

Paper Specific Instructions

1. The examination is of 3 hours duration. There are a total of 60 questions carrying 100 marks. The entire paper is divided into three sections, **A**, **B** and **C**. All sections are compulsory. Questions in each section are of different types.
2. **Section – A** contains a total of 30 **Multiple Choice Questions (MCQ)**. Each MCQ type question has four choices out of which only **one** choice is the correct answer. Questions Q.1 – Q.30 belong to this section and carry a total of 50 marks. Q.1 – Q.10 carry 1 mark each and Questions Q.11 – Q.30 carry 2 marks each.
3. **Section – B** contains a total of 10 **Multiple Select Questions (MSQ)**. Each MSQ type question is similar to MCQ but with a difference that there may be **one or more than one** choice(s) that are correct out of the four given choices. The candidate gets full credit if he/she selects all the correct answers only and no wrong answers. Questions Q.31 – Q.40 belong to this section and carry 2 marks each with a total of 20 marks.
4. **Section – C** contains a total of 20 **Numerical Answer Type (NAT)** questions. For these NAT type questions, the answer is a real number which needs to be entered using the virtual keyboard on the monitor. No choices will be shown for these type of questions. Questions Q.41 – Q.60 belong to this section and carry a total of 30 marks. Q.41 – Q.50 carry 1 mark each and Questions Q.51 – Q.60 carry 2 marks each.
5. In all sections, questions not attempted will result in zero mark. In **Section – A (MCQ)**, wrong answer will result in **NEGATIVE** marks. For all 1 mark questions, 1/3 marks will be deducted for each wrong answer. For all 2 marks questions, 2/3 marks will be deducted for each wrong answer. In **Section – B (MSQ)**, there is **NO NEGATIVE** and **NO PARTIAL** marking provisions. There is **NO NEGATIVE** marking in **Section – C (NAT)** as well.
6. Only Virtual Scientific Calculator is allowed. Charts, graph sheets, tables, cellular phone or other electronic gadgets are **NOT** allowed in the examination hall.
7. The Scribble Pad will be provided for rough work.

SECTION – A
MULTIPLE CHOICE QUESTIONS (MCQ)

Q. 1 – Q.10 carry one mark each.

Q.1 Which one of the following protozoan parasites belongs to the phylum *Apicomplexa*?

- (A) *Toxoplasma gondii* (B) *Leishmania donovani*
(C) *Entamoeba histolytica* (D) *Trichomonas vaginalis*

Q.2 Which one of the following statements is **CORRECT** for *Mycoplasma*?

- (A) Their cells are of definite shape.
(B) They are resistant to lysis by osmotic shock.
(C) Their growth is not inhibited by penicillin.
(D) They are nonpathogenic to human.

Q.3 Which one of the following organelles is enclosed by a single membrane?

- (A) Ribosome (B) Mitochondria
(C) Endoplasmic reticulum (D) Centrosome

Q.4 Pyramid of energy in a forest ecosystem is

- (A) always inverted. (B) dumb-bell shaped.
(C) spindle shaped. (D) always upright.

Q.5 In the feedback regulation of an enzyme, the end product binds to the

- (A) active site of the enzyme. (B) allosteric site of the enzyme.
(C) enzyme-substrate complex. (D) substrate.

Q.6 What is the source of electrons in photosynthesis?

