SA

KVPY QUESTION PAPER –STREAM SA
November 04, 2012

PART I

One-Mark Questions

MATHEMATICS

1 Let $f(x)$ be a quadratic polynomial with $f(2) = 10$ and $f(-2) = -2$. Then the coefficient of x in $f(x)$ is

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

2 The square-root of $\frac{(0.75)^3}{1-(0.75)}+\left(0.75+(0.75)^2+1\right)$ is

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

3 The sides of a triangle are distinct positive integers in an arithmetic progression. If the smallest side is 10, the number of such triangles is

A. 8 B. 9 C. 10 D. infinitely many

4 If a, b, c, d are positive real numbers such that $\frac{a}{3}=\frac{a+b}{4}=\frac{a+b+c}{5}=\frac{a+b+c+d}{6}$, then $\frac{a}{b+2c+3d}$ is

A. $\frac{1}{2}$ B. 1 C. 2 D. not determinable

5 For $\dfrac{2^2+4^2+6^2+\ldots+(2n)^2}{1^2+3^2+5^2+\ldots+(2n-1)^2}$ to exceed 1.01, the maximum value of n is

A. 99 B. 100 C. 101 D. 150

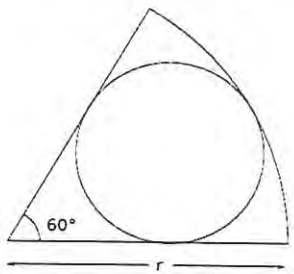
6 In triangle ABC, let AD, BE and CF be the internal angle bisectors with D, E and F on the sides BC, CA and AB respectively. Suppose AD, BE and CF concur at I and B, D, I, F are concyclic, then $\angle IFD$ has measure

A. 15^0 B. 30^0 C. 45^0 D. any value $\leq 90^0$

7 A regular octagon is formed by cutting congruent isosceles right-angled triangles from the corners of a square. If the square has side-length 1, the side-length of the octagon is

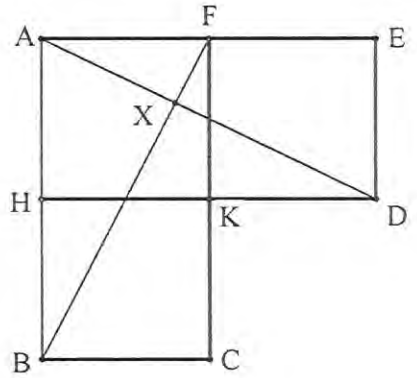
A. $\dfrac{\sqrt{2}-1}{2}$ B. $\sqrt{2}-1$ C. $\dfrac{\sqrt{5}-1}{4}$ D. $\dfrac{\sqrt{5}-1}{3}$

8 A circle is drawn in a sector of a larger circle of radius r, as shown in the adjacent figure. The smaller circle is tangent to the two bounding radii and the arc of the sector. The radius of the small circle is



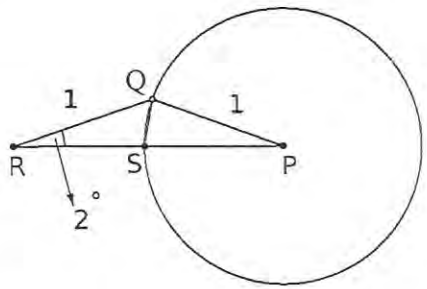
A. $\dfrac{r}{2}$ B. $\dfrac{r}{3}$ C. $\dfrac{2\sqrt{3}r}{5}$ D. $\dfrac{r}{\sqrt{2}}$

9 In the figure, $AHKF$, $FKDE$ and $HBCK$ are unit squares; AD and BF intersect in X. Then the ratio of the areas of triangles AXF and ABF is



A. $\dfrac{1}{4}$ B. $\dfrac{1}{5}$ C. $\dfrac{1}{6}$ D. $\dfrac{1}{8}$

10 Suppose Q is a point on the circle with centre P and radius 1, as shown in the figure; R is a point outside the circle such that $QR = 1$ and $\angle QRP = 2^0$. Let S be the point where the segment RP intersects the given circle. Then measure of $\angle RQS$ equals



A. 86^0 B. 87^0 C. 88^0 D. 89^0

11 Observe that, at any instant, the minute and hour hands of a clock make two angles between them whose sum is 360^0. At 6:15 the difference between these two angles is

A. 165^0 B. 170^0 C. 175^0 D. 180^0

12 Two workers A and B are engaged to do a piece of work. Working alone, A takes 8 hours more to complete the work than if both worked together. On the other hand, working alone, B would need $4\frac{1}{2}$ hours more to complete the work than if both worked together. How much time would they take to complete the job working together?

