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ENGINEERING & MEDICAL COACHING

Test Solution

Booster Engineering

Test Code : PT03-1617-BM

Biology

1. A.

Sol. Tubectomy is a surgical methods for females in which a small part of the fallopian tube is removed or tied up through a small incision in the abdomen or through vagina.

2. B.

Sol. Multiload 375 is a copper releasing IUDs; cervical cap and vaults are the Artificial barriers methods which prevent conception by blocking the entry of sperms through the cervix; LGG-20 is a hormone releasing IUDs which makes the uterus unsuitable for implantation and the cervix hostile to the sperms.

3. B.

Sol. IVF stands In Vitro fertilization i.e., fertilization of male and female gamete outside the body.

It is of 2 types :-

(a) Zygote intra fallopian transfer – It involves transfer of zygote or early embryos into the fallopian tube.

(b) Intra uterine transfer (IUT) – It involves transfer of embryos with more than 8 blastomeres into the uterus.

4. A.

Sol. Artificial insemination technique is the method of transferring semen collected from the husband or a healthy donor into the vagina or the uterus of the recipient female.

5. C.

Sol. Government of India legalised MTP (medical termination of pregnancy) in 1971.

It is also known as induced abortion.

6. C.

Sol. IVF techniques is of two types in which first type namely ZIFT involves transfer of zygote or embryo upto 8 blastomeres into fallopian tube. And second type namely IUT involves transfer of embryos with more than 8 blastomeres into the uterus.

During embryonic development where embryo with 8-16 blastomeres is known as Morula.

7. B.

Sol. Oxytocin is a birth hormone and vasopressin (anti-diuretic hormone) reabsorbs water from the renal tubules to conserve water in the body. They have no role in contraception.

8. C.

Sol. Tubectomy-In this, a small part of the fallopian tube is removed or tied up through a small incision in the abdomen or through vagina.

9. D

Sol. Test-tube baby programme is of two types:

(i) Zygote intra fallopian transfer (ZIFT)

(ii) Intra Uterine transfer (IUT)

10. D.

Sol. ● Cervical caps and diaphragms are made of rubbers, inserted into the female reproductive tract to cover the cervix before coitus.

● tubectomy is a permanent method involves sterilization which provides a permanent and sure birth control. But there are some ill-effects also like nausea, abdominal pain, breakthrough bleeding, irregular, menstrual bleeding.

● Intra uterine devices (IUDs) are plastic or metal objects which are inserted by doctors in the uterus through vagina. There are available as non-medicated, copper releasing, hormone releasing. This is the most widely accepted method of contraception in India.

11. B.

Sol. MTP are safe during the first trimester, (up to 12 weeks of pregnancy).

12. A.

Sol. GIFT is the method of transfer of gamete (ovum) from a donor into the fallopian tube of another female who is unable to produce ovum, but can provide right conditions for fertilization and development of an embryo.

13. B.

Sol. ZIFT is a process of in vitro fertilisation technique which involves transfer of zygote or early embryos (with up to 8 blastomeres) into fallopian tube.

14. D.

Sol.
- Amniocentesis is a prenatal diagnostic technique that is used to determine the metabolic disorders of the developing foetus in the mother's uterus through the observation of the chromosomal pattern.
- This method is also determine any kind of genetic disorder present in the foetus.

15. C.

Sol. IUDs increase phagocytosis of sperms. The Cu ions suppress motility and fertilising capacity of sperms.

16. A.

Sol.
- MTP during first trimester is generally safe. 2nd trimester abortions are very risky.
- IUDs like copper- T are effective because its increase phagocytosis of sperms and it also suppress motility and fertilising capacity of sperms. Above 2 statements are true.

17. C.

Sol. In isolated small tribal population if boys marry girls only from their own tribe then there will be decline in population because at some stage marriage will stop due to isolation and on the other hand marriages within same tribe will lead to homozygosity of disease and ultimately death thus leading to decline in population.

18. C.

Sol. Test tube baby means a baby born when azygote is grown inside a culture and after that embryo is formed, it is then implanted into uterus where it develops into foetus and then into a child.

19. A.

Sol.
- Oral contraceptives pills contain hormones-either progesterone or progesterone-estrogen combination.
- It inhibit ovulation and implantation as well as alter the quality of cervical mucus to prevent entry of sperms.

20. C.

Sol. Oral contraceptive pills contain hormones-either progesterone or progesterone-estrogen combination.

21. C.

Sol.
- Amniocentesis technique is being misused to detect the sex of the child before birth.
- Bars body is a structure consisting of a condensed X chromosome that is found in non dividing nuclei of female mammals.

22. B.

Sol. Test tube baby referred in vitro fertilisation where zygote is grown inside a culture and when embryo is formed, it is then implanted into uterus where it develops into foetus and then into a child.

23. B.

Sol. Carcinoma is a cancer of epithelial tissue and their derivatives like mucous membrane, skin, lungs, breast etc.

24. B.

Sol.
- Short lived immunity acquired from mother to foetus across placenta or through mothers milk to the infant is categorised as passive immunity.
- In this case, the foetus is not directly responsible for its body immunity but it be comes immunised by mothers milk and antibodies across placenta.

