Missiles:-

1. Cruise : Aerodynamic lift
2. Ballistic: Science of Mechanics for launching
3. Canister based: Can be launched from anywhere

On the basic speed: Subsonic,supersonic,hypersonic

- Launch mode: Surface-Surface,Sea-Sea,Surface-air,Air-air ,antitank etc.
- Range: Short,medium,intermediate,intercontinental

Propulsion:

- Solid (Aluminum powder-heavy),
- liquid (hydrocarbon)
- hybrid (solid+liquid fuel),
- cryogenic (gases liquefy at very low temp. Hydrogen fuel,O2 as oxidiser, extremely clean,H20 as waste,Satellites 2 tonnes or more into geosynchronous orbits)

Basis of warhead: Conventional (explosive) , strategic (nuclear)

- Guidance: Laser guided, beam guided ,GPS, terrestrial, command wire
- tactical ballistic missile is a ballistic missile designed for short-range battlefield use(Prahar, Shaurya, Pinaka)
- Beyond visual range: (37 km) or beyond
- **Nuclear triad:** strategic bombers, intercontinental ballistic missiles (ICBMs), and submarine-launched ballistic missiles (SLBMs)
- **Maithri project:** India-France cooperation to build short range surface-air missile (Similar to Akash)
- **Suryakiran:** India Nepaljoint military exercise
- **Garuda Shakti:** India &Indonesia joint military exercise
- Ramarao committee: Asked DRDO to focus on main projects(8-10)
- Naresh Chandra task force: PPP in defence

- Kaveri engine: India's first indigenous gas turbine engine.(Propulsion engine).Tested in Russia
- Sudarshan: Laser seeker kit->to convert conventional bombs into laser guided bombs
- Aerostat: Balloon used technology
- Airborne Early Warning and Control System (AEWCS)
    - Eyes in the sky
    - Can detect incoming aerial threat- Fighters, drones, cruise missile
    - Penetrate into enemy territory without physical entry
    - Airbus A330

- **Unmanned vehicles**

    - Lakshya : pilotless aircraft
    - (targeting,recce),Netra(Civil&Commercial),Predator(combat)
    - Currently Indian army uses Israel drones:Heron &Searcher + Indigenous: Lakshya& Nishant,Pancchi (wheeled version of nishant)
    - DRDO is developing Rustam I&II medium & long endurance drones for military purpose
    - [Used against Maoists now]
    - Recce: In military operations, reconnaissance is the exploration outside an area occupied by friendly forces to gain information about natural features and enemy presence
- **Rajendra** is a passive electronically scanned array radar developed by the Defence Research and Development Organisation (DRDO).
- It is multifunction radar, capable of surveillance, tracking and engaging low radar cross section targets. It is the heart of the **Akash surface-to-air** missile system and is the primary fire control sensor for an Akash battery.
- **Rafael:** Medium multirole combat aircraft-France

Armament system

- iSHAPORE selfloading rifle: DRDO
- Nirbheek: Small revolver-Ordnance factory: under Ministry of Defence.
- Adrushya mine: Mines to immobilize battle tanks
- Arjun MK1 :First indigenously developed ,designed and manufactured tank
- T72 Ajeya : Tank
- Divyadrushti : Integrated signal system (Sangraha: Navy, Samyukta: Army)
- Sujav: Electronic warfare suit
- Sagarika: nuclear-capable submarine-launched ballistic missile, K-15 missile

- BrahMos: short range ramjet supersonic cruise missile that can be launched from submarines, ships, aircraft or land. It is a joint venture between the Russian Federation's NPO Mashinostroeyenia and India's Defence Research and Development Organisation (DRDO) who have together formed BrahMos Aerospace Private Limited.
    - Can receive info from Glonass (Russian GPS)
    - Rings (GPS system), RINSS laser gyro based –GPS-Glonass

Missiles

Short range surface-to-surface missile (code-named Prithvi)

- surface-to-surface short-range ballistic missiles (SRBM)
- India's first indigenously developed ballistic missile

Missile	Type	Warhead	Payload (kg)	Range (km)	Dimension (m)	Fuel/Stages	Weight (kg)	In service	CEP (m)
Prithvi-I	Tactical	Nuclear, HE, submunitions, FAE, chemical	1,000	150	8.55X1.1	Single stage liquid	4,400	1988	30–50
Prithvi-II	Tactical	Nuclear, HE, submunitions, FAE, chemical	350–750	350	8.55X1.1	Single stage liquid	4,600	1996	10–15
Prithvi-III	Tactical	Nuclear, HE, submunitions, FAE, chemical	500–1,000	350–600	8.55X1	Single stage solid	5,600	2004	10–15

- Short range low-level surface-to-air missile (code-named Trishul)
- Medium range surface-to-air missile (code-named Akash) and
- Third-generation anti-tank missile (code-named Nag)

Agni

Missiles of Agni series are developed by DRDO and manufactured by Bharat Dynamics Limited.

