Entrance Test for Ph.D. Programme in Science Education – 2025

Read the following instructions carefully.

- This paper has two sections, section I is of multiple choice questions; and section II is a descriptive one, titled as critical reasoning.
- Section I of the written test carries **100 marks**.
- There are **a total of 80 questions** in section I distributed among different subjects as:
  - **Q 1 to 25:** Quantitative reasoning, scientific literacy and technical comprehension.
  - **Q 25 to 40:** Social and cognitive sciences and education.
  - **Q 41 to 80:** Ten questions each on biology (41 to 50), chemistry (51 to 60), mathematics (61 to 70) and physics (71 to 80).
- All questions are of multiple-choice type with four options, out of which only one option is correct. Each correct answer earns 2 marks. An unanswered question or a wrong answer earns no mark.
- You may answer **any 50 questions from section I**. In case **more than 50 questions** are attempted, the score obtained will be **normalized** to that corresponding to 50 questions, using the following formula.

$$Normalizedscore = \frac{Scoreobtained}{No.ofquestionsattempted} X50$$

- Section II of the written test carries **50 marks**. It has 3 questions, Q 81, Q 82, Q 83
  - Q 81is of 20 marks,
  - Q 82 and Q 83 are 15 marks each.

Please note

- You will need to click on **'Submit**' at the end of Section I (followed by prompts for submission for marking) to access Section II for the first time. **However,** you can continue switching between sections **anytime** to edit/update your response.
- While typing in the text boxes, the following function keys CANNOT be used/operated: Ctrl+C Ctrl+X Ctrl+V [Accidental or otherwise – use of the above keys will lead to erasing of the text matter already typed in that particular text box.] The text is saved automatically and you do not need to do anything.

Section I:

Multiple Choice Questions

Quantitative Reasoning, Scientific Literacy and Technical Comprehension

Question 1:

$ABCD$ is a four sided closed figure. Which of the following statements will definitely **not be true** about this figure?

A) $ABCD$ is both a square, and a rectangle.

B) $ABCD$ is a rectangle, but not a square.

C) $ABCD$ is a square, but not a rectangle.

D) $ABCD$ is neither a square nor a rectangle.

Answer: Option C

Question 2:

In 2003, there were 80 turtles living in a wetland. That year, the population began to grow by 12 turtles per year. Find a mathematical relation between the number of turtles (P) and number of years (t) that have passed since 2003.

A) $P = 80 + 12 + t$

B) $P = (80 + 12)t$

C) $P = 80t + 12$

D) $P = 80 + 12t$

Answer: Option D

Question 3:

Reena said to Jassi, "If you give me three of your pens, I will have thrice as many as you will have". Then Jassi told Reena, "If you give me three of your pens, I will have as many as you will have". How many pens do Reena and Jassi each have?

A) Reena has 9 pens, and Jassi has 15 pens.

B) Reena has 12 pens, and Jassi has 15 pens.

C) Reena has 15 pens, and Jassi has 12 pens.

D) Reena has 15 pens, and Jassi has 9 pens.

Answer: Option D

Question 4:

For what values of 'k' will the pair of equations $3x + 4y = 12$ and $kx + 12y = 30$ **NOT** have a unique solution?

A) 3

B) 7.5

C) 9

D) 12

Answer: Option C

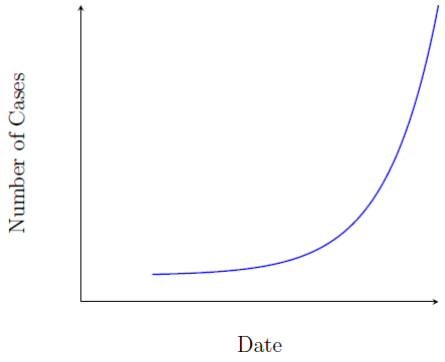
Question 5:

Following are the number of Coronavirus cases reported worldwide in the month of March 2021

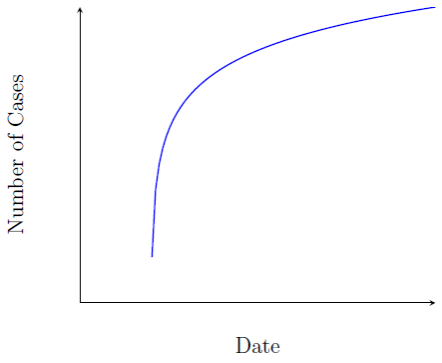
Date	Number of Cases
6 Mar	102050
17 Mar	198159
24 Mar	422574
26 Mar	531865

Which of the following graphs shows the best representation of the data? Assume both axes are scaled linearly.

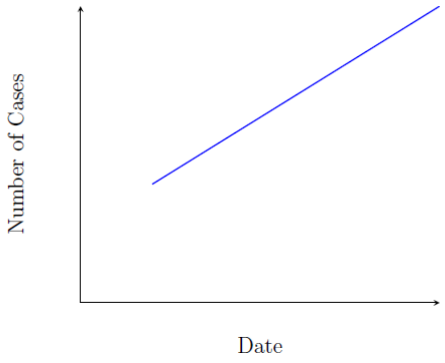
A)



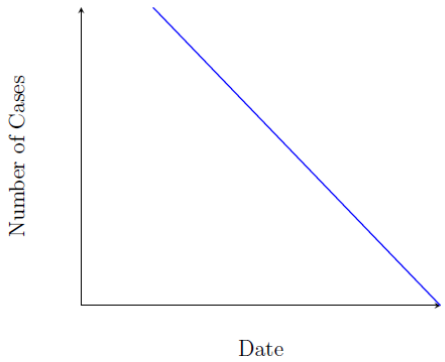
B)



C)



D)



Answer: Option A

Question 6:

In March 2024, a random sample of 900 Indian college students were surveyed on their views about the Israel-Gaza situation. 67% of the respondents agreed that India should take a neutral position. It was also stated that with 95% confidence that the maximum margin of sampling error was ±4 percentage points.
Consider following three statements related to this survey result.

(I) There are at least 600 college students in favour of a neutral position.

(II) Between 63% and 71% of all college students are in favour of a neutral position.

(III) There is a 95% chance that the percentage of all college students that are in favour of a neutral position is between 63% and 71%.

Which of these observations are true?

A) Only I B) Only III C) Only I and II D) Only I and III

Answer: Option D

Question 7:

Bhavya sold her house at a loss of 25 percent of the price she originally paid for the house and then bought another house at a price of 30 percent less than the price she originally paid for her first house. If she sold the first house for ₹22,50,000, what was her net gain, in rupees, for the two transactions?

A) ₹1,12,500 B) ₹1,50,000

C) ₹2,50,000 D) ₹6,00,000

Answer: Option B

Question 8:

A given physical process was modelled using three variables m, n, and p. The relationship between these variables is given by

$$m = k\frac{p}{3n^2}$$

where k is a constant. In an experiment based on this process, when the student doubled the value of n, the value of m was observed to be doubled. Which of the following statements is true?

A) p must double as well.

B) p must increase by a factor of 8.

C) p must increase by a factor of 4.

D) We can't tell what happens to p without knowing the value of k.

Answer: Option B

Question 9:

Akshat's shop tracks the percentage of customers who buy various items. The following percentages are recorded:

Item	% of Customers
Biscuits	60%
Chips	85%
Cold Drink	80%
Ice Cream	90%

The shop owner wants to offer a bundle that includes all four items. What is the minimum percentage of customers that must have bought all four items?

