Be sure with Vidyalankar Since 1960

AIPMT - 2015

Test Booklet Code

G

Do not open this Test Booklet until you are asked to do so.

Important Instructions :

1. The Answer Sheet is inside this Test Booklet. When you are directed to open the Test Booklet, take out the Answer Sheet and fill in the particulars on **side-1** and **side-2** carefully with **blue/black** ball point pen only.
2. The test is of **3 hours** duration and Test Booklet contains **180** questions. Each question carries **4** marks. For each correct response, the candidate will get **4** marks. For each incorrect response, **one mark** will be deducted from the total scores. The maximum marks are **720.**
3. Use ***Blue/Black Ball Point Pen only*** for writing particulars on this page / marking responses.
4. Rough work is to be done on the space provided for this purpose in the Test Booklet only.
5. **On completion of the test, the candidate must handover the Answer Sheet to the invigilator before leaving the Room / Hall. The candidates are allowed to take away this Test Booklet with them.**
6. The CODE for this Booklet is **G**. Make sure that the CODE printed on **Side–2** of the Answer Sheet is the same as that on this booklet. In case of discrepancy, the candidate should immediately report the matter to the invigilator for replacement of both the Test Booklet and the Answer Sheet.
7. The candidates should ensure that the Answer Sheet is not folded. DO not make any stray marks on the Answer Sheet. Do not write your roll no. anywhere else except in the specified space in the Test Booklet / Answer Sheet.
8. Use of white fluid for correction is **NOT** permissible on the Answer Sheet.
9. Each candidate must show on demand his / her Admission Card to the Invigilator.
10. No candidate, without special permission of the Superintendent or Invigilator, would leave his / her seat.
11. The candidates should not leave the Examination Hall without handing over their Answer Sheet to the Invigilator on duty and sign the Attendance Sheet twice. Cases where a candidate has not signed the Attendance Sheet second time will be deemed not to have handed over Answer Sheet and dealt with as an unfair means case.
12. Use of Electronic / Manual Calculator is prohibited.
13. The candidates are governed by all Rules and Regulations of the Board with regard to their conduct in the Examination Hall. All cases of unfair means will be dealt with as per Rules and Regulations of the Board.
14. No part of the Test Booklet and Answer Sheet shall be detached under any circumstances.
15. The candidates will write the Correct Test Booklet Code as given in the Test Booklet / Answer Sheet in the Attendance Sheet.

Name of the Candidate (in Capitals) : ____

Roll Number : in figures ____

: in words ____

Centre of Examination (in Capitals) : ____

Candidate's Signature : ______________________ Invigilator's Signature : ____________________

Fascimile signature stamp of Centre Superintendent _______________________________________

Questions and Solutions

BIOLOGY

1. Leaves become modified into spines in :
(1) Silk Cotton (2) *Opuntia* (3) Pea (4) Onion

1. (2)

2. Vertical distribution of different species occupying different levels in a biotic community is known as :
(1) Pyramid (2) Divergence (3) Stratification (4) Zonation

2. (3)

3. Transpiration and root pressure cause water to rise in plants by :
(1) pushing and pulling it, respectively (2) pulling it upward
(3) pulling and pushing it, respectively (4) pushing it upward

3. (3)

4. Gene regulation governing lactose operon of *E.coli* that involves the lac I gene product is :
(1) Feedback inhibition because excess of β−galactosidase can switch off transcription
(2) Positive and inducible because it can be induced by lactose
(3) negative and inducible because repressor protein prevents transcription
(4) negative and repressible because repressor protein prevents transcription

4. (2)

5. High value of BOD (Biochemical Oxygen Demand) indicates that :
(1) consumption of organic matter in the water is higher by the microbes
(2) water is pure
(3) water is highly polluted
(4) water is less polluted

5. (3)

6. Which one of the following matches is **correct**?

(1)	Agaricus	Parasitic fungus	Basidiomycetes
(2)	Phytophthora	Aseptate mycelium	Basidiomycetes
(3)	Alternaria	Sexual reproduction absent	Deuteromycetes
(4)	Mucor	Reproduction by Conjugation	Ascomycetes

6. (3)

7. Which of these is **not** an important component of initiation of parturition in humans?
(1) Release of prolactin (2) Increase in estrogen and progesterone ratio
(3) Synthesis of prostaglandins (4) Release of oxytocin

7. (1)

8. A chemical signal that has both endocrine and neural roles is :
(1) Cortisol (2) Melatonin (3) Calcitonin (4) Epinephrine

8. (4)

9. Match each disease with its **correct** type of vaccine :
(a) tuberculosis (i) harmless virus
(b) Whooping cough (ii) inactivated toxin
(c) diphtheria (iii) killed bacteria
(d) polio (iv) harmless bacteria

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

9. (4)

10. Nuclear envelope is a derivative of :
(1) Rough endoplasmic reticulum (2) Smooth endoplasmic reticulum
(3) Membrane of Golgi complex (4) Microtubules

10. (2)

11. The crops engineered for glyphosate are resistant/tolerant to:
(1) Herbicides (2) Fungi (3) Bacteria (4) Insects

11. (1)

12. Vascular bundles in monocotyledons are considered closed because :
(1) Xylem is surrounded all around by phloem
(2) A bundle sheath surrounds each bundle
(3) Cambium is absent
(4) There are no vessels with perforations

12. (3)

13. Read the following five statements (A to E) and select the option with **all correct** statements :
(A) Mosses and Lichens are the first organisms to colonise a bare rock.
(B) *Selaginella* is a homosporous pteridophyte.
(C) Coralloid roots in *Cycas* have VAM.
(D) Main plant body in bryophytes is gametophytic, whereas in pteridophytes it is sporophytic.
(E) In gymnosperms, male and female gametophytes are present within sporangia located on sporophyte
(1) (B), (C) and (E) (2) (A), (C) and (D) (3) (B), (C) and (D) (4) (A), (D) and (E)

13. (4)

14. True nucleus is absent in :
(1) *Volvox* (2) *Anabaena* (3) *Mucor* (4) *Vaucheria*

14. (2)

15. Which one of the following statements in **not** true?
(1) Honey is made by bees by digesting pollen collected from flowers
(2) Pollen grains are rich in nutrients, and they are used in the form of tablets and syrups
(3) Pollen grains of some plants cause severe allergies and bronchial afflictions in some people
(4) The flowers pollinated by flies and bats secrete foul odour to attract them

15. (1)

16. Removal of proximal convoluted tubule from the nephron will result in :
(1) No urine formation (2) More diluted urine
(3) More concentrated urine (4) No change in quality and quantity of urine

16. (3)

17. A gymnast is able to balance his body upside down even in the total darkness because of :
(1) Organ of corti (2) Cochlea
(3) Vestibular apparatus (4) Tectorial membrane

17. (3)

18. The hilum is a scar on the :
(1) Seed, where micropyle was present (2) Seed, where funicle was attached
(3) Fruit, where it was attached to pedicel (4) Fruit, where style was present

18. (2)

19. Which one of the following is **correct**?
(1) Blood = Plasma + RBC + WBC + Platelets (2) Plasma = Blood – Lymphocytes
(3) Serum = Blood + Fibrinogen (4) Lymph = Plasma + RBC + WBC

19. (1)

20. The guts of cow and buffalo possess :
(1) Cyanobacteria (2) *Fucus* spp.
(3) *Chlorella* spp. (4) Methanogens

20. (4)

21. Which one of the following may require pollinators, but is genetically similar to autogamy?
(1) Cleistogamy (2) Geitonogamy (3) Xenogamy (4) Apogamy

21. (2)

22. In sea urchin DNA, which is double stranded, 17 % of the bases were shown to be cytosine. The percentages of the other three bases expected to be present in this DNA are :
(1) G 8.5%, A 50%, T 24.5% (2) G 34%, A 24.5%, T 24.5%
(3) G 17%, A 16.5%, T 32.5% (4) G 17%, A 33%, T 33%

22. (4)

23. Capacitation refers to changes in the :
(1) sperm after fertilization (2) sperm before fertilization
(3) ovum before fertilization (4) ovum after fertilization

23. (2)

24. Which of the following had the smallest brain capacity?
(1) *Homo habilis* (2) *Homo erectus*
(3) *Homo sapiens* (4) *Homo neanderthalensis*

24. (1)

25. Which of the following viruses is **not** transferred through semen of an infected male?
(1) Ebola virus (2) Hepatitis B virus
(3) Human immunodeficiency virus (4) Chikungunya virus

25. (4)

26. A major characteristic of the monocot root is the presence of :
(1) Cambium sandwiched between phloem and xylem along the radius
(2) Open vascular bundles
(3) Scattered vascular bundles
(4) Vasculature without cambium

26. (4)

27. Blood pressure in the mammalian aorta is maximum during:
(1) Diastole of the right atrium (2) Systole of the left atrium
(3) Diastole of the right ventricle (4) Systole of the left ventricle

27. (4)

28. In Bt cotton, the Bt toxin present in plant tissue as pro–toxin is converted into active toxin due to :
(1) presence of conversion factors in insect gut (2) alkaline pH of the insect gut
(3) acidic pH of the insect gut (4) action of gut micro–organisms

28. (2)

29. In an ecosystem the rate of production of organic matter during photosynthesis is termed as :
(1) Net productivity (2) Net primary productivity
(3) Gross primary productivity (4) Secondary productivity

29. (3)

30. In a ring girdled plant :
(1) Neither root nor shoot will die (2) The shoot dies first
(3) The root dies first (4) The shoot and root die together

30. (3)

31. Erythropoiesis starts in :
(1) Red bone marrow (2) Kidney (3) Liver (4) Spleen

31. (1)

