LAST 7 Yrs. CUTOFF IIT JAM EXAM GEOLOGY (CATEGORY WISE)			
YEAR	**GENERAL**	**OBC-NCL/EWS**	**SC/ST/PWD**
2020	53.01	47.71	26.50
2021	34.65	31.18	17.32
2022	53.01	47.71	25.26
2023	31.04	25.58	22.45
2024	33.09	29.78	16.54
2025	21.06	18.95	10.53
2026	25.98	23.38	12.99

IIT JAM Preparation Tips

- Know the Exam Pattern
- Understand the Syllabus
- Build Concepts
- Study Plan
- Solve Previous Year Papers
- Practice Numericals (NAT)
- Attempt Mock Tests

Major Benefits of IIT JAM Exam

- **Admission to Top Institutes:** Entry into IITs, IISc, NITs for M.Sc. and Ph.D. programs.
- **Strong Career Opportunities:** Jobs in PSUs (ONGC, ISRO), R&D, academia, and MNCs. **Foundation for Higher Studies:** Ideal for NET, GATE, CSIR, and foreign education.
- **Scholarships & Stipends:** Eligible for INSPIRE, institute scholarships, fellowships.
- **Direct Integrated Ph.D. Entry:** Saves time, with early research exposure.
- **No Age Limit & Open to All Science Graduates:** Broad eligibility and inclusive access.
- **Research & Networking Exposure:** Learn, collaborate, and grow with top minds. **Pathway to Teaching Careers:** Become assistant professor, researcher, or lecturer.

SYLLABUS

The Planet Earth: Origin of the Solar System and the Earth; Geosphere and the composition of the Earth; Shape and size of the Earth; Earth-Moon system; Dating rocks and age of the Earth; Volcanism and volcanic landforms; Interior of the Earth; Earthquakes; Earth's magnetism and gravity, Isostasy; Basic elements of Plate Tectonics; Orogenic cycles.

Geomorphology: Weathering and erosion; Soil formation; Transportation and deposition by wind, ice, river, sea and resulting landforms.

Structural Geology: Orientation of planes and lines in space – concept of dip, strike, rake and plunge. Contour lines; Rule of 'V's and outcrop patterns; Interpretation of geological maps and cross-section construction; Classification and origin of folds, faults, joints, unconformities, foliations and lineations; Stereographic and equal-area projections of planes and lines; Numerical problems related to outcrop and bore-hole data.

Paleontology: Major steps in the evolution of life forms; Fossils, their mode of preservation and utility in age determination and paleoenvironmental interpretations; Morphology, major evolutionary trends and ages of important groups of animals – Brachiopoda, Mollusca, Trilobita, Graptoloidea, Anthozoa, Echinodermata; Gondwana plant fossils; Elementary idea of vertebrate fossils in India.

Stratigraphy: Principles of stratigraphy; Litho-, Chrono- and biostratigraphic classification; Stratigraphic correlation techniques; Archaean cratons of Peninsular India (Dharwar, Singhbhum and Aravalli); Proterozoic mobile belts; Stratigraphy of Cuddapah and Vindhyan basins; Stratigraphy of Paleozoic – Mesozoic of Spiti and Kashmir, Gondwana Supergroup, Jurassic of Kutch, Cretaceous of Trichinopoly, Tertiary and Quaternary sequences of Assam, Bengal and Siwaliks.

Mineralogy: Symmetry and forms in common crystal classes; Physical properties of minerals; Isomorphism, polymorphism, solid solution and exsolution; Classification of minerals; Structure of silicates; Mineralogy of common rock-forming minerals; Elements of Optical Mineralogy, Optical properties of common rock-forming minerals.

Petrology: Definition and classification of rocks; Igneous rocks – forms of igneous bodies; Processes of evolution and diversification of magma; Classification, association, and genesis of common igneous rocks. Sedimentary rocks – classification, texture, and structure; Petrology of sandstone and limestone; Elements of sedimentary environments and facies. Metamorphic rocks-classification and texture; Types of metamorphism; Controls on metamorphism – pressure, temperature and fluids; Concept of projections

ACF, AKF and AFM diagrams; Phase Rule and its applications; Concepts of zones and facies, Characteristic mineral assemblages of pelites in the Barrovian zones and mafic rocks in common facies.

Economic Geology: Physical properties of common economic minerals; General processes of formation of mineral deposits; Mode of occurrence and distribution of metallic and non-metallic mineral deposits in India; Fundamentals of reserve calculation; Elements of coal and hydrocarbon geology, Coal and hydrocarbon occurrences in India.

Applied Geology: Groundwater and hydrological cycle, Types of aquifers, porosity and permeability; Principles of engineering geology; Geological considerations in construction of dams and tunnels.

IIT JAM Conducting Institutes (2015–2025)

Sl. No.	Year	Conducting Institute	Abbreviation
1	2015	IIT Guwahati	IITG
2	2016	IIT Madras	IITM
3	2017	IIT Delhi	IITD
4	2018	IIT Bombay	IITB
5	2019	IIT Kharagpur	IITKGP
6	2020	IIT Kanpur	IITK
7	2021	IISc Bangalore	IISc
8	2022	IIT Roorkee	IITR
9	2023	IIT Guwahati	IITG
10	2024	IIT Madras	IITM
11	2025	IIT Delhi	IITD

I N D E X

IIT JAM - GEOLOGY

CHAPTER NO.	CHAPTER NAME	PAGE NO.
1	THE PLANT EARTH	1
2	GEOMORPHOLOGY	15
3	STRUCTURAL GEOLOGY	26
4	PALEONTOLOGY	58
5	STRATIGRAPHY	72
6	MINERALOGY	91
7	PETROLOGY	120
8	ECONOMIC GEOLOGY	155
9	APPLIED GEOLOGY	173

IIT JAM GEOLOGY: NUMBER OF QUESTIONS ASKED IN PREVIOUS EXAMS (2015-2026)													
TOPIC		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
1	The Planet Earth	5	4	3	8	5	7	1	6	4	3	3	9
2	Geomorphology	3	9	1	4	2	3	2	1	4	4	4	4
3	Structural geology	10	10	12	13	11	9	7	8	8	7	11	8
4	Paleontology	5	3	5	5	6	3	6	7	4	5	5	3
5	Stratigraphy	7	3	7	4	4	6	5	7	5	9	8	5
6	Mineralogy	11	10	13	10	12	9	9	8	5	10	8	8
7	Petrology	10	15	11	8	8	13	14	8	11	8	8	10
8	Economic Geology	7	5	4	5	5	7	8	5	8	4	6	5
9	Applied geology	2	2	4	1	5	5	6	9	9	10	7	8

CHAPTER-1 THE PLANET EARTH

PREVIOUS YEAR EXAM QUESTIONS

MCQ (Multiple Choice Questions)

Topic Cover: Origin of the Solar System and the Earth; Geosphere and the composition of the Earth; Shape and size of the Earth; Earth-Moon system; Dating rocks and age of the Earth; Volcanism and volcanic landforms; Interior of the Earth; Earthquakes; Earth's magnetism and gravity, Isostasy; Basic elements of Plate Tectonics; Orogenic cycles.