A. 4 hours B. 5 hours C. 6 hours D. 7 hours

13 When a bucket is half full, the weight of the bucket and the water is 10 kg. When the bucket is two-thirds full, the total weight is 11 kg. What is the total weight, in kg, when the bucket is completely full?

A. 12 B. $12\frac{1}{2}$ C. $12\frac{2}{3}$ D. 13

14 How many ordered pairs of (m,n) integers satisfy $\frac{m}{12}=\frac{12}{n}$?

A. 30 B. 15 C. 12 D. 10

15 Let $S=\{1,2,3,...,40\}$ and let A be a subset of S such that no two elements in A have their sum divisible by 5. What is the maximum number of elements possible in A?

A. 10 B. 13 C. 17 D. 20

PHYSICS

16 A clay ball of mass m and speed v strikes another metal ball of same mass m, which is at rest. They stick together after collision. The kinetic energy of the system after collision is

A. $mv^2/2$ B. $mv^2/4$ C. $2\,mv^2$ D. mv^2

17 A ball falls vertically downward and bounces off a horizontal floor. The speed of the ball just before reaching the floor (u_1) is equal to the speed just after leaving contact with the floor (u_2); $u_1 = u_2$. The corresponding magnitudes of accelerations are denoted respectively by a_1 and a_2. The air resistance during motion is proportional to speed and is not negligible. If g is acceleration due to gravity, then

A. $a_1 < a_2$
B. $a_1 = a_2 \neq g$
C. $a_1 > a_2$
D. $a_1 = a_2 = g$

18 Which of the following statements is true about the flow of electrons in an electric circuit?

A. Electrons always flow from lower to higher potential
B. Electrons always flow from higher to lower potential
C. Electrons flow from lower to higher potential except through power sources
D. Electrons flow from higher to lower potential, except through power sources

19 A boat crossing a river moves with a velocity v relative to still water. The river is flowing with a velocity $v/2$ with respect to the bank. The angle with respect to the flow direction with which the boat should move to minimize the drift is

A. 30° B. 60° C. 150° D. 120°

20 In the Arctic region hemispherical houses called Igloos are made of ice. It is possible to maintain a temperature inside an Igloo as high as 20°C because

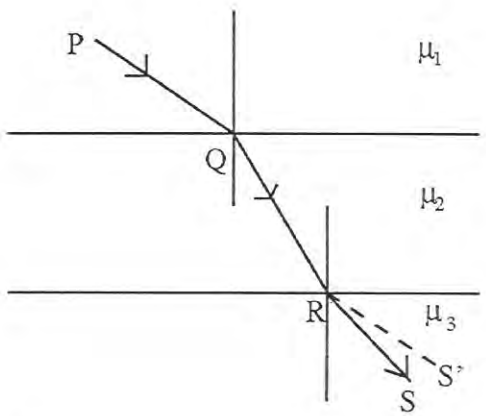
A. ice has high thermal conductivity

B. ice has low thermal conductivity

C. ice has high specific heat

D. ice has higher density than water

21 In the figure below, *PQRS* denotes the path followed by a ray of light as it travels through three media in succession. The absolute refractive indices of the media are μ_1, μ_2 and μ_3 respectively. (The line segment *RS'* in the figure is parallel to *PQ*).

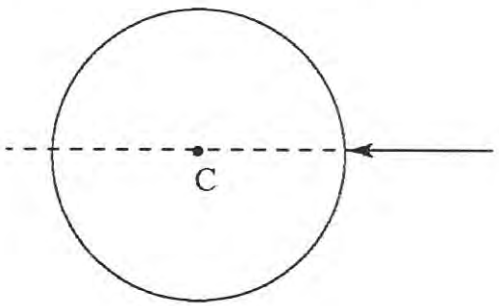


Then

A. $\mu_1 > \mu_2 > \mu_3$ C. $\mu_1 = \mu_3 < \mu_2$

B. $\mu_1 < \mu_2 < \mu_3$ D. $\mu_1 < \mu_3 < \mu_2$

22 A ray of white light is incident on a spherical water drop whose center is C as shown below. When observed from the opposite side, the emergent light



A. will be white and will emerge without deviating

B. will be internally reflected

C. will split into different colors such that the angles of deviation will be different for different colors

D. will split into different colors such that the angles of deviation will be the same for all colors

23 A convex lens of focal length 15 cm is placed in front of a plane mirror at a distance 25 cm from the mirror. Where on the optical axis and from the centre of the lens should a small object be placed such that the final image coincides with the object?