32. Keel is the characteristics feature of flower of :
(1) Tomato (2) Tulip (3) *Indigofera* (4) *Aloe*

32. (3)

33. In which of the following gametophyte is **not** independent free living?
(1) *Pinus* (2) *Funaria* (3) *Marchantia* (4) *Pteris*

33. (1)

34. The structures that are formed by stacking of organized flattened membranous sacs in the chloroplasts are:
(1) Stroma (2) Cristae (3) Grana (4) Stroma lamellae

34. (3)

35. Which of the following does **not** favour the formation of large quantities of dilute urine ?
(1) Atrial-natriuretic factor (2) Alcohol
(3) Caffeine (4) Renin

35. (4)

36. DNA is **not** present in:
(1) Mitochondria (2) Chloroplast (3) Ribosomes (4) Nucleus

36. (3)

37. Which of the following are the important flora rewards to the animal pollinators?
(1) Protein pellicle and stigmatic exudates
(2) Colour and large size of flower
(3) Nectar and pollen grains
(4) Floral fragrance and calcium crystals

37. (3)

38. Which of the following represents the **correct** combination without any exception?

	Characteristics	Class
(1)	Body covered with feathers; skin moist and glandular; fore-limbs form wings; lungs with air sacs	Aves
(2)	Mammary gland; hair on body; pinnae; two pairs of limbs	Mammalia
(3)	Mouth ventral; gills without operculum; skin with placoid scales; persistent notochord	Chondrichthyes
(4)	Sucking and circular mouth; jaws absent, integument without scales; paired appendages	Cyclostomata

38. (2)

39. Alleles are:
(1) heterozygotes (2) different phenotype
(3) true breeding homozygotes (4) different molecular forms of a gene

39. (4)

40. Hysterectomy is surgical removal of:
(1) Mammary glands (2) Uterus (3) Prostate gland (4) Vas-deference

40. (2)

41. The UN Conference of Parties on climate change in the year 2011 was held in :
(1) Qatar (2) Poland (3) South Africa (4) Peru

41. (3)

42. HIV that causes AIDS, first starts destroying:
(1) Thrombocytes (2) B – Lymphocytes
(3) Leucocytes (4) Helper T – Lymphocytes

42. (4)

43. Which one of the following statements is **wrong**?
(1) Mannitol is stored food in Rhodophyceae
(2) Algin and carragen are products of algae
(3) Agar–agar is obtained from *Gelidium* and *Gracilaria*
(4) *Chlorella* and *Spirulina* are used as space food

43. (1)

44. Cryopreservation of gametes of threatened species in viable and fertile condition can be referred to as:
(1) In situ cryo–conservation of biodiversity
(2) In situ conservation of biodiversity
(3) Advanced ex–situ conservation of biodiversity
(4) In situ conservation by sacred groves

44. (3)

45. Select the **correct** matching in the following pairs:
(1) Rough ER — Oxidation of fatty acids (2) Smooth ER — Oxidation of phospholipids
(3) Smooth ER — Synthesis of lipids (4) Rough ER — Synthesis of glycogen

45. (3)

46. Secondary Succession takes place on/in :
(1) Newly cooled lava (2) Bare rock
(3) Degraded forest (4) Newly created pond

46. (3)

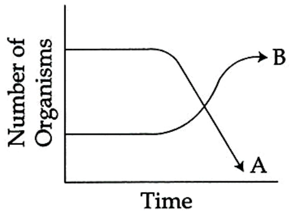
47. Which of the following is not a sexually transmitted disease ?
(1) Encephalitis
(2) Syphilis
(3) Acquired Immuno Deficiency Syndrome (AIDS)
(4) Trichomoniasis

47. (1)

48. The movement of a gene from one linkage group to another is called:
(1) Crossing over (2) Inversion (3) Duplication (4) Translocation

48. (1)

49. The following graph depicts changes in two populations (A and B) of herbivores in a grassy field. A possible reason for these changes is that:



(1) Population A consumed the members of population B
(2) Both plant populations in this habitat decreased
(3) Population B competed more successfully for food than population A
(4) Population A produced more offspring than population B

49. (3)

50. Typical growth curve in plants is :
(1) Parabolic (2) Sigmoid (3) Linear (4) Stair-steps shaped

50. (2)

51. Which one gives the most valid and recent explanation for stomatal movements ?
(1) Guard cell photosynthesis (2) Transpiration
(3) Potassium influx and efflux (4) Starch hydrolysis

51. (3)

52. Cytochromes are found in:
(1) Lysosomes (2) Matrix of mitochondria
(3) Outer wall of mitochondria (4) Cristae of mitochondria

52. (4)

53. Rachel Carson's famous book "Silent Spring" is related to:
(1) Ecosystem management (2) Pesticide pollution
(3) Noise pollution (4) Population explosion

53. (2)

54. Which of the following regions of the brain is **incorrectly** paired with its function ?
(1) Cerebrum - calculation and contemplation
(2) Medulla oblongata - homeostatic control
(3) Cerebellum - language comprehension
(4) Corpus callosum - communication between the left and right cerebral cortices

54. (3)

55. Which of the following characteristics is mainly responsible for diversification of insects on land?
(1) Eyes (2) Segmentation
(3) Bilateral symmetry (4) Exoskeleton

55. (4)

56. Sliding filament theory can be best explained as :
(1) When myofilaments slide pass each other, Myosin filaments shorten while Actin filaments do not shorten
(2) When myofilaments slide pass each other Actin filaments shorten while Myosin filament do not shorten
(3) Actin and Myosin filaments shorten and slide pass each other
(4) Actin and Myosin filaments do not shorten but rather slide pass each other

56. (4)

57. Which one of the following is **not** an inclusion body found in prokaryotes?
(1) Polysome (2) Phosphate granule
(3) Cyanophycean granule (4) Glycogen granule

57. (1)

58. The mass of living material at a trophic level at a particular time is called :
(1) Standing crop (2) Gross primary productivity
(3) Standing state (4) Net primary productivity

58. (1)

59. Select the correct option:

	I		II
(a)	Synapsis aligns homologous chromosomes	(i)	Anaphase-II
(b)	Synthesis of RNA and protein	(ii)	Zygotene
(c)	Action of enzyme recombinase	(iii)	G_2-phase
(d)	Centromeres do not separate but chromatids move towards opposite poles	(iv)	Anaphase-I
		(v)	Pachytene

	(a)	**(b)**	**(c)**	**(d)**
(1)	(ii)	(iii)	(iv)	(v)
(2)	(ii)	(i)	(iii)	(iv)
(3)	(ii)	(iii)	(v)	(iv)
(4)	(i)	(ii)	(v)	(iv)

59. (3)

60. Multiple alleles are present:
(1) On non-sister chromatids
(2) On different chromosomes
(3) At different loci on the same chromosome
(4) At the same locus of the chromosome

60. (4)

61. Which of the following is **not** one of the prime health risks associated with greater UV radiation through the atmosphere due to depletion of stratospheric ozone ?
(l) Increased liver cancer (2) Increased skin cancer
(3) Reduced Immune System (4) Damage to eyes

61. (1)

62. Which is the most common mechanism of genetic variation in the population of a sexually-reproducing organism?
(1) Recombination (2) Transduction
(3) Chromosomal aberrations (4) Genetic drift

62. (1)

63. Minerals known to be required in large amounts for plant growth include:
(1) magnesium, sulphur, iron, zinc (2) phosphorus, potassium, sulphur, calcium
(3) calcium, magnesium, manganese, copper (4) potassium, phosphorus, selenium, boron

63. (2)

64. Transmission tissue is characteristic feature of
(1) Wet stigma (2) Hollow style (3) Solid style (4) Dry stigma

64. (3)

65. A man with blood group ‘A’ marries a woman with blood group ‘B’. What are all the possible blood groups of their offsprings?
(1) O only (2) A and B only
(3) A, B and AB only (4) A, B, AB and O

65. (4)

66. Which of the following statements is **not** correct ?
(1) Acini are present in the pancreas and secrete carboxypeptidase
(2) Brunner's glands are present in the submucosa of stomach and secrete pepsinogen
(3) Goblet cells are present in the mucosa of intestine and secrete mucus
(4) Oxyntic cells are present in the mucosa of stomach and secrete HCl.

66. (2)

67. Perigynous flowers are found in :
(1) Rose (2) Guava (3) Cucumber (4) China rose

67. (1)

68. An abnormal human baby with 'XXX' sex chromosomes was born due to:
(1) fusion of two sperms and one ovum (2) formation of abnormal sperms in the father
(3) formation of abnormal ova in the mother (4) fusion of two ova and one sperm

68. (3)

69. What causes a green plant exposed to the light on only one side, to bend toward the source of light as it grows ?
(1) Auxin accumulates on the shaded side, stimulating greater cell elongation there.
(2) Green plants need light to perform photosynthesis.
(3) Green plants seek light because they are phototropic.
(4) Light stimulates plant cells on the lighted side to grow faster.