- (A) Carbohydrates (B) Water (C) CO₂ (D) NADH

Q.7 The value of $\lim_{x \rightarrow \infty} \frac{3x^2 + 5x + 4}{4 + 2x^2}$ is

- (A) 0 (B) 0.75 (C) 1.5 (D) 3

Q.8 Three vectors are as follows:

$$\vec{a} = 3\hat{i} - 10\hat{j} + 7\hat{k}$$

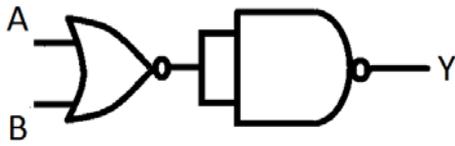
$$\vec{b} = -9\hat{i} + 6\hat{j} - 47\hat{k}$$

$$\vec{c} = 11\hat{i} - 17\hat{k}$$

The value of $(\vec{a} \times \vec{b}) \cdot \vec{c}$ is

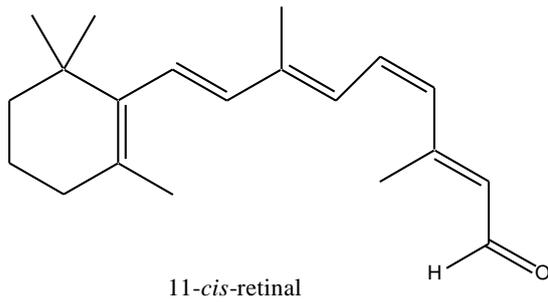
- (A) 614 (B) 746 (C) 2 (D) 134

Q.9 The logic operation (OR, AND, NOR or NAND) carried out by following circuit is



- (A) AND (B) NOR (C) OR (D) NAND

Q.10 The reaction of 11-*cis*-retinal with the lysine residue of a specific protein forms the light-sensitive pigment in the cells of retina. The light-sensitive pigment is an



- (A) amide. (B) acid.
(C) anhydride. (D) imine.

Q. 11 – Q. 30 carry two marks each.

Q.11 Viral capsids are made up of morphological subunits called capsomeres. One of the common capsomeres is icosahedral. The icosahedron is a regular polyhedron with

- (A) 16 triangular facets and 12 vertices.
- (B) 20 triangular facets and 12 vertices.
- (C) 16 triangular facets and 16 vertices.
- (D) 20 triangular facets and 16 vertices.

Q.12 Which of the following feature(s) should be present in a protein to generate strong immune response (antibody production) in an animal?

- I. At least one B-cell epitope
- II. At least one T-cell epitope
- III. Proteolytic cleavage site(s)

- (A) I only
- (B) II and III
- (C) I and III
- (D) I, II and III

Q.13 Match the entries in Group I with that in Group II.

Group I

- P) Cholera toxin
- Q) Diphtheria toxin
- R) Lipopolysaccharide
- S) Tetanus toxin

Group II

- 1) Endotoxin
- 2) Neurotoxin
- 3) Enterotoxin
- 4) Cytotoxin

- (A) P-1, Q-2, R-3, S-4
- (C) P-3, Q-4, R-1, S-2

- (B) P-3, Q-2, R-1, S-4
- (D) P-4, Q-1, R-2, S-3

Q.14 Proenzyme pepsinogen is secreted from 'P' of gastric mucosa and converted into active enzyme pepsin on exposure to 'Q' secreted from 'R'. Choose the **CORRECT** combination of P, Q and R.

- | | | |
|------------------------|-----------------------|--------------------|
| (A) P - chief cells | Q - hydrochloric acid | R - oxyntic cells |
| (B) P - parietal cells | Q - enterokinase | R - chief cells |
| (C) P - oxyntic cells | Q - hydrochloric acid | R - parietal cells |
| (D) P - peptic cells | Q - gastrin | R - oxyntic cells |

Q.15 When bacteria are grown in glucose-depleted media containing high concentration of lactose, expression of *lac* operon genes is activated by

- (A) the binding of *lac* repressor in the operator site and cAMP-CAP complex in the CAP site.
- (B) the dissociation of bound *lac* repressor from the operator site and binding of cAMP-CAP complex in the CAP site.
- (C) the dissociation of bound *lac* repressor only from the operator site.
- (D) the dissociation of both bound *lac* repressor from operator site and cAMP-CAP complex from CAP site.

