50. (a) : There are two major groups of monerans archaebacteria (ancient bacteria) and eubacteria (true bacteria). Eubacteria is of further two types – bacteria and cyanobacteria. Thermoacidophiles are a type of archaebacteria which live in extremely acidic environment (pH 2) that have extremely high temperatures (upto 110°C). They are found in hot sulphur springs. Some of the eubacteria are also famous for living under the most hostile environment like salt pans, petroleum pans, spilled oil, hot springs, sulphur springs, snow, etc.

154. (b)

75. (a) : Algae, bryophyte and pteridophyte are cryptogams, but out of them algae, and bryophytes are lower cryptogams and do not possess vascular tissue (xylem and phloem), whereas in pteridophytes, vascular tissue system is well developed and so these are higher cryptogams or vascular cryptogams. The term cryptogams means that these plants reproduce by means of spores and do not produce seeds.

The vascular tissue of pteridophytes is well developed. They contain both xylem and phloem. In xylem, vessels are absent and in phloem companion cells are absent.

So pteridophytes or vascular cryptogams are a group of seedless vascular plants, that have successfully invaded the land and reproduce by means of spores.

Gymnosperms are naked seed bearing plants called phanerogams.

31. (d) : Sea horse (*Hippocampus*) and flying fish (*Exocoetus*) belong to class osteichthyes of super class pisces. They have two chambered heart (one auricle and one ventricle) and are cold blooded animals.

8. (a) : Diatoms are marine or freshwater unicellular organisms which have cell walls (frustules) composed of pectin impregnated with silica and consisting of two halves, one overlapping the other. The siliceous frustules of diatoms do not decay easily.

47. (c) : The pathogen *Microsporum* is genus of Kingdom Fungi that causes diseases of skin and hair in humans and animals like dog, cat, monkey. Ringworm is caused by the dermatophyte fungi-species of *Microsporum*, *Trichophyton* and *Epidermophyton*.

Rhizopus, a black bread mould belongs to group zygomycetes of Kingdom Fungi.

152. (b) : Linnaeus put forward an "Artificial system" of plant classification which was based on sexual characters like cryptogamia, monoecia, monandria, diandria, polyandria etc. It is commonly also called as sexual system of plant classification.

71. (a) : A fern plant body is sporophytic (2n) and is differentiated into roots, stems and leaves. On the ventral surface of leaves sporangia are borne in a group called sori. Inside the sporangium are present the spores which are formed by reduction duvsion. Thus the spores produced are haploid in nature and germinate to produce a prothallus that represents the gametophytic generation. Antheridium and archegonium are borne on this prothallus. Thus meiosis takes place at the stage of spore formation.

29. (b) : *Pheretima* (earthworm) and related organisms feed upon the decaying organic matter found in the soil. They also feed on the bits of plants and animal matter. Thus, they are omnivorous.

177. (c) : *Typhlops* is a genus of blind snakes (non-poisonous snake) found in Europe, Africa, Asia and Central and South America. Sea snake is a poisonous snake while grass snake is a non-poisonous snake. Glass snake is a lizard.

44. (a) : Plasma membrane of eubacteria resembles plasma membrane of eukaryotic cell. But nucleus, ribosomes and cell wall are little different in eukaryotic cell in their structure and organization from eubacterial cell.

148. (b) : The infective stage of *Plasmodium* is a minute organism called sporozoite. When the mosquito bites man, sporozoites present in the salivary gland of female *Anopheles* mosquito are injected into the blood of the man. These sporozoites are spindle-shaped or sickle-shaped uninucleate organisms capable of wrigging (worm-like) movements. Each sporozoite consists of elastic pellicle, cytoplasm and nucleus.

69. (a) : *Cycas* belongs to Order Cycadales of gymnosperms because it has naked seed. It is not enclosed inside a fruit. It does not have double fertilization and so the endosperm formed is haploid in nature and not triploid. So it is not included in angiosperms as they have ovules (or seeds) produced inside fruit. This is the main difference between gymnosperms and angiosperms.

24. (d) : Reptiles represent the first class of vertebrates fully adapted for life in dry places on land. The characters of reptiles are in fact a combination of characters that are found in fish and amphibians on one hand and birds and mammals on the other. Their exoskeleton is of horny epidermal scales, shields, plates and scutes. The skin is dry, cornified and devoid of glands. Reptiles lack external ears and have immovable eyelids.

183. (a) : The common name of *Tubipora* is Organ Pipe Coral. It is a marine animal of the Class Anthozoa (Phylum Cnidaria). It occurs on reefs in shallow waters of the Indian and Pacific oceans and is characterized by long, parallel upright polyps or stalks, supported by a skeleton of rigid tubes of calcium carbonate.

41. (c) : *Azotobacter*, *Aspergillus* and *Trichoderma* all are free living microbes that help plants in their nutrition. *Glomus* is a fungus that symbiotically forms endomycorrhiza that helps in absorption of nutrition specially phosphorus from soil.

145. (c) : Amoebiasis can be prevented by drinking boiled water as it mainly occurs by ingestion of cysts of *E. histolytica* in food or drinks. The contamination of food or drinks occurs by (i) unhygienic habits of food handlers who by habit scratch the anus and then put the fingers in the food which they serve, (ii) habit of defecating in open fields causing contamination of vegetables and then washing the bottom in ponds causing the contamination of water, (iii) transmission of cysts from stools to food and drinks by flies and cockroaches. So, one should take following preventive measures :

(I) Proper sanitation of roads, streets, lanes and open drains.

(II) Purification of drinking water (by boiling).

(III) Proper disposal of sewage.

(IV) Covering of the food articles by the traders.

67. (b) : In angiosperms presence of vessels is not an universal feature as there are certain angiosperms where vessels are absent *e.g.*, *Wintera*, *Trochodendron* etc.

Secondary growth is increase in the girth or diameter of axis (root and stem) of the plant by formation of secondary tissue by the activity of lateral meristem. It occurs in dicotyledons of angiosperms and gymnosperms. But in monocotyledons of angiosperms the primary plant body is complete in itself and doesn't produce any secondary tissue.

Autotrophic plants are those which synthesise their organic food themselves by the process of photosynthesis. But certain angiospermic plants have heterotrophic mode of nutrition. *E.g. Rafflesia*, *Orobanche*, *Striga* are root parasites.

But double fertilization is universal in all angiosperms. It involves fusion of one male gamete with the egg cell and another male gamete with the diploid secondary nuclei.

8. (a) : Parapodia are flattened, fleshy, vertical flap-like outgrowths of body wall found in annelids on lateral sides of trunk segments. These are hollow structures enclosing coelom which is continuous with that of trunk segments. These serve the dual purpose of locomotion and respiration.

180. (c) : Tortoise belongs to the Class Reptilia. Its body is protected by a shell consisting of a dorsal carapace and ventral plastron.

38. (d) : Cyanobacteria is a phylum consisting of two groups of photosynthetic eubacteria: the blue-green bacteria (formerly known as blue-green algae, or cyanophyta), which comprise the vast majority of members, and the grass-green bacteria, or chloroxybacteria.

140. (c) : *Trypanosoma gambiense* is the parasitic zooflagellate which causes one of the deadliest ailments in human beings called sleeping sickness or trypanosomiasis. The disease is common in humid and subhumid zones of the African continent. The disease is transmitted by shade loving tse-tse fly (*Glossina palpalis*) which acts as the vehicle that carries the culprit protozoan parasite.

64. (d) : *Spirogyra* is a freshwater green alga which belongs to Class Chlorophyceae. The sexual reproduction in *Spirogyra* is called conjugation. It involves the fusion of two morphologically identical but physiologically dissimilar non-ciliated gametes. For development of gametes, some of the cells start to act like male and female gametangia in which the cell contents become separated from the cell wall, shrink and ultimately forms gametes. The fusion of these gametes takes place by scalariform conjugation or lateral conjugation.

5. (b) : *Ornithorhynchus* and *Tachyglossus* are oviparous mammals. Crocodile is a reptile which possesses four chambered heart. In cartilaginous fish (except *Chimaera*) gills are not covered by an operculum.

174. (b) : Bird vertebrae are heterocoelous *i.e.*, the centra of vertebrae have saddle - shaped ends. Acoelous refers to vertebrae that are flat on both ends (mammals). Amphicoelous means both ends of the centrum are concave (fish). Procoelous means concave in front and convex in back (anurans and reptiles).

34. (b): Fungi are achlorophyllous, heterotrophic, spore forming, non-vascular, eukaryotic organisms which often contain chitin or fungal cellulose in their walls. Hence, their cell wall is rigid.

138. (b) : Taxonomy and classification are a part of the broader field of systematics which is the study of diversity of organisms. Classification of a part of systematics as it lists the unique characters of each taxon.

63. (a) : Seed producing plants belong to spermatophyta. It includes gymnosperms and angiosperms. Seed habit or seed formation originated in gymnosperms. It requires the retention of megasporangium or the only on the parent plant and non-shedding of megaspore, development of integument and in site formation of female gametophyte. All these features developed in gymnosperms and angiosperms. Thallophytes, bryophytes and pteridophytes lack these features and thus do not reproduce by producing seeds.

Fern and *Funaria* belong to pteridophytes and bryophytes respectively so they do not reproduce by producing seeds.

1. (b) : An important characteristics that hemichordates and chorddates share is presence of pharyngeal gill slits. Gill slits are dorsal in position in hemichordates whereas they are lateral in chordates. A true unotochord does not occur in hemichordates. Nervous system is distinctly of vertebrate type being intraepidermal in position and having a ventral nerve cord.

169. (a) : Earthworms are very useful. All over the world they are used as bait for fishing. Earthworms are in general beneficial to agriculture. Their habit of burrowing and swallowing earth increases fertility of soil in many ways. Their burrows permit penetration of air and moisture in porous soil, improve drainage, and make easier the downward growth of roots. Excretory wastes and other secretions of worms also enrich soil by adding nitrogenous matters that form important plant food. Earthworms were used variously as medicines in the past. Earthworms were used to cure stones in bladder, yellowness of jaundice, pyorrhoea, piles, rheumatism or gout, diarrhoea. Earthworms are easily obtained and are of convenient size for dissections. They are, therefore, universally employed for class studies and for investigations in general and comparative physiology.

(b) : RNA of viroid has low molecular weight.