(2015: MARK-1)

1. Which amongst the following planets has the highest number of known satellites?

(A) Mars (B) Uranus
(C) Venus (C) Mercury

(2015: MARK-1)

2. Identify the mineral which has specific gravity >5, hardness <3 and gives a grey streak.

(A) Barite (B) Sphalerite
(C) Graphite (D) Galena

(2015: MARK-2)

3. Silica-rich viscous magmas often produce:

(A) Stratovolcano (B) Shield volcano
(C) Dome (D) Fissure eruption

(2015: MARK-2)

4. S-wave is terminated at:

(A) Crust----Mantle boundary
(B) Lithosphere-----Asthenosphere boundary
(C) Mantle----Core boundary
(D) Inner and outer core boundary

(2015: MARK-2)

5. Arrange the elements Fe, O, H, He, Si in decreasing order of their abundance in the solar system.

(A) H > He > O > Si > Fe (B) He > H > Si > O > Fe
(C) H > He > O > Fe > Si (D) Si > Fe > H > He > O

(2016: MARK-1)

6. The amplitude of ground motion during an earthquake of magnitude 7 in Richter scale is how many times more than that of a magnitude 5?

(A) 10 (B) 100
(C) 1000 (D) 10,000

(2016: MARK-1)

7. Which is the most abundant ion in the normal seawater?

(A) Cl (B) SO,
(C) Na* (D) K*

(2017: MARK-2)

8. Match the earth layers (Group I) with corresponding approximate thicknesses (Group II).

Group - I		Group - II	
P	Lithosphere	i	2900 km
Q	Mantle	ii	2250 km
R	Outer Core	iii	1200 km
S	Inner Core	iv	100 km

Code

	P	Q	R	S
(A)	iv	i	ii	iii
(B)	iv	i	iii	ii
(C)	iv	iii	i	ii
(D)	iii	ii	i	iv

(2017: MARK-2)

9. Pressure (IGPa = 10 kbar) and temperature at the centre of the Earth are estimated to be:

(A) 360 GPa, 2600 K (B) 450 GPa, 6000 K
(C) 360 GPa, 6000 K (D) 450 GPa, 2600 K

(2018: MARK-1)

10. Which one among the following planets in the Solar system is most similar in size to the Earth?

(A) Mercury (B) Venus
(C) Neptune (D) Uranus

(2018: MARK-1)

11. In which one of the following tectonic settings are the highest mountain chains and thickest crust found?

(A) Island arc (B) Continental arc
(C) Continental collision (D) Transcurrent

(2018: MARK-1)

12. The second-most abundant oxide in the Earth's crust is:

(A) Al_2O, (B) SiO
(C) Cao (D) Na_2O

(2018: MARK-2)

13. Isostasy involves _____ continental mountain belts.

(A) compensation in (B) creation of
(C) destruction of (D) thrusting in

(2018: MARK-2)

14. Identify the pair from the following list that is NOT correctly matched.

(A) Caldera-stratovolcano
(B) Pillow basalt - subaerial eruption
(C) Ropy lava-pahoehoe flow
(D) Amygdales-filled vesicles

(2018: MARK-2)

15. Wilson orogenic cycle in continents is initiated by:

(A) collision (B) rifting
(C) drifting (D) subduction

(2018: MARK-2)

16. The correct order of marine benthic habitats with increasing water depths is:

(A) abyssal, bathyal, neritic
(B) neritic, abyssal, bathyal
(C) neritic, bathyal, abyssal
(D) bathyal, abyssal, neritic

(2019: MARK-1)

17. Which of the following is associated with a divergent plate boundary?

(A) Ridge (B) Trench
(C) Island are (D) Accretionary prism

(2019: MARK-1)

18. Shear waves do not travel through the:

(A) upper continental crust
(B) upper mantle
(C) lower mantle
(D) outer core

(2020: MARK-1)

19. A trench is found at a:

(A) divergent plate boundary
(B) convergent plate boundary
(C) transform boundary
(D) passive margin

(2020: MARK-1)

20. The Earth's radius is maximum at which one of the following latitudes?

(A) 0° (B) 40° N
(C) 60° S (D) 90°

(2020: MARK-2)

21. Approximately 71% of the planetary mass in the solar system is concentrated in:

(A) Uranus (B) Mercury
(C) Saturn (D) Jupiter

(2020: MARK-2)

22. Match the seismic discontinuity in Group I with their occurrence in Earth's interior in Group II.

Group - I		Group - II	
P	Conrad	I	Between lower mantle and outer core
Q	Mohorovičić	II	Between crust and upper mantle
R	Gutenberg	III	Between inner and outer core
S	Lehmann	IV	Between lower and upper crust

Code

	P	Q	R	S
(A)	IV	II	I	III
(B)	IV	II	III	I
(C)	III	II	IV	I
(D)	II	IV	I	III

(2022: MARK-1)

23. Which one of the following seismic waves involves compression and rarefaction (but not rotation) of the material that it passes through?

(A) P-waves (B) S-waves
(C) Rayleigh waves (D) Love waves

(2022: MARK-2)

24. Matching the countries in Group I with the plate tectonic features in Group II cause seismic activity in them.

Group - I		Group - II	
P	Iceland	I	Subduction Zone
Q	Indonesia	II	Transform
R	Nepal	III	Mid – Oceanic Ridge
S	New Zealand	IV	Continental Collision

Code

	P	Q	R	S
(A)	III	I	IV	II
(B)	III	I	II	IV
(C)	I	III	IV	II
(D)	II	I	IV	III

(2022: MARK-2)

25. Which one of the magnitude scales given below DOES NOT saturate while estimating size of earthquakes?

(A) Local magnitude scale (ML)
(B) Body wave magnitude scale (Mb)
(C) Surface wave magnitude scale (Ms)
(D) Moment magnitude scale (Mw)

(2023: MARK-2)

26. Which one of the following is a gently sloping (<10°) volcanic landform resulting from eruption of basaltic lava?

(A) Shield volcano (B) Composite volcano
(C) Lava dome (D) Caldera

(2023: MARK-2)

27. On the magnetic polarity time scale, the present day epoch/chorn is called _____.

(A) Matuyama (B) Gilbert
(C) Gauss (D) Bruhnes

(2023: MARK-2)

28. Which one of the following options is the CORRECT sequence of seismic waves in order of arrival time recorded on a seismogram after an earthquake?

(A) P-waves, S-waves, Rayleigh waves, Love waves
(B) P-waves, Rayleigh waves, S-waves, Love waves
(C) S-waves, P-waves, Love waves, Rayleigh waves
(D) P-waves, S-waves, Love waves, Rayleigh waves

(2024: MARK-1)

29. The plate tectonic setting of Benioff-Wadati zone is:

(A) continental rift
(B) subduction zone
(C) passive margin
(D) mid-oceanic ridge

(2024: MARK-1)

30. Neutron-rich unstable nuclides undergo:

(A) β (negatron) decay (B) β^+(positron) decay
(C) α –decay (D) electron capture

(2024: MARK-2)

31. Which of the following is the correct decreasing order of abundance of elements in our solar system?

(A) O > H > Fe > He (B) O > Fe > He > H
(C) H > O > Fe > He (D) H > He > O > Fe

(2025: MARK-1)

32. The density contrast across which one of the following transitions in the Earth is maximum?

(A) Upper crust – lower crust
(B) Upper mantle – lower mantle
(C) Lower mantle – outer core
(D) Outer core – inner core

(2025: MARK-1)

33. The longitude of the person's position at a place 3 hours ahead of UTC (Prime Meridian) is:

(A) 15°E (B) 30°W
(C) 45°E (D) 45°W

(2026: 1 Marks)

34. Which one of the following primary structures can be used for paleocurrent measurement?

(A) Oscillation ripple
(B) Hummocky cross-strata
(C) Flute cast
(D) Load and flame structures

(2026: 1 Marks)

35. Choose the material on which the ^{14}C dating technique can be correctly applied.

(A) Charred food grains from the Indus Valley civilization
(B) Organic matter in carbonaceous chondrites
(C) Diamonds from the Earth's interior
(D) Graphite from Proterozoic sedimentary basins

(2026: 2 Marks)

36. Choose the correct statement about Moho.

(A) Seismic and petrologic Moho coincide
(B) Seismic Moho lies at shallower depths relative to the petrologic Moho
(C) Petrologic Moho lies at shallower depths relative to the seismic Moho
(D) Petrologic Moho lies above the layered gabbro in ophiolites

(2026: 2 Marks)

37. Which one of the following reasons best explains the occurrence of a large number of earthquakes at the active plate boundaries compared to the plate interiors?