69. (1)

70. The chromosomes in which centromere is situated close to one end are :
(1) Sub-metacentric (2) Metacentric
(3) Acrocentric (4) Telocentric

70. (3)

71. A technique of micropropagation is:
(1) Embryo rescue (2) Somatic hybridization
(3) Somatic embryogenesis (4) Protoplast fusion

71. (3)

72. A somatic cell that has just completed the S phase of its cell cycle, as compared to gamete of the same species, has:
(1) four times the number of chromosomes and twice the amount of DNA
(2) twice the number of chromosomes and twice the amount of DNA
(3) same number of chromosomes but twice the amount of DNA
(4) twice the number of chromosomes and four times the amount of DNA

72. (4)

73. Gastric juice of infants contains :
(1) amylase, rennin, pepsinogen (2) maltase, pepsinogen, rennin
(3) nuclease, pepsinogen, lipase (4) pepsinogen, lipase, rennin

73. (4)

74. Which of the following animals is **not** viviparous ?
(1) Whale (2) Flying fox (Bat) (3) Elephant (4) Platypus

74. (4)

75. $\oplus$ ⚥ $K_{(5)}$ $\overset{\frown}{C_{(5)}\ A_5}$ $G_{\underline{(2)}}$ is the floral formula of
(1) *Brassica* (2) *Allium* (3) *Sesbania* (4) *Petunia*

75. (4)

76. In which of the following both pairs have **correct** combination?
(1) *In situ* conservation: Tissue culture
Ex situ conservation: Sacred groves
(2) *In situ* conservation: National Park
Ex situ conservation: Botanical Garden
(3) *In situ* conservation: Cryopreservation
Ex situ conservation: Wildlife Sanctuary
(4) *In situ* conservation: Seed Bank
Ex situ conservation: National Park

76. (2)

77. Which body of the Government of India regulates GM research and safety of introducing GM organisms for public services ?
(1) Research Committee on Genetic Manipulation
(2) Bio - safety committee
(3) Indian Council of Agricultural Research
(4) Genetic Engineering Approval Committee

77. (4)

78. Which of the following endoparasites of humans does show viviparity ?
(1) *Ascaris lumbricoides* (2) *Ancylostoma duodenale*
(3) *Enterobius vermicularis* (4) *Trichinella spiralis*

78. (4)

79. The terga, sterna and pleura of cockroach body are joined by:
(1) Cartilage (2) Cementing glue
(3) Muscular tissue (4) Arthrodial membrane

79. (4)

80. Most animals are tree dwellers in a:
(1) tropical rain forest (2) coniferous forest
(3) thorn woodland (4) temperate deciduous forest

80. (1)

81. Which of the following enhances or induces fusion of protoplasts ?
(1) IAA and gibberellins (2) Sodium chloride and potassium chloride
(3) Polyethylene glycol and sodium nitrate (4) IAA and kinetin

81. (3)

82. Glenoid cavity articulates :
(1) humerus with scapula (2) clavicle with acromion
(3) scapula with acromion (4) clavicle with scapula

82. (1)

83. A population will **not** exist in Hardy–Weinberg equilibrium if :

(1) the population is large (2) individuals mate selectively

(3) there are no mutations (4) there is no migration

83. (2)

84. Male gametes are flagellated in :

(1) *Spirogyra* (2) *Polysiphonia* (3) *Anabaena* (4) *Ectocarpus*

84. (4)

85. When you hold your breath, which of the following gas changes in blood would first lead to the urge to breathe?

(1) rising CO_2 and falling O_2 concentration (2) falling O_2 concentration

(3) rising CO_2 concentration (4) falling CO_2 concentration

85. (3)

86. Which of the following cells during gametogenesis is normally diploid?

(1) Secondary polar body (2) Primary polar body

(3) Spermatid (4) Spermatogonia

86. (4)

87. In ginger vegetative propagation occurs through :

(1) Runners (2) Rhizome (3) Offsets (4) Bulbils

87. (2)

88. Which one of the following statements is **incorrect**?

(1) The presence of the competitive inhibitor decreases the Km of the enzyme for the substrate.

(2) A competitive inhibitor reacts reversibly with the enzyme to form an enzyme–inhibitor complex.

(3) In competitive inhibition, the inhibitor molecule is not chemically changed by the enzyme.

(4) The competitive inhibitor does not affect the rate of breakdown of the enzyme–substrate complex.

88. (1)

89. The active form of *Entamoeba histolytica* feeds upon:

(1) blood only

(2) erythrocytes; mucosa and submucosa of colon

(3) mucosa and submucosa of colon only

(4) food in intestine

89. (2)

90. How many pairs of contrasting characters in pea plants were studied by Mendel in his experiments?

(1) Seven (2) Five (3) Six (4) Eight

90. (1)

PHYSICS

91. A radiation of energy 'E' falls normally on a perfectly reflecting surface. The momentum transferred to the surface is (C = Velocity of light) :

(1) $\frac{E}{C^2}$ (2) $\frac{E}{C}$ (3) $\frac{2E}{C}$ (4) $\frac{2E}{C^2}$

91. (3)

$p = \frac{E}{c}$

For reflecting surface

$\Delta p = p - (-p) = 2p = \frac{2E}{c}$.

92. A ship A is moving Westwards with a speed of 10 km h^{-1} and a ship B 100 km South of A, is moving Northwards with a speed of 10 km h^{-1}. The time after which the distance between them becomes shortest, is :

(1) $10\sqrt{2}$ h (2) 0 h (3) 5h (4) $5\sqrt{2}$ h

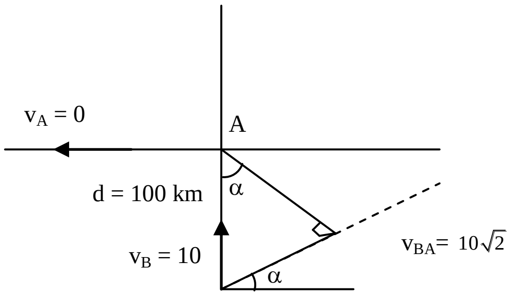
92. (3)

$v_{BA} = 10\sqrt{2}$ km $\alpha = 45°$

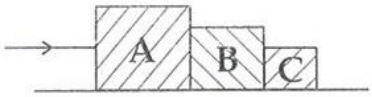
A N = minimum distance between the two

= d cos α

time taken to reach at N = $\frac{d\cos\alpha}{v_{BA}} = \frac{100\times\frac{1}{\sqrt{2}}}{10\sqrt{2}}$ = 5h



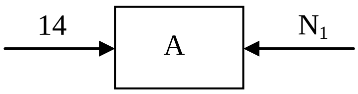
93. Three blocks A, B and C, of masses 4 kg, 2 kg and 1 kg respectively, are in contact on a frictionless surface, as shown. If a force of 14 N is applied on the 4 kg block, then the contact force between A and B is :



(1) 18 N (2) 2 N (3) 6 N (4) 8 N

93. (3)

$a = \frac{14}{7} = 2 m/s^2$



$\therefore 14 - N_1 = 4 \times 2$

$N_1 = 6N$

94. The electric field in a certain region is acting radially outward and is given by E = Ar . A charge contained in a sphere of radius 'a' centred at the origin of the field, will be given by :

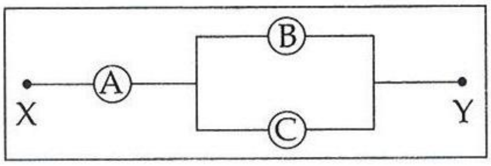
(1) $\epsilon_0 A a^3$ (2) $4\pi\epsilon_0 A a^2$ (3) $A\epsilon_0 a^2$ (4) $4\pi\epsilon_0 A a^3$

94. (4)

$$\oint \vec{E}\cdot\vec{ds} = E\,4\pi a^2 = A.a4\pi a^2 = 4\pi A a^3$$

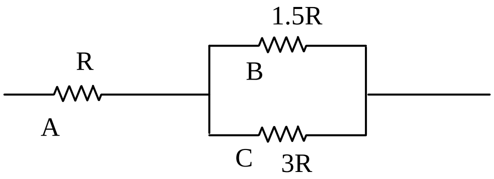
$$\oint \vec{E}\cdot\vec{ds} = \frac{Q_{ex}}{\varepsilon_0} \quad \therefore Q_{ex} = 4\pi\varepsilon_0 A a^3$$

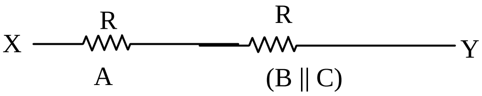
95. A, B and C are voltmeters of resistance R, 1.5 R and 3R respectively as shown in the figure. When some potential difference is applied between X and Y, the voltmeter readings are V_A, V_B and V_C respectively.
Then :



(1) $V_A \neq V_B \neq V_C$
(2) $V_A = V_B = V_C$
(3) $V_A \neq V_B = V_C$
(4) $V_A = V_B \neq V_C$

95. (2)
Ckt is equivalent to





$\therefore\ V_A = V_B = V_C$

96. In a double slit experiment, the two slits are 1 mm apart and the screen is placed 1 m away. A monochromatic light of wavelength 500 nm is used. What will be the width of each slit for obtaining ten maxima of double slit within the central maxima of single slit pattern ?
(1) 0.02 mm (2) 0.2 mm (3) 0.1 mm (4) 0.5 mm

96. (2)

In a double slit experiment, the two slits are 1 mm apart.

$d = 1\text{ mm} = 10^{-3}$ m.

The screen is placed at a distance D = 1 m away. Monochromatic light of wave length

$\lambda = 500\text{ nm} = 5 \times 10^{-7}$ m is used.

