COMPETITIVE EXAMINATION · FULLY SOLVED STUDY COPY

General Knowledge-I

General Science & Ability — Complete Solved Paper (2023 Pattern)

Part I — MCQs (20 Marks) | Part II — Section A & B (80 Marks) | Every Question Answered

How to use this copy: This is an independently prepared, fully worked answer key for self-study and exam practice. Every part and sub-part of the original question paper has been answered in full, including complete workings for all numerical/reasoning questions. Since the original Part I (MCQs) was not available in the source document, a fresh set of 20 representative General Science & Ability MCQs has been composed below, with the correct option highlighted in green.

PART I — MULTIPLE CHOICE QUESTIONS (20 Marks · 1 Mark Each)

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1. Which gas is the most abundant in Earth's atmosphere?
A) Oxygen B) **Nitrogen** C) Carbon dioxide D) Argon

2. The SI unit of electric current is:
A) Volt B) Watt C) **Ampere** D) Ohm

3. Which part of the human eye controls the amount of light entering it?
A) Retina B) Cornea C) **Iris** D) Lens

4. The chemical formula of common table salt is:
A) NaOH B) **NaCl** C) $CaCO_3$ D) KCl

5. Which planet is known as the "Red Planet"?
A) Venus B) **Mars** C) Jupiter D) Saturn

6. DNA stands for:
A) **Deoxyribonucleic Acid** B) Denatured Nucleic Acid C) Dual Nuclear Acid D) Deoxyribose Nitrogen Acid

7. The process by which plants lose water vapour through their leaves is called:
A) Respiration B) **Transpiration** C) Photosynthesis D) Osmosis

8. Which of the following is a vector quantity?
A) Speed B) Mass C) **Velocity** D) Distance

9. The pH value of pure water is:
A) 5 B) 6 C) **7** D) 8

10. Sound cannot travel through:
A) Solids B) Liquids C) Gases D) **Vacuum**

11. A train travels 300 km in 5 hours. Its average speed is:
A) 50 km/h B) 55 km/h C) **60 km/h** D) 65 km/h

12. Find the next number in the series: 2, 6, 12, 20, 30, ?
A) 40 B) **42** C) 44 D) 36

13. Which vitamin is produced in human skin upon exposure to sunlight?
A) Vitamin A B) Vitamin C C) **Vitamin D** D) Vitamin K

14. The "powerhouse of the cell" is:
A) Nucleus B) Ribosome C) **Mitochondria** D) Golgi body

15. Which metal is liquid at room temperature?
A) Iron B) **Mercury** C) Sodium D) Aluminium

16. The speed of light in vacuum is approximately:
A) 3×10^5 km/s B) **3×10^8 m/s** C) 3×10^6 m/s D) 3×10^3 km/s

17. The ratio of boys to girls in a class is 3:2, and there are 30 students in total. How many girls are there?
A) 10 B) **12** C) 15 D) 18

18. Which of these is a renewable source of energy?
A) Coal B) Natural gas C) **Solar energy** D) Petroleum

19. The scientific study of earthquakes is called:
A) **Seismology** B) Meteorology C) Geology D) Volcanology

20. A man buys an article for Rs. 500 and sells it for Rs. 600. His profit percentage is:
A) 15% B) **20%** C) 25% D) 10%

PART II — SECTION A (General Science, 5 Marks per Part)

Q.2 (a) Define ceramic and nano-ceramic materials. Why do nano-ceramics show better properties than their ceramic counterparts? Write applications of ceramic materials. 5

ANSWER

Ceramics are inorganic, non-metallic solid materials made by shaping and then permanently hardening (firing) natural raw materials such as clay and silica, or synthetic compounds such as oxides, carbides and nitrides. They are known for high hardness, high melting point, brittleness, chemical inertness and generally poor electrical/thermal conductivity.

Nano-ceramics are ceramics whose grain size is reduced to the nanometre range (below ~100 nm).

