SURA'S

RRB STATION MASTER

BASIC SCIENCE, MATHEMATICAL AND ANALYTICAL CAPABILITY

1. Basic Science & Mathematics

2. Data Analysis & Interpretation

LOGICAL CAPABILITY

1. Logical Reasoning

2. Reading Comprehension

MENTAL REASONING

V.V.K. Subburaj

SURA COLLEGE OF COMPETITION

Chennai

B1202

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RRB - STATION MASTER

ISBN: 978-93-6417-073-4
Code : B1202

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Printed at G.T. Krishna Press, Chennai - 600 102 and Published by
V.V.K.Subburaj for Sura College of Competition
1620, 'J' Block, 16th Main Road, Anna Nagar, Chennai - 600 040.
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RRB – STATION MASTER

COMPUTER BASED TEST (CBT)

a) Total Duration: 120 minutes

b) Total Questions: 100

c) There will be negative marking, and 1/3 mark shall be deducted for each wrong answer.

d) Normalization will be done for CBT held in multiple shifts.

The CBT is of screening nature and the standard of questions for the CBT will be generally in conformity with the educational standards prescribed for the posts. The normalized score of CBT shall be used for short listing of candidates for CBAT as per their merit.

SYLLABUS FOR CBT:

The Questions will be of objective type with multiple choices and are likely to include questions pertaining to:

1) Basic Science, Mathematical and Analytical Capability (60 Marks)

1. Basic Science & Mathematics (30 Marks): Number System, Ratio & Proportions, Averages, Percentages, Profit, Loss & Discounts, Time, Speed, Distance, Power & Work, Algebra, Linear Equations. Arithmetic Progression, LCM, HCF, Geometry and Trigonometry, Area & Volumes, Probability and Statistics (Both only Basic Level).Units, Measurements, Mass Weight and Density, Work Power, Energy, Kinetic Energy, Friction, Speed, Velocity, Relative Velocity, Heat and Temperature, Basic Electricity, Levers and Simple Machines.

2. Data Analysis & Interpretation (30 Marks): Multi-source Data Analysis – Examination, analysis and Inference drawing from text, tabular data and data represented graphically (charts, graphs, scatter plot, pie chart, statistical curve distribution, Venn Diagrams, Data Sufficiency, Data Arrangement.

2) Logical Capability (20 Marks)

1. Logical Reasoning: Binary Logic, Syllogism, Clocks & Calendars, Assumptions, Blood Relations, Family Tree, Solving logic-based puzzles.

2. Reading Comprehension: Reading Comprehension Passages and Questions would be given in English language from any subjects on History, Society, Literature, Science, Environment, Abstract, Mythology, Technology and Culture and the candidate would be required to understand and answer questions on the – Main idea, Supporting idea, Application, Logical Structure & Style of the given Paragraph.

3) Mental Reasoning (20 Marks)

Analogy – Identifying relationship between two items and applying it to another pair, Series Completion – Identifying the pattern in a sequence of numbers and predicting the next term, Solving Coding-Decoding type questions, Solving Ranking and Arrangements based problems.

It may be noted that the topics listed above are illustrative and not necessarily exhaustive.

Section Wise Distribution.

Exam Duration in Minutes	No. of Questions (each of 1mark)			Total No. of Questions
	Basic Science, Mathematical and Analytical Capability	Logical Capability	Mental Reasoning	
120	60	20	20	100

BASIC SCIENCE AND MATHEMATICS

PART I — MATHEMATICS

- Number System
- Ratio and Proportion
- Averages
- Percentages
- Profit, Loss and Discount
- Time, Speed and Distance
- Power and Work
- Algebra
- Linear Equations
- Arithmetic Progression
- LCM and HCF
- Geometry and Trigonometry
- Area and Volume
- Probability
- Statistics

PART II — BASIC SCIENCE

- Units and Measurements
- Mass, Weight and Density
- Work, Power and Energy
- Kinetic Energy
- Friction
- Speed and Velocity
- Relative Velocity
- Heat and Temperature
- Basic Electricity
- Levers
- Simple Machines

Part I — Mathematics

Chapter 1 Number System

1.1 The Structure of Numbers

A *number system* is an organised collection of numbers together with the rules for representing them and for combining them through the operations of addition, subtraction, multiplication and division. The numbers used in arithmetic are built up in stages, each stage being created to remove a limitation of the previous one.

The **natural numbers** are the counting numbers $N=\{1,2,3,\ldots\}$. They are closed under addition and multiplication, but not under subtraction, since $3-5$ is not a natural number. Including zero gives the **whole numbers** $W=\{0,1,2,3,\ldots\}$. Adjoining the negatives of the natural numbers gives the **integers** $Z=\{\ldots,-2,-1,0,1,2,\ldots\}$, which are closed under subtraction.

A **rational number** is any number that can be written in the form p/q, where p and q are integers and $q\neq 0$. The set of rational numbers, Q, is closed under all four operations, division by zero excepted. Every rational number has a decimal representation that either terminates (for example $3/8=0.375$) or repeats a block of digits indefinitely (for example $5/11=0.\overline{45}$). A fraction in lowest terms has a terminating decimal expansion if and only if the prime factors of its denominator are 2, 5 or both.

An **irrational number** is a number that cannot be expressed as a ratio of two integers. Its decimal expansion neither terminates nor repeats. Examples are $\sqrt{2}=1.41421\ldots$, $\sqrt{3}$, and $\pi=3.14159\ldots$. The rational and irrational numbers together form the **real numbers** R, which correspond one-to-one with the points of a number line. The nesting of these sets is

$$N\subset W\subset Z\subset Q\subset R. \tag{1.1}$$

1.2 Prime and Composite Numbers

A natural number greater than 1 is **prime** if its only positive divisors are 1 and itself; otherwise it is **composite**. The number 1 is neither prime nor composite. The number 2 is the only even prime. The primes below 50 are 2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, 43 and 47. Two numbers are **co-prime** when their only common positive divisor is 1, as with 8 and 15.

The **Fundamental Theorem of Arithmetic** states that every composite number can be expressed as a product of primes, and that this factorisation is unique apart from the order of the factors. Thus $360=2^3\times 3^2\times 5$. To test whether a number n is prime, it is sufficient to test divisibility by the primes not exceeding $\sqrt{n}$, because if $n=ab$ with $a\le b$, then $a\le\sqrt{n}$.

If $n=p_1^{a_1}p_2^{a_2}\cdots p_k^{a_k}$ is the prime factorisation of n, the number of positive divisors of n is

$$d(n)=(a_1+1)(a_2+1)\cdots(a_k+1). \tag{1.2}$$

This follows because each divisor is formed by choosing an exponent from 0 to a_i for each prime p_i independently.

Example 1.1 Find the number of positive divisors of 360 and determine whether 221 is prime.

Given: 360 and 221. *Required:* $d(360)$; primality of 221.

Solution: From $360=2^3\times 3^2\times 5^1$, Equation (1.2) gives $d(360)=(3+1)(2+1)(1+1)=24$. For 221, $\sqrt{221}\approx 14.9$, so the primes 2, 3, 5, 7, 11 and 13 are tested. Division by 13 gives $221=13\times 17$.

Answer: 360 has 24 divisors; 221 is composite.

1.3 Divisibility Rules

A divisibility rule is a test, based on the decimal digits of a number, that decides whether the number is divisible by a given divisor without carrying out the division. Each rule follows from the place-value expansion $N = a_k 10^k + \cdots + a_1 10 + a_0$.

Divisor	Condition on the number N	Reason
2	last digit is even	10 is divisible by 2
3	sum of digits divisible by 3	$10^k - 1$ is divisible by 3
4	number formed by last two digits divisible by 4	100 is divisible by 4
5	last digit is 0 or 5	10 is divisible by 5
8	number formed by last three digits divisible by 8	1000 is divisible by 8
9	sum of digits divisible by 9	$10^k - 1$ is divisible by 9
11	difference between sums of alternate digits is 0 or a multiple of 11	$10 \equiv -1 \pmod{11}$

A number is divisible by a composite divisor such as 6, 12 or 15 when it is divisible by each of a set of co-prime factors of that divisor. For instance, divisibility by 12 requires divisibility by both 3 and 4.

Example 1.2 Determine whether 741832 is divisible by 9 and by 11.

Solution: The digit sum is $7+4+1+8+3+2=25$, which is not a multiple of 9, so the number is not divisible by 9. For 11, the sum of digits in odd places from the right is $2+8+4=14$, and in even places is $3+1+7=11$. The difference $14-11=3$ is not a multiple of 11.

Answer: 741832 is divisible by neither 9 nor 11.

1.4 The Division Algorithm and Remainders

For any integer a and positive integer b, there exist unique integers q (quotient) and r (remainder) such that

$$a = b\,q + r,\ 0 \le r < b. \tag{1.3}$$

This statement, the **division algorithm**, underlies long division, the Euclidean method of finding the HCF (Chapter 11) and the study of remainders. Remainders behave consistently under addition and multiplication: the remainder of a sum or product, on division by b, equals the remainder of the sum or product of the individual remainders.

Example 1.3 A number when divided by 56 leaves remainder 29. Find the remainder when the same number is divided by 8.

Given: $N = 56q + 29$. *Required:* remainder of N on division by 8.

Solution: Since $56 = 8 \times 7$, the term $56q$ is divisible by 8. Hence the remainder depends only on 29, and $29 = 8 \times 3 + 5$.

Answer: The remainder is 5.

1.5 Exponents, Surds and Simplification

For a real number a and natural number n, the power a^n denotes the product of n factors each equal to a. The **laws of exponents**, valid for $a, b > 0$ and real m, n, are

$$a^m a^n = a^{m+n},\ \frac{a^m}{a^n} = a^{m-n},\ (a^m)^n = a^{mn},\ (ab)^n = a^n b^n,\ a^0 = 1,\ a^{-n} = \frac{1}{a^n}. \tag{1.4}$$

A fractional exponent represents a root: $a^{1/n} = \sqrt[n]{a}$ and $a^{m/n} = (\sqrt[n]{a})^m$. An irrational root of a rational number, such as $\sqrt{5}$ or $\sqrt[3]{2}$, is called a **surd**. Surds are simplified by extracting perfect-power factors, $\sqrt{72} = \sqrt{36 \times 2} = 6\sqrt{2}$, and a fraction with a surd denominator is **rationalised** by multiplying numerator and denominator by the conjugate surd, using $(\sqrt{a} + \sqrt{b})(\sqrt{a} - \sqrt{b}) = a - b$.

Numerical expressions are evaluated according to a fixed order of operations: brackets first, then powers and roots, then division and multiplication from left to right, and finally addition and subtraction from left to right. This convention ensures that every expression has a single value.

Example 1.4 Simplify (a) $\left(\frac{27}{8}\right)^{-2/3}$ and (b) $\frac{1}{\sqrt{5} - \sqrt{3}}$.

Solution: (a) $\left(\frac{27}{8}\right)^{-2/3} = \left(\frac{8}{27}\right)^{2/3} = \left(\frac{2}{3}\right)^2 = \frac{4}{9}$. (b) Multiplying by the conjugate, $\frac{\sqrt{5} + \sqrt{3}}{(\sqrt{5})^2 - (\sqrt{3})^2} = \frac{\sqrt{5} + \sqrt{3}}{2}$.

Answer: (a) $4/9$; (b) $(\sqrt{5} + \sqrt{3})/2$.

1.6 Conversion of Recurring Decimals

A recurring decimal can always be converted into a fraction. If $x = 0.\overline{d_1 d_2 \ldots d_k}$, with a repeating block of k digits, multiplication by 10^k shifts the decimal point past one complete block, and subtraction eliminates the infinite tail:

$$10^k x - x = d_1 d_2 \ldots d_k \Rightarrow x = \frac{d_1 d_2 \ldots d_k}{10^k - 1}. \tag{1.5}$$

When non-repeating digits precede the block, the number is first multiplied by a power of ten that moves those digits to the left of the decimal point.

Example 1.5 Express $0.4\overline{36}$ as a fraction in lowest terms.

Solution: Let $x = 0.4363636\ldots$ Then $10x = 4.363636\ldots$ and $1000x = 436.363636\ldots$ Subtracting, $990x = 432$, so $x = \frac{432}{990} = \frac{24}{55}$.

Answer: $0.4\overline{36} = 24/55$.

The ordering of real numbers allows comparison of fractions. To compare a/b and c/d with positive denominators, the cross-products are compared: $a/b > c/d$ if and only if $ad > bc$. For example, $7/9 > 11/15$ because $7 \times 15 = 105 > 9 \times 11 = 99$.

Chapter 13 Area and Volume

13.1 Perimeter and Area of Plane Figures

The **perimeter** of a closed plane figure is the length of its boundary, measured in units of length. The **area** is the measure of the region it encloses, expressed in square units; one square metre (m²) is the area of a square of side 1 m. Since $1\,\text{m} = 100\,\text{cm}$, $1\,\text{m}^2 = 10^4\,\text{cm}^2$; for land, $1\,\text{hectare} = 10^4\,\text{m}^2$.

The area of a rectangle of length l and breadth b is lb, which follows from counting unit squares. All other rectilinear area formulae are derived from it. A parallelogram can be rearranged, by cutting a right triangle from one end and moving it to the other, into a rectangle of the same base and height; hence its area is base × height. A triangle is half of a parallelogram on the same base and height. A trapezium is divided by a diagonal into two triangles of common height. The principal results are collected below.