25. D.

Sol. Leishmaniasis, also called kala-azar is caused by the protozoan leishmania donovani through the bite of the sand fly phlebotomus.

26. D.

Sol. Refer to Answer 28.

27. D.

Sol. T-lymphocytes are produced in bone massow but mature in thymus. And T-lymphocytes is responsible for cell mediated immunity.

28. A.

Sol.
- AIDS is a disorder of cell-mediated immune system of the body.
- Lymphocytes are the main cells of the immune system i.e., T-lymphocytes and B-lymphocytes.
- There is a reduction in the number of helper T-cells which stimulate antibody production by B-cells. This results in the loss of natural defense against viral infection.

29. A.

Sol. Immunog lobulins or antibody are glycoproteins made up of 4 polypeptide chains (liked by disulphide bonds)- two heavy (440 Aminoacid) and two light (220 amino acids).

30. A.

Sol. Lysozyme is an enzyme that degrade the polysaccharide protective coating on the surface of many bacteria and viruses to allow other enzymes and antibodies to find their appropriate attachment sight. And most of the bacteria affected by lysozyme are not pathogenic.

31. A

Sol. Saliva in the mouth and the tears from the eyes belong to the category of physiological barsier.

32. C.

Sol. ●The letter T in T-lymphocyte refers to thymus.

33. D.

Sol. ● Histamine is a chemical released from allergic cells in the body, usually in response to an allergen.

● The drugs called anti-histamines are of major importance in the treatment of allergic disorders.

34. C.

Sol. ● Tumor is of two types – Benign and malignant.

● Benign tumor is a large localised mass of abnormal tissue enclosed in connective tissue which does not invade adjacent tissue.

● Malignant tumor is not encapsulated and is capable of invading adjacent tissues and distant sites.

● Metastasis is a spread of cancerous cells from one part of the body to other part through blood, lymph and secondary harm of malignant tumor, Metastasis is the most feared property of malignant tumors.

35. A.

Sol. ● Common cold is a viral disease. It is caused by Rhinoviruses.

● AIDS is caused by HIV which is a retrovirus.

36. B.

Sol. Ringworm is a fungal diseases.

37. D.

Sol. Widal test is used for the diagnosis of typhoid.

38. B.

Sol. Prions are infectious agents which are made of proteins only. Prions are the causal agents of scrapie disease of sheep.

39. A.

Sol. Histopathological study is the invasive technique. Radiography and CT involves X-Rays which are harmful. In MRI strong magnetic fields and non-Ionising radiations are used to detect any physiological changes in the using tissue.

40. C.

Sol. Plasmodium is a protozoan which is responsible for causing malaria in human. A person which is suffering from this disease experiences recurring chill and fever at the time when the RBCs carrying plasmodium ruptures, it releases a toxic substance called haemozoin.

41. A.

Sol. A healthy person acquires infection, when a female anopheles mosquito, containing sporozoites in its saliva and bites the person and introduces some saliva into his blood stream.

42. B.

Sol. Tears.

43. A.

Sol. AIDS can be diagnosed by ELISA test and western blotting test, Western blotting test is employed for confirmation of ELISA positive cares.

44. A.

Sol. Common cold is not cured by antibiotics because it is caused by a virus. And Antibiotics are substances that destroy or inhibit the growth of micro organisms, particularly disease producing bacteria and fungi.

45. D.

Sol. Common cold is a viral disease whereas pneumonia is a bacterial diseases. In common cold, viruses affects nose and respiratory passage but not lungs. Pneumonia is a serious disease of lungs, in which fluid collects in the alveoli and bronchioles.

46. D.

Sol. Contact inhibition is a property of normal cells by virtue of which contact with other cells inhibits their uncontrolled growth. Cancerous cells lack this property.

47. B.

Sol. Cirrhosis of liver is caused by the chronic intake of alcohol.

48. B.

Sol. Corpus luteum secretes steroid hormones-progesterone and estrogen, to make uterus suitable for implantation (in case fertilization occurs) and it's maintenance (mainly endometrium).

49. C.

Sol. The trophoblastic cells secrete human chorionic ganadotropin hormone which has properties, similar to those of lutenizing hormone (LH) of the pituitary gland. The hCG maintains the corpus luteum and stimulates it to secrete progesterone, which maintains the endometrium of the uterus and causes it to grow throughout pregnancy.

50. B.

Sol. Parturition is induced by a complex neuro endocrine mechanism. The signals for parturition originate from the fully developed foetus and the placenta which induce mild uterine contraction called foetal ejection reflex. This triggers release of oxytocin from maternal pituitary.

51. C.

Sol. The corpus luteum secretes large amounts of progesterone which is essential for maintainance of endometrium. In absence of fertilization, the corpus luteum degeneraltes, which causes disintegration of the endometrium leading to menstruation.

52. C.

Sol. Ectoderm, Mesoderm and endoderm are three germ layers that give rise to specific tissues, organs and organ systems. Gonads, muscles, dermis, kidneys etc. develop from mesoderm.

53. A.

Sol. Sperms remain viable for 48 hrs to 72 hrs.

