored in sensible TES system?**
Option A:	Volume , temperature and specific heat capacity of storage material
Option B:	mass, temperature and specific heat capacity of storage material
Option C:	**mass , change in temperature and specific heat capacity of storage material**
Option D:	Volume , change in temperature and specific heat capacity of storage material
4	**How the energy stored in the rotor of Flywheel energy storage technology is generally increased?**
Option A:	**Increasing the Angular speed of the rotor**
Option B:	Decreasing the Mass of the rotor
Option C:	Increasing the volume of the rotor
Option D:	Increasing the Specific resistance of the rotor
5	**Which of the storage technology involves storing energy in the form of increase in internal energy of the material during isothermal phase change?**
Option A:	Pumped Hydroelectric energy storage
Option B:	Sensible Thermal Energy storage
Option C:	**Latent Thermal Energy storage**
Option D:	Compressed Air Energy storage
6	**The maximum amount of work (also called availability) that can be produced by a stream of matter or energy (heat, work, etc.) as it comes to equilibrium with a reference environment is defined as -**
Option A:	Energy
Option B:	Enthalpy
Option C:	**Exergy**
Option D:	Entropy

7	Which of the following battery parameter is important in determining the range in an Electric Vehicle?
Option A:	Specific Power
Option B:	Volumetric Energy density
Option C:	**Gravimetric Energy density**
Option D:	Cycle Life
8	_____ can be defined as the amount of stored energy relative to the total energy storage capacity of the battery
Option A:	**State of Charge**
Option B:	Depth of Discharge
Option C:	Self discharge
Option D:	Specific Energy
9	Determine the energy stored in a Capacitor of capacitance 1500 uF and charge across its plates is 0.2 C?
Option A:	133 J
Option B:	1333 J
Option C:	0.13 J
Option D:	**13.3 J**
10	Which of the following fuel cells has a high operating temperature (around 650 °C) and electrolyte is molten potassium lithium carbonate?
Option A:	Alkaline Fuel Cells
Option B:	Proton Exchange Membrane fuel Cell
Option C:	Direct Methanol Fuel Cell
Option D:	**Molten Carbonate Fuel Cell**
11	What is typically the value of specific energy density of Lithium Ion batteries?
Option A:	35 to 40 Wh/kg
Option B:	**150 to 200 Wh/kg**
Option C:	300 to 500 Wh/kg
Option D:	10 to 20 Wh/kg
12	Which of the following is a limitation of Super-capacitors?
Option A:	Low energy density than capacitors
Option B:	**Low cell voltage**
Option C:	Limited charge discharge cycles
Option D:	Long recharge times
13	What among the following results in high capacitance of EDLC type super-capacitors ?
Option A:	Both faradic and non-faradic reactions take place at the electrodes
Option B:	High cell voltage
Option C:	**Electric double layer formation at the electrode and electrolyte interface**
Option D:	Fast charging and discharging
14	Which of the following electrochemical reaction takes place at the positive electrode of a Lead acid battery at the time of discharging?

Option A:	$Pb + HSO_4^- \rightarrow PbSO_4 + H^+ + 2e–$
Option B:	**$PbO_2 + 3H^+ + HSO_4^- + 2e– \rightarrow PbSO_4 + 2H^2O$**
Option C:	$LiCoO_2 \rightarrow Li_{1-x}CoO_2 + xLi+ + xe-$
Option D:	$NiOOH + H_2O + e^- —> Ni(OH)_2 + OH^-$
15	Which of the following Energy storage technology has highest energy density?
Option A:	Lead acid battery
Option B:	Nickel metal hydride battery
Option C:	**Lithium ion battery**
Option D:	Vanadium redox flow battery
16	**Which of the following parameters of a battery defines the rate of energy output from the battery for any given application?**
Option A:	Specific energy
Option B:	**Specific power**
Option C:	Energy density
Option D:	State of charge
17	**Why salt is added in a Solar pond with concentration increasing towards the depth?**
Option A:	To increase dissipation of suns heat from the surface
Option B:	To purify water in the solar pond
Option C:	**To prevent rising of hot water to the surface**
Option D:	To make water clear and transparent
18	**What is the purpose of using superconducting materials for SMES systems?**
Option A:	Increase strength of magnetic field
Option B:	**Reduce the I^2R losses in the material**
Option C:	Reduce the resistance at high temperatures
Option D:	Increase permeability of the material
19	**---------- is defined as a system that uses refrigeration equipment at night to create a reservoir of cold material, which is tapped during the day to provide cooling capacity.**
Option A:	Sensible TES
Option B:	Solar ponds
Option C:	Seasonal TES
Option D:	**CTES**
20	_____ stores energy in the form of rotational kinetic energy.
Option A:	Pumped hydro storage system
Option B:	Compressed Air energy storage
Option C:	**Flywheel**
Option D:	SMES
21	Which of the following expressions gives the generated power P in Watts from a pumped hydro storage system? (Q – flow rate , H – hydraulic head height , ρ- water density , g – acceleration due to gravity , η - efficiency
Option A:	$P = (Q \times H \times \rho \times g) / \eta$