The distance between two successive maxima or two successive minima is

$$\frac{\lambda D}{d} = \frac{5\times10^{-7}}{10^{-3}} = 5\times10^{-4}\,\text{m} = 0.5\,\text{mm}$$

Ten maxima are contained within a distance

$10 \times 0.5\text{ mm} = 5\text{ mm}$

For a single slit pattern we have

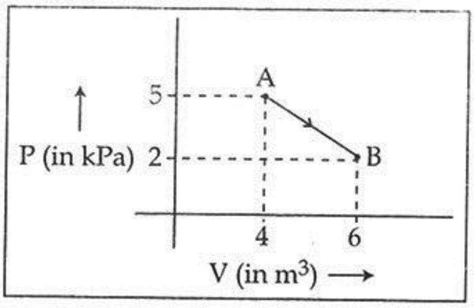
$$\sin\theta = \frac{\lambda}{a}$$

The width of the central maxima is

$$2D\sin\theta = \frac{2D\lambda}{a} = 5\text{ mm}$$

$$\therefore\quad a = \frac{2D\lambda}{5\times10^{-3}} = \frac{2\times5\times10^{-7}}{5\times10^{-3}} = 2\times10^{-4}\,\text{m} = 0.2\,\text{mm}$$

97. One mole of an ideal diatomic gas undergoes a transition from A to B along a path AB as shown in the figure,



The change in internal energy of the gas during the transition is :

(1) –12 kJ (2) 20 kJ (3) –20 kJ (4) 20 J

97. (3)

$\Delta U = nC_V \Delta T$

$= n\frac{5R}{2}\Delta T = \frac{5}{2}nR\Delta T$

$= \frac{5}{2}(P_f V_f - P_i V_i) = \frac{5}{2}(2 \times 6 - 5 \times 4) = \frac{5}{2}(-8) = -20$ kJ

98. A rod of weight W is supported by two parallel knife edges A and B and is in equilibrium in a horizontal position. The knives are at a distance d from each other. The centre of mass of the rod is at distance x from A. The normal reaction on A is :

(1) $\frac{W(d-x)}{d}$ (2) $\frac{Wx}{d}$ (3) $\frac{Wd}{x}$ (4) $\frac{W(d-x)}{x}$

98. (1)

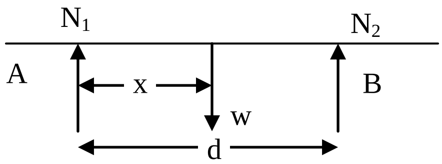
For equilibrium

$N_1 x = N_2 (d - x)$ and $N_1 + N_2 = w$

$\therefore N_1 x = (w - N_1)(d - x)$

$N_1 x + N_1 (d - x) = w(d - x)$

$\therefore N_1 = \frac{w(d-x)}{d}$



99. Kepler′s third law states that square of period of revolution (T) of a planet around the sun, is proportional to third power of average distance r between sun and planet

i.e. $T^2 = Kr^3$

here K is constant.

If the masses of sun and planet are M and m respectively then as per Newton′s law of gravitation force of attraction between them is

$F = \frac{GMm}{r^2}$, here G is gravitational constant

The relation between G and K is described as :

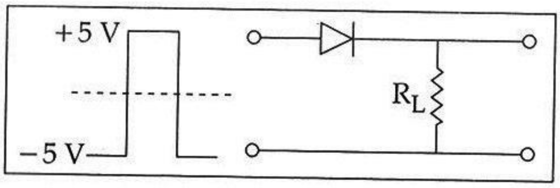
(1) $K = \frac{1}{G}$ (2) $GK = 4\pi^2$ (3) $GMK = 4\pi^2$ (4) $K = G$

99. (3)

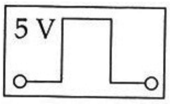
$$T = \frac{2\pi r}{v} = 2\pi \frac{r}{\sqrt{\frac{GM}{r}}} = 2\pi \frac{r^{3/2}}{\sqrt{GM}}$$

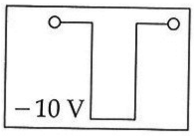
$T^2 = \frac{4\pi^2}{GM} r^3 = Kr^3$ $\therefore k = \frac{4\pi^2}{GM}$ $\therefore GMK = 4\pi^2$

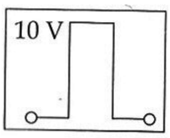
100. If in a p-n junction, a square input signal of 10 V is applied, as shown,

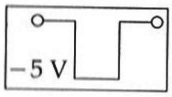


then the output across R_L will be :

(1) 

(2) 

(3) 

(4) 

100. (1)

101. Two particles of masses m_1, m_2 move with initial velocities u_1 and u_2. On collision, one of the particles get excited to higher level, after absorbing energy ε. If final velocities of particles be v_1 and v_2 then we must have :

(1) $\frac{1}{2}m_1^2u_1^2+\frac{1}{2}m_2^2u_2^2+\varepsilon = \frac{1}{2}m_1^2v_1^2+\frac{1}{2}m_2^2 v_2^2$

(2) $m_1^2u_1+m_2^2 u_2-\varepsilon = m_1^2 v_1+m_2^2 v_2$

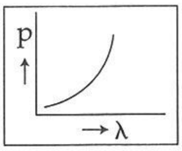
(3) $\frac{1}{\ }m_1u_1^2 \quad \frac{1}{\ }m_2 u_2^2 \quad \frac{1}{2}m_1v_1+\frac{1}{2}m_2v_2-\varepsilon$

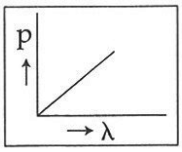
(4) $\frac{1}{\ }m_1u_1^2 \quad \frac{1}{\ }m_2u_2^2 \quad \frac{1}{2}m_1v_1+\frac{1}{2}m_2 v_2$

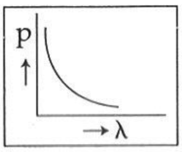
101. (4)
Systems energy will be used for excitation

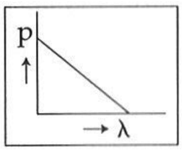
$$\therefore\ \frac{1}{2}m_1n_1^2+\frac{1}{2}m_2n_2^2=\frac{1}{2}m_1v_1^2+\frac{1}{2}m_2v_2^2+\varepsilon$$

102. Which of the following figures represent the variation of particle momentum and the associated de-Broglie wavelength?

(1) 

(2) 

(3) 

(4) 

102. (3)

$$p=\frac{h}{\lambda} \qquad \therefore\ p\propto\frac{1}{\lambda}$$

$\therefore$ (3) is the correct graph.

103. The approximate depth of an ocean is 2700 m. The compressibility of water is 45.4×10^{-11} Pa^{-1} and density of water is 10^3 kg/m^3. What fractional compression of water will be obtained at the bottom of the ocean?

(1) 1.4×10^{-2} (2) 0.8×10^{-2} (3) 1.0×10^{-2} (4) 1.2×10^{-2}

103. (4)

Compressibility = $\dfrac{1}{\text{bulk modulus}} = \dfrac{\Delta V}{V}\dfrac{1}{p}$

$\therefore \quad \dfrac{\Delta V}{V} = p \times \text{compressibility}$

$= h\rho g \cdot \text{compressibility}$

$= 2700 \times 10^3 \times 10 \times 45.4 \times 10^{-11}$

$= 1.2 \times 10^{-2}$

104. The two ends of a metal rod are maintained at temperatures 100°C and 110°C. the rate of heat flow in the rod is found to be 4.0 J/s. If the ends are maintained at temperatures 200°C and 210°C, the rate of heat flow will be :

(1) 4.0 J/s (2) 44.0 J/s (3) 16.8 J/s (4) 8.0 J/s

104. (1)

Rate of heat flow = $\dfrac{k \cdot A \cdot \Delta T}{x}$

Since ΔT is same i.e. 10°C, the rate of flow will be same i.e. 4.0 J/s.

105. A particle of unit mass undergoes one-dimensional motion such that its velocity varies according to

$v(x) = \beta x^{-2n}$,

where β and n are constants and x is the position of the particle. The acceleration of the particle as a function of x, is given by :

(1) $-2n\beta^2 e^{-4n+1}$ (2) $-2n\beta^2 x^{-2n-1}$ (3) $-2n\beta^2 x^{-4n-1}$ (4) $-2\beta^2 x^{-2n+1}$

105. (3)

$\upsilon(x) = \beta x^{-2n}$

$a = \dfrac{d\upsilon}{dt} = \dfrac{d\upsilon}{dx}\cdot\dfrac{dx}{dt} = \dfrac{d\upsilon}{dx}\cdot\upsilon$

$\dfrac{d\upsilon}{dx} = -2n\beta x^{-2n-1}$

$\therefore \quad a = -2n\,\beta\, x^{-2n-1}.\ \beta x^{-2n} \quad = -2n\,\beta^2\, x^{-4n-1}$

106. The refracting angle of a prism is A, and refractive index of the material of the prism is cot (A/2). The angle of minimum deviation is :

(1) 180° + 2A (2) 180° – 3A (3) 180° – 2A (4) 90° – A

106. (3)

$\mu = \cot\dfrac{A}{2} = \dfrac{\sin\left(\dfrac{A+\delta m}{2}\right)}{\sin\dfrac{A}{2}} \qquad \therefore \quad \dfrac{\cos\left(\dfrac{A}{2}\right)}{\sin\left(\dfrac{A}{2}\right)} = \dfrac{\sin\left(\dfrac{A+\delta m}{2}\right)}{\sin\left(\dfrac{A}{2}\right)}$

$\therefore \quad \cos\dfrac{A}{2} = \sin\left(\dfrac{A+\delta m}{2}\right) \qquad \therefore \quad \sin\left(90 - \dfrac{A}{2}\right) = \sin\left(\dfrac{A+\delta m}{2}\right)$

$\therefore \quad 90° - \dfrac{A}{2} = \dfrac{A+\delta m}{2}$

$\therefore \quad 180° - A = A + \delta m$

$\therefore \quad \delta m = 180° - 2A$

107. A particle is executing SHM along a straight line. Its velocities at distances x_1 and x_2 from the mean position are V_1 and V_2, respectively. Its time period is :