Q.16 Match the hormones in Group I with their functions in Group II

Group I

- P) Aldosterone
 Q) Luteinizing hormone (LH)
 R) Atrial natriuretic factor (ANF)
 S) Epinephrine

Group II

- 1) Stimulates the synthesis and secretion of androgens from the testis
 2) Helps in the re-absorption of Na^+ and water from the kidney
 3) Increases the heart rate and the strength of heart contraction.
 4) Causes dilation of blood vessels and reduction of blood pressure

- (A) P-2, Q-3, R-4, S-1
 (C) P-1, Q-2, R-3, S-3

- (B) P-2, Q-1, R-4, S-3
 (D) P-3, Q-4, R-2, S-1

Q.17 Match the entries in Group I with that in Group II

Group I

- P) Fehling's test
 Q) Ninhydrin reaction
 R) Biuret reaction
 S) Nitroprusside reaction

Group II

- 1) α -Amino acid
 2) Reducing sugar
 3) Sulfhydryl group
 4) Peptide linkage

- (A) P-1, Q-2, R-3, S-4
 (C) P-2, Q-1, R-4, S-3

- (B) P-3, Q-4, R-1, S-2
 (D) P-4, Q-1, R-2, S-3

Q.18 Match the entries in Group I with that in Group II

Group I

- P) Vitamin B₁
 Q) Vitamin B₂
 R) Vitamin B₅
 S) Vitamin B₆

Group II

- 1) Co-enzyme A
 2) Flavin mononucleotide
 3) Pyridoxal phosphate
 4) Thiamine pyrophosphate

- (A) P-4, Q-3, R-2, S-1
 (C) P-1, Q-2, R-3, S-4

- (B) P-3, Q-1, R-4, S-2
 (D) P-4, Q-2, R-1, S-3

Q.19 If $\log(x) = x^2$ and $\log(y) = 2^x$, then $\log(\log(y))$ is

(A) 2^{x^2}

(B) x^2

(C) 2^{2^x}

(D) x^2

Q.20 The number of three letter words, with or without meaning, which can be formed using letters of the word 'VIRUS' without repetition of letters is

(A) 30

(B) 40

(C) 60

(D) 120

Q.21 What is the solution of $\int x^2 \ln x \, dx$
 Given C is ? an arbitrary constant.

- (A) $\frac{x^3}{3} \ln x - \frac{x^3}{9} + C$ (B) $\frac{x^3}{3} \ln x + \frac{x^3}{9} + C$
 (C) $-\frac{x^3}{9} \ln x + \frac{x^3}{9} + C$ (D) $\frac{x^3}{9} \ln x - \frac{x^3}{3} + C$

Q.22 The area of an equilateral triangle with sides of length x is

- (A) $\frac{\sqrt{3}x^2}{4}$ (B) $\frac{\sqrt{3}x^2}{2}$ (C) $\frac{1}{2}x^2$ (D) $\frac{1}{\sqrt{2}}x^2$

Q.23 Nucleus of a radioactive material can undergo beta decay with half life of 4 minutes. Suppose beta decay starts with 4096 nuclei at $t = 0$, the number of nuclei left after 20 minutes would be

- (A) 1024 (B) 128 (C) 512 (D) 256

Q.24 Which one of the following shows the **CORRECT** relationship among velocity of light in a medium (v), permittivity of medium (ϵ) and magnetic permeability of medium (μ)?

- (A) $v = \frac{1}{\epsilon \mu}$ (B) $v = \frac{1}{\epsilon \mu^2}$ (C) $v = \frac{1}{\epsilon \mu}$ (D) $v = \frac{1}{\sqrt{\epsilon \mu}}$

Q.25 A 30 μF capacitor is connected to a 240 V, 50 Hz source. If the frequency of the source is changed from 50 Hz to 200 Hz, the capacitive reactance of the capacitor will

- (A) increase by a factor of two.
 (B) increase by a factor of four.
 (C) decrease by a factor of four.
 (D) decrease by a factor of two.