54. D.

Sol. Interstitial cells or Leydig cells are the cells interspersed between the seminiferous tubules of the testis, which secrete androgens in response to stimulation by luteininzing hormone from the anterior pituitary gland.

55. C.

Sol. The ruptured Graafian follicle, now called corpus luteum secretes hormones, mainly progesterone and estrogen. Both LH and progesterone help in growth and thickening of endometrium. The major change is that the endometrial glands become secretory. Hence this phase is called luteal or secretory phase that lasts for about 13 days.

56. A.

Sol. The seminiferous tubules of the testis open into vasa efferentia through rete testis the vasa efferentia leave the testis and open into epididymis located along the posterior surface of each testis. So if vasa efferentia gets blocked, the gametes will not be transported from testis to epididymis.

57. A.

Sol. Both LH and FSH attain a peak level in the middle of menstrual cycle (about 14^{th} day). Rapid secretion of LH leading to its maximum level during the mid-cycle called LH surge induces rupture of graafian follicle and release of ovum.

58. C.

Sol. Sertoli cells (named after Italian histologist-Enrico Sertoli) are found in the walls of the seminiferous tubules of the testis. They nourish the developing germ cells, especially the spermatids, which become partly embedded within them.

59. A.

Sol. Semen or seminal fluid or seminal plasma is the fluid ejaculated from penis at sexual climax. Each ejaculate may contain 300-500 million spermatozoa suspended in a fluid secreted by prostate gland, seminal vesicles and cowper's gland. It is rich in fructose, calcium and certain enzymes which nourishes and activates sperms.

60. B.

Sol. During fertilization, the sperm enter into the cytoplasm of the ovum through zona pellucida and the plasma membrane. This induces the completion of the meiotic division (2^{nd} division) of the secondary oocyte. The second meiotic division is also unequal and results in the formation of a second polar body and a haploid ovum (ootid).

61. B.

Sol. Acrosome is the cap-like structure on the front end of a spermatozoon. It breaks down just before fertilization, releasing a no. of hydrolytic enzymes, also called as sperm lysins that assist penetration between the follicle cells that surround the ovum, thus facilitating fertilization.

62. B

Sol. Each fallopian tube is about 10-12 cm long and extends from the periphery of each ovary to the uterus. The part closer to ovary is the funnel – shaped infundibulum, the edges of which possess finger – like projections called fimbriae, that help in collection of ovum after ovulation.

63. D.

Sol. Implantation in endometrial uterine wall takes place at blastocyte stage of embryonic development. It is the trophoblast layer through which blastocyte gets attached to the endometrium and the inner cell mass gets differenciated as the embryo.

64. A.

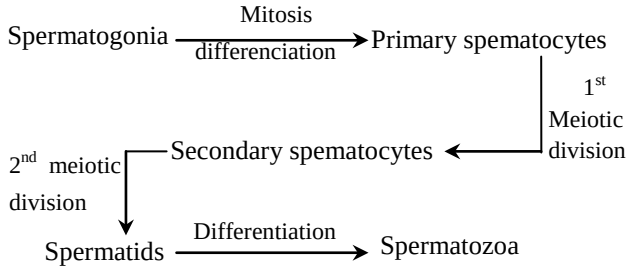
Sol. Eggs are of 4 types regarding the amount of yolk present in them.

(i) Alecithal egg- Almost free of yolk (e.g. man)
(ii) Microlecithal egg- Very small amount of yolk, (e.g. Branchiostoma)
(iii) Mesolecithal egg- Moderate amount of yolk (e.g. Frog's egg)
(iv) Macrolecithal egg Large amount of yolk (e.g. Birds).

65. A.

66. A.

Sol. Spermatogenesis is the process of formation of haploid spermatozoa (sperms) from diploid spermatogonia inside the testis of the male.



67. A.

Sol. Cleavage is a series of cell divisions by which a single fertilized egg cell is transformed into a multicelluar body, blastula. The mode of cleavage is determined by the amount of yolk and its distribution.

68. B.

Sol. Amnion is a type of extra embryonic membrane that surrounds the embryo creating the amniotic cavity that is filled with amniotic fluid. The amniotic fluid serves as a shock absorber for the foetus, regulates foetal body temperature and prevents dessication.

69. B.

Sol. Grey crescent is the area just opposite to the site of entry of sperm into ovum. It marks the future dorsal side of the embryo.

70. A.

Sol. A mature ovarian follicle is called Graafian follicle that contains follicular cells and oocyte. After ovulation, the empty Graafian follicle shows deposition of leutin and forms corpus luteum that ultimately degenerates.

71. C.

Sol. Egg (ovum) secretes a chemical named fertilizin (composed of glycoprotein = monossacharides + amino acids). The fertilizin of an egg interacts with the antifertilizin of a sperm of the same species. This interaction makes the sperms stick to the egg's surface.

72. C.

Sol. Acrosome reaction is Ca-dependent involving massive uptake of Ca and Na with an efflux of hydrogen, generating high pH and osmotic pressure, thus producing negative surface charge and partial or total release of the acrosomal enzymes.

73. B.

Sol. Depending mostly on the amount of yolk in the egg, the cleavage can be holoblastic (total or entire cleavage) or meroblastic (partial cleavage). In the presence of a large amount of yolk in a fertilized egg cell, cleavage can partial or meroblastic.