Figure	Perimeter	Area
Rectangle (l, b)	$2(l+b)$	lb
Square (side a)	$4a$	a^2
Triangle (base b, height h)	sum of sides	$1/2\,bh$
Equilateral triangle (side a)	$3a$	$\sqrt{3}/4\,a^2$
Parallelogram (sides a, b; base b, height h)	$2(a+b)$	bh
Rhombus (side a; diagonals d_1, d_2)	$4a$	$1/2\,d_1 d_2$
Trapezium (parallel sides a, b; height h)	sum of sides	$1/2\,(a+b)h$
Circle (radius r)	$2\pi r$	πr^2

When only the three sides a, b, c of a triangle are known, its area is given by **Heron's formula**:

$$A = \sqrt{s(s-a)(s-b)(s-c)},\ s = \frac{a+b+c}{2}. \tag{13.1}$$

13.2 Circles, Sectors and Rings

The ratio of the circumference of any circle to its diameter is the constant $\pi \approx 3.14159$ (often approximated by $22/7$). A **sector** of angle θ (in degrees) is the fraction $\theta/360$ of the full circle, so

$$\text{arc length } l = \frac{\theta}{360} \times 2\pi r,\ \text{sector area} = \frac{\theta}{360} \times \pi r^2 = \frac{1}{2} lr. \tag{13.2}$$

The region between two concentric circles of radii R and r is a **ring** (annulus) of area $\pi(R^2 - r^2)$. A wheel of radius r advances a distance $2\pi r$ in one revolution, so the number of revolutions required to cover a distance D is $D/(2\pi r)$.

Example 13.1 Find the area of a triangle with sides 13 cm, 14 cm and 15 cm.

Solution: $s = 21$. By Equation (13.1), $A = \sqrt{21 \times 8 \times 7 \times 6} = \sqrt{7056} = 84$ cm².

Answer: 84 cm².

Example 13.2 The wheel of a locomotive has a diameter of 1.4 m. How many revolutions does it make in covering 22 km? (Take $\pi = 22/7$.)

Solution: Circumference = $\pi d = 22/7 \times 1.4 = 4.4$ m. Revolutions = $22000/4.4 = 5000$.

Answer: 5000 revolutions.

Example 13.3 Find the area of a sector of a circle of radius 21 cm with central angle 120°. (Take $\pi = 22/7$.)

Solution: By Equation (13.2), area = $\frac{120}{360} \times \frac{22}{7} \times 21^2 = \frac{1}{3} \times 1386 = 462$ cm².

Answer: 462 cm².

13.3 Surface Area and Volume of Solids

A solid occupies a region of three-dimensional space. Its **volume** is the measure of that region in cubic units, and its **surface area** is the total area of its bounding surfaces. The **lateral** or **curved surface area** (CSA) excludes the top and bottom faces, while the **total surface area** (TSA) includes them. Since $1\,\text{m} = 100\,\text{cm}$, $1\,\text{m}^3 = 10^6\,\text{cm}^3$, and $1\,\text{litre} = 1000\,\text{cm}^3$, so that $1\,\text{m}^3 = 1000$ litres.

For any **right prism** or **cylinder** of uniform cross-section, the volume equals the area of the base multiplied by the height, because the solid may be regarded as a stack of identical thin layers. The curved surface of a cylinder unrolls into a rectangle of length $2\pi r$ and breadth h. A **cone** has one-third of the volume of a cylinder with the same base and height, and a **pyramid** has one-third of the volume of the corresponding prism. The curved surface of a cone unrolls into a sector of radius equal to the slant height $l = \sqrt{r^2 + h^2}$.

Solid	Curved / lateral surface	Total surface area	Volume
Cuboid (l, b, h)	$2h(l+b)$	$2(lb+bh+hl)$	lbh
Cube (edge a)	$4a^2$	$6a^2$	a^3
Cylinder (r, h)	$2\pi rh$	$2\pi r(r+h)$	$\pi r^2 h$
Cone (r, h, l)	πrl	$\pi r(l+r)$	$1/3\,\pi r^2 h$
Sphere (r)	$4\pi r^2$	$4\pi r^2$	$4/3\,\pi r^3$
Hemisphere (r)	$2\pi r^2$	$3\pi r^2$	$2/3\,\pi r^3$

The diagonal of a cuboid is $\sqrt{l^2+b^2+h^2}$, obtained by applying the Pythagorean theorem twice. For a hollow cylinder of external radius R and internal radius r, the volume of material is $\pi(R^2 - r^2)h$.

Example 13.4 A cylindrical water tank has internal diameter 2.8 m and height 3 m. Find its capacity in litres. (Take $\pi = 22/7$.)

Solution: $V = \pi r^2 h = 22/7 \times 1.4^2 \times 3 = 22/7 \times 1.96 \times 3 = 18.48$ m³. Capacity = $18.48 \times 1000 = 18480$ litres.

Answer: 18,480 litres.

Example 13.5 A cone has base radius 6 cm and height 8 cm. Find its slant height, curved surface area and volume, in terms of π.

Solution: $l = \sqrt{36+64} = 10$ cm. CSA = $\pi rl = 60\pi$ cm². $V = 1/3\,\pi \times 36 \times 8 = 96\pi$ cm³.

Answer: $l = 10$ cm; CSA = $60\pi \approx 188.5$ cm²; $V = 96\pi \approx 301.6$ cm³.

Example 13.6 A solid metal sphere of radius 6 cm is melted and recast into a cylindrical wire of radius 0.2 cm. Find the length of the wire.

Solution: Volume is conserved: $4/3\,\pi(6)^3=\pi(0.2)^2 L$. Thus $288\,\pi=0.04\,\pi\,L$ and $L=7200$ cm.

Answer: 72 m.

13.4 Effect of Change of Dimensions

Since area involves two dimensions and volume three, scaling every linear dimension of a figure by a factor k multiplies its area by k^2 and its volume by k^3. If the radius of a sphere is doubled, its surface area becomes four times and its volume eight times as great. In percentage terms, an increase of $r\%$ in each side of a square increases its area by $2r+r^2/100\%$, which is Equation (4.4) applied with equal successive changes.

Example 13.7 The radius of a cylinder is increased by 10% and its height is decreased by 10%. Find the percentage change in volume.

Solution: $V \propto r^2 h$, so the multiplying factor is $(1.1)^2 \times 0.9 = 1.21 \times 0.9 = 1.089$.

Answer: The volume increases by 8.9%.

Chapter 14 Probability

14.1 Random Experiments and Events

Probability is the numerical measure of the likelihood that an event will occur. It applies to a **random experiment**: an operation which can be repeated under identical conditions, whose possible outcomes are known in advance, but whose actual outcome on any one trial cannot be predicted with certainty. Tossing a coin, throwing a die and drawing a card from a well-shuffled pack are random experiments.

The set of all possible outcomes is the **sample space** S, and each outcome is a *sample point*. An **event** E is any subset of the sample space. For a throw of a single die, $S=\{1,2,3,4,5,6\}$ and the event "an even number" is $E=\{2,4,6\}$. An event with a single outcome is an *elementary event*. The event S itself is the **sure event**, and the empty set $\varnothing$ is the **impossible event**. Two events are **mutually exclusive** if they cannot occur together, that is, if they have no outcome in common. Outcomes are **equally likely** if, by symmetry or by construction, none is expected in preference to any other.

14.2 Classical Definition of Probability

If a random experiment has n equally likely, mutually exclusive and exhaustive outcomes, of which m are favourable to an event E, the probability of E is

$$P(E)=\frac{m}{n}=\frac{\text{number of outcomes favourable to } E}{\text{total number of possible outcomes}}. \tag{14.1}$$

Since $0\le m\le n$, it follows that $0\le P(E)\le 1$, with $P(\varnothing)=0$ and $P(S)=1$. The **complementary event** $\acute{E}$ ("not E") consists of all outcomes not in E; since its favourable outcomes number $n-m$,

$$P(\acute{E})=1-P(E). \tag{14.2}$$

The complement rule is particularly useful when "at least one" of several outcomes is required, since the complement "none" is often easier to count.

The classical definition relies on equally likely outcomes. The **empirical** or **experimental probability** of an event is the ratio of the number of trials in which it occurs to the total number of trials. As the number of trials increases, the empirical probability tends to approach the classical value, a fact that gives the classical definition its practical meaning.

14.3 The Addition Rule

For two events A and B, the outcomes favourable to "A or B" are those in A together with those in B; counting both sets counts the common outcomes twice. Hence

$$P(A\cup B)=P(A)+P(B)-P(A\cap B). \tag{14.3}$$

When A and B are mutually exclusive, $P(A\cap B)=0$, and the rule reduces to $P(A\cup B)=P(A)+P(B)$.

14.4 Standard Sample Spaces

Coins. A single toss has $S=\{H,T\}$. With k coins tossed together, there are 2^k equally likely outcomes; for two coins, $S=\{HH,HT,TH,TT\}$.

Dice. A single die has 6 outcomes. When two dice are thrown, there are $6\times 6=36$ ordered outcomes (i,j). The number of ways of obtaining each sum is 1, 2, 3, 4, 5, 6, 5, 4, 3, 2, 1 for sums 2 to 12 respectively; a sum of 7 is the most likely.

fuse is a short wire of low melting point placed in series with a circuit, which melts and breaks the circuit when the current exceeds a safe value.

The **electrical energy** consumed by an appliance of power P in time t is $E = Pt$. Commercially, energy is measured in kilowatt-hours, the "unit" on electricity bills: $1\,\text{kWh} = 3.6 \times 10^6$ J (Section 18.3). The power rating of an appliance, such as "1000 W, 230 V", specifies the power it draws when operated at the rated voltage; its resistance is $R = V^2/P$.

Example 24.3 An electric heater is rated 2000 W, 230 V. Find the current it draws, its resistance, and the cost of using it for 3 hours a day for 30 days at ₹ 6 per kWh.

Solution: $I = P/V = 2000/230 \approx 8.70$ A. $R = V^2/P = 52900/2000 = 26.45\,\Omega$. Energy = $2\,\text{kW} \times 3\,\text{h} \times 30 = 180$ kWh. Cost = $180 \times 6 = 1080$.

Answer: About 8.7 A; 26.45 Ω; ₹ 1,080.

Example 24.4 Two lamps rated 100 W and 60 W at 220 V are connected (a) in parallel and (b) in series across a 220 V supply. Which glows more brightly in each case?

Solution: Resistances: $R_{100} = 220^2/100 = 484\,\Omega$; $R_{60} = 220^2/60 \approx 807\,\Omega$. (a) In parallel each receives 220 V and dissipates its rated power, so the 100 W lamp is brighter. (b) In series the same current flows, and by $P = I^2R$ the lamp of greater resistance dissipates more power.

Answer: (a) the 100 W lamp; (b) the 60 W lamp.

Chapter 25 Levers

25.1 Moment of a Force

A force applied to a body pivoted about a fixed axis tends to rotate it. The turning effect of the force is called its **moment** or **torque**. The moment of a force F about a point O is the product of the force and the perpendicular distance d from O to its line of action:

$$\tau = F \times d. \tag{25.1}$$

The SI unit of moment is the newton metre (N m). Although this has the same dimensions as the joule, moment is a different physical quantity and is never expressed in joules. A moment is described as clockwise or anticlockwise according to the sense of rotation it tends to produce. The perpendicular distance d is the **moment arm**; a door is opened most easily by pushing at the edge farthest from the hinges, perpendicular to the door, because the moment arm is then greatest.

25.2 The Principle of Moments

A rigid body is in **equilibrium** when it has no tendency either to translate or to rotate. Two conditions must be satisfied: the vector sum of all forces acting on it must be zero, and the sum of the moments of all forces about any point must be zero. The second condition is the **principle of moments**:

$$\sum \text{clockwise moments} = \sum \text{anticlockwise moments}. \tag{25.2}$$

The principle underlies the beam balance, the see-saw and every type of lever. The weight of a body may be regarded as acting at a single point, its **centre of gravity**; for a uniform rod, this lies at its mid-point.

Example 25.1 A uniform metre rule of weight 1.2 N is pivoted at the 40 cm mark. Where must a weight of 2 N be hung for the rule to balance horizontally?

Solution: The weight of the rule acts at 50 cm, 10 cm to the right of the pivot, producing a clockwise moment $1.2 \times 0.10 = 0.12$ N m. The 2 N weight must be on the left at distance x: $2x = 0.12$, so $x = 0.06$ m.

Answer: At 6 cm to the left of the pivot, i.e. at the 34 cm mark.

25.3 The Lever

A **lever** is a rigid bar free to turn about a fixed point called the **fulcrum**. A force applied to the lever to do useful work is the **effort** E, and the force it overcomes is the **load** L. The perpendicular distances from the fulcrum to the lines of action of the effort and load are the **effort arm** d_E and **load arm** d_L. For an ideal (weightless, frictionless) lever in equilibrium, the principle of moments gives $E \times d_E = L \times d_L$, so the **mechanical advantage** is

$$\text{MA} = \frac{L}{E} = \frac{d_E}{d_L}. \tag{25.3}$$

This relation is called the **law of the lever**. A lever magnifies force when the effort arm exceeds the load arm, but the effort must then move through a correspondingly greater distance. Since the effort and load move through arcs proportional to their arms, the **velocity ratio** of a lever is also d_E/d_L. A lever cannot give more work than is put into it.