(A) Strain energy accumulation is higher at the plate boundaries
(B) Stiffness is higher at the plate boundaries
(C) Heat flow is lower at the plate boundaries
(D) Crust is thinner at the plate boundaries

(2026: 2 Marks)

38. If P, Q, R, and S refer to Rainfall induced landslide, Bolide impact, Milankovitch cycle, and Supercontinent cycle, then which one of the following correctly represents the decreasing order of their duration?

(A) S, R, P, Q (B) Q, P, R, S
(C) S, Q, P, R (D) S, P, Q, R

MSQ (Multiple Select Questions)

(2016: MARK-2)

1. The value of gravity at the Earth's surface is dependent on:

(A) latitude
(B) altitude
(C) composition of underlying material
(D) relative position of Sun-Earth

(2017: MARK-2)

2. P and S waves originate at earthquake focus and travel through the earth. Which of the following statements for these waves is/are correct?

(A) S-wave shadow zone is 154° wide
(B) P-wave shadow zones are 49° wide
(C) P-wave velocity abruptly increases downward at mantle-core boundary

(D) P-wave velocity abruptly drops downward at mantle- core boundary

(2020: MARK-2)

3. Which of the following statements in relation to the solar system is/are correct?

(A) The most abundant elements are H and He.

(B) The abundances of elements with atomic numbers 1-50 show an overall decreasing trend.

(C) The abundances of heavier elements (atomic number >50) are mostly higher than that of lig r elements (atomic number <50).

(D) Elements having odd atomic numbers are more abundant than their immediate neighbours.

(2022: MARK-2)

4. The acceleration due to gravity on the Earth's surface depends on:

(A) latitude

(B) longitude

(C) elevation

(D) topography of the surrounding terrain

(2025: MARK-2)

5. Moon is considered to have been formed due to high temperature condensation of post-collisional ejected material. Which of the following statement(s) related to its mantle composition as compared to CI carbonaceous chondrite is/are CORRECT?

(A) Depleted in volatile and refractory elements

(B) Depleted in volatile and enriched in refractory elements

(C) Higher Rb/Sr element ratio

(D) Lower K/U element ratio

(2026: 2 Marks)

6. Which of the following processes is/are responsible for the alternate bands of magnetic polarity observed in seafloor basalts?

(A) Convection in the mantle

(B) Convection in the outer core

(C) Convection in the inner core

(D) Seismicity at mid-oceanic ridges

(2026: 2 Marks)

7. The Earth's gravitational acceleration is higher at the poles compared to that at the equator due to

(A) higher density rocks at the poles

(B) shorter polar radius

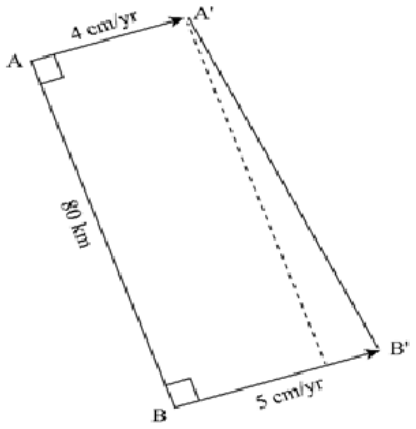
(C) lower centrifugal acceleration at the poles

(D) higher topography at the poles

NAT (Numerical Answer Type)

(2016: MARK-2)

1. Two localities A and B on a continental plate as shown in the figure below, are separated by a distance of 80 km. The plate velocities measured at A and B are 4 cm/yr and 5 cm/yr, respectively. Assuming no faulting in the area, the new distance between A and B will be 80.62 to 80.63 million years. Give an answer in two decimal places.



(2018: MARK-2)

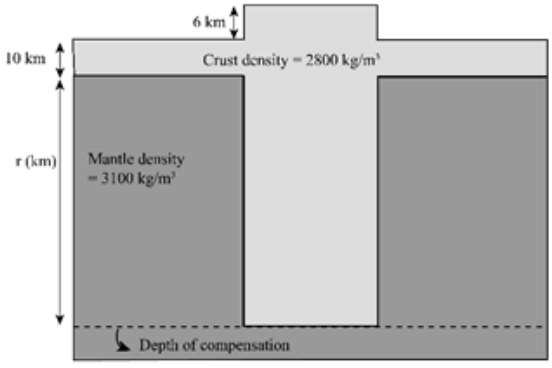
2. Assuming the Earth to be an ideal sphere, the volume % of the core relative to the total volume of the Earth is 14.0 to 18.0 (answer in one decimal place).

(2019: MARK-1)

3. The intensity of an earthquake of magnitude 8 on the Richter scale is greater than the intensity of an earthquake of magnitude 5 on the same scale by_____ times.

(2019: MARK-2)

4. In the given diagram, a 6 km high plateau is supported by a crustal root of thickness r. The system is in isostatic equilibrium as per Airy's hypothesis of isostasy. Densities of the crust and the mantle are 2800 kg/m³ and 3100 kg/m³, respectively. Assuming the acceleration due to gravity to be the same throughout the region, the thickness of the root (r) is_____ km.



(2019: MARK-2)

5. **Assume that the orbit of the earth is a circle of radius 150×10^6 km. The gravitational constant and the earth's orbital velocity are given as 6.7×10^{-11} Nm/kg and 30×10^3m/s, respectively. The calculated mass of the sun is _____$\times10^{30}$ kg (rounded off to two decimal places).**

(2020: MARK-1)

6. **In an ocean basin, a 4 Mo old oceanic crust lies 40 km away from the ridge axis. The average velocity (in cm/yr) of the oceanic lithosphere is _____.**

(2020: MARK-1)

7. **The closest value to the percentage Of Earth's surface covered by the oceans is:**

(A) 30% (B) 50%
(C) 70% (D) 90%

(2021: MARK-2)

8. **Which one of the following tectonic plates has the maximum average velocity?**

(1) Eurasian (2) Pacific
(3) African (4) North American

9. **The radius of the Earth's circular orbit around the Sun is 149×19^6 km. The earth takes 365 days to orbit the sun. The tangential velocity of the earth is _____km/hour. (π = 3.14)**

(2022: MARK-1)

10. **AP-ray arrives at the mantle-core boundary at an angle 25° with respect to the normal. At what angle to the normal does it enter the core? (P-wave velocity in the lower mantle is 13.7 km/s and outer core is 8.1 km/s) (Round off to two decimal places)**

(2022: MARK-1)