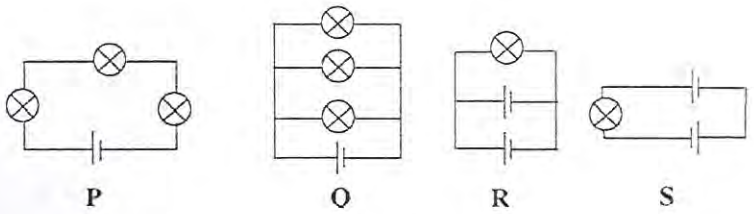
A. 15 cm and on the opposite side of the mirror

B. 15 cm and between the mirror and the lens

C. 7. 5cm and on the opposite side of the mirror

D. 7.5 cm and between the mirror and the lens

24 Following figures show different combinations of identical bulb(s) connected to identical battery(ies). Which option is correct regarding the total power dissipated in the circuit?



A. $P < Q < R < S$

B. $R < Q < P < S$

C. $P < Q < R = S$

D. $P < R < Q < S$

25 A circular metallic ring of radius R has a small gap of width d. The coefficient of thermal expansion of the metal is α in appropriate units. If we increase the temperature of the ring by an amount ΔT, then width of the gap

A. will increase by an amount $d\alpha\Delta T$

B. will not change

C. will increase by an amount $(2\pi R - d)\ \alpha\Delta T$

D. will decrease by an amount $d\alpha\Delta T$

26 A girl holds a book of mass m against a vertical wall with a horizontal force F using her finger so that the book does not move. The frictional force on the book by the wall is

A. F and along the finger but pointing towards the girl

B. μF upwards where μ is the coefficient of static friction

C. mg and upwards

D. equal and opposite to the resultant of F and mg

27 A solid cube and a solid sphere both made of same material are completely submerged in water but to different depths. The sphere and the cube have same surface area. The buoyant force is

A. greater for the cube than the sphere

B. greater for the sphere than the cube

C. same for the sphere and the cube

D. greater for the object that is submerged deeper

28 $^{238}_{92}U$ atom disintegrates to $^{214}_{84}Po$ with a half life of 4.5×10^9 years by emitting six alpha particles and n electrons. Here n is

A. 6 B. 4 C. 10 D. 7

29 Which statement about the Rutherford model of the atom is

NOT true?

A. There is a positively charged center in an atom called the nucleus

B. Nearly all the mass of an atom resides in the nucleus

C. Size of the nucleus is comparable to the atom

D. Electrons occupy the space surrounding the nucleus

30 A girl brings a positively charged rod near a thin neutral stream of water from a tap. She observes that the water stream bends towards her. Instead, if she were to bring a negatively charged rod near to the stream, it will

A. bend in the same direction

B. bend in the opposite direction

C. not bend at all

D. bend in the opposite direction above and below the rod

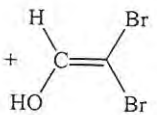
31 The weight of calcium oxide formed by burning 20 g of calcium in excess oxygen is

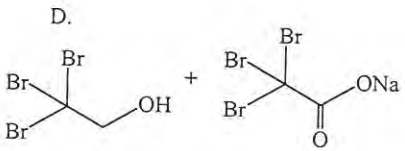
A. 36 g B. 56 g C. 28 g D. 72 g

32 The major products in the reaction $Br_3CCHO \xrightarrow{NaOH}$ are

A. $CHBr_3$ +

C. NaOBr + 

B. NaBr + 

D. 