A) 60 % B) 40 % C) 15 % D) 10 %

Answer: Option C

Question 10:

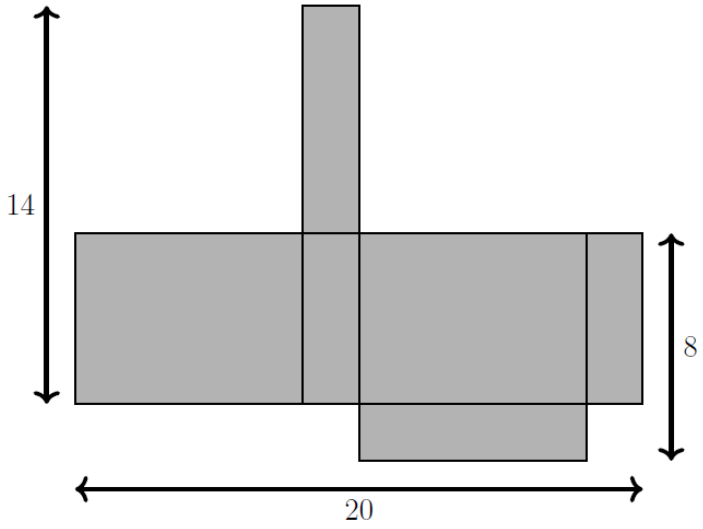
Two people are chosen at random from among 30 men and 28 women. What is the probability that both chosen people are women?

A) 23 % B) 28 % C) 58 % D) 77 %

Answer: Option A

Question 11:

A rectangular cardbord box (cuboid) has been unfolded into six connected rectangular faces laid flat. Some dimensions of the faces are provided (in cm) in the figure. Determine the volume of the cuboid when it is folded back into its original shape.



A) $63\ \text{cm}^3$

B) $96\ \text{cm}^3$

C) $280\ \text{cm}^3$

D) $300\ \text{cm}^3$

Answer: Option B

Question 12:

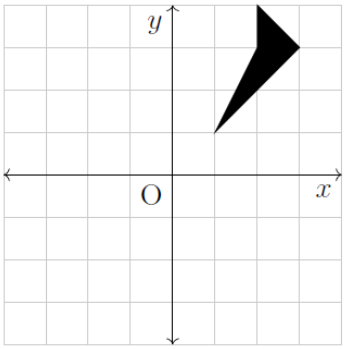
A triangle is formed by X-axis, Y-axis, and the line $3x + 4y = 60$. Then the number of points $P(a, b)$ which lie strictly inside the triangle, where a is an integer and b is a multiple of a, is

A) 29 B) 31 C) 37 D) 45

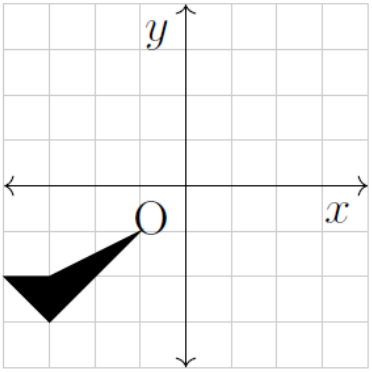
Answer: Option B

Question 13:

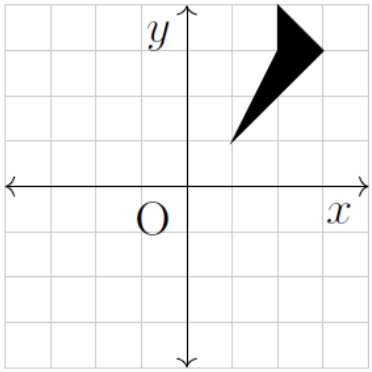
If the shaded object below is first reflected about the x axis and then rotated around the origin (O), it will now be seen as



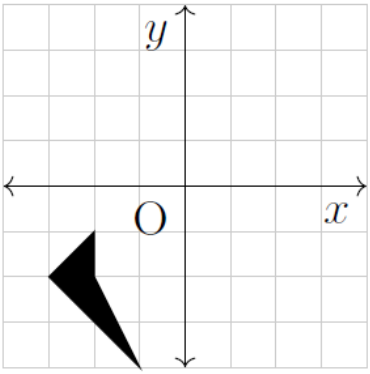
A)



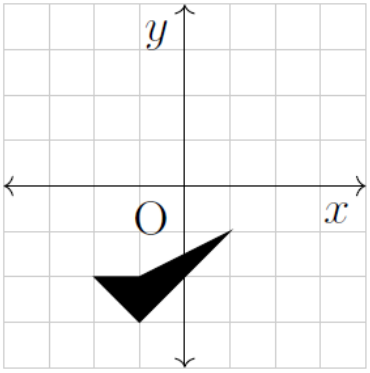
B)



C)



D)



Answer: Option A

Question 14:

The sum of all integers 'n' such that $200 < n < 300$ and H.C.F. $(77, n) > 1$ is

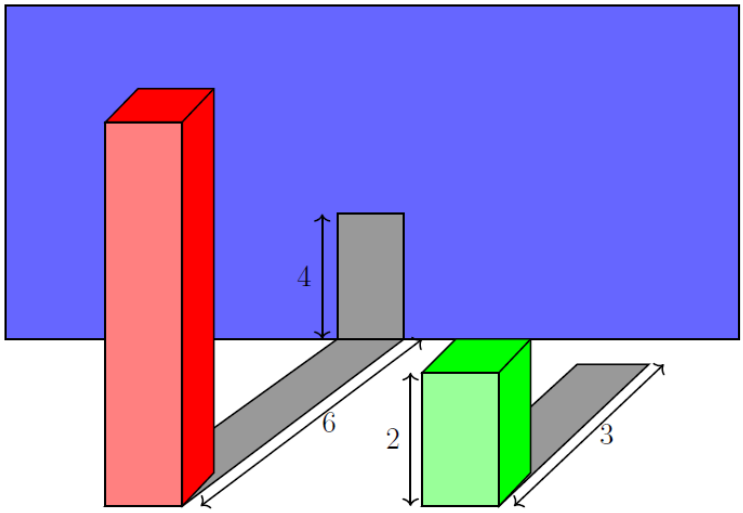
A) 5525 B) 5756 C) 5778 D) 6009

Answer: Option A

Question 15:

Two rectangular towers colored red and green, stand on the ground in front of a blue wall. The Sun casts shadows such that, the green tower, with a height of 2 m, casts a 3 m shadow on the ground. The red tower casts a 6 m shadow on the ground, with an additional 4 m shadow on the wall, as shown in the figure.

What should be the height of the red tower? You may ignore the thickness of the towers.



A) $20/3$ m B) $10/3$ m

C) 8 m D) 12 m

Answer: Option C

Question 16-20:

Read the passage carefully and answer questions based on the passage.

Protecting 30% of land and water for nature by 2030 was one of the key targets settled on by world leaders in a landmark 2022 agreement to save nature. However, simply designating more areas as protected "will not automatically result in better outcomes for biodiversity", researchers warn, in the latest study to challenge the effectiveness of conservation practices.

Nearly a quarter of the world's most biodiversity-rich land is within protected areas, but the quality of these areas is declining faster than it is outside protected areas, according to the analysis by the Natural History Museum (NHM).

Researchers looked at a Biodiversity Intactness Index, which scores biodiversity health as a percentage in response to human pressures. The report found the index declined by 1.88 percentage points globally between 2000 and 2020. It then focused on the critical biodiversity areas that provide 90% of nature's contributions to humanity, 22% of which is protected. The study found that within those critical areas that were not protected, biodiversity had declined by an average of 1.9 percentage points between 2000 and 2020, and within the areas that were protected it had declined by 2.1 percentage points.