Agni-V

- intercontinental ballistic missile developed by the Defence Research and Development Organisation (DRDO) of India
- Other intercontinental missile countries: P5+Israel
- Canister based(Road mobility,all weather,flexible launching) [Others: Shaurya, Brahmos(Only supersonic cruise missile in the world)]
- Range: >5ooo km
- 3 stage solid propellant
- Nuclear warhead
- Usage : small satellites,shoot down enemy satellites in short range

Shaurya missile

- canister launched hypersonic surface-to-surface tactical missile
- developed by the Indian Defence Research and Development Organisation (DRDO)
- range of between 750 to 1,900 km
- conventional or nuclear warhead
- short-intermediate range

Prahar

- solid-fuel rocket surface-to-surface guided short-range tactical ballistic missile
- DRDO
- omni-directional warheads and could be used for striking both tactical and strategic targets(all-weather, all-terrain,)
- Export version of Prahaar known as "Pragati"

Pinaka

- Tactical missile

Astra

- active radar homing (find and track its target autonomously.)
- beyond-visual-range (>37 km)
- air-to-air missile (BVRAAM)developed by the Defence Research and Development Organisation (DRDO),
- both short-range targets (up to 20 km) and long-range targets (up to 80 km) using alternative propulsion modes.
- Max: 110 km

Dhanush

- surface-to-surface/ship-to-ship Prithvi III missile,
- both conventional as well as nuclear warheads
- range of 350 km
- pay-load capacity of 500 kg
- Short Range Ballistic Missile
- Liquid propellant

Trishul

- short range surface-to-air missile
- Designed to be used against low-level (sea skimming) targets at short range
- to defend naval vessels against missiles and also as a short-range surface-to-air missile on land
- officially shut the down Trishul Missile project on 27 February 2008

Akash

- medium range surface-to-air missile
- developed as part of India's Integrated Guided Missile Development Program
- supersonic speed
- terminal guidance system capable of working through electronic countermeasures.

Nag

- India's third generation "Fire-and-forget" anti-tank missile.
- It is an all weather, top attack missile with a range of 3 to 7 km.
- Nag uses Imaging Infra-Red (IIR) guidance with day and night capability.
- Mode of launch for the IIR seeker is LOBL (Lock on Before Launch).
- Nag can be mounted on an infantry vehicle;
- a helicopter launched version will also be available with integration work being carried out with the HAL Dhruv.
- For the Army, the missiles will be carried by specialist carrier vehicles (NAMICA-Nag Missile Carrier) equipped with a thermographic camera for target acquisition.
- For the Air Force, a nose-mounted thermal imaging system has been developed for guiding the missile's trajectory "Helina".

National technology day:

- May 11 2015; commemorating operation Shakti (Pokhran II)
- Hansa III indigenous aircraft
- Trishul also successfully test fired
- TDB(Technology development Board) instituted a national award to commemorate this day – Whoever successfully commercialize the indigenous technology

Xylyl bromide:

- First chemical weapon
- Phosgene, Mustard gas: Other chemical weapon

HADR: Humanitarian Assistance and Disaster Relief: in Mali by India.

Indian Aircraft carriers:

- INS Vikrant : 1957 : decommissioned : British :Hercules:Maritime museum-Mumbai
- INS Virat: British(1987): HMS Hermes:Oldest
- INS Vikramaditya:Russia(2013): Admiral Gorkshov
- INS Vikrant: Indigenous, supposed to be commissioned by 2018,Cochin shipyard
- INS Vishal: Future plan

