Uka Tarsadia University(Diwaliba Polytechnic)

Diploma in Chemical Engineering

Objective Type Questions (Fertilizer Technology)

Unit 1: Overview of Fertilizers

1)Nitrogen content in ammonium sulphate is around_____percentage.
   a) 5
   b) 20
   c) 50
   d) 65

2) Which of the following fertilizers contains least percentage of nitrogen?
   a) Liquid Ammonia
   b) Urea
   c) Ammonium Phosphate
   d) Ammonium Sulphate

3) Pick out the wrong statement
   a) All nitrogenous fertilizers are not soluble in water
   b) A straight fertilizer contains only one nutrient
   c) Calcium cynamide is used as weed killer in onion field
   d) The phosphorous nutrient makes the plant stem stronger and increases its branches

4) Which of the following is not measure component necessarily to be present in fertilizers?
   a) Nitrogen
   b) Potassium
   c) Phosphorous
   d) Sulphur

5) _____is not a fertilizer
   a) Calcium Ammonium Nitrate
   b) Ferrous Sulphate
   c) Liquid Ammonia
   d) Ammonium Sulphate

6) $CaH_4(PO_4)_2$ is the chemical formula of
   a) Superphosphate
   b) Triple Superphosphate
   c) Calcium Phosphate
   d) Meta Phosphoric Acid

7) Nitrogen content of urea is about _____percentage.
   a) 10
   b) 46
   c) 80
   d) 94

8) Chemical formula of biuret is
   a) NH_2CONH_2
   b) NH_3COONH_3
   c) $NH_2CONHCONH_2$
   d) NH_4COONH_2

9) Calcium ammonium nitrate is _____fertilizer.
   a) A mixed fertilizer

b) A straight fertilizer
c) A complex fertilizer
d) Not a fertilizer; it is an explosive

10) A phosphatic fertilizer contains 16 % P_2O_5. It could be
a) Dicalcium phosphate
b) Superphosphate
c) Triple superphosphate
d) None of above

11) Nitrogen content of calcium ammonium nitrate(CAN) is _____percentage.
a) 10
b) 25
c) 50
d) 80

12) P_2O_5 content in triple superphosphate is about _____percentage.
a) 42-50
b) 15-20
c) 85-90
d) 70-75

13) P_2O_5 content in superphosphate is about _____percentage.
a) 30-35
b) 15-20
c) 65-70
d) 85-90

14) Triple superphosphate is chemical represented as
a) $CaF_2.3Ca_3(PO_4)_2$
b) $3Ca_3(PO_4)_2$
c) $Ca(PO_3)_2$
d) $Ca(H_2PO_4)_2$

15) Urea is _____Fertilizer.
a) Nitrogenous
b) Potassic
c) Phosphatic
d) None of these

16) Which of the following fertilizer is needed for promoting the development of leaves and stems during early stages of plant growth
a) Nitrogeneous fertiliser
b) Potassic fertiliser
c) Phosphatic fertiliser
d) None of these

17) NPK Fertilizer is a _____Fertilizer.
a) Complex
b) Mixed
c) Nitrogenous
d) Phosphatic

18) Base suspension fertilizer essentially contains
a) 13% N_2 and 43% P_2O_5
b) 43% N_2 and 13% P_2O_5
c) 43% N_2 and 13% K_2O
d) 43% K_2O and 43% P_2O_5

19) Nitrogen content of nitrogenous fertilizer is 35 %. It could be

a) Urea
b) Ammonium nitrate
c) Calcium ammonium nitrate (CAN)
d) Ammonium sulphate

20) Which of the following nitrogenous fertilizer has the highest percentage of nitrogen?
a) Calcium nitrate
b) Calcium ammonium nitrate (CAN)
c) Urea
d) Ammonium sulphate

21) Urea is a better fertilizer than ammonium sulphate because
a) It is cheaper
b) Nitrogen content is higher
c) It is not poisonous
d) It is easy to manufacture

22) Which is the best fertilizer for paddy?
a) Ammonium sulphate
b) Nitro-phosphate
c) Superphosphate
d) Potassium nitrate

23) Maximum nitrogen percentage is in
a) Ammonium sulphate
b) Calcium ammonium nitrate
c) Urea
d) Liquid ammonia

24) NPK means a _____ fertilizer
a) Mixed
b) Potassic
c) Liquid
d) Solid

25) Ammonium Sulphate fertilizer is
a) The highest concentration nitrogenous fertiliser
b) The best fertiliser for paddy
c) A basic fertiliser
d) A neutral fertiliser

26) Chemical formula of metaphosphoric acid is
a) H_3PO_4
b) $H_4P_2O_7$
c) HPO_3
d) Same as that of pyrophosphoric acid

27) Which of the following is a natural inorganic fertilizer?
a) Chile salt petre
b) Oilcake
c) Gobar mannure
d) None of these

28) Which of the following is not a mixed fertilizer?
a) Nitrophosphate
b) Calcium ammonium nitrate (CAN)
c) Ammonium phosphate

d) None of these

29) Which nutrient in the fertilizer makes the plant stems stronger and increases the branches?

a) Nitrogen
b) Phosphorous
c) Potassium
d) Calcium

30) Two gas based fertiliser plants are located in

a) Maharashtra and Gujarat
b) Maharashtra and Orissa
c) Gujarat and Madhya Pradesh
d) Jharkhand and Chattisgarh

31) HPO_3 is the chemical formula of _____phosphoric acid

a) Pyro
b) Ortho
c) Meta
d) None of these

32) Nitrogenous fertilizer is required

a) During the early stage of growth to promote development of stem and leaves
b) For accelerating fruit formation in later stage of growth
c) To lessen the effect of excessive potash application
d) None of these

33) H_3PO_4 is the chemical formula of _____phosphoric acid.

a) Pyro
b) Ortho
c) Meta
d) None of these

34) The most suitable fertilizer for accelerating seeding or fruit formation in later stages of plant growth is _____ fertilizer.

a) Nitrogenous
b) Phosphatic
c) Potassic
d) None of these

35) Phosphatic fertilizers

a) Are useful during early stage of the plant growth
b) Accelerate fruit formation in later stages of growth
c) Lessen the effect of excessive nitrogen application
d) None of these

36) Plant tranquillizers

a) Hold back stem growth and halt plants at a desired height
b) Cause early maturation of plants
c) Accelerate ripening of food and grain
d) Produce seedless fruit