(1) $2\pi\sqrt{\frac{V_1^2 - V_2^2}{x_1^2 - x_2^2}}$ (2) $2\pi\sqrt{\frac{x_1^2 + x_2^2}{V_1^2 + V_2^2}}$ (3) $2\pi\sqrt{\frac{x_2^2 - x_1^2}{V_1^2 - V_2^2}}$ (4) $2\pi\sqrt{\frac{V_1^2 + V_2^2}{x_1^2 + x_2^2}}$

107. (3)

$\upsilon_1 = \omega\sqrt{A^2 - x_1^2}$ $\therefore\ \upsilon_1^2 = \omega^2\left(A^2 - x_1^2\right)$

$\upsilon_2 = \omega\sqrt{A^2 - x_2^2}$ $\therefore\ \upsilon_2^2 = \omega^2\left(A^2 - x_2^2\right)$

$\therefore\ \upsilon_1^2 - \upsilon_2^2 = = \omega^2\left(x_2^2 - x_1^2\right)$ $\therefore\ \omega^2 = \frac{\upsilon_1^2 - \upsilon_2^2}{x_2^2 - x_1^2}$

$\therefore\ \omega = \sqrt{\frac{\upsilon_1^2 - \upsilon_2^2}{x_2^2 - x_1^2}}$ $\therefore\ T = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{x_2^2 - x_1^2}{\upsilon_1^2 - \upsilon_2^2}}$

108. Two similar springs P and Q have spring constants K_P and K_Q, such that $K_P > K_Q$. They are stretched, first by the same amount (case a), then by the same force (case b). The work done by the springs W_P and W_Q are related as, in case (a) and case (b), respectively :

(1) $W_P < W_Q; W_Q < W_P$ (2) $W_P = W_Q; W_P > W_Q$
(3) $W_P = W_Q; W_P = W_Q$ (4) $W_P > W_Q; W_Q > W_P$

108. (4)

Case (a) : $w = \frac{1}{2}kx^2$

$w_P = \frac{1}{2}k_P x^2$

$W_Q = \frac{1}{2}k_Q x^2$

$\because\ k_P > k_Q, w_P > w_Q$

Case (b) : $w = \frac{1}{2}Fx$

$F = k_P x_P = k_Q x_Q$

$\therefore\ \frac{x_P}{x_Q} = \frac{k_Q}{k_P}$

$\therefore\ \frac{w_P}{w_Q} = \frac{x_P}{x_Q} = \frac{k_Q}{k_P}$

$\because\ k_Q < k_P\ , w_P < w_Q$

109. Consider 3rd orbit of He^+ (Helium), using non-relativistic approach, the speed of electron in this orbit will be [given $K = 9 \times 10^9$ constant, Z = 2 and h(Planck′s Constant) = 6.6×10^{-34} J s]

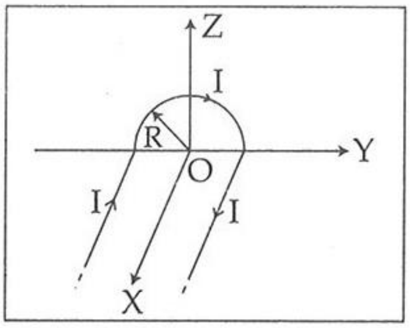
(1) 3.0×10^8 m/s (2) 2.92×10^6 m/s
(3) 1.46×10^6 m/s (4) 0.73×10^6 m/s

109. (3)

$v = \frac{1}{4\pi\varepsilon_0}\frac{2\pi z\varepsilon^2}{nh}$

substituting the values, we get
$v = 1.46 \times 10^6$ m/s.

110. A wire carrying current I has the shape as shown in adjoining figure. Linear parts of the wire are very long and parallel to X-axis while semicircular portion of radius R is lying in Y-Z plane. Magnetic field at point O is :



(1) $\vec{B} = \frac{\mu_0}{4\pi}\frac{1}{R}\left(\pi\hat{i} - 2\hat{k}\right)$ (2) $\vec{B} = \frac{\mu_0}{4\pi}\frac{I}{R}\left(\pi\hat{i} + 2\hat{k}\right)$

(3) $\vec{B} = -\frac{\mu_0}{4\pi}\frac{I}{R}\left(\pi\hat{i} - 2\hat{k}\right)$ (4) $\vec{B} = -\frac{\mu_0}{4\pi}\frac{I}{R}\left(\pi\hat{i} + 2\hat{k}\right)$

110. (4)

Due to Semicircular wire

$$\vec{B}_1 = \frac{\mu_0 I}{4R}\left(-\hat{i}\right) = \frac{\mu_0\, \pi\, I}{4\pi\, R}\left(-\hat{i}\right)$$

due to two straight wires

$$\vec{B}_2 = 2\frac{\mu_0 I}{4\pi R}\left(-\hat{k}\right)$$

Net field, $\vec{B} = \vec{B}_1 + \vec{B}_2 = -\frac{\mu_0 I}{4\pi R}\left(\pi\hat{i} + 2\hat{k}\right)$

111. A particle of mass m is driven by a machine that delivers a constant power k watts. If the particle starts from rest the force on the particle at time t is :

(1) $\frac{1}{2}\sqrt{mk}\, t^{-1/2}$ (2) $\sqrt{\frac{mk}{2}}\, t^{-1/2}$ (3) $\sqrt{mk}\, t^{-1/2}$ (4) $\sqrt{2mk}\, t^{-1/2}$

111. (3)

$K = F\upsilon$

$= F\,at = F\frac{F}{m}t$

$K = \frac{F^2}{m}t$

$F = \sqrt{\frac{mK}{t}} = \sqrt{mK}\, t^{-\frac{1}{2}}$

112. The fundamental frequency of a closed organ pipe of length 20 cm is equal to the second overtone of an organ pipe open at both the ends. The length of organ pipe open at both the ends is :

(1) 140 cm (2) 80 cm (3) 100 cm (4) 120 cm

112. (4)

For closed organ pipe fundamental frequency

$n_1 = \frac{v}{4\ell_1}$

For open organ pipe fundamental frequency

$n_2 = \frac{v}{2\ell_2}$

The second overtone is

$$n_2^1 = 3 \cdot n_2 = \frac{3v}{2\ell_2}$$

$$n_2^1 = n_1$$

$$\frac{3v}{2\ell_2} = \frac{v}{4\ell_1} \qquad \therefore\ \ell_2 = 6\ell_1 = 6 \times 20 = 120 \text{ cm.}$$

113. An electron moving in a circular orbit of radius r makes n rotations per second. The magnetic field produced at the centre has magnitude :

(1) $\frac{\mu_0 ne}{2r}$ (2) $\frac{\mu_0 ne}{2\pi r}$ (3) Zero (4) $\frac{\mu_0 n^2 e}{r}$

113. (1)

At the centre of a circular current

$$B = \frac{\mu_0\, i}{2r}$$

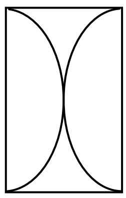
have $i = n\,e$

$$\therefore \quad B = \frac{\mu_0\, n\, e}{2r}$$

114. Two identical thin plano-convex glass lenses (refractive index 1.5) each having radius of curvature of 20 cm are placed with their convex surfaces in contact at the centre. The intervening space is filled with oil of refractive index 1.7. The focal length of the combination is :

(1) 50 cm (2) –20 cm (3) –25 cm (4) –50 cm

114. (4)



$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} + \frac{1}{f_3}$$

$$\frac{1}{f_1} = (1.5-1)\left(\frac{1}{\infty} - \frac{1}{-20}\right) = \frac{1}{40}$$

$$\frac{1}{f_3} = (1.5-1)\left(\frac{1}{20} - \frac{1}{\infty}\right) = \frac{1}{40}$$

$$\frac{1}{f_2} = (1.7-1)\left(\frac{1}{-20} - \frac{1}{20}\right); \qquad \frac{1}{f_2} = (1.7-1)\left(\frac{1}{-20} - \frac{1}{20}\right) = -\frac{0.7 \times 2}{20} = -\frac{2.8}{40}$$

$$\frac{1}{f} = \frac{1}{40} - \frac{2.8}{40} + \frac{1}{40} = \frac{1 - 2.8 + 1}{40} = -\frac{0.8}{40}$$

$$f = -\frac{40}{0.8} = -50 \text{ cm}$$

115. On observing light from three different stars P, Q and R, it was found that intensity of violet colour is maximum in the spectrum of P, the intensity of green colour is maximum in the spectrum of R and the intensity of red colour is maximum in the spectrum of Q. If T_P, T_Q and T_R are the respective absolute temperatures of P, Q and R, then it can be concluded from the above observations that :

(1) $T_P < T_Q < T_R$ (2) $T_P > T_Q > T_R$

(3) $T_P > T_R > T_Q$ (4) $T_P < T_R < T_Q$

115. (2)

Accordingly to Wien's law

$$\lambda \propto \frac{1}{T} \qquad \text{and} \qquad \lambda_V < \lambda_G < \lambda_R$$

$$\therefore \quad T_P > T_Q > T_R$$

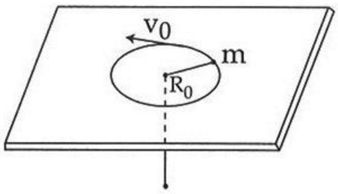
116. If energy (E), velocity (V) and time (T) are chosen as the fundamental quantities, the dimensional formula of surface tension will be :
(1) $[E^{-2} V^{-1} T^{-3}]$ (2) $[E V^{-2} T^{-1}]$ (3) $[E V^{-1} T^{-2}]$ (4) $[E V^{-2} T^{-2}]$

116. (4)
[Surface Tension] = MT^{-2}
$\therefore MT^{-2} = k E^a V^b T^c$
$= k (ML^2 T^{-2})^a (LT^{-1})^b T^c$
$MT^{-2} = KM^a L^{2a+b} T^{-2a-b+c}$
$\therefore$ a = 1
2a + b = 0
–2a – b + c = –2
On solving a = 1, b = –2, c = –2
$\therefore$ Required answer is $EV^{-2} T^{-2}$

117. A Carnot engine, having an efficiency of $\eta = \frac{1}{10}$ as heat engine, is used as a refrigerator. If the work done on the system is 10 J, the amount of energy absorbed from the reservoir at lower temperature is :
(1) 1 J (2) 100 J (3) 99 J (4) 90 J

117. (4)
$$\eta = \frac{Q_H - Q_L}{Q_H}$$
$$\frac{1}{10} = \frac{10}{Q_H}$$
$Q_H = 100$ J and $Q_H - Q_L = 10$
$\therefore 100 - Q_L = 10$
$Q_L = 100 - 10 = 90$ J

118. A mass m moves in a circle on a smooth horizontal plane with velocity v_0 at a radius R_0. The mass is attached to a string which passes through a smooth hole in the plane as shown.