135. (a) : *Plasmodium* has two hosts.
(i) Female *Anopheles* mosquito : Here the sexual phase of the malarial parasite occurs and it is considered the definitive host of malarial parasite.
(ii) Human beings : Here the asexual phase of malarial parasite occurs. It is considered as the intermediate host. Options (b), (c) and (d) are the stages of the asexual phase of *Plasmodium.*

62. (a) : Angiosperms are highly evolved and well adapted land plants. They have both vessels and tracheids in xylem for better conduction of water. Roots are modified into taproots, adventitious roots, pneumatophores, etc. to suit the desired climate.
Sex organs are highly developed, sporophylls are organized into flowers and the flowers are highly coloured or modified to attract pollinators at different times and places. Insect pollination is more prevalent because it is more efficient and leads to less wastage of pollen grains as compared to wind pollination. So the flowers are made attractive to attract a variety of insects. Seed are more protected as they are enclosed inside a fruit.
All these adaptations have made angiosperms more adaptive in diverse habitats.

126. (b) : In *Pinus*/*Cycas*/gymnosperms the endosperm is haploid because it is produced before fertilization.

166. (d) : The wishbone, known in anatomy as the furcula, is a sternum bone found in birds which is shaped like the letter Y. It is used as an attachment point for the wing muscles. It is so named because of a tradition: Two people pull on each side of such a bone, and when it breaks, the one who gets the larger part is said to have a wish granted. Two clavicles fused with inter clavicle to form a fork shaped bone called wish bone.

9. (a)

95. (a) : Using Gram stain, developed by Danish physician, Christian Gram in 1884, two kinds of bacteria were noted - those species of bacteria that are decolorized by alcohol are called gram negative and those that retain the stain are called gram positive. This property of bacteria is related with the structure and compositional differences between the walls of gram positive and gram negative forms.
In the cell wall of Gram +ve bacteria, both horizontal and vertical peptide linkages are present, due to which mesh is dense and hence the stain does not come out. Further outer layer of cell wall of Gram +ve bacteria is made of teichoic acid.
In the cell wall of Gram –ve bacteria, either horizontal or vertical peptide linkage are present, due to which mesh is loose and hence stain comes out. Further outermost layer of cell wall of Gram –ve bacteria is made of lipopolysaccharides.

58. (a) : Stele is a column containing vascular tissues which is surrounded by pericycle and separated from ground tissue by endodermis.

Siphonostele is medullated protostele or protostele with a central non-vascular pith. Leaf gaps are absent.

Siphonostele is of two types :

In Ectophloic siphonostele, central pith is surrounded successively by xylem, phloem, pericycle and endodermis. In amphiphloic siphonostele there is a central pith and xylem is surrounded on either side by phloem, pericycle and endodermis. It is found in *Osmunda* and *Equisetum*.

122. (a) : Apophysis is basal portion of capsule in continuation with seta. The outer layer of apophysis is epidermis which has stomata for gaseous exchange. In capsule of *Funaria* stomata are present only in apophysis.

161. (c) : Visceral leishmaniasis, also known as kala-azar and black fever, is the most severe form of leishmaniasis, a disease caused by parasites of the *Leishmania* genus. It is transmitted by sand fly. The adult female sand fly is a bloodsucker, usually feeding at night on sleeping prey. When the fly bites an animal infected with *L. donovani*, the pathogen is ingested along with the prey's blood.

Leishmania tropica produces skin ulcers known as oriental sore or Delhi sore. The disease is spread by sand flies. The parasite lives in the endothelial cells of skin capillaries. It leads to ulcerated wounds with raised edges. They do not cause much pain.

5. (b) : DNA replicates in bacteria just before they divide by fission.

92. (c) : Cauliflower mosaic virus contain dsDNA. It is circular and shows semidiscontinuous type of replication.

54. (c) : The partially decomposed *Sphagnum* mass accumulates to form compressed mass called peat, which after drying is used as coal. So it is also called peat moss. *Sphagnum* has the capacity to retain water for long periods and thus it is used to cover plant roots during transportation.

117. (a)

158. (a) : Cysticercus is the larval stage of tapeworm which is characterised by a large vesicle and one scolex. Cysticercus develops in adult tapeworm only when ingested by the human host. In pig's body it leads quite an inactive life and remains viable for several years, after which it dies and becomes calcified. Pork (pig's flesh) containing viable cysticerci is called measly pork for its spotted appearance.

3. **(b)** : Mycoplasmas are the smallest living cells, known without a definite cell wall. They are pathogenic to both plants and animals and can survive without oxygen.

89. (a)

24. (d) : Algae and moss are included in plant kingdom while fungi constitute a separate kingdom. Among them, mosses invariably show diplontic life cycle while others may or may not. Algae and moss are autotrophic while fungi are heterotrophs. But they all show multiplication by fragmentation.

112. (c) : In *Pinus*, if the pollen grain has 6 chromosomes then in its endosperm will also have 6 chromosomes as endosperm and pollen grains are both haploid structures.

155. (c) : Ecdysone is a steroid hormone, secreted by a pair of prothoracic glands in the thorax of insects and by Y-organs in crustaceans, that stimulates moulting and metamorphosis. In insects its release is stimulated by prothoracicotropic hormone.

19. (c) : To construct the hierarchy of classification, one or more species are grouped into a genus, one or more of genera into a family, families are clubbed into order, orders into class, classes into phylum and various phyla into kingdom.

87. (a) : Normally bacteria cannot survive in antibiotic containing medium but if it does so it must have acquired resistance against that antibiotic. These are well adapted to grow in streptomycin containing medium and thus are more evolved. So due to natural selection only the more evolved and better adapted species is able to survive.

20. (b) : Syngamy is the complete and permanent fusion of male and female gametes to form the zygote. When fertilization occurs outside the body of the organism, this type of gametic fusion is called external fertilization or external syngamy. In majority of algae, external fertilization occurs.

107. (c) : In *Ulothrix/Spirogyra* reduction division (meiosis) occurs at the time of zygospore formation. Plant body of *Ulothrix* and *Spirogyra*, is gametophytic (haploid), they produce zoogametes (n) which fuses to form zygosporic (2n) diploid, which is a resting spore. Onset of favourable condition zygospore undergoes reductional division, or meiosis to produce zoo-meiospores.

153. (b) : Radial symmetry is the arrangement of parts in an organ or organism such that cutting through the centre of the structure in any direction produces two halves that are mirror images of each other. All animals belonging to the cnidaria (*e.g.*, jellyfish) and echinodermata (*e.g.*, starfish) are radially symmetrical.

16. (b) : Bentham and Hooker in their monumental work *Genera Plantarum* (1862-1883) have provided elaborate keys for the easy identification of 202 natural orders and genera. Engler and Prantl wrote *Die naturlichen pflanzen familien*. Huchinson wrote a book titled "The Families of Flowering Plants."

84. (b) : Whittaker's system is based on the following three criteria –

- complexity of cell structure.
- complexity of the body organization.
- mode of nutrition.

On the basis of these criteria, Whittaker divided organisms into five kingdoms. These five kingdoms are monera, protista, algae, fungi and animalia. In the five kingdom classification all, prokaryotes have been placed in kingdom monera, all unicellular eukaryotes in kingdom protista, fungi (except slime moulds and water moulds) in their separate kingdom while kingdom plantae and kingdom animalia have been retained for multicellular, autotrophic and multicellular holozoic organisms respectively.

16. (a) : In oomycetes, like other oogamous organisms female gamete is large and non-motile, while male gamete is small and motile.

103. (c) : *Pinus* is a gymnospermic plant which has a well developed conducting tissue system but seeds are naked. Whereas mango is an angiospermic plant in which seed are enclosed in the ovary and fruit is present.

74. (c) : Uricotelism means excretion of uric acid. Uric acid excretion occurs in organisms which develop in an enclosed egg (where water is severely limited) or which normally experience very dry terrestrial environment as adult organisms. Uric acid is discharged as thick paste or as solid pellet: Examples: terrestrial reptiles, birds, insects, gastropod mollusc, etc.

12. (c) : *Ex situ* conservation means "offsite conservation". It is the process of protecting endangered species of plants and animals by removing it from an unsafe or threatened habitat and placing it or part of it under the care of humans. Botanical garden serve as *ex situ* conservation of germplasm of different plants, to maintain rare and endemic plant species and also to provide recreation and knowledge about plants to a common man.

79. (a) : Bacterial cells do not have nucleus, characteristic of eukaryotic cells. Nuclear material of bacteria lies free in the cell in the form of an irregular, thin, fibrillar and circular single molecule of DNA, called nucleoid or chromatin body. This DNA, sometimes attached at one or more points to a mesosome, frequently runs parallel to the axis of the cell. Bacterial DNA is not associated with histone protein and does not coil to form well-defined chromosomes during the multiplication. In addition to circular DNA, a small amount of subsidiary extrachromosomal DNA is also present as plasmids or episomes.

14. (d) : Among the bryophytes *Sphagnum* accounts by far the most important place economically. It is popularly called bog moss or peat moss. It is perennial and its growth continues year after year. Older portions undergo death but do not decompose due to secretion of acid that accounts for the antibacterial and antifungal actions. The increasing mass of dead remains accumulate year after year and form a compact dark coloured mass rich in carbon which is called peat. Peat is used as fuels. Paraffin, acetic acid, peat tar and ammonia are formed as by-products of peat obtained for industrial uses.

97. (d) : Bryophytes and pteridophytes both have alternation of generation. The gametophytic phase is dominant in bryophytes whereas in pteridophytes it is short lived. Sex organs are embedded is some members of bryophytes and pteridophytes. Sperms are flagellate and so water is required for fertilization. Sterile jacket is present around the sex organs for protection. Archegonium appeared for the first time in bryophytes in plant kingdom. It is a flask shaped structure. It has swollen basal portion called venter and upper elongated neck. The venter has egg cell and venter canal cell. There are 4-6 vertical rows of neck cells enclosing neck canal cells in bryophytes. The archegonia have short neck made of four rows of vertically elongated cells that encloses four neck canal cells in pteridophytes.

69. (c)

10. (a) : The International Code of Botanical Nomenclature (ICBN) is a set of rules and recommendations dealing with the formal botanical names given to plant. The foundations of ICBN are given in book written by C. Linnaeus named *Philosophia Botanica*. It is independent of zoological nomenclature. The rank of species is basic and relative order of the ranks of taxa are as : species, genus, tribe, family, order, series, class, division and kingdom.

The different ranks or categories have following specific endings of their names as division – phyla, class-ae, family-aceae.

75. (a) : Phenetic classification is a type of numerical taxonomy. In this type of classification the organisms are arranged according to overall similarity of existing organisms based on available characters. It is also called adansonian taxonomy because the same was first attempted by Adanson (1763), of course on the basis of external traits only. Numerical taxonomy evolved around 1950. It has received impetus with the availability of calculating machines and computers. In numerical taxonomy as many characters as possible are employed for evaluating degree of similarity and difference. All characteristics used in analysis are given equal weightage and importance. A proper selection of characters, their organisation and analysis in the light of current knowledge is key to success of this method. A lot of subjectivity can creep in depending upon the judgement of the biosystematist. No weightage is given to the quantity of the character present.

