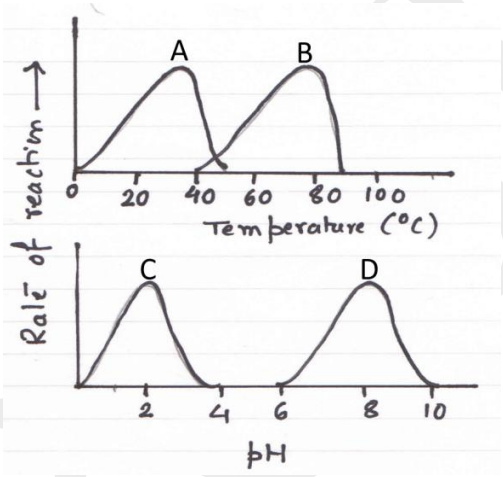
Questions (INJSO 2015)

Section A: Questions 1 to 30 are multiple choices with every correct answer carrying 1 mark and every wrong answer carrying -0.25 mark.

SECTION A

Q1. The following graphs represent activities of different enzymes (A to D) at different temperature and pH:



Observe the graphs carefully and infer which of the following options given below (most likely) represents correctly the combinations A, B, C and D.

a) A-enzyme of thermophilic bacteria; B- typical human enzyme; C-pepsin (stomach enzyme); D-Trypsin (intestinal enzyme)

b) A-enzyme of thermophilic bacteria; B- typical human enzyme; C-Trypsin (intestinal enzyme); D-pepsin (stomach enzyme)

c) A-a typical human enzyme; B-enzyme of thermophilic bacteria; C-Trypsin (intestinal enzyme); D-pepsin (stomach enzyme)

d) A-a typical human enzyme; B-enzyme of thermophilic bacteria; C-pepsin (stomach enzyme); D-Trypsin (intestinal enzyme)

Q2. Units of length, velocity and force in a certain system of units are double of those in SI (i.e. unit length in this system is 2 m, and so on for force and velocity). Read the following statements.

i) Unit of mass is unchanged.
ii) Unit of time is unchanged.
iii) Unit of linear momentum is doubled.
iv) Unit of energy is doubled.

Among the above statements _____.

a) All four are correct.
b) Only i, ii and iii are correct.
c) Only i and ii are correct.
d) Only ii and iii are correct.

Q3. Steel is an alloy of carbon and iron which is used in many utensils. Iron extracted will be of two types pig iron and wrought iron. Iron is extracted from its ore haematite by reduction with carbon monoxide. What (approximate) volume of carbon monoxide at NTP will be required to reduce 31.94 kg of haematite?

a) 12275 L
b) 4480 L
c) 9953 L
d) 13440 L

Q4. A plant (parental) bearing red flowers is self-pollinated and two kinds of progeny are obtained: plants with red flowers and plants with white flowers in a ratio of 3:1. Based on this observation which one of the following statements regarding genes controlling the flower colour is correct?

a) The parental plant had one kind of allele for the flower colour.
b) Two genes control the flower colour.
c) The parental plant had two different alleles for the flower colour.
d) All progeny plants with red flower colour have the same genotype as that of the parent.

Q5. A gas is obtained by fractional distillation of liquid air. The same gas can also be obtained by Haber's process at high temperature and low pressure. Find out the number of atoms present in one liter of the gas.

a) 2.67×10^{22}
b) 1.056×10^{23}
c) 5.28×10^{22}
d) 2.136×10^{23}

Q6. A beam of yellow light travelling in vacuum (λ = 600 nm) enters an ordinary transparent glass (μ = 1.5). Read the following statements.

i) Its wavelength becomes equal to that of red colour in vacuum.

ii) Its wavelength becomes equal to that of green colour in vacuum.

iii) Energy of the photons corresponding to refracted light is the same as that corresponding to the incident light.

iv) Energy of the photons decreases.

a) Only iii is correct.
b) Only ii & iii are correct.
c) Only i & iii are correct.
d) Only i & iv are correct.

Q7. Rajesh was performing the thermometric titration with caustic potash and oil of vitriol, under the same set of conditions. He dissolved 19.6 g of oil of vitriol in 1dm^3 of water and 5.6g of caustic potash in 1 dm^3 of water. Find the volume of oil of vitriol taken initially for thermometric titration. The observation table of his experiment is as follows.

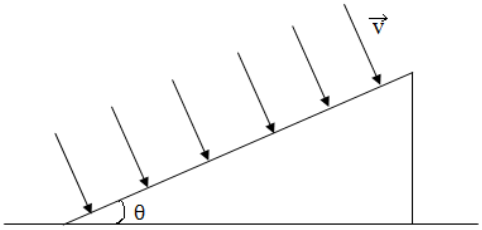
Obs No.	Volume of KOH added/cm^3	Temperature ^0C
1	20	27
2	30	27.4
3	40	27.5
4	50	27.8
5	60	27.6
6	70	27.2
7	80	26.9

a) 6.25 cm^3
b) 50 cm^3
c) 12.5 cm^3
d) 25 cm^3

Q8. Cabbage, Broccoli, Brussels sprouts are all derived from one species of wild mustard by the selection of desired traits. This has been developed by a process of:

a) Inheritance of acquired character
b) Natural selection
c) Adaptive selection
d) Artificial selection

Q9. Air of density ρ, moving with velocity v strikes normally on an inclined surface (having area A) of a wedge of mass m kept on a horizontal surface. Collisions are perfectly elastic (No loss of kinetic energy). Minimum coefficient of static friction between wedge and the horizontal surface, for the wedge to be stationary, is



a) $\frac{\rho A v^2}{mg + \rho A v^2 cos\theta}$

b) $\frac{2\rho A v^2 sin\theta}{mg + 2\rho A v^2 cos\theta}$

c) $\frac{\rho A v^2 tan\theta}{mg}$

d) $tan\ \theta$

Q10. Virulent forms (Methicillin-resistant) of the bacterium *Staphylococcus aureus* (MRSA) is a human pathogen. Some of these strains cause "flesh-eating disease" and are resistant to multiple antibiotics. The story of origin of these strains began in 1943 with the use of penicillin as an antibiotic. By 1945, 20% of the *S. aureus* strains in hospitals were resistant to penicillin. In 1959, doctors began using the powerful antibiotic methicillin. But within two years methicillin-resistant strains appeared followed by multidrug resistant strains. Which one of the following statements regarding development of multi-drug resistance in MRSA is correct?

a) Antibiotics helped in the selection of bacteria with mutations in the DNA conferring drug resistance which was already present in the population.

b) Antibiotics triggered DNA modification in the host cells that induced resistance among bacterial cells.

c) Antibiotics first led to specific mutation in the DNA of the bacteria conferring drug resistance that was later selected for.

d) MRSA would have developed in the same rate even if antibiotics were not used.

