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IPMAT INDORE 2021 OFFICIAL PAPER

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IPMAT INDORE - 2021
QUANTITATIVE ABILITY - (SA)

Questions: 10 (+4/-0)

Sectional Time: 30 Minutes

1. The number of positive integers which divide $(1890) \cdot (130) \cdot (170)$ and are not divisible by 45 is _____
2. The sum up to 10 terms of the series $1.3 + 5.7 + 9.11 + \dots$ is _____
3. It is given that the sequence $\{x_n\}$ satisfies $x_1 = 0, x_{n+1} = x_n + 1 + 2\sqrt{1 + x_n}$ for $n = 1, 2, \dots$. Then x_{31} is _____
4. There are 5 parallel lines on the plane. On the same plane, there are n other lines which are perpendicular to the 5 parallel lines. If the number of distinct rectangles formed by these lines is 360, what is the value of n ?
5. There are two taps, T1 and T2, at the bottom of a water tank, either or both of which may be opened to empty the water tank, each at a constant rate. If T1 is opened keeping T2 closed, the water tank (initially full) becomes empty in half an hour. If both T1 and T2 are kept open, the water tank (initially full) becomes empty in 20 minutes. Then, the time (in minutes) it takes for the water tank (initially full) to become empty if T2 is opened while T1 is closed is _____
6. A class consists of 30 students. Each of them has registered for 5 courses. Each course instructor conducts an exam out of 200 marks. The average percentage marks of all 30 students across all courses they have registered for, is 80%. Two of them apply for revaluation in a course. If none of their marks reduce, and the average of all 30 students across all courses becomes 80.02%, the maximum possible increase in marks for either of the 2 students is _____
7. What is the minimum number of weights which enable us to weigh any integer number of grams of gold from 1 to 100 on a standard balance with two pans? (Weights can be placed only on the left pan.)
8. If one of the lines given by the equation $2x^2 + axy + 3y^2 = 0$ coincides with one of those given by $2x^2 + bxy - 3y^2 = 0$, and the other lines represented by them are perpendicular then $a^2 + b^2$ is _____
9. If a function $f(a) = \max(a, 0)$ then the smallest integer value of x for which the equation $f(x - 3) + 2f(x + 1) = 8$ holds true is _____
10. In a class, 60% and 68% of students passed their Physics and Mathematics examinations respectively. Then at least _____ percentage of students passed both their Physics and Mathematics examinations.

QUANTITATIVE ABILITY - (MCQ)

Questions: 20 (+4/-1)

Sectional Time: 30 Minutes

11. Suppose that a real-valued function $f(x)$ of real numbers satisfies $f(x + xy) = f(x) + f(xy)$ for all real x, y , and that $f(2020) = 1$. Compute $f(2021)$.
 (a) $\frac{2021}{2020}$ (b) $\frac{2020}{2019}$
 (c) 1 (d) $\frac{2020}{2021}$
12. Suppose that $\log_2[\log_3(\log_4 a)] = \log_3[\log_4(\log_2 b)] = \log_4[\log_2(\log_3 c)] = 0$. Then the value of $a + b + c$ is
 (a) 105 (b) 71
 (c) 89 (d) 37
13. Let S_n be sum of the first n terms of an A.P. $\{a_n\}$. If $S_5 = S_9$, what is the ratio of $a_3 : a_5$?
 (a) 9:5 (b) 5:9
 (c) 3:5 (d) 5:3
14. If A, B and $A + B$ are non-singular matrices and $AB = BA$, then $2A - B - A(A + B)^{-1}A + B(A + B)^{-1}B$ equals
 (a) A (b) B
 (c) $A + B$ (d) I
15. If the angles A, B, C of a triangle are in arithmetic progression such that $\sin(2A + B) = 1/2$ then $\sin(B + 2C)$ is equal to
 (a) $-1/2$ (b) $1/2$
 (c) $-1/\sqrt{2}$ (d) $3/\sqrt{2}$
16. The unit digit in $(743)^{85} - (525)^{37} + (987)^{96}$ is
 (a) 9 (b) 3
 (c) 1 (d) 5
17. The set of all real values of p for which the equation $3 \sin^2 x + 12 \cos x - 3 = p$ has at least one solution is
 (a) $[-12, 12]$ (b) $[-12, 9]$
 (c) $[-15, 9]$ (d) $[-15, 12]$
18. ABCD is a quadrilateral whose diagonals AC and BD intersect at O. If triangles AOB and COD have areas 4 and 9 respectively, then the minimum area that ABCD can have is
 (a) 26 (b) 25
 (c) 21 (d) 16
19. The highest possible value of the ratio of A four digit number and the sum of its four digits is:
 (a) 1000 (b) 277.75
 (c) 900.1 (d) 999
20. Consider the polynomials $f(x) = ax^2 + bx + c$, where $a > 0$, b, c are real, and $g(x) = -2x$. If $f(x)$ cuts x -axis at $(-2, 0)$ and $g(x)$ passes through (a, b) , then the minimum value of $f(x) + 9a + 1$ is
 (a) 0 (b) 1
 (c) 2 (d) 3
21. In a city, 50% of the population can speak in exactly one language among Hindi, English and Tamil, while 40% of the population can speak in at least two of these three languages. Moreover, the number of people who cannot speak in any of these three languages is twice the number of people who can speak in all these three languages. If 52% of the population can speak in Hindi and 25% of the population can speak exactly in one language among English and Tamil, then the percentage of the population who can speak in Hindi and in exactly one more language among English and Tamil is _____
 (a) 22% (b) 25%
 (c) 30% (d) 38%
22. A train left point A at 12 noon. Two hours later, another train started from point A in the same direction. It overtook the first train at 8 PM. It is known that the sum of the speeds of the two trains is 140 km/hr. Then, at what time would the second train overtake the first train, if instead the second train had started from point A in the same direction 5 hours after the first train? Assume that both the trains travel at constant speeds.
 (a) 3 AM next day (b) 4 AM next day
 (c) 8 AM next day (d) 11 PM the same day
23. The number of 5-digit numbers consisting of distinct digits that can be formed such that only odd digits occur at odd places is
 (a) 5250 (b) 6240
 (c) 2520 (d) 3360
24. There are 10 points in the plane, of which 5 points are collinear and no three among the remaining are collinear. Then the number of distinct straight lines that can be formed out of these 10 points is
 (a) 10 (b) 25
 (c) 35 (d) 36

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VERBAL ABILITY**Questions: 30 (+4/-1)****Sectional Time: 30 Minutes**

Directions (Q.31-Q.36): Read the following passage and choose the answer that is closest to each of the questions that are based on the passage.