The authors say there are a few reasons why this might be the case. A lot of protected areas are not designed to preserve the whole ecosystem, but rather certain species that are of interest, which means total "biodiversity intactness" is not a priority.

Another reason is that these landscapes could have already been suffering degradation, which is why they were protected in the first place. Researchers say specific local analysis is key to working out why each one is failing. The amount of land protected for nature stands at 17.5% of land and 8.4% of marine areas – an increase of about half a percentage point each since COP15 in 2022. This will need to increase substantially by 2030 to meet the target. But for many of those areas, the "protections in place are not stringent enough", said Thomas.

"Countries need to continue their focus on 30x30, that shouldn't waver. They just need to bring more into it, and pay more attention to actually conserving the land which provides those ecosystem services," he said.

Oil, gas and mining concessions threaten key areas for biodiversity, as well as Indigenous territories. For example, Conkouati-Douli national park is one of the most biodiverse protected areas in the Republic of the Congo – yet more than 65% of the park is covered by oil and gas concessions, according to a new report by Earth Insight.

Recent research from the University of New South Wales in Sydney looked at forested land in 300,000 of the world's protected areas and found the policy was almost "completely ineffective" in many biodiversity-rich countries. Corruption, political instability and a lack of resources were key reasons why conservation laws were not implemented.

Protected areas are also being threatened by the effects of the climate crisis: wildfires and droughts do not respect their boundaries. Emma Woods, director of policy at the Natural History Museum, said: "We urgently need to move beyond the current approach of simply designating more protected areas to 30x30. Our analysis reinforces the view that this will not automatically result in better outcomes for biodiversity and ecosystems."

Adapted from an article published in The Guardian: https://www.theguardian.com/environment/2024/oct/24/biodiversity-declining-even-faster-in-protected-areas-scientists-warn-cop16-30x30-conservation-target

Question 16

The following options contain two main conclusions made by the National History Museum study. Which two of the conclusions are true?

I) Most of the world's most biodiversity rich land is inside protected areas

II) Most of world's biodiversity rich land is outside protected areas

III) The quality of biodiversity inside protected areas is declining faster than outside

IV) The quality of biodiversity outside protected areas is declining faster than inside

A) (I) and (IV) are correct

B) (II) and (III) are correct

C) (III) and (I) are correct

D) (IV) and (II) are correct

Answer: Option B

Question 17

Which among the following reasons does not account for the reported trend in the study by National History Museum?

A) The focus of preservation in the protected areas are specific species, often at the exclusion of other species

B) Climate change impacts such as prevalence of forest fires and drought

C) Protections in place are not stringent enough

D) The amount of land protected for nature stands at 17.5% of land and 8.4% of marine areas

Answer: Option D

Question 18

The authors say that more local analysis is needed to establish the cause of biodegradation in each of the protected areas because (choose two correct options):

I) The decline in biodiversity Health Index (BHI) by a value of 2.1% indicates the overall decrease for all protected areas

II) It will allow an analysis of what are the specific variables that are leading to declining BHI at each of the designated areas

III) They are unsure about the calculated BHI of 2.1% that they are arrived at for which confirmatory studies are required.

IV) The overall decline in BHI for all areas is 1.88%, for protected areas the decline is 2.1%, and for unprotected areas 1.9%

A) (I) and (II) B) (II) and (III) C) (III) and (IV) D) (IV) and (I)

Answer: Option A

Question 19

According to the article, there are several reasons why even the existing biodiversity protection policies don't work. Choose the right set of reasons mentioned in the article:

I) Provision of oil, gas and mining concessions

II) Corruption, political instability, lack of resources

III) Their focus on key species, at the exclusion of others

IV) Of the critical biodiversity areas that provide 90% of nature's contributions to humanity, only 22% are protected

A) (I), (III), and (IV)

B) (II), (III) and (IV)

C) (I), (II), and (III)

D) (I), (II), and (IV)

Answer: Option C

Question 20

Emma Woods argues that "We urgently need to move beyond the current approach of simply designating more protected areas to 30x30". Which among the following options, based on a reading of the article, would be a wrong move in this direction?

A) More local analysis of what has gone wrong in each of the protected areas

B) Proper implementation of existing protection policies

C) Strengthen climate change mitigation efforts

D) Focus on conservation of a few key species in protected areas

Answer: Option D

Question 21-25:

Read the passage carefully and answer questions based on the passage.

When it comes to believing "fake news," we are all at a disadvantage. As people we suffer from many different cognitive biases. The most prominent of these, when it comes to “fake news” is confirmation bias, defined as "*the tendency to process information by looking for, or interpreting, information that is consistent with one’s existing beliefs*". This is an innate bias that often we are unaware of, and even when we are we need to keep reminding ourselves. When it comes to our interaction with “fake news” we are much more likely to agree with information that matches what we want to be true, and are less likely to verify information that confirms our beliefs. This is largely how “fake news” spreads as misinformation, we are not deliberately trying to share false information with our friends and family, but we may genuinely believe it is true because we want it to be.

A concept closely tied to that of confirmation bias is the filter bubble. Filter bubbles are intellectual isolation that can occur when websites make use of algorithms to selectively assume the information a user would want to see, and then give information to the user according to this assumption. Websites make these assumptions based on the information related to the user, such as former click behaviour, browsing history, search history and location. As we can tell from the definition, we are the creators of our own filter bubbles. Varying algorithms from social media sites and search engines keep track of the content we choose to interact with and then begin to show us only what the algorithm has determined we want to see. When we pair this with our innate confirmation bias, we begin creating a bubble of information that only confirms the beliefs we already have. This can aid in the spread of “fake news” because we are more likely to interact with people who hold similar beliefs as us, when those people share "fake news" it is likely to appeal to us also and so we take up the story and share it. Similarly, when we share “fake news” it is likely to appeal to our friends and they will share it. The real issue is that these algorithms are so common we may not even notice that information from other viewpoints is missing.

In this context, a recent study explored possibilities to mitigate the confirmation bias that emerges and strengthens because of social media algorithms. The study concluded that these issues should be addressed on several levels—individual, societal and technical—to most effectively combat the negative consequences of confirmation bias on social media. The most efficient way to diminish confirmation bias includes individuals themselves being aware of it and trying to prevent it. This can be encouraged through the societal and technical levels. The study also discusses challenges that are encountered on this front, particularly because of the ambiguity surrounding the black-boxed algorithms and the efficiency of debiasing strategies.

Source: Adapted from the website of the Northeastern University Library (2024) and thesis of Nella Tiainen, 2023.

Question 21

Based on the passage, which of the following may be considered as examples of confirmation bias?

(I) Seeking objective facts

(II) Interpreting information to support existing belief

(III) Only remembering details that uphold your belief

(IV) Noticing multiple perspectives

A) Statements (I) and (II)
B) Statements (II) and (III)
C) Statements (I) and (III)
D) Statements (III) and (IV)

Answer: Option B

Question 22

What does the statement "we are the creators of our own filter bubbles" imply about user agency in the digital landscape?

A) Users have no control over the content they encounter online.

B) Users are entirely dependent on external sources and websites for diverse viewpoints.

C) Users actively contribute to the narrowing of their information exposure through their choices.

D) Users can eliminate filter bubbles simply by changing biases.

Answer: Option C

Question 23

Which of the following aptly describes the interaction between confirmation bias and filter bubbles create a feedback loop that aids the spread of news and beliefs?

A) Confirmation bias leads users to engage more with conflicting information, reducing the influence of filter bubbles, thereby promoting fake news.