74. B.

Sol. ● In summer squash or cucurbita pepo, there are three types of fruit colour-yellow, green and white.

● White colour is dominant over the others colours while yellow is dominant over green. Yellow colour is formed only when the dominant epistatic gene is represented by its recessive allele(ω).

● When the hypostatic gene is also recessive (γ), the colour of the fruit is green, i.e.,

W-Yy, W-yy → White

wwY → Yellow

wwyy → Green

75. B.

Sol. Jaundice because it is not a chromosomal disorder thus cannot be tested by amniocentesis.

76. C.

Sol. ● The phenomenon of expression of both the alleles in a heterozygote is called codominance.

● The codominant alleles are able to express themselves independently when present alone.

77. C.

Sol. ● Linkage is the phenomenon of certain genes staying together and their enblock inheritance from generation to generation without any change or separation due to their being present on the same chromosome.

● Such genes are called linked genes. So A and B are linked genes.

78. B.

Sol. Down syndrome in humans is due to trisomy of 21^{st} chromosome.

79. A.

Sol. ●Test cross is a cross between an organism with unknown genotype and a recessive parent.

● It is used to determine whether the individual is homozygous or heterozygous for a trait. Specially it is performed to determine the genotype of F_2 plant.

80. C.

Sol. Four different phenotype can occur which shown below

Genotypes	**Phenotypes**
I^AI^A, I^Ai	Blood group A
I^BI^B, I^Bi	Blood group B
I^BI^B	Blood group AB
ii	Blood group O

81. A.

Sol. ● Test cross is performed to determine the genotype of F_2 plant.

● It is called test cross because it can be used to test genotype of a dominant phenotype. If individual is pure (homozygous) it will produce only dominant trait in progeny.

82. A.

Sol. The female parent is heterozygous.

83. C.

Sol. ● The given situation is an example of incomplete dominance where phenotype found in F_1 generation donot resemble either of the two parents.

● A monohybrid cross between the plants having red flower and white flower are:

Parents : - Red (RR) White (rr)

Gametes :- R r

F_1 Generation :- Rr (Pink)

● Rr is the genotype of the two plants used for hybridization.

84. B.

Sol. ADA deficiency can be permanenty cured if the isolated gene from bone marrow cells producing ADA is introduced into cells at early embryonic stages.

85. C.

Sol. ● Both sickle cell anaemia and huntingtosis chorea are congenital disorders.

● A congenital disorders is a medical condition that is present at birth.

● Congenital disorders can be a result of genetic abnormalities, the intrauterine environment, or unknown factor.

86. D.

Sol. ●Sickle cell anaemia is an autosomal hereditary disorder in which the erythrocytes become sickle shaped.

● Carriers of this disease gene are protected against malaria because of their particular haemoglobin mutation ; this explains why sickle cell anaemia is particularly common among people of African origin.

● Therefore, in areas where malaria is problem, people's chances of survival actually increase if they carry sickle cell anaemia. Thus, sickle cell anaemia is a potential saviour from malaria.

87. B.

Sol. Traits governed by sex-linked recessive genes one- (a) Produce disorders in males more often than in females. (b) Express themselves in males even when represented by a single allele because γ-chromosome does not carry any corresponding alleles, (c) Seldom appear in both father and son, (d) fail to appear in females unless their father also possesses the same and the mother is a carrier. (e) female heterozygous for the trait function as carrier. (f) female homozygous for the recessive trait transfer the trait to all the sons.

Ex. Colour blindness.

88. B.

Sol. ● AABB × aabb is suitable for experiment on linkage.

● In linkage, parental combinations of characters are found more frequently in offspring than non-parental.

89. B.

Sol. Parent – RRTt (Red Tall) rrtt (Yellow short)

Gametes – RT Rt r t

F_1 Generation – RrTt (Red Tall) Rrtt (red short)

At 50 map units, cis is changed to trans and vice versa, hence no fixed linkage.

Genotype – 1 :1

Therefore, 50% red with tall and 50%, red with short.

90. D.

Sol. ● The linkage is incomplete.

● Chromosome mapping is based on the fact that genes are linearly arranged in the chromosome and frequency of crossing over is directly proportional to the distance between two genes.

Physics

91. (B)

Sol. $\vec{r} = (9-3)\hat{i} + (12-4)\hat{j} = 6\hat{i} + 8\hat{j}$

or $r = \sqrt{6^2 + 8^2} = 10 \text{ m}$

$$E = \frac{9\times10^9 \times 10^{-6}}{10^2} = 9000 \text{ Vm}^{-1}$$

92. (D)

Sol. $\frac{kQ_2}{x^2} = \frac{kQ_1}{(x-R)^2}$ or $x = \frac{R}{2}$

93. (A)

Sol. $F = \frac{1}{4\pi\varepsilon_0}\frac{q}{a^2}$

Suppose the charge is present at the sixth vertex also, then electric field at center would be zero. Now, if charge is not present at this vertex, the electric field at center would be because of other five charges, which should be equal and opposite to the field produced due to single charge at the sixth vertex.