From ancient Rome up to the Victorian era, a training in logic and rhetoric was meant to help privileged young men recognise spurious arguments and facts. Times have changed, but contemporary Italy is determined that its youth are prepared, as their ancient counterparts were, to engage meaningfully with the present-day version of the Forum — social media. At the end of October, 8,000 Italian schools will teach their students how to spot fake news through a programme developed with the help of journalists as well as tech giants Google and Facebook. In Israel, the University of Haifa is launching a course titled “Fake News”.

The purpose of these courses is to ensure that public debate, particularly during election campaigns, is not hijacked by vested interests. Since the US presidential election in 2016, the spectre of Russia and its use of online propaganda has loomed large over public discourse in the West. In other parts of the world too, doctored images and blatant lies have been published by “news” websites. Given the speed with which information is shared online, the damage is already done by the time a fake story is exposed. The voters of tomorrow certainly need to be armed with the ability to sift bare facts from motivated fiction. The effects of social media on the formation of opinion, however, go far beyond fake news.

Traditional or legacy media is ordered by a need for balance. A newspaper, for example, has sections that deal with politics, crime, sports, the arts et al. There is, at least in principle, an attempt to tell both sides of a story in each report. On social media, the only editor is the user herself. **Algorithms ensure that people see more of what they “like”, that biases are reinforced rather than countered.** Fake news is certainly a crucial aspect of online propaganda. But for young citizens to form opinions based on multiple viewpoints, they need to consciously seek out more than they are comfortable with.

31. The writer of the passage suggests that
- the purpose of education in early times was very different from what it is now.
 - there are similarities in the aims of education in early times and those of today.
 - the purpose of education in early times was to help students attain a position of privilege.
 - as times have changed the basis of education has expanded.
32. The passage points out that an important difference between traditional media and social media is that
- social media reaches more people.
 - traditional media tries to present different points of view.
 - social media is more balanced in its reports.
 - it is easier to spread fake stories through traditional media.
33. Social media is dangerous in its ability to influence opinion in readers through
- its choice of news items which are presented.
 - its balanced reporting of wide-ranging stories.
 - its ability to guide the reader to motivated conclusions.
 - the creation of interest by using dubious facts.
34. ‘Vested interests’ (Para 2) means
- hidden purposes.
 - popular interests.
 - self-serving intentions.
 - profitable motives.
35. The antonym for ‘spurious’ (Para 1) is
- inferior.
 - incisive.
 - dubious.
 - genuine.
36. The writer of the passage calls social media ‘the present-day version of the Roman Forum’ because it is a space for
- carrying out political propaganda.
 - discussing ideas.
 - nurturing political ambitions.
 - spreading spurious arguments.
- Directions (Q.37-Q.42):** Complete the following sentences by choosing the appropriate word/phrase from the options given below.
37. The impatient and intolerant mother made every effort to _____
- domineer her children.
 - dominate the child’s lives.
 - denominate her children.
 - dominion her children.

38. To avoid the ecological issues, scientists and government agencies consider how sustainable development_____
- effects the citizen.
 - affects the citizen.
 - is affective to the citizen.
 - is affectionate to the citizen.
39. I now have more productive time during the day because I keep the office gossips
- a foot away. (b) at arm's length.
 - at bay's length. (d) out of harm's way.
40. We need to cut down on our expenses, so that we are able to_
- make ends meet.
 - tie up the loose ends.
 - be more philanthropic.
 - be tax compliant.
41. A portion of the house collapsed because the contractor _____and built it with very poor quality materials.
- short-changed places
 - cut corners
 - bit the bullet
 - made a fortune
42. Our team has won every single match that they have played since January. They seem to be
- rolling in luck. (b) rolling in money.
 - on a roll. (d) on a roller coaster.
- Directions (Q.43-Q.45):** Choose the alternative so that the underlined part of the sentence is rendered correct.
43. Other politicians may have claims to seniority over their peers, based upon their accomplishments and their ability to lead campaigns, but Alexandria Ocasio-Cortez, who is often described as merely being a junior member of the House of Representatives, has
- an unparalleled seniority over all of them by virtue of her prowess in social media management.
- as merely being a junior member of the House of Representatives
 - as being a merely junior member of the House of Representatives
 - for merely being a junior member of the House of Representatives
 - as a mere junior member of the House of Representatives
44. Although the coastal city of Kundapur was once home to a flourishing maritime trade, their economy has been dependent in more recent years on the cotton textile and sugar industries.
- it's economy had depended in more recent years
 - its economy has in more recent years depended
 - the economy having in more recent years depended
 - their economy has depended in more recent years
45. Due to the progress in the field of modern medicine and advances in nutrition and hygiene, less people die every year from infectious diseases than ever before.
- fewer people die every year from infectious diseases than ever before.
 - less people die every year from infectious diseases than ever before.
 - fewer people die every year from infectious diseases than ever before.
 - every year, fewer people die from infectious diseases than have ever before.
- Directions (Q.46 and Q.47):** Each of the paragraphs given below has a sentence missing which is indicated by a blank. From the choices given below each paragraph, choose the sentence that seems most logically appropriate to complete the paragraph.




