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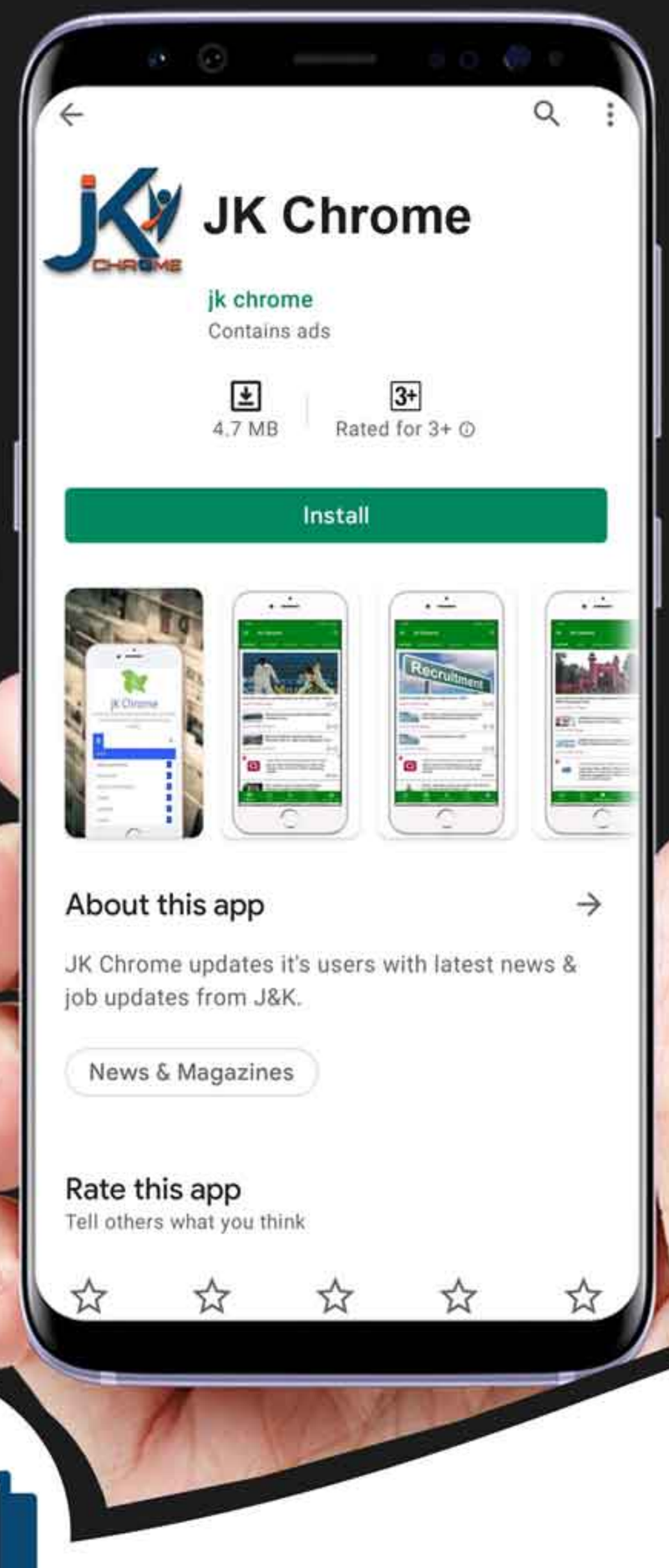

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NANOTECHNOLOGY

#1 What is meant by Nanotechnology?

1) Nanotech → Branch of Science → Understanding & Control of matter → Particle dimension → Nanometer scale → Utility: (i) Design; (ii) Production; (iii) Application of Materials.
2) Types: (i) Descending nanotech; (ii) Ascending nanotech; (iii) Wet nanotech; (iv) Dry nanotech

#2 What are the applications of Nanotechnology?

1) In Energy: (a) Nanotech → Effective replacement → Silicon plate of Solar panels → Benefits: (i) Efficiency → Doubled; (ii) Depreciation rate→Halved compared to silicon panels; (b) Nanotech → Streamlined wind turbines→High tensile strength → Blades → Higher power output.
2) In Biomedicine → (i) Drug delivery system [Example: Paclitaxel]; (ii) Gene/Protein delivery system; (iii)Minuscule camera→Endoscopy.
3) In Environment: Air purification→Ion exchange process; Nano-filtration→Water purifying systems; Nanocatalyst → Negligible waste generation→Chemical process.
4) In Electronics: (i) MRAM → Instant booting; (ii) UHD displays → Quantum dots → More vibrant colors;(iii) Flash memory chip→ Smart phone.
5) In Food sector: (i) Nano biosensors→Pathogens; (ii) Nano-composites → Increasing mechanical & thermal resistance.

#3What is the significance of Nanotechnology?

1) (i) Properties alterations→ Nano-scale → Color, Melting point, Magnetic properties etc; → Diverse applications in Material science [Example: Graphene]; (ii) In Nano-scale → Hassle free arrangement pattern → Different elements; (iii) Reduce the mass of product → Increase the efficiency; (iv) Eliminate the human error → Surgical procedure & High end engineering operations → Nanobots; (v) Pollution abatement → Urban area → Air; Water; Sewage treatment etc.

#4 What are the limitations of Nanotechnology?

1) (i) Unintended consequences → Nano particles → On ecosystem → [Example: Rupture the cell wall of microorganism]; (ii) Sophisticated devices & relative price weight→Processing the nano particles; (iii) Security threat → Higher accessibility of material science tech → Atomic weapons → Terror outfits; (iv) Poor drug loading capacity & Burst delivery; (v) Toxity effect → Bio accumulation & Bio magnification [Example: Zinc oxide]

#5 What are the initiatives taken in the Nano tech front?

1) Indian initiatives: (i) Nano mission; (ii) MEITY→INUP; (iii) IMPRINT-India Initiative.
2) International initiatives: (i) US National Nano tech initiative; (ii) NANO Futures→Europe; (iii) Sofradir → 150m€ → French nanotech initiative; (iv) Iran nanotech initiative council.

Artificial Intelligence

#1 What is meant by Artificial intelligence?

1) AI→Machine learning →Self improvement-natural Intelligence→Perceives the command→from external environment→maximizes the efficiency→To accomplish the task.

#2 What are the applications of Artificial intelligence?

1) (i)Robotics: AI→Increased the penetration→Finance; Marketing; Healthcare etc→Sophia→ Humanoid; (ii)AI→Online platform→Targeted business strategy→Profit multiplier. [Example: Amazon; Flipkart]
2) Outer space exploration→(i)Map building; (ii) Satellite navigation; (iii)Tracking technology;
3) Stock market and finance: Analyzing the historical performance→AI Algorithm→Precise decision making in future prospects. [Example: Nomura Group].
4) Automated cars→Sense the stimuli→External & Internal environment→Hassle-free driving experience. [Example: Tesla]
5) Healthcare Industry→Predict the patient history→Reduce the snag→Golden hour→In emergency cases. [Example: IBM Watson Health]

#3 What is the significance of Artificial Intelligence?

1) (i)Cutting edge technology→Broadened the scope of application→In various industries [Example: Israel's Robotic Infantry]; (ii)Round the clock performance→Prompt & precise→Decision making skills; (iii)Tools and techniques→Better work place environment→High labour Productivity; (v)Harness the potential→Agrarian sector→To nullify the economic inequality.

#4 What are the challenges in Artificial Intelligence?

1) (i)Expensive architecture→Building neural network→Unaffordable by Industrial Giants too; (ii)AI fuelling→Major unemployment scenario [Example: Automobile sector]; (iii)Absence of Skilled labour force→Ancillary activities; (iv)Security breach→In sensitive installations→Will seek hefty toll [Example: Nuclear power plant]; (v)Data storage→Consumer pattern→Business houses→Unethical marketing strategy; (vi)High Operational Energy intensity→Carbon burden on developing & LDC countries.