12. (a) : *Ectocarpus* produces biflagellate gametes. *Anabaena* is a cyanobacteria and does not reproduce sexually. *Spirogyra* produces non-flagellated male gamete during conjugation, where entire cell content functions as gamete. *Polysiphonia* also produces non-flagellated spermatia.

93. (b) : Gymnosperms show distinct alternation of generations. The sporophytic phase is dominant. The sporphyte is differentiated into root, stem and leaves. So the number of chromosomes in a leaf cell is diploid (2n), (2n = 16). Double fertilization is absent in gymnosperms. The endosperm develops before fertilization directly from the megaspore. So the number of chromosomes in endosperm will be 8(n = 8).

67. (a) : Platyhelminthes do not have body cavity so they are acoelomates. In annelids, the body cavity is true and schizocoelous. Both annelids and platyhelminthes have bilateral symmertry.

9. (c)

74. (c) : Viruses like bacteriophage T4 undergo lytic cycle that involves lysis of bacteria. The replication cycle of bacteriophage T4 consists of following phases –

(i) Adsorption of the phage to bacterial or host cell. Then the viral genetic material penetrates into the host cell.

(ii) Eclipse period involves the synthesis of new phage DNA and proteins.

(iii) Maturation involves the assembly of phage DNA into the protein coat.

(iv) Lysis of host cell occurs and releases infective progeny phases.

8. (b) : The sperms of bryophytes and pteridophytes are flagellated and hence require an external supply of water to reach archaegonia.

88. (a) : The Division Bryophyta includes three classes Hepaticopsida, Anthocerotopsida and Bryopsida. The members of Hepaticopsida and Anthocerotopsida have a thallose plant body which is dorsiventrally differentiated and dichotomously branched. On the ventral surface unicellular or multicellular rhizoids are present. The member of Bryopsida have a main plant body that has a leafy gametophore made up of an axis having spirally arranged leaves. The rhizoids are multicellular and branched *e.g. Sphagnum*, *Funaria*, *Riccia*, *Anthoceros*. So only few member of bryophytes have leafy gametophytes.

64. (d) : The term metamerism refers to a linear repetition of parts in an animal body. It occurs in three highly organized phyla : Annelida, Arthropoda and Chordata. Each segment is called a metamere, or somite. Segmentation often affects both external and internal structures. Such a condition is called metameric segmentation. In chordates, the segmentation is apparent only in the embryonic stage. In the adult chordates, segmentation is visible in the internal structures, such as vertebrae, ribs, nerves and blood vessels. Other animals have unsegmented bodies.

7. **(b)** : *Plasmodium falciparum* is a protozoan parasite, one of the species of *Plasmodium* that causes malaria in humans. Being digenetic, its life cycle is complete in two hosts — man and mosquito. Its sexual cycle is completed in female *Anopheles* mosquito and infective individuals called sporozoites are formed. Which are transmitted to humans with the bite of infected female *Anopheles*. Asexual cycle is passed in man in two phases. Malaria caused by *P. falciparum* (also known as aestivo-autumnal, malignant tertian or pernicious malaria) is the most dangerous form of malaria, with the highest rate of complication and mortality. In this case fever cycle is of 48 hours and is often fatal to patient as it affects the brain.

Scientific name of common house lizard is *Hemidactylus* whereas *Musca domestica* is the scientific name of common housefly. Scientific name of Indian tiger is *Panthera tigris*. Full name of *E.coli* is *Escherichia coli*.

71. (a) : Basopilic prokaryotes are facultatively anaerobic bacteria. They grow and multiply in very deep marine sediments. Most basophiles grow better at a pH of 8.5 or higher.

5. (c) : Needle like leaves with thick cuticle and sunken stomata are xerophytic adaptations of conifers for tolerating extreme environmental conditions.

84. (b) : Heterospory means production of two different sizes of spores-megaspore and microspore. All bryophytes are homosporous. Heterospory originated in some pteridophytes like *Selaginella*. It is commonly called club moss or spike moss. Its leaves contain a flap-like outgrowth at the base on the adaxial side called ligule. The leaves are of two types - megasporophyll bearing megasporangia and microsporophylls bearing microsporangia. The megasporangia contains four large megaspores and the microsporangia contains large number of small microspores. Thus *Selaginella* is heterosporous. In some species of *Selaginella* the embryo remains attached to the sporophyte for a long time and it is the habit towards seed habit.

48. (b) : Agnatha is subphylum or superclass of marine and fresh water vertebrates that lack jaws. They are fish-like animals with cartilaginous skeletons and well-developed sucking mouthparts with horny teeth. The only living agnathans are lampreys and hagfishes (Class Cyclostomata), which are parasites or scavengers.

6. (a) : Potato (*Solanum tuberosum*) and tomato (*Lycopersicum esculentum*) both belong to family Solanaceae, which is commonly called as the "potato family". Many plants belonging to this family are sources of vegetables, fruits etc.

54. (d) : Chemosynthetic autotrophic bacteria oxidise various inorganic substances such as nitrates, nitrites and ammonia and use the released energy for their ATP production. They play a great role in recycling nutrients like nitrogen, phosphorous, iron and sulphur.

2. **(d)** : *Pinus* is a monoecious plant, *i.e.*, in *Pinus* the male and female cones or strobili are borne on the same plant.

83. (d) : Transfusion tissue is a specialized tissue present on either side of midrib in between the palisade and spongy tissues of the leaf of *Cycas* and also in *Pinus* leaf at the sides of the sclerenchymtous region. It is made of horizontally arranged tracheids. These supply water and minerals to mesophyll tissue upto margins so that the mesophyll cells can carry out photosynthesis. It is of two types primary transfusion tissue present next to the midrib bundle and secondary transfusion tissue that runs upto margins of the leaf. In *Pinus* it consists of tracheids and albuminous cells.

44. (b) : Nephridia is the excretory organ of the earthworm. Earthworms have three types of nephridial structures called as septal, integumentary and pharyngeal nephridia. These three nephridial structures are present on different positions in the body and also vary in structures. Septal and pharyngeal nephridia are both enteronephric *i.e.*, nitrogen products are expelled in gut. Integumentary nephridia is exonephric *i.e.*, nitrogen waste products are directly discharged outside.

5. (a) : Museums have collections of preserved plant and animal specimens for study and reference. Specimens are preserved in the containers or jars in preservative solutions. Plant and animal specimens may also be preserved as dry specimens. Insects are preserved in insect boxes after collecting, killing and pinning. Larger animals like birds and mammals are usually stuffed and preserved. Museums often have collections of skeletons of animals too.

52. (b) : *Streptococcus* is a bacteria which is included under Kingdom Monera. Monerans have prokaryotic cell organisation in which membrane bound organelles like mitochondria, E.R., Golgi bodies, etc. are absent. All the other three *i.e.*, *Saccharomyces* (a fungus) *Chlamydomonas* (an algae) and *Plasmodium* (a protozoan protist) are eukaryotes containing true membrane bound organelles.

159. (c) : Lichens are found in Artic Tundra region where no other plant can grow. Lichens prefer to grow in pollution free environment. They are often used as a indicator of pollution and also they are very sensitive to SO_2. They are first to die in a polluted environment (more SO_2).

78. (b) : *Cycas* belongs to Order Cycadales of gymnosperms. Its leaves show circinate vernation *i.e.* the leaves are coiled in young stage. The coralloid roots in *Cycas* arise from the lateral branches of the normal roots and contain blue-green algae like *Nostoc* and *Anabaena*. A well developed flower like that of angiosperms is absent in *Cycas*. It has compact cones containing microsporophylls and megasporophylls. The megaspores are loosely arranged on the megasporophyll. The male cone is a compac structure. Vessels in xylem are absent and it contains only tracheids for conduction of water.

41. (c) : *Spongilla* is a common, widely distributed fresh water sponge belonging to phylum porifera. Canal system in *Spongilla* is essentially of rhagon type with choanocytes restricted to small rounded chambers. It is not found in leech, dolphin and penguin.

(c) : $Rb(37) : 1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2\,3d^{10}\,4p^6\,5s^1$

For $5s$, $n = 5$, $l = 0$, $m = 0$, $s = +1/2$ or $-1/2$

(c) : $n = 2, l = 1$

It means $2p$-orbitals

Total no. of electrons that can be accomodated in $2p$ orbitals = 6

(c) : Elements (a), (b) and (d) belong to the same group since each one of them has two electrons in valence shell. In contrast, element (c) has seven electrons in the valence shell, and hence it lies in other group.

(a) : $c = \upsilon\lambda$

$$\lambda = \frac{c}{\upsilon} = \frac{3\times10^{17}}{6\times10^{15}} = 50\ \text{nm}$$

(b) : As per Aufbau Principle.

The principle states : In the ground state of the atoms, the orbitals are filled in order of their increasing energies.

(d) : Abnormally high difference between 2^{nd} and 3^{rd} ionisation energy means that the element has two valence electrons, which is a case in configuration (d).

(b) : The orbital associated with $n = 3, l = 1$ is $3p$. One orbital (with $m = -1$) of $3p$-subshell can accomodate maximum 2 electrons.

(d) : This is a Pauli's Exclusion principle.

(c) : Electronic configuration of an element is

$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^3$

Hence it lies in fifth or 15^{th} group.

(a) : Only one orbital, $3p_z$ has following set of quantum numbers, $n = 3, l = 1$ and $m_l = 0$.

(b) : Atomic No. of Ca = 20

$\therefore$ Electronic configuration of Ca = [Ar]$4s^2$

(a) : These are isoelectronic ions (ions with same number of electrons) and for isoelectronic ions, greater the positive nuclear charge, greater is the force of attraction on the electrons by the nucleus and the smaller is the size of the ion. Thus Al^{3+} has the smallest size.