B) The algorithms employed by platforms deliberately promote a diverse range of viewpoints to counteract the effects of confirmation bias, and prevent fake news from spreading.

C) Filter bubbles limit exposure to diverse information, which challenges confirmation bias and discourages the sharing of similar beliefs.

D) Filter bubbles limit exposure to diverse information, which reinforces confirmation bias and encourages the sharing of similar beliefs.

Answer: Option D

Question 24

Based on the passage, which of these seem like a likely implication for social discourse?

A) The reinforcement of confirmation bias through filter bubbles leads to polarization, where individuals become entrenched in their views, diminishing the potential for constructive dialogue.

B) Confirmation bias is mitigated by social media algorithms that intentionally introduce dissenting opinions to challenge user beliefs.

C) Filter bubbles primarily affect individuals with low cognitive engagement, while those who critically evaluate information are less influenced by algorithmic curation.

D) Social media users are likely to experience a broadening of their perspectives due to algorithms presenting diverse viewpoints.

Answer: Option A

Question 25

Which of these may be considered as problems arising from Black-Box Algorithms?

(I) It can become difficult to design targeted debiasing interventions.

(II)Users are more likely to misunderstand and/or misinterpret the information they are exposed to due to these algorithms.

(III) It can become a cause for information overload for the user.

(IV) This can inadvertently prioritize certain types of content over others.

A) Statements (I) and (III) B) Statements (II) and (III)

C) Statements (I) and (IV) D) Statements (II), (III), and (IV)

Answer: Option C

Social Sciences, Cognitive Sciences and Education

Question 26:

Some of the important fundamental principles guiding National Educational Policy 2020 (NEP 2020) are:

I. Achieving foundational literacy and numeracy by grade 3

II. Emphasis on conceptual learning over rote learning and exam-centered learning

III. Focus on summative over formative assessment

IV. Clear separation between arts and sciences, and curricular and extracurricular activities

A) (I) and (II) B) (II) and (III) C) (I) and (IV) D) (I) and (III)

Answer: Option A

Question 27:

The following are **NOT stipulated** by the Right to Education (2009) Act:

I) Right of children to free and compulsory education till completion of class XII in a neighborhood school

II) Provisions for a non-admitted child to be admitted to an age appropriate class.

III) Prohibition of screening procedures for admission of students

IV) Encouraging private tuition (coaching) by teachers

A) (I) and (II) B) (II) and (III) C) (I) and (IV) D) (II) and (IV)

Answer: Option C

Question 28:

What is constructionism?

A) Constructionism is a theory describing the developmental changes of adolescents.

B) Constructionism is an approach for deigning physical spaces on educational campuses.

C) Constructionism is an approach to learning via building things.

D) Constructionism is a guiding process for memorizing key concepts.

Answer: Option C

Question 29:

The term ‘liberalization in 1991’ in the Indian context refers to:

A) Opening up the Indian economy to the world market.

B) Instituting educational reforms that are progressive in nature

C) Implementing equal rights for women and men in the workplace

D) Getting rid of the conservative outlook in all legislation

Answer: Option A

Question 30:

Which of the following statements is true regarding the relationship between basic sciences and engineering?

A) Engineering develops after basic sciences.

B) Engineering precedes work in basic sciences.

C) Engineering and basic sciences develop in tandem.

D) All the above scenarios are possible.

Answer: Option D

Question 31:

Which of the following statements is the **most appropriate** in relation to the role played by intuitions and everyday reasoning in scientific knowledge construction?

A) Intuitions and everyday reasoning stifle the construction of scientific knowledge.

B) Intuitions and everyday reasoning act as resources while constructing scientific knowledge.

C) Intuitions and everyday reasoning distract the construction of scientific knowledge.

D) There are no substantial differences between intuitive knowledge and scientific knowledge.

Answer: Option B

Question 32:

Which of the following constructs is **NOT** part of a theory of cognitive development?

A) Equilibration

B) Assimilation

C) Nominalization

D) Zone of Proximal Development

Answer: Option C

Question 33:

The NEP 2020 document recommends 6% of the GDP of India to education. The total spending on education by the Government of India is what percent of the GDP of India (on average over the last 5 years) (Pick the nearest choice.)

A) 2% B) 4% C) 8% D) 12%

Answer: Option B

Question 34:

Of these four statistical measures, which one is/are descriptive statistical measure/s?

I) Standard deviation II) Confidence intervals

III) MANOVA IV) Correlation coefficient

A) I only B) I and II only C) II and III only D) IV only

Answer: Option A

Question 35:

As a part of implementation of NEP 2020 the Ministry of Education, Government of India has launched the NIPUN Bharat Mission. The aims of the NIPUN Bharat Mission are

I) ensure that children learn in a joyful manner through play, stories, rhymes, activities, local art, craft and music.

II) development of initiatives to promote undergraduate student networks.

III) ensure undergraduate laboratory needs are met across the country.
IV) improve foundational literacy & numeracy from preschool to grade 3.

The correct choice is ─

A) I only B) II and III only C) I and IV only D) IV only

Answer: Option C or D

Question 36:

In 2001, the Sarva Shiksha Abhiyan (SSA) programme was introduced by the Government of India to ensure universal retention and achievement at the elementary stage. It promoted:

A) Formative evaluation B) Summative evaluation

C) Diagnostic evaluation D) Continuous & Comprehensive evaluation

Answer: Option D

Question 37:

Which among the following types of learning could be **most difficult** to achieve using conventional methods of teaching?

I) Skill acquisition II) Acquisition of facts III) Conceptual change

IV) Memorization of theorems V) Building responsively on students' diverse ideas

A) I and II B) II and IV C) III and V D) I and IV

Answer: Option C

Question 38:

Coursera, EdX, MIT OCW, Swayam, Udemy, Udacity are some examples of MOOCs. What are MOOCs?

A) Massive Online Open Curriculum
B) Mobile Open Online Classroom
C) Massive Open Online Course
D) Modular Open Online Course

Answer: Option C

Question 39:

Learning is described as a sociocultural process according to Vygotsky. Which of the following condition/s then affect learning?

I) Availability of interaction and language

II) Penalty and Rewards

III) Presence of others

IV) Approval of society

A) IV B) I and III C) II and IV D) II and III

Answer: Option B

Question 40 [new question]:

Three former education schemes of the Government of India ─ Sarva Shiksha Abhiyan (SSA), Rashtriya Madhyamik Shiksha Abhiyan (RMSA) and Teacher Education (TE) were subsumed under a new framework to treat school education holistically without segmentation from pre-nursery to Class 12. The merged scheme is called ─

A) National Curriculum Framework for School Education (NCFSE 2023)

B) Samagra Shiksha Abhiyan

C) National Education Policy (NEP 2020)

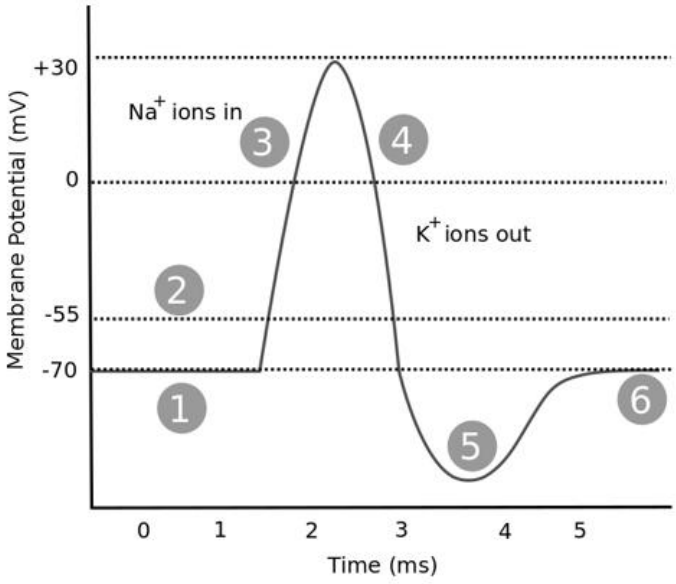
D) Padhe Bharat Badhe Bharat

Answer: Option B

Biology

Question 41:

In the following graph of action potential in neuron, label the sequences appropriately:



A)

(1) resting state

(2) resting potential

(3) threshold

(4) depolarization

(5) hyperpolarization

(6) repolarization

B)

(1) threshold

(2) resting potential

(3) repolarization

(4) depolarization

(5) hyperpolarization

(6) resting state

C)

(1) resting state

(2) hyperpolarization

(3) threshold

(4) repolarization

(5) resting potential

(6) depolarization

D)

(1) resting potential

(2) threshold

(3) depolarization

(4) repolarization

(5) hyperpolarization

(6) resting state

Answer: Option D

Question 42:

Earthworms tend to escape when introduced in NaCl solution. In an experimental study, the time of escape was recorded in NaCl solution and distilled water was used as a control. Assign the independent variable (IV) and dependent variable (DV) in the experimental design.

A) NaCl solution (IV) and Time (DV)

B) Time (IV) and NaCl solution (DV)

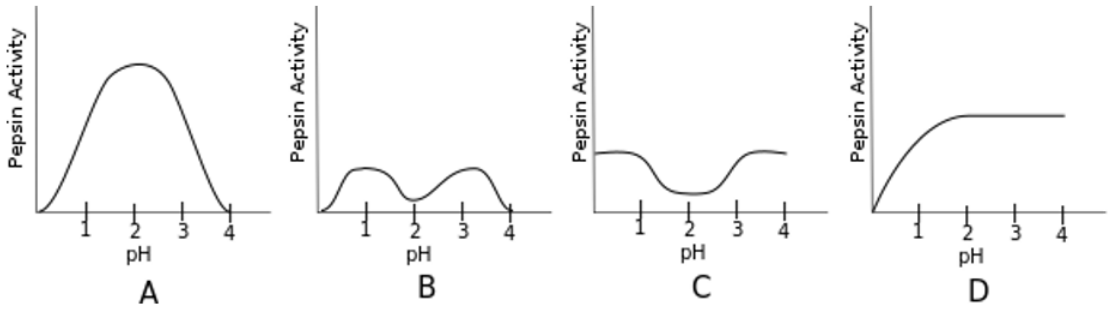
C) Distilled water (IV) and NaCl solution (DV)

D) NaCl solution (IV) and Distilled water (DV)

Answer: Option A

Question 43:

Pepsin is an enzyme present in the cells in the stomach that helps to digest food. Which of the following graphs depict the activity of pepsin when the pH of the stomach is increased?

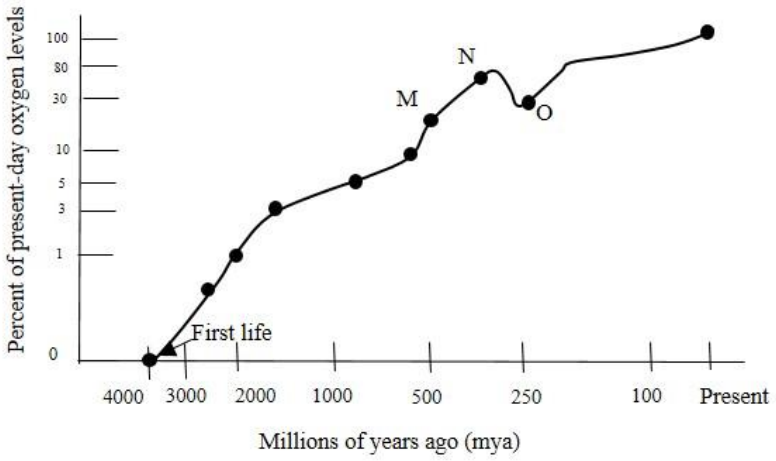


A) Graph A B) Graph B C) Graph C D) Graph D

Answer: Option A

Question 44:

The given plot shows points indicating milestone evolutionary events in relation to the increasing oxygen levels in the atmosphere.



Points M, N, O respectively represent:

A) First flowering plants; invasion of land; first chordates

B) Invasion of land; first aerobic bacteria; first chordates

C) First chordates; invasion of land; first flowering plants

D) Invasion of land; first photosynthetic bacteria; first flowering plants

Answer: Option C

Question 45:

In a cloning experiment, (i) an enucleated egg from a black mouse (ii) was fused with the nucleus from an agouti mouse and (iii) transplanted into an albino 'surrogate mother'. What would be the expected phenotype/s of the offspring?

A) Albino only

B) Black and agouti mice in equal numbers

C) Black, agouti and albino mice in the ratio 1:2:1

D) Agouti only

Answer: Option D

Question 46:

Black body colour in guinea pigs is completely dominant over albino. A cross between two guinea pigs resulted in 75% of the progeny pups having black body colour while the rest were albino. The parents most likely are:

A) Homozygous black and albino

B) Heterozygous black and albino

C) Homozygous black and heterozygous black

D) Heterozygous black and heterozygous black

Answer: Option D

Question 47:

Which of the following statement is ***not true*** in case of X linked recessive inheritance.

A) Male progeny cannot be a carrier when the mother is affected and father unaffected.

B) Carrier female and affected male produce 50% affected and 50% carrier female progeny.

C) Affected male can pass on the trait to his son even if the mother is normal.

D) Affected female passes the traits to all her sons but not necessarily to all her daughters.

Answer: Option C

Question 48:

Which of the following is FALSE regarding RNA polymerase during eukaryotic transcription?

A) It does not require a primer.

B) It requires NTPs.

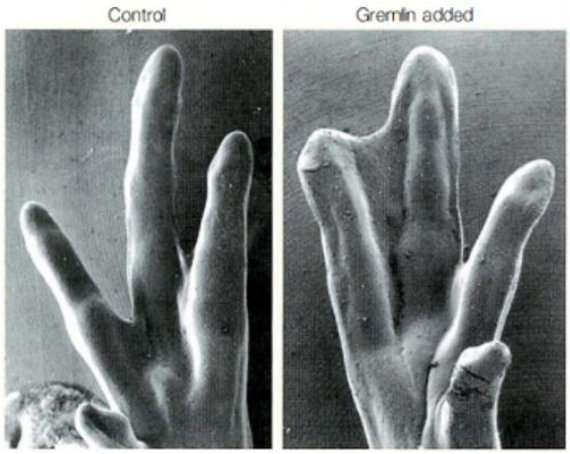
C) It does not have proof-reading activity.

D) It makes an RNA starting with AUG.

Answer: Option D

Question 49:

In an experiment on avian limb development, developing chicken eggs were opened and beads that secrete a protein Gremlin were added to the area of webbing of the chicken embryonic hindlimbs. Beads that do not contain Gremlin were added to the other hind limbs. The eggs were closed and the limb development was observed. The results are shown. Based on what is known regarding limb development and the results of this experiment, choose the correct statement/s.