94. (B)

Sol. Force on the block: $F = qE$ toward left

Let spring be compressed maximum by x, Then

$$Fx = \frac{1}{2}kx^2 \text{ or } qEx = \frac{1}{2}kx^2 \text{ or } x = \frac{2qE}{k}$$

95. (C)

Sol. For external points, a charged sphere behaves as if the whole of its charge is concentrated at its center.

Force on A due to B,

$$F_{AB} = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{(2R)^2} = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{4R^2} \text{ along } \overrightarrow{BA}$$

And force on A due to C,

$$F_{AC} = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{(2R)^2} = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{4R^2} \text{ along } \overrightarrow{CA}$$

Now as angle between BA and CA is 60° and

$$| F_{AB} | = | F_{AC} | = F$$

$$\therefore \quad F_A = \sqrt{F^2 + F^2 + 2FF\cos 60} = \sqrt{3}F$$

$$= \frac{1}{4\pi\varepsilon_0}\frac{\sqrt{3}}{4}\left(\frac{q}{R}\right)^2$$

96. (D)

Sol. If there has been a sixth charge $+q$ at the remaining vertex of hexagon, force due to all six charges on $-q$ at O will be zero.

Now if is the force due to the sixth charge and F due to the remaining five charges, then

$$\vec{F} + \vec{f} = 0, \text{ i.e., } \vec{F} = -\vec{f}$$

$$\left|\vec{F}\right| = \left|\vec{f}\right| = \frac{1}{4\pi\varepsilon_0}\frac{q\times q}{L^2} = \frac{1}{4\pi\varepsilon_0}\left(\frac{q}{L}\right)^2$$

97. (D)

Sol. $AC = \sqrt{2}\,t = BD$

or $BO = \frac{1}{\sqrt{2}}$

$$F_{BO} = F_{BD} + (F_{BA} + F_{BC})\cos 45^\circ$$

Solving, we get

$Q = \frac{q}{4}(1+2\sqrt{2})Q$ should be negative of q.

98. (B)

Sol. $E_{\text{net}} = 4E\cos\theta = \frac{4}{4\pi\varepsilon_0}\frac{Q}{a^2}\frac{1}{\sqrt{2}} = \frac{Q}{\sqrt{2}\pi\varepsilon_0 a^2}$

99. (A)

Sol. Take PO as the x-axis and PA as the y-axis. Consider two elements EF and $E'F'$ of width $d\theta$ at angular distance θ above and below PO, respectively.

The magnitude of the field at P due to either element is

$$dE = \frac{1}{4\pi\varepsilon_0}\frac{rd\theta \times Q/(\pi r/2)}{r^2} = \frac{Q}{2\pi^2\varepsilon r^2}dt$$

Resolving the fields, we find that the components along PO sum up to zero, and hence the resultant field is along PB Therefore, field at P due to pair of elements is $2d$ E sin θ

$$E = \int_0^{\pi/2} 2d\,E\sin\theta$$

$$= 2\int_0^{\pi/2}\frac{Q}{2\pi\varepsilon_0 r^2}\sin\theta d\theta = \frac{Q}{\pi^2\varepsilon_0 r^2}$$

100. (A)

Sol. Net force $F_{net} = qE_x$

$$F = q\frac{\lambda}{4\pi\varepsilon_0} = \frac{\lambda q}{4\pi\varepsilon_0 r}$$

101. (B)

Sol. $E_1 = E_4 = 2E_2 = 2E_3$

Horizontal components will be canceled, net field will be upward.

102. (D)

Sol. Both angles will remains same at any time. It is because, force on the balls will be equal and opposite, although they have different charges. $\phi > \theta$, because force has increased. Angles would have been different if masses were different.

103. (B)

Sol. Net force on q will be zero for any values of q and Q. Net force on each Q should also be zero. For this q should be negative of Q.

$$F_2 = 2F_1 \cos 30°$$

or $$\frac{kqQ}{(a/\sqrt{3})^2} = 2\frac{kQ^2}{a^2}\frac{\sqrt{3}}{2} \text{ or } \frac{q}{Q} = \frac{1}{\sqrt{3}}$$

104. (D)

105. (D)

Sol. Four between two charges does not depend upon the presence or absence of third charge.

106. (A)

Sol. Time period is independent of a constant force acting on the block of spring-block system. Its time period will remain same as

$$T = 2\pi\sqrt{\frac{m}{k}}$$

107. (C)

Sol. From the directions of fields from graph, it is clear that q_1 is negative and q_2 is positive. Now since electric field is zero to the right of q_2, q_2 should be smaller in magnitude.