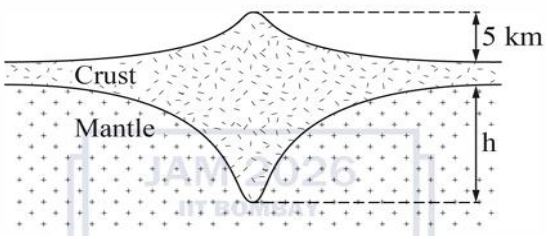
11. **The mass of the Earth is 80 times that of the Moon while the radius of the Earth is four times that of the Moon. The surface gravity of the Earth is _____ times that of the Moon? (In integer)**

(2023: MARK-1)

12. **The amplitude recorded at a station for a magnitude 5 earthquake is x. If another earthquake recorded at the same station has an amplitude of 15x. then the magnitude of this earthquake is _____, (Round off to two decimal places)**

(2026: 2 Marks)

13. **A mountain of height 5 km is in static equilibrium with a crustal block of zero elevation. If the density of the crust and the mantle are 2700 and 3300 kg/m3, respectively, the thickness of the mountain root (h) is _____ km (Round off to one decimal place)**



(2026: 2 Marks)

14. **Consider a perfect Geocentric Axial Dipole model for the geomagnetic field. At a latitude of 30°N, the inclination of a freely suspended magnetic needle, in degree, is _____ . (Round off to the nearest integer)**

ANSWER KEY

MCQ (Multiple Choice Question)

1	2	3	4	5	6
(B)	(D)	(C)	(C)	(A)	(B)
7	**8**	**9**	**10**	**11**	**12**
(A)	(A)	(C)	(B)	(C)	(A)
13	**14**	**15**	**16**	**17**	**18**
(A)	(B)	(B)	(B)	(A)	(D)
19	**20**	**21**	**22**	**23**	**24**
(B)	(A)	(D)	(A)	(A)	(A)
25	**26**	**27**	**28**	**29**	**30**
(D)	(A)	(D)	(D)	(B)	(A)
31	**32**	**33**	**34**	**35**	**36**
(D)	(C)	(C)	(C)	(A)	(B)
37	**38**				
(A)	(A)				

MSQ (Multiple Select Question)

1	2	3	4	5
(A,B,C,D)	(A,D)	(A,B)	(A,C,D)	(B,D)
6	**7**			
A,B	B,C			

NAT (Numerical Answer Type)

1	2	3	4
(80.62 to 80.63)	(16.3 to 16.3)	(1000 to 1000)	(56)
5	**6**	**7**	**8**
(2.00 to 2.02)	(1 to 1)	(3 to 3)	(2 to 2)
9	**10**	**11**	**12**
(106817.0 to 106818.0)	(14.35 to 14.50)	(5 to 5)	(6.15 to 6.19)
13	**14**		
(22.4 to 22.6)	(48 to 50)		

EXPLANATION

MCQ (Multiple Choice Questions)

1. **Correct Answer is (B):** Uranus has the highest number of known satellites compared to the other planets listed in the options. Uranus has 27 known moons. These include some of the largest moons like Titania, Oberon, Ariel, and Umbriel. Many of these moons were discovered using telescopes, and further exploration by spacecraft, like Voyager 2, has provided more insights into their characteristics.

2. **Correct Answer is (D): Galena** is a dense mineral, with a **specific gravity of approximately 7.4**. Specific gravity is the ratio of a mineral's density compared to the density of water. This means Galena is much denser than most common minerals. A specific gravity greater than 5 makes it a relatively heavy mineral.

3. **Correct Answer is (C):** Dome is correct because silica-rich magmas are highly viscous, causing them to pile up near the volcanic vent and form steep, dome-shaped structures. These lava domes (formed from magmas like rhyolite or andesite) are small, steep-sided, and often associated with explosive eruptions.

4. **Correct Answer is (C):** S-waves (secondary or shear waves) are one of the two main types of seismic waves generated by earthquakes. They can move through solids but cannot travel through liquids. S-waves are transverse waves that involve the oscillation of particles perpendicular to the direction of wave propagation. S-waves are terminated or do not pass through the outer core because the outer core is liquid. This is why we observe a shadow zone for S-waves on the opposite side of an earthquake, where no S-waves are detected.

5. **Correct Answer is (A):** The abundance of elements in the solar system is primarily based on their presence in the Sun, as it accounts for most of the matter in the solar system. The order of abundance of these elements is determined by both their relative amounts in the Sun and their general distribution in the solar nebula, which eventually formed the planets and other solar system bodies. **Hydrogen (H):** Hydrogen is the most abundant element in the solar system, making up about 74% by mass of the Sun and approximately 92% by number of atoms. **Helium (He):** Helium is the second most abundant element, constituting about 24% by mass of the Sun. **Oxygen (O):** Oxygen is the most abundant element in the Earth's crust and is third in overall solar system abundance. It accounts for about 0.8% by mass in the Sun. **Silicon (Si):** Silicon is relatively abundant in the solar system, especially in rocky planets like Earth. It makes up about 0.4% by mass in the Sun. **Iron (Fe):** Iron is abundant in the cores of terrestrial planets and in meteorites, but overall it is less abundant than the elements mentioned above, accounting for about 0.1% by mass in the Sun.

6. **Correct Answer is (B):** The Richter scale is logarithmic, meaning that the amplitude of the ground motion increases by a factor of 10 for each unit increase in magnitude. To find how many times greater the amplitude is for an earthquake of magnitude 7 compared to magnitude 5, we use the following logarithmic relationship: Magnitude difference: 7−5 = 2. Since the Richter scale is logarithmic, the amplitude increases by a factor of (or 100) for each 2-magnitude increase.

7. **Correct Answer is (A):** In normal seawater, the most abundant ion is **Na^+** (sodium ion), which makes up a significant portion of the dissolved salts in seawater. Sodium chloride (NaCl) is the most abundant salt in seawater, contributing to the high concentration of sodium ions. **Sodium (Na^+)** is present in much higher concentrations compared to other ions like chloride (Cl^-), sulfate (SO_4^{2-}), or potassium (K^+) in seawater. **Chloride (Cl^-)** is also abundant and, together with sodium, forms sodium chloride (NaCl), but sodium is the positively charged ion that is the most abundant.

8. **Correct Answer is (A):** The Earth is divided into several layers, and each layer has an approximate thickness. Let's break down the thicknesses: Lithosphere: The lithosphere is the outermost layer of the Earth, including the crust and the uppermost part of the mantle. Its approximate thickness is about 100 km. This is the rigid layer that is broken into tectonic plates.

9. **Correct Answer is (C): Pressure**: At the Earth's core, the pressure is indeed extremely high. The pressure at the center of the Earth is typically estimated to be around 360 GPa, which is equivalent to 3600 kbar. **Temperature**: The temperature at the Earth's core is

thought to be around 6000 K. This estimate is based on various factors such as the Earth's internal heat production, which comes from radioactive decay and residual heat from the planet's formation.

10. **Correct Answer is (B):** Venus is often called Earth's "sister planet" because it is very close to Earth in size, mass, and composition. Diameter of Earth ≈ 12,742 km, Diameter of Venus ≈ 12,104 km, The difference in diameter is only about 638 km. In comparison, Mercury is much smaller, and Neptune and Uranus are gas giants, much larger than Earth.

11. **Correct Answer is (C):** Continental collision occurs when two continental plates converge and collide, leading to the formation of very high mountain ranges and extremely thick continental crust. Example: The collision between the Indian Plate and the Eurasian Plate formed the Himalayas, the highest mountain range on Earth, with crust thickness exceeding 70 km. Island arcs and continental arcs are associated with subduction zones but not with the thickest crust or highest mountains. Transcurrent (strike-slip) boundaries (like the San Andreas Fault) mainly involve horizontal motion, not mountain building.