33 The number of electrons plus neutrons in $^{40}_{19}K^{+}$ is

A. 38 B. 59 C. 39 D. 40

34 Among the following, the most basic oxide is

A. Al_2O_3 C. SiO_2

B. P_2O_5 D. Na_2O

35 By dissolving 0.35 mole of sodium chloride in water, 1.30 L of salt solution is obtained. The molarity of the resulting solution should be reported as

A. 0.3 B. 0.269 C. 0.27 D. 0.2692

36 Among the quantities, density (ρ), temperature (T), enthalpy (H), heat capacity (C_p), volume (V) and pressure (P), a set of intensive variables are

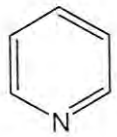
A. (ρ, T, H) C. (V, T, C_p)

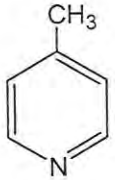
B. (H, T, V) D. (ρ, T, P)

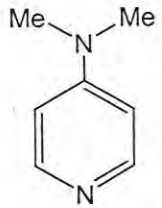
37 The value of 'x' in $KAl(SO_4)_x \cdot 12H_2O$ is

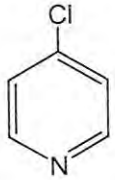
A. 1 B. 2 C. 3 D. 4

38 Among the following substituted pyridines, the most basic compound is

A. 

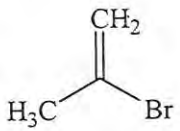
C. 

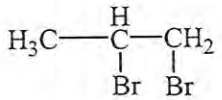
B. 

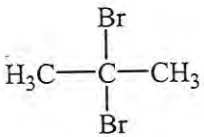
D. 

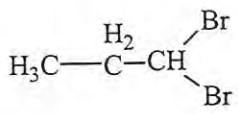
39 The major product in the following reaction is

$$H_3C—C{\equiv}C—H + HBr \text{ (excess)}$$

A. 

C. 

B. 

D. 

40 The major product in the following reaction at 25 °C is

$$CH_3COOH \xrightarrow{CH_3CH_2NH_2}$$

A. $CH_3CONHCH_2CH_3$

C. $NH_3^+CH_2CH_3.CH_3COO^-$

B. $CH_3CH{=}NCH_2CH_3$

D. $CH_3CON{=}CHCH_3$

41 A reaction with reaction quotient Q_C and equilibrium constant K_C, will proceed in the direction of the products when

A. $Q_C = K_C$

C. $Q_C > K_C$

B. $Q_C < K_C$

D. $Q_C = 0$

42 Acetylsalicylic acid is a pain killer and is commonly known as

A. paracetamol

C. ibuprofen

B. aspirin

D. penicillin

43 The molecule which does **not** exhibit strong hydrogen bonding is

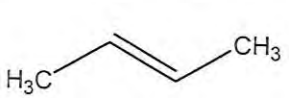
A. methyl amine

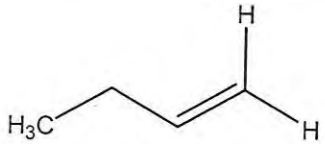
C. diethyl ether

B. acetic acid

D. glucose

44 The following two compounds are

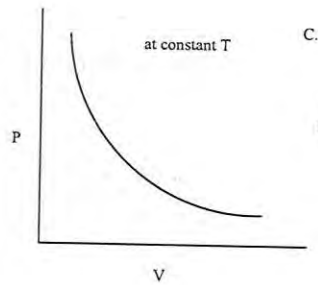




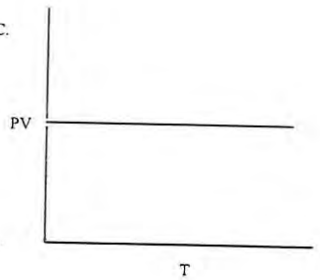
A. geometrical isomers
C. functional group isomers
B. positional isomers
D. optical isomers

45 The graph that does **not** represent the behaviour of an ideal gas is

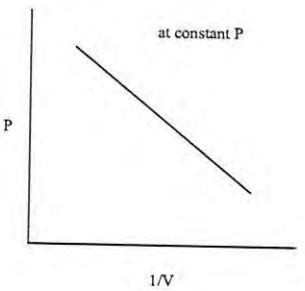
A.



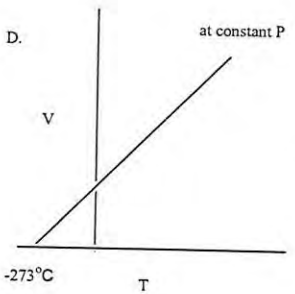
C.