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46. Captive breeding has helped revive wildlife such as the Eurasian beaver, the cheetah and the Arabian Onyx. Several species have been reintroduced into locations in order that the ecological balance is restored. When herbivorous bandicoots were set free in the wild, they dug the ground and redistributed dry leaves and branches, reducing the chance of bush fires. But some predators may overhunt or threaten other vulnerable species.
- Hence, wildlife conservationists should revive more of herbivorous animals and enrich the ecosystems. _____
 - Conservation of carnivorous animals is complex and could be dangerous to so many other vulnerable species.
 - The revival of the ecosystem therefore, depends on the eating habits of the animals introduced therein.
 - Therefore, all species must be revived and allowed to live in forests regardless of their being carnivorous.
47. Postponed from last year, the Tokyo Olympics are set to begin this year. The locals are wary, the athletes are anxious, training sessions are truncated, and restrictions are extensive. _____ Yet Japan, in many ways is seen as a safe choice, because of its past experience of hosting big events. It has an impeccable reputation for discipline and the ability to deliver the goods.
- The Japanese are anxious but ready to welcome the athletes.
 - The shadow of the pandemic looms large over the Tokyo Olympics.
 - The International Olympic Committee has fully supported the Tokyo games.
 - Japan is going through an economic recession and could run out of funds.
48. When we think about listening, we tend to assume that it is basically the same as hearing; this is a _____ because it leads us to believe that effective listening is _____. As a result, we make little effort to learn, or develop listening skills and thereby _____ a vital communication function.
- blunder, spontaneous, forget
 - fallacy, impulsive, ignore
 - mistake, natural, reject
 - misconception, instinctive, neglect
49. As vaccination rates rise and governments relax their pandemic _____. The recovery of the event ecosystem is happening faster than expected. Event management _____ see the number of events and event attendance reaching and potentially _____ pre-pandemic levels in 2019.
- regulations, professionals, surpassing
 - monitoring, experts, confounding
 - resolutions, practitioners, reducing
 - systems, masters, exceeding
50. This _____, _____ man was actually the _____ manager the company ever had.
- assiduous, ludicrous, most able
 - assiduous, analytical, best
 - well-groomed, assertive, compassionate
 - kind-hearted, thoughtful, friendly
51. The best strategy to give an _____ is to deliver it orally as well as in _____. It is also important to _____ the employee's achievements in the same manner.
- approval, awards, promote
 - indictment, memos, realise
 - appraisal, writing, recognize
 - appreciation, increments, advertises
52. The Aravalli range is the oldest _____ geological feature anywhere in the world. These were once tall mountains, possibly as high as the Himalayas. Over hundreds of millions of years these tall mountains have been _____ to low hills and ridges. Yet, these diminutive hills have been _____ to many important events in Indian history.
- existing, reduced, sentinel
 - prevailing, destroyed, testament
 - surviving, eroded, witness
 - continuing, broken down, observers

Directions (Q.48-Q.52): The sentences below have words that are missing. Choose the best option from those given below to complete the sentence.

Directions (Q.53-Q.57): One of the statements below contains a word used incorrectly. Choose the option which has the incorrect or inappropriate usage of the word.

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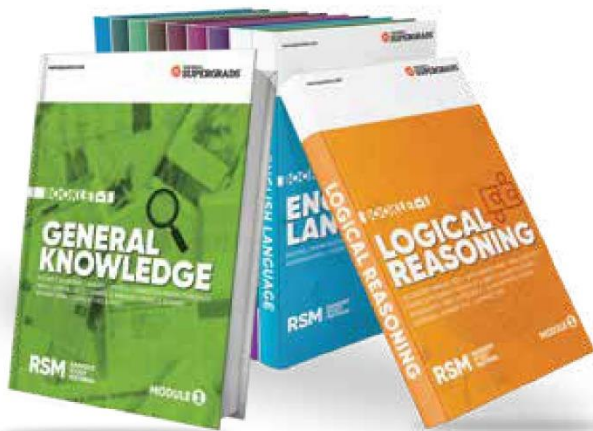
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53. One of the statements below contains a word used incorrectly. Choose the option which has the incorrect or inappropriate usage of the word.
- Naturally, the fauna of the region varies with climatic changes.
 - Some plants adapt themselves to a variety of climatic conditions.
 - When the last tree dies in the climactic scene, the message in the movie becomes clear.
 - The climactic changes from summer to winter affected the moods of the hero of the film.
54. One of the statements below contains a word used incorrectly. Choose the option which has the incorrect or inappropriate usage of the word.
- The lives of the little princes in the large castle in the rich city were luxurious.
 - The rooms were adorned with luxuriant trimmings of gold, silk and velvet.
 - They were handsome men who were distinguished by their luxuriant, golden tresses.
 - The cruise ship was of medium size, but the suites were very luxurious.
55. One of the statements below contains a word used incorrectly. Choose the option which has the incorrect or inappropriate usage of the word.
- The king was under intensive pressure to protect the borders of his vast empire.
 - The subject's loathing of the cruel emperor was intense.
 - Without intensive study, it is difficult for most students to get admitted into any course.
 - The intense debate between states led to the resolution of issues across the border.
56. One of the statements below contains a word used incorrectly. Choose the option which has the incorrect or inappropriate usage of the word.
- We called a mechanic to appraise the car before we bought it.
 - The principal called a meeting to apprise the school's governing board of the progress made by all the students in the past year.
 - At the end of each practice session, the teacher trainees are expected to appraise their own performance.
 - The soldiers returned to the camp to appraise the commanding officer of the enemy's location.
57. One of the statements below contains a word used incorrectly. Choose the option which has the incorrect or inappropriate usage of the word.
- The young girl said, "I now request our chief guest to come forward for the lighting of the lamp."
 - I just read that two men who took shelter under a tall tree during a thunderstorm were struck by lightning.
 - I believe that skin lightning products have a lot of undesirable side effects.
 - The young girl helped her mother carry some of the groceries home, thereby lightening her heavy load.
- Directions (Q.58-Q.60):** The sentences given below, when properly sequenced, form a coherent paragraph. Each sentence is labelled with a number. Decide on the most logical order and enter the sequence of numbers in the space provided, for e.g., 1234.
58. 1. In the past, companies with international aspirations simply familiarised themselves with any differences in the legal system or in the procedures used in the day-to-day business of import and export.
2. Modern trade, however, demands more from companies.
3. Today, the company seeking international success must also understand the people who live and work in countries they deal with, how they think, behave and do business.
4. To succeed in today's global market place, it is essential to learn as much as possible about the conditions in overseas markets.
59. 1. It mentions a video on TikTok that questioned an influencer's possible views on the Israel-Palestine crisis.
2. Social media has given us the expectation that every video, every tweet needs to be irreproachable and encompass the lived experiences of the audience.
3. Should celebs always have a take, asks an article in a magazine.
4. "Do you guys even care about the issue or do you care about influencers caring about the issue?"
60. 1. In a recent incident, villagers in a tea estate were shocked to find a leopard cub in a trench.
2. The cub was then taken to the area where she was discovered and reunited with her mother.
3. The 12,500 leopards in India stray into villages due to their shrinking habitat.
4. The wildlife vet examined and declared it to be uninjured but dehydrated.