108. (C)

Sol. From the free body diagram of the sphere, using Lami's theorem,

we get $$\frac{F}{mg} = \tan\theta \qquad \text{(i)}$$

When suspended in liquid, as q remains same,

$$\frac{F'}{mg\left(1-\frac{\rho}{d}\right)} = \tan\theta \qquad \text{(ii)}$$

Using (i) and (ii), we get

$$\frac{F}{mg}=\frac{F'}{mg\left(1-\frac{\rho}{d}\right)} \text{ where } F'=\frac{F}{K}$$

$$=\frac{F'}{mgK\left(1-\frac{\rho}{d}\right)}$$

$$\Rightarrow\ K=\frac{1}{1-\frac{\rho}{d}}=2$$

109. (A)

Sol. $T\sin\theta=F=\frac{kq^2}{d^2},\ T\cos\theta=mg$

$$\Rightarrow\quad \tan\theta=\frac{k}{mg}.\frac{q^2}{x^2}\Rightarrow\frac{x}{2\ell}=\frac{k}{mg}.\frac{q^2}{x^2}$$

$$\Rightarrow\quad x^3=\frac{2k\ell}{mg}q^2\Rightarrow q\propto x^{3/2}$$

$$\Rightarrow\quad \frac{dq}{dt}\propto\frac{3}{2}x^{1/2}\frac{dx}{dt}\quad\left(\frac{dq}{dt}\text{ is constant}\right)$$

$$\Rightarrow\quad c\propto x^{1/2}v\Rightarrow v\propto x^{-1/2}$$

110. (C)

111.(B)

Sol. Net force on $-q_1$ along the x-axis is

$F = F_{13}\sin\theta + F_{12}$

$$=\frac{q_1q_3}{4\pi\varepsilon_0a^2}\sin\theta+\frac{q_1q_2}{4\pi\varepsilon_0b^2}$$

$$=\frac{q_1}{4\pi\varepsilon_0}\left(\frac{q_2\sin\theta}{a^2}+\frac{a_2}{b_2}\right)$$

$$\therefore\quad F\propto\frac{q_2\sin\theta}{a^2}+\frac{q_2}{b^2}$$

112. (A)

Sol. From Gauss's law, we have

$$\frac{\text{Charge enclosed}}{\varepsilon_0}=\text{Flux leaving the surface}$$

$$\Rightarrow\quad \frac{q}{\varepsilon_0}=\phi_2-\phi_1$$

$$\Rightarrow\quad q=(\phi_2-\phi_1)\varepsilon_0$$

113. (A)

Sol. In equilibrium,

$qE = mg$

$\Rightarrow\quad q = 3.3\times10^{-18}$ C

114. (B)

Sol. Considering the equilibrium of $-Q$, we have

$$\sqrt{2}\,F_1+F_2=F_3$$

$$\frac{1}{4\pi\varepsilon_0}\left[\frac{\sqrt{2}Q^2}{a^2}+\frac{Q^2}{2a^2}\right]=\frac{1}{4\pi\varepsilon_0}\frac{Qq}{\left(\frac{a}{\sqrt{2}}\right)^2}$$

$$q=+\frac{Q}{4}(1+2\sqrt{2})$$

115. (A)

Sol. For zero electric field, the electric field of both charges at that point should be equal and opposite, so

$$\frac{K(2q)}{d^2}=\frac{K(8q)}{(L+d)^2}$$

$L + d = 2d \Rightarrow d = L$

The distance from the origin is

$(L + L) = 2L.$

$$V_A=\frac{Kq}{R}-\frac{Kq}{\sqrt{R^2+d^2}}$$

116. (C)

Sol. Here $V_1 = V_2$. So

$$\frac{1}{4\pi\varepsilon_0}\times\frac{q_1}{R_2}=\frac{1}{4\pi\varepsilon_0}\times\frac{q_2}{R_1}$$

$$\Rightarrow\quad \frac{q_1}{q_2}=\frac{R_1}{R_2}$$

Also,

$$\frac{E_1}{E_2}=\frac{q_1}{q_2}\times\left(\frac{R_2}{R_1}\right)\frac{R_1}{R_2}\times\frac{R_2^2}{R_2^1}=\frac{R_2}{R_1}=2:1$$

117. (C)

Sol. Linear charge density is

$$\lambda=\frac{q}{2\pi}$$

$$E=\int dE\sin\theta(-\hat{j})=\int\frac{K\times dq}{r^2}\sin\theta(-\hat{j})$$

$$= \frac{K}{r^2}\int \frac{dr}{\pi r} d\theta \sin\theta(-\hat{j})$$

$$= \frac{K}{r^2}\frac{q}{\pi}\int_0^{\pi} \sin\theta(-\hat{j})$$

$$= \frac{-q}{2\pi^2\varepsilon_0 r^2}(-\hat{j})$$

118. (B)

Sol. $W_{eq} = q(V_A - V_B)$

or $50 \times 10^{-6} = 2 \times 10^{-6}(V_A - V_B)$

or $V_A - V_B = 25$ V

119. (C)

Sol. As potential at A and B is the same, $V_A = V_B = kQ/d$. So work done in both the cases will be the same.

120. (A)

Sol. Potential decreases in the direction of electric field.

121. (B)

Sol. $$E_x = -\frac{-2V}{-2\times10^{-2}\text{m}} = -100\ \text{Vm}^{-1}$$

$$E_y = -\frac{-2V}{1\times10^{-2}\text{m}} = 200\ \text{Vm}^{-1}$$

Time-saving solution

Clearly, x-component is negative and y-component is positive

122. (D)

Sol. We know, $E = -\frac{dV}{dx}$

At B, $dV/dx = 0$, hence $E_x = 0$

At A, dV/dx is positive, hence E_x is negative.