37) A nitrogenous fertilizer contains 20 % N_2. It could be

a) Ammonium nitrate
b) Calcium ammonium nitrate (CAN)
c) Urea
d) Ammonium chloride

38) A fertilizer contains 82 % N_2. It could be
   a) Urea
   b) Liquid NH_3
   c) Ammonium nitrate
   d) None of these
39) _____ is required more for leafy crops
   a) Nitrogen
   b) Phosphorous
   c) Potassium
   d) Carbon
40) Which of the following does not come under the category of "Micro-Nutrient" for plant growth ?
   a) Chlorine
   b) Iron
   c) Boron
   d) Carbon
41) pH value of the soil is maintained at _____by the addition of fertilizer for optimum growth and health of the plant.
   a) 4-5
   b) 7-8
   c) 9-10
   d) 12-13
42) Effectiveness of the fertilizer is independent of the
   a) Nature of soil
   b) Type of crop
   c) pH of soil
   d) None of these
43) Which of the following does not come under the category of "Secondary Nutrient" for plant growth?
   a) Calcium
   b) Magnesium
   c) Sulphur
   d) Oxygen
44) Which of the following does not come under the category of "Primary Nutrient" for plant growth?
   a) Potassium
   b) Nitrogen
   c) Phosphorous
   d) Sulphur
45) Phosphatic fertilizer is graded based on its _____content.
   a) P_2O_3
   b) PCl5
   c) P_2O_5
   d) H_3PO_4
46) Which of the following fertilizer is used as a cattle feed?
   a) Urea
   b) Calcium ammonium nitrate
   c) Superphosphate
   d) Ammonium sulphate
47) Ammonium phosphate is a _____fertilizer.

a) Nitrogenous
b) Phosphatic
c) Complex
d) Mixed

48) Urea is represented as
a) $NH_2.CO.NH_2$
b) $NH_3CO.CH_3$
c) $NH.CO_2.NH$
d) $NH_3.CO_2.NH_3$

49) Commercial fertilizers are available mostly in the form of
a) Powder
b) Grannules
c) Lumps
d) Flakes

50) Bio-fertilizers are cheaper, renewable and pollution free. They improve the _____of the soil.
a) Nutrient supply
b) Texture
c) Water holding capacity
d) All of the above

Unit 2: Nitrogeneous Compounds

1. Urea is a.....fertiliser.
   a) nitrogenous
   b) phosphatic
   c) potassic
   d) none of these

2. Fertiliser value of a nitrogenous fertiliser is expressed in terms of its.....content.
   (a) N_2 (b) KNO_3(c) NO_2 (d) HNO_3

3. Raw materials for urea production are
   (a) CO_2 and N_2 (b) CO_2, H_2 and N_2 (c) NH_3 and CO (d) HNO_3 and $CaCO_3$

4. Catalyst used in Haber's process for ammonia production is
   (a) reduced iron oxide (b) nickel (C)vanadium pentoxide (d) silica gel

5. Catalyst used in the oxidation of ammonia is
   (a) platinum-beryllium
   (b) platinum-rhodium
   (c) cobalt-molybdenum
   (d) platinum-molybdenum

6. Nitrogenous fertiliser is required

(a) during the early stage of growth to promote development of stem and leaves.

(b) for accelerating fruit formation in later stage of growth.

(c) to lessen the effect of excessive potash application.

(d) none of these.

7. Ammonium nitrate (is mixed with limestone) is not used as fertiliser as such, because

(a) it is hygroscopic and explosive in nature.

(b) it is highly acidic in nature.

(c) it is a liquid at room temperature.

(d) its nitrogen content is very less.

8. Nitrogen content of urea is about.....percent

(a) 10 (b) 46(c) 80 (d) 94

9. Nitrogen content of calcium ammonium nitrate (CAN) is.....percent.

(a) 10 (b) 25(c) 50 (d) 80

10. Fertiliser plants get their N_2 requirement

(a) by fractionation of liquified air.

(b) By dissociating oxides of nitrogen.

(c) From coal gas (coke oven gas).

(d) From producer gas.

11. Ammonia synthesis reaction is

(a) exothermic (b) endothermic (c) autocatalytic (d) none of these

12. Ammonium phosphate is a.....fertiliser.

(a) nitrogenous (b) phosphatic (c) complex (d) mixed

13. Coal based fertiliser plants

(a) use coal for heating purpose.

(b) gasify coal to get hydrogen from coal gas.

(c) use coal as filler in fertiliser.

(d) use coal as conditioner in fertiliser.

14. Naphtha in a fertiliser plant is used as a source of

(a) fuel (b) H_2 (C)N_2 (d) O_2

15. Catalyst used in steam reforming of naphtha is

(a) nickel (b) platinum (c) silica gel (d) rhodium

16. Temperature and pressure in ammonia converter is

(a) 200 atm, 1000°C (b) 450 atm, 200°C (c) 450 atm, 550°C (d) 450 atm, 1000°C

17. Oxidation of ammonia is

(a) exothermic (b) endothermic (c) non-catalytic (d) autocatalytic

18. Dehydration of ammonium carbamate to yield urea is a/an.....reaction.
    (a) exothermic (b) endothermic (c) autocatalytic (d) catalytic
19. Neutralisation of nitric acid with ammonia to produce ammonium nitrate is a/an.....reaction.
    (a) catalytic (b) endothermic (c) exothermic (d) autocatalytic
20. Gas based fertiliser plants use
    (a) natural gas as a source of hydrogen.
    (b) natural gas as heating medium.
    (c) coal gas as a source of hydrogen.
    (d) coal gas as heating medium.
21. Raw materials for nitric acid manufacture are
    (a) hydrogen peroxide, air and water.
    (b) anhydrous ammonia and air.
    (c) anhydrous ammonia, air and water.
    (d) wet ammonia, air and water.
22. Effectiveness of a fertiliser is independent of the
    (a) nature of soil (b) type of crop (c) pH of soil (d) none of these
23. Dehydration of ammonium carbamate produces
    (a) urea (b) biuret (c) ammonia water (d) none of these
24. Lower temperature and large excess of ammonia in urea melt
    (a) increases biuret formation
    (b) decreases biuret formation
    (c) is undersirable
    (d) does not effect biuret formation
25. With increases in pressure, the conversion of ammonium carbamate into urea
    (a) increases
    (b) decreases
    (c) remains unaltered
    (d) can either increase or decrease ; depends on Biuret content
26. An increase in the NH_3/CO_2 ratio in urea manufacture results in
    (a) increased degree of conversion of CO_2 to urea.
    (b) decreased degree of conversion of NH3 to urea.
    (c) decreased yield of urea.