Q.26 Match the entries in Group I (Mechanical system) with analogous quantities in Group II (Electrical system)

Group I

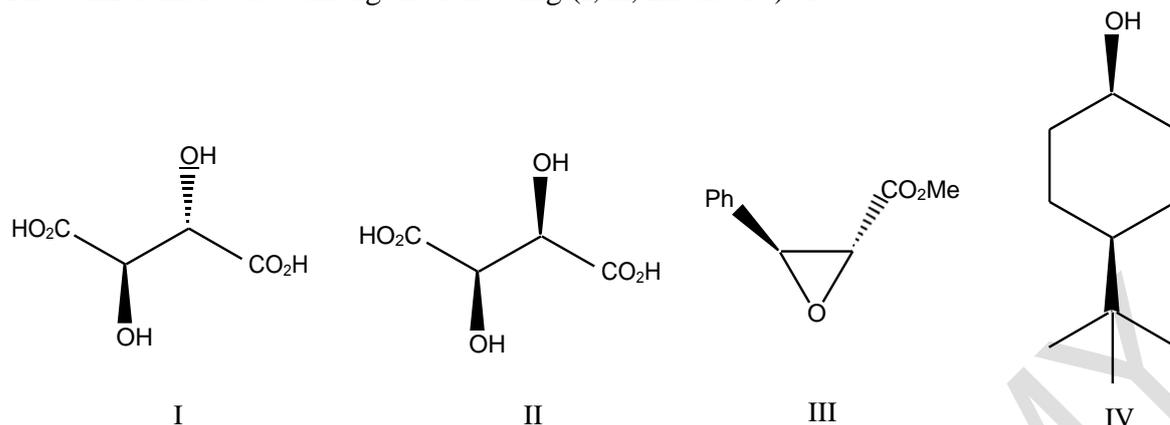
- P) Mass
 Q) Spring constant
 R) Displacement
 S) Velocity

Group II

- 1) Current
 2) Voltage
 3) Reciprocal capacitance
 4) Charge
 5) Inductance

- (A) P-3, Q-5, R-4, S-1 (B) P-5, Q-3, R-4, S-2
 (C) P-3, Q-5, R-4, S-2 (D) P-5, Q-3, R-4, S-1

Q.27 The achiral molecules among the following (I, II, III and IV) are



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

Q.28 Match the entries in Group I with those in Group II

Group I

- P) Proline
Q) Oxytocin
R) Aspartame
S) Penicillin

Group II

- 1) Artificial sweetener
2) Cyclic amino acid
3) β -Lactam
4) Peptide hormone

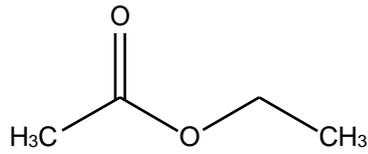
- (A) P-2, Q-4, R-1, S-3 (B) P-3, Q-1, R-4, S-2
(C) P-4, Q-3, R-1, S-2 (D) P-2, Q-1, R-4, S-3

Q.29 Which one of the following statements is **CORRECT**?

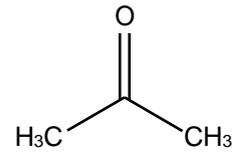
- (A) BF_3 is a stronger Lewis acid than BI_3 .
(B) CO and CN^- are good π -accepting ligands.
(C) *cis*-Diamminedichloroplatinum (II) has zero dipole moment.
(D) Central atom in BCl_3 is sp^3 hybridized.

Q.30 In the ^1H NMR spectrum, which one of the following compounds will show a triplet?

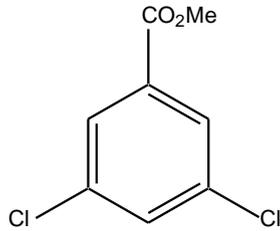
(A)



(B)



(C)



(D)



SECTION - B**MULTIPLE SELECT QUESTIONS (MSQ)**

Q. 31 – Q. 40 carry two marks each.

Q.31 Antibody binds to antigen in solution through

- (A) ionic interactions. (B) hydrogen bonds.
(C) van der Waals interactions. (D) hydrophobic interactions.