(d) : Number of *d*-electrons in $Fe^{2+} = 6$

Number of *p*-electrons in Cl = 11

(c) : Due to ground state, state of hydrogen atom $(n) = 1$

Radius of hydrogen atom $(r) = 0.53$ Å

Atomic no. of Li $(Z) = 3$

Now, radius of Li^{2+} ion $= r \times \frac{n^2}{Z}$

$$= 0.53 \times \frac{(1)^2}{3} = 0.17 Å$$

(c) : Among the halogens the electron affinity value of 'F' should be maximum. But due to small size the 7-electrons in its valence shell are much more crowded, so that it feels difficulty in entry of new electrons. Thus, the E.A. value is slightly lower than chlorine and the order is

$$I < Br < F < Cl.$$

(d) : As we know,

22400 cc of N_2O contain 6.02×10^{23} molecules

$\therefore$ 1 cc of N_2O contain $\frac{6.02 \times 10^{23}}{22400}$ molecules

Since in N_2O molecule there are 3 atoms

$\therefore$ 1 cc $N_2O = \frac{3 \times 6.02 \times 10^{23}}{22400}$ atoms

$= \frac{1.8 \times 10^{22}}{224}$ atoms

No. of electrons in a molecule of N_2O

$= 7 + 7 + 8 = 22$

[Z of N = 7 and O = 8]

Hence, no. of electrons $= \frac{6.02 \times 10^{23}}{22400} \times 22$ electrons

(b) : The longest wavelength means the lowest energy. We know that relation for wavelength

$$\frac{1}{\lambda} = R_H \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$$

here $n_1 = 2, n_2 = 3$

R_H (Rydberg constant = 109677 cm^{-1}

$$\frac{1}{\lambda} = 109677 \left(\frac{1}{(2)^2} - \frac{1}{(3)^2} \right) = 15233$$

or, $\lambda = \frac{1}{15233} = 6.56 \times 10^{-5}$ cm

$= 6.56 \times 10^{-7}$ m = 656 nm

(a) : Ionic radius in the n^{th} orbit is given by

$$r_n = \frac{n^2 a_0}{Z^*} \quad \text{or,} \quad r_n \propto \frac{1}{Z^*}$$

Where n is principal quantum number, a_0 the Bohr's radius of H-atom and Z^*, the effective nuclear charge.

(a) : 1 mol of $CO_2 = 44$ g of CO_2

$\therefore$ $4{\cdot}4$ g $CO_2 = 0.1$ mol CO_2

$= 6 \times 10^{22}$ molecules

[Since, 1 mole $CO_2 = 6 \times 10^{23}$ molecules]

$= 2 \times 6 \times 10^{22}$ atoms of O

$= 1.2 \times 10^{23}$ atoms of O

(d) : According to uncertainty principle the product of uncertainty in position and uncertainty in momentum is constant for a particle.

$$i.e., \Delta x \times \Delta p = \frac{h}{4\pi}$$

As, Δx =1.0 nm for both electron and helium atom, so Δp is also same for both the particles. Thus uncertainty in momentum of the helium atom is also 5.0×10^{-26} kg m s^{-1}.

(a) : $X - X$ bond F – F Cl – Cl Br – Br I – I

Bond dissociation energy (kcal/mol) 38 57 45.5 35.6

The lower value of bond dissociation energy of fluorine is due to the high inter-electronic repulsion between non-bonding electrons in the $2p$-orbitals of fluorine. As a result F – F bond is weaker in comparison to Cl – Cl and Br – Br bonds.

(a) : Here, $C_p/C_V = 1.4$ which shows that the gas is diatomic.

22.4 L at NTP $= 6.02 \times 10^{23}$ molecules

$\therefore$ 11.2 L at NTP $= 3.01 \times 10^{23}$ molecules

Since gas is diatomic.

$\therefore$ 11.2 L at NTP $= 6.02 \times 10^{23}$ atom

(d) : Sommerfield modified Bohr's theory considering that in addition to circular orbits electrons also move in elliptical orbits.

(b) : The atomic radii decrease on moving from left to right in a period, thus order of sizes for Cl, P and Mg is Cl < P < Mg. Down the group size increases. Thus overall order is : Cl < P < Mg < Ca.

(c) : If 1L of one gas contains N molecules, 2 L of any gas under the same conditions will contain 2 N molecules.

(a) : Species having same no. of electrons are called as isoelectronics.

The no. of electrons in $CO = CN^- = NO^+ = C_2^{2-} = 14$.

So these are isoelectronics.

(c) : $S^{2-} > Cl^{-} > K^{+} > Ca^{2+}$

Among isoelectronic species, ionic radii increases with increase in negative charge. This happens because effective nuclear charge (Z_{eff}) decreases. Similarly, ionic radii decreases with increase in positive charge as Z_{eff} increases.

(c) : Each nitrogen atom has 5 valence electrons, therefore total number of electrons in N_3^- ion is 16. Since the molecular mass of N_3 is 42, therefore total number of electrons in 4.2 g of N_3^- ion

$$= \frac{4.2}{42} \times 16 \times N_A = 1.6\, N_A$$

(a) : $n = 3, l = 2, m = +2$

It symbolises one of the five *d*-orbitals (3*d*).

$m = +2 \quad +1 \quad 0 \quad -1 \quad -2$

(a) : $Na \rightarrow Na^{+} + e^{-}$; $\Delta H = 5.1$ eV

$Na^{+} + e^{-} \rightarrow Na$; $\Delta H = -5.1$ eV

(c) : $Ne^{2+}(8) \Rightarrow 1s^2 2s^2\ 2p_x^2 2p_y^1 2p_z^1$

$Be^{+}(3) \Rightarrow 1s^2 2s^1$

$Cl^{-}(18) \Rightarrow 1s^2 2s^2 2p^6 3s^2 3p^6$

$As^{+}(32) \Rightarrow 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p_x^1 4p_y^1$

Cl^{-} is not paramagnetic, as it has no unpaired electron.

(a) : Let us consider the nucleus of hydrogen atom having one proton of charge $+e$. The electron revolves round this nucleus in an orbit of radius r. Centripetal force is supplied by electrostatic force of attraction between the revolving electron and nucleus.

$$\therefore \quad \frac{mv^2}{r} = \frac{e^2}{r^2} \Rightarrow mv^2 = e^2/r \qquad \ldots (i)$$

According to Bohr's theory,

$mvr = \frac{nh}{2\pi}$ (Angular momentum is an integral multiple of $h/2\pi$) $\Rightarrow \quad r = \frac{nh}{2\pi mv} \qquad \ldots (ii)$

From (i) and (ii), $mv^2 = \frac{e^2 \times 2\pi mv}{nh}$

$$\Rightarrow \quad mv = \frac{\pi e^2}{nh} \times 2m \quad \Rightarrow \quad m^2v^2 = \left(\frac{\pi e^2}{nh}\right)^2 \times 4m^2$$

$$\text{Kinetic energy} = \frac{1}{2}mv^2 = \left(\frac{\pi e^2}{nh}\right)^2 \times 2m$$

$$\text{Total energy } E_n = -\frac{2\pi^2 me^4}{n^2h^2} = -\left(\frac{\pi e^2}{nh}\right)^2 \times 2m$$

$\therefore$ Kinetic energy $= -E_n$

Energy of first excited state is -3.4 eV

$\therefore$ Kinetic energy of same orbit ($n = 2$) will be $+3.4$ eV.

Exp. **(c)**

560 g of Fe

$$\text{Number of moles} = \frac{560\ \text{g}}{56\ \text{g mol}^{-1}} = 10\ \text{mol}$$

For 70 g of N

14 g N = 1 mol of N-atom

70 g N = 5 mol of N-atom

For 20 g of H

1 g H = 1 mol of H-atom

20 g H ≡ 20 mol of H-atom

(b) : In $A_3(BC_4)_2$, $(+2) \times 3 + 2[+5 + 4(-2)]$

$\Rightarrow +6 + 10 - 16 = 0$

Hence in the compound $A_3(BC_4)_2$, the oxidation no. of 'A', 'B' and 'C' are +2, +5 and –2 respectively.

(d) : Principal quantum number represents the name, size and energy of the shell to which the electron belongs.

Azimuthal quantum number describes the spatial distribution of electron cloud and angular momentum. Magnetic quantum number describes the orientation or distribution of electron cloud. Spin quantum number represents the direction of electron spin around its own axis.

(a) : No. of radial nodes in $3p$-orbital $= n - l - 1$

$= 3 - 1 - 1 = 1$

(a) : Specific volume (vol. of 1 g) cylindrical virus particle = 6.02×10^{-2} cc/g

Radius of virus, $r = 7$ Å $= 7 \times 10^{-8}$ cm

Volume of virus = $\pi r^2 l$

$$= \frac{22}{7} \times (7 \times 10^{-8})^2 \times 10 \times 10^{-8} = 154 \times 10^{-23} \text{ cc}$$

wt. of one virus particle = $\dfrac{\text{Volume}}{\text{Specific volume}}$

$$\Rightarrow \frac{154 \times 10^{-23}}{6.02 \times 10^{-2}} \text{ g}$$

$\therefore$ Molecular wt. of virus = wt. of N_A particle

$$= \frac{154 \times 10^{-23}}{6.02 \times 10^{-2}} \times 6.02 \times 10^{-23} \text{ g/mol.}$$

$$= 15400 \text{ g/mol} = 15.4 \text{ kg/mol}$$

(c) : Uncertainty in momentum

$(m\Delta v) = 1 \times 10^{-18}$ g cm s^{-1}

Uncertainty in velocity,

$$(\Delta v) = \frac{1 \times 10^{-18}}{9 \times 10^{-28}} = 1.1 \times 10^{9} \text{ cm s}^{-1}$$

(b) : Both He and Li^+ contain 2 electrons each.

(d) : Average isotopic mass of X

$$= \frac{200 \times 90 + 199 \times 8 + 202 \times 2}{90 + 8 + 2}$$

$$= \frac{18000 + 1592 + 404}{100} = 199.96 \text{ a.m.u.}$$

$$\approx 200 \text{ a.m.u.}$$

(b) : In an atom, for any value of n, the values of $l = 0$ to $(n-1)$.

For a given value of l, the values of $m_l = -l$ to 0 to $+l$ and the value of $s = +1/2$ or $-1/2$.

(b) : No. of orbitals in a sub-shell $= 2l + 1$

$\Rightarrow$ No. of electrons $= 2(2l + 1) = 4l + 2$

(a) : $\underset{1\text{ vol.}}{C_3H_8} + \underset{5\text{ vol.}}{5O_2} \longrightarrow \underset{3\text{ vol.}}{3CO_2} + \underset{4\text{ vol.}}{4H_2O}$ (balanced equation)

According to the above equation
1 vol. or 1 litre of propane requires to 5 vol. or 5 litre of O_2 to burn completely.