Option B:	P = (H × ρ × g)/ Q η
Option C:	P = (Q × H × g) / (ρ × η)
Option D:	**P = Q × H × ρ × g × η**
22	The cell voltage of Lithium ion batteries is typically in the range of -
Option A:	1.3 to 1.6 V
Option B:	2.3 to 2.7 V
Option C:	1.8 to 2.1 V
Option D:	**3.6 to 4.1 V**
23	The energy density (Wh/L) of Vanadium redox flow batteries is in the range of -
Option A:	**20-70**
Option B:	100-250
Option C:	0.1 - 2
Option D:	1000 - 1500
24	The operating temperature of which of the following fuel cell types is very high typically 900 – 1000 deg C
Option A:	Proton exchange membrane fuel cells
Option B:	**Solid oxide Fuel cells**
Option C:	Alkaline Fuel cells
Option D:	Direct Methanol fuel cells
25	The method of battery charging in which a constant voltage lower than maximum battery voltage is applied to battery continuously to maintain it at 100 % SOC for emergency power back up is called as -
Option A:	Constant voltage charging
Option B:	Pulse charging
Option C:	Reflex charging
Option D:	**Float charging**
26	_____ is the technology for transferring the electricity stored in electric vehicle (EV) batteries to the grid, buildings, houses, and other energy-consuming destinations.
Option A:	G2V
Option B:	V2G
Option C:	V2H
Option D:	**V2X**
27	---------- is defined as the fraction or percentage of the capacity which has been removed from the fully charged battery.
Option A:	State of charge
Option B:	State of health
Option C:	**Depth of discharge**
Option D:	Self -discharge

28	_____ store energy in the magnetic field created by the flow of direct current in a superconducting coil which has been cryogenically cooled to a temperature below its critical temperature.
Option A:	Flywheel ESS
Option B:	Super capacitors
Option C:	**SMES**
Option D:	Batteries
29	The material used for anode and cathode of Nickel metal hydride batteries is -
Option A:	NiOOH anode , Alloy of metal hydride cathode
Option B:	**NiOOH cathode , Alloy of metal hydride Anode**
Option C:	graphite anode , lithium cobalt oxide [$LiCoO_2$] cathode
Option D:	graphite cathode , lithium cobalt oxide [$LiCoO_2$] anode
30	What will be the C-rate of a battery with capacity of 15 kWh if it discharges power at 30 kW in 30 min?
Option A:	0.1C
Option B:	**2C**
Option C:	4C
Option D:	3C

DESCRIPTIVE QUESTIONS

1.	What is the need of energy storage with Renewable energy sources?
2.	Explain with neat diagram any Renewable energy source with TES storage system.
3.	Explain the principle, types and applications of (TES) Thermal Energy storage systems.
4.	Compare between Sensible and Latent Thermal Energy storage systems.
5.	Mention any three application areas where there is a need of Energy storage. Give justification.
6.	Explain with neat diagram the features of a seasonal thermal energy storage system.
7.	Explain with neat diagram (CTES) Cold thermal Energy storage system.
8.	Explain with neat diagram the working and applications of Flywheel energy storage system (FESS).
9.	Explain working of Solar Ponds.
10.	Explain with neat diagram the principle, working and applications of (SMES) Supermagnetic Energy storage system.
11.	Explain with neat diagram the principle, working, components of a (PHES) Pumped Hydro Energy storage system. Give its applications.
12.	Explain with neat diagram the principle, working, components of a (CAES) Compressed Air Energy storage system. Give its applications.
13.	Explain the construction, working, cell reactions and applications of Lead acid batteries.
14.	Explain Vanadium redox flow batteries in detail.
15.	What are ultra-capacitors? Explain its features and applications.
16.	Explain the construction , working , cell reactions and applications of Lithium Ion batteries
17.	Compare the performance of Lead acid , Nickel metal Hydride and Lithium ion batteries.
18.	What are the types of Fuel cells? Explain any two in detail.

19.	Determine the size of a battery required as Energy storage for a standalone PV system. The connected load is as given below. Consider no.of days of autonomy = 2.

Load	Watts	H/day	Number
CFL	9	5	3
Fan	60	10	2
TV	150	2	1
Refrigerator	150	8	1
Computer	250	3	1

20.	Compare the different energy storage technologies with reference to their energy densities, life, Number of charge-discharge cycles, response time, cost, applications etc.