(d) decreased specific volume of molten mass.

27. Biuret formation in urea is kept at minimum (< 1%), because it is
    (a) corrosive in nature.
    (b) toxic and harmful to some crops.
    (c) helpful in decomposition of urea.
    (d) explosive in nature.

28. Though liquid ammonia itself is a fertiliser (with 82% nitrogen content) yet it is commonly
not used as such in a tropical country like India, because it
    (a) has a pungent smell.
    (b) vaporises at normal temperature.
    (c) is toxic and highly corrosive.
    (d) is in short supply.

29. In ammonia synthesis ($N_2 + 3H_2 = 2NH_3$), there is a decrease in total volume, hence to get
high equilibrium conversion, the reaction should be carried out at
    (a) low pressure.
    (b) high pressure.
    (c) very high temperature.
    (d) atmospheric pressure; as the pressure has no effect on conversion.

30. Nitrogen content in ammonium sulphate (a fertiliser) is around.....percent.
    (a) 5 (b) 20 (c) 50 (d) 65

31. Monte catini process is a widely used process for the manufacture of
    (a) urea
    (b) calcium ammonium nitrate
    (c) triple superposphate
    (d) none of these

32. Prilling of urea should be accomplished (in a sprayer) just above the melting point of urea with minimum of retention time, otherwise it will result in
    (a) Low bulk density product
    (b) biuret formation
    (c) non-spherical prills
    (d) Substantially wet non-flowing and sticky product

33. In the manufacture of urea, the intermediate chemical formed is
    (a) biuret
    (b) ammonium carbamate
    (c) ammonium carbonate
    (d) none of these

34. Maximum nitrogen percentage is in
    (a) ammonium sulphate.
    (b) calcium ammonium nitrate.
    (c) urea.
    (d) liquid ammonia.
35. Urea is a better fertilizer than ammonium sulphate, because
    (a) it is cheaper.
    (b) nitrogen content is higher.
    (c) it is not poisonous.
    (d) it is easy to manufacture.
36. P_2O_5 content in superphosphate is about..... percent.
    (a) 30–35 (b) 15–20 (c) 65–70 (d) 85–90
37. Optimum reaction temperature in steam reforming of naphtha is.....°C.
    (a) 700–1000 (b) 300–450 (c) 1500–1700 (d) 100–200
38. Commercial production of hydrogen for the manufacture of nitrogeneous fertilisers is done by
    (a) Steam reforming of naphtha and cracking of natural gas
    (b) electrolysis of water.
    (c) cryogenic separation of hydrogen from coke oven gas.
    (d) all (a), (b) and (c)
39. Nitric acid is produced on commercial scale in a fertiliser plant by
    (a) oxidation of ammonia.
    (b) CaNO3 + H2SO4 reaction.
    (a) (c)passing air through high voltage electric arc.
    (b) (d)none of these.
40. Liquid ammonia and 60% nitric acid reaction (which produces ammonium nitrate) is
    (a) exothermic (b) endothermic (c) autocatalytic (d) none of these
41. Ammonia synthesis gas is produced from fuel oil by

a) steam reforming (b) hydrocracking (c) partial oxidation (d) hydrogenation .

42. Which of the following set of conditions is favourable for the maximum yield of ammonia by

Haber's process ?

(a) High pressure, low reactants concentration, high temperature.

(b) High pressure, low reactants concentration, low temperature.

(c) High pressure, high reactants concentration, low temperature.

(d) Low pressure, high reactants concentration, low temperature.

43. Ammonia synthesis gas is produced from natural gas by

(a) (thermal cracking (b) steam reforming (c)partial oxidation (d) hydrogenation

44. Urea is represented as

(a) $NH_2.CO.NH_2$ (b) $NH_3CO.CH_3$ (c) $NH.CO_2.NH$ (d) $NH_3.CO_2.NH_3$

45. The concentration (weight %) of nitric acid produced by the oxidation of ammonia and absorption of nitrogen oxides with water is about.....percent.

(a) 60 (b) 30 (c) 95 (d) 100

46. Formation of ammonium carbamate by reaction of NH_3 with CO_2 is a/an.....reaction.

(a) catalytic (b) exothermic (c) endothermic (d) reversible

47. Dehydration of ammonium carbamate (to produce urea) is a/an.....reaction.

(a) reversible (c) exothermic (b) catalytic (d) endothermic

48. .....catalyst is used in the production of urea from CO_2 and NH_3.

(a) Vanadium pentoxide (b) No(c) Alumina (d) Nickel

49. Pick out the correct statement.

(a) Reaction of NH_3 with HNO_3 to produce $(NH_4)_2NO_3$ is endothermic.

(b) With increase in NH_3/CO_2 ratio, urea yield decreases for a given temperature, pressure and total feed rate.

(c) Biuret (an intermediate during urea manufacture) is toxic to seeds andanimals.

(d) both (b) and (c).

50. Which is a catalyst promoter used in catalytic ammonia synthesis reaction ?

(a) Al_2O_3 (b) Cr_2O_3 (c) K_2O (d) MnO

Unit 3: Nitrogeneous Fertilizers

1) Which one of the following is used as a nitrogenous fertilizer, as a weed killer in the onion fields and for correcting acidic soils?

a) Urea
b) CAN
c) Ammonium sulphate
d) Calcium cyanamide

2) Temperature and pressure in urea autoclave is

a) 120°C and 300 atm
b) 190°C and 200 atm
c) 400°C and 550 atm
d) 200°C and 10 atm

3) Liquid ammonia and 60% nitric acid reaction (which produces ammonium nitrate) is

a) Exothermic
b) Endothermic
c) Autocatalytic
d) None of these

4) Neutralisation of nitric acid with ammonia to produce ammonium nitrate is a/an _____ reaction.

(a) Catalytic
(b) Endothermic
(c) Exothermic
(d) Autocatalytic

5) Fertilizer plant making ammonium sulphate employing gypsum-ammonia reaction (usual practice is to use ammonia and sulfuric acid) is located at

a) Rourkela (under SAIL)
b) Bokaro (under SAIL)
c) Sindri (under FCI)
d) Baroda (under G.S.F.C.)