#5 What are the initiatives which are taken for promoting Artificial Intelligence?

1) Indian initiatives: (i)AI Portal; (ii)National Research Foundation→NEP 2020; (iii)Promoting AI in schools; (iv)AIRAWAT; (V)Ministry of commerce→Task force on AI.
2) International initiatives: (i)Global AI policy; (ii)OECD→AI live repository; (iii)Council of Europe→AI initiatives.

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3-D Printing Technology

#1 What is meant by 3-D Printing Technology?

1) 3D printing→Variety of process→Under computer control→To create 3D object→Process: (i)Deposition; (ii)Joining; (iii)Solidification
2) General principles: (i)Modeling; (ii)Printing; (iii)Finishing; (iv)Materials; (v)Multi material 3D printing.
3) Process→Seven categories→(i)VAT Photo polymerization; (ii)Material jetting; (iii)Binder jetting; (iv)Powder bed fusion; (v) Directed energy deposition; (vi) Sheet lamination.

#2 What are the applications of 3-D printing?

1) Food sector→Additive manufacturing of food→NASA→3D printed food products→For astronauts→To limit food waste→In international space station.
2) (i)In Pharma: Fused deposition modeling→Drug delivery→Depends on patient needs; (ii)3D Printed soft actuators→To develop soft structures→Organ & tissue development.
3) Education→Open source 3-D printers & technology→Unprecedented revolution→STEM segment.
4) Military segment: Designing the firearms & Armor plates→Low retardation rate→In mass production. [Example: GE Aviation→Manufacture the chopper→16 parts instead 900]
5) In Transport sector: Additive manufacturing→Transformation →(i) Uni-body fuselage &Power train→Design & production. [Example: AUDI RSQ→KUKA Robots]

#3 What is the significance of 3D-printing?

1) (i)Speed of 3D printing→Zero defect manufacturing practices; (ii)3D technology→Cheap alternative for CNC Machining & Injection molding; (iii)Tangible design & Product testing→Competitive advantage; (iv)Quality→Step by step building→Enhancement of design/Better quality of products; (v)Risk reduction→3D tech→Allows manufacturers→To create flawless product→Multi level production system; (vi)Access→Open algorithm and programming languages→Ensures equality in accessibility.

#4 What are the challenges of 3D Technology?

1) (i)Integrated 3D printing unit→Space congestion;(ii)Illinois institute of technology→3D printing→releases 200 tiny toxic particles/Minute; (iii)Eco-unfriendly→Plastic filaments→Plastic by products→Harmful to environment; (iv)Different talent requirements→Monopolistic tendency→Some tech giants & Countries; (v)Increased intensity of 3D Automated Machines→Spurt the lay-off→In Assembly line;(vi)3D-Materials→Low heat deflection temperature; (vii)Energy intensive operations→High carbon burden→On LDC countries.

#5 What are the measures that can be taken for promoting 3-D Technology?

1) (i)Increase the R&D→Support from commerce ministry; (ii) Incentives/Tax holiday→Corporate participation; (iii)Shaping of knowledge network; (iv)Awareness campaign; (v)Policy initiative→Dedicated mission on 3D printing→Converging key ministries.

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Quantum Computing

#1 What is meant by Quantum computing?

1) Quantum computing→Principle: Quantum mechanics→Collective properties of quantum states →(i)Superposition; (ii)Quantum Interference; (iii)Entanglement.
2) Qubit→Basic unit of information→Classical bits are binary→Qubits capacity→Superposition of all possible states→Expeditious processing of information.

#2 What are the applications of Quantum computing?

1) Machine learning: Widespread application→Voice; Image & Handwriting recognition→High speed & Accuracy→In solving Complex task.
2) Computational chemistry: IBM reveals→Existence of Both 0 & 1→Map the Molecule→Potential chemical & Material science research [Example: Room temperature superconductor]
3) Drug design & development→ AI + Quantum tech→(i)Analyzing the effect of drug→On humans & animals; (ii)Efficient drug loading capacity→Complex pharma products.
4) Cyber-security & Cryptography: Aid from machine learning + Quantum cryptography→ foolproof cyber-security. [Example: Infineon technologies→Trapped ion technology]
5) Logistics optimization: Improved data analysis+ Robust modeling→Hassle free supply chain management→(i)Traffic management; (ii)Fleet operations; (iii)Air traffic control; (iv)Freight distribution [IBM & Maersk partnership→Logistics management]

#3 What is the significance of Quantum computing?

1) (i)Time consumption for computation→On lower scale [Example: 65Qubit processor→1400 CLOPS]; (ii) Addition of qubits→Exponential expansion of storage; (iii)Per computation Energy intensity→Very low→Eco green computational system; (iv)Computing qubit→Conventional superimposition state→Exponential speed up & Exponential calculations capability; (v)Precision & prompt result→Expand the scope→Sensitive installations [Example: Secure communication→ Stakeholders of Theatre commands]

#4 What are the challenges of Quantum computing?

1) (i)Qubits are not digital→Impossible to use→Conventional error correction; (ii)Minimum energy requirement→5 times of conventional computers; (iii)Quantum CPU→Trade-off→Between Heat & Efficiency→Carbon burden on Developing countries; (iv)Research in quantum→Immature→Delay in deployment→Competitive price; (v)Monopolistic tendency of Tech giants→Retard the growth→Other stakeholders & Countries.

#5 What are the initiatives which have been taken in Quantum computing front?

1) India: (i)National Mission on Quantum Tech and Application; (ii)DST→QuEST initiative; (iii)Quantum computing tech park→Gujarat; (iv)Start-up India scheme→8 quantum start ups.
2) International: (i)US→NIST→$1.2bn; (ii)Canada→D-wave→$400mn; (iii)UK→2.4% of GDP→Quantum technology→£153mn.

Internet of Things

#1 What is meant by Internet of Things?

1) IoT→Network of physical objects→Embedded with Software, Sensors & Technologies→ Purpose: Connect together & Exchange data→Hassle-free accomplishment of task.
2) Technology behind IoT: (i)Low cost/Low power sensor technology; (ii)Cloud computing platforms; (iii)Machine learning & Analytics; (iv)Conversational Artificial Intelligence.
3) Core principles: (i) Convergence; (ii) Connectivity; (iii) Communication; (iv)Collectivity etc.

#2 What are the applications of Internet Of Things?

1) Smart homes: Blend→Intelligent Utility systems + Entertainment →(i) Automatic illumination system; (ii) Advanced locking system; (iii) Connected surveillance system etc.
2) Smart city: Connected technology + Infrastructural assets →(i) Fleet traffic management; (ii) Water distribution & Management; (iii) Electricity management; (iv) Sewage & Industrial effluent treatment.
3) Transport: Machine learning→several sensors & embedded systems→Cloud connected→Data generation→Feedback→Informed decision making.
4) Agriculture: Boost the productivity→ Water proof sensors + Remote connectivity →(i) Drip irrigation; (ii) Cropping patterns; (iii) Farm surveillance.
5) Electricity: Smart grid→Extensive range of I.T+ Real time ultra modern mechanisms→(i)Reduce pilferage; (ii)Optimizing the T&D losses.

#3 What is the Significance of IoT?

1) (i)Competitive advantage in Supply chain→Inventory maintenance→Profit multiplier; (ii)IoT + AI → Predictive analysis→Transparent functioning→Workplace atmosphere; (iii) Spillover effect→Big data→Productivity of ancillary sectors; (iv)Data & Real-time feedback loop→Prompt decision making; (v)IoT→Improves M2M communication→Spurt in efficiency→Both user & Organization; (vi)Better quality of life→Handy technology→Permissive operations.

#4 What are the challenges exist in IoT systems?