Q11. In today's world demand for energy is increasing every day. Hence it is necessary to identify inefficient machines and rectify them.
Following two reactions are carried out in an oven

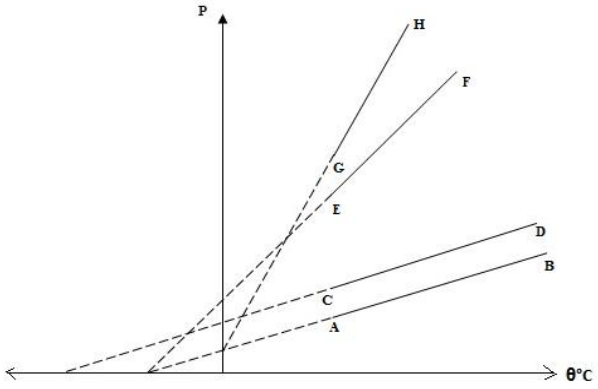
1) $C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$
Difference in heat content of reactant and product for reaction 1 = -394 kJ/mol

2) $C_{(s)} + 1/2O_{2(g)} \longrightarrow CO_{(g)}$
Difference in heat content of reactant and product for reaction 2 = -111 kJ/mol

100 kg impure sample of coal containing 80 % carbon is burnt by supplying insufficient oxygen so that 60 % carbon is converted to CO_2 and 40 % of carbon is converted to CO. Then the total heat generated will be

a) -2340×10^3 kJ
b) -1872×10^3 kJ
c) -1576×10^3 kJ
d) -468×10^3 kJ

Q12. A scientist measures the pressure (P) of a particular mass of an ideal gas in a fixed volume as a function of temperature ($\theta\,^0C$). The plot of his readings is shown in the figure below as the line AB.



He now repeats the experiment with the same gas in the same volume, but with different mass. Likely plot of pressure against temperature will be

a) AB itself.
b) CD
c) EF
d) GH

Q13. Seed of an angiosperm is composed of cells

a) Having diploid (2n) number of chromosomes only.

b) Having triploid (3n) number of chromosomes only.

c) Having diploid (2n) and triploid (3n) number of chromosomes.

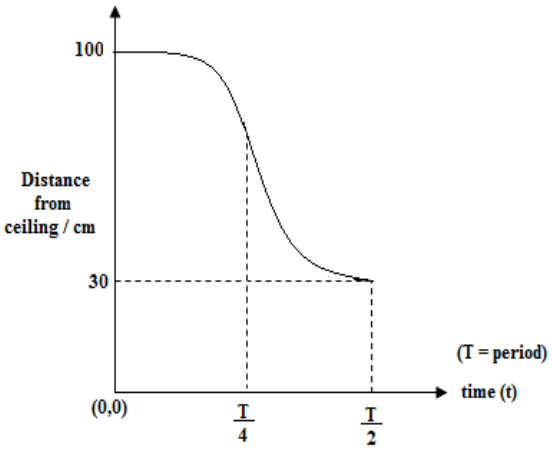
d) Having diploid (2n) and haploid (n) number of chromosomes.

Q14. If the atomic number of a noble gas element is Z, then the element that has the greatest electronegativity in the same period according to the Pauling scale will have atomic number:

a) Z – 1 b) Z -2

c) Z + 1 d) Z + 2

Q15. A mass hanging with a spring suspended from a ceiling is pulled down and released. The mass then oscillates with simple harmonic motion of period *T*. the graph shows how its distance from the ceiling varies with time. What can be deduced from the graph?



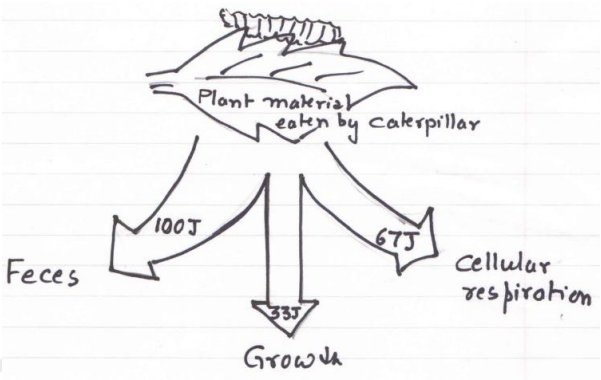
a) The amplitude of oscillations is 70 cm.

b) The kinetic energy is maximum at t = T/2

c) The speed is maximum at t = T/4

d) The restoring force on the mass increases between t = 0 and t = T/4

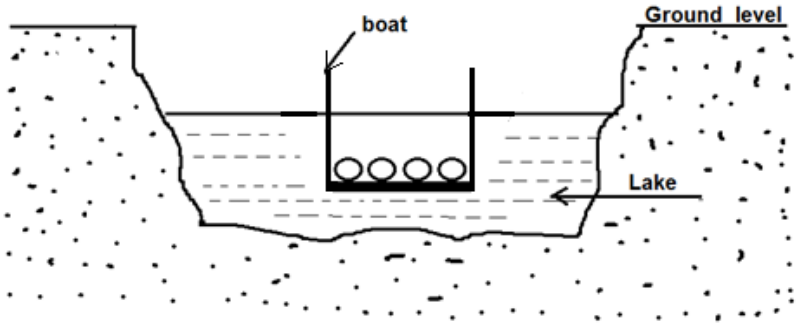
Q16. The following question refers to energy transfer between trophic levels in an ecosystem. Primary production is the amount of light energy converted to chemical energy (organic compounds) by the autotrophs in an ecosystem during a given time period. Net Secondary production is the amount of chemical energy in consumers' food that is converted to their own new biomass during a given period of time. The following figure represents the partitioning of energy by a caterpillar eating a leaf and consuming 200J of energy.



What percentage of the energy in the caterpillar's food is actually used for secondary production?

a) 16.5
b) 33.0
c) 33.5
d) 50.0

Q17. Figure given below shows a small boat, containing some iron balls, floating on a still lake.These iron blocks are now dropped into the lake. Select the ***WRONG*** statement.



a) Level of the lake will fall, with ground reference.
b) The boat will rise, with water reference.
c) Level of the boat will rise, with ground reference.
d) Water level will not change, from the ground reference.