The tension in the string is increased gradually and finally m moves in a circle of radius $\frac{R_0}{2}$. The final value of the kinetic energy is :
(1) $\frac{1}{2}mv_0^2$ (2) mv_0^2 (3) $\frac{1}{4}mv_0^2$ (4) $2mv_0^2$

118. (4)
When a mass moves in a circle of radius R_0 with velocity v_0, its kinetic energy is given by
$$KE_1 = \frac{1}{2}mv_0^2 \quad \text{............... (1)}$$
The centripetal force required for circular motion is
$$F_C = \frac{mv_0^2}{R_0} \quad \text{............... (2)}$$
The tension in the string is gradually increased and the radius of the circle decreased to $\frac{R_0}{2}$.

When the radius of the circle is R $\left(R_0 > R > \frac{R_0}{2}\right)$ the tension in the string is the same as the centripetal force.

$T = F_C = \frac{mv^2}{R} = \frac{L^2}{mR^3}$ …………….. (3)

where L = mRv is the angular momentum which is conserved.

Work done in reducing the radius of the circle from R_0 to $\frac{R_0}{2}$ is

$$W = -\int_{R_0}^{R_0/2} F_C dR = -\int_{R_0}^{R_0/2} \frac{L^2 dR}{mR^3} = -\frac{L^2}{m}\int_{R_0}^{R_0/2} \frac{dR}{R^3} = -\frac{L^2}{m}\left[-\frac{1}{2R^2}\right]_{R_0}^{R_0/2}$$

$$= -\frac{L^2}{2m}\left[\frac{1}{R^2}\right]_{R_0/2}^{R_0} = \frac{L^2}{2m}\left[\frac{1}{R^2}\right]_{R_0}^{R_0/2}$$

$$= \frac{L^2}{2m}\left[\frac{4}{R_0^2} - \frac{1}{R_0^2}\right] = \frac{L^2}{2m}\frac{3}{R_0^2} = \frac{m^2 v_0^2 R_0^2}{2m}\frac{3}{R_0^2} = \frac{3}{2}mv_0^2$$

Total kinetic energy = Initial kinetic energy + Work done

$$= \frac{1}{2}mv_0^2 + \frac{3}{2}mv_0^2 = 2mv_0^2$$

119. For a parallel beam of monochromatic light of wavelength ‘λ’, diffraction is produced by a single slit whose width ‘a’ is of the order of the wavelength of the light. If ‘D’ is the distance of the screen from the slit, the width of the central maxima will be :

(1) $\frac{2Da}{\lambda}$ (2) $\frac{2D\lambda}{a}$ (3) $\frac{D\lambda}{a}$ (4) $\frac{Da}{\lambda}$

119. (2)

For a parallel beam of monochromatic light of wavelength λ, diffraction is produced by a single slit whose width 'a' is of the order of the wavelength we have

$\sin\theta = \frac{\lambda}{a}$ …………… (1)

where θ is the angle subtended by the first minima and the central maxima at the slit.

$\therefore$ $2\sin\theta = \frac{2\lambda}{a}$ …………… (2)

If x is the width of the central maxima, we have

$\frac{x}{D} = \frac{2\lambda}{a}$

$\therefore$ $x = \frac{2D\lambda}{a}$ …………… (3)

where D is the distance of the screen from the slit.

120. A wind with speed 40 m/s blows parallel to the roof of a house. The area of the roof is 250 m^2. Assuming that the pressure inside the house is atmospheric pressure, the force exerted by the wind on the roof and the direction of the force will be :

(P_{air} = 1.2 kg/m^3)

(1) 2.4×10^5 N, downwards (2) 4.8×10^5 N, downwards

(3) 4.8×10^5 N, upwards (4) 2.4×10^5 N, upwards

120. (4)

From Bernoulli's equation

$P = P_0 + \frac{1}{2}\rho v^2$

Force will act due to pressure difference

$\therefore$ $P - P_0 = \frac{1}{2}\rho v^2$

$= \frac{1}{2} \times 1.2 \times (40)^2$

$= 0.0096 \times 10^5$

$\therefore$ Force acting upwards

$F = 0.0096 \times 10^5 \times 250 = 2.4 \times 10^5$ N upwards

121. The ratio of the specific heats $\frac{C_p}{C_v} = \gamma$ in terms of degrees of freedom (n) is given by :

(1) $\left(1+\frac{n}{2}\right)$ (2) $\left(1+\frac{1}{n}\right)$ (3) $\left(1+\frac{n}{3}\right)$ (4) $\left(1+\frac{2}{n}\right)$

121. (4)

For a monoatomic gas

$C_V = \frac{3}{2}R \quad C_P = \frac{5}{2}R \quad \gamma = \frac{C_P}{C_V} = \frac{5}{3}$

For a diatomic gas

$C_V = \frac{5}{2}R \quad C_P = \frac{7}{2}R \quad \gamma = \frac{C_P}{C_V} = \frac{7}{5}$

For a triatomic gas

$C_V = 3R \quad C_P = 4R \quad \gamma = \frac{C_P}{C_V} = \frac{4}{3}$

This fits into the pattern $\left(1+\frac{2}{n}\right)$, where n is the number of the degrees of freedom.

122. If radius of the $^{27}_{13}Al$ nucleus is taken to be R_{Al}, then the radius of $^{125}_{53}Te$ nucleus is nearly :

(1) $\left(\frac{13}{53}\right)^{1/3} R_{Al}$ (2) $\left(\frac{53}{13}\right)^{1/3} R_{Al}$ (3) $\frac{5}{3}R_{Al}$ (4) $\frac{3}{5}R_{Al}$

122. (3)

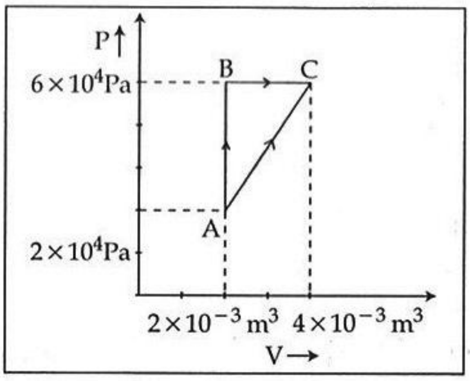
Radius of the nucleus goes as

$R \propto A^{1/3}$, where A is the atomic mass.

If R_{Te} is the radius of the nucleus of telurium atom and R_{Al} is the radius of the nucleus of aluminium atom we have

$\frac{R_{Te}}{R_{Al}} = \frac{(125)^{1/3}}{(27)^{1/3}} = \frac{5}{3}$ $\therefore$ $R_{Te} = \frac{5}{3}R_{Al}$

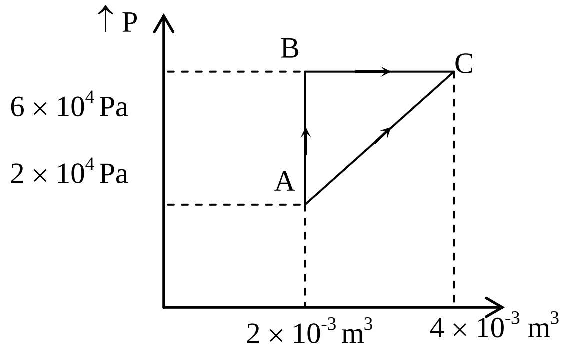
123. Figure below shows two paths that may be taken by a gas to go from a state A to a state C.



In process AB, 400 J of heat is added to the system and in process BC, 100 J of heat is added to the system. The heat absorbed by the system in the process AC will be :

(1) 300 J (2) 380 J (3) 500 J (4) 460 J

123. (4)



See figure alongside

Process AB is isochoric so no work is done.

Heat added to be system is Q = 400 J.

$$Q = \Delta U + \Delta W$$

where ΔU is the change in internal energy

ΔW is the work done.

Since $\Delta W = 0$

$\Delta U = Q = 400$ J

Change in internal energy is 400 J.

Process BC is isobaric and the work done is given by

$$\Delta W = P(V_2 - V_1) = 6 \times 10^4(4 \times 10^{-3} - 2 \times 10^{-3})$$
$$= 6 \times 10^4 \times 2 \times 10^{-3} = 120 \text{ J}$$

Heat added to be system is Q = 100 J.

Since $Q = \Delta U + \Delta W$

$\therefore \quad \Delta U = Q - \Delta W = (100 - 120)$ J $= -20$ J

Change in internal energy is – 20 J.

