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BPSC 2018
PRELIMINARY EXAMINATION

Assistant Engineer

General Paper
MECHANICAL ENGINEERING
Data of Exam : 16-09-2018

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Bihar Public Service Commission Prelims Exam, 2018

General Paper : Mechanical Engineering

(Assistant Engineer)

1. Light-emitting diode is an example of
   (A) photonic devices
   (B) mechanical devices
   (C) optoelectronic devices
   (D) sensing devices

Ans. (C)
   Optoelectronics is the communication between optics and electronics which includes the study, design and manufacture of a hardware device that converts electrical energy into light and light into energy through semiconductors. Light-emitting diode is an example of optoelectronic devices.

   Alternate solutions:
   Light Emitting Diode (LED) is an Optoelectronic device.

2. The premature ignition of fuel is called
   (A) engine knock   (B) autoignition
   (C) detonation   (D) All of the above

Ans. (B)

3. Skin stress is also called as
   (A) shear stress   (B) bending stress
   (C) lateral stress   (D) temperature stress

Ans. (B)

4. National Science Day is celebrated on
   (A) 26th December   (B) 26th January
   (C) 28th February   (D) 5th September

Ans. (C)
   National Science Day is celebrated on 28th February each year to mark the discovery of the Raman Effect by Indian Physicist Sir Chandrashekhara Venkata Raman on 28th February 1928.

5. Which of the following is *not* a part of venturimeter?
   (A) Diverging part   (B) Converging part
   (C) Working fluid   (D) Throat

Ans. (C)

6. What is the principle of the 'Johansson Mikrokator'?
   (A) Button spinning on a loop of string
   (B) Principle of interference
   (C) Optical magnification
   (D) Principle of transformer

Ans. (A)

7. At 0°C, silicon behaves as a/an
   (A) conductor   (B) insulator
   (C) semiconductor   (D) superconductor

Ans. (B)
   At 0°C, silicon behaves as an insulator.

8. Temperature stress is a function of
   (A) coefficient of linear expansion
   (B) change in temperature
   (C) modulus of elasticity
   (D) All of the above

Ans. (D)
   Thermal stress, $\sigma_{thermal} = (\alpha \Delta T E)$
   where, α = Coefficient of linear expansion
   ΔT = Change in temperature
   E = Young's modulus of elasticity

9. Who has served as the 11th President of India?
   (A) Shri Pranab Mukherjee
   (B) Shri K.R. Narayanan
   (C) Shri A.P.J. Adbul Kalam
   (D) Smt. Pratibha Patil

Ans. (C)
Avul Pakir Jainulabdeen Abdul Kalam was an Indian scientist who served as the 11th President of India from 2002 to 2007.

10. NASA was established in the year
(A) 1915   (B) 1950
(C) 1958   (D) 1985

Ans. (C)
- The National Aeronautics and Space Administration (NASA) is an independent agency of the executive branch of the federal government of the United States responsible for the civilian space program.
- President Dwight D. Eisenhower established NASA in 1958 with a distinctly civilian orientation encouraging peaceful applications in space science.

11. When air passes through silica gel
(A) it absorbs water vapour molecules
(B) latent heat of condensation is released
(C) DBT of air increases
(D) All of the above

Ans. (D)

12. Which of the following screw threads is stronger than other threads?
(A) Square threads   (B) Trapezoidal threads
(C) Buttress threads   (D) V threads

Ans. (C)

13. In Physics, the Nobel Prize, 2014 was awarded for the discovery of
(A) gravitational LED
(B) blue light LED
(C) neutrino oscillations
(D) MRI

Ans. (B)
The Nobel Prize in Physics 2014 was awarded jointly to Isamu Akasaki, Hiroshi Amano and Shuji Nakamura "for the invention of efficient blue light-emitting diodes which has enabled bright and energy-saving white light sources.