At C, dV/dx is negative, hence E_x is positive.

123. (C)

Sol. The electrostatic potential on the surface of the spherical shell of radius R having charge q is

$$\frac{1}{4\pi\varepsilon_0}\frac{q}{R},$$

which is same as the potential at P (or any interior point). Now, if we place charge Q at the centre, the potential at P due to Q will be

$$\frac{1}{4\pi\varepsilon_0}\frac{Q}{R/2}$$

124. (D)

Sol. Capacitance $C = 100\ \mu\text{F} = 100 \times 10^{-6}\text{F} = 10^{-4}\text{F}$

Charge $Q = 8 \times 10^{-18}$ C

Hence, the required work done is

$$W = \frac{1}{2}\frac{Q^2}{C^2}$$

$$= \frac{1}{2}\times\frac{(8\times10^{-8})^2}{(10^{-4})}$$

$= 32 \times 10^{-32}$ J

125. (B)

Sol. The potential at A due to both rings is

$$V_A = \frac{Kq}{R} - \frac{Kq}{\sqrt{R^2+d^2}}$$

The potential at B due to both rings is

$$V_B = \frac{K(-q)}{R} + \frac{Kq}{\sqrt{R^2+d^2}}$$

$$V_A - V_B = \frac{Q}{2\pi\varepsilon_0}\left[\frac{1}{R} - \frac{1}{\sqrt{R^2+d^2}}\right]$$

126. (B)

Sol. Let us consider the electric field due to wire (3) only

$$\vec{E}_3 = E\hat{u}$$

$$\vec{E}_3 = \frac{\lambda}{2\pi\varepsilon_0(a^2+a^2)^{1/2}}(\hat{i}\cos45^\circ + \hat{j}\cos45^\circ)$$

$$= \frac{\lambda}{2\sqrt{2}\pi\varepsilon_0 a}\frac{1}{\sqrt{2}}(\hat{i}+\hat{j})$$

$$\vec{E}_3 = \frac{\lambda}{4\pi\varepsilon_0 a}(\hat{i}+\hat{j})$$

Similarly, electric field due to wires (1) and (2)

$$\vec{E}_1 = \frac{\lambda}{4\pi\varepsilon_0 a}(\hat{j}+\hat{k}) \text{ and } \vec{E}_2 = \frac{\lambda}{4\pi\varepsilon_0 a}(\hat{i}+\hat{k})$$

$$\vec{E}_{net} = \vec{E}_1 + \vec{E}_2 + \vec{E}_3 + \vec{E}_{net} = \frac{\lambda}{2\pi\varepsilon_0 a}(\hat{i}+\hat{j}+\hat{k})$$

127. (D)

128. (D)

Sol. We have

$$\frac{1}{2}mv^2 = \frac{1}{4\pi\varepsilon_0}\frac{Qq}{r}$$

$$\therefore \quad r \propto \frac{1}{v^2}$$

129. (B)

Sol. $\vec{E} = a(y\hat{i} + x\hat{j})$

$$V_2 - V_1 = -\int (ayd\,x - axd\,y)$$

Take $V_1 = C$ and $V_2 = V$. Then

$$V = -a\int (ydx + xdy) + C = -a\int d(yx) + C$$

$$= -axy + C$$

130. (B)

Sol. On connecting, the entire amount of charge will shift to the outer sphere. Heat generated is

$$U_1 - U_f = \frac{q^2}{8\pi\varepsilon_0 R_1} - \frac{q^2}{8\pi\varepsilon_0 R_2}$$

$$= \frac{(20\times10^{-6})\times9\times10^9}{2}\left[\frac{1}{0.10} - \frac{1}{0.20}\right] = 9\text{ J}$$

131. (A)

Sol. $E = \frac{V}{d}, E = eE = eV/d$

$$a = \frac{F}{m} = \frac{eV}{md}$$

$$d = \frac{1}{2}at^2 \text{ or } t = \sqrt{\frac{2d}{a}}$$

or $$t = \sqrt{\frac{2d\ md}{eV}} = \sqrt{\frac{2\,md^2}{eV}}$$

132. (D)

Sol. $E_x = \frac{dV}{dx} = -4x = -4\times2 = -8$

$$E_y = 0, E_z = 0$$

Hence, $\vec{E} = -8\hat{i}$ NC^{-1}

133. (B)

Sol. $W_{el.} = q(V_i = V_f)$

or $6.4 \times 10^{-19} = -1.6 \times 10^{-19}(V_A - V_B)$

or $V_A - V_B = -4$ V

or $V_A - V_C = -4$ V ($\because V_B = V_C$)

or $V_C - V_A = 4$ V

134. (B)

Sol. $W_{AB} = W_{AC} + W_{CB}$

W_{CB} should be zero, because in moving from C to B, we always move perpendicular to field. Hence, force applied by field and displacement will be at 90°.

$$W_{AC} = -e(V_C - V_A)$$

$\therefore V_C - V_A = -E \times AC = -10 \times 4 = -40$

$$W_{AC} = -e \times (-40) = 40e$$

So, $W_{AB} = 40e$ J = 40 eV

135. (D)

Sol. $Q = nq$, $R = n^{1/3}r$

$$E_{small} = \frac{kq}{r^2}, E_{big} = \frac{kQ}{R^2}$$

$$E_{big} = \frac{k\,nq}{n^{2/3}r^2} = (n^{1/3})\frac{kq}{r^2} = n^{1/3}\,E_{small}$$

$$V_{small} = \frac{kq}{r}, V_{big} = \frac{kQ}{R}$$

$$V_{big} = \frac{k\,nq}{n^{1/3}r} = n^{2/3}\frac{kq}{r} = n^{2/3}\,V_{small}$$

Chemistry

136. B.

137. B.

138. A.

Sol.