- Smaller grains mean many more grain boundaries, which resist the movement of cracks and dislocations — this raises strength and hardness (Hall–Petch effect).
- The huge internal surface area allows some grain-boundary sliding, giving nano-ceramics improved fracture toughness and reduced brittleness compared to coarse-grained ceramics.
- Finer particles sinter (fuse) at lower temperatures, saving energy in manufacturing.
- Quantum and surface effects also enhance optical, electrical and catalytic behaviour.

Applications of ceramics: cutting tools, thermal-barrier coatings on turbine blades, biomedical implants (hip joints, dental crowns), electrical insulators, spark plugs, capacitors, piezoelectric sensors, bullet-proof armour, and refractory linings for furnaces/kilns.

Q.2 (b) What is a 'Black Hole'? How are black holes formed and discovered? 5

ANSWER

A **black hole** is a region of spacetime where gravity is so intense that nothing — not even light — can escape once it crosses the boundary called the *event horizon*.

Formation: Most stellar black holes form when a massive star (core mass greater than about 3 solar masses) exhausts its nuclear fuel, explodes as a supernova, and its core collapses under its own gravity into an infinitely dense point called a singularity. Supermassive black holes at galactic centres are thought to grow through repeated mergers and accretion of matter over billions of years; black holes can also form from the merger of two neutron stars.

Discovery: Black holes were first predicted mathematically from Einstein's General Theory of Relativity (1915) through the Schwarzschild solution (1916). The term "black hole" was popularised by physicist John Wheeler in 1967. The first strong observational evidence came from the X-ray binary system Cygnus X-1 in the 1970s. In 2015, LIGO detected gravitational waves from two merging black holes, and in 2019 the Event Horizon Telescope captured the first-ever direct image of a black hole's shadow (in galaxy M87).

Q.2 (c) Write two applications each of: (i) Ultraviolet (ii) Infra-red (iii) Microwaves (iv) Radio waves (v) X-rays. 5

ANSWER

Radiation	Application 1	Application 2
Ultraviolet (UV)	Sterilising water, air and surgical equipment	Triggers Vitamin D synthesis in skin; used in fluorescent lamps
Infra-red (IR)	Night-vision and thermal imaging cameras	Remote controls and IR heating/physiotherapy devices
Microwaves	Cooking in microwave ovens	Radar systems and satellite/mobile communication links
Radio waves	Radio and television broadcasting	Long-range wireless communication and ship/aircraft navigation
X-rays	Medical diagnostic imaging (bone fractures, chest X-rays)	Airport baggage security scanning and industrial flaw detection in metals

Q.2 (d) What is Wildfire? Explain its types, causes, spread and prevention. 5

ANSWER

A **wildfire** is an uncontrolled fire that burns rapidly through vegetation such as forests, grasslands or bushland.

Types:

- **Ground fires** — burn organic matter and peat beneath the surface, spreading slowly and often undetected.
- **Surface fires** — burn dry leaves, grass and litter on the forest floor; the most common type.
- **Crown fires** — spread rapidly through the tree canopy; the most intense and destructive type.

Causes: Natural — lightning strikes, volcanic activity, spontaneous combustion of very dry vegetation. Human — unattended campfires, discarded cigarettes, agricultural/stubble burning, arson, sparking power lines, and climate change–driven heat and drought.

Spread: Governed by the "fire triangle" — availability of fuel (dry vegetation load), weather (wind speed/direction, temperature, low humidity), and topography (fire spreads faster uphill and through dense, continuous fuel).

Prevention: Controlled/prescribed burning to reduce fuel build-up, maintaining firebreaks, early-warning systems using satellites/drones, public awareness campaigns, rapid-response fire-fighting teams, and sound forest-management/land-use planning.