1) (i) Lack of encryption→Manipulated algorithms→Prone to hack; (ii) Insufficient testing & Updating→IoT Manufacturers→Hunt for profit→Compromise the security→Testing stage; (iii)Brute forcing→ default Weak credentials & login details→Valuable information at risk; (iv)Battery life→Low weight of battery unit→Low power delivery; (v)Cross platform capability→Tech changes in future→Extended utility is questionable; (vi)Energy intensity→High.

#5 What are the initiatives which are taken for promoting IoT?

1) India: (i) National Digital communication policy-2018; (ii) IoT component→Digital India Mission; (iii)Draft Policy on IoT→DEITY;(iv)100%FDI→Telecom sector.
2) International: (i) ITU→IoT GSI; (ii)Global IoT Standardization activities→EU+US; (iii) IEEE→IoT initiative;(iv) WEF→Future of connected world.

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RT-PCR & PCR

#1 What is meant by Polymerase Chain Reaction & RT-PCR?

1) PCR→Laboratory technique→To amplify DNA sequences→ Denaturation; Primers; Amplification & Replication→DNA replication enzyme→Copies of target DNA samples.
2) RT-PCR→RNA strands from Virus→Reverse transcription→RNA to DNA→Amplification of DNA→Polymerase chain reaction.

#2 What are the applications of RT-PCR & PCR?

1) Genetic research: (i)Amplification of DNA→Northern/Southern blot hybridization;(ii) Study→Gene expression patterns; (iii)DNA sequencing→Area of interest + other gene; (iv)Chromosomal analysis→Genetic birth defects; (v)Human genome project.
2) Medicine: (i)Microbiology→Genotyping→Early identification→Tuberculosis like bacteria→Golden time treatment;(ii) Virology→Detect the viral strain→Viral behavior & Infection pattern [Example: Screening→Blood donated in camps]
3) Forensic Science: (i)DNA Fingerprinting→Fragments of DNA→Crime scene evidence→Cross check with Database→Identification of offenders & Criminals; (ii)Paternity testing→DNA from Individual→ Verification with parental database→Establishing paternity.
4) Environmental microbiology: (i) Sensitive detection→Biodegrading microorganisms→Toxic waste and pollutants→Effective bioremediation; (ii)Detect & Monitor→Waterborne pathogens.

#3 What is the significance of PCR &RT-PCR?

1) (i) Detection of mutations→Early gene therapy→Saving precious life; (ii)Higher sensitivity→Compared to culture & Staining; (iii)Ability to test→Anti microbial resistance; (iv) Expeditious result→4 to 8 hours; (v)Highly cost effective→Suitable for mass testing; (vi)Increased ability to detect→Less common organisms→Virus etc; (vii)Competent to detect→Live infections with high accuracy.

#4 What are the challenges in PCR &RT-PCR?

1) (i) Lower specificity→Compared to culture & Staining; (ii) Narrow list of causative agents→To use specific primers; (iii)Possibility of amplification→Normal flora→Corneal scrapings; (iv) Less cost effective→Multi organism PCR approach; (v)Initial cost→Meteoric high→Machineries; Training; Supply cost etc.

#5 What are the alternatives available for swift testing apart from RT-PCR?

1) **Rapid Antigen Detection Test**: Swabbed nasal samples→Detects Antigen→Found with SARS- COV-2 virus →Advantage: Low time consumption→Than RT-PCR; Disadvantage: Fail to detect→Active infection.
2) **Serological test:** Detect the Antibodies→Disease specific→Advantage: Detect→Asymptomatic & Symptomatic carriers; Importance→Surveillance→Pandemic & Endemic scenarios.

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Blockchain Technology

#1 What is meant by Blockchain technology?

1) Blockchain→Indestructible Digital ledger→Ledger: Account Book→Debit & Credit→Digitized; Decentralized Public ledger→Operations visibility→ every nodes.
2) Distributed nodes→Transfer of digital assets→No need: Centralized authorizations.

#2 What are the applications of Blockchain technology?

1) Real time encrypted ledger systems →(a)Money transfer →(i) Eliminates Bureaucratic red-tapism; (ii) Reduce third party fee.
2) Smart contracts →(i) Health care→Personalized health plan: Transfer sensitive information→ between patients & doctors; [Example: Burst IQ] (ii) Logistics & Supply chain→ Releasing payment; Recording ledger entries etc.
3) In Government: (i)Public procurement→Eliminates corruption; (ii)Land registry [Example: Sweden]; (iii)Electronic voting→Decentralized; Immutable; Encrypted qualities→Eliminates election malpractices; (iv)Social security benefits disbursements.

#3 What is the significance of Blockchain technology?

1) (i) Security→Decentralized nature→Impossible to breach; (ii)Transparency→Entry & Follow-up→Visible to everyone→In decentralized network; (iii)Low cost economic model + Foolproof security + Operational efficiency→Suitable for Banking segment[Example: ICICI & HDFC]

#4 What are the challenges in Blockchain technology?

1) (i) Scalability→Managing large number of users→In single time→Formidable challenge; (ii)Shadow dealing→Lacks regulatory oversight→Terror funding; (iii)Principles of Encryption & Distributed ledger→Complex to understand & Adopt.

#5 Should the government regularize crypto currencies?

1) **Favorable:** (i)Prevent market manipulation→To protect investors; (ii)Technology at breakneck pace; (ii)Online fraudsters→Threatening the livelihood base of common people; (iv)Scope of terror funding.
2) **Unfavorable**: (i) Regulating crypto currency→Impact the formal liquidity pattern; (ii) Possibility of Capital flight; (iii) Catalyst for Public attitude→Investing in Future Informal financial transaction.

#6 What are the measures that can be taken for reaping the benefits of Blockchain technology?

1) (i) Government initiatives→Enlarge the blockchain application→In Education; Pharmaceutical & Health sectors; Logistics etc; (ii)Legal enactment & SOP; (iii)Certification & Mentorship→ Generating skill force; (iv)Interoperability→Ramp-up R&D.

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Hyperloop Technology

#1 What is meant by Hyperloop technology?

1) Hyper-loop→Transportation through low pressure tubes; Custom designed capsules/Pods→ Front portion: Compressor; Mid-portion→Passenger cabin; Rear portion→Air caster skis.
2) Principle: Vactrain & Magnetic levitation;

#2 What is the operational mechanism of Hyperloop?

1) Two main parts→(i)Tracks;(ii) Capsules; Partial vacuum→Consequent low pressure→Inside the tube; Compressor fan at Capsule front→Redirect Air to Rear end→Additional propulsion.
2) Pod flotation: Low pressure + Ultra low aerodynamic drag→Glides at airline speeds.

#3 What is the significance of Hyperloop technology?

1) (i)Swift transportation→Speed equal that of flight→Intercontinental mobility will spurt; (ii) Emission intensity→Very lower than conventional transports; (iii) Cost/Km→Long overhaul transportation→Highly affordable; (iv) Operational Immunity→Bad weather conditions; (v)Seismic movements→Won't affect the operational capability; (vi)Safety & Reliability→Encouraging for the stakeholders.

#4 What are the challenges involved in Hyperloop technology?

1) (i) Technology still in nascent stage→It'll take years to fully operational;(ii)Initial investment + Overhead cost→Very high; (iii)Large scale production of superconductors→ Meager production capacity; (iv)Health impact on human→Dizziness; Fatigue at ultra high speed;(v)Collision impact assessment→Not fully materialized; (vi)Limited cabin space→Obstruct free movement→Inside cabin.

#5 What are the measures that can be taken to promote Hyperloop transportation?

1) (i) Rigorous testing→To predict unintended consequences; (ii) Research & Development→ Alternatives for Steel tube; (iii) Standard Safety protocol→Health of vulnerable passengers; (iv) Underground track→Instead overhead track→Ensure Biodiversity conservation; (v) Government→Land-banks → Expeditious construction.