Q18. Sudha was studying the reaction between aluminium and iodine using 1.2 g aluminium and 2.4 g iodine. Calculate the weight of aluminium iodide formed.

a) 2.57 g
b) 2.49 g
c) 1.35 g
d) 1.25 g

Q19. Students were studying cellular processes such as osmosis and plasmolysis. To make them understand the concept better, the teacher asked them to study the effect of a given solution on a specific plant cell. They placed the plant material in a given solution and studied the pattern of movement of water for about two hours duration. It was observed that there was no net movement of water during this period from the cell into the solution or vice a versa. Which of the following condition must be true in the given situation?

a) Turgor pressure is more than the wall pressure
b) Turgor pressure is equal to the wall pressure.
c) Turgor pressure is less than the wall pressure.
d) Turgor pressure is zero and wall pressure has a negative value.

Q20. Soaps (sodium salt of fatty acid) are the molecules in which the two ends have differing properties; one is hydrophilic whereas other is hydrophobic. Hydrophobic part refers to tail of the soap which is always out of water.

Which of the following statement is true about soap?

	Hydrophilic	Hydrophobic
a)	Sodium	Fatty acid
b)	Fatty acid	Sodium
c)	Glycerine	Sodium
d)	Sodium	Ester

Q21. In Maize plant grafting cannot be done successfully because in this plant:

a) Cambium present is inactive.
b) Cambium is absent.
c) Cambium is short lived.
d) Cambia of stock and scion are incompatible.

Q22. There exists a uniform magnetic field perpendicular and inwards to the plane of the figure, through rectangular area ABCD only. PQRS is a rectangular loop of an electrically conducting wire, partly inserted in the region ABCD, in the plane of the figure. Read the following statements.

Figure 1

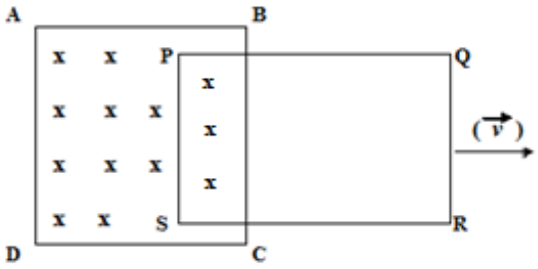


Figure 2

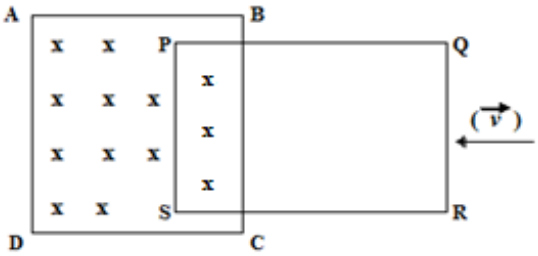


Figure 3

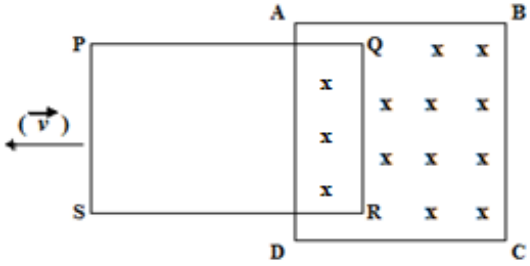
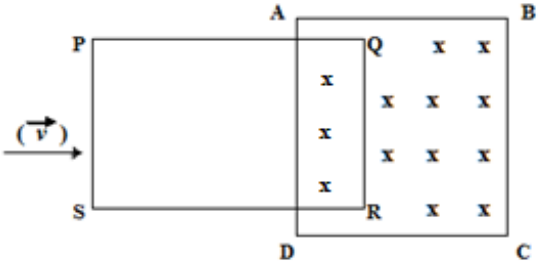


Figure 4



i) Clockwise current will be set up in the loop, in the situation of figure 1.

ii) Clockwise current will be set up in the loop, in the situation of figure 2.

iii) Clockwise current will be set up in the loop, in the situation of figure 3.

iv) Clockwise current will be set up in the loop, in the situation of figure 4.

a) Only i and iv are correct.
b) Only i and iii are correct.
c) Only ii and iii are correct.
d) Only ii and iv are correct.

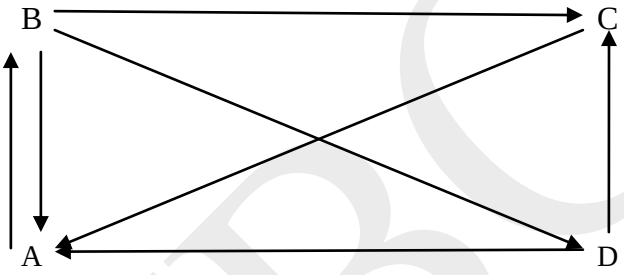
Q23. Minute arm and hour arm of a clock come together after every 65 minutes as measured by an ideal clock. How much does the clock gain per day?

a) Little less than 600 sec.
b) Little more than 600 sec.
d) Exactly 600 sec.
d) Clock will not gain but, will lose time.

Q24. Alkaline potassium permanganate or acidified potassium dichromate is used to convert alcohol to acid. Choose the correct option from the following if methanol (CH_3OH) is treated with acidified potassium dichromate solution.

	Formula of acid formed	Potassium dichromate is undergoing	Methanol is undergoing
a)	CH3COOH	Reduction	oxidation
b)	HCOOH	Oxidation	Reduction
c)	CH3COOH	Oxidation	Reduction
d)	HCOOH	Reduction	oxidation

Q25. Study the following ray diagram in which: 'A' represents atmosphere, 'B' represents green plants, 'C' represents decomposers and 'D' represents animals.



The above ray diagram represents

a) Energy flow through the given ecosystem.

b) Interconnections among different food chains in the given ecosystem.

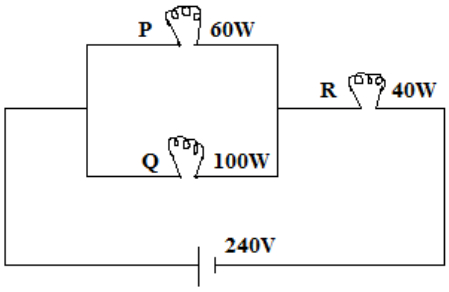
c) Movement of carbon among A, B, C and D.

d) Movement of nitrogen among A, B, C and D

Q26. A bottle of 200 ml of hydrogen peroxide was accidentally left open for long time. Which of the following facts hold good for the chemical reaction that takes place?
(Kp is an equilibrium constant in terms of partial pressures of reactants and products and Kc is equilibrium constant in terms of molar concentrations of reactants and products).

a) Kp=Kc
b) Kp> Kc
c) Kp < Kc
d) Kp and Kc cannot be correlated

Q27. Three filament bulbs made from a metal of low thermal coefficient of resistivity are arranged as shown in the figure. The wattage rating of each bulb is the power output if it is connected independently across 240V. The bulb that glows brightest and least bright are respectively:



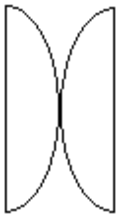
a) P,Q
b) Q,R
c) Q,P
d) R,Q

Q28. Alka was walking through a forest. A leech caught one of her legs. It sucked blood and got detached from Alka's leg when it was full with blood. Find which of the following observations of the table in column 'A' will be true in this case. Further, from the options given below (a, b, c, d) find the correct option which matches the suitable explanation (in column 'B') to your selected answer in column 'A'.