Q.3 (a)(i) Why are the bat and whale considered mammals? (ii) Write a note on liver juice 'Bile'. 5

ANSWER

(i) Although a bat flies like a bird and a whale swims like a fish, both are classified in **Class Mammalia** because they share the defining mammalian traits: they are warm-blooded (endothermic), give birth to live young (viviparous) rather than laying eggs, nourish their young with milk from mammary glands, possess hair at some stage of life, and have a four-chambered heart with a muscular diaphragm. Habitat or mode of locomotion does not determine classification — reproductive and physiological features do.

(ii) Bile is a greenish-yellow digestive fluid produced continuously by the liver, stored and concentrated in the gallbladder, and released into the duodenum during digestion. It is composed of bile salts, bile pigments (bilirubin and biliverdin, from the breakdown of red blood cells), cholesterol, water and electrolytes. Its main function is to **emulsify fats** — breaking large fat globules into smaller droplets so that pancreatic lipase can act on them more effectively — and it also helps absorb fat-soluble vitamins (A, D, E, K) and serves as an excretory route for cholesterol and bile pigments.

Q.3 (b) How is urine formed? Describe the role of the kidney in excretion. 5

ANSWER

Urine formation occurs in the nephron (the functional unit of the kidney) in three stages:

- **Glomerular filtration:** Blood pressure forces water, glucose, salts, urea and other small molecules from the glomerulus into the Bowman's capsule, forming a filtrate; blood cells and large proteins remain in the blood.
- **Selective reabsorption:** As the filtrate passes through the proximal convoluted tubule, loop of Henle and distal convoluted tubule, useful substances — glucose, amino acids, most water and salts — are reabsorbed back into the blood.
- **Tubular secretion:** Additional waste ions (H^+, K^+, ammonia, some drugs) are actively secreted from the blood into the tubule.

The remaining fluid, now called urine, passes through the collecting duct to the renal pelvis, then the ureter, and is stored in the bladder.

Role of the kidney in excretion: The kidneys filter roughly 180 litres of blood plasma per day, removing nitrogenous wastes such as urea, uric acid and creatinine, while regulating water balance, electrolyte concentration, blood pressure and pH — maintaining the body's internal homeostasis.

Q.3 (c)(i) How is a bacterial cell different from a plant cell? (ii) Why are cold-blooded animals slowed down by low temperatures? 5

ANSWER

(i)

Feature	Bacterial Cell	Plant Cell
Cell type	Prokaryotic — no true nucleus	Eukaryotic — true membrane-bound nucleus
Organelles	No membrane-bound organelles	Has mitochondria, chloroplast, ER, Golgi body, etc.
Cell wall	Made of peptidoglycan	Made of cellulose
DNA	Single circular DNA (plus plasmids), free in cytoplasm	Linear DNA organised into chromosomes inside nucleus
Size / Ribosomes	Very small (1–10 µm); 70S ribosomes	Larger (10–100 µm); 80S ribosomes
Special features	None	Large central vacuole, chloroplasts for photosynthesis

(ii) Cold-blooded (ectothermic) animals cannot internally regulate their body temperature — it changes with the surrounding environment. At low temperatures, the enzymes that drive their metabolic reactions work more slowly (enzyme activity is highly temperature-dependent), which reduces their metabolic rate, muscle activity and nerve conduction. This is why reptiles and amphibians become sluggish, feed less and may enter dormancy (brumation) in cold conditions.

Q.3 (d) What is hepatitis, its types, causes, prevention and cure? 5

ANSWER

Hepatitis is inflammation of the liver, most commonly caused by viral infection but also by toxins, alcohol, drugs, or autoimmune disease.

Types: Hepatitis A, B, C, D and E are the main viral forms. A and E spread through the faecal–oral route (contaminated food/water) and are usually acute and self-limiting. B, C and D spread through blood and body fluids (unsafe injections, transfusions, mother-to-child transmission) and can become chronic, potentially leading to cirrhosis or liver cancer. Alcoholic, toxic and autoimmune hepatitis are non-viral forms.

Causes: Viral infection, heavy alcohol consumption, certain medicines/toxins, and autoimmune attack on liver cells.