#6 What are the initiatives which are taken in Hyperloop transportation front?

1) India: (i) AP government→Vijayawada to Amravati; (ii) Virgin group + Maharashtra government → Mumbai to Pune;
2) International**:** (i)Hyperloop Australia→Brisbane to Adelaide; (ii) UAE→Abu Dhabi to Dubai; (iii) Texas →USA; (iv)Europe→Amsterdam to Rotterdam & Paris to Berlin.

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LIDAR

#1 What is meant by LIDAR?

1) LIDAR→Light Detection & Ranging→Remote sensing tool→High energy Pulse laser→Algorithm of laser→3D representation of objects.
2) Types: (i) Ground based; (ii)Airborne; (iii)Orientation.

#2 What is the mechanism of LIDAR?

1) (i) Principle of LIDAR→Same as of Electronic Distance Measuring Instrument; (ii) LIDAR→Emits laser light→Calculates time→Based on Transmission & Receiving; (iii) Repetition of Process→Quick intervals→Complex mapping.

#3 What are the applications of LIDAR?

1) Autonomous vehicle→Self driving cars; Drones; Robots→Navigation using LIDAR→(i)Obstacle avoidance & Detection; (ii)Adaptive cruise control→To control the speed.
2) Physics & Astronomy→(i)NASA's MARS global surveyor→Global topographical survey; (ii) Atmospheric physics→ Density measurement→Middle & Upper atmosphere; (iii)Distribution pattern→Aerosol particles.
3) Military & Law enforcement → (i) Recording→Vehicle speed measurements; (ii) Laser Induced Fluorescence→Detect→Bio-threats→Aerosols form; (iii) High resolution systems→Identify targets.
4) Agriculture: (i) Topographical mapping; (ii) Clues for Fertilizer application→Sun slopes & exposures; (iii) Zonation →Based on yield→Insurance aspect.
5) Archaeology: (i) Mapping features→Under Forest canopy; (ii) Digital elevation models of archaeological sites→ Micro topography of hidden vegetation.

#4 What is the significance of LIDAR technology?

1) (i) Automated functionality→Reduce the experienced man power→In operations; (ii) Agility→Trans-receivers operations→In nanoseconds; (iii) 360 degree mapping facility→Inaccessible terrain→High mountains; Dense forest etc; (iv) Short wave length→Detect even small objects→3D models; (v) LIDAR technology→Incredibly accurate→Low price→Than any-other technologies→ Surveying & Mapping; (vi) Integration with other data sources → Easy to analyze → Complex data.

#5 What are the drawbacks in LIDAR technology?

1) (i) LIDAR system→Complex setup→Run base stations; (ii) Deep understanding→Functioning of sensors; (iii)High end LIDAR sensors & Mapping small area→Hefty price tag; (iii) High sun angles & Huge reflections→Affects the operational capacity; (iv) No international protocols→Collection & Analysis of data; (v) High energy beams→Impact the vision→Human eye; (vi) High skill power→Data analysis & Interpretation.

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IRNSS (NaviC)

#1 What is IRNSS?

1) IRNSS→Brainchild of ISRO→Independent Regional Navigation System→Aim: Accurate position information service; Range of IRNSS: 1500 km from India's boundary.
2) Two types of services: (a) Standard positioning service→Accessible to everyone; (b) Restricted service→Accessible to Military + Authorized government users.

#2 What is the working mechanism of IRNSS?

1) Space segment: 3 Geo stationary orbit satellites + 4 Geo synchronous satellites→Functions: (i)Transmission of navigation; (ii)Timing information; (iii)Generation of Onboard navigation data.
2) Ground segment: Responsible for maintenance + operation →(i) Master control center→Spacecraft control & Navigation; (ii) IRNSS tracking & integrity monitoring systems; (iii)Up-linking telemetry stations; (iv)Communication links etc.
3) User segment: Specially designed receivers + Antennas & Signal processing unit.

#3 What are the applications of IRNSS?

1) (i) Terrestrial; Aerial & Marine Navigation; (ii)Disaster management; (iii)Vehicle tracking & Fleet management; (iv)Integration with mobile phones; (v)Mapping + Geodetic data capture; (vi)Terrestrial navigation→Hikers & Travelers; (vii)Visual + Voice navigation→Drivers.

#4 What is the significance of IRNSS?

1) (i) Accuracy of restricted service is 10cm→(a) Enable cutting edge military operations; (b) Ensuring the fool proof communication & tracking system; (ii) Dedicated messaging service→Satisfy the strategic requirements; (iii) Foster the diplomatic good will→Extending positioning services→To neighbor countries; (iv) Restricted services→Ensures the swift mobilization→National security; (v) Help the nation→Anti trafficking; Creating Land banks; Geo tagging etc. (vi) Sound Logistics management→ Decrease the logistics cost→Ease of doing business.

#5 What are the challenges in the IRNSS System?

1) (i) Receiver→Consumes more power→Carbon burden is increasing; (ii)Coverage is regional centric; (iii) Rubidium clocks are Malfunctioning→ Questioning the precision; (iv)Microwaves→ Doesn't penetrate concrete buildings→ Underground rescue in Disaster management is difficult; (v)Signal transmission time is High→Because of Geostationary orbit satellites→Positioning distance from earth:36000KM.

#6 What are the other positioning services functioning throughout the world?

1) India: GAGAN [GPS AIDED GEO AUGUMENTED NAVIGATION]
2) International: US→GPS; Russia→GLONASS; (iii) EU→Galileo; (iv) China→BeiDou; (v) Japan→QZSS [Regional navigation]

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Assisted Reproductive Technology

#1 What is meant by Assisted Reproductive Technology?

1) ART→Medical procedure→To address infertility; Medical procedures: In-vitro fertilization; intra cyto plasmic sperm injection; Cryopreservation etc.
2) Mechanism→Fusion of gametes: Male gamete + Female gamete→In-vitro fertilization→ Placement of zygote→Women's uterus.

#2 What are the highlights of ART bill-2021?

1) Definition of ART→All methods→To detect pregnancy→Outside human body→Transmitting the embryo→Female reproductive system.
2) National Register of Clinics And Banks→Database of all clinics and banks→Powers: (i)Timeline for validity: 5 year after registration; (ii) Extended up to another 5 years; (iii)Termination→Violating the protocols.
3) ART Banks: Establishment for supply→Sperm; Oocyte & Oocyte donors; ART service provider rules→Informed consent→Donor & Recipient.
4) (i)National & State boards: (i)Regulating ART services; (ii)Advisory role→Policy matters; (ii) Rights of child→ All rights & privileges.
5) Genetic testing: In pre-implantation stage→To identify: Pre existing Genetic + Non genetic disorders.
6) Penal provisions: Abandonment; Exploitation; Human trafficking; Importing human embryos; Abusing a couple→Imprisonment: 5 to 12 years; Monetary penalty: INR 5 Lakh to 25 Lakh.

#3 What is the significance of ART?

1) (i) Optimize the chances→Singleton pregnancies; (ii) Increase the probability: Healthy baby; (iii) Broadened the time factor: Using preservation→In pregnancies; (iv)PGT: Validation of Genetic compatibility→Reduce the chance of Miscarriage; (v)Opportunity for Same sex couples: To up bring the children.

#4 What are the challenges in the ART?

1) (i) Role of government establishments→Didn't get a clear picture; (ii)Cost of procedure→Higher end→Violates Right to equality; (iii)Multiple establishments→State & Centre: Overlapping of functions; (iv)Technical glitches→Cryogenic preservation unit & In-vitro systems; (v)Involvement third party→Who don't have any role in parental care.

#5 What are the measures that can be taken for better implementation of ART?

1) (i) Profit motive of ART establishments→ Monitoring wing is dire need; (ii) Expansion of coverage in bill→LGBTQIA + Single Men/ Women; (iii) District ethics committee→To address ethical concerns; (iv) Regulating research with embryos→Need to be brought back; (v) Synchronization→Surrogacy & ART bills: Accrual of social wellness.