12. **Correct Answer is (A):** The most abundant oxide in Earth's crust is SiO_2 (silicon dioxide). The second-most abundant is Al_2O_3 (aluminum oxide). SiO_2 and Al_2O_3 together make up a major portion of the Earth's continental crust. CaO and Na_2O are present but in much smaller proportions compared to Al_2O_3.

13. **Correct Answer is (A):** Isostasy refers to the equilibrium of Earth's lithosphere floating on the more fluid asthenosphere. In continental mountain belts, isostasy involves the compensation of the thickened crust from mountain building. The crust sinks deeper into the mantle, and surrounding areas uplift to maintain balance, forming a root beneath the mountains.

14. **Correct Answer is (B): Pillow basalt - Subaerial eruption:** Pillow basalts are lava formations that form when lava erupts underwater (in subaqueous environments), not during a subaerial eruption. Therefore, this pair is incorrect. Pillow basalts are associated with underwater eruptions, typically along mid-ocean ridges.

15. **Correct Answer is (B):** The Wilson cycle is the cyclical process of the opening and closing of ocean basins, which ultimately leads to the formation and destruction of continents and mountain belts. The cycle begins with rifting, where a continent breaks apart due to extensional forces. This rifting forms an ocean basin between the two pieces of the continent. The rifting process initiates the cycle, eventually leading to the ocean basin's closure by subduction, followed by the collision of continental plates. Collision and subduction are later stages of the Wilson cycle, but rifting is what starts the cycle by initiating the separation of landmasses.

16. **Correct Answer is (B):** The correct sequence of marine benthic habitats, from the shallowest to the deepest, is based on water depth and distance from shore.**Neritic Zone**: The neritic zone is the shallowest part of the ocean, found close to the shore. It extends from the low tide mark to about 200 meters deep. It is the most biologically productive zone due to the availability of sunlight and nutrients from land runoff. **Abyssal Zone**: The abyssal zone is located at the greatest depths of the ocean, typically below 4,000 meters, and can reach up to 6,000 meters. This zone is dark, cold, and under immense pressure. Despite its harsh conditions, it hosts a variety of life forms adapted to extreme environments. **Bathyal Zone**: The bathyal zone lies between 200 meters and 4,000 meters in depth. It is deeper than the neritic zone but not as deep as the abyssal zone. The bathyal zone is characterized by low light levels, and as you go deeper, the conditions become colder and darker.

17. **Correct Answer is (A):** A **divergent plate boundary** is where two tectonic plates move away from each other. This usually occurs beneath oceans and is characterized by: **Mid-ocean ridges**, where magma rises from the mantle to fill the gap, creating **new oceanic crust**. These ridges are long, linear volcanic mountain chains under the sea, such as the **Mid-Atlantic Ridge**.

    Other Option

    Trenches are formed at **convergent boundaries**, where one plate subducts beneath another. **Island arcs** form above subduction zones, again at convergent boundaries. **Accretionary prisms** develop at subduction zones due to the scraping off of sediments from the subducting plate.

18. **Correct Answer is (D):** Shear waves (S-waves) are a type of seismic wave that move particles perpendicular to the direction of wave propagation. They require a solid medium to travel, because their motion depends on the material's rigidity (shear modulus). The Earth's outer core is in a liquid state, composed mainly of molten iron and nickel. Since liquids cannot support shear stress, S-waves cannot propagate through the outer core. This is also why a seismic "shadow zone" exists for S-waves on the Earth's surface opposite to the earthquake source.

19. **Correct Answer is (B):** Trenches are typically formed at convergent plate boundaries, where one tectonic plate is forced beneath another in a process known as subduction. This leads to the formation of deep oceanic trenches, such as the Mariana Trench. These trenches mark regions where an oceanic plate is subducting beneath either another oceanic plate or a continental plate.

20. **Correct Answer is (A):**
The Earth is not a perfect sphere—it is an oblate spheroid. This means:
- It is flattened at the poles.
- It is bulged at the equator.

Reason: Due to the Earth's rotation, centrifugal force pushes outward at the equator.
This causes the equatorial radius to be greater than the polar radius.
Key Facts:
- Equatorial radius ≈ 6,378 km
- Polar radius ≈ 6,357 km
- Difference ≈ 21 km
- Therefore, Earth's radius is maximum at 0° latitude, i.e., the equator.

21. **Correct Answer is (D):** Jupiter is the largest planet in the solar system and contains about 71% of the total planetary mass. It is primarily composed of hydrogen and helium and is significantly more massive than any other planet in the solar system, which is why it holds the majority of the planetary mass.

22. **Correct Answer is (A):** The correct matching is P–IV, Q–II, R–I, S–III. **Conrad Discontinuity - Between lower and upper crust:** Conrad Discontinuity is the boundary within the continental crust separating the upper crust from the lower crust. It is characterized by a change in seismic wave velocities due to differences in rock composition and density. Typically found at depths of 15–20 km in continental regions. **Mohorovičić Discontinuity (Moho) - Between crust and upper mantle:** The Moho is the boundary between the Earth's crust and the upper mantle. Identified by a sudden increase in seismic wave velocities. Located at depths of approximately 35 km beneath continents and 7 km beneath oceanic crust. **Gutenberg Discontinuity - Between lower mantle and outer core:** The Gutenberg Discontinuity marks the boundary between the Earth's lower mantle and the outer core. Characterized by a significant change in seismic wave behavior: P-waves decrease in velocity, and S-waves disappear entirely, indicating a transition from solid to liquid. Located at a depth of about 2,900 km. **Lehmann Discontinuity - Between inner and outer core:** The Lehmann Discontinuity is the boundary between the Earth's liquid outer core and solid inner core. Identified by the detection of seismic waves that reflect off the solid inner core, indicating a transition from liquid to solid. Discovered by seismologist Inge Lehmann in 1936.

23. **Correct Answer is (A): P-waves (Primary waves)** are **longitudinal** seismic waves that cause the material they travel through to compress and rarefy. These waves are similar to sound waves, where the particles of the medium move in the same direction as the wave propagation (back and forth), causing alternating compression and rarefaction. P-waves can travel through both solids and liquids.
O**ther option**
S-waves (Secondary waves): S-waves are transverse seismic waves, meaning they cause particles to move perpendicular to the direction of wave propagation (side to side). They do not involve compression and rarefaction but involve shear motion. **Rayleigh waves**: Rayleigh waves are surface waves that travel along the Earth's surface. They cause both vertical and horizontal ground motion, but they do not involve compression and rarefaction in the same way as P-waves. **Love waves**: Love waves are also surface waves that cause horizontal motion in a side-to-side direction. They do not involve compression and rarefaction but rather shearing motion in the horizontal plane.

24. **Correct Answer is (A):** The Correct matching is P-III, Q-I, R-IV, T-II. **Iceland - Mid-Oceanic Ridge:** Iceland is located on the Mid-Atlantic Ridge, a divergent plate

boundary where the Eurasian and North American plates are moving apart. This causes volcanic and seismic activity due to magma rising from the mantle. **Indonesia - Subduction Zone:** Indonesia lies on the Ring of Fire where the Indo-Australian plate is subducting beneath the Eurasian plate. This subduction zone results in frequent earthquakes and volcanic eruptions. **Nepal - Continental Collision:** Nepal is located at the boundary between the Indian Plate and the Eurasian Plate. The ongoing continental collision formed the Himalayas and caused strong seismic activity. **New Zealand - Transform:** New Zealand lies along the Alpine Fault, which is a transform boundary between the Pacific and Australian plates. The sliding motion leads to earthquakes.

