1. Match the following unmanned space probes with their mission focus:  
   List–I — List–II  
   a. Chandrayaan-1 — 1. Lunar exploration  
   b. Mars Orbiter Mission (MOM) — 2. Mars atmospheric studies  
   c. Aditya-L1 — 3. Solar corona studies  
   d. Venus Orbiter Mission (Shukrayaan proposed) — 4. Venus atmospheric studies  
   Select the correct answer using the codes given below.  
   (A) abcd → 1234  
   (B) abcd → 1324  
   (C) abcd → 1342  
   (D) abcd → 1423

Answer 51. (A) abcd → 1234

Explanation:

* Chandrayaan-1 was India’s first lunar orbiter focused on chemical, mineralogical, and topographic mapping, including landmark findings related to lunar water signatures.
* The Mars Orbiter Mission carried instruments like the Methane Sensor for Mars to study the Martian atmosphere and its constituents.
* Aditya-L1 is a dedicated solar observatory at the Sun–Earth L1 point to study the solar corona, flares, and space weather.
* The proposed Venus Orbiter Mission (Shukrayaan) is planned to study Venus’s dense atmosphere and surface/topography interactions.

1. Consider the following statements about Nano-titanium dioxide (TiO2):  
   (i) It is used as a UV blocker in sunscreens.  
   (ii) Nano-TiO2 is photo-catalytic and can degrade organic pollutants.  
   (iii) It is completely non-toxic and environmentally safe in all forms.  
   (iv) It finds applications in self-cleaning coatings.  
   Which of the above statements are correct?  
   (A) (i), (ii), and (iv) only  
   (B) (ii) and (iii) only  
   (C) (i) and (iii) only  
   (D) All the statements are correct

Answer 52. (A) (i), (ii), and (iv) only

Explanation:

* Nano-TiO2 is widely used in sunscreens as a physical UV filter due to its high refractive index and strong UV scattering/absorption.
* Owing to its photocatalytic properties, nano-TiO2 can generate reactive species under UV and degrade organic pollutants, enabling environmental remediation uses.
* Its photocatalytic activity also underpins self-cleaning coatings where organic grime is broken down and washed off.
* It is not “completely non-toxic” in all forms; concerns exist regarding nanoparticle size, coatings, photoreactivity, and potential oxidative stress, so statement (iii) is incorrect.

1. Consider the following statements about nuclear fission:  
   (i) It involves splitting a heavy nucleus into lighter nuclei.  
   (ii) It releases neutrons which sustain chain reactions.  
   (iii) Nuclear fission is the principle behind stars' energy production.  
   (iv) Fission produces high-level radioactive waste.  
   Which of the above are correct?  
   (A) (i), (ii), and (iv) only  
   (B) (ii), (iii), and (iv) only  
   (C) (i) and (iii) only  
   (D) All the statements are correct

Answer 53. (A) (i), (ii), and (iv) only

Explanation:

* Fission is the splitting of a heavy nucleus like uranium-235 or plutonium-239 into lighter fragments, releasing energy.
* The process emits neutrons that can induce further fissions, enabling a self-sustaining chain reaction in reactors and weapons.
* Stars derive energy primarily from nuclear fusion of light nuclei (e.g., hydrogen to helium), not fission, making statement (iii) incorrect.
* Spent nuclear fuel from fission contains high-level radioactive waste and minor actinides, necessitating long-term management.

1. Which of the following types of RNA molecules are non-coding RNAs involved in gene regulation?  
   (i) microRNA (miRNA)  
   (ii) Small interfering RNA (siRNA)  
   (iii) Ribosomal RNA (rRNA)  
   (iv) Transfer RNA (tRNA)  
   Select the correct answer:  
   (A) (i) and (ii) only  
   (B) (ii), (iii) and (iv) only  
   (C) (i), (ii), and (iii) only  
   (D) All of the above

Answer 54. (A) (i) and (ii) only

Explanation:

* miRNA and siRNA are classic regulatory non-coding RNAs that mediate post-transcriptional gene silencing via the RNA interference pathway.
* rRNA and tRNA are non-coding but function primarily as housekeeping RNAs in protein synthesis rather than regulatory control of gene expression.
* Hence only miRNA and siRNA in the list are designated regulatory ncRNAs.

1. Which of the following statements about Bose’s career is/are correct?  
   (i) Bose served as a professor at the University of Dhaka.  
   (ii) He worked extensively on X-ray crystallography.  
   (iii) Bose strictly worked only in theoretical physics.  
   (iv) He was the first Indian physicist to have a subatomic particle named after him.  
   Select the correct answer:  
   (A) (i), (ii), and (iv) only  
   (B) (ii) and (iii) only  
   (C) (i) and (iii) only  
   (D) All of the above

Answer 55. (A) (i), (ii), and (iv) only

Explanation:

* Satyendra Nath Bose returned to India in the 1920s and became Professor and later Head of Physics at the University of Dhaka.
* He helped set up and work with X-ray spectroscopy and crystallography facilities, reflecting significant experimental engagement.
* He was not confined strictly to theoretical physics; his career included experimental and instrumentation work, so statement (iii) is incorrect.
* Particles with integer spin are called bosons in his honor, making him the first Indian physicist to have a subatomic particle class named after him.