- 16 submarines-10 Sindhughosh, 4-indigenous(Shishumar class) ,leased nuclear submarine from Russia(Akula class),indigenous Arihant
- **Sindhughosh-class submarines** are Kilo-class diesel-electric submarines in active service with the Indian Navy.-total 10
- **INS Arihant:** First indigenous ballistic missile nuclear submarine-Advance vessel technology
- **INS alleppey**: Russia,decommissioned
- **Vessel Mhadeyi** :Sailor ship that went around the world
- **Calvari submarine**: Indian Navy scorpion class submarine under project 75- French collaboration, air independent propulsion
- **Varuna :** IndoFrench naval exercise (Goa)
- **Dakota III :** Aircarft used during Bangaladesh war. Recently handed over to BL.
- Titanium : High strength & non corrosive

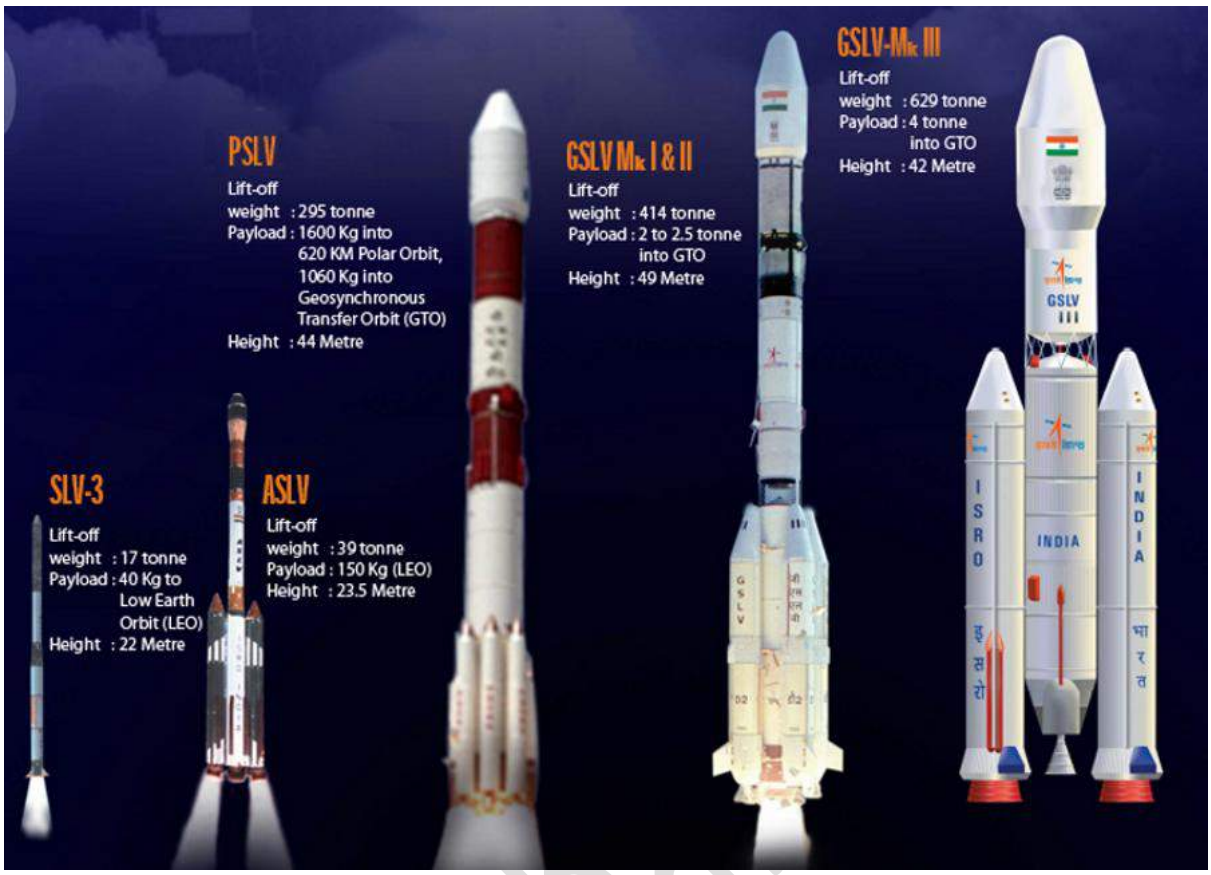
Indian Space Program is using indigenously made Titanium sponge to make satellite parts

What is GAGAN?

- GAGAN stands for Geo Augmented Navigation System for civil aviation purpose. It is a joint effort of ISRO and AAI to help the air traffic to land and fly airplanes in bad weather.
- GPS-Aided Geo Augmented Navigation (GAGAN) system, will offer navigation over the country, the Bay of Bengal, South East Asia, Middle East and up to Africa.
- Benefits are improved efficiency, direct routes, increased fuel savings, approach with vertical guidance at runways, significant cost savings
- It bridges the gap in the coverage areas of the European Union's EGNOS and Japan's MSAS.