Gaganyaan Mission

#1 What is meant by Gaganyaan mission?

1) Gaganyaan→Demonstration of Human space flight→Indian crewed orbital spacecraft: 3 astronauts to LEO.
2) Objective: (i) To demonstrate Indigenous capability; (ii) Sustained space program→In long run; (iii) Inspiring youth; (iv)International collaboration etc.

#2 What are the functional mechanisms are there in Gaganyaan?

1) GSLV MK-III: (a)3 stage vehicle→(i)Stage I→Solid boosters; Stage 2→Liquid motor; Stage 3→ Cryogenic upper stage;(b) Pay load capacity→ (i)4 tones→ Geosynchronous orbit; 10 tones→Low earth orbit.
2) Crew module: (i)Fully autonomous spacecraft; (ii)Equipped with two parachutes→Redundancy; (iii)Emergency mission abort; (iv)Crew escape system; (v)Environmental control systems
3) Service module: (i)Orbit rising maneuver; (ii)Unified bipropellant system.
4) Testing: (i) Pad abort test→Crew escape system; (ii) CE-20 Engine qualification; (iii)Service module propulsion system.

#3 What is the significance of Gaganyaan mission?

1) (i) High Technology capability→Human space exploration; Sample return mission; Scientific exploration; (ii)Spurt the industrial growth→IN-SPACe→Increase the private participation; (iii)Pooling of diverse tech + Industrial capabilities→Enhanced participation of stakeholders; (iv)Micro gravity platform→Test bed of future technologies; (v)Generation of skilled man power→Advanced technologies; (vi)Independence on foreign launch vehicles→Will be reduced.

#4 What are the challenges in Gaganyaan mission?

1) (i) Creating earth like situations in Crew capsule→Major hurdle; (ii) Return mission protocol→Yet be tested; (iii)Zero gravity environment→Impact on human behaviors; (iv)Crew module weights→Twice that of communication satellite; (v)Radiation level→Ten times that of earth→Cancer; Impact the Nervous system & Endocrine system.

#5 What are the measures that can be taken forward to better utilization of Gaganyaan mission?

1) (i) Establishment of knowledge networks→Ramp up Indigenous knowledge; (ii)Propelling the progress→Establishing India's own space stations; (iii)Ramp up Space Start ups→Under Start up India mission; (iv) Dedicated Wing→Orienting Human space missions; (v)Tech transfer from International space industry→Cheaper human space mission.

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GENETICALLY MODIFIED CROPS

#1What is meant by GM Crops?

1) Genetic Engineering Mechanism: Tissue culture → inserting target DNA + Genome of organism → Desired trait; Principles → Mutation; Insertion; Deletion of genes. [Example: Bt cotton]
2) Objectives: (i) Resistance → Pests; Diseases; Environmental conditions; (ii) Desired Nutrient enrichment; (iii) Increase the yield etc.

#2 What is the mechanism behind GM Crops?

1) Isolating gene of interest: Identification of desired genes [Example: Bacillus thuringiensis for Bollworm] → To achieve the desired trait.
2) Transformation with desired gene: Recombinant DNA technology → loading the desired gene in plasmid → Bombardment in to target cell→Cell replication.
3) Selection & Regeneration: Repetitive selection process→To analyze the function of Gene marker → Multiplication of cells.
4) Verification of Transformation & characterization: Demonstration→production of Messenger RNA/protein → Evaluation of functionality.
5) Testing of plant performance: Exposure of plant→Pest; Diseases; Environmental conditions etc → Plant with Transformed gene will survive.

#3 What is the significance behind GM crops?

1) (i) Improves farm productivity→Doubling farmers' income; (ii) Reduction in consumption → Pesticide/Acre; Fertilizer/acre; (iii) Streamline the food security→ever expanding global population; (iv) Expanding agricultural region→Can be averted; (v)Selective nutrient enrichment→quell the malnutrition; (vi) Tailoring products→Based on consumer taste patterns.

#4 What are the challenges involved in GM crops?

1) (i) Impose high risk to Ecosystem→Engineered genes→Favors particular species alone; (ii) Cost of cultivation → High; (iii) Shifting the gears→Towards immoral market practices; (iv) Biologically altered foods→Impact on human health→Lot of research needed; (v) Development of Resistance: Against Pest; Disease etc. → Rendered ineffective (vi) Invasive tendency: Cornell university report→Herbicide resistant amaranth→proliferated in 76 countries.

#5 What are the measures that can be for GM crops?

1) (i) Need to involve ICAR & IARI→Broadening the scope of research; (ii) Social & Ecological impact assessment→Rigorous testing protocol; (iii) Ethics committee in district level→For ensuring best practices→Industries using GM crops; (iv)Informed trial phases→Through Gram panchayats→During the trial phase; (v) Labeling GM→Awareness to customers; (vi) Illegal cultivation of GM→Farm level policing +Participation of farmers.

Satellite Based Internet Connectivity

#1 What is Satellite based internet connectivity?

1) Satellite communication system: Communication Satellites in LEO/GSO→Radio wave transmission: Beam internet connectivity →To Internet enabled devices in earth.
2) (a)Lower earth orbit: (i) Range→180 to 2000kms above Earth's surface; (ii) Purpose: Hosting Cheap telecommunication satellites; (b)Geo stationary orbit: Range→36000 KM above Equator; (ii)Purpose: Meteorology; Ocean & atmospheric tracking etc.

#2 What is the functional mechanism behind Satellite Based Internet Connectivity?

1) Internet systems & communication links→Network operation centre: Signal transmission uplink→Data packets collected & processed: In Satellite [Geo stationary satellite/Low earth satellite]
2) Spot beam technology: Reuse of assigned bandwidth: Maximum capacity utilization□ Transmission of signals to earth→Receiving antenna + Downlink→Satellite router to communication devices.

#3 What is the significance of Satellite Based Internet connectivity?

1) (i) Anywhere /Anytime connectivity→Inaccessible terrain; (ii) Average maximum speed up to 100MBPS→Multiple device access without drag; (iii)Infrastructural investment is comparatively lower than Deep sea systems; (iv) On Board Wi-Fi & Entertainment system→Aviation sector; (iv)Satellite based connectivity→It'll spurt the Blue economy→Providing seamless connectivity in Maritime & Logistics; (v) Digital readiness→Lower time consumption for installation : Ground segments; (vi) Reliability of satellite infrastructure-→Very high than terrestrial infrastructure.

#4 What are the Challenges in the Satellite based Internet connectivity?

1) (i) High latency→Shuttling of data packets: Because of positioning in Geo stationary orbits; (ii) Satellite Data cap of10GB→Service providers; (iii) Weather conditions: Cloudiness; Precipitation; Strong wind etc→ Impact the signal strength; (iv) Relatively higher expenditure than terrestrial connectivity→100$ for 2MBPS; (v) Minor obstructions can affect the connectivity→Constant check needed in Tropical area; (vi) Space junk→LEO/ GSO→ Possibility of becoming graveyard orbits.

#5 What are the initiatives which are taken for promoting Satellite based Internet connectivity?

1) (i) Google: Project LOON→Balloon based connectivity→Mission abandoned; (ii) Amazon: Project Kuiper; (iii) Space X: Starlink →Lower earth orbit-based system; (iv) One web+ Airtel→ LEO based System; (v) Via sat; (vi) Hughes Net.

Anti-Ballistic Missile Defense System

#1 What is meant by Anti-Ballistic Missile Defense system?

1) Anti Ballistic Missile: Surface to Air missile→Intercept, Counter & Destroy: Ballistic threats [Any warheads: Nuclear; Chemical; Biological & Conventional threats]
2) Anti Ballistic Missile Defense System→(i)Integrated interceptor Missile batteries; (ii)Sophisticated Advanced Radar System; (iii) Integrated command & control centre; (iv)Early warning system.