6) Which of the following is not measure component necessarily to be present in fertilizers?

e) Nitrogen
f) Potassium
g) Phosphorous
h) Sulphur

7) Dehydration of ammonium carbamate (to produce urea) is a/an _____reaction.

a) Reversible
b) Catalytic
c) Exothermic
d) Endothermic

8) Yield of urea can be increased with excess ammonia and higher pressure & temperature, but because of _____ this is normally not done.

a) Increased biuret formation
b) High corrosion rate
c) Increased cost of equipment
d) All of the above

Formation of ammonium carbamate by reaction of NH_3 with CO_2 is a/an _____ reaction.

a) Catalytic
b) Exothermic
c) Endothermic
d) Reversible

10) Dehydration of ammonium carbamate to yield urea is a/an _____ reaction.

a) Exothermic
b) Endothermic
c) Autocatalytic
d) Catalytic

11) Ammonium nitrate is

a) Having about 40% N_2
b) Not hygroscopic
c) Not prone to explosive thermal decomposition
d) Mixed with limestone powder to reduce its explosive nature before using it as a fertilizer

12) Ammonium nitrate (is mixed with limestone) is not used as fertiliser as such, because

a) its nitrogen content is very less.
b) it is a liquid at room temperature.
c) it is highly acidic in nature.
d) it is hygroscopic and explosive in nature.

13) Prilling of urea should be accomplished (in a sprayer) just above the melting point of urea with minimum of retention time, otherwise it will result in

a) Low bulk density product

b) Biuret formation
c) Non-spherical prills
d) Substantially wet non-flowing and sticky product

14) _____ is the undesirable by-product produced in the manufacture of urea.

a) Ammonium carbonate
b) Biuret
c) Carbon dioxide
d) Ammonium carbamate

15) Raw materials for urea production are

a) CO_2 and N_2
b) CO_2, H_2 and N_2
c) NH_3 and CO
d) HNO_3 and $CaCO_3$

16) Lower temperature and large excess of ammonia in urea melt

a) Increases biuret formation
b) Decreases biuret formation
c) Is undersirable
d) Does not effect biuret formation

17) With increases in pressure, the conversion of ammonium carbamate into urea

a) Increases
b) Decreases
c) Remains unaltered
d) Can either increase or decrease depends on biuret content

18) The composition of fresh feed to the high temperature, high pressure urea autoclave is

a) Excess liquid ammonia and liquefied CO_2
b) Excess liquid ammonia and compressed CO_2 gas
c) Liquid ammonia and excess compressed CO_2
d) Compressed ammonia gas and excess compressed CO_2

19) An increase in the NH_3/CO_2 ratio in urea manufacture results in

a) Increased degree of conversion of CO_2 to urea
b) Decreased degree of conversion of NH_3 to urea
c) Decreased yield of urea
d) Decreased specific volume of molten mass

20) Vapor phase reaction of ammonia & nitric acid to produce ammonium nitrate is termed as the _____ process.

a) Haber's
b) Stengel
c) Le-chatlier's
d) Du-pont's

21) Biuret formation in urea is kept at minimum (< 1 %), because it is

a) Corrosive in nature
b) Toxic and harmful to some crops
c) Helpful in decomposition of urea
d) Explosive in nature

22) In the manufacture of urea, the intermediate chemical formed is

a) Biuret
b) Ammonium carbamate
c) Ammonium carbonate
d) None of these

23) Ammonium nitrate (a fertiliser) is coated with limestone powder to

a) Increase its nitrogen content
b) Cut down its production cost
c) Avoid the risk of explosion
d) Add extra nutrient as fertiliser

24) Ammonium sulphate can be produced by reacting gypsum with

a) Ammonia
b) Ammonium carbonate
c) Nitric acid
d) None of these

25) Urea (a nitrogeneous fertiliser) is produced from carbon dioxide and

a) Nitric acid
b) Ammonia
c) Ammonium nitrate
d) Nitric oxide

26) Dehydration of ammonium carbamate produces

a) Urea
b) Biuret

c) Ammonia water
d) None of these

27) Which fertiliser is made (using coke oven gas) in by products plant of an integrated steel plant?

a) Urea
b) CAN
c) Ammonium sulphate
d) Superphosphate

28) C/H ratio (by weight) of naphtha used in nitrogenous fertiliser making is about

a) 2
b) 6
c) 13
d) 20

29) Prilling tower is found in the flowsheet for the manufacture of

a) Ammonia
b) Urea
c) Superphosphate
d) Triple superphosphate

30) Fertiliser produced during soda ash manufacture by dual process is ammonium

a) Chloride
b) Sulphate
c) Nitrate
d) None of these

31) Fertiliser value of a nitrogeneous fertiliser is expressed in terms of its _____ content.

a) N_2
b) KNO_3
c) NO_2
d) NHO_3

32) During conversion of ammonium carbamate into urea, presence of large excess of water

a) Increases the yield of urea
b) Adversely affects the yield of urea
c) Reduces the evaporator load by diluting the urea solution

d) Does not affect the yield of urea

_____ catalyst is used in the production of urea from CO_2 and NH_3.

a) Vanadium pentoxide
b) No
c) Alumina
d) Nickel

34) Urea is formed only

a) In liquid phase
b) In vapour phase
c) At very high temperature
d) At very low pressure (vacuum)

35) Out of the following, N_2 content is minimum in

a) Urea
b) Ammonium nitrate
c) Ammonium sulphate
d) Ammonium chloride

36) Which of the following is not a nitrogenous fertilizer?

a) Ammonium Sulphate
b) Urea
c) Ammonium Nitrate
d) Super Phosphate

37) The Factories which produce fertilizers usually have plants of

1. ammonia production
2. nitric acid production
3. ammonium nitrate production
4. all of above

38) The only condition for nitrogen-based fertilizers is that they must be soluble in

1. acid
2. base
3. water
4. alkalis

39) The molecular weight of urea is_____gm/mole

a) 60
b) 70
c) 80
d) 90

40) The molecular weight of Ammonium Nitrate is _____gm/mole

a) 60
b) 70
c) 80
d) 90

41) The molecular weight of Ammonium Sulphate is_____gm/mole

a) 122
b) 132
c) 142
d) 152

42) The molecular weight of Ammonium Carbonate is_____gm/mole

a) 76
b) 86
c) 96
d) 106

43) Urea is produced by

a) Stamicarbon's CO_2 stripping process
b) Stainlycarbon's CO_2 abosorbing process
c) Stamicarbon's CO_2 abosorbing process
d) Stainlycarbon's CO_2 stripping process