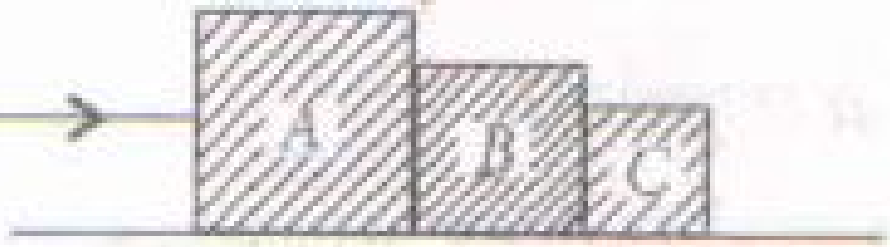
(b) : $E_1 = \frac{hc}{\lambda_1}$ and $E_2 = \frac{hc}{\lambda_2}$; $\frac{E_1}{E_2} = \frac{hc}{\lambda_1} \times \frac{\lambda_2}{hc} = \frac{\lambda_2}{\lambda_1}$

or $\frac{25}{50} = \frac{\lambda_2}{\lambda_1}$ or $\frac{1}{2} = \frac{\lambda_2}{\lambda_1} \Rightarrow \lambda_1 = 2\lambda_2$

(d) : It is uncertainty principle and not Bohr's postulate.

17. (d) : Average speed $= \dfrac{\text{total distance travelled}}{\text{total time taken}}$

$$= \frac{s+s}{t_1+t_2} = \frac{2s}{\dfrac{s}{v_u}+\dfrac{s}{v_d}} = \frac{2v_u v_d}{v_d+v_u}.$$

7. **(d) :** $F = 14$ N 

Here, $M_A = 4$ kg, $M_B = 2$ kg, $M_C = 1$ kg, $F = 14$ N

Net mass, $M = M_A + M_B + M_C = 4 + 2 + 1 = 7$ kg

Let a be the acceleration of the system.

Using Newton's second law of motion,

$$F = Ma$$

$$14 = 7a \quad \therefore \quad a = 2 \text{ m s}^{-2}$$

Let F' be the force applied on block A by block B *i.e.* the contact force between A and B. Free body diagram for block A

Again using Newton's second law of motion,

$$F - F' = 4a$$

$$14 - F' = 4 \times 2 \quad \Rightarrow 14 - 8 = F' \quad \therefore \quad F' = 6 \text{ N}$$

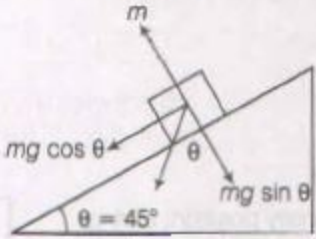
Exp. (a)

When friction is absent

$$ma_1 = mg\sin\theta$$

$$a = g\sin\theta$$

$$\therefore \quad s_1 = \frac{1}{2}a_1 t_1^2 \qquad \ldots(i)$$



When friction is present, friction is in opposite to the direction of motion

$$a_2 = g\sin\theta - \mu_k g\cos\theta$$

$$\therefore \quad s_2 = \frac{1}{2}a_2 t_2^2 \qquad \ldots(ii)$$

From Eqs. (i) and (ii), we get

$$\frac{1}{2}a_1 t_1^2 = \frac{1}{2}a_2 t_2^2$$

$$\Rightarrow \quad a_1 t_1^2 = a_2 (nt_1)^2 \qquad [\because t_2 = nt_1]$$

or $$a_1 = n^2 a_2$$

$$\Rightarrow \quad \frac{a_2}{a_1} = \frac{g\sin\theta - \mu_k g\cos\theta}{g\sin\theta} = \frac{1}{n^2}$$

or $$\frac{g\sin 45° - \mu_k g\cos 45°}{g\sin 45°} = \frac{1}{n^2}$$

or $$1 - \mu_k = \frac{1}{n^2}$$

or $$\mu_k = 1 - \frac{1}{n^2}$$

14. (b) : $v^2 - u^2 = 2as$

Given $v = 20\ \text{ms}^{-1}$, $u = 10\ \text{ms}^{-1}$, $s = 135\ \text{m}$

$$\therefore \quad a = \frac{400 - 100}{2 \times 135} = \frac{300}{270} = \frac{10}{9}\ \text{m/s}^2$$

$$v = u + at \Rightarrow t = \frac{v - u}{a} = \frac{10\ \text{m/s}}{\frac{10}{9}\ \text{m/s}^2} = 9\ \text{s}$$

5. (c) : Let v be tangential speed of heavier stone. Then, centripetal force experienced by lighter stone is

$$(F_c)_{\text{lighter}} = \frac{m(nv)^2}{r}$$ and that of heavier stone is

$$(F_c)_{\text{heavier}} = \frac{2mv^2}{(r/2)}$$

But $(F_c)_{\text{lighter}} = (F_c)_{\text{heavier}}$ (given)

$$\therefore \quad \frac{m(nv)^2}{r} = \frac{2mv^2}{(r/2)}$$

$$n^2\left(\frac{mv^2}{r}\right) = 4\left(\frac{mv^2}{r}\right)$$

$$n^2 = 4 \quad \text{or} \quad n = 2$$

Exp. **(b)**

From Newton's equations, we have

$$v^2 = u^2 - 2as$$

Given, $v = 0$ [car is stopped]

As friction provide the retardation

$$a = \mu g,\ v = 100\ \text{ms}^{-1}$$

$$\therefore \quad (100)^2 = 2\,\mu\, gs$$

$$\Rightarrow \quad s = \frac{100 \times 100}{2 \times 0.5 \times 10}$$

$$= \frac{100 \times 100}{5 \times 2} = 1000\,\text{m}$$

11. (a) : Let the two balls meet after t s at distance x from the platform.

For the first ball

$$u = 0, t = 18 \text{ s}, g = 10 \text{ m/s}^2$$

Using $h = ut + \frac{1}{2} gt^2$

$$\therefore \quad x = \frac{1}{2} \times 10 \times 18^2 \qquad \text{...(i)}$$

For the second ball

$$u = v, t = 12 \text{ s}, g = 10 \text{ m/s}^2$$

Using $h = ut + \frac{1}{2} gt^2$

$$\therefore \quad x = v \times 12 + \frac{1}{2} \times 10 \times 12^2 \qquad \text{...(ii)}$$

From equations (i) and (ii), we get

$$\frac{1}{2} \times 10 \times 18^2 = 12v + \frac{1}{2} \times 10 \times (12)^2$$

or $$12v = \frac{1}{2} \times 10 \times [(18)^2 - (12)^2]$$

$$= \frac{1}{2} \times 10 \times [(18 + 12)(18 - 12)]$$

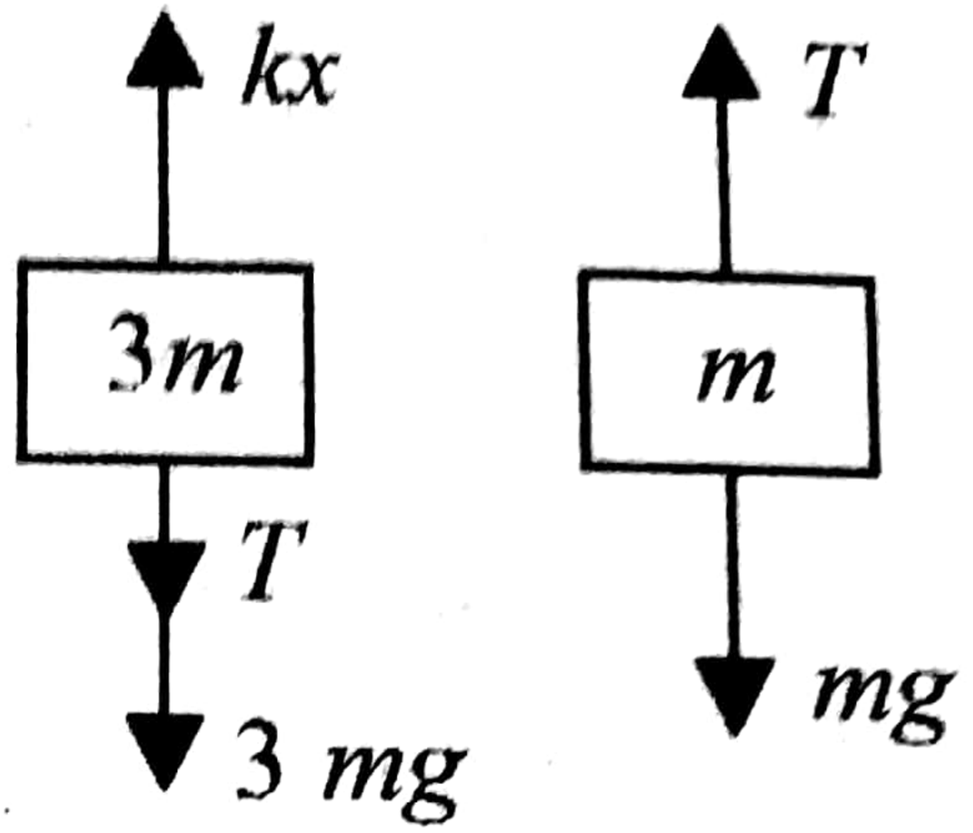
$$12v = \frac{1}{2} \times 10 \times 30 \times 6$$

or $$v = \frac{1 \times 10 \times 30 \times 6}{2 \times 12} = 75 \text{ m/s}$$

1. (a) : Before the string is cut

$$kx = T + 3mg \quad \text{...(i)}$$

$$T = mg \quad \text{...(ii)}$$



Before the string is cut

From eqns. (i) and (ii)