Prevention: Vaccination (available for hepatitis A and B), safe drinking water and food hygiene, avoiding needle-sharing, screening of blood transfusions, and safe medical/sexual practices.

Cure/Treatment: Hepatitis A and E usually resolve with rest and supportive care. Hepatitis B is managed with long-term antiviral drugs. Hepatitis C can now be cured in most patients using modern direct-acting antiviral (DAA) therapy. Severe, advanced cases may require a liver transplant.

Q.4 (a) Difference between fog and smog; causes of smog and its effects on health; a modern technology to eliminate smog. 5

ANSWER

Fog is a natural weather phenomenon — a suspension of tiny water droplets in air near the ground caused by cooling of moist air, reducing visibility. **Smog** is a form of air pollution — a mixture of smoke and fog, or more precisely a photochemical haze formed when pollutants (nitrogen oxides, volatile organic compounds) from vehicles and industry react with sunlight to form ground-level ozone and fine particulate matter.

Causes of smog: vehicle exhaust, industrial emissions, crop-residue/fossil-fuel burning, temperature inversions that trap pollutants near the ground, and calm, windless weather.

Health effects: respiratory problems (asthma, bronchitis), eye and throat irritation, reduced lung function, cardiovascular strain, and premature death in severe episodes.

Modern technology — Smog Towers: Large air-purifying towers (used in cities such as Delhi and Lahore) draw in polluted air through fans, pass it through fine filters (e.g., HEPA-based systems), and release cleaner air, measurably reducing local particulate-matter concentration.

Q.4 (b) What is the role of oxygen-demanding wastes in water pollution? How can it be prevented? 5

ANSWER

Oxygen-demanding wastes are organic wastes (sewage, food-processing effluent, agricultural runoff, decaying matter) that are broken down by aerobic bacteria, which consume the dissolved oxygen (DO) present in water — measured as **Biochemical Oxygen Demand (BOD)**. High BOD loads deplete dissolved oxygen, causing hypoxic ("dead") zones, killing fish and aquatic life, and encouraging foul-smelling anaerobic decomposition.

Prevention: treating sewage before discharge (primary, secondary and tertiary treatment), controlling fertiliser/agricultural runoff, treating industrial effluents, maintaining vegetative buffer zones along water bodies, and regular water-quality monitoring.

Q.4 (c) What is the biosphere? Write a note on the 'Energy Resources' available in the biosphere. 5

ANSWER

The **biosphere** is the global sum of all ecosystems — the zone of Earth, spanning parts of the land, water and atmosphere, in which life exists and interacts.

Energy resources of the biosphere are broadly classified as:

- **Renewable:** solar energy (the primary driver of photosynthesis and climate), wind, hydro power, geothermal energy, biomass/biofuels, and tidal energy — naturally replenished over short timescales.
- **Non-renewable:** fossil fuels (coal, petroleum, natural gas) formed from ancient organic matter over millions of years, and nuclear fuel (uranium) — finite resources that deplete with use.

These resources power both natural ecological processes and human activity, making sustainable management essential to avoid depletion and environmental damage.

Q.4 (d) What are the different layers of the atmosphere? On what basis are they classified? Where do Auroras form and where do satellites orbit? 5

ANSWER

The atmosphere is classified into layers based on how **temperature changes with altitude**:

Layer	Approx. Altitude	Key Feature
Troposphere	0–12 km	Weather occurs; temperature falls with height
Stratosphere	12–50 km	Contains ozone layer; temperature rises with height
Mesosphere	50–85 km	Coldest layer; meteors burn up here
Thermosphere	85–600 km	Temperature rises sharply; **Auroras form here**
Exosphere	600 km+	Merges into space; extremely thin

Satellites: Most low-Earth-orbit satellites (including the ISS) orbit within the thermosphere/upper mesosphere region (roughly 160–2,000 km), while geostationary satellites orbit much further out, around 35,786 km, in the exosphere region.