14. In India, 15th September is celebrated as
(A) Engineer's Day   (B) Scientist's Day
(C) Labour's Day   (D) Women's Day

Ans. (A)
15th September is celebrated as Engineer's Day in India in the memory of M. Visvesvaraya.

15. Ministry of Science and Technology was formed in the year
(A) 1950   (B) 1971
(C) 1985   (D) 1992

Ans. (B)
Ministry of Science and Technology was established in May 1971 to promote new areas of science and technology and to play the role of a nodal department for organising, coordinating and promoting Scientific and Technological activities in the country.

16. Who among the following scientists has made his contribution in the establishment of ISRO?
(A) A.P.J. Abdul Kalam
(B) C.V. Raman
(C) Vikram Sarabhai
(D) Aryabhatta

Ans. (C)
ISRO was formed in 1969 by the efforts of independent India's first Prime Minister, Jawaharlal Nehru, and his close aide and scientist Vikram Sarabhai. It is managed by the Department of Space, which reports to the Prime Minister of India.

17. Dr. B.R. Ambedkar was independent India's first
(A) Textile Minister   (B) Law Minister
(C) HRD Minister   (D) Foreign Minister

Ans. (B)
After Independence of India on 15 August, 1947, Babasaheb Ambedkar was appointed as the first Union Law Minister and Chairman of the Constitution Drafting Committee, which was given the responsibility to write India's new Constitution.

18. Graphene is a
(A) one-dimensional material
(B) two-dimensional material
(C) three-dimensional material
(D) All of the above

Ans. (B)

19. Bihar Diwas (Bihar Day) is observed every year on
(A) 25th March　　　　(B) 22nd March
(C) 1st April　　　　　(D) 1st March

Ans. (B)
Bihar Diwas (Bihar Day) is observed every year on March 22, marking the formation of the state of Bihar.

20. Sardar Sarovar Dam is located on
(A) Ganga river　　　　(B) Narmada river
(C) Sutlej River　　　　(D) Godavari river

Ans. (B)
The Sardar Sarovar Dam is a gravity dam on the Narmada River near Navagam, Gujarat.

21. The First Bharat Ratna Award was given in the year
(A) 1951　　　　　(B) 1952
(C) 1953　　　　　(D) 1954

Ans. (D)
The first recipients of the Bharat Ratna were politician C. Rajagopalachari, philosopher Sarvepalli Radhakrishnan, and scientist C. V. Raman, who were honoured in 1954.

22. Raxaul Airport is located in the State of
(A) Goa　　　　　(B) Maharashtra
(C) Bihar　　　　(D) Uttarakhand

Ans. (C)
Raxaul Airport is located at Raxaul in the state of Bihar. It was established after the Sino-Indian War of 1962, when it served as an emergency landing ground for the Indian Army.

23. Which of the following weldings is used for welding vertical section in one pass?
(A) Electroslag welding
(B) Atomic hydrogen welding
(C) Laser-beam welding
(D) Electrogas welding

Ans. (A & D)

24. Rateau turbine belongs to the category of
(A) pressure-compounded turbine
(B) reaction turbine
(C) velocity-compounded turbine
(D) radial flow turbine

Ans. (A)
Rateau turbine → Pressure compounded turbine
Curtis turbine → Velocity compounded turbine
Parson turbine → 50% reaction turbine

25. Gradually varied flow is
(A) steady uniform
(B) non-steady non-uniform
(C) non-steady uniform
(D) steady non-uniform

Ans. (D)
In gradually varied flow if area is changing continuously and mass flow rate is same then flow is known as steady non-uniform flow.