ANSWER KEY AND EXPLANATIONS

1. **(320)** Factors of N which are not divisible by 45 = Total number of factors of N - Total number of factors which are multiple of 45.
 $\Rightarrow N = 1890 \times 170 \times 130$
 $= 2^3 \times 3^3 \times 5^3 \times 7 \times 13 \times 17$
 It's total no. of factors = $(3 + 1)(3 + 1)(3 + 1)(1 + 1)(1 + 1)(1 + 1)$
 $= 4 \times 4 \times 4 \times 2 \times 2 \times 2$
 $= 512$
 Now, finding its factors which are divisible by 45 or which are multiples of 45.
 Writing N as $3^2 \times 5 \times (2^3 \times 3 \times 5^2 \times 7 \times 13 \times 17)$
 $45 \times (2^3 \times 3 \times 5^2 \times 7 \times 13 \times 17)$
 Finding the factors of the bold part of N.
 $(3 + 1)(1 + 1)(2 + 1)(1 + 1)(1 + 1)(1 + 1)$
 $4 \times 2 \times 3 \times 2 \times 2 \times 2$
 $= 192$
 So, number of factors of N which are not divisible by 45 = $512 - 192$
 $= 320$

2. **(5310)** Given series can be seen as it is obtained by multiplying respective terms of two Arithmetic Progressions.
 First AP : 1, 5, 9, 13
 Its general term $T_{n_1} = 1 + (n - 1)4 = 4n - 3$
 Second AP: 3, 7, 11, 15
 Its general term $T_{n_2} = 3 + (n - 1)4 = 4n - 1$
 Now, general term of given series will be
 $(4n - 3)(4n - 1) = 16n^2 - 16n + 3$
 $\sum(16n^2 - 16n + 3) = 16 \sum n^2 - 16 \sum n + 3n$
 $16 \frac{n(n+1)(2n+1)}{6} - 16 \frac{n(n+1)}{2} + 3n$
 Put $n = 10$, we get sum as 5310.

3. **(960)** $x_1 = 0$
 Put $n = 1$, $x_2 = x_1 + 1 + 2\sqrt{1 + x_1} = 0 + 1 + 2\sqrt{1 + 0} = 3 = 2^2 - 1$
 Put $n = 2$, $x_3 = x_2 + 1 + 2\sqrt{1 + x_2} = 3 + 1 + 2\sqrt{1 + 3} = 8 = 3^2 - 1$
 Put $n = 3$, $x_4 = x_3 + 1 + 2\sqrt{1 + x_3} = 8 + 1 + 2\sqrt{1 + 8} = 15 = 4^2 - 1$
 \therefore Following the pattern $x_{31} = 31^2 - 1 = 961 - 1 = 960$

4. **(9)**

No. of rectangles = ${}^5C_2 \times {}^nC_2 = 360$

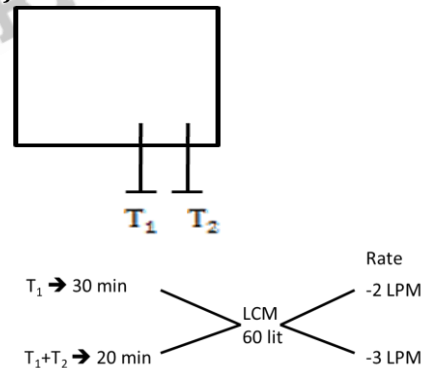
$$= 10 \times \frac{n!}{(n-2) \times 2!} = 360^\circ$$

$$= \frac{n(n-1)(n-2)!}{(n-2) \times 2} = 36$$

$$= n(n-1) = 72$$

Solving $n = 9$.

5. **(60) 60 min**



Let LCM of 30 & 20 i.e. 60L. be the capacity of the tank.
 Emptying rate of $T_1 = 60L/30min = -2$ litres/min (- sign indicates tank is being emptied)
 Emptying rate of (T_1+T_2) combined = $60L/20min = -3$ litres/min.
 Emptying rate of $T_1 +$ Emptying rate of $T_2 =$ Net rate of emptying (or, combined rate)
 $\Rightarrow -2LPM + x = -3LPM$
 $x = -1LPM$
 So, time reqd. by T_2 to empty the tank = $\frac{60L}{1LPM} = 60$ min
 $\therefore \text{time} = \frac{\text{work}}{\text{rate}}$
 $= 60$ min.

6. **(6)** Total marks = $200 \times 5 = 1000$
 Average marks = 800 (Before revaluation)
 Average marks = 80.2

(After revaluation)

Change in average = 0.2

We know, change is average = $\frac{\text{Net addition of marks}}{\text{Total number of students}}$

$$0.2 = \frac{\text{Net addition of mark}}{30}$$

$$6 = a + b$$

So the maximum value of a or b can be 6 when other is zero.

7. (7) Minimum 7 weights will be required.
 The rule, $2^n \leq 100$, where $n = 0, 1, 2, \dots$
 $2^0 = 1\text{gm}$ (smallest weight) | $2^1 = 2\text{gm}$ (second smallest weight) | $2^2 = 4\text{gm}$ | $2^3 = 8\text{gm}$ | $2^4 = 16\text{gm}$ | $2^5 = 32\text{gm}$ | $2^6 = 64\text{gm}$ (The largest weight)
 Any integer number of any gram of gold from 1 to 100gm. can be weighed using different combination of these 7 weights only.