#2 What is India's Ballistic Missile Defense Program?

1) BMD program→Indian version of Anti Ballistic Missile Defense system: Multi layered mechanism→Two tier automated system: (i) Prithvi Air Defense [PAD]; (ii) Advanced Air Defense [AAD].
2) PAD→ (i) Exo-atmospheric interceptor; (ii) Intercepting Altitude→50-80 KMs; (iii) Two stage→Solid propellants.
3) AAD→ (i) Endo-atmospheric interceptor; (ii) Intercepting Altitude→Up to 30 KMs; (iii) Single stage solid propellant system.

#3 What is the significance of Anti Ballistic Missile Defense system?

1) (i) Regional Nuclear hostility→From Pakistan & China; (ii) Committed No First use policy→BMD aids to with stand the attack & Retaliation→Credible minimum deterrence; (iii) BMD→Reducing the lethal ballistic strategic capability of enemies; (iv) Indigenous system→Reduce the import bill→Protect the government's precious Forex coffers; (v) Other benefits→Battle field readiness; Reconnaissance; Tracking & Situation awareness etc.

#4 What are the challenges in Anti-Ballistic Missile Defense System?

1) (i) BMD systems→Cannot guarantee 100% success rate→In interception & destroy; (ii) Evasion of Weapons of Mass Destruction→It'll take a hefty toll on Infrastructure & people; (iii) China's A2/AD strategy→Impact the order in Indian ocean→BMD will be used to counter it→But weapon proliferation will happen; (iv) Controlled environment testing→Real efficacy is unknown; (v) Undulating & irregular topography→challenge in assigning the priority for critical assets; (vi) Enemies in vicinity→Massive cruise missile capacity→BMD ineffective against it.

#5 What are the measures which are taken in the ABMD front?

1) India: (i) DRDO+IAI→Barak 8; (ii) Akash indigenous system→Range: 25KM; (iii) S-400 Triumf→Imported from Russia→Range: 400km; (iv)QR-SAM of DRDO→Range 30KMs;
2) International arena: (i) US→THAAD; (ii) Israel→David's sling; (iii)China→Hong Qi 9; (iv) Israel →Iron dome.
3) Private sector: (i) Lockheed martin→MIM-104 Patriot; (ii)EUROSAM→Aster 30 SAMP/T

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India Based Neutrino Observatory

#1 What is meant by Neutrinos?

1) Neutrinos →Meaning: "Little Neutral ones" →(i) Subatomic particle; (ii) No electrical charge; (iii) Very small mass; (iv) Belongs to Leptons; (v)Three variants→(a)Near to electron; Muon; Tau.
2) Properties →(i) Not affected by electromagnetic forces→No ionization of matter; (ii) Neutrinos react with matter→only through weak interactive forces; (iii) Penetration power through matter→Enormously High; (iv) Neutrinos →Change one nucleus in to another.

#2 What is India Based Neutrino Observatory?

1) INM→Non accelerator based high energy & Nuclear physics→Multi institutional effort→To study atmospheric neutrinos alone.
2) Iron Calorimeter Detector→Monolith detector→ (i) 50000 tonnes magnetized detector; (ii)Iron→Passive detector element; (ii) Resistive plate chambers→Active detector elements→Detect final state particles→Reconstruction of tracks→Energy & direction of final state particles.
3) Goals of ICAL→ (i) Precise determination→Neutrino oscillation parameters; (ii) Study of matter effects→Electric charge identification; (iii) To study about Kolar events; (iv) To unravel→Charge conjugation & Charge parity.

#3 What is the significance of India Based Neutrino Observatory?

1) (i) Studying the principles of neutrinos→Hone the knowledge towards constituents of universe; (ii) Neutrino research→Expand the horizon→(a) High speed communications; (b) Detect the Nuclear weapons→Non proliferation;(c)Studies→Dark matter; (iii) Requires & Employs→State of art technologies→Design & Development→Spillover effect in other sectors; (iv)Detect, Diagnosis& Treatment→Medical imaging→X-Rays, MRI etc; (v)Exploration→Oil & Petroleum; Mineral deposits; (vi) No toxic/Radioactive waste generation→Eco-green system of operation.

#4 What are the challenges involved in Neutrino research?

1) (i) Extreme difficult to detect→Low mass & lack of electrical charge; (ii) Reconstructing the energy pattern→Prone to error; (iii) Neutrino detectors→ Often give incorrect particle energies; (iv) Enormous initial investment & maintenance→ INR 1500 crore incase of Indian Neutrino observatory; (v) Generation of Ultra pure water → Highly water intensive process→Degradation to environment & biodiversity.

#5 What are the other initiatives which are taken in Neutrino based research front?

1) (i) P-ONE→US + Germany; (ii) LAGUNA & LAGUNA-LBNO→Europe; (iii) Hyper Kamiokande→Japan; (iv) Baikal-GVD→Russia; (v) KM3Ne T→France.

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5G

#1 What is meant by 5G?

1) 5G→5th generation mobile network→Designed to connect virtually → Object, devices and humans.
2) Characteristics: (i)Up to 10GBPS data-rate [Real data transfer-50MBPS To 1GBPS]; (ii)Transmission lag[latency] -1 milli-second ;(iii) Bandwidth/unit area→Greater than 4G version; (iv)Connected devices/Unit area→100 times compared to 4G; (v) Availability→99.99% uptime; (vi) Network energy usage→90 % reduction; (vii)Up to 10 year battery life→Low power IoT device.

#2 What is the evolution behind 5G?

1) **First generation[1G]:** (i) Analog radio signals; (ii)Voice calls only; (iii)Speed→2.4KBPS.
2) **Second generation[2G]:** (i) Digital radio signals; (ii) Voice & Data transmission; (iii) Speed→40KBPSs; (iv) Improved coverage & capacity text available→SMS &MMS.
3) **Third generation [3G]:** (i)Voice with data→Internet; Video calls; Mobile TV; (ii)Speed→384KBPS; (iv) LTE→Offers decent data speed.
4) **Fourth generation [4G]:** (i)Designed for data→Internet; IM, Video calls, Cloud computing, Gaming; Virtual reality etc; (ii)Speed→50MBPS; (iii)Voice over LTE→Digital packet voice services delivered over IP.

#3 What is the significance of 5G?

1) (i) Real time services requiring high peak data→(a)Gaming & Machine reality; (b)Massive Machine Type Communication→Industrial IoT; (ii)Network slicing→Multiple services to coexist→Manufacturing; Telemedicine; Immersive online education etc; (iii)Spectral efficiency of 5G→Better use of mid & low band frequencies→High peak data rates; (iv)5G in E-governance→ Smart management of Urban economy; (v)AI + 5G architecture→Real time information & decision making→Food & agriculture; Law enforcement etc.

#4 What are the challenges in 5G?

1) (i) 5G bad for aircraft→Interference with On-board systems →Prevent engine & braking systems to landing mode; (ii) 5G device transmits large volume data→Current 4G backhaul services inadequate to carry 5G service; (iii) Lack of capacity→ Data analytics; AI; Edge & cloud computing; (iv) Security & privacy→Protection of personal data; (v) Technological challenges→Standardization & application of 5G services.

#5 What are the measures than can be taken for expanding the footprint of 5G?

1) (i) Fiber foot prints→Need to expand in North east & Himachal range states; (ii) Domestic silicon chips manufacturing→Need to ramp up under Digital India Mission; (iii)Harmony in standardization→5Gi standard & Global 3GPP standard→Resolve interoperability issues; (iv)Spectrum pricing→Rationalization is dire need; (iv)Glitches in Airport→Need to be resolved.

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Mission Shakti

#1 What is meant by ASAT?