$Fe_{0.9}\ S_{1.0} = Fe_{90}\ S_{100}$

Fe^{2+} Fe^{3+}

x $90 - x$

Charge $+ 2\times x$ $+3(90 - x)$

Total +ve $= 2x + 3(90 - x)$

Total –ve $= -2 \times 100 = -200$

$\Rightarrow$ $2x + 3(90 - x) = 200$

$2x - 3x = 200 - 270$

$-x = -70$

$x = 70$

$\Rightarrow$ $Fe^{2+} = 70 \mid Fe^{3+} = 90 - 70 = 20$

$\Rightarrow$ $\dfrac{Fe^{3+}}{Fe^{2+}} = \dfrac{20}{70} = 0.28.$

139. B

140. B

141. B

142. B

143. B

144. C

145. B

146. A.

147. C.

Sol. $2(C_6H_5COOH) \longrightarrow (C_6H_5COOH)_2$

1 0

$1 - \alpha$ $\alpha/2$

Total $= 1 - \alpha + \dfrac{\alpha}{2}$

$i = \dfrac{1 - \alpha + \frac{\alpha}{2}}{1}$

$i = 1 - \alpha + \dfrac{\alpha}{2}$

$\boxed{i = 1 - \dfrac{\alpha}{2}}$

148. B.

As $\boxed{\text{Volume} \propto T}$

149. C.

150. D

151. D

152. C

Sol. Density = 1·179/cc

$\therefore$ conc^{n} = 1170 g/e^{-1}

$= \dfrac{1170}{36 \cdot 5} = 32 \cdot 05$ M.

153. B

Sol. $6 \cdot 02 \times 10^{20}$ molecules $= \dfrac{6 \cdot 02 \times 10^{20}}{6 \cdot 022 \times 10^{23}}$ moles

$= 10^{-3}$ mol.

$\therefore$ molar conc$^{n} = \dfrac{10^{-3}}{100} \times 1000 = 0.01$ M.

154. A

Sol. $n^2 = \dfrac{n_2}{n_1 + n_2} = \dfrac{n_2}{\frac{w_1}{w_2} + n_2}$

If $w_1 = 1000\ g$

n_2 = molality (m)

$m_1 = 78.$

$\Rightarrow$ $\dfrac{m}{\frac{1000}{78} + m} = 0 \cdot 2$

$\Rightarrow$ $m = 3 \cdot 2.$

155. A

Sol. Conc^{n} = of cone sugar = 5·12% = 51·2 gl^{-1}

$\dfrac{51 \cdot 2}{342}$ mol l^{-1}

Conc^{n} = of unknown Sol^{n} = 0·9 %

= 9 g/l

$= \dfrac{9}{m}$ mol l^{-1}

Sol^{n}= are isotonic

$\Rightarrow \dfrac{9}{m} = \dfrac{51 \cdot 2}{342}$

$m = 60.$

156. A.

$2KI + HgI_2 \rightarrow K_2HgI_2$

Due to molecular association F.P. is raised.

157. B

Sol. $Ba(NO_3)_2 \rightleftharpoons Ba^{2+} + 2NO_3^-$

1 0 0

$1-\alpha$ α 2α

Total = $1 + 2\alpha$

$i = 1 + 2\alpha$

$\alpha = \frac{i-1}{2}$

$\alpha = \frac{2\cdot74-1}{2}$

$\alpha = 0\cdot87$

$\% \alpha = 87\%$

158. C

159. B

160. C

Sol. no. of sphere = 4

Hence vol = $4\times\frac{4}{3}\pi r^3 = \frac{16}{3}\pi r^3$.

161. B

162. C

163. C

164. B

Sol. $2(C_6H_5COOH) \rightleftharpoons (C_6H_5COOH)_2$

165. A

Sol. $P_S = P_A^o x_A + P_B^o x_B$

$= 0\cdot5 \times 120 + 0\cdot5 \times 80$

$= 100 \Longrightarrow$ Ideal (Sol^n)

166. A

167. B.

Sol. $\frac{\Delta T_b}{\Delta T_f} = \frac{kb\cdot m}{kf\cdot m}$

$\frac{\Delta T_b}{0\cdot186} = \frac{0\cdot52}{1\cdot86}$

$\Delta T_b = 0\cdot52^\circ C$

$\therefore$ B. · P. = 100 + 0·052

= 100·052°C

168. A

169. C

170. A

Sol. $BaCl_2$ (Three particle) > NaCl (Two particle) > Glucose (undissosiated)

171. A

172. C

173. D

174. A

175. D

176. C

177. A

178. A

179. C

180. B