25.4 Classes of Levers

Levers are classified by the relative positions of the fulcrum (F), load (L) and effort (E).

First class. The fulcrum lies between the effort and the load (E–F–L). The mechanical advantage may be greater than, equal to or less than 1, depending on the relative arm lengths. Examples are a see-saw, a

beam balance, a pair of scissors, pliers, a crowbar used to raise a stone, and a railway semaphore signal lever.

Second class. The load lies between the fulcrum and the effort (F–L–E). The effort arm is always longer than the load arm, so the mechanical advantage is always greater than 1, and such levers are force multipliers. Examples are a wheelbarrow, a nutcracker, a bottle opener and a lemon squeezer.

Third class. The effort lies between the fulcrum and the load (F–E–L). The effort arm is always shorter than the load arm, so the mechanical advantage is always less than 1. Such levers sacrifice force to gain speed and range of movement. Examples are a pair of tongs, tweezers, a fishing rod, a broom in use, and the human forearm, in which the biceps applies the effort between the elbow (fulcrum) and the hand (load).

Class	Arrangement	Mechanical advantage	Examples
First	fulcrum between effort and load	> 1, $= 1$ or < 1	see-saw, scissors, crowbar
Second	load between fulcrum and effort	always > 1	wheelbarrow, nutcracker
Third	effort between fulcrum and load	always < 1	tongs, forearm, fishing rod

Example 25.2 A crowbar 1.5 m long is used to lift a stone weighing 900 N. The fulcrum is placed 0.25 m from the end in contact with the stone. Find the minimum effort required at the other end and the mechanical advantage.

Given: $L = 900$ N, $d_L = 0.25$ m, $d_E = 1.5 - 0.25 = 1.25$ m. *Required:* E, MA.

Solution: By Equation (25.3), MA = $1.25/0.25 = 5$, so $E = 900/5 = 180$ N.

Answer: 180 N; MA = 5.

Example 25.3 In a wheelbarrow, the load of 600 N acts at 0.4 m from the axle (fulcrum), and the handles are 1.2 m from the axle. Find the upward effort required.

Solution: $E \times 1.2 = 600 \times 0.4$, so $E = 200$ N. MA = 3.

Answer: 200 N.

Example 25.4 In the human forearm, the biceps is attached 4 cm from the elbow joint, and a 5 kg mass is held in the hand 32 cm from the joint. Find the force exerted by the biceps, neglecting the weight of the forearm. ($g = 10\ \text{m s}^{-2}$.)

Solution: Load = 50 N. $E \times 0.04 = 50 \times 0.32$, so $E = 400$ N. MA = $50/400 = 0.125$.

Answer: 400 N; the forearm, a third-class lever, multiplies distance and speed eight-fold at the cost of force.

Chapter 26 Simple Machines

26.1 Machines and Their Purpose

A **machine** is a device that receives energy in one form and delivers it in a more convenient form to perform a desired task. A **simple machine** is a device with few or no moving parts that changes the magnitude, direction or point of application of a force. The six classical simple machines are the **lever**, the **wheel and axle**, the **pulley**, the **inclined plane**, the **wedge** and the **screw**. All complex machines are combinations of these. A simple machine may act as a *force multiplier*, allowing a small effort to overcome a large load; as a *speed multiplier*, allowing a small movement of the effort to produce a larger and faster movement of the load; or as a means of changing the direction of a force to a more convenient one.

26.2 Mechanical Advantage, Velocity Ratio and Efficiency

The performance of a machine is described by three quantities.

The **mechanical advantage** (MA) is the ratio of the load to the effort:

$$\text{MA} = \frac{L}{E}. \tag{26.1}$$

The **velocity ratio** (VR) is the ratio of the distance moved by the effort to the distance moved by the load in the same time:

$$\text{VR} = \frac{d_E}{d_L}. \tag{26.2}$$

The velocity ratio depends only on the geometry of the machine, whereas the mechanical advantage depends also on friction and on the weight of moving parts.

The **efficiency** η is the ratio of the useful work output to the work input:

$$\eta = \frac{\text{work output}}{\text{work input}} = \frac{L\,d_L}{E\,d_E} = \frac{\text{MA}}{\text{VR}}. \tag{26.3}$$

Efficiency is usually expressed as a percentage. In an **ideal machine**, free from friction and with weightless parts, no energy is lost, $\eta = 100\,\%$ and $\text{MA} = \text{VR}$. In every practical machine, some work input is spent against friction and in lifting moving parts, so $\eta < 100\,\%$ and $\text{MA} < \text{VR}$. This is a direct consequence of the conservation of energy (Section 18.5): a machine may multiply force, but never work.

26.3 The Inclined Plane, Wedge and Screw

An **inclined plane** is a sloping surface used to raise a load with an effort smaller than its weight. If a load L is pushed up a frictionless plane of length l to a height h by an effort parallel to the plane, the effort moves through l while the load rises through h. Hence

$$\text{VR} = \frac{l}{h} = \frac{1}{\sin\theta}, \tag{26.4}$$

where θ is the angle of inclination. A gentle slope requires a smaller effort applied through a longer distance. Ramps, sloping roads in hilly regions and the gradients of railway lines are inclined planes; the ruling gradient of a railway limits the load a locomotive can haul.

A **wedge** is a pair of inclined planes placed back to back, used to split or separate objects; an axe, a knife and a chisel are wedges. A **screw** is an inclined plane wrapped round a cylinder. When a screw jack with a

329. In a right triangle ABC right-angled at B, $AB = 5$ cm and $\angle ACB = 30^\circ$. The length of AC is
(A) $5\sqrt{3}$ cm (B) $\frac{10}{\sqrt{3}}$ cm (C) 10 cm (D) 2.5 cm
Answer: (C) 10 cm
Explanation: AB is the side opposite $\angle C$ and AC is the hypotenuse. $\sin 30^\circ = \frac{AB}{AC}$, so $AC = \frac{5}{1/2} = 10$ cm.

330. If $\tan\theta + \cot\theta = 2$, then $\tan^2\theta + \cot^2\theta$ is
(A) 4 (B) 0 (C) 1 (D) 2
Answer: (D) 2
Explanation: Square both sides: $\tan^2\theta + 2\tan\theta\cot\theta + \cot^2\theta = 4$. Since $\tan\theta\cot\theta = 1$, $\tan^2\theta + \cot^2\theta = 4 - 2 = 2$.

CHAPTER 13 30 QUESTIONS · Q.331–360
AREA AND VOLUMES

331. The area of a square whose perimeter is 48 cm is
(A) 144 cm^2 (B) 96 cm^2 (C) 196 cm^2 (D) 48 cm^2
Answer: (A) 144 cm^2
Explanation: Side $= \frac{\text{Perimeter}}{4} = \frac{48}{4} = 12$ cm. Area $=$ side$^2 =$ 144 cm^2.

332. A rectangular plot measures 24 m by 15 m. The cost of fencing it at ₹12 per metre is
(A) ₹468 (B) ₹4,320 (C) ₹936 (D) ₹1,872
Answer: (C) ₹936
Explanation: Perimeter $= 2(l+b) = 2(24+15) = 78$ m. Cost $= 78 \times 12 =$ ₹936.

333. The area of a triangle with base 18 cm and height 11 cm is
(A) 198 cm^2 (B) 29 cm^2 (C) 49.5 cm^2 (D) 99 cm^2
Answer: (D) 99 cm^2
Explanation: Area $= \frac{1}{2} \times$ base $\times$ height $= \frac{1}{2} \times 18 \times 11 = 99$ cm^2.

334. The area of a triangle with sides 13 cm, 14 cm and 15 cm is
(A) 91 cm^2 (B) 105 cm^2 (C) 84 cm^2 (D) 72 cm^2
Answer: (C) 84 cm^2
Explanation: Heron's formula: $s = \frac{13+14+15}{2} = 21$. Area $= \sqrt{s(s-a)(s-b)(s-c)} = \sqrt{21 \times 8 \times 7 \times 6} = \sqrt{7056} = 84$ cm^2.

335. The area of an equilateral triangle of side 8 cm is
(A) $32\sqrt{3}$ cm^2 (B) $64\sqrt{3}$ cm^2 (C) $16\sqrt{3}$ cm^2 (D) $8\sqrt{3}$ cm^2
Answer: (C) $16\sqrt{3}$ cm^2
Explanation: Area of an equilateral triangle $= \frac{\sqrt{3}}{4}a^2 = \frac{\sqrt{3}}{4} \times 64 = 16\sqrt{3}$ cm^2.

336. The area of a parallelogram with base 15 cm and corresponding height 8 cm is
(A) 60 cm^2 (B) 46 cm^2 (C) 240 cm^2 (D) 120 cm^2
Answer: (D) 120 cm^2
Explanation: Area of a parallelogram $=$ base $\times$ height $= 15 \times 8 = 120$ cm^2.

337. The area of a rhombus whose diagonals are 18 cm and 14 cm is
(A) 252 cm^2 (B) 64 cm^2 (C) 126 cm^2 (D) 32 cm^2
Answer: (C) 126 cm^2
Explanation: Area of a rhombus $= \frac{1}{2}d_1d_2 = \frac{1}{2} \times 18 \times 14 = 126$ cm^2.

338. The parallel sides of a trapezium are 20 cm and 12 cm and the distance between them is 7 cm. Its area is
(A) 224 cm^2 (B) 84 cm^2 (C) 140 cm^2 (D) 112 cm^2
Answer: (D) 112 cm^2
Explanation: Area of a trapezium $= \frac{1}{2}(a+b)h = \frac{1}{2}(20+12) \times 7 = 16 \times 7 = 112$ cm^2.

339. The area of a circle of radius 21 cm is $\left(\pi = \frac{22}{7}\right)$
(A) 132 cm^2 (B) 1386 cm^2 (C) 693 cm^2 (D) 2772 cm^2
Answer: (B) 1386 cm^2
Explanation: Area $= \pi r^2 = \frac{22}{7} \times 21 \times 21 = 22 \times 3 \times 21 = 1386$ cm^2.

340. The perimeter of a semicircular plate of diameter 14 cm is $\left(\pi = \frac{22}{7}\right)$
(A) 36 cm (B) 22 cm (C) 44 cm (D) 29 cm
Answer: (A) 36 cm
Explanation: Perimeter of a semicircle $= \pi r + 2r$ (curved edge plus diameter). With $r = 7$: $22 + 14 = 36$ cm.

341. The area of a sector of a circle of radius 21 cm with central angle 60° is $\left(\pi = \frac{22}{7}\right)$
(A) 462 cm^2 (B) 231 cm^2 (C) 22 cm^2 (D) 1386 cm^2
Answer: (B) 231 cm^2
Explanation: Area of sector $= \frac{\theta}{360^\circ} \times \pi r^2 = \frac{60}{360} \times 1386 = 231$ cm^2.

342. A path 2 m wide runs around the outside of a rectangular garden 30 m by 20 m. The area of the path is
(A) 200 m^2 (B) 208 m^2 (C) 216 m^2 (D) 816 m^2
Answer: (C) 216 m^2
Explanation: Outer rectangle $= (30+4) \times (20+4) = 34 \times 24 = 816$ m^2. Garden $= 600$ m^2. Area of path $= 816 - 600 = 216$ m^2.

343. A wheel of radius 35 cm rolls without slipping. The number of revolutions it makes in covering 1.1 km is $\left(\pi = \frac{22}{7}\right)$
(A) 250 (B) 1000 (C) 550 (D) 500
Answer: (D) 500
Explanation: Circumference $= 2\pi r = 2 \times \frac{22}{7} \times 35 = 220$ cm. Distance $= 1.1$ km $= 110000$ cm. Revolutions $= \frac{110000}{220} = 500$.

344. The area of a square whose diagonal is 10 cm is
(A) 100 cm^2 (B) 25 cm^2 (C) 40 cm^2 (D) 50 cm^2
Answer: (D) 50 cm^2
Explanation: Area of a square $= \frac{d^2}{2} = \frac{100}{2} = 50$ cm^2. (Side $= \frac{10}{\sqrt{2}} = 5\sqrt{2}$ cm, and $(5\sqrt{2})^2 = 50$.)

345. The volume of a cube of edge 6 cm is
(A) 36 cm^3 (B) 216 cm^3 (C) 432 cm^3 (D) 72 cm^3
Answer: (B) 216 cm^3
Explanation: Volume of a cube $= a^3 = 6^3 = 216\ cm^3$. Volume is measured in cubic units.

346. The total surface area of a cuboid measuring 8 cm × 6 cm × 5 cm is
(A) 240 cm^2 (B) 236 cm^2 (C) 118 cm^2 (D) 140 cm^2
Answer: (B) 236 cm^2
Explanation: TSA $= 2(lb + bh + hl) = 2(48 + 30 + 40) = 2 \times 118 = 236\ cm^2$.