25. Correct Answer is (D): The Moment Magnitude Scale (Mw) is based on the seismic moment, which is calculated using:$M0=\mu \times A \times D$

Where: μ\m = rigidity of the rocks, A = area of the fault that slipped, D = amount of slip on the fault.

This scale reflects the **total energy released** during an earthquake and is **linearly related to earthquake size**, even for the **largest events (Mw > 9)**.

Unlike traditional scales such as:

- **ML (Local Magnitude/Richter)** – saturates near 6.5
  Mb (Body wave magnitude) – saturates around 6.5
- **Ms (Surface wave magnitude)** – saturates near 8.0

These scales underestimate the magnitude for **very large earthquakes**, making them unreliable for global comparisons.

26. Correct Answer is (A): A shield volcano is a broad, gently sloping volcanic landform, typically having a slope of less than 10°. It forms from the effusive eruption of low-viscosity basaltic lava, which can travel long distances before solidifying.

27. Correct Answer is (D): The magnetic polarity time scale (MPTS) is a geochronological record of Earth's magnetic field reversals. These are captured in the magnetic minerals of oceanic crust and volcanic rocks. The present-day epoch/chron on the MPTS is known as the Bruhnes Chron, which is characterized by normal magnetic polarity (i.e., the magnetic north pole is near the geographic north pole).

- Start of Bruhnes Chron: ~0.78 million years ago
- Polarity: Normal
- Named after French physicist Bernard Brunhes, who discovered the phenomenon of magnetic reversals.

28. Correct Answer is (D): After an earthquake, seismic waves travel outward from the focus in different forms, and their arrival time on a seismogram depends on their speed through the Earth's layers. **P-waves (Primary waves)** are the fastest, compressional in nature, and travel through solids, liquids, and gases, making them the first to arrive. **S-waves (Secondary waves)** are slower than P-waves, are shear in nature, travel only through solids, and arrive second. **Love waves**, which are surface waves that move the ground side to side, travel faster than Rayleigh waves and arrive after the body waves but before Rayleigh waves. **Rayleigh waves** are the slowest of all major seismic waves, rolling along the ground like ocean waves, and they arrive last on the seismogram.

29. Correct Answer is (B): The **Benioff-Wadati zone** refers to a **zone of seismic activity** that dips into the Earth's mantle along a **subducting tectonic plate**. It is named after seismologists **Hugo Benioff** and **Kiyoo Wadati**, who studied earthquake distribution in subduction zones.

- It is characterized by **deep-focus earthquakes** (up to 700 km depth), which occur as one tectonic plate **descends beneath another**.
- This zone marks the **interface between the overriding and subducting plates**, typically found in **convergent plate boundaries**, especially **oceanic-continental or oceanic-oceanic subduction**.

30. Correct Answer is (A): Neutron-rich unstable nuclides have **more neutrons than protons**, which makes the nucleus unstable. To become more stable, they **convert a neutron into a proton**, and this process releases a **β^- (beta minus or negatron)** particle (which is an electron) and an **antineutrino**:

$n \rightarrow p + \beta^- + \bar{\nu}e$

This increases the proton number by 1 and moves the nuclide closer to the line of stability.

31. Correct Answer is (D): The **abundance of elements in the solar system** is based primarily on data from the **solar photosphere**, **cosmic abundances**, and **meteorites**.

1. **Hydrogen (H)** – Most abundant element in the universe and in the solar system.

2. **Helium (He)** – Second most abundant, formed by nuclear fusion in stars.
3. **Oxygen (O)** – Most abundant heavier (metallic) element.
4. **Iron (Fe)** – Among the most abundant metals but less than O, He, and H.

32. Correct Answer is (C): The **density contrast** refers to the sudden change in density between two adjacent layers within the Earth. Let's examine the options: **Upper crust – lower crust:** Density increases slightly (around 2.7–2.9 to ~3.0 g/cm³). The change is minor and gradual. **Upper mantle – lower mantle:** Density increases from ~3.4 to ~5.0 g/cm³. Moderate contrast, but not the maximum. **Lower mantle – outer core:** Very sharp contrast: Lower mantle density ≈ 5.0–5.5 g/cm³. Outer core density ≈ 9.9–12.2 g/cm³. This boundary is called the Core-Mantle Boundary (CMB) or the Gutenberg Discontinuity, and has the largest jump in density (~4.5–6.7 g/cm³ difference). **Outer core – inner core:** Density increases from ~11.0–12.2 g/cm³ to ~12.6–13.0 g/cm³. Noticeable, but not as large as at the CMB.

33. Correct Answer is (C): The Earth rotates 360° in 24 hours, which means it rotates 15° of longitude per hour (360° ÷ 24 = 15°/hour). If a location is 3 hours ahead of UTC, then it lies east of the Prime Meridian, since eastern longitudes are ahead of UTC in time. To find the longitude: 3 hours×15∘/hour=45∘. Since it's ahead of UTC, the longitude is 45°E.

34. Correct Answer is (C): Flute casts are asymmetrical erosional structures with a blunt upstream end and a tapered downstream end, clearly indicating flow direction, so they are used to measure paleocurrents.

35. Correct Answer is (A): Radiocarbon (^{14}C) dating is used only for **recent organic materials** (once-living things). Charred food grains contain organic carbon, so they can be dated, while diamonds, graphite, and meteorites are too old or inorganic.

36. Correct Answer is (B): The **seismic Moho** is defined by a sharp increase in seismic wave velocity (crust → mantle), while the **petrologic Moho** marks the actual compositional change; typically, the seismic boundary appears **slightly shallower** than the true petrologic boundary.

37. Correct Answer is (A): At plate boundaries, tectonic plates interact (collide, diverge, or slide), causing **stress and strain to build up**, which is released as earthquakes; such accumulation is much less in stable plate interiors.

38. Correct Answer is (A): S (Supercontinent cycle) → longest (hundreds of millions of years). **R (Milankovitch cycle)** → tens to hundreds of thousands of years. **P (Rainfall-induced landslide)** → short (minutes to days). **Q (Bolide impact)** → shortest (seconds to minutes).

MSQ (Multiple Select Questions)

1. Correct Answer is (A, B, C & D): Latitude: Gravity is slightly stronger at the poles and weaker at the equator. This is because the Earth is not a perfect sphere; it is an oblate spheroid, meaning it is slightly flattened at the poles and bulging at the equator. The centrifugal force caused by Earth's rotation also reduces the apparent gravity at the equator. Therefore, gravity varies with latitude. **Altitude:** Gravity decreases with altitude (height above sea level). As you move farther from the Earth's center (such as climbing a mountain or flying in an airplane), the gravitational force becomes weaker because the distance from the Earth's center increases.
Composition of underlying material: The composition of the underlying material also affects gravity. Denser materials exert slightly stronger gravitational forces than less dense materials. This means that areas with denser rock formations or materials will experience a slightly stronger gravitational pull. **Relative position of Sun-Earth:** The relative position of the Sun-Earth does not significantly affect gravity at the Earth's surface. The gravitational influence of the Sun on the Earth's surface is very small compared to the Earth's own gravitational pull. While the Earth does experience tidal forces due to the Moon and Sun, these forces primarily affect ocean levels and are not significant at the Earth's surface on a day-to-day basis.