$$kx = 4mg$$

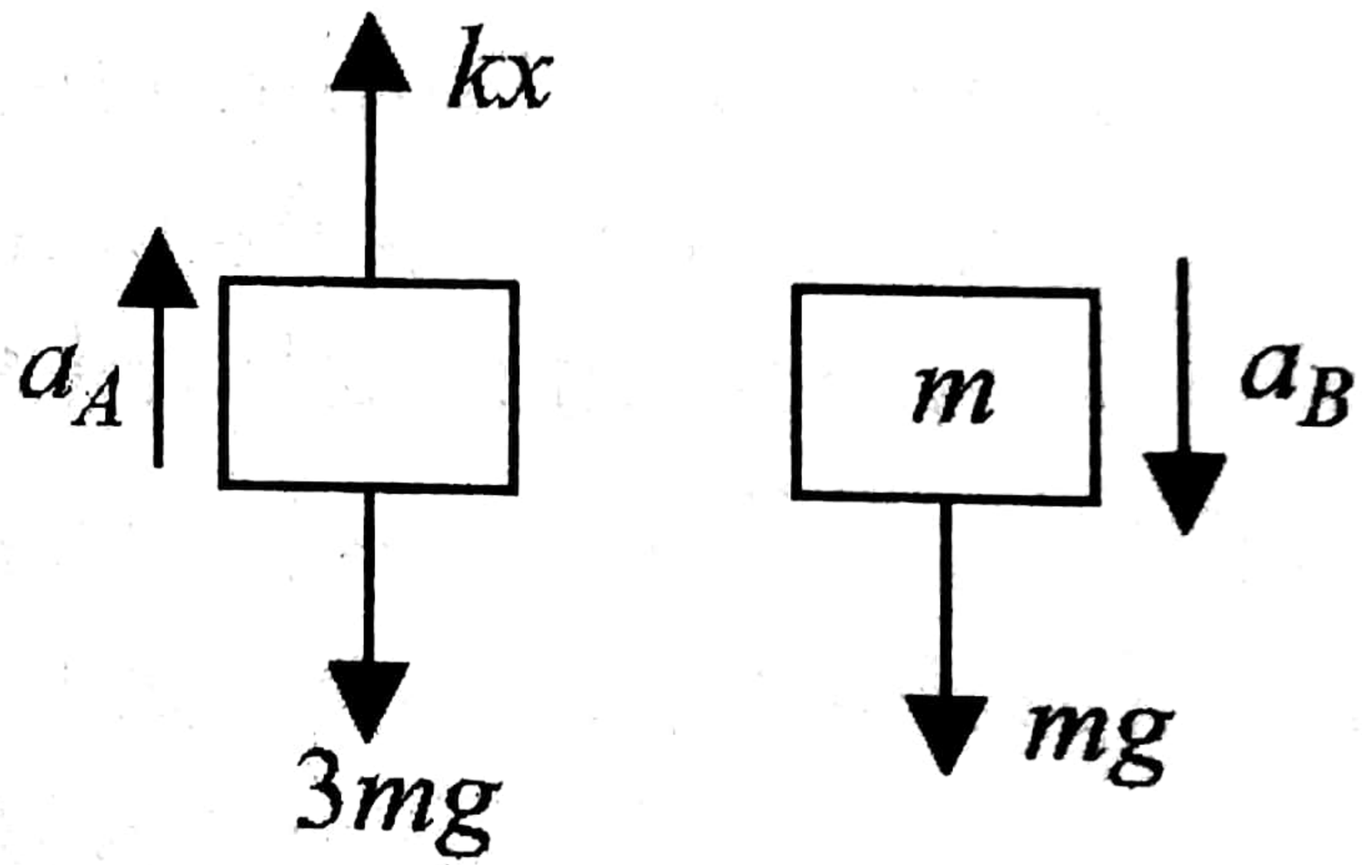
Just after the string is cut

$$T = 0$$

$$a_A = \frac{kx - 3mg}{3m}$$

$$a_A = \frac{4mg - 3mg}{3m}$$

$$= \frac{mg}{3m} = \frac{g}{3}$$



After the string is cut

and also $a_B = g$.

Exp. (c)

This is the question based on impulse-momentum theorem.

$$|F \cdot \Delta t| = |\text{Change in momentum}|$$

$$\Rightarrow \quad F \times 0.1 = |p_f - p_i|$$

As the ball will stop after catching

$$p_i = mv_i = 0.15 \times 20 = 3, \; p_f = 0$$

$$\Rightarrow \quad F \times 0.1 = 3$$

$$\Rightarrow \quad F = 30 \text{ N}$$

9. (c) : Let S be the total distance travelled by the particle.

Let t_1 be the time taken by the particle to cover first half of the distance. Then

$$t_1 = \frac{S/2}{v_1} = \frac{S}{2v_1}$$

Let t_2 be the time taken by the particle to cover remaining half of the distance. Then

$$t_2 = \frac{S/2}{v_2} = \frac{S}{2v_2}$$

$$\text{Average speed, } v_{av} = \frac{\text{Total distance travelled}}{\text{Total time taken}}$$

$$= \frac{S}{t_1 + t_2} = \frac{S}{\frac{S}{2v_1} + \frac{S}{2v_2}} = \frac{2v_1 v_2}{v_1 + v_2}$$

45. (b) : For a unit vector $\hat{n}, |\hat{n}| = 1$

$$\left|0.5\hat{i} - 0.8\hat{j} + c\hat{k}\right|^2 = 1^2 \Rightarrow 0.25 + 0.64 + c^2 = 1$$

or $c = \sqrt{0.11}$

Exp. (*d*)

The situation is shown in figure. At initial time, the ball is at P, then under the action of a force (exerted by hand) from P to A and then from A to B let acceleration of ball during PA be a ms^{-2} (assumed to be constant) in upward direction and velocity of ball at be is v m/s.

Then, for PA

$$v^2 = 0^2 + 2a \times 0.2$$

For AB,

$$0 = v^2 - 2 \times g \times 2$$

$$\Rightarrow \quad v^2 = 2g \times 2$$

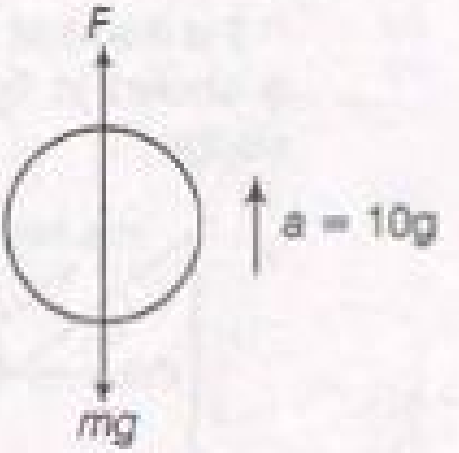
From above equations,

$$a = 10g = 100 \text{ ms}^{-2}$$

Then, for PA, FBD of ball is

$$F - mg = ma$$

[F is the force exerted by hand on ball]



$$\Rightarrow \quad F = m(g + a)$$

$$= 0.2(11g) = 22 \text{ N}$$

Alternate Method Using work-energy theorem

$$W_{mg} + W_F = 0$$

$$\Rightarrow \quad -mg \times 2.2 + F \times 0.2 = 0$$

or

$$F = 22 \text{ N}$$

8. (b) : Here, $u = 0, g = 10\ \text{m s}^{-2}, h = 20\ \text{m}$

Let v be the velocity with which the stone hits the ground.

$\therefore \quad v^2 = u^2 + 2gh$

or $\quad v = \sqrt{2gh} = \sqrt{2 \times 10 \times 20} = 20\ \text{m/s} \quad (\because \quad u = 0)$

41. (c) : Vertical acceleration in both the cases is g, whereas horizontal velocity is constant.

52. (c) : Let T be the tension in the branch of a tree when monkey is decending with acceleration a

Thus, $mg - T = ma$

also, $T = 75\%$ of weight of monkey

$$T = \left(\frac{75}{100}\right)mg = \frac{3}{4}mg$$

$$\therefore \quad ma = mg - \left(\frac{3}{4}\right)mg = \frac{1}{4}mg \text{ or } a = \frac{g}{4}$$

6. (b) : Given : $t = \sqrt{x} + 3$ or $\sqrt{x} = t - 3$

Squaring both sides, we get

$$x = (t-3)^2$$

Velocity, $v = \frac{dx}{dt} = \frac{d}{dt}(t-3)^2 = 2(t-3)$

Velocity of the particle becomes zero, when

$$2(t-3) = 0 \text{ or } t = 3 \text{ s}$$

At $t = 3$ s,

$$x = (3-3)^2 = 0 \text{ m}$$

(c) : $\omega = \frac{2\pi}{t}$. t is same $\therefore$ $\frac{\omega_1}{\omega_2} = 1$

48. (c) : Force $(\vec{F}) = 6\hat{i} - 8\hat{j} + 10\hat{k}$ and acceleration $(a) = 1$ m/s^2.

$$\text{Mass } (m) = \frac{|\vec{F}|}{a} = \frac{|6\hat{i} - 8\hat{j} + 10\hat{k}|}{1}$$

$$= \sqrt{36 + 64 + 100} = \sqrt{200} = 10\sqrt{2} \text{ kg.}$$

2. (d) : Position of the car P at any time t, is

$$x_P(t) = at + bt^2$$

$$v_P(t) = \frac{dx_P(t)}{dt} = a + 2bt \qquad \text{...(i)}$$

Similarly, for car Q,

$$x_Q(t) = ft - t^2$$

$$v_Q(t) = \frac{dx_Q(t)}{dt} = f - 2t \qquad \text{...(ii)}$$

$\because$ $v_P(t) = v_Q(t)$ **(Given)**

$\therefore$ $a + 2bt = f - 2t$ or, $2t(b + 1) = f - a$

$\therefore$ $t = \dfrac{f - a}{2(1 + b)}$

22. (d) : Because the slope is highest at C,

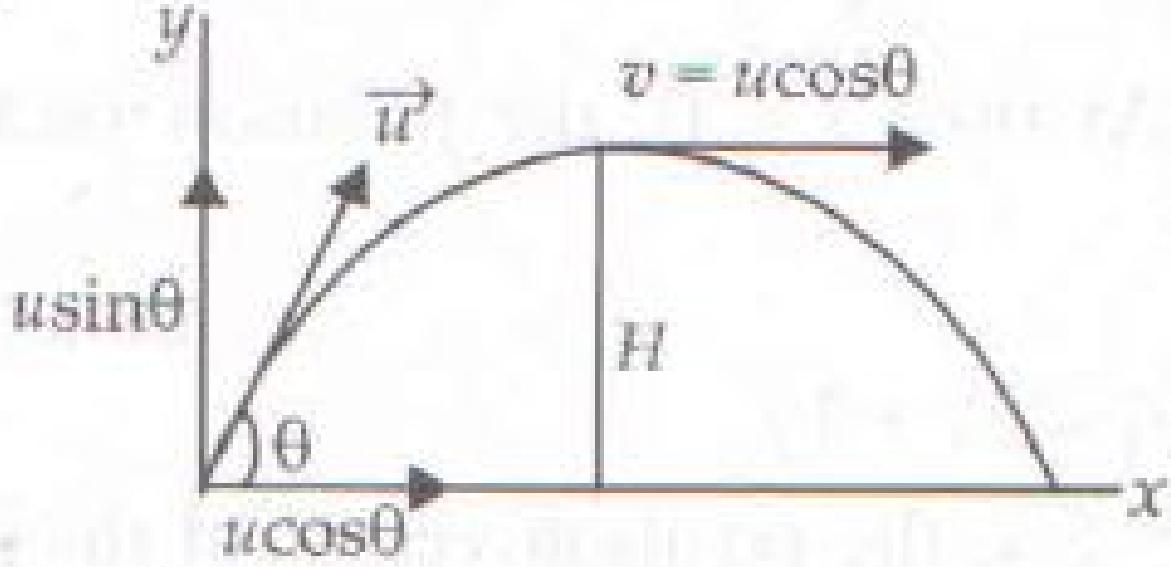
$$v = \frac{ds}{dt} \text{ is maximum.}$$

45. (b) : Thrust $= M(g + a) = u\frac{dm}{dt}$

$$\frac{dm}{dt} = \frac{M(g+a)}{u} = \frac{5000(10+20)}{800} = 187.5 \text{ kg/s}$$

31. (b) : Pressure $= \frac{\text{Force}}{\text{Area}}$. Therefore dimensions of pressure $= \frac{[MLT^{-2}]}{[L^2]} = ML^{-1}T^{-2}$.