44) Ammonium Nitrate is produced by

a) Drilling process
b) Prilling process
c) Both a) and b)
d) None of the above

45) Specific gravity of urea is

a) 1.005
b) 0.995
c) 1.335
d) 1.995

46) The molecular formula of gypsum is

a) $CaSO_4.2H_2O$
b) $CaCO_3.2H_2O$
c) $CaO.2H_2O$
d) $CaCl_2.2H_2O$

47) Fertilizer is generally defined as " any material, organic or inorganic, natural or synthetic, which supplies one or more of the chemical elements required for the plant growth".

a) True
b) False

48) Urea is odorless
a) True
b) False

49) Snamprogetti ammonia stripping process is used to make

a) Urea
b) Formaldehyde
c) Malamine Formaldehyde
d) Urea Formaldehyde

50) Toyo Koatsu total recycle process is used to make

a) Urea
b) Formaldehyde
c) Malamine Formaldehyde
d) Urea Formaldehyde

Unit 4: Phosphatic Fertilizer

1.Fluorapatite predominates in

a) igneous phosphate rocks
b) sedimentary phosphate rocks.
c) both (a) & (b).
d) neither (a) nor (b)

2. francolite predominates in

a) igneous phosphate rocks
b) sedimentary phosphate rocks.
c) both (a) & (b).
d) neither (a) nor (b)

3. Select the advantage of dihydrate systems

a) Operating temperatures are low
b) Start-up and shut-down are easy

c) Wet rock can be used (saving drying costs)

d) All of the above

4. Select the disadvantage of dihydrate systems

a) Relatively weak product acid (26-32% P2O5)

b) High energy consumption in the acid concentration stage

c) 4-6% P2O5 losses

d) All of the above

5. Molecular weight of Single superphosphate is

a) 234.05

b) 50

c) 100

d) 110

6 Select the major raw materials of single super phosphate

a) Sulfuric acid

b) rock phosphate

c) both (a) & (b).

d) neither (a) nor (b)

7. P_4 is chemical name

a) Red phosphorous

b) Yellow phosphorous

c) Pink phosphorous

d) White phosphorous

8. Select the correct statement for triple super phosphate

a) It has the highest P content of dry fertilizers that do not contain N.

b) Over 90% of the total P in TSP is water soluble, so it becomes rapidly available for plant uptake

c) TSP also contains 15%calcium (Ca), providing an additional plant nutrient.

d) All of the above

9. "Enriched" superphosphate is essentially a mixture of

a) Sulphuric acid and rock

b) Hydrochloric acid and rock

c) SSP (single super phosphate) and TSP (Triple super phosphate)

d) None of the above

10 Select the correct statement for Basic slag

a) also called Thomas slag,
b) byproduct of the steel industry
c) both (a) & (b).
d) neither (a) nor (b)

11. Select the formula of Monopotassium phosphate
    a) KH_2PO_4
    b) K_2HPO_4
    c) $K_4P_2O_7$
    d) KPO_3
12. Select the formula of Dipotassium phosphate
    a) KH_2PO_4
    b) K_2HPO_4
    c) $K_4P_2O_7$
    d) KPO_3
13. Select the formula of Tetra potassium pyrophosphate
    a) KH_2PO_4
    b) K_2HPO_4
    c) $K_4P_2O_7$
    d) KPO_3
14. Select the formula of Potassium metaphosphate
    a) KH_2PO_4
    b) K_2HPO_4
    c) $K_4P_2O_7$
    d) KPO_3
15. Phosphatic fertiliser is graded based on its.....content.
    (a) P_2O_3 (b) PCl_5 (c) P_2O_5 (d) H_3PO_4
16. Rock phosphate constitutes mainly of
    a) fluorapatite
    b) di-calcium phosphate
    c) mono-calcium phosphate
    d) di-ammonium phosphate
17. Superphosphate is manufactured by reacting phosphate rock with
    (a) aceticacid
    (b) sulphuric acid

(a) aluminium chloride

(b) none of these

18. Triple superphosphate is made by reacting phosphate rock with.....acid.

a) phosphoric (b) nitric (c) sulphuric (d) hydrochloric

19. Triple superphosphate is chemically represented as

(a) $CaF_2.3Ca_3(PO_4)_2$ (b)$3Ca_3(PO_4)_2$ (c) $Ca(PO_3)_2$ (d) $Ca(H_2PO_4)_2$

20. Phosphoric acid is produced in wet process from phosphate rock and

(a) dilute H_2SO_4

(b) concentrated H_2SO_4

(c) concentrated HNO_3

(d) concentrated HCl

21. Electric furnace method for production of phosphorus uses phosphate rock

(a) And phosphoric acid

(b) And coke

(c) And sulphuric acid

(d) Silica and coke

22. Phosphatic fertilisers

(a) are useful during early stage of the plant growth.

(b) accelerate fruit formation in later stages of growth.

(c) lessen the effect of excessive nitrogen application.

(d) none of these

23. Rock phosphate used for the production of phosphatic fertiliser is mined at

(a) Amjhor (Jharkhand)

(b) Talchar (Orissa)

(c) Bailladella (M.P.)

(d) Kiriburu (Bihar)

24. Electric process as compared to wet process (for the manufacture of phosphoric acid)

(a) Can use only high grade phosphate rock.

(b) is used less frequently.

(c) Produces a valuable by-product called gypsum.

(d) Is weak acid process.

25. Nitro-phosphate (manufactured at Trombay) is a.....fertiliser.

(a) Mixed

(b) complex

(c) highly hygroscopic

(d) highly explosive

26. Which is the best fertiliser for paddy ?

(a) Ammonium sulphate

(b) Nitro-phosphate

(c) Superphosphate

(d) Potassium nitrate

27. Which of the following is not a mixed fertiliser ?

(a) Nitrophosphate

(b) Calcium ammonium nitrate (CAN)

(c) Ammonium phosphate

(d) None of these

28. Which nutrient in fertiliser makes the plant stems stronger and increases branching ?

(a) Nitrogen (b) Phosphorous (c) Potassium (d) Calcium

29. P_2O_5 content in triple superphosphate is

(a) 42–50

(b) 15–20

(c) 85–90

(d) 70–75

30. Heating a mixture of phosphate rock, coke and sand in an electric furnace produces

(a) phosphoric acid

(b) ammonium phosphate

(c) phosphorous

(d) superphosphate

31. H_3PO_4 is the chemical formula of..... phosphoric acid.

(a) pyro (b) ortho(c) meta (d) none of these

32. HPO_3 is the chemical formula of..... phosphoric acid.

(a) pyro (b) ortho(c) meta (d) none of these

33. $H_4P_2O_7$ is the chemical formula of..... phosphoric acid.