Q.5 (a) What are antioxidants and why are they used in foods? Note on natural and synthetic antioxidants. 5

ANSWER

Antioxidants are substances that inhibit oxidation reactions, neutralising the free radicals that would otherwise degrade food quality. They are added to food to prevent rancidity of fats and oils, prevent enzymatic browning of fruits/vegetables, extend shelf life, and preserve colour, flavour and nutritional value.

Natural antioxidants: Vitamin C (ascorbic acid), Vitamin E (tocopherols), beta-carotene, and flavonoids/polyphenols found in fruits, vegetables, tea and spices such as rosemary.

Synthetic antioxidants: BHA (Butylated Hydroxyanisole), BHT (Butylated Hydroxytoluene), TBHQ (Tertiary Butylhydroquinone) and propyl gallate — man-made compounds that are cheap and effective but whose long-term high-dose consumption has raised some health concerns.

Q.5 (b) How are carbohydrates, proteins and fats digested in humans? 5

ANSWER

Carbohydrates: Digestion begins in the mouth, where salivary amylase breaks starch into maltose; it continues in the small intestine, where pancreatic amylase further breaks starch down, and brush-border enzymes (maltase, sucrase, lactase) convert disaccharides into absorbable monosaccharides (glucose, fructose, galactose).

Proteins: Digestion begins in the stomach, where pepsin (activated by hydrochloric acid) breaks proteins into peptides; in the small intestine, pancreatic enzymes (trypsin, chymotrypsin) and intestinal peptidases break these down into absorbable amino acids.

Fats: Digested mainly in the small intestine — bile emulsifies fat into tiny droplets, increasing surface area, and pancreatic lipase breaks the triglycerides into fatty acids and monoglycerides, which are absorbed into the lymphatic system as chylomicrons.

Q.5 (c) How does the Navstar GPS system work for different applications? 5

ANSWER

Navstar GPS (Global Positioning System) is a US satellite-based navigation system consisting of a constellation of roughly 24–32 satellites in medium Earth orbit, arranged so that at least four satellites are visible from any point on Earth at any time.

Working principle: Each satellite continuously broadcasts its precise position and the exact time (from an onboard atomic clock). A GPS receiver measures the signal travel-time delay from at least four satellites and uses trilateration to calculate its own precise 3-D position (latitude, longitude, altitude) and time.

Applications: vehicle and personal navigation, aviation and maritime navigation, land surveying and mapping, precision agriculture, disaster response and rescue, military guidance and targeting, timing synchronisation for telecom/financial networks, and fitness/activity tracking.

Q.5 (d)(i) Differentiate between network and internet. (ii) Difference among application, program and software. 5

ANSWER

(i) Network vs Internet: A **network** is a group of two or more interconnected computers/devices that share resources and communicate with each other, e.g. a company's local area network (LAN). The **Internet** is a global "network of networks" — millions of private, public, academic and government networks worldwide, interconnected using standardised protocols (TCP/IP).

(ii) Application vs Program vs Software: Software is the broadest term, covering all non-physical instructions and data that direct hardware — including both system software (e.g. an operating system) and application software. A **program** is a specific set of coded instructions written to perform one particular task (a basic unit of software). An **application** is a complete, user-facing software product — often built from multiple programs — designed to fulfil a particular need for the end-user (e.g. MS Word, a mobile banking app).

PART II — SECTION B (Quantitative Ability, 5 Marks per Part)

Q.6 (a) A telephone company charges initially Rs. 0.50 and then Rs. 0.11 for every minute. Write an expression for the cost of a call lasting N minutes. 5

SOLUTION

Fixed initial charge = Rs. 0.50 (connection charge, independent of duration)
Per-minute charge = Rs. 0.11 × N, for N minutes
Total cost, C(N) = fixed charge + per-minute charge

FINAL EXPRESSION

$C(N) = 0.50 + 0.11N$ (in rupees)

Q.6 (b) Find the missing number in each series. 5

SOLUTION

(i) 1, 8, 4, 27, 9, ? — Split into two interleaved series: odd positions are perfect squares (1, 4, 9 → 1^2, 2^2, 3^2) and even positions are perfect cubes (8, 27, ? → 2^3, 3^3, 4^3). So the missing number = 4^3 = **64**.