26. The temperature of normal human body is
(A) 38.6°C　　　　(B) 37°C
(C) 37.6°C　　　　(D) 38°C

Ans. (B)
Temperature of normal human body = 98.6°F

$$\frac{C}{5} = \frac{F-32}{9}$$

$$C = \frac{5}{9}(98.6-32) = \frac{5}{9} \times 66.6$$

Temperature of human body,
$$C = 37°C$$

27. Who was the founder of Aligarh Muslim University?
(A) Sir Syed Ahmad Khan
(B) Mohammad Ali Jinnah
(C) Abul Kalam Azad
(D) Ram Mohan Roy

Ans. (A)
Sir Syed Ahmad Khan founded the predecessor of Aligarh Muslim University, the Muhammadan Anglo Oriental College, in 1875. The movement of Muslim awakening associated with Syed Ahmad Khan and M.A.O. College came to be known as Aligarh Movement.

28. Mr. Jagadish Chandra Bose is a famous scientist for the invention of
(A) Bose-Einstein statistics
(B) crescograph
(C) X-rays
(D) scattering of light

Ans. (B)

Jagadish Chandra Bose was one of the most prominent first Indian scientists, he proved by experimentation that both animals and plants share much in common. Bose contrived a very sophisticated instrument called the crescograph, which could record and observe plants minute responses to external stimulants.

29. Albert Einstein was awarded the Nobel Prize for
    (A) theory of relativity
    (B) quantum optics
    (C) photoelectric effect
    (D) Bose-Einstein theory

Ans. (C)

Albert Einstein received the 1921 Nobel Prize in Physics "for his services to theoretical physics, and especially for his discovery of the law of the photoelectric effect", a pivotal step in the development of quantum theory.

30. Rana Pratap Sagar Dam is situated on
    (A) Chambal river   (B) Yamuna river
    (C) Narmada river   (D) Brahmaputra river

Ans. (A)

The Ranapratap Sagar Dam is a gravity dam built on the Chambal River at Rawatbhata in Rajasthan.

31. An instrument, that is used for the detection of earthquake, is
    (A) barometer   (B) lactometer
    (C) seismograph   (D) holograph

Ans. (C)

A seismograph, or seismometer, is an instrument used to detect and record earthquakes.

32. The Head Office of the Central Pollution Control Board (CPCB) is located in
    (A) Mumbai   (B) Kolkata
    (C) Patna   (D) None of the above

Ans. (D)

The Central Pollution Control Board (CPCB) of India is a statutory organisation under the Ministry of Environment, Forest and Climate Change

(MoEFCC). It was established in 1974 under the Water (Prevention and Control of Pollution) Act, 1974. CPCB has its head office in New Delhi, with seven zonal offices and 5 laboratories.

33. RDX is a chemical compound. How is it used?
    (A) As a composition
    (B) As a reactor
    (C) As an explosive
    (D) As a nuclear weapon

Ans. (C)

RDX is a white solid chemical compound which is widely used as an explosive.

34. The planet Neptune was discovered by
    (A) Galle   (B) Galileo
    (C) Kepler   (D) Newton

Ans. (A)

Neptune was supposedly discovered in 1846 by Johann Gottfried Galle using calculations by Urbain Le Verrier and John Couch Adams, making it a joint British-French-German discovery.

35. Resistance of which of the following is unaffected by temperature?
    (A) Manganin   (B) Constantan
    (C) Nichrome   (D) All of the above

Ans. (D)

36. Which of the following is the first calculating devices?
    (A) Abacus   (B) Calculator
    (C) Turing machine   (D) Pascaline

Ans. (A)

The earliest recorded calculating device is the abacus. Used as a simple computing device for performing arithmetic, the abacus most likely appeared first in Babylonia (now Iraq) over 5000 years ago.

37. Name the polymer used in making bulletproof glass.
    (A) Melamine   (B) Bakelite
    (C) Lexan   (D) Vinyl rubber

Ans. (C)

The bulletproof glass is made up of Polycarbonate. Polycarbonate usually consist of products such as Armormax, Makroclear, Cyrolon, Lexan or Tuffak, which are often laminated as the final layer.