(a) pyro (b) ortho (c) meta (d) none of these

34. Reaction of orthophosphoric acid with soda

(a) sodium tripolyphosphate (STPP)

(b) tricresyl phosphate

(c) tributyl phosphate

(d) nitrophosphate

35. Reaction of nitric acid and sulphuric acid with phosphate rock produces
    (a) nitrophosphate
    (b) diammonium phosphate
    (c) tricresyl phosphate
    (d) tributyl phosphate
36. Reaction of dilute sulphuric acid with phosphate rock produces
    (a) phosphoric acid
    (b) superphosphate
    (c) triple superphosphate
    (d) gypsum
37. Reaction of orthophosphoric acid with phosphate rock produces
    (a) superphosphate
    (b) triple superphosphate
    (c) metaphosphoric acid
    (d) mono ammonium phosphate
38. $CaH_4(PO_4)_2$ is the chemical formula of
    (a) Superphosphate
    (b) Triple superphosphate
    (c) Calcium phosphate
    (d) Meta phosphoric acid
39. Main constituent of phosphate rock is
    (a) Ammonium phosphate
    (b) flourapatite
    (c) calcium fluoride
    (d) Calcium phosphate
40. Reaction of phosphate rock with 98% H_2SO_4 produces
    (a) orthophosphoric acid (b) superphosphate (c) white phosphorous (d) none of these
41. Reaction of anhydrous liquid ammonia with orthophosphoric acid produces
    (a) ammonium phosphate
    (b) superphosphate
    (c) triple superphosphate
    (d) none of these

42. the most suitable fertiliser for accelerating seeding or fruit formation in later stages of plant

growth is.....fertiliser.

(a) nitrogenous (b) phosphatic (c) potassic (d) none of these

43. Pick out the wrong statement.

(a) Dehydration of ammonium carbamate to produce urea is endothermic.

(b) Direct use of liquid ammonia as a fertiliser for a tropical country like India is suitable.

(c) Gypsum ($CaSO_4$. $2H_2O$) is obtained as a by-product in the wet process for manufacture of ortho phosphoric acid.

(d) Phosphate rock when reacted with dilute H_2SO_4 produces superphosphate

44. Action of phosphoric acid on rock phosphate produces

(a) Superphosphate

(b) triple superphosphate

(c) Nitrophosphate

(d) Diammonium phosphate

45. A phosphatic fertiliser contains 16% P_2O_5. It could be

(a) dicalcium phosphate

(b) superphosphate

(c) triple superphosphate

(d) none of these

46. Reaction of .....acid with phosphate rock produces superphosphates.

(a) hydrochloric (b) sulphuric (c)nitric (d)phosphoric

47. The main constituent of rock phosphate is

(a) mono-calcium phosphate

(b) di-calcium phosphate

(c) fluorspar

(d) none of these

48. $(CH_3\ C_6\ H_4)_3\ PO_4$ is the chemical formula of

(a) triple superphosphate

(b) tricresyl phosphate

(c) flourapatite

(d) superphosphate

49. In the manufacturing of H_3PO_4 (ortho), ; strong $H_2\ SO_4$ leaching wet process as compared to electric furnace process

(a) uses lower grade phosphate rock.

(b) requires lower capital investment in the plant.

(c) produces lower purity acid

(d) is very costly

50. Yield of elemental phosphorous from rock catalyst helps in.....of the catalyst. phosphate is about.....percent.

(a) 1–2 (b) 15–25 (c) 40–45 (d) 60–65

51. Heating of coke, sand & phosphate rock in an electric furnace is done for the manufacture of

(a) phosphoric acid.

(b) superphosphate.

(c) phosphorous

(d) triple superphosphate.

52. P_2O_5 percentage in the phosphoric acid produced by wet process is about

(a) 10 (b) 30(c) 50 (d) 70

Unit 5: Potassic Fertilizers

1) A potassic fertiliser contains 50% K_2O. It could be

a) Potassium sulphate
b) Potassium chloride
c) A mixture of NaCl+ KCl
d) None of these

2) Potassic Fertilizers do not promote the development of

a) Stems & leaves during early stage of plant growth
b) Starches of potatoes & grains
c) Sugar of fruits & vegetables
d) Fibrous materials of plants

3) Potassic fertilizers

a) Are useful during early stage of the plant growth
b) Stimulate early growth and accelerate seeding
c) Help in development of starches of potatoes and grain
d) None of these

4) Potassic fertilizer is graded based on its _____content.

a) KCl
b) K_2O
c) KNO_3
d) K_2SO_4

5) Vetrocoke solution is

a) A mixture of K_2CO_3 and As_2O_3
b) K_2SO_4
c) A mixture of Na_2CO_3 and As_2O_3
d) Na_2SO_4

6) Which of the following fertilizers is required for the development of fibrous materials of the plants and of the sugar of vegetable & fruits ?

a) Nitrogenous Fertilizers
b) Phosphatic Fertilizers
c) Potassic Fertilizers
d) None of the above

7) Presently, which of the following chemical fertilizer is not produced in India and is being imported?

a) Triple Superphosphate
b) Potassium Sulphate
c) Ammonium Sulphate
d) All of these

8) Potassium Chloride is represented as

a) KlC

b) KCl

C) KOH

d) KHO

9) Potassium Nitrate is represented as

a) KNO

b) KNO_2

c) KNO_3

4) KNO_4

10) Potassium Sulphate is represented as

a) KSO

b) K_2SO_2

c) K_2SO_4

d) K_2SO_6

11) Molecular weight of potassium sulphate is _____gm/mole

a) 154
b) 164
c) 174
d) 184

12) Molecular weight of potassium chloride is_____gm/mole

a) 54.5
b) 64.5
c) 74.5
d) 84.5

13) Molecular weight of potassium nitrate is_____gm/mole

a) 81
b) 91
c) 101
d) 111

14) Potassium nitrate is produced by the raw material

a) Potassium Chloride and Nitric Acid
b) Sodium Chloride and Nitric Acid
c) Potassium Chloride and Sulfuric Acid
d) Sodium Chloride and Sulfuric Acid