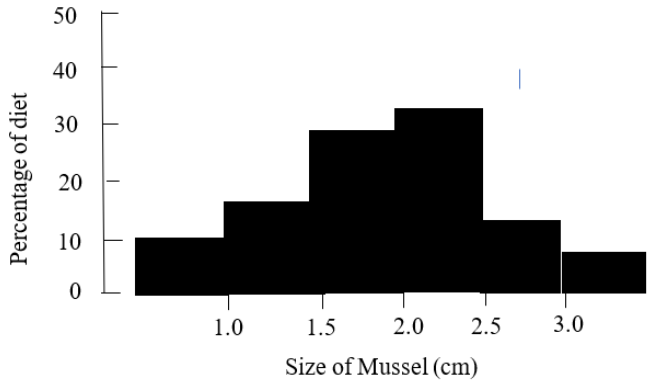
I. Gremlin causes the growth of weblike skin between the digits.
II. Use of hindlimbs of a duck would serve as a more appropriate control for the experiment.
III. Addition of Gremlin to duck limbs would most likely lead to development of chicken-like toes.
IV. Gremlin could be an inhibitor of a protein involved in the apoptosis cascade.

A) (I) and (III)
B) (II) and (III)
C) (II) and (IV)
D) Only (IV)

Answer: Option D

Question 50:

In a study on the prey-catching behavior of shore crabs (*Carcinus maenas*), the crabs were given a choice of different-sized mussels. After capturing, the crabs crack open the shells and consume the prey. The % of different sized mussels consumed by the crabs when given the choice is plotted in the given graph.



The results indicate that:

A) The rate of energy return is highest for the largest sized mussels.

B) The cost to benefit ratio for the crab is lowest when it consumes small sized mussels since the actual consumable food is least.

C) The energy content of the medium sized mussels is the highest due to which the crabs prefer them the most.

D) The time taken to find mussels and the ability of the crab to handle the mussels prior to consumption influences prey selection.

Answer: Option D

Chemistry

Question 51:

Given that H_2SO_4 has $pK_{a1} = -3$ and $pK_{a2} = 2$, which option best describes a 0.1 M H_2SO_4 solution?

A) $[H_3O^+] = 0.1\ M, [HSO_4^-] < 0.1\ M$

B) $[H_3O^+] = 0.2\ M, [SO_4^{2-}] = 0.1\ M$

C) $[H_3O^+] > 0.1\ M, [HSO_4^-] > 0.1\ M$

D) $[H_3O^+] > 0.1\ M, [SO_4^{2-}] < 0.1\ M$

Answer: Option D

Question 52:

For the reaction, $PCl_5(g) \leftrightharpoons PCl_3(g) + Cl_2(g)$ in a closed container with a movable piston at a fixed (high) temperature (maintained by keeping it in contact with a thermal bath), the forward reaction is favored by:

1. introducing nitrogen gas at constant volume.
2. introducing nitrogen gas at constant pressure.
3. doubling moles of all gases following their equilibrium amounts keeping the pressure unchanged.
4. doubling moles of all gases following their equilibrium amounts keeping the volume unchanged.
5. decreasing the pressure of the container.

A) 4, 5 B) 2, 5 C) 4, 3 D) 1, 4

Answer: Option B

Question 53:

The degeneracy of the first excited state of the H and He atoms are respectively (without considering electron spin):

A) 4 and 1 B) 4 and 4 C) 3 and 1 D) 1 and 1

Answer: Option A

Question 54:

Identify the option where all selected molecules possess permanent dipole moments at room temperature.

A) NO_2, O_3, BF_3 B) O_3, BF_3, $BeCl_2$

C) BF_3, $BeCl_2$, H_2S D) NO_2, H_2S, BrF_5

Answer: Option D

Question 55:

Identify the option where all selected reactions are redox reactions:

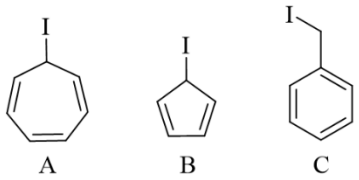
1. $Pb^{2+}(aq) + H_2S(aq) \rightarrow PbS\ (s) + 2H^+(aq)$
2. $2NaN_3\ (s) \rightarrow 2Na\ (s) + 3N_2\ (g)$
3. $HNO_3\ (aq) + NH_3\ (aq) \rightarrow NH_4NO_3\ (aq)$
4. $3O_2 + UV\ light \rightarrow 2O_3$
5. $CO_2\ (aq) + H_2O\ (l) \rightarrow C_6H_{12}O_6\ (aq) + O_2\ (g)$
6. $nCH_2{=}CH_2\ (g) \rightarrow {-}(CH_2 - CH_2){-}_n\ (s)$

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

Answer: Option B

Question 56:

Hydrolysis is a process that involves the breakage of a bond facilitated by water. In case of halogenated compounds such as given below, A, B and C, the hydrolysis is typically followed by substitution reactions to give corresponding alcohols. The correct order of the overall reaction will be:



A) $C > A > B$

B) $C > B > A$

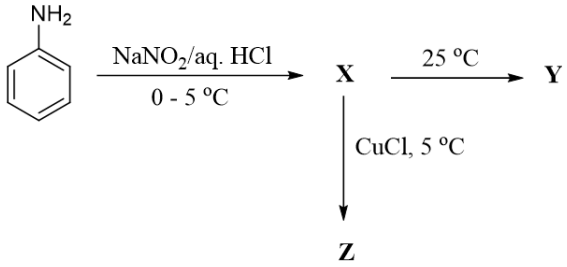
C) $A > C > B$

D) $B > A > C$

Answer: Option C

Question 57:

Consider the following reaction with aniline as the starting material. Under the given conditions, the conversion of **X** to **Y** occurs when the reaction mixture is allowed to reach 25 °C, while the conversion of **X** to **Z** takes place upon adding cuprous chloride to the reaction mixture at 5 °C. Identify **X**, **Y**, and **Z**.



A) **X**: Nitrobenzene; **Y**: 3-hydroxynitrobenzene; **Z**: 3-chloronitrobenzene

B) **X**: Benzenediazonium chloride; **Y**: 3-hydroxynitrobenzene; **Z**: 3-chloronitrobenzene

C) **X**: Nitrobenzene; **Y**: Phenol; **Z**: Chlorobenzene

D) **X**: Benzenediazonium chloride; **Y**: Phenol; **Z**: Chlorobenzene

Answer: Option C

Question 58:

Which of these pairs of compounds could be separated on the basis of their solubility in water?

A) $AgNO_3$ and $CaBr_2$

B) CCl_4 and C_6H_{14}

C) $ZnSO_4$ and $AgCl$

D) $BaCO_3$ and $CaCO_3$

Answer: Option C

Question 59:

In a laboratory experiment, you are given an unknown organic compound. Through preliminary tests, you observe the following:

Solubility test: Insoluble in water, dilute NaOH and dilute HCl

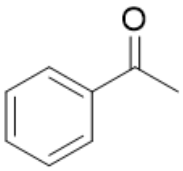
Ignition test: The compound burns with a sooty flame

Reaction with 2,4-Dinitrophenylhydrazine (DNPH): A yellow precipitate forms

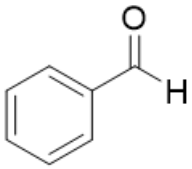
Tollen's test: No reaction occurs

Based on these observations, which of the following is the likely the compound?