Column A	Column B
i. Bleeding from Alka's leg will stop immediately.	1. Leech produces only anticoagulant when it attaches human body.
ii. Bleeding from Alka's leg will stop immediately but she will feel acute pain immediately after the leech detaches from her leg.	2. Leech produces anticoagulant as well as anti-inflammatory substance (histamine like) when it attaches to human body.
iii. Alka will continue to bleed for some time with acute pain in her leg after the leech detaches from her leg.	3. Leech plugs the blood vessel when it detaches from human body.
iv. Alka will continue to bleed for sometime without any pain after the leech detaches from her leg.	4. Leech plugs the blood vessel and removes anti- inflammatory substance when it detaches from the human body.

a) i-3
b) ii-4
c) iii-1
d) iv-2

Q29. An equiconvex lens of focal length f is cut into two equal halves which are pasted as shown in the figure, the focal length of the new system will be:



a) f b) $(0.5)f$

c) $2f$ d) Infinity.

Q30. Sunanda was experimenting with an electrolytic cell. She took an aqueous solution of sodium chloride and added some zinc sulphate into it. When she dipped platinum electrodes in the electrolyte and passed electric current through the solution the species discharged at cathode and anode respectively were

a) Zinc and Chlorine b) Sodium and Oxygen

c) Hydrogen and Chlorine d) Zinc and Oxygen

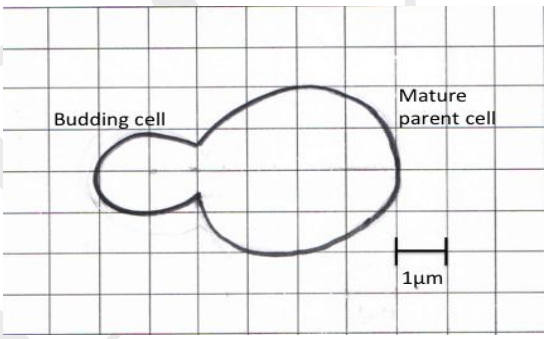
Section B: Questions 31 to 42 are of 5 marks each. Marks will also be indicated in the questions if there is more than one part to it.

SECTION B (Long questions)

Q31. Theory question based on the need for different sizes of cells

Metabolic requirements of a cell impose upper limits on its size that is practical for a single cell. The **plasma membrane** functions as a selective barrier that allows passage of oxygen, nutrients and wastes to service the cell. For each square micrometer of membrane, only a limited amount of material can cross per second, so the ratio of surface area to volume is critical. The following exercise asks you to calculate the volume and surface areas of two actual cells- a mature yeast cell and a cell budding from it.

The unicellular yeast *Saccharomyces cerevisiae* divides by budding off a small new cell that then grows to full size. During its growth, the new cell synthesizes new cytoplasm, which increases its volume and new plasma membrane which increases its surface area. In an experiment yeast cells were grown under conditions that promoted division by budding. The cells were then viewed with a differential interference contrast light microscope and photographed. The drawing below shows a budding yeast about to be released from the mature parent cell.



(i) Based on the above figure calculate the volume of the mature parent cell and the budding yeast cell. For calculations the shape of each cell can be considered to be a sphere. ($V=4/3\ \pi r^3$). Answers to be rounded off to whole numbers. **[1 mark]**

(ii) Based on the above figure calculate the surface area of the mature parent cell and the budding yeast cell. ($A=4\pi r^2$) **[0.5 marks]**

(iii) Calculate the surface area to volume ratio for a mature yeast cell? **[0.5 marks]**

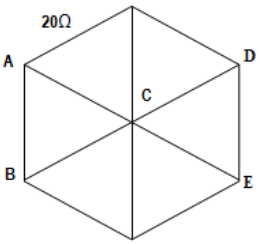
(iv) Fill in the blanks from the given choice: **[2 marks]**

a) As the budding cell increases in size, it's surface area grows proportionally _____ (**less / more)** than its volume.

b) A smaller cell has a _____ **(lesser / greater)** ratio of surface area to volume than a larger cell.
c) Cells that exchange a lot of material with their surroundings are expected to have _____. **(a high ratio of surface area to volume / a high ratio of volume to surface area)**
d) Between intestinal and mesophyll cells, the _____ **(intestinal / mesophyll)** cells have higher ratio of surface area to volume.

(v) Nine small cells have the same volume (take up the same amount of space) as a certain large cell. Which has more cell membrane for nutrients and wastes to pass? **(the one large cell / the nine smaller cells)** **[1 mark]**

Q32a. Twelve identical wires are connected in the plane as shown in the figure. The six outer wires make a regular hexagon and the remaining six join the vertices of this hexagon with common centre at C. Each wire has a resistance of 20 Ω. Calculate effective resistance between A and B. (If you connect a battery across A and B, the currents in AC and CB are the same and those in DC and CE are the same).



[3 marks]

Q32b. When 5 V are applied across the terminals of a galvanometer, 100 mA current passes through its coil and the galvanometer shows full scale deflection. With suitable modification, it can be used to measure p.d. or currents with certain sensitivities.

A shunt resistance is now connected parallel to the galvanometer so that 80 % of the current approaching the coil goes through the shunt. This ammeter is used to measure current supplied by an ideal cell of emf 6 V, connected across a bulb of resistance 40 Ω.