Total increase in internal energy is going from state A to state C is 400 – 20 = 380 J

Work done in process AC is the area under the curve.

$$\text{Area of the trapezium} = \frac{1}{2}(P_2 + P_1) \times (V_2 - V_1)$$
$$= \frac{1}{2}(6\times10^4 + 2\times10^4)\times(4\times10^{-3} - 2\times10^{-3})$$
$$= \frac{1}{2}\times8\times10^4\times2\times0^{-3} = 80 \text{ J.}$$

Since $Q = \Delta U + \Delta W$

and ΔU the change in internal energy in process AC, we have

$\Delta U = 380$ J and $\Delta W = 80$ J

$\therefore \quad Q = \Delta U + \Delta U = 380 + 80 = 460$ J

124. A block of mass 10 kg, moving in x direction with a constant speed of 10 ms^{-1}, is subjected to a retarding force F = 0.1 x J/m during its travel from x = 20 m to 30 m. Its final KE will be :

(1) 250 J (2) 475 J (3) 450 J (4) 275 J

124. (2)

The block of mass M = 10 kg is moving in the x – direction with a speed v = 10 m/s.

Its initial kinetic energy is

$$KE_i = \frac{1}{2}mv^2 = \frac{1}{2} \times 10 \times (10)^2 = 500 \text{ J.}$$

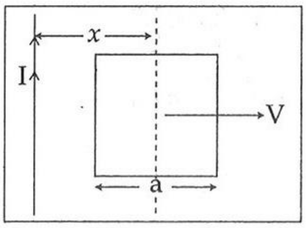
It is subjected to a retarding force F = 0.1 x J/m during its travel from x = 20 m to 30 m.

Work done is given by

$$W = -\int_{x=20}^{x=30} \vec{F}.\overrightarrow{dx} = -\int_{x=20}^{x=30} (0.1\,x)dx = -0.1\left[\frac{x^2}{2}\right]_{x=20}^{x=30} = -0.1\left[\frac{900}{2} - \frac{400}{2}\right]$$
$$= -0.1 \times \frac{500}{2} = -0.1 \times 250 = -25 \text{ J}$$

Final kinetic energy is, $KE_f = KE_i + W = 500 - 25 = 475$ J

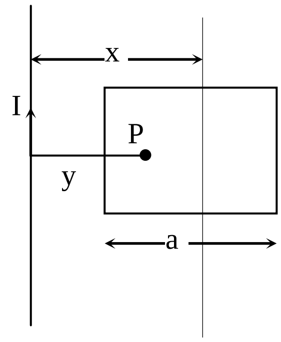
125. A conducting square frame of side 'a' and a long straight wire carrying current I are located in the same plane as shown in the figure. The frame moves to the right with a constant velocity 'V'. The emf induced in the frame will be proportional to :



(1) $\frac{1}{(2x-a)(2x+a)}$ (2) $\frac{1}{x^2}$ (3) $\frac{1}{(2x-a)^2}$ (4) $\frac{1}{(2x+a)^2}$

125. (1)

See figure alongside.



Let x be the distance of the centre of the frame from the long straight wire carrying current I.

Consider the point P at a distance y from the long straight wire carrying current I.

Strength of magnetic induction at point P is given by

$$B = \frac{\mu_0}{4\pi}\frac{2I}{y}$$

Integrating over y from y = (x – a/2) to y = (x + a/2)

We get

$$\int_{x-\frac{a}{2}}^{x+\frac{a}{2}} B\,dy = \int_{x-\frac{a}{2}}^{x+\frac{a}{2}} \frac{\mu_0}{4\pi}\frac{2I}{y}dy = \frac{\mu_0}{2\pi} I \int_{x-\frac{a}{2}}^{x+\frac{a}{2}} y\,dy = \frac{\mu_0 I}{2\pi}\left[\ln y\right]_{(x-a/2)}^{(x+a/2)}$$

$$= \frac{\mu_0 I}{2\pi}\ln\left[\frac{x+a/2}{x-a/2}\right]$$

Total flux contained in the square frame is

$$\phi = \frac{\mu_0 Ia}{2\pi}\ln\left[\frac{x+a/2}{x-a/2}\right]$$

Rate of change of flux is

$$\frac{d\phi}{dt} = \frac{\mu_0 Ia}{2\pi}\frac{d}{dt}\left[\ln\left[\frac{x+a/2}{x-a/2}\right]\right] = \frac{\mu_0 Ia}{2\pi}\left[\frac{x-a/2}{x+a/2}\right]\frac{d}{dt}\left[\frac{x+a/2}{x-a/2}\right]$$

$$= \frac{\mu_0 Ia}{2\pi}\left[\frac{2x-a}{2x+a}\right]\frac{(x-a/2)\frac{d}{dt}(x+a/2)-(x+a/2)\frac{d}{dt}(x-a/2)}{(x-a/2)^2}$$

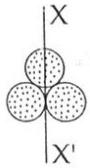
$$= \frac{\mu_0 Ia}{2\pi}\frac{(2x-a)}{(2x+a)}\times\frac{4}{(2x-a)^2}\left[(x-a/2)v-(x+a/2)v\right]$$

$$= \frac{2\mu_0 Ia}{\pi}\frac{1}{(2x-a)(2x+a)}v\left[-a\right] = -\frac{2\mu_0 Ia^2 v}{\pi}\frac{1}{(2x-a)(2x+a)}$$

$$\varepsilon = -\frac{d\phi}{dt} = \frac{2\mu_0 Ia^2 v}{\pi}\frac{1}{(2x-a)(2x+a)}$$

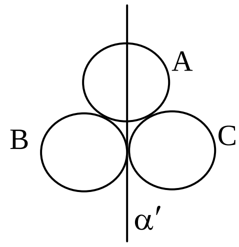
$$\varepsilon \propto \frac{1}{(2x-a)(2x+a)}$$

126. Three identical spherical shells, each of mass m and radius r are placed as shown in figure. Consider an axis XX′ which is touching to two shells and passing through diameter of third shell.
Moment of inertia of the system consisting of these three spherical shells about XX′ axis is :



(1) $4\ mr^2$ (2) $\frac{11}{5}mr^2$ (3) $3\ mr^2$ (4) $\frac{16}{5}mr^2$

126. (1)
See figure alongside



A is a spherical shell whose mass is m and radius is r.
Its moment of inertia about the XX' axis is $I_A = \frac{2}{3}mr^2$
B is a spherical shell whose mass is m and radius is r.
Its moment of inertia about its own axis is $I_B = \frac{2}{3}mr^2$
Its moment of inertia about XX' axis is

$$I_{B'} = I_B + mr^2 = \frac{5}{3}mr^2$$

Similarly the moment of inertia of the spherical shell C about the XX' axis is

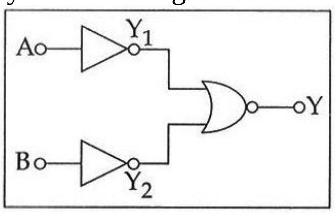
$$I_{C'} = \frac{5}{3}mr^2$$

Total moment of inertia is

$$I = I_A + I_{B'} + I_{C'}$$

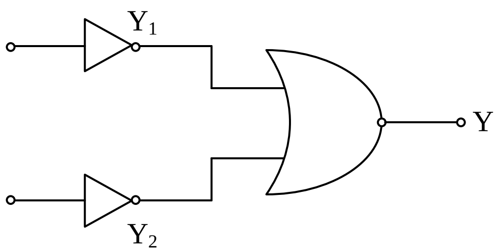
$$= \frac{2}{3}mr^2 + \frac{5}{3}mr^2 + \frac{5}{3}mr^2 = 4mr^2$$

127. Which logic gate is represented by the following combination of logic gates ?



(1) NOR (2) OR (3) NAND (4) AND

127. (4)
We have $\left(\overline{\overline{A}+\overline{B}}\right)$



Truth table

A	B	Y_1	Y_2	Y
0	0	1	1	0
1	0	0	1	0
1	0	0	1	0
0	1	1	0	0
1	1	0	0	1

This correspond to AND gate

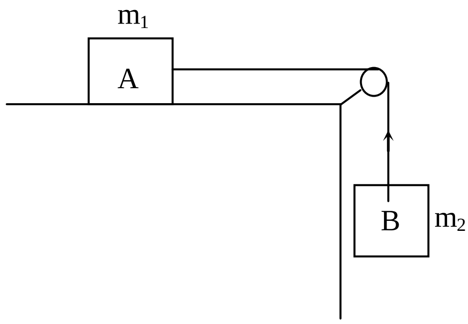
128. A block A of mass m_1 rests on a horizontal table. A lights string connected to it passes over a frictionless pulley at the edge of table and from its other end another block B of mass m_2 is suspended. The coefficient of kinetic friction between the block and the table is μ_k. When the block A is sliding on the table, the tension in the string is :

(1) $\dfrac{m_1m_2(1-\mu_k)g}{(m_1+m_2)}$ (2) $\dfrac{(m_2+\mu_k m_1)g}{(m_1+m_2)}$

(3) $\dfrac{(m_2-\mu_k m_1)g}{(m_1+m_2)}$ (4) $\dfrac{m_1m_2(1+\mu_k)g}{(m_1+m_2)}$

128. (4)

See figure alongside



Let T be the tension in the string.

Let a be the acceleration of the combination.

We have,

$m_2g - T = m_2 a$ ....(1)

for block B.

And

$T - \mu_k m_1 g = m_1 a$ ...(2)

for block A.