347. The length of the longest rod that can be placed in a box 12 cm × 4 cm × 3 cm is
(A) 13 cm (B) 19 cm (C) 12 cm (D) 15 cm
Answer: (A) 13 cm
Explanation: The longest rod lies along the diagonal: $d = \sqrt{l^2 + b^2 + h^2} = \sqrt{144 + 16 + 9} = \sqrt{169} = 13$ cm.

348. The volume of a cylinder of radius 7 cm and height 10 cm is $\left(\pi = \frac{22}{7}\right)$
(A) 440 cm^3 (B) 3080 cm^3 (C) 1540 cm^3 (D) 220 cm^3
Answer: (C) 1540 cm^3
Explanation: $V = \pi r^2 h = \frac{22}{7} \times 49 \times 10 = 1540\ cm^3$.

349. The curved surface area of a cylinder of radius 7 cm and height 10 cm is $\left(\pi = \frac{22}{7}\right)$
(A) 440 cm^2 (B) 1540 cm^2 (C) 748 cm^2 (D) 220 cm^2
Answer: (A) 440 cm^2
Explanation: CSA $= 2\pi rh = 2 \times \frac{22}{7} \times 7 \times 10 = 440\ cm^2$. (Adding the two ends gives the TSA, 748 cm^2.)

350. The curved surface area of a cone of radius 6 cm and height 8 cm is
(A) 48π cm^2 (B) 96π cm^2 (C) 60π cm^2 (D) 36π cm^2
Answer: (C) 60π cm^2
Explanation: Slant height $l = \sqrt{r^2 + h^2} = \sqrt{36 + 64} = 10$ cm. CSA $= \pi rl = \pi \times 6 \times 10 = 60\pi\ cm^2$.

351. The volume of a cone of radius 7 cm and height 12 cm is $\left(\pi = \frac{22}{7}\right)$
(A) 1848 cm^3 (B) 616 cm^3 (C) 308 cm^3 (D) 528 cm^3
Answer: (B) 616 cm^3
Explanation: $V = \frac{1}{3}\pi r^2 h = \frac{1}{3} \times \frac{22}{7} \times 49 \times 12 = 616\ cm^3$.

352. The volume of a sphere of radius 21 cm is $\left(\pi = \frac{22}{7}\right)$
(A) 38808 cm^3 (B) 5544 cm^3 (C) 19404 cm^3 (D) 29106 cm^3
Answer: (A) 38808 cm^3
Explanation: $V = \frac{4}{3}\pi r^3 = \frac{4}{3} \times \frac{22}{7} \times 9261 = \frac{4 \times 22 \times 1323}{3} = 38808\ cm^3$.

353. The total surface area of a solid hemisphere of radius 7 cm is $\left(\pi = \frac{22}{7}\right)$
(A) 462 cm^2 (B) 308 cm^2 (C) 616 cm^2 (D) 154 cm^2
Answer: (A) 462 cm^2
Explanation: TSA of a solid hemisphere = curved surface $2\pi r^2$ + flat base $\pi r^2 = 3\pi r^2 = 3 \times \frac{22}{7} \times 49 = 462\ cm^2$.

354. The surface area of a sphere is 616 cm^2. Its radius is $\left(\pi = \frac{22}{7}\right)$
(A) 14 cm (B) 3.5 cm (C) 49 cm (D) 7 cm
Answer: (D) 7 cm
Explanation: $4\pi r^2 = 616$ gives $r^2 = \frac{616 \times 7}{4 \times 22} = 49$, so $r = 7$ cm.

355. A tank measures 3 m × 2 m × 1.5 m. Its capacity in litres is
(A) 900 L (B) 90,000 L (C) 9,000 L (D) 6,500 L
Answer: (C) 9,000 L
Explanation: Volume $= 3 \times 2 \times 1.5 = 9\ m^3$. Since 1 $m^3 = 1000$ L, capacity = 9000 L.

356. A rectangular field measures 250 m by 160 m. Its area in hectares is
(A) 40 ha (B) 4 ha (C) 0.4 ha (D) 400 ha
Answer: (B) 4 ha
Explanation: Area $= 250 \times 160 = 40000\ m^2$. Since 1 hectare $= 10000\ m^2$, area = 4 hectares.

357. Three solid cubes of edges 3 cm, 4 cm and 5 cm are melted and recast into a single cube. The edge of the new cube is
(A) 12 cm (B) 7 cm (C) 8 cm (D) 6 cm
Answer: (D) 6 cm
Explanation: Volume is conserved: $3^3 + 4^3 + 5^3 = 27 + 64 + 125 = 216\ cm^3$. Edge $= \sqrt[3]{216} = 6$ cm.

358. A figure consists of a square of side 14 cm with a semicircle drawn outward on one side as diameter. The area of the figure is $\left(\pi = \frac{22}{7}\right)$
(A) 273 cm^2 (B) 350 cm^2 (C) 245 cm^2 (D) 196 cm^2
Answer: (A) 273 cm^2
Explanation: Area = square + semicircle $= 14^2 + \frac{1}{2}\pi r^2$ with $r = 7$: $196 + \frac{1}{2} \times \frac{22}{7} \times 49 = 196 + 77 = 273\ cm^2$.

359. A cylinder and a cone have equal base radii and equal heights. The ratio of their volumes is
(A) 1 : 3 (B) 3 : 1 (C) 2 : 1 (D) 1 : 1
Answer: (B) 3 : 1
Explanation: $V_{cylinder} = \pi r^2 h$ and $V_{cone} = \frac{1}{3}\pi r^2 h$. Ratio $= 1 : \frac{1}{3} = 3 : 1$.

360. How many spherical bullets of radius 1 cm can be made by melting a solid cylinder of radius 4 cm and height 12 cm?
(A) 192 (B) 48 (C) 96 (D) 144
Answer: (D) 144
Explanation: Number $= \frac{\text{volume of cylinder}}{\text{volume of one bullet}} = \frac{\pi \times 16 \times 12}{\frac{4}{3}\pi \times 1^3} = \frac{192 \times 3}{4} = 144$.

CHAPTER 14 — 20 QUESTIONS · Q.361–380

PROBABILITY

361. Which of the following cannot be the probability of an event?

(A) 1.2 (B) 0 (C) 0.7 (D) $\frac{2}{3}$

Answer: (A) 1.2

Explanation: For any event E, $0 \le P(E) \le 1$. The value 1.2 exceeds 1, so it cannot be a probability.

362. When three coins are tossed together, the number of outcomes in the sample space is

(A) 6 (B) 3 (C) 9 (D) 8

Answer: (D) 8

Explanation: Each coin has 2 equally likely outcomes. For 3 coins the sample space has $2^3 = 8$ outcomes: HHH, HHT, HTH, THH, HTT, THT, TTH, TTT.

363. A die is thrown once. The probability of getting a number greater than 4 is

(A) $\frac{1}{2}$ (B) $\frac{2}{3}$ (C) $\frac{1}{3}$ (D) $\frac{1}{6}$

Answer: (C) $\frac{1}{3}$

Explanation: Total outcomes = 6. Favourable outcomes = $\{5,6\}$, i.e. 2. $P = \frac{2}{6} = \frac{1}{3}$.

364. If $P(E) = 0.35$, then $P(\text{not } E)$ is

(A) 0.35 (B) 1.35 (C) 0.53 (D) 0.65

Answer: (D) 0.65

Explanation: For complementary events, $P(E) + P(\bar{E}) = 1$. So $P(\bar{E}) = 1 - 0.35 = 0.65$.

365. A card is drawn at random from a well-shuffled pack of 52 cards. The probability that it is a king is

(A) $\frac{1}{52}$ (B) $\frac{1}{13}$ (C) $\frac{1}{4}$ (D) $\frac{4}{13}$

Answer: (B) $\frac{1}{13}$

Explanation: There are 4 kings in 52 cards. $P(\text{king}) = \frac{4}{52} = \frac{1}{13}$.

366. Two coins are tossed together. The probability of getting at least one head is

(A) $\frac{1}{2}$ (B) $\frac{3}{4}$ (C) $\frac{1}{4}$ (D) 1

Answer: (B) $\frac{3}{4}$

Explanation: Sample space = $\{HH, HT, TH, TT\}$. At least one head: HH, HT, TH, i.e. 3 outcomes. $P = \frac{3}{4}$. (Equivalently, $1 - P(TT) = 1 - \frac{1}{4}$.)

367. A card is drawn from a pack of 52 cards. The probability that it is a red face card is

(A) $\frac{3}{13}$ (B) $\frac{1}{26}$ (C) $\frac{6}{13}$ (D) $\frac{3}{26}$

Answer: (D) $\frac{3}{26}$

Explanation: Face cards are J, Q, K. There are 2 red suits with 3 face cards each, so 6 red face cards. $P = \frac{6}{52} = \frac{3}{26}$.

368. A bag contains 5 red, 3 blue and 2 green balls. One ball is drawn at random. The probability that it is not red is

(A) $\frac{3}{10}$ (B) $\frac{1}{5}$ (C) $\frac{1}{2}$ (D) $\frac{2}{5}$

Answer: (C) $\frac{1}{2}$

Explanation: Total balls = 10; not red = 3 + 2 = 5. $P(\text{not red}) = \frac{5}{10} = \frac{1}{2}$.

369. Two dice are thrown together. The probability that the sum of the numbers is 7 is

(A) $\frac{7}{36}$ (B) $\frac{5}{36}$ (C) $\frac{1}{6}$ (D) $\frac{1}{12}$

Answer: (C) $\frac{1}{6}$

Explanation: Total outcomes = 36. Sum 7: (1,6), (2,5), (3,4), (4,3), (5,2), (6,1), i.e. 6 outcomes. $P = \frac{6}{36} = \frac{1}{6}$.

370. Two dice are thrown together. The probability that the sum of the numbers is 10 is

(A) $\frac{1}{12}$ (B) $\frac{1}{18}$ (C) $\frac{5}{36}$ (D) $\frac{1}{9}$

Answer: (A) $\frac{1}{12}$

Explanation: Total outcomes = 36. Sum 10: (4,6), (5,5), (6,4), i.e. 3 outcomes. $P = \frac{3}{36} = \frac{1}{12}$.

371. Three coins are tossed together. The probability of getting exactly two heads is

(A) $\frac{1}{4}$ (B) $\frac{1}{2}$ (C) $\frac{7}{8}$ (D) $\frac{3}{8}$

Answer: (D) $\frac{3}{8}$

Explanation: Total outcomes = 8. Exactly two heads: HHT, HTH, THH, i.e. 3 outcomes. $P = \frac{3}{8}$.

372. A number is chosen at random from 1 to 30. The probability that it is a prime number is

(A) $\frac{3}{10}$ (B) $\frac{1}{3}$ (C) $\frac{11}{30}$ (D) $\frac{2}{5}$

Answer: (B) $\frac{1}{3}$

Explanation: Primes up to 30: 2, 3, 5, 7, 11, 13, 17, 19, 23, 29, i.e. 10 numbers. $P = \frac{10}{30} = \frac{1}{3}$.

373. A card is drawn from a pack of 52 cards. The probability that it is a spade or an ace is

(A) $\frac{4}{13}$ (B) $\frac{17}{52}$ (C) $\frac{1}{4}$ (D) $\frac{5}{13}$

Answer: (A) $\frac{4}{13}$

Explanation: Spades = 13, aces = 4, and the ace of spades is counted in both. Favourable = 13 + 4 − 1 = 16. $P = \frac{16}{52} = \frac{4}{13}$.

374. A die is thrown once. The probability of getting an even prime number is

(A) $\frac{1}{2}$ (B) $\frac{1}{6}$ (C) $\frac{1}{3}$ (D) 0

Answer: (B) $\frac{1}{6}$

Explanation: The only even prime is 2. Favourable outcomes = 1 out of 6. $P = \frac{1}{6}$.

375. The probability that a leap year selected at random contains 53 Sundays is

(A) $\frac{2}{7}$ (B) $\frac{1}{7}$ (C) $\frac{53}{366}$ (D) $\frac{3}{7}$

Answer: (A) $\frac{2}{7}$

Explanation: A leap year has 366 days = 52 weeks +2 days. The 2 extra days can be (Sun, Mon), (Mon, Tue), …, (Sat, Sun): 7 equally likely pairs. Two of them contain Sunday. $P = \frac{2}{7}$.

376. Two dice are thrown. The probability that the product of the numbers is 6 is

(A) $\frac{1}{6}$ (B) $\frac{1}{12}$ (C) $\frac{1}{18}$ (D) $\frac{1}{9}$

Answer: (D) $\frac{1}{9}$

Explanation: Product 6: (1,6), (6,1), (2,3), (3,2), i.e. 4 outcomes out of 36. $P = \frac{4}{36} = \frac{1}{9}$.

377. A bag contains 4 white and 6 black balls. Two balls are drawn at random. The probability that both are white is

(A) $\frac{4}{25}$ (B) $\frac{1}{5}$ (C) $\frac{2}{15}$ (D) $\frac{2}{5}$

Answer: (C) $\frac{2}{15}$

Explanation: Number of ways to draw 2 balls = $\binom{10}{2} = 45$. Ways to draw 2 white = $\binom{4}{2} = 6$. $P = \frac{6}{45} = \frac{2}{15}$.