Calculate the error (percentage) in the measurement of current passing through the bulb? **[2 marks]**

Q33a. Jiya had a piece of plumber's solder weighing 3.0g. She dissolved it in dilute nitric acid and the resultant solution she treated with dil.H_2SO_4. She got precipitate of lead sulphate which after washing and drying weighed 2.93g. From the filtrate she obtained stannic acid. She heated stannic acid to obtain stannic oxide. The yield of stannic oxide was 1.27 g. Help Jiya to find out percentage of lead and stannous in the piece of plumber's solder. **[3 Marks]**

Q33b. Methyl orange and phenolphthalein are two commonly used indicators in neutralization titrations. Acid base indicators are weak acids that can be represented as HIn. These indicators dissociate in alkaline medium to give the anionic form (In^-).

i. Write the equation for dissociation of indicator. [**0.5 Mark]**

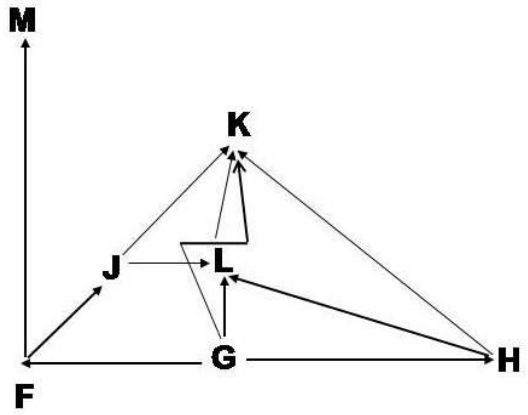
ii. Write the expression for dissociation constant (KIn) for the indicator. [**0.5 Mark]**

iii. From the expression obtained in (ii) derive an expression for pH of the indicator in terms of pK_{In}. [**0.5 Mark]**

iv. If the value of indicator dissociation constant for an indicator is 1×10^{-9} then calculate pH of the solution at the point at which the concentration of anionic form and undissociated form of the indicator become equal. [**0.5 Mark]**

Q34. Answer the following questions.

i. Study the following food web and answer the questions. **[3 Marks]**



a) Name the producers:

b) Which organisms are primary consumers?

c) Which organisms will receive maximum energy in the ecosystem?

d) Which organisms represent top level carnivores?

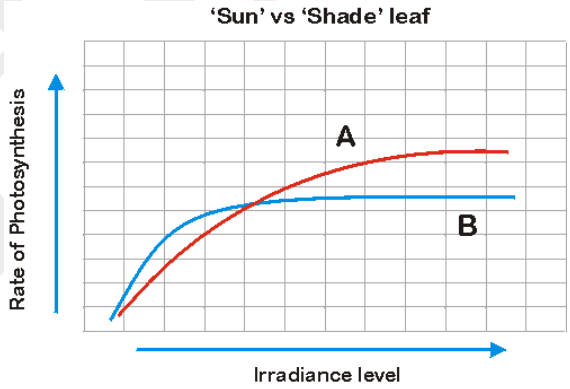
e) Which organisms occupy more than one trophic levels in the given food web?

ii. Tropical rain forest biome is constituted by four very distinct layers of trees. These layers have been identified as the emergent layer, canopy, understory, and forest floor.

The **emergent layer** contains a small number of very large trees called **emergents**, which grow above the general canopy, reaching heights of 45–55 meters, or even larger. They withstand the hot temperatures and strong winds that occur above the canopy in some areas.
The **canopy** layer contains trees, typically 30 metres to 45 tall. The plants here are adapted to carry out photosynthesis efficiently in bright sunlight. Light is easily available at the top of this layer, but it greatly reduces the amount of light below it.
The **understory** layer lies between the canopy and the forest floor. This level is made up of shrubs, ferns and mosses, along with epiphytes growing on barks of trees, small trees growing in constant shade. Understory plants therefore are shade tolerant. They photosynthesize adequately using the little amount of light that reaches their leaves. They often are able to use wavelengths that canopy plants cannot. The forest floor is usually completely shaded, except where a canopy tree has fallen and created an opening. The **forest floor**, usually receives only 2% of the sunlight that is actually incident on earth surface. Only plants adapted to low light can grow in this region. A lot of litter falls on the ground where it is quickly decomposed by decomposers.

Answer the questions given below.

a) A study was conducted to find out the physiologic differences between the trees of the canopy and understory plants. Photosynthesis rate at various irradiance level (i.e. photons of light that strike the leaf- measured in $\mu molm^{-1}s^{-1}$) was measured and a graph was plotted to obtain a photosynthesis response curve for a leaf of a plant from the canopy and that from an understory as shown below (Rate of photosynthesis is measured as net O_2 evolution).



Which curve shows the photosynthesis rate of a leaf of a plant that is growing in the understory? _____ **[1Mark]**

b) State whether the following statements are true or false. [1 Mark]

bi) Both the curves level off (reach saturation point) after certain irradiance level because the light dependent reaction gets limited by the products produced during light independent reaction.

bii) On average, the rate of photosynthesis is higher for curve A when compared to curve B at lower level of irradiance.

Q35 a. A cylindrical vessel of diameter 12 cm contains 736π cm^3 of water. A cylindrical solid glass piece of diameter 8 cm and height 8 cm is placed in the vessel. If a point object at the bottom of the vessel under the glass piece is seen by paraxial rays, locate the image of this object and find the total apparent shift of the bottom. Refractive index of water = 4/3 and refractive index of glass = 3/2. **[3 marks]**

Q35 b. The sharpest image of the sun cast by a converging lens with focal length 20 cm has a diameter of 0.5 cm. A diverging lens of focal length 10 cm is placed at 15 cm from the converging lens on the other side of the sun. Determine the size of the final image and its position with respect to the diverging lens? **[2 marks]**

Q36. Decay of organic matter such as vegetation or chemical reaction with sulphur containing mineral in rock and soil produces gas which has rotten egg smell. Calculate the percentage dissociation of the gas produced by the sulphur reducing bacteria if dissociation constant (Kc) of the gas is 1.0×10^{-6}. There are 0.1 moles of the gas in 1.6 dm^3 vessel.

i. Write the equation for dissociation of the gas produced in the reaction. **[1 Mark]**

ii. If x moles of the gas are dissociated, write the expression for equilibrium constant in terms of x. (Detail working expected) **[2 Marks]**

iii. Calculate the value of x and hence percentage dissociation. **[2 Marks]**

Q37. Answer the following questions.

i. Name the region of alimentary canal where maximum digestion of carbohydrate takes place. **[0.5 mark]**

ii. Name the region of alimentary canal where lipid digestion starts. **[0.5 mark]**

iii. Which of the following event most likely would not happen in stomach?

a) Inactivation of salivary amylase
b) Denaturation of proteins that helps in its subsequent digestion
c) Activation of salivary amylase
d) Activation of pepsin **[0.5 mark]**

iv. A biochemist isolated active amylase enzyme from human saliva. She was interested in assaying the enzyme activity of amylase. Which of the following buffer will she be most likely choosing?