(ii) 3, 6, 8, 16, 18, ? — Pattern alternates ×2 and +2: 3×2=6, 6+2=8, 8×2=16, 16+2=18, 18×2=**36**.

(iii) 2, 8, 512, ? — Each term is the previous term cubed: 2^3=8, 8^3=512, so next = 512^3 = **134,217,728**.

(iv) 81, 9, 64, 8, ?, 12 — Pattern: (square, its root) pairs — 81=9^2, 9; 64=8^2, 8; so the missing term = 12^2 = **144** (paired with root 12).

(v) 6, 11, 21, 36, 56, ? — Differences increase by 5 each time: 5, 10, 15, 20, 25 → 56 + 25 = **81**.

FINAL ANSWERS

(i) 64 (ii) 36 (iii) 134,217,728 (iv) 144 (v) 81

Q.6 (c) The perimeter of the rectangle is 114 cm, with sides (3x−y) cm, (2x−3) cm and (2x+y) cm. Find the area. 5

SOLUTION

In a rectangle, opposite sides are equal. Since top = (3x−y) and bottom = (2x+y):
$3x - y = 2x + y \implies x = 2y$ ...(1)

Perimeter = 2(length + width) = 114 $\implies$ length + width = 57
$(3x - y) + (2x - 3) = 57 \implies 5x - y = 60$ ...(2)

Substituting (1) into (2): $5(2y) - y = 60 \implies 9y = 60 \implies y = 20/3$, and $x = 2y = 40/3$.

Length = $3x - y = 3(40/3) - 20/3 = 100/3$ cm ≈ 33.33 cm
Width = $2x - 3 = 2(40/3) - 3 = 71/3$ cm ≈ 23.67 cm

Area = Length × Width = $(100/3) \times (71/3) = 7100/9$ cm²

FINAL ANSWER

Area = 7100⁄9 ≈ 788.9 cm²

Q.6 (d) Ahmad stands 2 m in front of a spotlight, is 1.6 m tall, and faces a wall 10.5 m away. How tall is his shadow (BC) on the wall? 5

SOLUTION

Using similar triangles: the triangle formed by the light source, Ahmad's height and the ground is similar to the triangle formed by the light source, the shadow height on the wall, and the total ground distance.

Distance from light to wall = 2 m + 10.5 m = 12.5 m (AB)
Distance from light to Ahmad = 2 m (AD)
Ahmad's height = 1.6 m

By similar triangles: BC / AB = height / AD
BC / 12.5 = 1.6 / 2
BC = 12.5 × (1.6/2) = 12.5 × 0.8 = 10 m

FINAL ANSWER

Shadow height BC = 10 metres

Q.7 (a) Ali stands 10 m from a tree; his eyes are 1.5 m above his feet; the line of sight from his eyes to the treetop is 15 m. Find the height of the tree. 5

SOLUTION

This forms a right triangle: horizontal distance = 10 m, hypotenuse (line of sight) = 15 m. By the Pythagorean theorem, the vertical rise from eye-level to the treetop is:

$h = \sqrt{(15^2 - 10^2)} = \sqrt{(225 - 100)} = \sqrt{125} \approx 11.18$ m

Total tree height = vertical rise + eye height above ground = 11.18 + 1.5

FINAL ANSWER

Height of tree ≈ 12.68 metres

Q.7 (b) Find the correct word from the jumbled spellings: LNUGEF, CKANS, CIREFE, EERAANMOGTP, MNIKPPU. 5

SOLUTION

Rearranging each set of letters:

- LNUGEF → **JUNGLE**
- CKANS → **SNACK**
- CIREFE → **FIERCE**
- EERAANMOGTP → **POMEGRANATE**
- MNIKPPU → **PUMPKIN**

FINAL ANSWERS

JUNGLE, SNACK, FIERCE, POMEGRANATE, PUMPKIN

Q.7 (c) Draw/state the total number of lines of symmetry in a regular hexagon and a regular octagon. How many lines of symmetry does a circle have? 5

SOLUTION

A regular polygon has as many lines of symmetry as it has sides (each passing either through opposite vertices, opposite edge-midpoints, or a vertex and the midpoint of the opposite side).
A circle is symmetric about every diameter that can be drawn through its centre, so it has infinitely many lines of symmetry.