378. A number is chosen at random from 1 to 50. The probability that it is a multiple of 3 or 5 is

(A) $\frac{23}{50}$ (B) $\frac{27}{50}$ (C) $\frac{13}{25}$ (D) $\frac{21}{50}$

Answer: (A) $\frac{23}{50}$

Explanation: Multiples of 3: 16; multiples of 5: 10; multiples of 15 (counted twice): 3. Favourable = 16 + 10 − 3 = 23. $P = \frac{23}{50}$.

379. Two dice are thrown together. The probability that the sum of the numbers is a prime number is

(A) $\frac{1}{2}$ (B) $\frac{7}{18}$ (C) $\frac{5}{12}$ (D) $\frac{1}{3}$

Answer: (C) $\frac{5}{12}$

Explanation: Prime sums 2, 3, 5, 7, 11 occur in 1 + 2 + 4 + 6 + 2 = 15 ways out of 36. $P = \frac{15}{36} = \frac{5}{12}$.

380. Two cards are drawn at random, without replacement, from a pack of 52 cards. The probability that both are kings is

(A) $\frac{1}{169}$ (B) $\frac{1}{221}$ (C) $\frac{1}{13}$ (D) $\frac{2}{13}$

Answer: (B) $\frac{1}{221}$

Explanation: Ways to draw 2 cards = $\binom{52}{2} = 1326$. Ways to draw 2 kings = $\binom{4}{2} = 6$. $P = \frac{6}{1326} = \frac{1}{221}$.

CHAPTER 15 — 20 QUESTIONS · Q. 381–400
STATISTICS

381. Data collected by an investigator directly from the source for a specific purpose are called

(A) secondary data (B) primary data
(C) grouped data (D) cumulative data

Answer: (B) primary data

Explanation: Data collected first-hand by the investigator are primary data. Data taken from published or already collected sources are secondary data.

382. The arithmetic mean of 4, 8, 12, 16 and 20 is

(A) 10 (B) 14 (C) 60 (D) 12

Answer: (D) 12

Explanation: Mean = $\frac{\sum x}{n} = \frac{4+8+12+16+20}{5} = \frac{60}{5} = 12$.

383. The median of 7, 3, 9, 5, 11, 13 is

(A) 7 (B) 8 (C) 9 (D) 5

Answer: (B) 8

Explanation: Arrange in order: 3, 5, 7, 9, 11, 13. With $n = 6$ (even), median = average of the 3rd and 4th values = $\frac{7+9}{2} = 8$.

384. The mode of 2, 3, 4, 3, 5, 3, 4, 6 is

(A) 4 (B) 2 (C) 3 (D) 5

Answer: (C) 3

Explanation: The mode is the value that occurs most often. 3 occurs three times, 4 twice and the others once. Mode = 3.

385. The range of the data 23, 45, 12, 67, 34 is

(A) 55 (B) 44 (C) 33 (D) 67

Answer: (A) 55

Explanation: Range = highest value − lowest value = 67 − 12 = 55.

386. The class mark of the class interval 20–30 is

(A) 10 (B) 25 (C) 20 (D) 30

Answer: (B) 25

Explanation: Class mark = $\frac{\text{lower limit}+\text{upper limit}}{2} = \frac{20+30}{2} = 25$.

387. The median of the first ten prime numbers is

(A) 11 (B) 13 (C) 12 (D) 10

Answer: (C) 12

Explanation: The first ten primes are 2, 3, 5, 7, 11, 13, 17, 19, 23, 29. With $n = 10$, median = average of the 5th and 6th values = $\frac{11+13}{2} = 12$.

388. Values x: 1, 2, 3, 4, 5 have frequencies f: 3, 5, 8, 3, 1. The mean is

(A) 3 (B) 2.5 (C) 2.9 (D) 2.7

Answer: (D) 2.7

Explanation: Mean = $\frac{\sum fx}{\sum f} = \frac{3+10+24+12+5}{3+5+8+3+1} = \frac{54}{20} = 2.7$.

READING COMPREHENSION

PASSAGE 1 — THE PLANNED CITIES OF THE INDUS

When archaeologists began excavating Harappa and Mohenjo-daro in the 1920s, they expected to find the scattered remains of villages. Instead, they uncovered cities laid out with a regularity that would impress a modern town planner. Broad streets ran roughly north to south and east to west, dividing the settlements into blocks. Houses of baked brick, many with private wells and bathing areas, opened onto narrow lanes rather than the main thoroughfares, a feature that probably protected household privacy and reduced street noise.

The most remarkable achievement of these cities lay beneath their streets. Covered drains, built of carefully fitted bricks, carried waste water away from homes and into larger channels. Inspection holes allowed workers to clear blockages. Few ancient societies devoted such attention to public sanitation, and many later cities lacked anything comparable for thousands of years.

Uniformity extended beyond architecture. Bricks across widely separated sites followed a common ratio of thickness, width and length, while stone weights conformed to a standard system. Such consistency suggests that some form of shared authority or widely accepted convention regulated construction and trade. Yet historians remain cautious about naming that authority. No grand palaces or royal tombs have been identified, and the Indus script has not been deciphered, so the precise nature of government remains a matter of informed speculation.

What the evidence does reveal is a civilisation that valued order, cleanliness and cooperation. Building and maintaining a drainage network required planning, labour and continuous upkeep; it could not have been the work of isolated households acting alone. The cities of the Indus therefore tell us less about individual rulers than about collective discipline. Their silent streets remind us that a society can leave a powerful record of its priorities even when its own words remain unread.

1. According to the passage, why did houses open onto narrow lanes rather than main streets?

A) Narrow lanes allowed waste water to drain more quickly into the covered channels.
B) The arrangement probably protected household privacy and reduced noise from the streets.
C) The main streets were reserved exclusively for religious processions.
D) Building regulations required every house to be placed beside a public well.

Explanation: **Ans : (B)**
The first paragraph states directly that houses opened onto narrow lanes, "a feature that probably protected household privacy and reduced street noise". The passage says nothing about processions or building regulations concerning wells, and drainage is discussed separately, not as the reason for the position of doorways.

2. How does the third paragraph relate to the rest of the passage?

A) It provides the author's final verdict that the uniform bricks and weights prove the Indus cities were ruled by a single monarch from a central palace.
B) It contradicts the claims of the first paragraph by showing that the cities were unplanned.
C) It extends the evidence of planning to bricks and weights and then introduces the limits of what historians can conclude about government.
D) It shifts the discussion from the Indus cities to the later history of sanitation.

Explanation: **Ans : (C)**
The third paragraph begins, "Uniformity extended beyond architecture", building on the earlier evidence, and then adds a note of caution: historians "remain cautious about naming that authority". It neither contradicts the earlier paragraphs nor names a monarch, and the history of later sanitation belongs to the second paragraph only as a brief comparison.

3. Which of the following best expresses the central idea of the passage?

A) The cities' planning and civic works reveal a society valuing order and collective effort, though its government remains uncertain.
B) The Indus cities were governed by powerful kings whose palaces and royal tombs, recently identified by archaeologists, explain the uniformity of their bricks and weights.
C) The drainage system of the Indus cities was superior to that of every city built in later history.
D) The failure to decipher the Indus script has made it impossible to learn anything about Harappan society.

Explanation: **Ans : (A)**
The passage moves from street planning to drainage to standardised bricks and weights, and concludes that these features show "order, cleanliness and cooperation" and "collective discipline", while admitting that the "precise nature of government remains a matter of informed speculation". The option about kings contradicts the statement that no palaces have been identified. The claim about every later city exaggerates the more limited remark that many later cities lacked comparable systems. The claim about the script ignores the author's point that the physical evidence still reveals a great deal.

4. The author's attitude towards the evidence from the Indus cities can best be described as

A) dismissive of the achievements of the Indus people.
B) appreciative but careful to separate established facts from speculation.
C) uncritically certain about the political system of the cities.
D) humorous and deliberately exaggerated.

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Explanation: **Ans : (B)**
Words such as "remarkable achievement" and "impress a modern town planner" show appreciation, while phrases such as "historians remain cautious" and "informed speculation" show restraint. The author is neither dismissive nor certain about government, and the tone is serious rather than humorous.

5. A modern municipality introduces a common size for all paving stones and a single approved set of market weights across its districts. According to the reasoning of the passage, what would this policy most likely indicate to a future historian?
- **A)** That some shared authority or accepted convention was regulating construction and trade.
- **B)** That households were responsible for designing their own public works.
- **C)** That each district was competing to attract traders with its own measurements.
- **D)** That the municipality possessed an undeciphered written script.

Explanation: **Ans : (A)**
The author argues that a "common ratio" of brick sizes and a "standard system" of weights "suggests that some form of shared authority or widely accepted convention regulated construction and trade". Applying the same reasoning, uniform paving stones and weights would point to coordinated regulation. Independent competition and household design contradict the idea of uniformity, and writing systems are irrelevant to the inference.

PASSAGE 2 — ASHOKA AND THE LANGUAGE OF THE EDICTS

Rulers have always used monuments to announce their power, but few have used them as strikingly as the Mauryan emperor Ashoka in the third century BCE. Across his vast empire, from present-day Afghanistan to Karnataka, he had messages inscribed on rocks and polished stone pillars. Most were written in Prakrit, the spoken language of ordinary people, and in the Brahmi script, though inscriptions in the north-west used Kharoshthi, and some appeared in Greek and Aramaic. The choice was deliberate: the emperor wanted his words to be understood, not merely admired.

The content of the edicts is as unusual as their form. In one inscription Ashoka expresses remorse for the suffering caused by his conquest of Kalinga, where, by his own account, more than a hundred thousand people were killed. Instead of celebrating victory, he declares a preference for conquest by dhamma, a moral code emphasising tolerance, respect for elders, kindness to servants and restraint in the killing of animals. He appointed special officers, the dhamma-mahamattas, to spread these principles and to look after the welfare of different communities.

Historians debate how far these ideals shaped daily administration. The empire still maintained an army, collected taxes and punished offenders. Some scholars see dhamma as a sincere personal philosophy; others interpret it as a practical method of holding together a population divided by language, region and belief. The two readings need not be exclusive. A ruler can be morally convinced and politically shrewd at the same time.

What remains undisputed is the significance of the inscriptions themselves. After the Brahmi script was deciphered by James Prinsep in 1837, these stones allowed historians to hear the voice of an ancient ruler directly. Few sources from that age speak so personally about guilt, duty and the purpose of government.

6. A modern head of state publicly regrets the human cost of a past war and creates a department to promote social harmony, while still keeping a strong army. Which view from the passage would best describe this approach?
- **A)** Moral conviction and political shrewdness can operate together.
- **B)** Rulers who express remorse must abandon all forms of punishment.
- **C)** Public messages are effective only if written in a classical language.
- **D)** Moral codes are entirely incompatible with the maintenance of state power.

Explanation: **Ans : (A)**
The author concludes that "a ruler can be morally convinced and politically shrewd at the same time". The situation combines a moral gesture with continued state power, matching that view. The other options either contradict the passage or misrepresent its claims about language.

7. Which detail from the passage supports the claim that Ashoka wanted his messages to be understood by ordinary people?
- **A)** Ashoka appointed dhamma-mahamattas to look after communities.
- **B)** The edicts were inscribed on polished stone pillars.
- **C)** The empire continued to maintain an army.
- **D)** Most edicts were written in Prakrit, the spoken language of the people.

Explanation: **Ans : (D)**
The first paragraph links the use of Prakrit, "the spoken language of ordinary people", directly to the conclusion that "the emperor wanted his words to be understood, not merely admired". Polished pillars relate to display, the officers relate to administration, and the army is evidence in the debate about policy, not about language.

8. The tone of the passage is best described as
- **A)** emotional and sentimental.
- **B)** balanced and analytical.
- **C)** polemical and one-sided.
- **D)** sarcastic and dismissive.

Explanation: **Ans : (B)**
The author describes the edicts, presents opposing scholarly interpretations fairly and draws a measured conclusion. There is no mockery, no sentimental appeal and no attempt to argue only one side.

9. How does the third paragraph develop the discussion?

A) It explains how James Prinsep deciphered the Brahmi script.

B) It presents two competing interpretations of dhamma and suggests that they can be reconciled.

C) It narrates the military campaign against Kalinga in chronological detail.

D) It rejects the view that Ashoka had any genuine moral convictions and treats dhamma purely as a political device.

Explanation: **Ans : (B)**

The third paragraph sets out the view that dhamma was "a sincere personal philosophy" against the view that it was "a practical method" of unity, and then concludes that "the two readings need not be exclusive". The Kalinga war and Prinsep appear in other paragraphs, and the author explicitly allows for sincere conviction rather than rejecting it.

10. Which title best represents the passage?

A) The Military Conquests of the Mauryan Empire in Kalinga

B) Taxation and Punishment in Ancient India

C) Stones That Speak: Ashoka's Edicts and the Ideal of Dhamma

D) The Life and Work of James Prinsep

Explanation: **Ans : (C)**

The passage centres on the form, content and historical value of Ashoka's inscriptions and his idea of dhamma. Military conquest, Prinsep and taxation are mentioned only as supporting details, so titles based on them are too narrow or misdirected.