20. (a) : Let v be velocity of a projectile at maximum height H.



$$v = u\cos\theta$$

According to given problem, $v = \frac{u}{2}$

$$\therefore \quad \frac{u}{2} = u\cos\theta \Rightarrow \quad \cos\theta = \frac{1}{2} \Rightarrow \theta = 60^\circ$$

43. (d) : When $F = 0$, $600 - 2 \times 10^5 t = 0$

$$\therefore \quad t = \frac{600}{2 \times 10^5} = 3 \times 10^{-3} \text{ s}$$

Now, impulse, $I = \int_0^t F dt = \int_0^t (600 - 2 \times 10^5 t) dt$

$$600t - 2 \times 10^5 \frac{t^2}{2} = 600 \times 3 \times 10^{-3} - 10^5 \times (3 \times 10^{-3})^2$$

or, $\quad I = 1.8 - 0.9 = 0.9$ N-s.

30. (a) : Percentage error in mass $= 2\% = \frac{2}{100}$ and percentage error in speed $= 3\ \% = \frac{3}{100}$.

$$K.E. = \frac{1}{2}mv^2$$

Therefore the error in measurement of kinetic energy

$$\frac{\Delta K.E.}{K.E.} = \frac{\Delta m}{m} + 2 \times \frac{\Delta v}{v} = \frac{2}{100} + 2 \times \frac{3}{100} = \frac{8}{100} = 8\ \%$$

18. (b) : Here,

Initial velocity, $\vec{u} = 3\hat{i} + 4\hat{j}$

Acceleration, $\vec{a} = 0.4\hat{i} + 0.3\hat{j}$

Time, $t = 10$ s

Let $\vec{v}$ be velocity of a particle after 10 s.

Using, $\vec{v} = \vec{u} + \vec{a}t$

$$\therefore \quad \vec{v} = (3\hat{i} + 4\hat{j}) + (0.4\hat{i} + 0.3\hat{j})(10)$$

$$= 3\hat{i} + 4\hat{j} + 4\hat{i} + 3\hat{j} = 7\hat{i} + 7\hat{j}$$

Speed of the particle after 10 s $= |\vec{v}|$

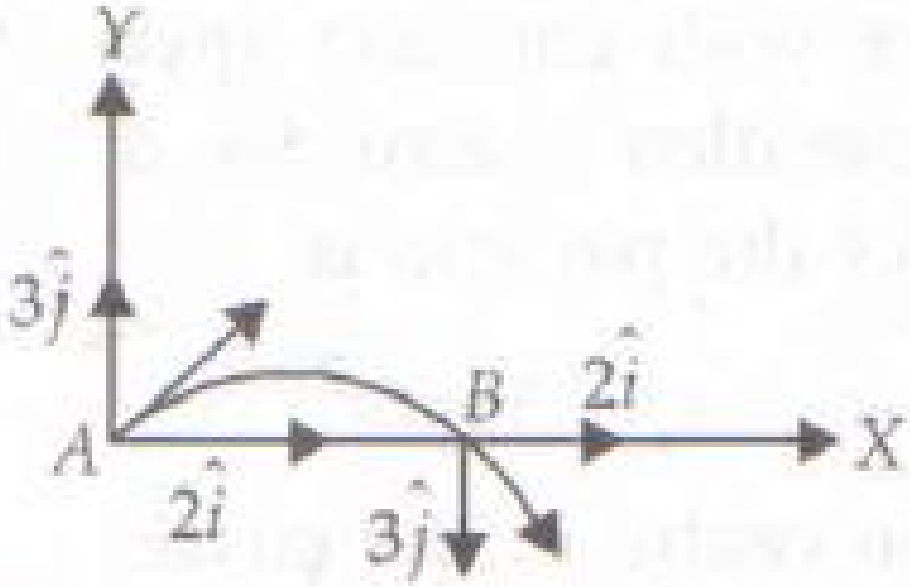
$$= \sqrt{(7)^2 + (7)^2} = 7\sqrt{2} \text{ units}$$

37. (b) : Impulse = Change in momentum

$$F \cdot \Delta t = m \cdot v \; ; \; F = \frac{m \cdot v}{\Delta t} = \frac{150 \times 10^{-3} \times 20}{0.1} = 30 \text{ N}.$$


(a)

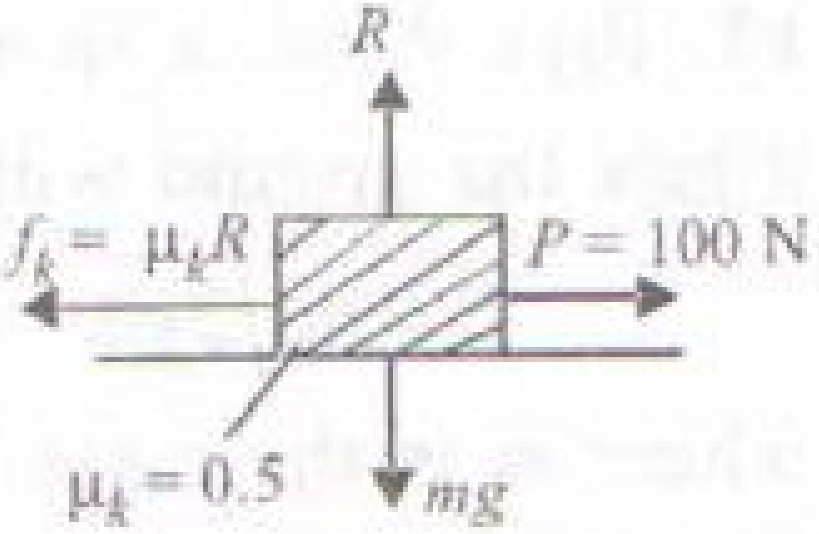
10. (a) :



At point B X component of velocity remains unchanged while Y component reverses its direction.

$\therefore$ The velocity of the projectile at point B is $2\hat{i} - 3\hat{j}$ m/s.

34. (b) : $m = 10$ kg.



$R = mg$

$\therefore$ Frictional force $= f_k$

$= \mu_k R = \mu_k mg$

$= 0.5 \times 10 \times 10$

$= 50$ N $[g = 10$ m/sec$^2]$

$\therefore$ Net force acting on the body $= F = P - f_k$

$= 100 - 50 = 50$ N.

$\therefore$ Acceleration of the block $= a = F/m$

$= 50/10 = 5$ m/sec^2.

(c) : Force between two charges

$$F = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{r^2} \Rightarrow \varepsilon_0 = \frac{1}{4\pi}\frac{q^2}{Fr^2} = \mathrm{C^2/N\text{-}m^2}$$

45. (b) : Distance covered in n^{th} second is given by

$$s_n = u + \frac{a}{2}(2n-1)$$

Given : $u = 0, a = g$

$$\therefore \quad s_4 = \frac{g}{2}(2\times 4 - 1) = \frac{7g}{2}$$

$$s_5 = \frac{g}{2}(2\times 5 - 1) = \frac{9g}{2} \qquad \therefore \quad \frac{s_4}{s_5} = \frac{7}{9}$$

31. (d) : When the lift is accelerating upwards with acceleration a, then reading on the scale

$$R = m(g + a) = 80(10 + 5)\,\text{N} = 1200\,\text{N}.$$

16. (c) : According to Ohm's law,

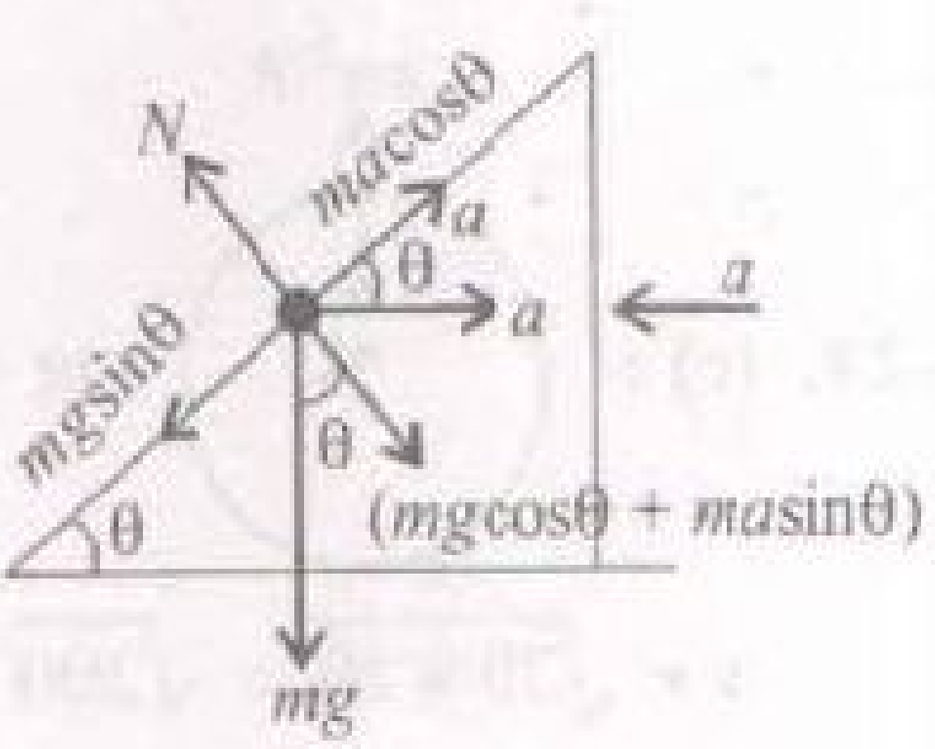
$$V = RI \quad \text{or} \quad R = \frac{V}{I}$$

$$\text{Dimensions of } V = \frac{W}{q} = \frac{[ML^2T^{-2}]}{[IT]}$$

$$\therefore \quad R = \frac{[ML^2T^{-2} / IT]}{[I]} = [ML^2T^{-3}I^{-2}].$$

40. (b) : In one dimensional motion, the body can have at a time one value of velocity but not two values of velocities.

29. (d) : The wedge is given an acceleration to the left.



∴ The block has a pseudo acceleration to the right, pressing against the wedge because of which the block is not moving.