15) Boiling point of potassium nitrate is_____ ^oC

a) 100
b) 200
c) 300
d) 400

16) Melting point of potassium nitrate is_____ ^oC

a) 74

b) 124
c) 254
d) 334

17) Boiling point of potassium chloride is_____ ^{o}C

a) 1420
b) 1220
c) 820
d) 720

18) Melting point of potassium chloride is_____ ^{o}C

a) 270
b) 470
c) 770
d) 1070

19) Melting point of potassium sulphate is_____ ^{o}C

a) 769
b) 869
c) 1069
d) 1169

20) Boiling point of potassium sulphate is_____ ^{o}C

a) 869
b) 1119
c) 1169
d) 1689

21) Most of the chemical grade potash is used for production of

a) Sodium Hydroxide
b) Sodium Chloride
c) Potassium Hydroxide
d) None of the above

22) The main use of caustic potash is in the manufacture of
a) liquid soaps
b) textile operations
c) production of grease
d) All of the above

23) Potassium Sulphate is produced by the raw material

a) Potassium Chloride and Nitric Acid
b) Sodium Chloride and Nitric Acid
c) Potassium Chloride and Sulfuric Acid

d) Sodium Chloride and Sulfuric Acid

24) Potassium Sulphate is Soluble in water
a) True
b) Flase

25) Potassium Sulphate is produced by the raw material

a) Sylvinite
b) Magnesite
c) Hematite
d) None of the above

26) Potassium chloride is obtained by

a) Flotation process
b) Desulfurization process
c) Aldehyde Process
d) None of the above

27) Floatation process for extraction of potassium chloride is much cheaper than leaching process

a) True
b) Flase

28) Appearance of potassium chloride is

a) White crystalline solid
b) Yellow crystalline solid
c) Blue crystalline solid
d) Green crystalline solid

29) Potassium chloride is soluble in
a) Glycerol
b) Water
c) Both a) and b)
d) None of the above

30) Sylvinite contain

a) Potassium chloride
b) Sodium chloride
c) Both a) and b)
d) None of the above

31) Density of potassium chloride is_____gm/ml
a) 0.984
b) 1.984
c) 2.984
d) 3.984

32) Potassium chloride is odorless
a) True
b) Flase

33) Potassium chloride is insoluble in

a) Glycerol
b) Water
c) Ether
d) None of the above

34) Potassium chloride is slightly soluble in
a) Glycerol
b) Water
c) alcohol
d) None of the above

35) _____is used in flotation chamber during the production of potassium chloride.

a) CO_2
b) Air
c) SO_2
d) NO_2

36) The consumption of chemical grade potash is maximum in _____industry
a) Detergents and soaps
b) Glass and ceramics
c) Textiles and dyes
d) Pharmaceutical

37) Potassium nitrate is also called
a) saltpeter
b) petersalt
c) presalt
d) none of the above

38) Density of potassium nitrate is _____g/cm^3.
a) 1.109
b) 2.109
c) 3.109
d) 0.909

39) Appearance of potassium sulphate is

a) White crystalline solid
b) Yellow crystalline solid
c) Blue crystalline solid
d) Green crystalline solid

40) Density of potassium sulphate is _____g/cm^3.
a) 0.66
b) 1.66
c) 2.66
d) 3.66

41) The reactor which operates about _____^oC to manufacture potassium nitrate.

a) 75
b) 85
c) 95
d) 105

42) The consumption of chemical grade potash is _____in glass and ceramics industry.
a) 30%-35%

b) 25%-28%
c) 20%-22%
d) 13%-15%

43) The consumption of chemical grade potash is _____in textiles and dyes industry.
a) 30%-35%
b) 25%-28%
c) 20%-22%
d) 13%-15%

44) The consumption of chemical grade potash is _____in chemicals & drugs industry.
a) 30%-35%
b) 25%-28%
c) 20%-22%
d) 13%-15%

45) The consumption of chemical grade potash is _____in Detergents and Soaps industry.
a) 30%-35%
b) 25%-28%
c) 20%-22%
d) 13%-15%

46) Molecular weight of potassium hydroxide is _____gm/mole.
a) 46
b) 56
c) 66
d) 76

47) Melting point of potassium hydroxide is _____^{o}C.
a) 160
b) 260
c) 360
d) 460

48) Boiling point of potassium hydroxide is _____^{o}C.
a) 1227
b) 1327
c) 1427
d) 1527

49) Density of potassium hydroxide is _____g/cm^{3}.
a) 1.12
b) 2.12
c) 3.12
d) 4.12

50) Potassium chloride is a metal halide salt composed of potassium and chlorine.
a) True
b) False

Unit 6: Complex Fertilizer and Bio Fertilizer

1.Biofertilizers are defined as preparations containing

(a) living cells

(b) dead cells

(c) both (a) & (b).

(d) neither (a) nor (b)

2 Free living nitrogen fixer bacteria is/are

(a) Azotobacter

(b) Beijerinckia

(c) Anabaena

(d) All of the above

3. Symbiotic nitrogen fixer bacteria is

(a) Rhizobium

(b) Azotobacter

(c) Beijerinckia

(d) Anabaena

4. Associative symbiotic nitrogen fixer bacteria is

(a) Azotobacter

(b) Beijerinckia

(c) Anabaena

(d) Azospirillum

5.Phosphorus solubilizers Bacteria is

(a) Pseudomonas striata

(b) Azotobacter

(c) Beijerinckia

(d) Anabaena

6.Select the correct statement for Biofertilizers

a) Biofertilizers are low cost

b) The can be used either for seed treatment or soil applications

c) Biofertilizers are referred to the use of soil microorganisms to increase the availability and uptake of mineral nutrients for plants.

d) All of the above

7. Heterocysts are :

a) Biological fertilizers

b) Biofertilizers

c) Specialized cells for nitrogen fixation.

d) Enzymes required for nitrogen fixation

8. Biological fertilizers are obtained from

a) Plants
b) Animals
c) Plant and animal residues
d) All of the above

9. Rhizobium enters the plant through
a) Leaf b) Stem c) Flower d) Root hair

10. Symbiotic biofertilizer is :
a) Nitrosomonas b) Rhizobia c) Azotobacter d) Azospirillum

11. Biofertilizers are
a) Urea b) Potassium c) Micro-organism d) None of these

12.A symbiotic nitrogen fixing bacteria is
a) Rhizobium b) Azotobacter c) Anabaena d) Azolla

13.Free living nitrogen fixing bacteria is/are
a) Azotobacter b) Clostridium c) Both 'a' and 'b' d) None of these

14.An asymbiotic blue-green algae is
a) Anabaena b) Azolla c) Nostoc d) All of these.