Name of the buffer	Sodium acetate buffer	Sodium Phosphate Buffer	Tris-Hcl buffer	CAPS buffer
pH at room temperature	2.00	6.8	8.10	9.7

Answer_____ **[0.5 mark]**

v. A sprint runner was fasting a night before the running event due to spiritual reasons. On the day of the event also he did not take his breakfast and chose to run empty stomach. After he completed the running, he was given 300 ml of 10% glucose solution to drink. If the absorption efficiency of glucose through his intestine is 10%, then calculate the total number and mole of ATP that will be generated out of the glucose he had taken. Consider that complete oxidation of one glucose molecule generates 36 ATP. **[3 marks]**

[Instructions: M.W. glucose: 180, M.W. ATP: 507, Consider 1 mole = $6x10^{23}$ molecule]

Important: Show steps of your calculations as they carry marks

Q38 a. A bar magnet of mass 0.2 kg hangs from a string. A metal sphere of mass 0.5 kg is held underneath in contact with the magnet by magnetic force 20 N. An upward force is now applied to the string that develops tension T in the string. Calculate the maximum possible value of T for which the sphere is in contact with the magnet. **[3 marks]**

Q38 b. A food packet of mass 20 kg is dropped from a helicopter at rest, in air. The packet falls under gravity. It gains a kinetic energy of 5000 J when it acquires terminal velocity (constant velocity) due to air resistance. The force of air resistance F is given by $F = -kv$. Calculate the value of k. **[2 marks]**

Q39. A mixture of $H_2C_2O_4$ (oxalic acid) and $NaHC_2O_4$ weighing 2.02 g was dissolved in water and this solution was made upto one liter. Two titrations were carried out and the result obtained: 10 ml of the solution required 3 ml of 0.1NaOH for complete neutralization. Calculate the amount of $H_2C_2O_4$ and $NaHC_2O_4$ in the mixture? **[5 Marks]**

Q40. Origin of life in earth is traced back to about 3 billion years ago. Oparin (1924), and John Haldane (1929), independently suggested that if, the primitive atmosphere was reducing (as opposed to oxygen-rich), and if there was an appropriate supply of energy, such as lightning or ultraviolet light, then a wide range of organic compounds might be synthesized. Their hypothesis was proven by the famous Miller and Urey experiment. Using high voltage electric sparks they could experimentally generate bio-molecules from elemental gases.

These experiments helped us to understand the sequence of events that might have helped in origin of life in earth.

(i) Considering the above information into account; predict which of the following combination makes the appropriate sequence of formation of bio-molecules and sub- cellular organelles. **[1 mark]**

a) amino acid---protein ---chlorophyll
b) chlorophyll –-starch- --glycogen
c) nucleic acid-- amino acid- -chlorophyll
d) chlorophyll--nucleic acid ----amino acid

(ii) Which of the following components might be logically most abundant in primitive earth? **[1 mark]**

a) Ammonia and helium
b) Juvenile water vapour
c) Oxygen
d) Hydrogen and Methane

(iii) Which of the following energy source might have helped maximally for the formation of first life form in earth? **[1 mark]**

a) Sunlight
b) UV rays and lightening energy
c) Hydrostatic pressure of sea water
d) All of these

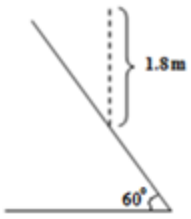
(iv) DNA or RNA is the genetic material for organisms. While RNA as the genetic material is mainly restricted to some viruses, DNA forms the genetic material from bacteria to higher organisms. The striking difference between DNA and RNA is in the pentose sugar (deoxy- ribose for DNA and ribose for RNA). This basic difference also brings about difference in their stability in water. The 2' OH of RNA (which do not form a part of the RNA chain) acts as a nucleophile and makes the RNA unstable in water. On the contrary, the absence of the 2' OH (instead presence of a 2'H in DNA) makes DNA more stable in water.

The Hypotheses for origin of life takes into account DNA and/or RNA as the genetic material. There are two schools of thought regarding the origin of life. One school of thought hypothesizes that life originated in water. In this process, different primary biomolecules after their formation were immersed in water to form a hot primodial soup. The second school proposes that life originated in some nitrogen rich medium.

From the following statements given below, predict the statements supporting school 1 and the statements supporting school 2. Write either school 1 or 2 in the space provided for your answers. **[2 marks]**

a) DNA was the first genetic material_____
b) RNA was the first genetic material_____
c) DNA is chemically stable and makes the obvious choice for becoming the genetic material___ _____ _
d) RNA is unstable inside the cell sap_____ _____ ___

Q41a. A tiny ball is dropped on a smooth inclined plane as shown in the figure. It falls through 1.8 m before striking the plane. Coefficient of restitution of impact is 0.5. Calculate time taken by the ball before second impact. Neglect air resistance. (Coefficient of restitution for collision of two bodies is defined as the numerical ratio of relative speed of recede to relative speed of approach). **[3 Marks]**



Q41b. Masses of 300 g and 500 g are hung at the opposite ends of a light inextensible string. The string passes over a smooth horizontal peg. The system is released from rest. Calculate the loss in gravitational potential energy of the system when the 300 g mass has ascended by 1 m. At this instant, the other mass is suddenly reduced by 400 g. How much further will the 300 g mass ascend? Neglect air resistance. **[2 Marks]**

Q42. Aruna was studying the interaction between various chemicals. She found that when she mixed potassium bromate ($KBrO_3$) with potassium bromide (KBr) and acidified the solution with H_2SO_4, vapours of Br_2 were evolved. On addition of KI to the reaction mixture, a deep brown colour was obtained due to formation of iodine, and this could be titrated with sodium thiosulphate ($Na_2S_2O_3$) using starch indicator.

i. Write down the balanced reaction occurring at each stage. **[3 Marks]**

ii. In what molar proportion should $KBrO_3$ and KBr be mixed? **[1 Mark]**

iii. Starting with 10 ml of 0.01M $KBrO_3$ and using excess of KBr, H_2SO_4 & KI, what volume of 0.05 M $Na_2S_2O_3$ will be required? **[1 Mark]**

Space for Rough Work

Space for Rough Work

Section A

Q.No.	(a)	(b)	(c)	(d)	Q.No.	(a)	(b)	(c)	(d)
1	☐	☐	☐	☒	16	☒	☐	☐	☐
2	☐	☒	☐	☐	17	☐	☐	☐	☒
3	☐	☐	☐	☒	18	☒	☐	☐	☐
4	☐	☐	☒	☐	19	☐	☒	☐	☐
5	☐	☐	☒	☐	20	☒	☐	☐	☐
6	☒	☐	☐	☐	21	☐	☒	☐	☐
7	☐	☐	☒	☐	22	☐	☒	☐	☐
8	☐	☐	☐	☒	23	☐	☒	☐	☐
9	☐	☒	☐	☐	24	☐	☐	☐	☒
10	☒	☐	☐	☐	25	☐	☐	☒	☐
11	☐	☒	☐	☐	26	☐	☒	☐	☐
12	☐	☐	☒	☐	27	☐	☐	☐	☒
13	☐	☐	☒	☐	28	☐	☐	☐	☒
14	☒	☐	☐	☐	29	☒	☐	☐	☐
15	☐	☐	☒	☐	30	☐	☐	☒	☐

SECTION B (Long questions)

Ans 31.