8. (26) $2x^2 + axy + 3y^2 = (y - mx)(y - m'x) = y^2 + (-m - m')xy + mm'x^2$

$$2x^2 + bxy - 3y^2 = \left(y + \frac{1}{m}x\right)(y - m'x)$$

$$= y^2 + \left(\frac{1}{m} - m'\right)xy - \frac{m'}{m}x^2$$

Comparing the coefficient of like terms, we get

$$\left(\frac{2}{3}\right)x^2 + \left(\frac{a}{3}\right)xy + y^2$$

$$= mm'x^2 + (-m - m')xy + y^2$$

$$\left(\frac{2}{-3}\right)x^2 + \left(\frac{b}{-3}\right)xy + y^2$$

$$= -\frac{m'}{m}x^2 + \left(\frac{1}{m} - m'\right)xy + y^2$$

Equating the coefficients of like terms, we get

$$mm' = \frac{2}{3} \text{-----eq.1}$$

$$-\frac{m'}{m} = \frac{2}{-3} \text{-----eq.2}$$

$$-m - m' = \frac{a}{3} \text{-----eq.3}$$

$$\frac{1}{m} - m' = \frac{b}{-3} \text{-----eq.4}$$

Solving equations 1 and 2, we get $m = \pm 1$ & $m' = \pm \frac{2}{3}$

\therefore put $m = 1$ & $m' = \frac{2}{3}$ in equation 3

$$\Rightarrow a = -5$$

& put $m = -1$ & $m' = -\frac{2}{3}$ in equation 3

$$\Rightarrow a = 5$$

Similarly, $b = 1$ or -1

$$\therefore a^2 + b^2 = 25 + 1 = 26$$

9. (3) It is evident that the function's value will be 0, if the input a is any negative integer.

And the value of function will be a, if it is positive integer.

So checking for.

$$x = 0 \quad f(-3) + 2f(1) = 0 + 2 \times 1 = 2 \neq 8$$

$$x = 1 \quad f(-2) + 2f(2) = 0 + 2 \times 2 = 4 \neq 8$$

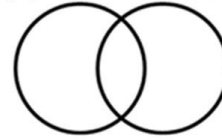
$$x = 2 \quad f(-1) + 2f(3) = 0 + 2 \times 3 = 6 \neq 8$$

$$x = 3 \quad f(0) + 2f(4) = 0 + 2 \times 4 = 8$$

$$x = 3$$

10. (28)

P (60%) M (68%)



$$n(P \cup M) = n(P) + n(M) - n(P \cap M)$$

$$n(P \cap M) = n(P) + n(M) - n(P \cup M)$$

Or,

$$n[\text{passed in both P \& M}] = n[\text{passed in Math}] +$$

$$n[\text{passed in Physics}]$$

$$- n[\text{passed in at least one of the subjects}]$$

$$n[P \& M] = 68\% + 60\% - n[P \text{ or } M]$$

In order to minimize $n[P \& M]$, we need to maximize $n[P \text{ or } M]$, which can be 100%.

$$\therefore [n(\text{passed in both})]_{\text{least}} = 68\% + 60\% - 100\% = 28\%$$

11. (a) This functional equation holds true for only one kind of function i.e.,

$f(x) = k \cdot x$, when $k \rightarrow$ is any constant

$$\therefore \text{if } f(2020) = 1$$

$$\Rightarrow k \cdot 2020 = 1$$

$$\therefore k = \frac{1}{2020} \dots \dots \dots (1)$$

$$\therefore f(2021) = k \cdot 2021$$

Putting the value of k from option (1)

$$f(2021) = \frac{2021}{2020}$$

12. (c) Take $\log_2 \log_3 \log_4 a = 0$

$$\log_3 \log_4 a = 1$$

$$(\because \log_2 1 = 0)$$

$$\log_4 a = 3$$

$$(\because \log_3 3 = 1)$$

Converting it into exponential form, we get

$$a = 4^3 = 64$$

$$\text{Similarly } b = 2^4 = 16$$

$$\& c = 3^2 = 9$$

$$\therefore a + b + c = 64 + 16 + 9 = 89$$

13. (a) Given $S_5 = S_9$

$$\frac{5}{2}[2a + 4d] = \frac{9}{2}[2a + 8d]$$

$$\frac{5}{2} \times 2[a + 2a] = \frac{9}{2} \times 2[a + 4d]$$

$$\frac{a+2d}{a+4d} = \frac{9}{5} = \frac{a_3}{a_5}$$

$$a_3 : a_5 = 9 : 5$$

14. (a) We should know the property of matrices mentioned below:

$$AA^{-1} = I \ \& \ A.I = I.A = A$$

$$2A - B - A(A+B)^{-1}A + B(A+B)^{-1}B$$

$$= 2A - B - (A+B)^{-1}[A.A - B.B]$$

$$= 2A - B - (A+B)^{-1}[A^2 - B^2]$$

$$= 2A - B - (A+B)^{-1}[(A+B)(A-B)]$$

$$= 2A - B - (A+B)^{-1}(A+B)(A-B)$$

$$= 2A - B - I.(A-B) \quad [\text{Using property } A.A^{-1}=I]$$

$$= 2A - B - (A-B) \quad [\text{Using property } A.I = A]$$

$$= 2A - B - A + B$$

$$= A.$$

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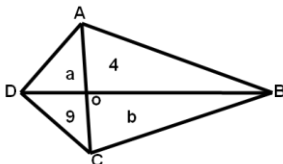