2. Correct Answer is (A & D): P-waves (Primary waves): Travel through solids and liquids, but their velocity decreases when passing from the mantle (solid) to the outer core (liquid), creating a P-wave shadow zone from 104° to 140°-150° (about 49° wide). **S-waves (Secondary waves):** Only travel through

solids. They cannot pass through the liquid outer core, creating an S-wave shadow zone from 104° to 180° (about 76° wide). **(S-1):** The S-wave shadow zone is not 154° wide. It typically spans from about 104° to 180°, so it is approximately 76° wide. **(S-4):** At the mantle-core boundary, the P-wave velocity drops abruptly because the outer core is in a liquid state. This results in a significant decrease in the speed of P-waves as they enter the liquid outer core, causing a P-wave shadow zone.

3. **Correct Answer is (A, B): Hydrogen** (H) and Helium (He) are by far the most abundant elements in the solar system, particularly in the Sun and gas giants. They make up about 98% of the total mass of the solar system. This is due to their primordial origin from the Big Bang nucleosynthesis. If we plot **elemental abundances** vs. atomic numbers, we see a general decrease up to Z = 50, although there are some local peaks (e.g., Fe, O, Si). This trend is related to stellar nucleosynthesis and the binding energy curve, which favors the production of lighter elements.

4. **Correct Answer is (A, C & D):**
Latitude: The acceleration due to gravity on Earth varies with latitude. This is because the Earth is not a perfect sphere; it's an oblate spheroid, meaning it is slightly flattened at the poles and bulging at the equator. Gravity is stronger at the poles and weaker at the equator. The centrifugal force due to Earth's rotation also causes gravity to be slightly weaker at the equator. Therefore, gravity decreases as you move from the poles towards the equator. **Elevation:** The acceleration due to gravity decreases with an increase in elevation. As you move higher above the Earth's surface, you are farther from the Earth's center, where gravity is weaker. Therefore, gravity decreases with height above sea level. This effect is noticeable at high altitudes like in mountains or high-altitude regions. **Topography of the surrounding terrain:** The local topography, or the physical features of the terrain, can influence gravity slightly. For example, areas with large masses like mountains or valleys can affect the local gravitational field. The presence of large geological formations, such as mountains or dense mineral deposits, can lead to variations in the gravitational pull in that specific area. This is because gravitational attraction depends on the mass and distance of objects.

5. **Correct Answer is (B & D):** The Moon's mantle composition reflects its unique formation process — mainly from high-temperature condensation of material ejected after a giant impact. This affects its elemental makeup compared to CI carbonaceous chondrites (primitive meteorites used as a reference for solar system composition). **Depleted in volatile and enriched in refractory elements:** The Moon is depleted in volatile elements (elements that vaporize easily, like water, K, Na) due to the high temperatures involved in its formation. is enriched in refractory elements (elements with high condensation temperatures, like Ca, Al, Ti) because these elements condense and remain solid under high-temperature conditions. Compared to CI chondrites, the Moon shows this distinct signature of volatile loss and refractory element retention. **Lower K/U element ratio:** The K/U ratio (potassium to uranium) is lower in the Moon because potassium (a volatile element) was depleted during formation, while uranium (a refractory element) remained relatively enriched. This reduced K/U ratio is a well-documented geochemical characteristic of lunar rocks.

6. **Correct Answer is (A & B): Convection in the mantle:** Drives seafloor spreading at mid-ocean ridges, creating new basalt that records Earth's magnetic field as it cools. **Convection in the outer core:** Generates the Earth's magnetic field (geodynamo); periodic reversals of this field produce alternating magnetic polarity bands in oceanic crust.

7. **Correct Answer is (B & C): Shorter polar radius:** The Earth is an oblate spheroid, so the distance from the center is smaller at the poles than at the equator. Gravitational acceleration ($g \propto 1/R^2$) is therefore higher at the poles. **Lower centrifugal acceleration:** Due to Earth's rotation, centrifugal force is maximum at the equator and zero at the poles. This reduces effective gravity at the equator, making g higher at the poles.

NAT (Numerical Answer Type)

1. **Correct Answer is: (80.62 to 80.63)**
New distance between localities A and B after 1 million years is nearly accurate, but there is a small error in your final conversion from the change in distance.

Given Data: Initial distance between A and B: 80 km, Plate velocity at A: 4 cm/yr, Plate velocity at B: 5 cm/yr.

1. **Calculate the Velocity Difference**: $\Delta V = V_B - V_A = 5\ cm/yr - 4\ cm/yr = 1\ cm/yr$
2. **Convert Velocity Difference to km/yr**: $\Delta V = 1\ cm/yr = 0.00001\ km/yr$
3. **Calculate the Change in Distance Over Time**: Using $t = 1{,}000{,}000$ years:
$$\Delta D = \Delta V \times t = 0.00001\ km/yr \times 1{,}000{,}000\ years = 10\ km$$
4. **Calculate the New Distance Between A and B**: $New\ distance = Initial\ distance + \Delta D = 80\ km + 10\ km = 90\ km.$

2. **Correct Answer is: (16.3 to 16.3)** To calculate the **volume percentage** of the Earth's core relative to the **total volume** of the Earth, we can use the formula for the volume of a sphere: $V = \frac{4}{3}\pi r^3$

Let's define:

- R_e = Radius of the Earth ≈ 6371 km
- R_c = Radius of the core ≈ 3480 km (outer boundary of the core)

Step 1: Total volume of Earth $V_{Earth} = \frac{4}{3}\pi R_e^3$

Step 2: Volume of the core $V_{core} = \frac{4}{3}\pi R_c^3$

We can cancel out the common factor $\frac{4}{3}\pi$ when calculating the ratio:

$$Volume\ \%\ of\ core = \left(\frac{R_c^3}{R_e^3}\right) \times 100 = \left(\frac{3480^3}{6371^3}\right) \times 100$$
$$= \left(\frac{42.144 \times 10^9}{258.5 \times 10^9}\right) \times 100 \approx 16.3\%$$

3. **Correct Answer is: (1000)**

The **Richter scale** is a logarithmic scale, meaning that each whole number increase on the scale represents a tenfold increase in amplitude and approximately 31.6 times more energy release.

To find how much greater the intensity of an earthquake of magnitude 8 is compared to one of magnitude 5, we use the following formula: $Intensity\ ratio = 10^{(M_1 - M_2)}$

Where: M_1 is the magnitude of the larger earthquake (magnitude 8), M_2 is the magnitude of the smaller earthquake (magnitude 5).

Substituting the values: $Intensity\ ratio = 10^{(8-5)} = 10^3 = 1{,}000$

Thus, the intensity of an earthquake of magnitude 8 is **1,000 times greater** than the intensity of an earthquake of magnitude 5.

4. **Correct Answer is: (56)**

Given: Height of plateau = 6 km, Normal crust thickness = 10 km, Density of crust (ρc) = 2800 kg/m³, Density of mantle (ρm) = 3100 kg/m³, Crustal root thickness below base = r km, Acceleration due to gravity is the same, so it cancels out in equilibrium.

According to Airy's hypothesis:

The mass per unit area (or pressure) must be equal at the depth of compensation.