B.



D.



BIOLOGY

46 A smear of blood from a healthy individual is stained with a nuclear stain called hematoxylin and then observed under a light microscope. Which of the following cell type would be highest in number?

A. neutrophils
C. eosinophils
B. lymphocytes
D. monocytes

47 Which of the following biological phenomenon involves a bacteriophage?

A. transformation
C. translocation
B. conjugation
D. transduction

48 In which compartment of a cell does the process of glycolysis takes place?

A. Golgi Complex
C. mitochondria
B. cytoplasm
D. ribosomes

49 Huntington's disease is a disease of the

A. nervous System
C. respiratory system
B. circulatory system
D. excretory system

50 A cell will experience the highest level of endosmosis when it is kept in

A. distilled water
C. salt solution
B. sugar solution
D. protein solution

51 When the leaf of the 'touch-me-not' (chui-mui, *Mimosa pudica*) plant is touched, the leaf droops because

A. a nerve signal passes through the plant
B. the temperature of the plant increases
C. water is lost from the cells at the base of the leaf
D. the plant dies

52 If you are seeing mangroves around you, which part of India are you visiting?

A. Western Ghats
C. Sunderbans
B. Thar desert
D. Himlayas

53 Myeloid tissue is a type of

A. haematopoietic tissue
C. muscular tissue
B. cartilage tissue
D. areolar tissue

54 The heart of an amphibian is usually

A. two chambered
C. four Chambered
B. three chambered
D. three and half chambered

55 Gigantism and acromegaly are due to defects in the function of the following gland:

A. adrenals
C. pancreas
B. thyroid
D. pituitary

56 The pH of 10^{-8} M HCl solution is,

A. 8
C. 1
B. close to 7
D. 0

57 Which one of the following organelles can synthesize some of its own proteins?

A. lysozome
C. vacuole
B. Golgi apparatus
D. mitochondrion

58 Maltose is a polymer of

A. one glucose and one fructose molecule

B. one glucose and one galactose molecule

C. two glucose molecules

D. two fructose molecules

59 The roots of some higher plants get associated with a fungal partner. The roots provide food to the fungus while the fungus supplies water to the roots. The structure so formed is known as

A. lichen

B. anabaena

C. mycorrhiza

D. rhizobium

60 Prehistoric forms of life are found in fossils. The probability of finding fossils of more complex organisms

A. increases from lower to upper strata

B. decreases from lower to upper strata

C. remains constant in each stratum

D. uncertain

PART II

Two-Mark Questions

MATHEMATICS

61 Let a, b, c be positive integers such that $\frac{a\sqrt{2}+b}{b\sqrt{2}+c}$ is a rational number, then which of the following is always an integer?

A. $\frac{2a^2+b^2}{2b^2+c^2}$

B. $\frac{a^2+2b^2}{b^2+2c^2}$

C. $\frac{a^2+b^2-c^2}{a+b-c}$

D. $\frac{a^2+b^2+c^2}{a+c-b}$

62 The number of solutions (x, y, z) to the system of equations

$$x+2y+4z=9,$$
$$4yz+2xz+xy=13,$$
$$xyz=3,$$

such that at least two of x, y, z are integers is

A. 3 B. 5 C. 6 D. 4

63 In a triangle ABC, it is known that $AB = AC$. Suppose D is the mid-point of AC and $BD = BC = 2$. Then the area of the triangle ABC is

A. 2 B. $2\sqrt{2}$ C. $\sqrt{7}$ D. $2\sqrt{7}$

64 A train leaves Pune at 7:30 am and reaches Mumbai at 11:30 am. Another train leaves Mumbai at 9:30 am and reaches Pune at 1:00 pm. Assuming that the two trains travel at constant speeds, at what time do the two trains cross each other?