ISRO's GAGAN to provide navigational support to Railways

- GAGAN is an indigenous navigational guide system developed by ISRO on the lines of GPS system of the US.
- Jointly developed by the ISRO and Airports Authority of India (AAI) with a view to assist aircraft in accurate landing.
- The GAGAN signal is being broadcast through 2 Geostationary Earth Orbit (GEO) satellites.= GSAT 8 & GSAT 10
- How will it aid railways?
- Help provide safety at unmanned level crossings
- Provide information on under stressed railway tracks – water clogging, dismantled tracks
- Identifying routes when the rail cruises through mountaineous/ difficult region
- A micro satellite weighs between 10 to 100 kgs while a nano satellite weighs between 1 to 10 kgs
- GSLV Mark III: Unmanned crew vehicles



What is NISAR?

- NISAR stands for NASA ISRO synthetic aperture radar. It is being developed to take a radar imagery of earth in an unprecedented detail.
- NISAR will use two different radar frequencies – L-Band by NASA and S-band by ISRO.

ISRO pitches cost-effective fire-proofing technology

- CASPOL, is a water-based ready-to-coat and easy-to-use flame-proof coating. Has excellent flame retardant, waterproofing, and thermal-control properties.

ISRO navigation satellite in orbit

- ISRO's PSLV C-27 successfully launched Indian Regional Navigation Satellite System (IRNSS) 1-D satellite into the intended orbit.
- IRNSS is a navigation system that will cover India, and also extend 1,500 kms from its boundaries.
- Will provide 2 kinds of services, Standard Positioning Services, which is available to all users, and an encrypted service that is provided only to authorized users.

ISRO successfully tests indigenous cryogenic engine

- This engine will allow launch vehicles to carry satellites of up to capacity of 4 tonnes in geostationary orbit.
- It will also give boost to India's interplanetary probes and manned space missions.
- A cryogenic engine is more efficient as it provides more thrust for every kilogram of propellant burnt.
- Extremely clean as they give out only water while burning.
- The engine uses liquid oxygen at -2530C and liquid hydrogen at -1830C.

Android-based application 'Sakaar' has been launched, intended to give a real world environment to visualise ISRO projects such as Mars Mission.

Mercury

- Mariner 10 & Messenger
- BEPI Colombo(proposed to be launched in 2017-Japan&EU)

Venus

- Venera(USSR)
- Marina (Marina 5 will fly by)
- Akatsuki: Japan-failed
- Venera 4-success
- Venera D(USSR)-proposed
- Venus insitu explorer(VISE)-NASA-proposed

Mars

- Phoenix lander
- **Orbiters**
- Mars Odyssey-NASA
- Mars Express –ESA
- Mars Reconnaissance- NASA
- MoM
- MAVEN –NASA
- Viking-NASA
- Mars 112-China
- **Rovers**
- Spirit- Inactive now
- Opportunity-Active
- Curiosity-Active(Studied Gale crater)

Swing by

- Rosetta

Jupiter

Features of Jupiter:

- Red spots
- Ganymede, the largest moon in solar system
- Europa ,another moon
- Magnetosphere of Jupiter is the largest in solar system

Pioneer 10 (First one to have escape velocity from solar system)

Pioneer 11 (Astroid belt)

En route: Cassini, New Horizon, Ulysses

Galileo (Entered orbit-Observed the collision of Schumacher Levy with Jupiter)- Galileo discovered Ganymede, the largest moon in solar system

Saturn

- Features: White spot,rings, countless small particles orbit Saturn
- Titan-the second largest moon
- Cassini
- Huygens (Discovered Titan)

Uranus

- Features: Dark rings,
- Moon: Miranda,
- Blue green colour due to methane
- Voyager 2

Neptune

- Voyager 2
- Feature: Dark spots,blue colour(methane+something)

Pluto

- New Horizon
- Probe by Nasa
- Pluto's Main moon: Charon

Orion deep: To take astronauts to deep space

Ceres: Icy dark planet- Largest object in asteroid belt

Oort cloud: Comets beyond Kuiper belt eg:-Halley's comet, Comet Ison

Rosetta: Comet 67 P +Phylae lander

New Horizon: Pluto

Juno : Jupiter