PASSAGE 3 — ROADS OF SILK AND EXCHANGE

The term "Silk Road" was coined only in the nineteenth century by the German geographer Ferdinand von Richthofen, yet the network it describes had operated for well over a thousand years. It was never a single road. It was a shifting web of caravan routes, river crossings and sea lanes linking China, Central Asia, India, Persia and the Mediterranean world. Few merchants travelled its entire length; goods usually passed from hand to hand, changing owners at oasis towns and market cities along the way.

Silk gave the network its modern name, but it carried far more. Spices, cotton textiles, horses, glassware, paper and precious metals moved in different directions. Each exchange created opportunities for intermediaries. Cities such as Samarkand and Bukhara grew wealthy not because they produced every valuable commodity but because they occupied strategic positions where routes met. Their prosperity depended on security, reliable markets and the confidence of traders.

The most lasting cargo, however, was not material. Buddhism travelled from India into Central Asia and China along these routes, carried by monks and merchants alike. Technologies such as papermaking spread westward, while artistic styles blended in surprising ways; statues in the Gandhara region, for instance, combine Indian religious themes with Greek-influenced sculpture. Languages, foods and musical instruments followed similar paths.

Exchange also brought danger. Bandits threatened caravans, rulers imposed heavy tolls, and disease could travel as easily as goods. The great plague of the fourteenth century is widely believed to have moved along trade routes connecting Asia and Europe. The Silk Road thus illustrates a central truth of economic history: networks that connect societies distribute risks as well as rewards, and the same pathways that enrich can also endanger.

11. Which modern situation best illustrates the "central truth" stated at the end of the passage?

A) A village farmer sells vegetables only to his immediate neighbours.

B) A museum displays ancient silk garments for visitors.

C) International air travel boosts tourism and business but also enables infectious diseases to spread rapidly across countries.

D) A government bans all imports so that local industries can grow without foreign competition and the country can remain self-sufficient.

Explanation: **Ans : (C)**

The central truth is that connecting networks distribute both rewards and risks. Air travel brings economic benefits and also spreads disease, mirroring the Silk Road example. The other situations involve no wide network or no combination of reward and risk.

12. What is the function of the final paragraph in relation to the preceding paragraphs?

A) It explains the origin of the term "Silk Road".

B) It contradicts the claim that ideas travelled along the routes.

C) It repeats the list of goods mentioned in the second paragraph and adds new examples of commodities carried along the routes.

D) It introduces the negative consequences of exchange and draws a general conclusion that balances them against the benefits.

Explanation: **Ans : (D)**

After two paragraphs on material and cultural benefits, the final paragraph opens with "Exchange also brought danger" and concludes that networks distribute "risks as well as rewards". It does not repeat the goods, deny the movement of ideas or discuss the origin of the term, which is covered in the first paragraph.

13. According to the passage, why did cities such as Samarkand and Bukhara become wealthy?

A) They occupied strategic positions where trade routes met.

B) They produced most of the valuable goods traded on the network.

C) They controlled the sea lanes of the Mediterranean.

D) They were the only cities to manufacture silk.

Explanation: **Ans : (A)**
The second paragraph states that these cities "grew wealthy not because they produced every valuable commodity but because they occupied strategic positions where routes met". The production-based options are explicitly denied, and the Mediterranean sea lanes are not linked to these cities.

14. What is the main point of the passage?
- **A)** The Silk Road was a single highway, built by the Chinese, along which merchants carried silk to Europe.
- **B)** Trade routes in history caused more harm than benefit.
- **C)** Silk was the only commodity of real importance in ancient trade.
- **D)** The Silk Road was a complex network that spread goods, ideas and dangers among many societies.

Explanation: **Ans : (D)**
The author describes the network as "a shifting web", explains the movement of goods and ideas, and ends with the observation that networks distribute "risks as well as rewards". The single-highway and silk-only options are contradicted directly, and the claim that trade did more harm than good ignores the balance the author draws between rewards and dangers.

15. The writing in the passage is primarily
- **A)** satirical, mocking the idea of long-distance trade.
- **B)** expository, explaining a historical phenomenon with examples.
- **C)** narrative, telling the story of a single merchant's journey.
- **D)** persuasive, urging readers to revive ancient trade routes.

Explanation: **Ans : (B)**
The passage explains what the Silk Road was, what it carried and what consequences followed, using examples such as Samarkand, Buddhism and the plague. There is no individual narrative, no call to action and no mockery.

PASSAGE 4 — REFORM AND THE QUESTION OF CUSTOM

Nineteenth-century India witnessed an intense debate about the relationship between tradition and justice. Reformers such as Raja Rammohun Roy argued that certain customs, especially sati, the burning of widows on their husbands' funeral pyres, had no true foundation in the oldest religious texts. Roy studied scriptures in Sanskrit, Persian and Arabic, and he used his learning to show that practices defended as ancient and essential were neither universal nor unquestionable. His campaign contributed to the abolition of sati in Bengal in 1829 under Governor-General William Bentinck.

Roy's method deserves attention. He did not simply condemn his society from outside. He argued from within its own intellectual traditions, insisting that reason and compassion were part of that inheritance. In 1828 he founded the Brahmo Sabha, later known as the Brahmo Samaj, which rejected idol worship and caste distinctions and promoted rational religious inquiry.

Later reformers followed different paths. Ishwar Chandra Vidyasagar championed the remarriage of widows, and the Hindu Widows' Remarriage Act was passed in 1856. Jyotirao Phule, working in Maharashtra, challenged caste hierarchy and opened schools for girls and for children from oppressed communities, often facing hostility from orthodox groups. Their approaches differed, yet they shared a conviction that customs must be judged by their effects on human dignity.

Reform movements rarely succeed through legislation alone. Laws can forbid a practice, but attitudes change slowly through education, public debate and personal example. The reformers understood this, which is why they wrote pamphlets, founded journals and built schools. Their legacy lies not only in the laws they helped bring about but also in the habit of critical questioning they encouraged.

16. Which word best describes the author's attitude towards the reformers?
- **A)** Contemptuous **B)** Mocking
- **C)** Respectful **D)** Indifferent

Explanation: **Ans : (C)**
The author says Roy's method "deserves attention", describes the reformers' courage in facing hostility and speaks positively of their legacy. This shows respect, not indifference, contempt or mockery.

17. What relationship does the third paragraph establish between the reformers it mentions?
- **A)** It contrasts their different approaches while identifying a shared underlying conviction.
- **B)** It explains how each reformer was influenced by Bentinck.
- **C)** It ranks them in order of importance.
- **D)** It shows that the reformers opposed one another's goals and competed for the support of the government.

Explanation: **Ans : (A)**
The paragraph states, "Their approaches differed, yet they shared a conviction that customs must be judged by their effects on human dignity." This is a contrast followed by a point of agreement. No ranking, opposition or influence by Bentinck is described.

18. Which of the following best describes the central theme of the passage?
- **A)** All nineteenth-century reformers used exactly the same methods.
- **B)** Religious texts in India supported the practice of sati.
- **C)** Nineteenth-century reformers questioned harmful customs and sought change through argument, law and education.
- **D)** The British government alone was responsible for social reform in India, while Indian thinkers played no part in it.

Explanation: **Ans : (C)**
The passage examines how Roy, Vidyasagar and Phule challenged customs, noting legislation, education and

Explanation: **Ans : (A)**
The passage explains that the light-dependent reactions produce "energy-carrying molecules" which "provide the energy needed to fix carbon dioxide" in the Calvin cycle. The other options reverse or misstate this relationship.

102. According to the passage, what is released when water molecules are split during the light-dependent reactions?
A) Oxygen **B)** Chlorophyll
C) Glucose **D)** Carbon dioxide

Explanation: **Ans : (A)**
The second paragraph says that splitting water "releases oxygen as a by-product". Carbon dioxide is taken in, glucose is produced later in the Calvin cycle, and chlorophyll is the pigment that absorbs light.

103. A greenhouse farmer wants to increase the growth of tomato plants. Based on the passage, which action is most likely to help?
A) Painting the greenhouse walls black to block the light and keep the plants warm.
B) Removing the leaves to reduce water loss.
C) Lowering the temperature to freezing point.
D) Increasing the carbon dioxide concentration and providing additional light.

Explanation: **Ans : (D)**
The final paragraph notes that light intensity, carbon dioxide concentration and temperature affect the rate of photosynthesis, and that farmers increase carbon dioxide or provide lighting to raise yields. Blocking light, removing leaves or freezing would reduce photosynthesis.

104. What is the central idea of the passage?
A) Chlorophyll reflects red and blue light.
B) Fossil fuels are produced entirely in modern laboratories.
C) Photosynthesis is a complex process by which plants capture light energy, and it sustains much of life on Earth.
D) Greenhouses, because they control light and carbon dioxide, are the most efficient way to grow all kinds of food.

Explanation: **Ans : (C)**
The passage explains how photosynthesis works and why it matters for oxygen, food and fuel. The passage says chlorophyll absorbs red and blue light, greenhouses are only an example, and fossil fuels are described as remains of ancient plants.

105. The description of the leaf as a "factory" in the passage is an example of
A) an ironic criticism of farmers who use artificial lighting.
B) a statistical comparison.
C) a literal statement of industrial fact.
D) a metaphor used to make a scientific process vivid.

Explanation: **Ans : (D)**
Calling a leaf "a factory that runs on sunlight" is figurative language that helps readers picture production of sugars. It is not literal, ironic or statistical.

PASSAGE 22 — THE BODY'S MEMORY

The human body is constantly exposed to microorganisms, many of which could cause disease. Its first lines of defence are general barriers: the skin, mucous membranes, stomach acid and white blood cells that attack any foreign invader. These innate defences act quickly but do not distinguish clearly between different pathogens.

The adaptive immune system works differently. It recognises specific molecules, called antigens, on the surface of particular microbes. When a new pathogen enters the body, certain white blood cells known as lymphocytes respond to its antigens. B cells produce antibodies, proteins that bind to the antigens and mark the invaders for destruction, while T cells help coordinate the response and destroy infected cells. This specific response takes several days to develop fully, which is why a person may fall ill before recovering.

Crucially, the adaptive system remembers. After an infection is cleared, some lymphocytes remain in the body as memory cells. If the same pathogen appears again, these cells recognise it quickly and launch a faster, stronger response, often defeating the microbe before symptoms develop. This is why people who have recovered from certain diseases, such as measles, are usually protected for life.

Vaccination makes use of this memory. A vaccine introduces antigens in a harmless form, such as weakened or inactivated microbes, or fragments of them. The immune system responds and forms memory cells without the person having to suffer the disease itself. In 1796, the English physician Edward Jenner showed that material from cowpox could protect against smallpox, laying the foundation of vaccination. Large-scale vaccination later led to the eradication of smallpox, declared by the World Health Organization in 1980. When enough people in a community are immune, the spread of infection is limited, protecting even those who cannot be vaccinated.

106. Which of the following best describes the style of the passage?
A) Poetic, using rhyme and rhythm.
B) Expository, explaining biological processes in a clear sequence.
C) Narrative, telling the life story of Edward Jenner and his work.
D) Argumentative, attacking critics of vaccination.

Explanation: **Ans : (B)**
The passage explains how immunity works in a logical sequence without attacking anyone, narrating a biography or using poetic devices.

107. What is the main focus of the passage?
A) How adaptive immunity recognises and remembers pathogens, and how vaccines use this.
B) Why the skin, as the first line of defence, is the most important organ of the body.
C) The causes of all childhood diseases.
D) The history of the World Health Organization.

Explanation: **Ans : (A)**
Most of the passage explains antigens, lymphocytes, memory cells and vaccination. The World Health Organization and skin appear only briefly, and the causes of diseases are not discussed.

108. A child who has been vaccinated against a disease is later exposed to that disease but does not become ill. Which process described in the passage best explains this?
- **A)** The vaccine itself causes the disease in a mild form every time.
- **B)** The skin prevents all microbes from entering the body.
- **C)** Memory cells recognise the pathogen and launch a rapid response.
- **D)** Stomach acid destroys every pathogen.

Explanation: **Ans : (C)**
Vaccination leads the immune system to form memory cells, which "recognise it quickly and launch a faster, stronger response". The skin and stomach acid are general barriers that cannot account for specific protection, and the passage says vaccines work without the person having to suffer the disease.

109. According to the passage, why may a person fall ill before recovering from a new infection?
- **A)** The innate defences, such as skin and stomach acid, are absent in most people.
- **B)** Antibodies make the microbes multiply faster.
- **C)** Memory cells attack the body's own tissues.
- **D)** The specific adaptive response takes several days to develop fully.

Explanation: **Ans : (D)**
The second paragraph states that the specific response "takes several days to develop fully, which is why a person may fall ill before recovering". The other options are not supported by the passage.

110. How is the passage organised?
- **A)** It begins with the eradication of smallpox and then describes only the history of the World Health Organization.
- **B)** It moves from general defences to specific immunity, then to immune memory and finally to its use in vaccination.
- **C)** It compares diseases in different countries.
- **D)** It presents arguments for and against vaccination equally.

Explanation: **Ans : (B)**
The paragraphs progress from innate defences, to the adaptive response, to memory cells, to vaccination. The passage does not start with vaccination, compare countries or present a debate.

PASSAGE 23 — THE FAIR TEST

Suppose a company claims that a new fertiliser makes wheat grow taller. How could we know whether the claim is true? We might apply the fertiliser to a field and observe that the wheat grows well. But this observation alone proves little. Perhaps the season was unusually rainy, or the soil in that field was already rich. To test the claim fairly, scientists use controlled experiments.