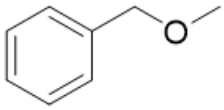
A)



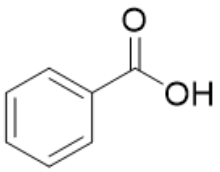
B)



C)



D)



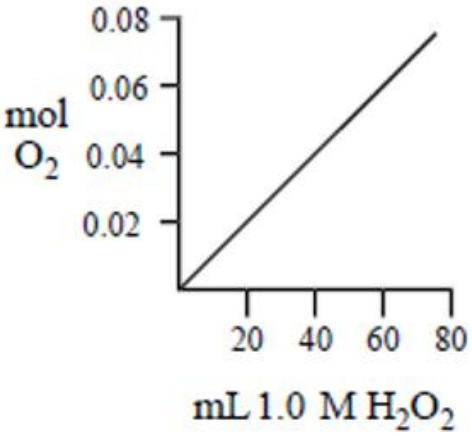
Answer: Option B

Question 60:

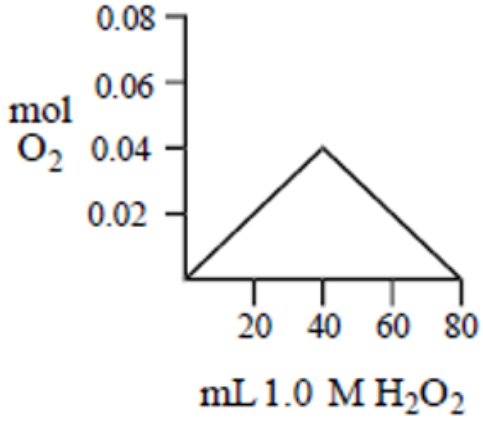
A sample containing 0.040 mol $KMnO_4$ solution is treated with varying amounts of 1.00 M aqueous H_2O_2. According to the chemical reaction shown, the graph which correctly represents the amount of O_2 (g) that evolved is-

$$2KMnO_4 + 3H_2SO_4 + 5H_2O_2 \rightarrow K_2SO_4 + 2MnSO_4 + 8H_2O + 5O_2$$

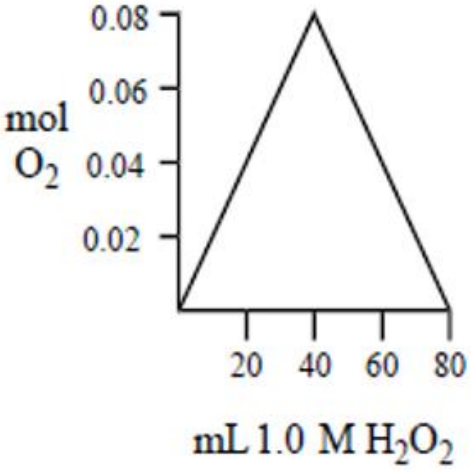
A)



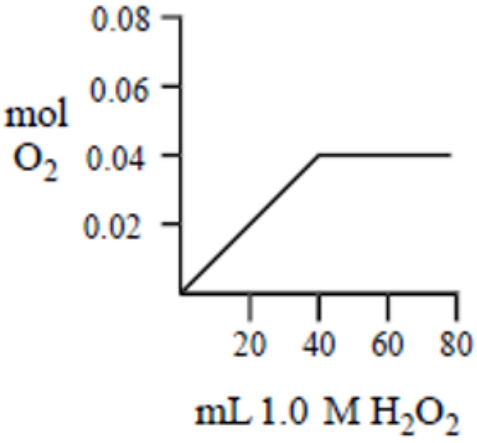
B)



C)



D)



Answer: Option A

Mathematics

Question 61:

Let α and β be the roots of $x^2 - 5x + p = 0$ and γ and δ be the roots of $x^2 - 10x + q = 0$. If α, β, γ, and δ form a geometric progression. Then ratio $(3q + p) : (3q - p)$ is:

A) 11:13 B) 13:11

C) 7:9 D) 9:7

Answer: Option B

Question 62:

Let f be any function continuous on $[a, b]$ and twice differentiable on (a, b). If for all $x \in (a, b)$, $f'(x) > 0$ and $f''(x) < 0$, then for any $c \in (a, b)$, $\frac{f(c)-f(a)}{f(b)-f(c)}$ is always greater than:

(I) $\frac{b-c}{c-a}$

(II) $\frac{c-a}{b-c}$

(III) $\frac{c+a}{b-c}$

(IV) $\frac{b+c}{c-a}$

A) only I is TRUE B) only II is TRUE

C) I and IV are TRUE D) II and III are TRUE

Answer: Option B

Question 63:

Three baskets P, Q, and R contain the following:

- Basket P: 8 white and 2 blue balls
- Basket Q: 6 white and 4 blue balls
- Basket R: 8 white and 8 blue balls

If a basket is selected at random and a ball is drawn from it, and the ball drawn is blue, what is the probability that it was drawn from basket Q?

A) $\frac{1}{9}$

B) $\frac{2}{7}$

C) $\frac{4}{11}$

D) None of the above

Answer: Option C

Question 64:

Consider the following statements.

(I) The smallest positive integer is neither prime nor composite.

(II) The smallest positive real number does not exist.

(III) $3.14 < \pi < \frac{22}{7}$.

(IV) $(\sqrt{-1})^{2024} + (\sqrt{-1})^{2025} + (\sqrt{-1})^{2026}$ is a real number.

The number of correct statements among statements (I), (II), (III), (IV) is

A) 1 B) 2 C) 3 D) 4

Answer: Option C

Question 65:

Let $A = \{1, 2, 3, 4\}$ and $R = \{(1, 2), (3, 4), (2, 4)\}$ be a relation on A. Let S be an equivalence relation on A such that $R \subset S$ and the number of elements in S is n. Then the minimum value of n is:

A) 10 B) 12 C) 14 D) 16

Answer: Option D

Question 66:

The number of ways of choosing a pair of parallel diagonals of a regular octagon $PQRSTUVW$ is

A) 16 B) 24 C) 32 D) 40

Answer: Option A

Question 67:

Let E be the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ where $a > b > 0$ and let P be a point on E. As P moves along the circumference of E the midpoint M of the line segment joining the feet of the perpendiculars drawn from P onto the tangents drawn to E from the point $T(b, a)$ describes

A) straight line B) circle C) parabola D) ellipse

Answer: Option D

Question 68:

Let $\mathbb{R}$ be the set of all real numbers. Let $f : \mathbb{R} \to \mathbb{R}$ and $g : \mathbb{R} \to \mathbb{R}$ be two functions. Suppose f is an even function and $g(x) + g(-x) = 1$ for all real numbers x. Then $\int_{-1}^{1} f(x)g(x)dx$ is equal to

A) $\int_0^1 f(x)dx$ B) $\int_0^1 g(x)dx$

C) $\int_0^1 f(x)g(x)dx$ D) 0

Answer: Option A

Question 69:

Let A, G, H be the arithmetic mean, geometric mean and harmonic mean respectively of two distinct positive real numbers. Let λ be a positive real number. The largest subset of $\mathbb{R}$ over which the function

$$f(x) = \frac{(A+\lambda)x^2 - 2Gx + (H-\lambda)}{(H+\lambda)x^2 - 2Gx + (A+\lambda)}$$

admits finite real values is

A) $(-\infty, -\lambda) \cup (\lambda, \infty)$.

B) $(-\infty, -\sqrt{A}) \cup (\sqrt{A}, \infty)$.

C) $(-\infty, -\sqrt{H}) \cup (\sqrt{H}, \infty)$.

D) $(-\infty, \infty)$.

Answer: Option D

Question 70:

In triangle ABC,

$$\sin A \sin B + \cos A \cos B \sin C = 1$$

and the length of one of its sides is 1. Let s be the sum of the other two sides of ABC. Then

A) s is always irrational and s^2 is always rational.