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15. (a) Let the angle A, B & C be $a - d, a, a + d$
 $(a - d) + a + (a + 2a) = 180^\circ$
 $3a = 180^\circ$
 $a = 60^\circ$
 Given $\sin(2A + B) = \frac{1}{2}$
 $\therefore 2A + B = 30^\circ$ or 150°
 $2(a - d) + a = 30^\circ$
 $3a - 2d = 30^\circ$
 $3 \times 60^\circ - 2d = 30^\circ$
 $d = 75^\circ$
 Angle A = $a - d = -15^\circ$. Not possible.
 Or
 $2A + B = 150^\circ$
 $3a - 2d = 150^\circ$
 $2d = 30^\circ$
 $d = 15^\circ$
 $A = a - d = 60 - 15 = 45^\circ$. Possible.
 also $B = 60^\circ, C = 75^\circ$
 $\therefore \sin(B + 2C) = \sin(60 + 150)$
 $\sin 210 = \sin(180 + 30)$
 $= -\sin 30^\circ$
 $= -1/2$.
16. (a) Unit digit of $(743)^{85} = (3)^{85} = 3$ (using cyclicity method)
 Unit digit of $(525)^{37} = (5)^{37} = 5$ (using cyclicity)
 Unit digit of $(987)^{96} = (7)^{96} = 1$ (using cyclicity)
 The unit digit of the expression will can be find out as follows:
 $= (...3) - (...5) + (...1)$
 $= (...4) - (...5)$
 $= (...9)$, by subtracting 5 from 14.
17. (c) $3 \sin^2 x + 12 \cos x - 3 = p$
 $\Rightarrow 3(1 - \cos^2 x) + 12 \cos x - 3 = p$
 $\Rightarrow -3 \cos^2 x + 12 \cos x = p$
 $\Rightarrow \cos^2 x - 4 \cos x = -p/3$
 $\Rightarrow \cos^2 x - 4 \cos x = -p/3$
 $\Rightarrow \cos^2 x - 4 \cos x + 4 = -p/3 + 4$
 $\Rightarrow (\cos x - 2)^2 = -p/3 + 4$
 \Rightarrow We know $-1 \leq \cos x \leq 1$
 $\Rightarrow -3 \leq \cos x - 2 \leq -1$
 $\Rightarrow 9 \geq (\cos x - 2)^2 \geq 1$
 $\Rightarrow 1 \leq (\cos x - 2)^2 \leq 9$
 $\Rightarrow 1 \leq -p/3 + 4 \leq 9$
 $\Rightarrow -3 \leq -p/3 \leq 5$
 $\Rightarrow 3 \geq p/3 \geq -5$
 $\Rightarrow 9 \geq p \geq -15$
 $\Rightarrow -15 \leq p \leq 9$.
 Or $[-15, 9]$.
Ans. $[-15, 9]$

18. (b)



Let the area of ΔAOD & ΔBOC be 'a' & 'b' unit respectively.

Property1: In any quadrilateral, product of area of pair of opposite Δ s formed by the two diagonals is a constant.

Using it, we put $4 \times 9 = a \times b$

Or $36 = a \times b$ -----(1)

Property 2: In algebra, we know

If $a, b = k$ (a constant)

Minimum value of $(a + b)_2$ can be obtained, only when $a = b$.

In order to minimize the area of Quad. ABCD,

sum of a & b should be minimum or $(a + b)_{\min} = ?$

From (1), we have

$$a \cdot b = 36$$

$$a \cdot a = 36$$

$$a^2 = 36$$

$$a = b = 6.$$

$$\therefore \text{Minimum value of } a + b = 6 + 6 = 12$$

$$\therefore \text{Minimum value of area of Quad. ABCD}$$

$$= a + b + 9 + 4 = 12 + 9 + 4 = 25.$$

19. (a) Let the A-digit no. be ABCD.

In expanded form $1000A + 100B + 10C + D$.

Required ratio will be maximum only when the digit B, C, D are '0'.

eg.

$$\frac{9000}{9+0+0+0} = \frac{9000}{9} = 1000 \text{ (max ratio)}$$

$$\frac{2000}{2+0+0+0} = \frac{2000}{2} = 1000 \text{ (max ratio)}$$

Taking any other no.

$$\frac{1234}{1+2+3+4}$$

$$= 123.4$$

(too less compared to 1000)

Explanation:

Let's us assume the ratio required is greater than or equal to 1000.

$$\frac{1000a+100b+10c+d}{a+b+c+d} \geq 1000$$

We get

$$0 \geq 900b + 990c + 999d$$

only condition possible is $0 = 900b + 990c + 999d = 0$

Therefore, $b = c = d = 0$

& a could be any non-zero digit form (0-9).

20. (b) $g(x)$ passes through (a, b), means this point should satisfy the line $g(x) = -2x$

$$\therefore b = -2a$$
 -----(1)

Also $f(x)$ passes through $(-2, 0)$, therefore

$$f(x) = ax^2 + bx + c$$

$$0 = a(-2)^2 + b(-2) + c$$

$$0 = 4a - 2b + c$$
 -----(2)

From eqn. (1) & (2), we get

$$c = 2b - 4a$$

$$= 2(-2a) - 4a$$

$$c = -4a - 4a = -8a$$
 -----(3)

The given expression is

$$E = f(x) + 9a + 1$$

$$E = ax^2 + bx + c + 9a + 1$$

$$E = ax^2 + (-2a)x + (-8a) + 9a + 1$$

$$E = ax^2 - 2ax + a + 1$$

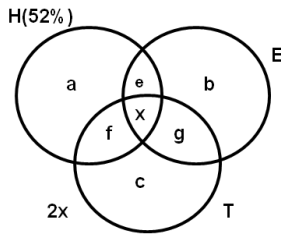
We have to find E's minimum value,

$$\frac{dE}{dx} = 2ax - 2a = 0$$

$$= a - 2a + a + 1$$

$$E_{\min} = 1.$$

21. (a)



Given

$$a + b + c = 50\% \text{ -----(1)}$$

$$e + f + g + x = 40\% \text{ -----(2)}$$

Adding two condition

$a + b + c + e + f + g + x = 90\%$. This represents the population who speaks at least one language.

It means 10% population does not speak any language i.e. $2x = 10\%$

$$\Rightarrow x = 5\%$$

Also given $b + c = 25\%$

$$\text{From diagram } b + g + c = 90\% - [52\%] = 38\%$$

$$\therefore g = 38\% - 25\% = 13\%$$

Now put value of g & x in equation (2)

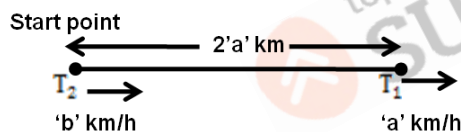
$$e + f + g + x = 40\%$$

$$e + f + 13\% + 5\% = 40\%$$

$$e + f = 40\% - 18\% = 22\%$$

No. of people who speaks Hindi and exactly one other language = $e + f = 22\%$

22. (c) At 2 pm:



Let the speed of train first a train second be 'a' and 'b'

$$\text{After 2pm, both train will meet after } = \frac{2a}{b-a} = 6 \text{ hr.}$$

(\because from 2pm - 8pm, it is 6hr.)

$$\Rightarrow 2a = 6b - 6a$$

$$8a = 6b$$

Put $x = 1$

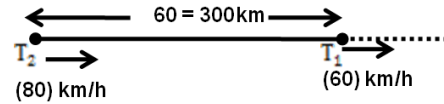
$$\text{In } E = ax^2 - 2ax + a + 1$$

$$b : a = 4 : 3$$

As $a + b = 140 \text{ km/h}$.