So,

$$Mass\ under\ plateau = Mass\ under\ normal\ crust$$
$$\Rightarrow 2800 \times (10 + 6 + r) + 3100 \times (D - r) = 2800 \times 10 + 3100 \times D$$

Here, D is the depth of compensation from the surface and cancels out. Simplifying:

$$2800 \times (16 + r) + 3100 \times (D - r)$$
$$= 2800 \times 16 + 2800r + 3100D - 3100r$$
$$= 2800 \times 10 + 3100 \times D$$

Cancel out $3100D$ from both sides:

$$44800 + 2800r - 3100r = 28000$$
$$44800 - 300r = 28000$$
$$16800 = 300r$$
$$r = \frac{16800}{300} = 56\ km$$

5. **Correct Answer is: (2.00 to 2.02)**

Formula: $F_{gravity} = \frac{GMm}{r^2} = \frac{mv^2}{r}$

Where:

- G = gravitational constant = $6.7 \times 10^{-11}\ Nm^2/kg^2$
- M = mass of the Sun (to be found)
- m = mass of the Earth (cancel out)
- r = radius of Earth's orbit = $150 \times 10^6\ km = 1.5 \times 10^{11}\ m$
- v = orbital velocity = $30 \times 10^3\ m/s$

Step-by-step Calculation:

From: $\frac{GM}{r^2} = \frac{v^2}{r} \Rightarrow M = \frac{v^2 r}{G}$

Substitute values: $M = \frac{(30\times10^3)^2 \times 1.5\times10^{11}}{6.7\times10^{-11}}$

First, compute numerator: $(30 \times 10^3)^2 = 900 \times 10^6$

$$900 \times 10^6 \times 1.5 \times 10^{11} = 1350 \times 10^{17}$$

Now, divide: $M = \frac{1350\times10^{17}}{6.7\times10^{-11}} \approx 201.49 \times 10^{28} = 2.0149 \times 10^{30}\ kg$

6. **Correct Answer is: (1 to 1)**

The image contains an explanation of how to calculate the average velocity of oceanic lithosphere. The given data includes:

- Distance from ridge: 40 km (or 4,000,000 cm)
- Age of crust: 4 million years (Ma)

The calculation for velocity is shown as:

$$Velocity = \frac{Distance}{Time} = \frac{4{,}000{,}000\ cm}{4{,}000{,}000\ years}$$
$$= 1\ cm/year$$

This demonstrates that the average velocity of the oceanic lithosphere moving away from the ridge is 1 cm/year.

7. Correct Answer is (3): The Earth's surface is divided into land and water (oceans, seas, rivers, lakes). Among these: Approximately 71% of Earth's surface is covered by water, and about 29% is land.

Of the 71% water: The vast majority (about 97%) is contained in the oceans. This means oceans alone cover about 70% of Earth's surface.

Breakdown: Total surface area of Earth ≈ 510 million km², Oceans ≈ 361 million km²

(361 / 510) × 100 ≈ 70.8%

8. Correct Answer is (2): The average velocity of tectonic plates varies depending on their location and the forces acting on them (like mantle convection, slab pull, and ridge push). Among the major tectonic plates, the Pacific Plate is known to move the fastest.

Comparison of Average Velocities (approximate)	
Plate	**Average Velocity**
Pacific Plate	7–11 cm/year (fastest)
North American Plate	~2.5 cm/year
Eurasian Plate	~2.0 cm/year
African Plate	~2.5 cm/year

Pacific Plate: Moves in a northwest direction. Driven strongly by slab pull (subduction zones around it, e.g., Japan Trench, Tonga Trench). Involved in the "Ring of Fire", indicating intense tectonic activity. Covers a vast oceanic region with active spreading centers (like the East Pacific Rise).

9. Correct Answer is (106817.0 to 106818.0):

The formula provided is for calculating the tangential velocity v of Earth in its orbit around the Sun: $v = \frac{2\pi r}{T}$

where:

- v = tangential velocity (km/hr)
- r = radius of Earth's orbit (km)
- T = orbital period (hours)
- π = 3.14

Given:

- $r = 149 \times 10^6$ km = 14,900,000 km
- $T = 365 \times 24 = 8760$ hours
- $\pi = 3.14$

Step 1: Calculate the orbit's circumference:

$$Circumference = 2\pi r = 2 \times 3.14 \times 14{,}900{,}000$$
$$\approx 93{,}532{,}000\ km$$

Step 2: Calculate the tangential velocity:

$$v = \frac{93{,}532{,}000}{8760} \approx 10{,}681.78\ km/hr$$

So, Earth's tangential velocity in its orbit around the Sun is approximately **10,681.78 km/hr**.

10. Correct Answer is: (14.35 to 14.50)

The problem involves using Snell's Law of seismic wave refraction to find the angle of refraction r in the core, given the velocities of P-waves in the lower and outer mantle, and the incident angle i.

Given:

- $i = 25°$
- $v_1 = 13.7\ km/s$
- $v_2 = 8.1\ km/s$

The law is applied as: $\frac{\sin i}{v_1} = \frac{\sin r}{v_2}$

Calculations: $sin(25°) \approx 0.4226$

Plugging into Snell's Law: $\frac{0.4226}{13.7} = \frac{\sin r}{8.1}$

Solve for $\sin r$: $\sin r = \frac{8.1 \times 0.4226}{13.7} \approx 0.2499$

- Find r: $r = sin^{-1}(0.2499) \approx 14.47°$

11. Correct Answer is: (5)

The calculation compares the surface gravity of Earth and Moon using the formula:

$$g = \frac{GM}{R^2}$$

The ratio of Earth's gravity to Moon's gravity is derived as:

$$\frac{g_E}{g_M} = \frac{M_E/R_E^2}{M_M/R_M^2} = \frac{M_E}{M_M} \times \left(\frac{R_M}{R_E}\right)^2$$

Given:

- $M_E = 80M_M$
- $R_E = 4R_M$

Substituting into the ratio: $\frac{g_E}{g_M} = 80 \times \left(\frac{1}{4}\right)^2 = 80 \times \frac{1}{16} = 5$

12. Correct Answer is: (6.15 to 6.19)

The image provides a detailed explanation of how to use the Richter magnitude scale to calculate the magnitude of an earthquake. It includes the logarithmic formula: $M = log_{10}\left(\frac{A}{A_0}\right)$

where:

- M is the magnitude,
- A is the amplitude of seismic waves,
- A_0 is a reference amplitude.

For comparing two earthquakes, the simplified formula is: $M_2 - M_1 = log_{10}\left(\frac{A_2}{A_1}\right)$

Given values are:

- $M_1 = 5$,
- $A_1 = x$,
- $A_2 = 15x$.

The specific calculation proceeds as follows:

- $M_2 - 5 = log_{10}(15)$,
- $M_2 = 5 + log_{10}(15)$,
- $log_{10}(15) \approx 1.1761$,
- Therefore, $M_2 \approx 6.1761$.

13. Correct Answer is (22.4 to 22.6): This is based on Airy isostasy principle.

Formula: h = $\frac{p_c}{p_m - p_c} \times H$

Where:

- ρ_c = 2700 kg/m^3 (crust)
- ρ_m = 3300 kg/m^3 (mantle)
- H = 5km (mountain height)

Substitute values: h = $\frac{2700}{300-2700} \times 5 = \frac{2700}{600} \times 5$ = 4.5 × 5 = 22.5km.

14. Correct Answer is (48 to 50): For a Geocentric Axial Dipole (GAD) model, the relation is: tan⍰I = 2tan⍰λ

Where:

- I = inclination
- λ = 30° (latitude)

Substitute value: tanI = 2tan30°

tan30° = 0.577

tanI = 2 × 0.577 = 1.154

Find inclination: I = tan^{-1}(1.154) ≈ 49°