1. Which of the following statements about topological insulators are correct?  
   (i) They are materials that conduct electricity on their surfaces but act as insulators inside.  
   (ii) Topological insulators have potential applications in quantum computing.  
   (iii) They were discovered in the early 20th century.  
   (iv) Their surfaces are resistant to impurities and defects.  
   Select the correct answer:  
   (A) (i), (ii), and (iv) only  
   (B) (ii) and (iii) only  
   (C) (i) and (iii) only  
   (D) All the statements are correct

Answer 56. (A) (i), (ii), and (iv) only

Explanation:

* Topological insulators exhibit insulating bulk states with conducting surface or edge states protected by topology.
* Their robust, spin-polarized surface states and reduced backscattering make them promising for fault-tolerant quantum and spintronic applications.
* The field emerged in the 2000s following theoretical predictions and experimental confirmations, not in the early 20th century, so (iii) is incorrect.
* Topological protection endows surface states with resilience to non-magnetic impurities and certain defects, supporting (iv).

1. Consider the following statements in rotational motion:  
   (i) The moment of inertia depends on the axis of rotation.  
   (ii) Angular momentum of a system is conserved only if external torque is zero.  
   (iii) In pure rotational motion, all particles have the same angular velocity but different linear velocities.  
   (iv) Torque is directly proportional to angular acceleration.  
   Which of the above statements are correct?  
   (A) (i), (ii), and (iii) only  
   (B) (ii), (iii), and (iv) only  
   (C) (i) and (iv) only  
   (D) All of the above

Answer 57. (D) All of the above

Explanation:

* The moment of inertia varies with both mass distribution and the chosen axis, as described by the parallel-axis theorem and geometry.
* Angular momentum conservation requires zero net external torque on the system, mirroring linear momentum conservation conditions.
* In rigid body rotation about a fixed axis, angular velocity is common to all points, while linear speed varies with radial distance (v = ωr).
* For a rigid body with constant moment of inertia, τ = Iα shows torque is directly proportional to angular acceleration.

1. The bulk modulus of a liquid is a measure of its:  
   (A) Compressibility  
   (B) Viscosity  
   (C) Surface tension  
   (D) Density

Answer 58. (A) Compressibility

Explanation:

* Bulk modulus K quantifies resistance to uniform compression, defined as K = −V dp/dV.
* Higher bulk modulus implies lower compressibility, and liquids typically exhibit high K compared to gases.
* Viscosity measures flow resistance, surface tension measures interfacial energy, and density measures mass per unit volume, none of which is represented by bulk modulus.

1. Match the following Assamese writers with their reputed works:  
   a. Homen Borgohain | 1. Pita Putra  
   b. Indira Goswami (Mamoni Raisom Goswami) | 2. The Moth-Eaten Howdah of the Tusker  
   c. Nabakanta Barua | 3. Kapili (poetry collection)  
   d. Lakshminath Bezbaroa | 4. Kripabor Boruar Kakatar Topola  
   (A) abcd → 1 2 3 4  
   (B) abcd → 2 1 4 3  
   (C) abcd → 1 3 2 4  
   (D) abcd → 4 2 1 3

Answer 59. (A) abcd → 1 2 3 4

Explanation:

* Homen Borgohain is associated with works like Pita Putra in Assamese literature.
* Indira Goswami’s acclaimed English title The Moth-Eaten Howdah of the Tusker is based on her Assamese Dontal Haatir Uiye Khowa Haoda.
* Nabakanta Barua is renowned for poetry collections including Kapili.
* Lakshminath Bezbaroa, a pioneer of modern Assamese literature, authored Kripabor Boruar Kakatar Topola.

1. Which of the following SDGs are directly related to gender equality and women’s empowerment?  
   (i) SDG 3: Good Health and Well-being  
   (ii) SDG 5: Gender Equality  
   (iii) SDG 10: Reduced Inequalities  
   (iv) SDG 8: Decent Work and Economic Growth  
   Select the correct answer using the codes given below.  
   (A) (ii) and (iii) only  
   (B) (i), (ii), and (iv) only  
   (C) (ii), (iii), and (iv) only  
   (D) All of the above

Answer 60. (D) All of the above

Explanation:

* SDG 5 is explicitly dedicated to achieving gender equality and empowering all women and girls.
* SDG 3 includes targets on maternal health, reproductive health services, and addressing gendered health disparities, directly impacting women’s empowerment.
* SDG 8 emphasizes full and productive employment and decent work with equal pay and opportunities, central to economic empowerment of women.
* SDG 10 targets reducing inequalities within and among countries, including gender-based disparities, thereby reinforcing gender equality objectives.