We get, $b = 80 \text{ km/h}$ & $a = 60 \text{ km/h}$

Now, at 5pm:



Given $a + b = 140 \text{ kmph}$.

$$3x + 4x = 140.$$

$$7x = \frac{140}{x} = 20$$

Time taken by train 2 to meet 1st train after 5pm

$$= \frac{300}{80-60} = \frac{300}{20} = 15 \text{ hr.}$$

i.e. 8am next day.

23. (c) 5 ways \times 7 ways \times 4 ways \times 6 ways \times 3 ways. (Underlined positions are odd position)

After filling odd positions with odd digits, we can fill even place with 7 left out digit.

$$\therefore \text{Total numbers formed} = 5 \times 7 \times 4 \times 6 \times 3$$

24. (d) ${}^{10}C_3 - {}^5C_3 + 1$

$$45 - 10 + 1 = 36$$

$$= 36.$$

25. (a) First find the coordinates of the point of intersection of the two lines.

$$x + 2y = 4$$

$$2x + 3y = 6$$

($x = 0, y = 2$) it means our line passes through point (0, 2)

Our line is also perpendicular to $3x - y = 2$

Any line which is perpendicular to $3x - y = 2$ will be in the form $x + 3y + k = 0$ (where $k = \text{a constant}$)

Now it is given that this line passes through (2, 0)

Then this point should satisfy the equation.

$$\text{Put } x = 0 \text{ \& } y = 2, \text{ we get } k = -6$$

$$\therefore \text{equation of required line } \Rightarrow x + 3y - 6 = 0.$$

$$3x + y = 6.$$

Transforming it into intercept form, we get

$$\frac{x}{2} + \frac{y}{6} = 1$$

$$x - \text{intercept} = 2.$$

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Hint [26-30]:

Total matches played between 6 teams = ${}^6C_2 = 15$ matches.

(A playing with B, B playing with A is same case)

#1. In a match, total points awarded = 2

(i) 2 points to winner team and 0 to losing team, or

(ii) 1 point to each team, which ends in a draw.

#2. Total points awarded in 15 matches = $15 \times 2 = 30$ points

Total points bagged by E & F together

= $30 - [8+6+5+5] = 30 - 24 = 6$ points.

Possible cases: E+F=6 points

(i) $4+2 \Rightarrow$ Only possibility

(ii) $3+3 \Rightarrow$ Not possible

(iii) $2+4 \Rightarrow$ Not possible

Justification for the possibility of case (i) only.

E scores less than 5 points (given)

E also lost 1 match out of 5 played (given)

Means rest of the 4 matches that E played should end in 4 draw and its scores come out as 4 points.

If we take E won 1 match, draws 3, then its total point will become 5 (Not possible)

Final Conclusion:

E lost 1 & draws 4. Total points = 4 points

F lost 3 & draws 2. Total points = 2 points

Justification for 2 draws for F

Out of 5 matches played by E, 4 resulted in draw. Table below shows that E cannot have draw against B, as B had 0 draws.

Means E definitely had one draw with F.

In order to score 2 points, only possibility with F is to have 2 draws and 3 losses.

Now let's Fill The Table

Team	Matches played	Matches won ($\times 2$)	Match lose ($\times 0$)	Match ending in a draw ($\times 1$)	Total points
A	5	3	0	2	8
B	5	3	2	0	6
C	5	2	2	1	5
D	5	1	1	3	5
E	5	0	1	4	4
F	5	0	3	2	2

26. (d) Adding all the entries in 'draw' column of the table we get 12 draw matches.

Halving them will give us the correct number of matches those end in a draw

$\therefore 12/2 = 6$ matches.

[In 12, A draw match with D & D draw match with A considered as different cases whereas, it should be taken as single drawn match.]

27. (d) Team E

28. (c) 2 points

29. (c) One team must be D [it has 3 draws, which cannot be with C & B]

\therefore A- D must be a draw.

One team must be E [E had 4 draws, except with B]

\therefore A- E must be a draw.

Team D

30. (c) Obviously, E had 4 draw matches and 1 lost.

(From the table, B had no draw')

Thus 'B' must have beaten 'E'.

Only Team B

31. (b) The aim of education in the past and even now is to train the young to recognize and understand the fake arguments as stated in the opening lines of the first paragraph.
32. (b) It's a direct question. As stated in the third line of the last paragraph, There is, at least in principle, an attempt to tell **both sides of a story in each report**, clearly suggests that option is the most appropriate answer.
33. (c) It's a direct question. The fifth line of the last paragraph clearly suggests that the biases are reinforced than countered in the present day forum – social media. Hence option C is the only appropriate answer.
34. (c) It's a contextual vocabulary based question. It means self-serving intentions.
35. (d) It's a contextual vocabulary based question. Spurious means – fake. It's opposite is genuine
36. (d) The first paragraph is about the purpose of education in olden days and the present day is to help the young recognize and understand the spurious or fake arguments and how contemporary Italy is determined that its youth are prepared to engage meaningfully with the present-day version of **the Forum** — social media. The focus of the passage is no political propaganda or nurturing political ambitions. Neither is it to discuss idea. The entire passage is about fake arguments and how the present generation should deal with it. Hence option D.
37. (a) Domineer – browbeat, bully
Dominate – control, influence
Denominate - be expressed in a specified monetary unit
Dominion - sovereignty or control
The word required in the given blank has to be a verb as it is preceded by 'to'. Option D - Dominion being a noun will be eliminated.
Option C – denominate is a misfit contextually
Option B – dominate is a good choice but child's lives will be grammatically wrong.
Option A is a perfect fit
38. (b) Effect – Consequence, result
Affect - influence
Affective – relating to mood, need and attitude
Affectionate – loving, fond, adoring
The word required in the given blank has to be a verb.
Option A, C and D will be ruled out.
39. (b) At arm's length – avoid, keep away from
Out of harm's way – in a safe place
A foot away means literary at some distance and at bay's length is an incorrect expression.
40. (a) **make ends meet – to have just enough to survive** tie up the loose ends - **to complete the parts of something that have not been completed** philanthropic – benefactor, a person who seeks to promote the welfare of others, especially by the generous donation of money

to good causes. be tax compliant - disposed to agree with others or obey rules, especially to an excessive degree; acquiescence option A is the perfect fit.