Adding equation (1) and (2) we get,

$(m_2 - \mu_k m_1) g = (m_1 + m_2) a$

$\therefore \quad a = \dfrac{(m_2-\mu_k m_1)g}{(m_1+m_2)}$ ....(3)

From equation (2) and (3) we get,

$$T = \mu_k m_1 g + m_1 a$$

$$= \mu_k m_1 g + m_1 g\frac{(m_2-\mu_k m_1)}{(m_1+m_2)} = m_1 g\left[\mu_k + \frac{(m_2-\mu_k m_1)}{(m_1+m_2)}\right]$$

$$= m_1 g\left[\frac{\mu_k m_1 + \mu_k m_2 + m_2 - \mu_k m_1}{(m_1+m_2)}\right]$$

$$= m_1 g\left[\frac{m_2(1+\mu_k)}{(m_1+m_2)}\right] = \frac{m_1 m_2(1+\mu_k)g}{(m_1+m_2)}$$

129. A certain metallic surface is illuminated with monochromatic light of wavelength, λ. The stopping potential for photo-electric current for this light is $3V_0$. If the same surface is illuminated with light of wavelength 2 λ, the stopping potential is V_0. The threshold wavelength for this surface for photo-electric effect is :

(1) $\dfrac{\lambda}{6}$ (2) 6λ (3) 4λ (4) $\dfrac{\lambda}{4}$

129. (3)

We have,

$\dfrac{hc}{\lambda} = W + e\,(3V_0)$ ....(1)

where W is the work function and $(3V_0)$ is the stopping potential when monochromatic light of wavelength λ is used.

Also,

$\dfrac{hc}{2\lambda} = W + e\,V_0$ ....(2)

where V_0 is the stopping potential when monochromatic light of wavelength 2λ is used.

Subtracting equation (2) from equation (1)

We get,

$$\frac{hc}{2\lambda} = 2e\,V_0$$

$$\therefore \quad V_0 = \frac{hc}{4e\lambda} \qquad \text{....(3)}$$

Substituting in equation (2) we get,

$$\frac{hc}{2\lambda} = W + e\,V_0 = W + \frac{hc}{4\lambda}$$

$$\therefore \quad W = \frac{hc}{4\lambda}$$

The threshold wavelength is therefore 4λ.

130. When two displacements represented by $y_1 = a\sin(\omega t)$ and $y_2 = b\cos(\omega t)$ are superimposed the motion is :

(1) simple harmonic with amplitude $\frac{(a+b)}{2}$

(2) not a simple harmonic

(3) simple harmonic with amplitude $\frac{a}{b}$

(4) simple harmonic with amplitude $\sqrt{a^2+b^2}$

130. (4)

$y_1 = a\sin(\omega t)$ $\qquad$ $y_2 = b\cos(\omega t)$

Let $a = c\cos(\phi)$ and $b = c\sin(\phi)$

We have,

$$y_1 + y_2 = a\sin(\omega) + b\cos(\omega t)$$
$$= c\cos\phi\sin(\omega t) + c\sin\phi\cos(\omega t)$$
$$= c\,[\sin(\omega t + \phi)]$$

where $c^2 = a^2 + b^2$ $\quad$ [since $a^2 + b^2 = c^2\cos^2(\phi) + c^2\sin^2(\phi) = c^2$]

$$\therefore \quad c = \sqrt{a^2+b^2}$$

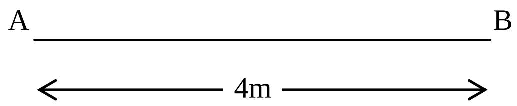
The superimposed motion is simple harmonic with amplitude $\sqrt{a^2+b^2}$.

131. A potentiometer wire has length 4 m and resistance 8 Ω. The resistance that must be connected in series with the wire and an accumulator of e.m.f. 2V, so as to get a potential gradient 1 mV per cm on the wire is :

(1) 48 Ω $\qquad$ (2) 32 Ω $\qquad$ (3) 40 Ω $\qquad$ (4) 44 Ω

131. (2)

Figure alongside shows a potentiometer wire of length L = 4m and resistance $R_{AB} = 8\Omega$.



Resistance connected in series is R.

When an accumulator of emf ε = 2V is used, we have current I given by,

$$I = \frac{\varepsilon}{R + R_{AB}} = \frac{2}{8+R}$$

The resistance per unit length of the potentiometer wire is given by,

$$\frac{R_{AB}}{L} = \frac{8}{4} = 2\,\Omega/\text{m}$$

The potential gradient is given by

$$\frac{IR_{AB}}{L} = \frac{2}{8+R} \times \frac{R_{AB}}{L} = \frac{2\times 2}{8+R}$$

For a potential gradient $1\,\text{mV}$ per cm $= \dfrac{1\times10^{-3}}{10^{-2}} = 0.1\,\text{V/m}$

We have $\dfrac{4}{8+R} = 0.1$

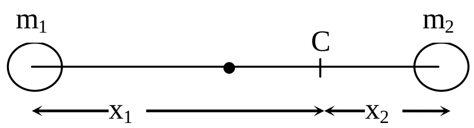
$\therefore$ 8 + R = 40 $\quad\therefore$ R = 32 Ω

132. Two spherical bodies of mass M and 5 M and radii R and 2 R are released in free space with initial separation between their centres equal to 12 R. If they attract each other due to gravitational force only, then the distance covered by the smaller body before collision is :

(1) 1.5 R (2) 2.5 R (3) 4.5 R (4) 7.5 R

132. (4)

Let m_1 = M and m_2 = 5M



Let centre of mass C at a distance x_1 from m_1 and x_2 from m_2.

$m_1x_1 = m_2x_2$

$Mx_1 = 5Mx_2$

$\therefore\ x_1 = 5x_2$ and $x_1 + x_2 = 12R$

$\therefore\ 5x_2 + x_2 = 12R$

$\therefore\ 6x_2 = 12R$

$x_2 = 2R$

$\therefore\ x_1 = 10R$

Since the masses are moving under mutual attraction the position of centre of mass remains constant.

When the masses are in contact, let x_1' and x_2' be the distance of their centres from the centre of mass.

$\therefore\ m_1x_1' = m_2x_2'$

$\therefore\ Mx_1' = 5Mx_2'$

$\therefore\ x_1' = 5x_2'$

Also $x_1' + x_2' = 3R$

$5x_2' + x_2' = 3R$

$6x_2' = 3R$

$\therefore\ x_2' = 0.5R$ and $x_1' = 2.5R$

Hence the distance travelled by the smaller mass is

$x_1 - x_1' = 10R - 2.5R = 7.5R$

133. A resistance 'R' draws power 'P' when connected to an AC source. If an inductance is now placed in series with the resistance, such that the impedance of the circuit becomes 'Z', the power drawn will be :

(1) P (2) $P\left(\dfrac{R}{Z}\right)^2$ (3) $P\sqrt{\dfrac{R}{Z}}$ (4) $P\left(\dfrac{R}{Z}\right)$

133. (2)

A resistance R draws power P when connected to an AC source.

The magnitude of voltage of the AC source is

$V^2 = RP$

$\therefore\ V = \sqrt{PR}$

An inductor of inductance L and reactance ωL is now placed in series with the resistance.

The impedance Z is given by

$$Z = \sqrt{R^2 + \omega^2 L^2}$$

$$\tan\phi = \frac{\omega L}{R} \qquad \tan^2\phi = \frac{\omega^2 L^2}{R^2}$$

$$1 + \tan^2\phi = \frac{1 + \omega^2 L^2}{R^2} = \frac{R^2 + \omega^2 L^2}{R^2} = \sec^2\phi$$

$$\cos^2\phi = \frac{R^2}{R^2 + \omega^2 L^2} \qquad \cos\phi = \frac{R}{(R^2 + \omega^2 L^2)^{1/2}} = \frac{R}{Z}$$

Power drawn is $VI' \cos\phi = V\left(\frac{V}{Z}\right)\left(\frac{R}{Z}\right)$

$$= \frac{V^2 R}{Z^2} = \frac{V^2}{R}\left(\frac{R^2}{Z^2}\right) = P\left(\frac{R}{Z}\right)^2$$

134. Across a metallic conductor of non-uniform cross section a constant potential difference is applied. The quantity which remains constant along the conductor is :

(1) electric filed
(2) current density
(3) current
(4) drift velocity

134. (3)

135. A parallel plate air capacitor of capacitance C is connected to a cell of emf V and then disconnected from it. A dielectric slab of dielectric constant K, which can just fill the air gap of the capacitor, is now inserted in it. Which of the following is **incorrect** ?

(1) The charge on the capacitor is not conserved.
(2) The potential difference between the plates decreases K times.
(3) The energy stored in the capacitor decreases K times.
(4) the change in energy stored is $\frac{1}{2}CV^2\left(\frac{1}{K} - 1\right)$.

135. (1)

A parallel plate air capacitor of capacitance C is connected to a cell of emf V and then disconnected from it.

The charge on the capacitor is given by

$$Q = CV$$

The energy stored in the capacitor is

$$E = \frac{1}{2}CV^2$$

When a dielectric slab of dielectric constant K is inserted in it, the charge Q is conserved. The capacitance becomes K times the original capacitance. ($C' = KC$)

The voltage becomes $\frac{1}{K}$ time the original voltage.

$$V' = \frac{V}{K}$$

The change in energy stored is

$$\frac{Q^2}{2C'} - \frac{Q^2}{2C} = \frac{Q^2}{2KC} - \frac{Q^2}{2C} = \frac{Q^2}{2C}\left[\frac{1}{K} - 1\right]$$

$$= \frac{1}{2}CV^2\left[\frac{1}{K} - 1\right]$$