In a controlled experiment, the researcher changes only one factor, called the independent variable, and measures its effect on another, the dependent variable. All other conditions are kept the same. In the fertiliser example, two groups of plants would be grown in similar soil, with the same amount of water, sunlight and temperature. Only one group would receive the fertiliser. The group without fertiliser, known as the control group, provides a baseline for comparison.

Several further precautions strengthen the result. Plants should be assigned to groups randomly so that unnoticed differences do not favour one group. The experiment should use a large enough sample, since a few plants may vary by chance. Finally, the experiment should be repeated, ideally by other researchers, to check that the result is reliable.

In medical research, an additional difficulty arises: people's expectations can influence their health. Patients who believe they are receiving a treatment sometimes feel better even if they have been given an inactive substance, a phenomenon called the placebo effect. To overcome this, many trials are double-blind, meaning that neither the patients nor the doctors administering the treatment know who receives the real drug. Such procedures may seem elaborate, but they protect us from mistaking coincidence or wishful thinking for genuine evidence.

111. What is the relationship between the third and fourth paragraphs?
- **A)** The third gives general precautions; the fourth adds one needed in medical research.
- **B)** The third paragraph describes the placebo effect in detail, and the fourth paragraph refutes it with evidence.
- **C)** The third rejects controlled experiments, and the fourth restores them.
- **D)** The fourth paragraph repeats the fertiliser example in more detail.

Explanation: **Ans : (A)**
The third paragraph covers randomisation, sample size and repetition. The fourth begins, "In medical research, an additional difficulty arises", introducing double-blind trials. The other options misrepresent the content.

112. The opening of the passage with a hypothetical claim about fertiliser serves to
- **A)** criticise farmers for believing advertisements about new fertilisers.
- **B)** prove that the fertiliser works.
- **C)** engage the reader with a concrete example before explaining the general method.
- **D)** introduce a fictional character.

Explanation: **Ans : (C)**
Beginning with "Suppose a company claims..." gives readers a relatable problem through which the method can be explained. The passage does not prove the claim, criticise farmers or introduce a character.

113. A researcher tests whether a new study method improves examination scores. Which design best follows the principles described in the passage?

A) Randomly assigning many students to the new or usual method, keeping other conditions similar.
B) Trying the method once and announcing the result immediately without repetition.
C) Asking a few volunteers who already like the method to try it.
D) Giving the new method to the best students in the class and comparing their scores with those of the weaker students.

Explanation: **Ans : (A)**
The passage recommends changing one factor, keeping other conditions the same, random assignment, a large sample and repetition. Random assignment of a large group with other conditions kept similar meets these principles; the others introduce bias, small samples or lack of repetition.

114. What is the main purpose of the passage?

A) To describe the history of agriculture.
B) To argue that medical trials are unnecessary because patients feel better whatever they are given.
C) To explain how controlled and carefully designed experiments allow claims to be tested reliably.
D) To advertise a new fertiliser for wheat farmers.

Explanation: **Ans : (C)**
The passage uses the fertiliser example to introduce controlled experiments, then explains randomisation, sample size, repetition and double-blind trials. It does not advertise, oppose trials or discuss agricultural history.

115. What is the purpose of the control group in the fertiliser experiment?

A) To grow in different soil and sunlight so that natural variation can be measured.
B) To provide a baseline for comparison with the group that receives fertiliser.
C) To receive a double dose of fertiliser.
D) To ensure that the season is rainy.

Explanation: **Ans : (B)**
The second paragraph states that the group without fertiliser "provides a baseline for comparison". It receives no fertiliser and is kept in the same conditions.

PASSAGE 24 — SCIENCE IN THE KITCHEN CUPBOARD

Long before anyone had seen a bacterium, people discovered ways to keep food from spoiling. They dried fish in the sun, salted meat, pickled vegetables in vinegar and stored grain in cool, dry places. These methods were developed through experience, but modern science explains why they work.

Food spoils mainly because microorganisms such as bacteria, yeasts and moulds grow on it, breaking down its substances and sometimes producing harmful toxins. Like all living things, these organisms need certain conditions to grow: water, suitable temperature, nutrients and, in many cases, a moderate level of acidity. Preservation methods succeed by removing or altering one or more of these conditions.

Drying removes the water that microbes need. Salting and sugaring work in a similar way: high concentrations of salt or sugar draw water out of microbial cells through osmosis, preventing them from multiplying. This is why jams, rich in sugar, can be stored for months. Pickling in vinegar increases acidity, creating an environment in which most harmful bacteria cannot survive. Refrigeration does not kill microbes, but it slows their growth by lowering the temperature, while freezing halts it almost entirely.

Heat treatment offers another approach. In the 1860s, Louis Pasteur showed that gently heating liquids such as wine could kill many of the microbes that caused spoilage, a process later applied to milk and now known as pasteurisation. Canning combines heat with airtight sealing, preventing new microbes from entering.

Understanding these principles helps in everyday life. Food left at room temperature for long periods may allow bacteria to multiply rapidly, even if it looks and smells normal. A refrigerator slows spoilage but cannot reverse it. Traditional wisdom and laboratory science thus meet in the kitchen, each confirming and explaining the other.

116. Which statement best expresses the main idea of the passage?

A) Louis Pasteur invented every method of food preservation.
B) Modern refrigerators have made all traditional methods of preserving food useless and unsafe.
C) Food that looks and smells normal is always safe to eat.
D) Traditional methods work by denying microbes the conditions they need.

Explanation: **Ans : (D)**
The passage explains the scientific reasons behind traditional methods and concludes that traditional wisdom and science "meet in the kitchen". It does not dismiss traditional methods, attributes only pasteurisation to Pasteur and warns that normal-looking food may be unsafe.

117. Which word best describes the author's attitude towards traditional preservation methods?

A) Respectful **B)** Uninterested
C) Scornful **D)** Suspicious

Explanation: **Ans : (A)**
The author states that science "explains why they work" and that traditional wisdom and science confirm each other. This shows respect rather than scorn, suspicion or lack of interest.

118. According to the passage, how does refrigeration preserve food?

A) It kills all the microbes in food immediately, so that food can be kept indefinitely.
B) It removes all water from food.
C) It slows the growth of microbes by lowering the temperature.
D) It increases the acidity of food.

Explanation: **Ans : (C)**
The passage states that refrigeration "does not kill microbes, but it slows their growth by lowering the temperature". Acidity is linked to pickling, and removing water is linked to drying.

119. How does the second paragraph contribute to the passage?
- **A)** It provides the general principle that explains all the methods described later.
- **B)** It narrates the history of salting and drying fish in different countries.
- **C)** It contradicts the claim that traditional methods work.
- **D)** It describes how to operate a refrigerator.

Explanation: **Ans : (A)**
The second paragraph explains what microbes need and states that preservation "succeeds by removing or altering one or more of these conditions". The following paragraphs apply this principle to particular methods.

120. Based on the passage, which method would work by the same principle as salting fish?
- **A)** Sealing food in an airtight can after heating.
- **B)** Heating milk to kill microbes.
- **C)** Storing milk in a refrigerator.
- **D)** Preserving fruit in a thick sugar syrup.

Explanation: **Ans : (D)**
Salting draws water out of microbial cells through osmosis, and the passage says "salting and sugaring work in a similar way". Thick sugar syrup uses the same principle. Refrigeration slows growth through temperature, and heating and canning kill or exclude microbes.

PASSAGE 25 — THE QUIET WORK OF POLLINATORS

When we think of the creatures that sustain agriculture, we usually picture oxen, tractors or earthworms. Yet some of the most important agricultural workers are small enough to pass unnoticed: bees, butterflies, moths, beetles, birds and bats that carry pollen from one flower to another. Without this transfer, many plants cannot produce fruits or seeds.

The relationship between flowers and pollinators is one of mutual benefit. Flowers offer nectar and pollen as food, and their colours, scents and shapes have evolved to attract particular visitors. In return, the animals carry pollen on their bodies, fertilising the next flower they visit. Some partnerships are highly specialised; certain orchids, for instance, can be pollinated by only one species of insect.

Scientists estimate that a large share of the world's food crops, including many fruits, vegetables, nuts and oilseeds, benefit to some degree from animal pollination. Staple cereals such as rice and wheat are mainly wind-pollinated, so pollinator decline would not cause immediate famine. It would, however, reduce the variety and nutritional quality of diets, since many foods rich in vitamins depend on pollinators.

There is growing evidence that pollinator populations are under pressure in many regions. The causes are interconnected: loss of natural habitat, the heavy use of certain pesticides, disease, and changes in climate that disturb the timing of flowering and insect activity. A field of a single crop may offer abundant food for a few weeks and none for the rest of the year.

Protecting pollinators does not always require dramatic measures. Planting hedgerows and native flowering plants, reducing unnecessary pesticide use and preserving patches of wild land can make a significant difference. Such steps remind us that biodiversity is not a luxury for nature lovers. It is part of the foundation on which human well-being rests.

121. A farmer who grows a single crop notices fewer bees each year. Which action would best follow the passage's recommendations?
- **A)** Increasing the use of pesticides so that the crop is protected from insects that damage it.
- **B)** Replacing all flowering plants with a single cereal crop.
- **C)** Planting native flowering hedgerows around the fields and reducing unnecessary pesticide spraying.
- **D)** Clearing nearby wild land to expand the crop area.

Explanation: **Ans : (C)**
The final paragraph recommends "planting hedgerows and native flowering plants, reducing unnecessary pesticide use and preserving patches of wild land". The other options would worsen the causes listed in the fourth paragraph.

122. What is the relationship between the fourth and fifth paragraphs?
- **A)** The fifth paragraph repeats the statistics of the fourth and adds new figures on pollinator decline.
- **B)** The fourth describes the causes of a problem, and the fifth suggests practical ways to address it.
- **C)** Both paragraphs describe the anatomy of flowers.
- **D)** The fourth offers a solution, and the fifth rejects it.

Explanation: **Ans : (B)**
The fourth paragraph explains why pollinator populations are "under pressure". The fifth begins, "Protecting pollinators does not always require dramatic measures," and lists remedies. This is a problem-solution structure.

123. Which statement best expresses the central argument of the passage?
- **A)** Orchids are the most valuable flowering plants.
- **B)** Pollinators are vital to food and ecosystems, and protecting them protects human well-being.
- **C)** Bees are more important than all other animals in agriculture.
- **D)** Pollinator decline will cause rice and wheat harvests to fail immediately, leading to famine.

Explanation: **Ans : (B)**
The passage explains the role of pollinators, the threats they face and simple protective steps, concluding that

communication" may gain, while those performing easily automated tasks may lose. The engineer fits the first group; the others perform routine tasks.

209. What is the function of the third paragraph?

A) It suggests the present wave may differ and notes economists' disagreement.
B) It recommends specific social security policies for workers who lose their jobs.
C) It describes the Luddite movement in detail.
D) It lists jobs that have disappeared completely.

Explanation: **Ans : (A)**
The paragraph begins, "The present wave of automation may differ from earlier ones," and reports that "Economists disagree". Luddites appear in the first paragraph and policies in the last.

210. Which of the following best expresses the main argument of the passage?

A) Automation will certainly cause permanent mass unemployment, as the Luddites feared it would.
B) Automation affects only routine physical tasks.
C) The Luddites were correct that machines always destroy jobs.
D) Automation removes and creates tasks, and its social effects depend on how gains are shared.

Explanation: **Ans : (D)**
The passage balances lost and created work, notes uncertainty about the current wave, and concludes that the key question is whether gains "will be widely shared". It reports disagreement rather than predicting certain unemployment, presents history as more complex than the Luddites believed, and says automation now reaches cognitive tasks.

PASSAGE 43 — SATELLITES AND EVERYDAY LIFE

When people think of space technology, they often imagine astronauts, rockets and distant planets. Yet some of its most important effects are felt on Earth, in activities so ordinary that we rarely notice them. Satellites orbiting high above us help forecast the weather, guide travellers, connect telephone calls and monitor crops.

Weather satellites observe cloud patterns, temperatures and moisture across vast areas. Their images allow meteorologists to track cyclones days before they reach land, giving authorities time to evacuate vulnerable populations. Over the past few decades, improved forecasting and early warning have greatly reduced the loss of life from cyclones along India's eastern coast.

Navigation satellites send precise time signals. By receiving signals from several satellites and comparing their timing, a receiver can calculate its position on Earth. This principle underlies the Global Positioning System and India's own regional system, known as NavIC. Such technology guides ships and aircraft, helps delivery services plan routes and allows farmers and fishermen to locate their fields or fishing grounds.

Earth-observation satellites capture images that reveal changes in land use, forest cover, water bodies and crop health. Planners use them to monitor droughts, map flood damage and estimate harvests. Communication satellites relay television broadcasts and connect remote areas where laying cables would be difficult.

India's space programme, led by the Indian Space Research Organisation, has from its beginnings emphasised such practical applications. Its achievements in planetary exploration have drawn worldwide attention, including the landing of Chandrayaan-3 near the Moon's south polar region in August 2023. But its most enduring contribution may lie in the quiet, continuous services that satellites provide to millions who never look up.