$\therefore mg\sin\theta = ma\cos\theta$

or $a = \dfrac{g\sin\theta}{\cos\theta}$

Total reaction of the wedge on the block is $N = mg\cos\theta + ma\sin\theta$.

or $N = mg\cos\theta + \dfrac{mg\sin\theta\cdot\sin\theta}{\cos\theta}$

or $N = \dfrac{mg(\cos^2\theta + \sin^2\theta)}{\cos\theta} = \dfrac{mg}{\cos\theta}$.

12. (b) : From the relation

$$h = ut + \frac{1}{2}gt^2$$

$$h = \frac{1}{2}gt^2 \implies g = \frac{2h}{t^2} \quad (\because \text{ body initially at rest})$$

Taking natural logarithm on both sides, we get

$$\ln g = \ln h - 2 \ln t$$

Differentiating, $\frac{\Delta g}{g} = \frac{\Delta h}{h} - 2\frac{\Delta t}{t}$

For maximum permissible error,

$$\text{or } \left(\frac{\Delta g}{g} \times 100\right)_{\max} = \left(\frac{\Delta h}{h} \times 100\right) + 2 \times \left(\frac{\Delta t}{t} \times 100\right)$$

According to problem

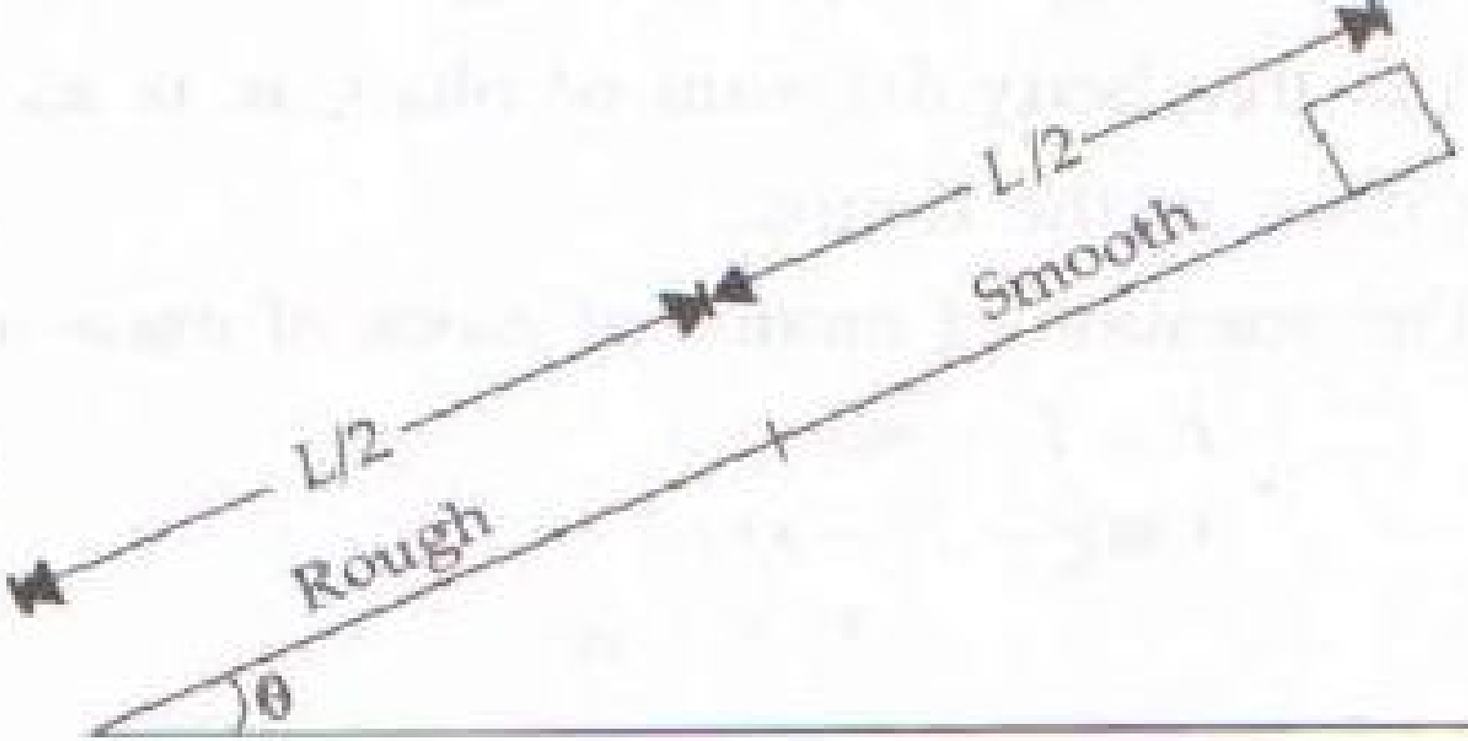
$$\frac{\Delta h}{h} \times 100 = e_1 \text{ and } \frac{\Delta t}{t} \times 100 = e_2$$

$$\text{Therefore, } \left(\frac{\Delta g}{g} \times 100\right)_{\max} = e_1 + 2e_2$$

38. (a) : The velocity $(v) = \frac{ds}{dt}$.

Therefore, instantaneous velocity at point E is negative.

14. (a) :



Let m be mass of the block and L be length of the inclined plane.

According to work-energy theorem

$W = \Delta K = 0$ (Initial and final speeds are zero)

$\therefore$ Work done by friction + Work done by gravity = 0

$$-\mu mg\cos\theta\frac{L}{2} + mg\sin\theta L = 0$$

$$\frac{\mu}{2}\cos\theta = \sin\theta$$

$$\mu = \frac{2\sin\theta}{\cos\theta} = 2\tan\theta$$

(c) : As $n_1 u_1 = n_2 u_2$

$$4\frac{g}{cm^3} = n_2 \frac{100\,g}{(10\,cm)^3} \Rightarrow n_2 = 40$$

21. (a) : $x = 40 + 12t - t^3$

$\therefore$ Velocity $v = \dfrac{dx}{dt} = 12 - 3t^2$

When particle come to rest, $dx/dt = v = 0$

$\therefore \quad 12 - 3t^2 = 0 \quad \Rightarrow \quad 3t^2 = 12 \quad \Rightarrow \quad t = 2$ sec.

Distance travelled by the particle before coming to rest

$$\int_0^s ds = \int_0^2 v\,dt \qquad s = \int_0^2 (12 - 3t^2)\,dt = 12t - \frac{3t^3}{3}\Bigg|_0^2$$

$$s = 12 \times 2 - 8 = 24 - 8 = 16 \text{ m.}$$

Alternate solution: As all blocks are moving with constant speed, therefore, acceleration is zero. So net force on each block is zero.

(c) : The speed of the light in vacuum is

$$c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}} = (\mu_0 \varepsilon_0)^{-1/2}$$

$$[(\mu_0 \varepsilon_0)^{-1/2}] = [c] = [LT^{-1}]$$

20. (c) : Distance travelled in one rotation (lap) = $2\pi r$

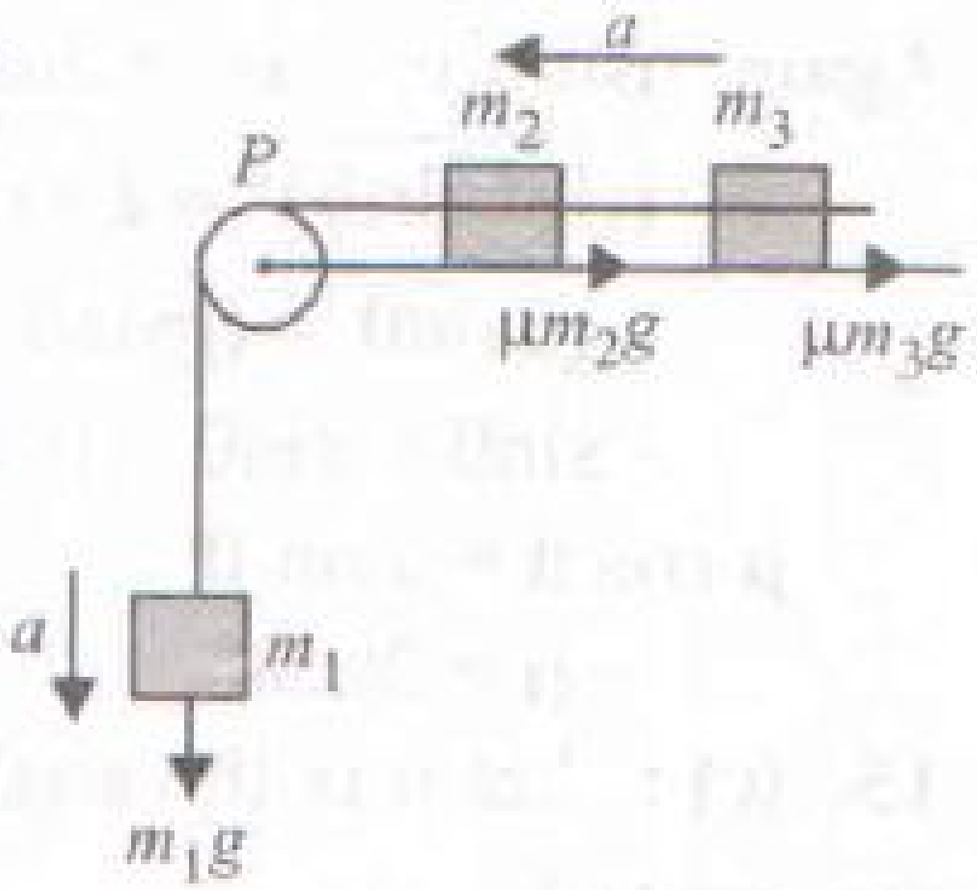
$$\therefore \quad \text{Average speed} = \frac{\text{distance}}{\text{time}} = \frac{2\pi r}{t}$$

$$= \frac{2 \times 3.14 \times 100}{62.8} = 10 \text{ m s}^{-1}$$

Net displacement in one lap = 0

$$\text{Average velocity} = \frac{\text{net displacement}}{\text{time}} = \frac{0}{t} = 0.$$

9. (c): Force of friction on mass $m_2 = \mu m_2 g$



Force of friction on mass $m_3 = \mu m_3 g$

Let a be common acceleration of the system.

$$\therefore \quad a = \frac{m_1 g - \mu m_2 g - \mu m_3 g}{m_1 + m_2 + m_3}$$

Here, $m_1 = m_2 = m_3 = m$

$$\therefore a = \frac{mg - \mu mg - \mu mg}{m + m + m} = \frac{mg - 2\mu mg}{3m} = \frac{g(1 - 2\mu)}{3}$$

Hence, the downward acceleration of mass m_1 is $\frac{g(1-2\mu)}{3}$.

NEET Solutions

The solutions are lined up in sequential order from 1 to 180.

For the questions, the student can revisit the test link for taking reference.