B) s and s^2 are always irrational.

C) either s^2 is rational or $(s-1)^2$ is rational.

D) s is rational.

Answer: Option C

Physics

Question 71:

A force $\vec{F}$ is acting on a particle moving in the X-Y plane. The linear momentum of the particle is given by $\vec{p}(t) = \cos(at)\hat{\mathbf{i}} - \sin(at)\hat{\mathbf{j}}$, where a is a constant. The angle between the momentum and force is

A) $0°$ B) $30°$

C) $45°$ D) $90°$

Answer: Option D

Question 72:

If the kinetic energy of a body is increased by 300 %, its momentum will increase by

A) 100% B) 150% C) 600% D) 900%

Answer: Option A

Question 73:

Imagine yourself going around on a merry-go-round, while your friend is standing on the ground. In your frame of reference, what are the forces on your friend, apart from the forces of gravity and normal force exerted by the ground?

A) No other force B) Centrifugal force only

C) Coriolis force only D) Centrifugal force and Coriolis force

Answer: Option D

Question 74:

The equation of a transverse wave is

$$y = 4\sin\pi(0.01x - 2t)$$

Here x and y are in cm and t is in s. The speed of the wave is

A) $2\pi ms^{-1}$

B) $2ms^{-1}$

C) $4ms^{-1}$

D) $20ms^{-1}$

Answer: Option B

Question 75:

In a laboratory experiment, a student measures the voltage across a resistor using a digital voltmeter with least count 0.01 V and with a known systematic error of +0.05 V. The voltmeter records the following measurements for three different resistors:

1. Resistor 1: Measured voltage $V_1 = 12.10$ V
2. Resistor 2: Measured voltage $V_2 = 13.65$ V
3. Resistor 3: Measured voltage $V_3 = 14.80$ V

The student wants to report the average voltage and its maximum possible uncertainty, considering the systematic and random uncertainty. Choose the correct option.

A) $13.52 \pm 0.05V$

B) $13.52 \pm 0.06V$

C) $13.47 \pm 0.03V$

D) $13.47 \pm 0.05V$

Answer: Option C

Question 76:

In a spectrometer experiment using a diffraction grating, a student measures the angles of diffraction for multiple wavelengths of light emitted from a spectral source. Considering the grating equation $d \sin\theta = n\lambda$, which of the following scenarios best illustrates the impact of varying the slit spacing d on the diffraction pattern and wavelength resolution?

A) Increasing the slit spacing *d* will result in larger angles for all orders of the spectrum, enhancing the visibility of closely spaced wavelengths, thereby improving wavelength resolution.

B) Decreasing the slit spacing *d* will cause the diffraction angles to decrease for a fixed wavelength, allowing higher orders of the spectrum to be resolved without ovelapping, thus improving wavelength resolution.

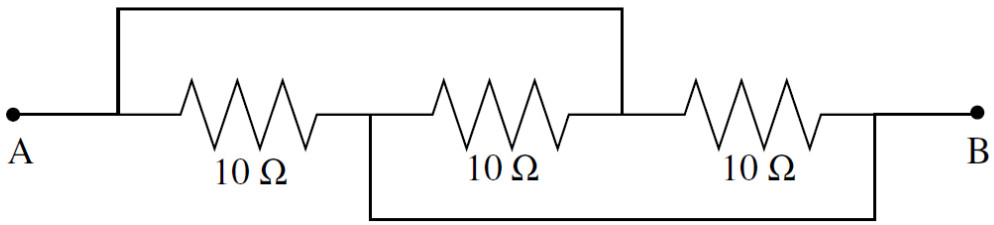
C) The wavelength resolution remains constant regardless of changes in slit spacing *d*; thus, altering *d* only affects the intensity of the diffracted light, not the angle or order of the spectrum.

D) Changing the slit spacing *d* affects the diffraction angles such that higher orders become more closely spaced at smaller *d*, making it difficult to resolve them distinctly without increasing the distance to the screen.

Answer: Option D

Question 77:

Effective resistance between points A and B of the following resistance network is



A) $\frac{10}{3}\Omega$

B) $\frac{20}{3}\Omega$

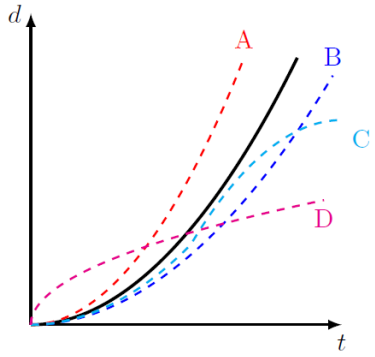
C) 15Ω

D) 20Ω

Answer: Option A

Question 78:

Consider a body falling vertically after being released from a height. The black solid graph below shows how the distance d measured from the point of release varies with time t for a freely falling body. Now suppose that the body is falling through air, i.e., the effect of air cannot be neglected. Select one of the dashed graphs to describe this motion.

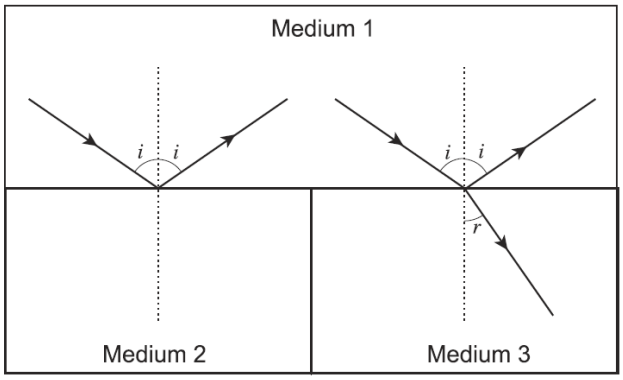


A) A B) B C) C D) D

Answer: Option B

Question 79:

The figure below shows what happens to an incident ray of light at the interface of Mediums 1 and 2 and also at the interface of Mediums 1 and 3.



Choose the correct relation for the refractive indices of Medium 1, Medium 2 and Medium 3.

A) $n_1 < n_2 < n_3$

B) $n_1 < n_3 < n_2$

C) $n_2 < n_1 < n_3$

D) $n_2 < n_3 < n_1$

Answer: Option C

Question 80:

Consider a material whose work function is 4 eV. What is the longest wavelength of light that can cause photoelectric emission from this material. Take the Plancks constant, $h = 6.626 \times 10^{-34}$ Js, if needed.

A) 170 nm B) 310 nm C) 440 nm D) 670 nm

Answer: Option B

Section II

Critical reasoning

Question 81:

Describe briefly any research topic of your interest in science education, OR mathematics education, OR technology education. (Provide arguments for why that research is important, and outline the possible educational outcomes of the research you have described.) Please stick to a word limit of **approximately 300 words**.

Question 82:

Write a short essay (**approximately 250 words each**) on **any ONE** of the following three themes/issues in science education. Mention your essay serial number (for example, Essay No. 2) at the start.

1) Skills/competencies/attitudes that can be nurtured by the science and mathematics curriculum to students who decides to pursue STEM as well as non-STEM careers
2) Integration of computational thinking in science curricula
3) Teaching about topics at the interface of science, ethics, and politics (for example climate change, vaccination, food safety, pollution or any other similar topic)

Question 83:

Write a short essay (**approximately 250 words each**) on **any ONE** of the following three themes/issues in science education. Mention your essay serial number (for example, Essay No. 2) at the start.

1) Celebrations, cultural practices & waste management.
2) Relationship between gender and STEM disciplines
3) Engaging students in scientific modelling exercise