A. 10:20 am C. 11:30 am

B. 10:26 am D. data not sufficient

65 In the adjacent figures, which has the shortest path?

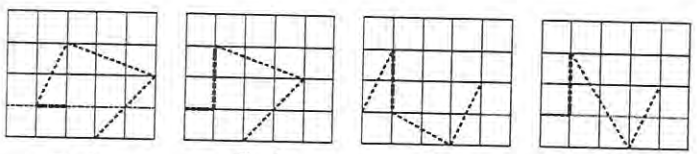
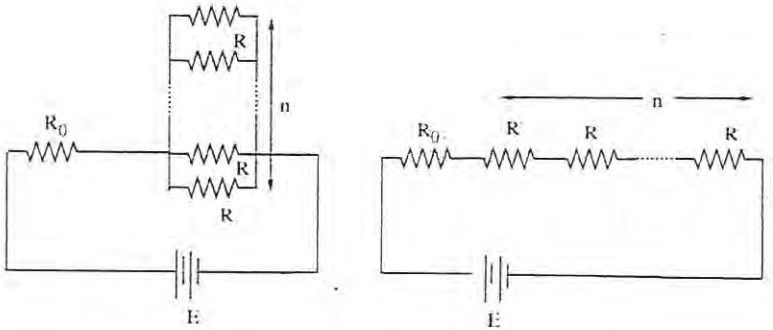


Fig 1. Fig 2 Fig 3 Fig 4

A. Fig 1 B. Fig 2 C. Fig 3 D. Fig. 4

66 In the circuit shown, n identical resistors R are connected in parallel (n>1) and the combination is connected in series to another resistor R_0. In the adjoining circuit n resistors of resistance R are all connected in series along with R_0.



The batteries in both circuits are identical and net power dissipated in the n resistors in both circuits is same. The ratio R_0/R is

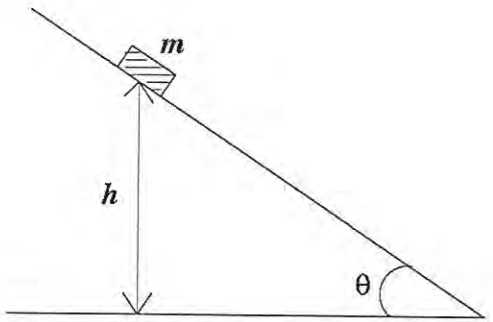
A. 1 B. n C. n^2 D. $1/n$

67 A firecracker is thrown with velocity of 30 $m.s^{-1}$ in a direction which makes an angle of 75° with the vertical axis. At some point on its trajectory, the firecracker splits into two identical pieces in such a way that one piece falls 27 m far

from the shooting point. Assuming that all trajectories are contained in the same plane, how far will the other piece fall from the shooting point? (Take $g = 10\ m.s^{-2}$ and neglect air resistance)

A. 63 m or 144 m
C. 72 m or 99 m
B. 28 m or 72 m
D. 63 m or 117 m

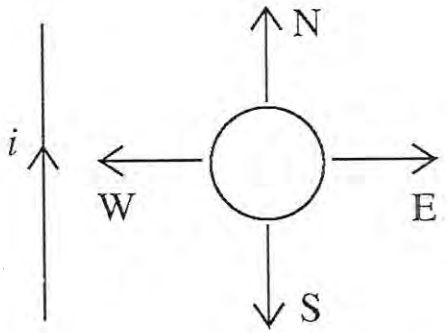
68 A block of mass m is sliding down an inclined plane with constant speed. At a certain instant t_o, its height above the ground is h. The coefficient of kinetic friction between the block and the plane is μ. If the block reaches the ground at a later instant t_g, then the energy dissipated by friction in the time interval $(t_g - t_o)$ is



A. μmgh
C. $\mu mgh/\sin\theta$
B. mgh
D. $\mu mgh/\cos\theta$

69 A circular loop of wire is in the same plane as an infinitely

long wire carrying a constant current i. Four possible motions of the loop are marked by N, E, W, and S as shown.



A clockwise current is induced in the loop when loop is pulled towards

A. N
B. E
C. W
D. S

70 150 g of ice is mixed with 100 g of water at temperature 80°C. The latent heat of ice is 80 cal/g and the specific heat of water is 1 cal/g-°C. Assuming no heat loss to the environment, the amount of ice which does **not** melt is

A. 100 g
B. 0 g
C. 150 g
D. 50 g

71 Upon fully dissolving 2.0 g of a metal in sulfuric acid, 6.8 g of the metal sulfate is formed. The equivalent weight of the metal is