1) (i) ASAT [Anti Satellite Missile]→Incapacitate or destroy the satellites→Tactic or strategic purposes; (ii) Two variants: (a) Kinetic based attack; (b)Explosion based attack.
2) Roles→(i) Defensive measures→Space based nuclear weapons; (ii) Counter measure→Anti-ballistic missile system; (iii) Asymmetric warfare; (iv) Counter value weapon.

#2 What is Mission Shakti?

1) India's ASAT→DRDO's brainchild-Kinetic kill vehicle: Prithvi defense vehicle Mark-II→Developed under Project XSV-I.
2) PDV-Mark-II:3 stage vehicle→ (i)First two stages-Solid propellant→Same technology of Sagarika missile; (ii)Third stage→Kill vehicle; (iii)Composite propellant→Higher thrust than Agni series; (iv)Accuracy of kill vehicle→Less than 10cm.
3) Target→ISRO's Micro sat-R in Lower earth orbit [300 KM above Earth's surface] : Relative velocity of 10.2 KMPS.

#3 What is the significance of Mission Shakti?

1) (i) India→Elite club of space superpower countries; (ii)Reinforcement→India's Nuclear deterrence capability + No First Use policy; (iii) Credibility of Indigenous Exo atmospheric Anti-Ballistic missile system is enhanced; (iv)Strengthening of peace & order→Indian ocean maritime zone;(v)India's kinetic force based attack mission→Hadn't violate any international space treaties & protocols;(vi)Reserving the seat in international arena→Future space negotiation & Conventions.

#4 What are the challenges in ASAT missions?

1) (i) Weaponization of space & Proliferation of WMD; (ii) Space battlefield→Generation of space debris→Detriment for critical space assets like GPS; ISS; IRNSS & INSAT etc.; (iii) India's critical capability of ASAT→In Geo synchronous orbit is yet to be tested; (iv)Interception on Third party satellite usage→International ramifications in space diplomacy; (v)Least error in attack phase→Futile the entire effort; (vi) Explosive ASAT→Will violate the international treaties; (vii) Defensive measures: Inclination changes→Would render the mission to go vain.

#5 What are the other safe alternatives available to attack the satellites?

1) (i) Dazzle with stream of LASER→Partially blind: To make satellites dysfunctional; (ii)Interfering with radio signals→Jamming the communication system; (iii)Levitate from the designated orbit→By launching close proximity deterrent satellites.

#6 What are the initiatives which are taken in the ASAT attack capability front?

1) (i) USA→RIM-161 Standard missile 3 ABM: Explosion of Hydrazine fuel tank;
2) Russia→(i) PL 19 Nudol: Direct assent & hit; (ii) MiG-31D-Foxhound launch system→Vympel anti satellite system.
3) China→SC-19: Kinetic war head.
4) Israel→Arrow-3/Hetz-3: Anti-ballistic missile: Yet to be tested.

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Ballistic & Cruise Missile Systems

#1 What is meant by Ballistic Missile systems?

1) Ballistic missile→Principle: Travels in Ballistic trajectory towards target→ Capable to deliver multiple warheads: To neutralize the target.
2) Guided→Only for brief periods; Majority of trajectory→Unpowered.
3) Components: (i)Missile guidance; (ii)Flight system; (iii)Engine; (iv)Warhead.
4) Two major variants: (i)Short range ballistic missile→Travel within Earth's atmosphere; (ii)Inter-continental Ballistic Missile→Exo atmosphere trajectory.
5) Example: (i) Agni series; (ii) Prithvi series etc.

#2 What is the significance of Ballistic Missile systems?

1) (i) Due to its trajectory path→Attack range is extreme high [Example: AGNI V-5000KM]; (ii)Unpowered trajectory phase→ Hefty Payload carrying capacity; (iii)One shot multiple kill principle: carrying multiple payloads→Neutralizing large area in one shot; (iv)Mid-air warhead ejection→Enable the targeting of multiple cities; (v) Canister based launch: Broadened the launch platforms→Ensures credible minimum deterrence; (vi) Requirement of Fewer logistics→Than war planes.

#3 What are the drawbacks in Ballistic Missile systems?

1) (i) Missile system embedded with Jet engine→Effortless to track & shoot; (ii)High altitude trajectory+ sub sonic speed→Easy to shoot with the help of ABM; (iii)High cost:10 times that of cruise missile→Manufacture & maintenance; (iv) Shelf life is poor→prone to deteriorate to varied climatic conditions; (v) Targets cannot be varied in trajectory; (vi) No self-destructive mechanism→Mission can't be aborted in mid-air.

#4 What is meant by Cruise missile systems?

1) (i) Cruise missile→Guided missile against terrestrial targets; (ii) Major portion of travel: Constant speed;
2) Components: (i) Guidance system → (a) Radar altimeter; (b) Barometric altimeter; (c) Satellite guidance; (d) Terrain contour matching [TERCOM]; (ii) Engines → (a) Jet engine; (b) Turbofan engine; (iii) Payloads→Conventional & Nuclear warheads.
3) Multiple variants based on speed: (i) Subsonic speed; (ii) Super-sonic speed; (iii) Hyper sonic speed.
4) Example: (i) Tomohawk; (ii) Brahmos; (iii) Nirbhay etc.

#5 What is the significance of Cruise missile systems?

1) (i) Ground hugging flight profile→evade from radar systems; (ii) Low probability of intercept→Unpredictable flight path; (iii) Varied speed options availability→Enlarged footprint in operations; (iv) Wartime readiness is higher that of ICBMs; (v)Self destructive capability →Option to abort the mission in mid-air; (vi) Cost effective: Make & fire→Than Ballistic variants.

#6 What are the drawbacks in Cruise missile systems?

1) (i) Operational attack range: Maximum of 2400KM→Lower than ballistic variant; (ii)Fraction of warhead to total size→Extreme bottom end; (iii) Submarine launch→Reveals the location of Underwater submarines; (iv) Complexity→In aerodynamics; (v) Requires multiple testing→Before operational readiness. [Example: Nirbhay]

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AGNI MISSILE SYSTEMS

#1 What is Integrated Guided Missile Development Program?

1) IGMDP→ (i) To attain self-sufficiency in Missile technology; (ii) Promoting R&D→Comprehensive range of missiles; (iii) Converging the knowledge→Scientific institutions.
2) Missiles developed under IGMDP: (i) Prithvi→Short range surface to surface missile; (ii) AGNI→Intermediate to Intercontinental range surface to surface ballistic missile; (iii)Trishul→ Short range Surface to Air missile; (iv) Akash→Medium range Surface to Air missile; (v) Nag→Anti-tank missile.

#2 What is meant by AGNI series and list down their characteristic features?

1) AGNI series→Range: Medium to Intercontinental range; Nuclear warhead capable; Segment: Surface to Surface ballistic missiles.
2) AGNI-I: (i)Two stage→1st stage solid propellant; (ii)Payload capacity:1000KG/Nuclear capable; (iii)Operational range:700 to 900KM; (iv)Launch pad→Road/Rail mobile platforms.
3) AGNI-II: (i)Two stage→Only solid propellants; (ii)Payload capacity:1000KG/Nuclear capable; (iii)Operational range:2000 to 3000KM; (iv)Part of Credible deterrence apparatus.
4) AGNI-III: (i)Two stage→Only solid propellants; (ii)Payload capacity:1.5 Tonnes/Thermo nuclear or Boosted fission; (iii)Operational range:3500KM; (iv)Highly lethal than AGNI-II.
5) AGNI-IV: (i)Two stage→Only solid propellants; (ii)Payload capacity:1Ton/Thermo nuclear or Boosted fission; (iii)Operational range:4000KM; (iv)Searing temperature→3000° Celsius.
6) AGNI-V: (i)Three stage→Two stages solid propellants + Composite third stage; (ii)Payload capacity:1.5Ton/Nuclear capable; (iii)Operational range:5500KM [Intercontinental ballistic missile]; (iv)High Operational flexibility: Canister based launch; (v)India→Completed Nuclear triad.