The question is based on a 'Scientific Skills Exercise' given in Biology a global approach 10th Edition Campbell et al. (Pearson publication).

		Budding cell	Mature cell
	Diameter (μm)	2	4
Ans. i.	Volume (μm^3)	4	32
Ans. ii.	Surface area (μm^2)	12	48
Ans iii.	SA/Volume	3	3/2

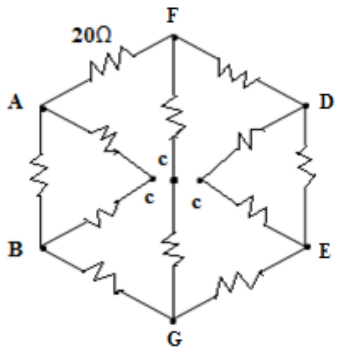
iv.

a) less
b) greater
c) a high ratio of surface area to volume
d) intestinal

v. Nine smaller cells

Ans 32a.

Using the hint given in the question, equivalent circuit can be drawn as given below.



$R_{DE} = 40/3\ \Omega$, $R_{FDEG} = 160/3\ \Omega$,

$R_{FG} = 160/7\ \Omega$, $R_{AFGB} = 440/7\ \Omega$,

$R_{AB} = 11\ \Omega$.

Ans 32b.

Conversion into ammeter always decreases the sensitivity as more current gives the same deflection, while voltage sensitivity is unaffected as there is same voltage across galvanometer and its shunt, i.e., across the ammeter.

$I_g = 100\ \mu A,\ V_g = 5\ V \quad \therefore G = 50\ \Omega$

Shunt deviates 80% of total current.

$\therefore I_s = 4I_g \therefore S = \frac{G}{4} = 12.5\ \Omega \therefore Resistance\ of\ ammeter = 10\ \Omega$

(Correct) current passing through the bulb, $I = 6/40 = 0.15$ A
Current actually passing through the bulb after connecting the ammeter,
$I' = 6/50 = 0.12$ A

$$\therefore \Delta I = 0.03\ A \therefore \frac{\Delta I}{I} = \frac{0.03}{0.15} = 0.2 = 20\ \%$$

Ans 33a.

Mol. wt of SnO_2 = 151 g/mol

% of Sn = (119/ 151) x 100 = 78.8 % Sn in SnO_2

1.27 x (78.8/100) = 1 g of Sn in sample

Mol. wt. of $PbSO_4$ = 303 g/mol

% of Pb = (207/303) x 100 = 68.3 % of Pb in $PbSO_4$

2.93X (68.3/100) = 2 g of Pb in sample

(2/3) x 100 = 66.7 % of Pb (1/3) x100 = 33.3 % of Sn

Ans 33 b.

a. $HIn \rightleftharpoons H^+ + In^-$

b. $K_{In} = [H^+]\,[In^-]/\,[HIn]$

c. At eq. point,
[HIn] = [In-]
Substituting in b we get,
pKIn = pH

d. $K_{In} = 10^{-9}$
pKIn = 9 = pH

Ans 34.

a) G / F
b) F, L, H
c) G
d) K / M
e) K, L

a(i) Ans Curve B

Explanation The canopy keeps sunlight from reaching the plants in the understory. Hence filtered light reaches the plant. Due to this the photosynthetically active radiation (PAR)reaching the leaves of the plants is less as compared to leaves of plant in the canopy. Hence the plants in the understory carry out photosynthesis at a slower rate when compared to plants of the canopy.

bi) False
Explanation: The photo synthesis rate at low irradiance level can be determined by drawing a tangent t o the curve(at low irradiance) the slope of the tangent determines the rate . It is more for curve B. The plants in the understory are shade loving plant and it is seen that they have more chlorophyll content per grana than the plants of the canopy. Hence they are activated at low irradiance level.

bii) True
Explanation: The plants in the canopy receive more sunlight (i.e. PAR reaching them is more) when compared to that reaching the plants of the understory. Hence the overall rate of photosynthesis is high.

Ans 35a.

The volume of the glass piece is 128π cm^3.

The total volume of the water + glass piece is 864π cm^3.

The height of the water level from the bottom is $864\pi / 36\pi = 24$ cm.

The depth of water above the glass piece is 24 - 8 = 16 cm.

The total apparent shift of the bottom is

$$h_1\left(1 - \frac{1}{\mu_w}\right) + h_2\left(1 - \frac{1}{\mu_g}\right) = 16\left(1 - \frac{3}{4}\right) + 8\left(1 - \frac{2}{3}\right) = \frac{20}{3} \text{ cm}$$

Ans 35b.

The sun may be assumed to be at infinity, so the image is formed 5cm behind the diverging lens. The image distance, v is given by $1/(-5) + 1/v = 1/(-10)$ $\therefore v = 10$ cm.
The lateral magnification is 2, so the size of the final image is (0.5) x 2 = 1 cm

Ans 36.

a. $H_2S \rightleftharpoons 2H^+ + S2^-$

b. $H_2S \rightleftharpoons 2H^+ + S2^-$

0.1	0	0
0.1- x	2x	x

$$\frac{0.1-x}{1.6} \quad \frac{2x}{1.6} \quad \frac{x}{1.6}$$

$$K = \frac{[\frac{2x}{1.6}]^2 \; [\frac{x}{1.6}]}{\frac{0.1-x}{1.6}}$$

$$\frac{4x^3}{2.56 \times 0.1} = 1 \times 10^{-6}$$

$4x^3 = 256 \times 10^{-9}$

$x^3 = 64 \times 10^{-9}$

$x = 4 \times 10^{-3}$

$\%x = 4 \times 10^{-3} \times 10^2$

$= 4 \times 10^{-1}$

= 0.4 %

Ans 37. Duodenum/small intestine (as the salivary amylase in inactivated due to acidity of stomach)

i. Duodenum/small intestine (as the salivary amylase is inactivated due to acidity of stomach)

ii. Duodenum/small intestine (as it is the 1st site to receive bile juice which starts emulsification)

iii. 'C' as salivary amylase is inactivated due to stomach acidity.

iv. Sodium phosphate buffer pH 6.8

v. 300 ml of 10% glucose contains 30 g glucose = 1/6 mole

Out of that the absorption efficiency is 10%

So the absorbed glucose will be 1/60 mole

1 mole contains $6x10^{23}$ molecule glucose that generates $36x6x10^{23}$ molecules of ATP

So 1/60 mole glucose generates $3.6x10^{23}$ molecules of ATP

Ans 38a

Let '*a*' be the upward acceleration of the system when the sphere is about to detach.