Q.32 Plasmid mediated antibiotic resistances in bacteria are acquired by

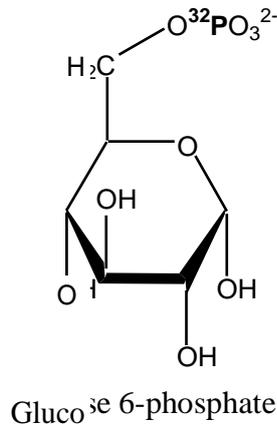
- (A) hydrolysis by β -lactamase (penicillin resistance).
(B) expression of aminoglycoside modifying enzyme (kanamycin resistance).
(C) mutation in DNA gyrase (quinolone resistance).
(D) overproduction of dihydrofolate reductase (trimethoprim resistance).

Q.33 Which of the following statements is/are **CORRECT** for G protein-coupled receptor (GPCR) mediated signaling?

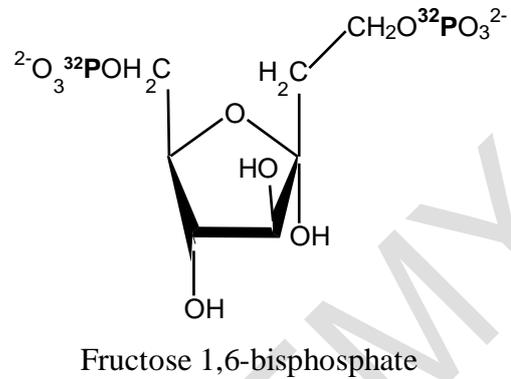
- (A) GPCRs contain seven membrane spanning regions.
(B) GPCRs are linked to heterotrimeric G protein consisting of α , β and γ subunits.
(C) In the absence of GPCR interacting ligand, α subunit of G protein is bound to GTP and complexed with $\beta\gamma$ subunits.
(D) In the presence of GPCR interacting ligand, GTP is displaced from α subunit of G protein by GDP, GDP bound α subunit dissociates from $\beta\gamma$ dimer and activates the effector.

Q.34 Glucose is incubated with enzymes of glycolytic pathway (except pyruvate kinase), gamma ^{32}P -ATP and unlabeled inorganic phosphate. Which of the following products is/are formed?

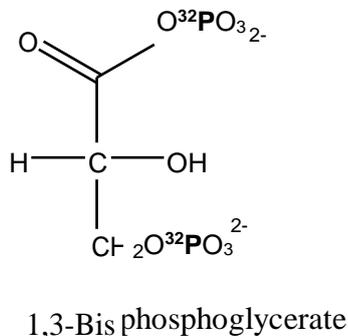
(A)



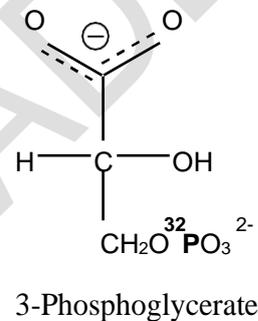
(B)



(C)



(D)



Q.35 In a double stranded DNA, which of the following ratios is/are always equal to 1?
A, T, G and C denote the number of bases.

- (A) $(A+T)/(G+C)$ (B) $(A+G)/(T+C)$ (C) A/G (D) $(G+T)/(A+C)$

Q.36 Consider the equation $x^3 - 1 = 0$. If one of the solutions to this equation is 1, the other solution(s) is/are

- (A) $\frac{-1}{2} + \frac{\sqrt{3}}{2}i$ (B) i
(C) $-i$ (D) $-\frac{1}{2} - \frac{\sqrt{3}}{2}i$

Q.37 Which of the following statements is/are **CORRECT** regarding self-inductance of a long solenoid having cross sectional area (A), length (l) and having n turns per unit length filled with material of relative permeability μ_r ?