#3 What is the significance of AGNI series missile developments?

1) (i) Successful testing of AGNI V→India entered elite ICBMs club; (ii)Canister based launch system→Highly agile & operational readiness; (iii)Ensures credible minimum deterrence→Against Nuclear attack; (iii)Facility of MERVs→Neutralizing multiple targets; (vi) Development of composite material→Applications in Infrastructure & Development; Prosthetics etc.; (v)Hassle free targeting→Up to Northeastern China [AGNI-V]

#4 What are the challenges are there for AGNI missiles?

1) (i) Being Exo-atmospheric trajectory→Anti-ballistic missile defence system: Easy to Track & shoot it down; (ii) Absence of Self destruction facility; (iii) Trajectory of missile path→highly predictable; (iv)Thermal heating on reentry→Prone to deteriorate the Chemical/Biological warheads; (v)Because of massive size of ICBM→Locating through satellite images are trouble-free.

#5 What are the recent initiatives which are taken in the AGNI segment?

1) AGNI-VI: (i) 4-stage ICBM;(ii) Payload delivery range:12000 KMs; (iii) Multiple independently targetable reentry vehicle→Up to 10 warheads; (iv)Sleekly & easily transportable→Versatility in operations.
2) AGNI-P: (i) 2 stage-Medium range ballistic missile; (ii) Operational range-1000 to 2000KMs; (iii) Maneuverable reentry vehicle; (iv) Composite motor casing +Canister based launch systems.

RAMJET & SCRAMJET

#1 What is meant by RAMJET?

1) RAMJET [Flying stovepipe]: Air breathing jet engine→Principle: Engine's forward motion to compress incoming air.
2) (i)Assisted take-off in RAMJET→ To attain operating thrust;(ii) Attains Peak efficiency: MACH-3; (iii)Shock cones→To decelerate the air flow to Subsonic level.
3) Working: Highspeed moving object→ High pressure in upstream: Ducted through chamber +Combustion→Exit through outlet nozzle: Generates forward thrust.
4) Solid Fuel Ducted RAMJET: Mission propulsion→Solid fuel + Atmospheric O_2 →Operations same as like RAMJET engines.

#2 What is meant by SCRAMJET?

1) Supersonic combustion RAMJET→(i)Variant of RAMJET engine; (ii)Combustion: Supersonic airflow; (iii)No shock cones→ Supersonic airflow in converging inlet
2) Working: (i)Combustion→Oxidizer [Atmospheric O_2] +Fuel [Liquid Hydrogen]; (ii)Diverging outlet : Generates forward thrust→Due to exhaustion.
3) (i) Absence of Multi-stage Turbofan: Reduces the weight +Capitalize maximum thrust; (ii) Atmospheric oxidizer→Extended trajectory in mission operations.

#3 What is the significance of RAMJET & SCRAMJET Engines?

1) (i) Air to Air Missiles + SFDR [Example: ASTRA]→Operational Range can be enhanced; (ii)SCRAMJET operational speed: Hypersonic level[Above MACH-5]→Elevates India's horizon in Hypersonic Missile technology; (iii) Induction of SCRAMJET in ISRO→Reliable satellite carriers + Affordable pricing/Launch; (iv) SCRAMJET & RAMJET→Enhances India's capability in Anti-ballistic missile defence systems; (v) SCRAMJET + RAMJET→Modernization of existing missile arsenal; (vi) Boost: Indigenous military aircraft production [Example: X-43A→Hypersonic Jet plane]

#4 What are the challenges lying ahead in the domain of RAMJET & SCRAMJET?

1) (i) Incapable to generate initial thrust→Mandating Assisted take-off; (ii) Shock wave generation→In outlet section is detrimental factor; (iii) SCRAMJET→Still in nascent stage & Yet to be tested multiple times; (iv) RAMJET is highly inefficient→Below MACH-2; (v) Hefty price tag→Stealth enabled variants; (vi) Very High thrust to body weight ratio→In scramjet variants.

#5 What are the initiatives which are taken in Global arena?

1) **India:** (i) Recently tested→HSTD vehicle; (ii) Development of SFDR→DRDO
2) **International arena:** (i) Russia→3M22 ZIRCON hypersonic missile [Scramjet]; (ii) China→Recently conducted Scramjet enabled Missile; (iii) US→Boeing X-51 tech demonstration flight.

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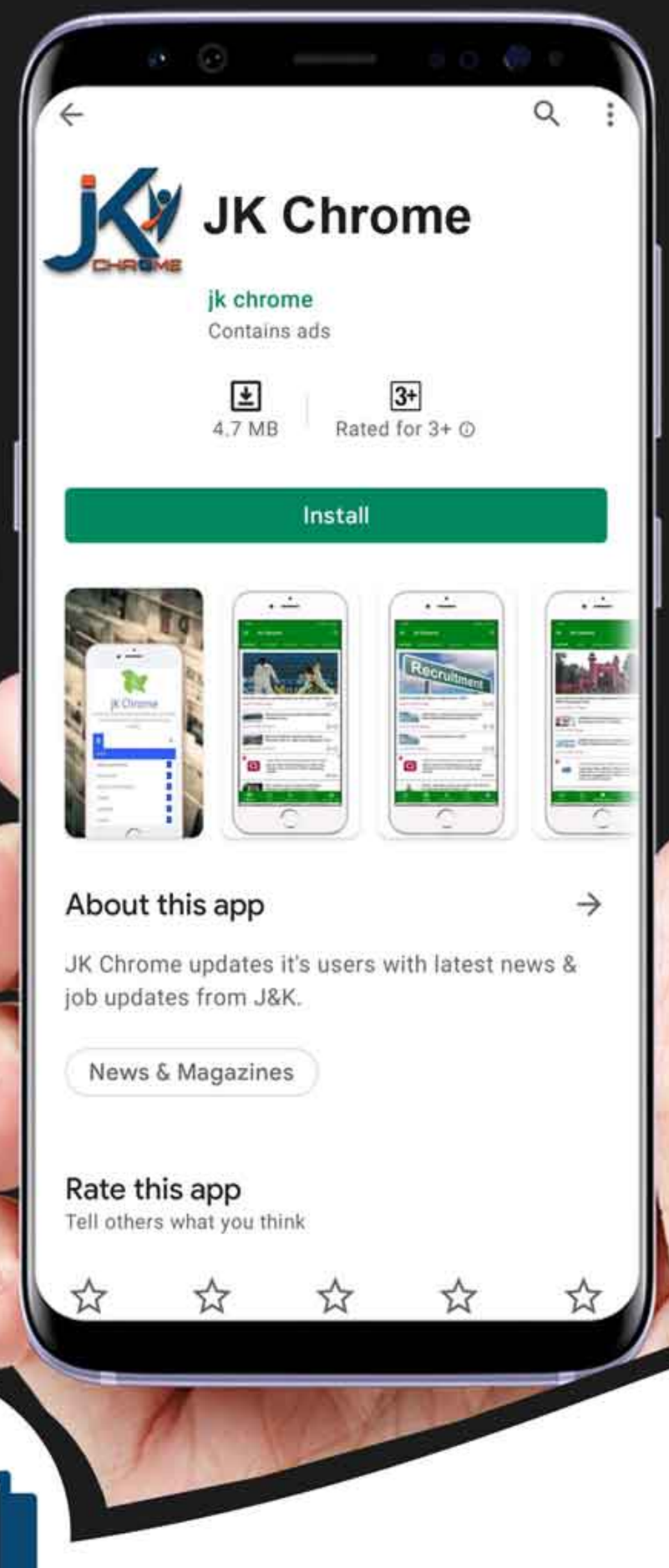

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