15.A symbiotic association which is not useful as biofertilizer is _____
a) Azolla and Anabaena
b) Rhizobium and legume root
c) Fungi and roots of higher plants
d) Algae and fungi.

16. Blue-green algae is also called as
a) Mycoplasma b) Cyanobacteria c) Green algae d) None of these

17.Which blue-green algae lacks heterocyst ?
a) Anabena
b) Nostoc
c) Oscillatoria
d) Chlamydomona

18. Oxygen carrying substance present in the root nodules is
a) Heterocyst
b) Leghaemoglobin
c) Plasma
d) Haemoglobin

19. Biofertilizers are _____ in nature.

a) Fungal b) Algal c) Bacterial d) All of these

20.Which of the following algae is nitrogen fixer ?

a) Nostoc b) Chlorella c) Azolla d) Spirogyra

21. Mushroom are used in the preparation of

a) Soups b) Pizza c) Pickle d) All of these

22. Which of the following plants is of a great medicinal use ?

a) Brassica olevacea
b) Areca catechu
c) Aloe vera
d) Musa paradisica.

23. Rhizobium enters in the root through

a) Root cap b) Root hair c) Lenticel d) Cortex.

24. Which of the following statements is correct?

a) Atmosphere is the major reservoir for plants
b) Nitrogen is the most abundant nutrient for plants
c) Nitrogen cycle is a sedimentary cycle
d) All

25. Nitrogen is absorbed by the plants in the form of

a) Ammonium
b) Nitrites
c) Nitrates
d) All

26. Nitrogen fixation is the conversion of

a) N_2 to N
b) N_2 to NH_3
c) N_2 to NO_3^-
d) N_2 to urea

27. Important enzymes involved in nitrogen fixation are

a) Nitrogenase and hydrogenase
b) Nitrogenase and hexokinase
c) Nitrogenase and peptidase
d) Nitrogenase and hydrolyase

28. Symbiotic nitrogen fixing cyanobacteria are not present in

a) Azolla

b) Gnetum
c) Anthoceros
d) Cycas

29. How many molecules of ATP are required to fix one molecule of nitrogen?
    a) 12
    b) 20
    c) 6
    d) 16
30. Ammonification is formation of
    a) Ammonia from nitrates by decomposers
    b) Ammonia from nitrogen
    c) Ammonia from amino acids
    d) Ammonia from nitrates by nitrogen fixers

31. Conversion of nitrates to nitrogen is called
    a) Ammonification
    b) Nitrification
    c) Nitrogen fixation
    d) Denitrification
32. Conversion of nitrites to nitrates is called
    a) Nitrosococcus
    b) Clostridium
    c) Nitrobacter
    d) Nitrosomonas
33. Conversion of ammonia to nitrite and then to nitrates is called
    a) Ammonification
    b) Denitrification
    c) Assimilation
    d) Nitrification
34. A Biofertilizers which involves a pteridophyte host is
    (a) Rhizobium
    (b) Anabaena
    (c) Clostridium
    (d) Azotobacter

35.A fern commonly inoculated to paddy fields is

(a) Azolla

(b) Marsilea

(c) Salvinia

(d) Anabaena

36.A free living nitrogen fixing bacterium is

(a) Clostridium

(b) Azotobacter

(c) Rhizobium

(d) Both (a) and (b)

37.A free living nitrogen fixing cyanobacterium which can also form symbiotic association with

Azolla is

(a) Nostoc

(b) Anabaena

(c) Tolypothrix

(d) Gleocapsa

38.A medicine for bronchitis is got from

(a) Rauwolfia serperntina

(b) Curcuma longa

(c) Adhatoda vasica

(d) Hemidesmus indicus

39.A neem product used as insect repellent is

(a) Azardirachtin

(b) Rotenone

(c) Endrin

(d) Parathion

40.A nitrogen fixing blue green alga is

(a) Ulothrix

(b) Spirogyra

(c) Anabaena

(d) Rhizobium

41.A piosnous mushroom among the following is

(a) Agaricus bisporus

(b) Morchella esculenta

(c) Hydnum sp.

(d) Amanita sp.

42.A plant effective in ensuring safe delivery ans prevent abortions is

(a) Azadirachta

(b) Ocimum

(c) Adhatoda

(d) Asparagus

43.A quatic fern which is an excellent biofertilizer

(a) Salvinia

(b) Azolla

(c) Marsilea

(d) Pteridium

44.A well known “Kumari Asav “ is obtained from

(a) Aloe vera

(b) Azadirachta indica

(c) Ocimum sanctum

(d) Asparagus racemosus

45.Agaricus is

(a) Bread mould

(b) Button mushroom

(c) Paddy straw mushroom

(d) Oyster mushroom

46.Aloe vera cures cough and by taking mixture of

(a) leaf juice and crushed poppy seeds

(b) leaf juice and tumeric

(c) Leaf juice, honey and tumeric

(d) Leaf juice and cumin

47.An edible fungus is

(a) Aspergillus

(b) Ustilago

(c) Polyporus

(d) Morchella

48. Antiseptic properties are found in the leaves of
    (a) Asparagus racemosus
    (b) Azadirachta indica
    (c) Aloe vera
    (d) Adhatoda zeylanica
49. Azolla is used as biofertilizer because it
    (a) Multiplies very fast to produce massive biomass
    (b) Has association of nitrogen fixing Rhizobium
    (c) Has association of nitrogen fixing cyanobacteria
    (d) Has association of mycorrhiza
50. Azotobacter and bacillus polymyxa are
    (a) Decomposers
    (b) Nonsymbiotic nitrogen fixers
    (c) Symbiotic nitrogen fixers
    (d) pathogenic bacteria
51. Bacterial fertilizer is
    (a) Anabaena
    (b) Nostoc
    (c) Rhizobium
    (d) Phycomyces
52. Biofertilizers include
    (a) Cowdung manure and farmyard waste
    (b) A quick growing crop ploughed back
    (c) BGA / Anabeana and Azolla
    (d) All the above