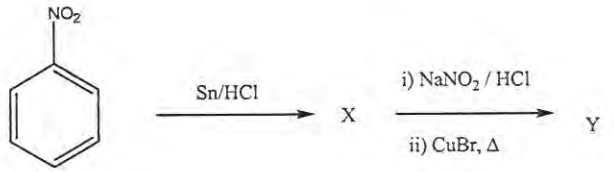
A. 13.6 g B. 20.0 g C. 4.0 g D. 10.0 g

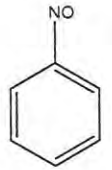
72 Upon mixing equal volumes of aqueous solutions of 0.1 M HCl and 0.2 M H_2SO_4, the concentration of H^+ in the resulting solution is

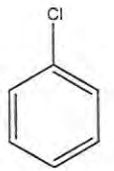
A. 0.30 mol/L C. 0.15 mol/L

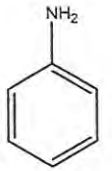
B. 0.25 mol/L D. 0.10 mol/L

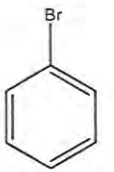
73 The products X and Y in the following reaction sequence are

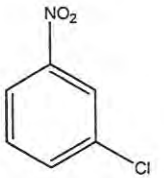


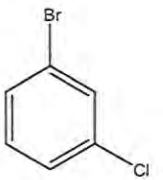
A. X: 

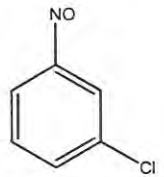
Y: 

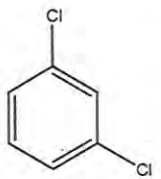
B. X: 

Y: 

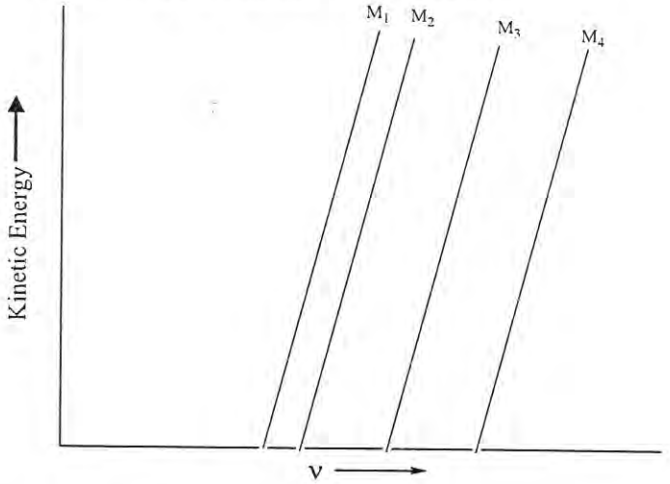
C. X: 

Y: 

D. X: 

Y: 

74 A plot of the kinetic energy ($\frac{1}{2}mv^2$) of ejected electrons as a function of the frequency (ν) of incident radiation for four alkali metals (M_1, M_2, M_3, M_4) is shown below.



The alkali metals M_1, M_2, M_3, and M_4 are, respectively

A. Li, Na, K, and Rb
C. Na, K, Li, and Rb
B. Rb, K, Na, and Li
D. Rb, Li, Na, and K

75 The number of moles of Br_2 produced when two moles of potassium permanganate are treated with excess potassium bromide in aqueous acid medium is

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

76 A baby is born with the normal number and distribution of rods, but no cones in his eyes. We would expect that the baby would be

A. color blind
C. blind in both eyes
B. night blind
D. blind in one eye

77 In mammals, pleural membranes cover the lungs as well as insides of the rib cage. The pleural fluid in between the two membranes

A. dissolves oxygen for transfer to the alveoli
B. dissolves CO_2 for transfer to the blood
C. provides partial pressure
D. reduces the friction between the ribs and the lungs

78 At which phase of the cell cycle, DNA polymerase activity is at its highest?

A. Gap 1 (G1)
C. Synthetic (S)
B. Mitotic (M)
D. Gap 2 (G2)

79 Usain Bolt, an Olympic runner, at the end of a 100 meter sprint, will have more of which of the following in his

muscles?

A. ATP

B. Pyruvic acid

C. Lactic acid

D. Carbon dioxide

80 Desert temperature often varies between 0 to 50 °C. The DNA polymerase isolated from a camel living in the desert will be able to synthesize DNA most efficiently at

A. 0 °C B. 37 °C C. 50 °C D. 25 °C