41. (b) cut corners - to do something in the easiest, cheapest, or fastest way bite the bullet - decide to do something difficult or unpleasant made a fortune - To earn a very large amount of money
Now a portion of the house collapsed as the contractor had used poor quality material hence "cut corners" implying cheap quality material.
42. (c) rolling in money - to be very rich
On a roll - experiencing a prolonged spell of success or good luck. on a roller coaster - sudden or extreme changes in a short time.
Rolling in luck is not a valid expression. Since the players have won every single match, they are rolling in luck. Winning doesn't automatically mean rolling in money.

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43. (d) Merely being an adverb will modify a verb whereas here the sentence is talking about a noun, Alexandria Ocasio-Cortez, therefore an adjective is required to modify it. Hence, option a, b and c will be eliminated.
44. (b) The subject of the sentence is the coastal city of Kundapur therefore option D should be eliminated since it uses the incorrect pronoun "their".
It's - it is
Its - shows possession. Therefore option A will also be eliminated.
Option C is grammatically wrong. Option B is grammatically and syntactically correct.
45. (d) To get the answer, let's understand the problems in the sentence.
Less - refers to quantity
Fewer - refers to number
Than - refers to comparison
Then - refers to time
Option A and B can be eliminated.

option C fails to maintain the parallel structure since the position of 'every year' is faulty.

Option D is the most appropriate answer.

46. (c) The paragraph talks about reviving both carnivorous and herbivorous animals and restoring the eco system. Option A talks about reviving more of herbivorous animals only. Similarly option B talks about conservation of just the carnivorous. Option D looks irrelevant as it talks about reviving all the species regardless of their being carnivorous. Option C is about the revival of the ecosystem that depends on the eating habits of the animals introduced therein. Hence the perfect conclusion to the given passage.
47. (d) The paragraph preceding the blank refers to the problems. The part following the blank talks about Japan seen as a safe option to host the Olympic. This line begins with YET that denotes contrast. Hence option D is the only option that can bridge the two parts perfectly.
48. (d) To get the answer right, all the three words should fit in the blanks contextually and grammatically.
Option A and C can be eliminated as one can't 'forget' or 'reject' a vital function.
Fallacy - is a false idea as it is based on incorrect facts or reasoning whereas misconception means a wrong idea or understanding of something. Therefore, misconception, instinctive and neglect fit perfectly in the given blanks.
49. (a) To get the answer right, all the three words should fit in the blanks contextually and grammatically.
Pandemic resolutions or systems can't be relaxed hence options c and d can be eliminated. Confounding which means confusing is a misfit in the third blank. The correct answer is option A.
50. (b) To get the answer right, all the three words should fit in the blanks contextually and grammatically
Solution: option B
The words "compassionate and friendly" won't fit the third blank as it requires a superlative. Option C and D get eliminated.
Assiduous - diligent
Analytical - systematic and logical
Ludicrous - absurd
Option A will be a misfit because both the adjectives are contrasting. Option B is a good answer choice.
51. (c) Appraisal - the act of assessing something/someone
Recognise - identify
To get the answer right, all three words should fit in the blanks contextually and grammatically.
The word writing in the second blank is the key. "The best strategy to give an appraisal is to deliver it orally as well as in **writing**."
No company would **advertise** or **realize** its employee's achievements. Therefore option b and d get eliminated. The approval can't be delivered as award hence option will also get eliminated.
52. (c) To get the answer right, all three words should fit in the

blanks contextually and grammatically.

Surviving – continuing to exist,

Eroded – to gradually wear away

Witness – observer

Third word in option d observers will be a misfit as these diminutive hills can't be observers 'to' many important events. Therefore option D gets eliminated. Second word 'destroyed' in option B is a misfit as when rocks, soil and mountains wear away, they get eroded not destroyed or reduced. Thus option B and A also get eliminated.

53. **(a)** Climatic – relating to climate
Climactic – final, culminating, forming an exciting climax
The words climatic and climactic have been correctly used in sentence b, c and d. however, the usage is incorrect in sentence a.
54. **(b)** Luxurious – opulent, sumptuous, extremely comfortable
Luxuriant – rich and profuse in growth
The usage is incorrect in sentence B.
55. **(a)** Intensive: Thorough, exhaustive
Intense – great, enormous.
The words intense and intensive have been correctly used in sentence b, c and d. the usage in sentence A is wrong.
56. **(d)** Appraise – to evaluate, access, estimate
Apprise – to inform, tell
The words appraise and apprise have been correctly used in sentence a, c and b. the word appraise in sentence D has been incorrectly used hence it is the answer.
57. **(c)** To get the answer, first we need to understand the meaning of the words that have been repeated in all the four sentences.

Lighting: abrupt electric discharge from cloud to cloud

Lighting: Illumination

Lightening: To become lighter or less dark; brighter

So, apparently, the word lighting and lightning have been used correctly in sentence A and B respectively. In sentence C however, the usage is incorrect. The word that should have been used is lightening which means to make brighter.

58. **(4123)** sentence 4 works as a passage opener for it explains what needs to be done in order to succeed globally in today's global market place. Sentence 1 will follow as it elaborates how companies with international aspirations familiarized themselves with the any differences in the legal system or in the procedures used in the day-to-day business of import and export in the past. Sentence 2 and 3 are connected statements that will follow as sentence B takes the idea forward as talks about the modern trade and its demands. Sentence 3 builds on it. **4123**
59. **(3142)** Sentence 3 works a passage opener for it begins with a question. Sentence 3 and 1 are connected as the pronoun 'it' in sentence 3 refers to the article mentioned in sentence 1. sentence 4 takes the idea forward by posing the question. Sentence 2 concludes the passage. **3142**
60. **(3142)** Let's start solving this parajumble by looking for a passage opener. Sentence 3 looks like a plausible start as it is a broad statement that introduces the leopards. Sentence 1 builds on it as it talks about a recent incident when the villagers found a cub in a trench. Sentence 1 and 3 are connected statements as these talk about the cub and how "it" was found and then taken to the vet. Sentence 4 concludes the paragraph as it says that the cub was then reunited with her mother. So the correct sequence is 3142

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