- (A) It depends on the geometry of solenoid.
(B) It does not depend on geometry of solenoid.
(C) It depends on cross sectional area of solenoid.
(D) It depends on relative permeability of the medium.

Q.38 If an optician prescribes a corrective lens of power -2.0 D, the required lens

- (A) is a concave lens.
- (B) is a convex lens.
- (C) has a focal length of $+50$ cm.
- (D) has a focal length of -50 cm.

Q.39 Which of the following statements is/are **CORRECT**?

- (A) Absorption occurs at all wavelengths if light passes through a given solution.
- (B) The efficiency of a photochemical process is often expressed in terms of quantum yield.
- (C) The unit of molar extinction coefficient is $\text{litre mole}^{-1}\text{cm}$.
- (D) The extent of absorption in a dilute solution would be the same if the concentration is doubled and the path-length of light passing through solution is halved.

Q.40 Which of the following pairs of compounds can be distinguished by iodoform test performed in ammonium hydroxide?

- | | |
|--|---|
| (A) CH_3COCH_3 and $\text{C}_2\text{H}_5\text{OH}$ | (B) $\text{C}_2\text{H}_5\text{OH}$ and CH_3OH |
| (C) CH_3COCH_3 and $\text{C}_6\text{H}_5\text{COCH}_3$ | (D) $\text{C}_6\text{H}_5\text{COCH}_3$ and $\text{C}_2\text{H}_5\text{OH}$ |

SECTION – C

NUMERICAL ANSWER TYPE (NAT)

Q. 41 – Q. 50 carry one mark each.

Q.41 The total number of genetically different types of gametes that will be produced by a heterozygous plant carrying the genotypes AABbCc is _____.

Q.42 A healthy individual has the cardiac output of 5.5 L and heart rate of 72 beats per minute. The stroke volume of the individual is _____ mL.

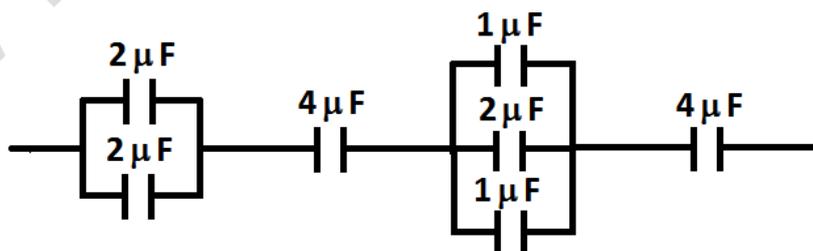
Q.43 Both strands of a DNA molecule are labeled with radioactive thymidine and are allowed to duplicate in an environment containing non-radioactive thymidine. The number of DNA molecules that will contain radioactive thymidine after three duplications is _____.

Q.44 The number of cycles required for complete degradation of Palmitic acid (16 Carbon) by β -oxidation is _____.

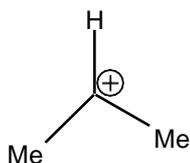
Q.45 The value of $\log_{\square} 4^{-16}$ is -32 . The value of \square is _____.

Q.46 The determinant of the matrix $\begin{vmatrix} 1 & 3 & 0 \\ 2 & 6 & 4 \\ -1 & -1 & 2 \end{vmatrix}$ is _____.

Q.47 The equivalent capacitance of following assembly of capacitors is _____ μF .

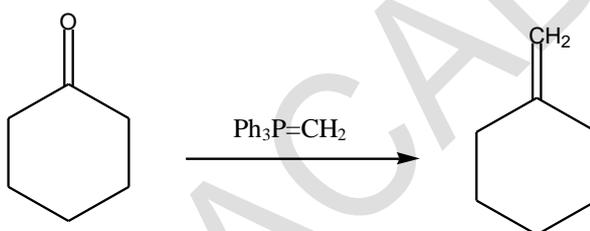


Q.48 The stability of the following carbocation arises from hyperconjugation with _____ number of hydrogen atoms.