(The contact force (reaction force, not magnetic force) between sphere and magnet just becomes zero at this acceleration).

Force equation for the sphere (with zero contact force) is

$0.5a = 20 - 0.5g - 0$

$\therefore a = 15$ m/s^2

For the magnet, (with zero contact force),

$0.2a = T - 0.2g - 20 + 0$

$\therefore T = 28$ N.

Ans 38b.

At terminal (constant) velocity,

mg = air resistance = kv_T *and* $K.E. = \frac{1}{2} mv_T^2$

$\therefore v_T = \sqrt{500}$ *and* $k = \sqrt{80}$

Ans 39.

Let x be the mass of $H_2C_2O_4$ in the mixture, then (2.02 –x) is the mass of $NaHC_2O_4$

Amount of $H_2C_2O_4$ = x/ 90gmol^{-1}

Amount of $NaHC_2O_4$ = (2.02 – x)/112gmol^{-1}

The mixture is dissolved to make 1 liter of solution

Hence molarity of H2C2O4 = (x/90 g) molL-^{1}

Molarity of $NaHC_2O_4$ = ((2.02 – x) / 112g) molL-^{1}

Reaction, $H_2C_2O4 + 2\ NaOH = Na_2C_2O4 + 2H_2O$

$NaHC_2O_4 + NaOH = Na_2C_2O_4 + H_2O$

Hence, 1 mol $H_2C_2O_4$ = 2eq H_2C_2O4

1 mol $NaHC_2O_4$ = 1eq $NaHC_2O_4$

Normality of $H_2C_2O_4$ = (x/90)(2) = (x/45)

Normality of $NaHC_2O_4$ = (2.02 – x/112) (1)

Total Normality of the solution

$N_{Total} = [(x/45) + (2.02 – x/112)]$

Since 10 ml of the solution is titrated, hence the amount (in equivalent) of the mixture in 10ml of the solution will be

$10/1000 [(x/45) + (2.02 – x/112)] = 10^{-2} [(x/45) + (2.02 – x/112)]$ eq…… 1

Since 3ml of 0.1N NaOH is consumed, the amount (in equivalent) of the mixture will be

3 ml / 1000 (0.1) = 3×10^{-4} eq …….2

Equating 1 and 2 we get

$3 \times 10^{-4} = 10^{-2} [(x/45) + (2.02 – x/112)]$

Solving x we get, x = 0.9g (Oxalic acid)

$2.02 – x = 2.02 - 0.9$

$= 1.12$ g ($NaHC_2O_4$)

Ans 40.

i) nucleic acid-- amino acid- -chlorophyll
Simpler compounds were formed earlier and complex biomolecules later

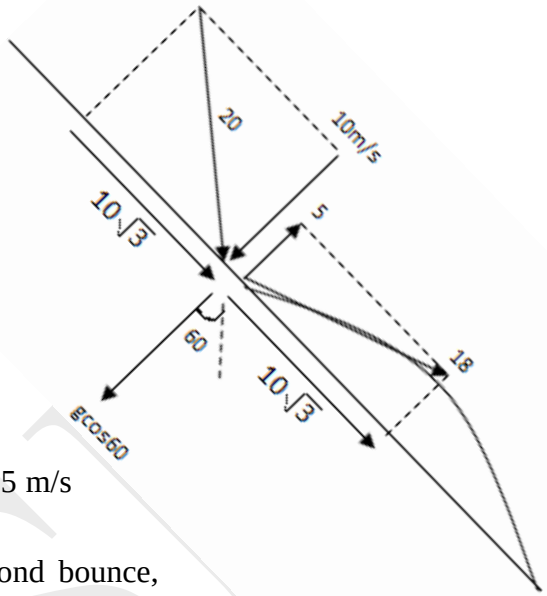
ii) Hydrogen and Methane
Primitive earth had reducing environment.

iii) UV rays and lightening energy
High energy was required for formation of biomolecules.

(iv)

a) school one
b) school two
c) school one
d) school two

Ans 41a.



Striking speed at first impact = 6 m/s. Its component along the plane ($3\sqrt{3}$ m/s) is unchanged. The component normal to the plane (3 m/s) decreases due to partially inelastic collision (e = 0.5) and becomes 1.5 m/s.

Thus the ball bounces with normal component 1.5 m/s and 'along plane' component $3\sqrt{3}$ m/s.

Method I: For projectile between first and second bounce, time of flight, $T = \frac{2usin\theta}{g'}$ = 0.6 second

where u is the bouncing speed ($usin\ \theta$ = normal component = 1.5 m/s)

g' = normal component of $g = gcos\theta = gcos\ 60^0 = 5\ m/s^2$

Method II: At the instant of second bounce, displacement normal to the plane is zero. Effective g' (normal to the plane) is $gcos\ 60^0 = 5\ m/s^2$. Initial normal velocity (for second bounce) = 1.5 m/s

$\therefore 0 = 1.5T - \frac{1}{2} g' T^2 \therefore T = 0.6\ s$

Ans 41b.

Loss in the gravitational potential energy of the system = $(0.5 - 0.3)g$ = 2 J.

Equating the gain in kinetic energy of the system to the loss of gravitational P. E., the velocity v of the system is given by

$1/2(0.3 + 0.5)v^2 = (0.5 - 0.3)g$

$\therefore v^2 = g/2 = 5$

At this instant, the mass of 400 g is removed from the system. This reduces the K. E. of the system by ½(0.4)5 = 1 J.

The distance ascended by the 300 g mass (after this) should be such that the K. E. of the system is reduced to zero at the uppermost position of 300 g mass.

Hence, $(0.3 - 0.1).g.h = 1$

$\therefore h = 1/2$ m

Ans 42.

Reaction : (ia) $KBrO_3 + 5KBr + 3H_2SO_4 \longrightarrow 3K_2SO_4 + 3H_2O + 3Br_2$

(ib) $2KI + Br_2 \longrightarrow 2KBr + I_2$

(ic) $I_2 + 2Na_2S_2O_3 \longrightarrow 2NaI + Na_2S_4O_6$

i. Molar proportion $KBrO_3 : KBr = 1:5$

ii. $1[KBrO_3] = 3[Br_2] = 3[I_2] = 6[Na_2S_2O_3]$
10ml of 0.01M $KBrO_3$ = 0.1M mol $KBrO_3$ = 0.6M mol $Na_2S_2O_3$
Therefore, 12ml of 0.05M $Na_2S_2O_3$ are required.