211. A state government wants to assess the area of crops damaged by floods soon after heavy rains. Which type of satellite described in the passage would be most useful?

A) A satellite designed only to land on the Moon
B) An Earth-observation satellite
C) A communication satellite relaying television broadcasts
D) A navigation satellite

Explanation: **Ans : (B)**
The fourth paragraph states that Earth-observation satellites help "map flood damage and estimate harvests". Navigation and communication satellites serve different purposes, and lunar missions are not relevant to mapping crop damage.

212. According to the passage, how does a navigation receiver determine its position?

A) By photographing the ground below it and matching it with stored maps.
B) By comparing the timing of signals from several satellites.
C) By measuring the temperature of the clouds.
D) By connecting to a television broadcast.

Explanation: **Ans : (B)**
The third paragraph explains that "by receiving signals from several satellites and comparing their timing, a receiver can calculate its position". Photographing the ground and measuring clouds describe observation satellites, and broadcasting describes communication satellites.

213. How is the passage primarily organised?

A) By comparing Indian and foreign astronauts.
B) By presenting a debate about the cost of space programmes.
C) By narrating the history of rocket launches in chronological order.
D) By introducing a general idea and then describing types of satellites.

Explanation: **Ans : (D)**
After the opening paragraph introduces the everyday effects of space technology, the following paragraphs discuss weather, navigation, Earth-observation and communication satellites in turn. There is no chronology of launches, astronaut comparison or cost debate.

214. The phrase "millions who never look up" suggests that

A) many people benefit from satellites unknowingly.

B) people are not interested in astronomy.
C) most people are unable to see the sky.
D) satellites are visible only at night.

Explanation: **Ans : (A)**
The phrase emphasises the "quiet, continuous services" that reach people who are unaware of their source. It is figurative and does not literally describe eyesight or interest in astronomy.

215. What is the main point of the passage?
A) Chandrayaan-3 was the first spacecraft ever launched.
B) Weather forecasting has become unnecessary.
C) Satellites benefit everyday life on Earth in many ways.
D) Space exploration is useful only for studying distant planets.

Explanation: **Ans : (C)**
The passage shows how satellites assist weather forecasting, navigation, monitoring and communication, concluding that ISRO's "most enduring contribution may lie in the quiet, continuous services" of satellites. The other options contradict or exaggerate the passage.

PASSAGE 44 — THE NETWORK WITHOUT A CENTRE

Ordinary telephone systems of the mid-twentieth century worked by circuit switching. When a call was placed, a dedicated line was established between the two telephones and remained reserved for the entire conversation, even during silences. The system was reliable but inefficient, and a single break in the line could cut off communication.

The internet grew from a different idea, known as packet switching, developed in the 1960s by researchers including Paul Baran in the United States and Donald Davies in Britain. In packet switching, a message is divided into small units called packets. Each packet carries information about its destination and travels independently through the network, possibly by a different route from the other packets. At the destination, the packets are reassembled into the original message. Because no line is reserved, many users can share the same network efficiently.

This design gave the network remarkable resilience. If one connection fails, packets can be routed around the damage through other paths. The early network known as ARPANET, funded by the United States Department of Defense, began operating in 1969 and connected a small number of universities and research centres. Over the following decades, common protocols allowed different networks to communicate with one another, creating an interconnected "network of networks".

The decentralised structure also shaped the culture of the internet. No single authority controlled its content, and anyone with access could publish information. This openness encouraged innovation and the rapid spread of knowledge. The World Wide Web, proposed by Tim Berners-Lee in 1989, made it easy to link documents and navigate between them.

Openness, however, brings challenges as well as benefits. The same features that allow free exchange make it difficult to prevent the spread of harmful content, cyber-attacks and fraud. The internet's history shows that technical design choices can have profound social consequences, many of them unforeseen by its creators.

216. The final sentence of the passage suggests the author's view that
A) the internet should be shut down.
B) technical decisions can have far-reaching and unexpected social effects.
C) technology has no influence on society.
D) the creators of the internet intended every consequence of their design.

Explanation: **Ans : (B)**
The sentence states that design choices "can have profound social consequences, many of them unforeseen by its creators". This contradicts the other options.

217. Which title best represents the passage?
A) The History of the Telephone
B) The Biography of Tim Berners-Lee
C) Packet Switching and an Open Network
D) How to Prevent Cyber-Attacks

Explanation: **Ans : (C)**
The passage explains packet switching, the resilience and decentralisation it produced, and the social consequences of openness. The telephone, cyber-attacks and Berners-Lee are supporting details.

218. During a storm, a major data cable in one region is damaged, yet emails continue to reach their destinations, though slightly more slowly. Which feature of the internet described in the passage explains this?
A) Packets can be routed around damaged connections.
B) A single authority approves each message.
C) Every email is sent through one reserved line.
D) The World Wide Web links documents together.

Explanation: **Ans : (A)**
The third paragraph explains that the network's resilience comes from routing packets "around the damage through other paths". The other features either describe circuit switching, are irrelevant or contradict the decentralised structure.

219. How does the first paragraph prepare for the explanation that follows?
A) It describes the problems of cyber-attacks.
B) It argues that telephones based on reserved lines are more reliable and therefore superior to the internet.
C) It describes circuit switching so that packet switching can be understood by contrast.
D) It explains how the World Wide Web was invented.

Explanation: **Ans : (C)**
The first paragraph describes the reserved lines and vulnerability of circuit switching, and the second introduces packet switching as "a different idea". The

Web and cyber-attacks appear later, and the paragraph does not argue for telephones.

220. According to the passage, why is packet switching more efficient than circuit switching?

A) A single authority controls all routes.
B) No line is reserved, so many users can share the same network.
C) Each message travels through a single dedicated line.
D) Packets are never divided into smaller units.

Explanation: **Ans : (B)**
The second paragraph states, "Because no line is reserved, many users can share the same network efficiently." The other options describe circuit switching or contradict the passage.

PASSAGE 45 — THE PRICE OF CONVENIENCE

Many of the digital services we use every day appear to be free. We search the internet, use maps, share photographs and communicate with friends without paying money. Yet these services are expensive to build and maintain. Often, the price is paid in another currency: personal data.

Each time we use an online service, we may leave traces of information, including our location, our searches, the pages we visit and the products we buy. Companies collect and analyse this data to predict our preferences and to show us targeted advertisements. In many cases, such analysis improves the service, suggesting a useful route or a relevant book. But it also allows a detailed profile of a person's habits, interests and even health or financial situation to be assembled, often without the person fully realising it.

The risks of such data collection take several forms. Information may be stolen in security breaches and used for fraud. It may be shared with third parties in ways users did not anticipate. Profiles may be used to influence choices, from purchases to political opinions, in ways that are difficult to detect. And because data can be stored indefinitely, information shared casually today may have consequences years later.

Many people say they value privacy but continue to accept terms and conditions without reading them. This apparent contradiction is understandable. Privacy policies are often long and complex, and refusing them may mean losing access to services that have become essential for work and social life.

For this reason, responsibility cannot rest on individuals alone. Laws that require clear consent, limit data collection to legitimate purposes and give people the right to see and delete their information can shift the balance. India's Digital Personal Data Protection Act, passed in 2023, is one example of such an effort. Technology companies, too, can design systems that protect privacy by default. Convenience and privacy need not be enemies, but reconciling them requires deliberate choices.

221. According to the passage, why do many people accept terms and conditions without reading them?

A) Policies are complex, and refusing them may mean losing essential services.
B) They do not value privacy at all.
C) Companies pay them to accept the terms.
D) The law forbids users from reading or questioning the privacy policies of companies.

Explanation: **Ans : (A)**
The fourth paragraph explains that policies "are often long and complex, and refusing them may mean losing access to services that have become essential". The passage suggests people do value privacy, and the other options are not supported.

222. What is the relationship between the fourth and fifth paragraphs?

A) The fifth paragraph describes in detail a security breach that was mentioned briefly in the fourth.
B) The fourth recommends laws, and the fifth rejects them.
C) The fourth shows why individuals struggle; the fifth concludes that wider responsibility is needed.
D) Both paragraphs list the benefits of targeted advertising.

Explanation: **Ans : (C)**
The fourth paragraph explains the difficulty individuals face, and the fifth begins, "For this reason, responsibility cannot rest on individuals alone." This is a cause-and-conclusion relationship. The other options misdescribe the paragraphs.

223. A new mobile application collects users' contacts and location even though it only needs their email address to function. According to the principles in the passage, what would a suitable law require?

A) That users be prevented from deleting their accounts.
B) That the application be allowed to collect all available data.
C) That only advertisers decide what data is collected.
D) That collection be limited to legitimate purposes, with clear consent.

Explanation: **Ans : (D)**
The final paragraph favours laws that "require clear consent, limit data collection to legitimate purposes and give people the right to see and delete their information". Collecting unnecessary data violates the purpose limitation, and the other options contradict the principles.

224. What is the central argument of the passage?

A) Personal data collection has no benefits at all.
B) Individuals who accept terms and conditions without reading them have given up any right to privacy.
C) Free services often rely on personal data, so privacy needs laws and responsible design, not only individual care.
D) Digital services should charge everyone high fees.

Explanation: **Ans : (C)**
The passage explains how data pays for "free" services, describes the risks, and argues that "responsibility cannot rest on individuals alone". It recognises that data analysis can improve services and does not call for fees or deny users' rights.

225. The title "The Price of Convenience" suggests that the author's purpose is to
- **A)** reveal the hidden costs of free services.
- **B)** argue that convenience is always harmful.
- **C)** describe the history of the mobile phone.
- **D)** advertise a particular digital service.

Explanation: **Ans : (A)**
The passage explains that free services are often paid for "in another currency: personal data". The title draws attention to this hidden cost. The author does not advertise, give a history or condemn convenience, stating that convenience and privacy "need not be enemies".

PASSAGE 46 — A LAND OF MANY TONGUES

Few countries possess the linguistic richness of India. The census records hundreds of mother tongues, belonging to several major language families, including Indo-Aryan, Dravidian, Austroasiatic and Tibeto-Burman. The Eighth Schedule of the Constitution currently lists twenty-two languages, among them Assamese, Bengali, Hindi, Kannada, Malayalam, Marathi, Tamil, Telugu and Urdu. Many Indians grow up speaking two or three languages, moving easily between a home language, a regional language and a language used for education or work.

Each language carries more than a means of communication. It preserves a way of seeing the world: words for local plants and seasons, proverbs that encode practical wisdom, songs and stories passed down through generations. When a language disappears, much of this knowledge may vanish with it. Linguists warn that many smaller languages around the world, including some in India, are endangered because younger generations increasingly adopt dominant languages for economic and social reasons.

The causes of language decline are understandable. Parents naturally want their children to learn languages that offer access to higher education and employment. Migration to cities brings speakers of different languages together and encourages the use of common languages. Media and digital content are concentrated in a relatively small number of widely spoken languages.

Protecting linguistic diversity need not mean rejecting these widely spoken languages. Multilingualism allows a person to retain a mother tongue while acquiring others. Research on education suggests that children often learn more effectively when early schooling makes use of their home language, which can then serve as a bridge to additional languages. Documentation projects, community radio, local publishing and digital tools can also give smaller languages new life.

A society that values its languages does not merely preserve words; it respects the communities that speak them and the knowledge they have accumulated. Linguistic diversity is not an obstacle to unity but one of the forms that unity can take.

226. What is the central idea of the passage?
- **A)** The Eighth Schedule lists every language spoken in India.
- **B)** India's linguistic diversity holds valuable knowledge and can be preserved through multilingualism.
- **C)** Smaller languages are useless in the modern economy.
- **D)** India should adopt a single language for all official, educational and commercial purposes in order to promote unity.

Explanation: **Ans : (B)**
The passage describes India's many languages, explains their cultural value and the causes of decline, and recommends multilingualism and other measures. It does not call for a single language or dismiss smaller ones, and it says the Eighth Schedule lists twenty-two languages while the census records hundreds of mother tongues.

227. What is the function of the fourth paragraph?
- **A)** It proposes ways of protecting linguistic diversity without rejecting widely spoken languages.
- **B)** It explains why languages carry cultural knowledge.
- **C)** It argues that the decline of smaller languages cannot be prevented, whatever measures are taken.
- **D)** It lists the language families found in India.

Explanation: **Ans : (A)**
The paragraph begins, "Protecting linguistic diversity need not mean rejecting these widely spoken languages," and suggests multilingual education and other measures. Cultural knowledge is discussed in the second paragraph and language families in the first.

228. The final sentence of the passage expresses
- **A)** an ironic criticism of linguists.
- **B)** fear that diversity will divide the nation.
- **C)** a view of diversity as compatible with unity.
- **D)** a neutral statistical observation.

Explanation: **Ans : (C)**
By stating that diversity "is not an obstacle to unity but one of the forms that unity can take", the author offers an optimistic reinterpretation. There is no fear, statistic or irony.

229. Which of the following is mentioned as a cause of language decline?
- **A)** Smaller languages have no words for local plants.
- **B)** Governments have banned all regional languages.
- **C)** Children are unable to learn more than one language.
- **D)** Parents' wish for languages that lead to education and jobs.

Explanation: **Ans : (D)**
The third paragraph lists parental choices, migration and media concentration as causes. The passage does not