Q.49 Oxidation state of Fe in the complex $K_3[Fe(CN)_5NO]$ is (+)_____.

Q.50 The mechanism of the following reaction involves the formation of a _____ membered ring.



Q. 51 – Q. 60 carry two marks each.

Q.51 The concentration of a purified enzyme is 10 mg/mL. Ten microlitres of the enzyme solution in a total reaction volume of 1 mL catalyses the formation of 20 nanomoles of product in one minute under optimum conditions. The specific activity of the enzyme is _____ unit/mg.

Q.52 A 100 nucleotide-long single stranded poly-(A) is synthesized from adenosine monophosphate (AMP) at physiological pH.
(Atomic mass of C = 12, H = 1, O = 16, P = 31; at physiological pH, Molecular mass of AMP = 345).

The molecular mass of the resulting poly-(A) at physiological pH is _____.

Q.53 If a colour-blind woman marries a normal man, the chance that their boy child will be colour-blind is _____%.

Q.54 For a 0.1 M aqueous solution of lysine, the pH at which it carries no net charge is _____.

(pK_a values for: α-carboxylic group = 3.1, α-amino group = 8.0, ε-amino group = 10.8)

Q.55 For $a =$ _____, the following simultaneous equations have an infinite number of solutions:

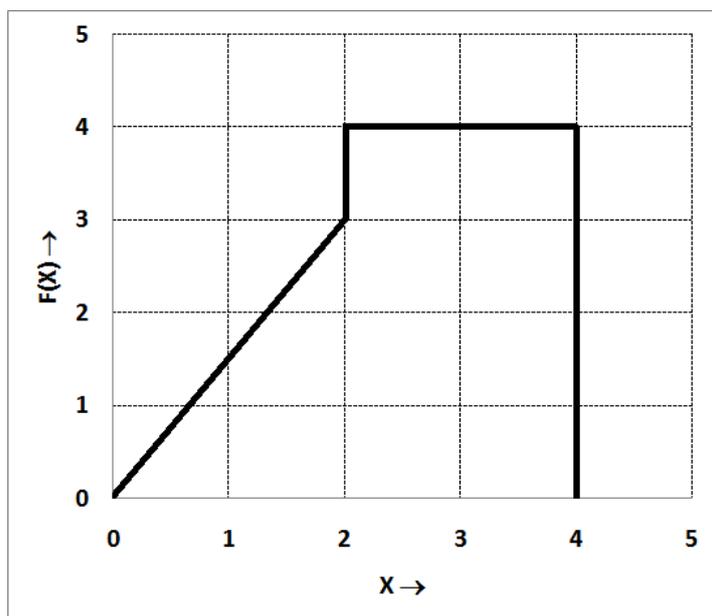
$$10x + 13y = 6$$

$$x + 32.5y = 15$$

Q.56 If A and B are events such that $P(A) = 0.3$, $P(B) = 0.2$ and $P(A \cup B) = 0.45$, the value of $P(A \cap B)$ is _____.

Q.57 An ultrasound signal of frequency 50 KHz is sent vertically down into a medium. The signal gets reflected from a depth of 25 mm and returns to source 0.00005 seconds after it is emitted. The wavelength of the ultrasound signal in that medium is _____ cm.

- Q.58 The relationship between the applied force $F(X)$ (in Newton) on a body and its displacement X (in metre) is given below. The total amount of work done in moving the body from $X = 0$ to $X = 4$ m is _____ Joule.



- Q.59 The number of axial C-H bond(s) in the major product (**P**) of the given reaction is _____.



- Q.60 A first order reaction is 87.5% complete at the end of 30 minutes. The half-life of the reaction is _____ minute(s).

END OF THE QUESTION PAPER