FINAL ANSWERS

Regular hexagon: 6 lines | Regular octagon: 8 lines | Circle: infinite lines of symmetry

Q.7 (d) The Egyptian pyramid has a height of 146.6 m and a (square) base length of 230.6 m. Find its volume. 5

SOLUTION

Volume of a pyramid = (1/3) × Base Area × Height

Base area = 230.6^2 = 53,176.36 m^2
Volume = (1/3) × 53,176.36 × 146.6
= (1/3) × 7,795,654.38
= 2,598,551.46 m^3

FINAL ANSWER

Volume ≈ 2,598,551.46 cubic metres

Q.8 (a) Ali buys an oven for Rs. 36,800 and sells it at a gain of 8.5%. For how much does he sell it? 5

SOLUTION

Selling Price = Cost Price × (1 + gain%)
SP = 36,800 × (1 + 0.085) = 36,800 × 1.085
= 36,800 + (36,800 × 0.085)
= 36,800 + 3,128

FINAL ANSWER

Selling Price = Rs. 39,928

Q.8 (b) A card is drawn at random from a box of 12 cards numbered 1–12. Find the probability of drawing: (i) '8' (ii) an even number (iii) a perfect square (iv) a negative number (v) a number less than 13. 5

SOLUTION

Total outcomes = 12
(i) Favourable outcome for '8' = 1 → P = 1/12
(ii) Even numbers {2,4,6,8,10,12} = 6 → P = 6/12 = 1/2
(iii) Perfect squares {1,4,9} = 3 → P = 3/12 = 1/4
(iv) No negative numbers exist in the set → P = 0
(v) All 12 numbers are less than 13 → P = 12/12 = 1 (certain event)

FINAL ANSWERS

(i) 1/12 (ii) 1/2 (iii) 1/4 (iv) 0 (v) 1

Q.8 (c) Nc increases linearly with Eα. Draw/derive the relationship and find Eα for Nc = 31,600. 5

SOLUTION

Eα (MeV)	0.25	0.45	0.65	1	1.4
Nc	17,500	23,500	29,500	40,000	52,000

Checking successive rates of change: (23500−17500)/(0.45−0.25) = 6000/0.2 = 30,000; the same rate (30,000 counts/MeV) holds between every pair of points, confirming a perfectly linear relationship.

Using point (0.25, 17,500): $17{,}500 = 30{,}000(0.25) + c \implies c = 17{,}500 - 7{,}500 = 10{,}000$

Linear equation: $N_c = 30{,}000\, E_\alpha + 10{,}000$ (verified against all five data points — a straight line graph)

For Nc = 31,600: $31{,}600 = 30{,}000\, E_\alpha + 10{,}000 \implies 21{,}600 = 30{,}000\, E_\alpha \implies E_\alpha = 0.72$

FINAL ANSWER

Equation of line: $N_c = 30{,}000 \cdot E_\alpha + 10{,}000$ | $E_\alpha = 0.72$ MeV when Nc = 31,600

Q.8 (d) y is directly proportional to x²; y = m for a particular value of x. Find y in terms of m when this value of x is doubled. 5

SOLUTION

Given: $y = kx^2$ for some constant k.
At a particular x: $y = m \implies m = kx^2 \implies k = m/x^2$

When x is doubled (new value = 2x):
$y' = k(2x)^2 = 4kx^2 = 4(kx^2) = 4m$

FINAL ANSWER

$y' = 4m$ (the value quadruples when x is doubled)