38. Where was the World Wide Web created and in which year?
    (A) CERN, 1989   (B) Photonics 21, 1989
    (C) CLUSTER, 1995 (D) Gikll, 1993

Ans. (A)

- The World Wide Web (WWW), also called the Web, is an information space where documents and other web resources are identified by Uniform Resource Locators (URLs), interlinked by hypertext links, and accessible via the Internet.
- English scientist Tim Berners-Lee invented the World Wide Web in 1989 while employed at CERN in Switzerland.

39. Name an acid which is secreted in the stomach
    (A) Sulphuric acid   (B) Hydrochloric acid
    (C) Carbonic acid   (D) Nitric acid

Ans. (B)

Gastric acid, gastric juice or stomach acid, is a digestive fluid formed in the stomach and is composed of hydrochloric acid (HCl), potassium chloride (KCl) and sodium chloride (NaCl).

40. The term 'CTBT' is related to
    (A) nuclear weapons (B) taxes
    (C) space research   (D) railway goods

Ans. (A)

The Comprehensive Nuclear-Test-Ban Treaty (CTBT) is the Treaty banning all nuclear explosions. The Treaty was negotiated at the Conference on Disarmament in Geneva and adopted by the United Nations General Assembly.

41. India's fist mobile court was inaugurated in
    (A) Maharashtra   (B) Haryana
    (C) Uttar Pradesh   (D) Rajasthan

Ans. (B)

42. In which year, railway finances were separated from the general finances of the Central Government?
    (A) 1920   (B) 1972
    (C) 1923   (D) 1924

Ans. (D)

43. Logarithm tables were invented by
    (A) J.J. Thomson   (B) John Napier
    (C) Paul Ehrlich   (D) A.G. Bell

Ans. (B)

John Napier is best known as the discoverer of logarithms. He also invented the so-called "Napier's bones" and made common the use of the decimal point in arithmetic and mathematics.

44. What is India's per capita emission of greenhouse gases (GHG)?
    (A) 0.8 tonne of CO_2
    (B) 1.0 tonne of CO_2
    (C) 1.2 tonnes of CO_2
    (D) 1.5 tonnes of CO_2

Ans. (D)

As per latest report India's per capita emission of greenhouse gases (GHG) is 1.8 tonnes of CO_2.

45. A new study provided the first evidence that fatter people may be more affected by exposure to
    (A) sunlight   (B) X-rays
    (C) γ-rays   (D) ozone

Ans. (B)

46. Which of the following units is used for measuring the speed of processor?
    (A) MPIS   (B) MISP
    (C) MIPS   (D) MSIP

Ans. (C)

Million instructions per second (MIPS) is an older, obsolete measure of a computer's speed and power. MIPS measures roughly the number of machine instructions that a computer can execute in one second.

47. Nerves from the eyes and ears are connected to the
    (A) cerebrum
    (B) cerebellum

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(C) medulla oblongata

(D) spinal cord

Ans. (A)

48. Rainbow Revolution is related to which sector of the economy?
   (A) Small-scale industries
   (B) Information technology services
   (C) Overall development of agriculture sector
   (D) Mining sector

Ans. (C)
   The concept of Rainbow revolution is an integrated development of crop cultivation, horticulture, forestry, fishery, poultry, animal husbandry and food processing industry.

49. Who among the following was the first economist to hold the Office of Secretary, Department of Economic Affairs in the Union Finance Ministry?
   (A) Dr. I.G. Patel   (B) Dr. Manmohan Singh
   (C) Rakesh Mohan   (D) Dr. M.S. Ahluwalia

Ans. (A)

50. Who is the author of Soul and Structure of Governance in India?
   (A) V.K. Duggal   (B) Jairam Ramesh
   (C) Dr. I.G. Patel   (D) Jagmohan

Ans. (D)

51. A cantilever beam of rectangular cross-section is subjected to a point load at its free end. If width and depth of the beam section are doubled, then the deflection at free end of the beam will be reduced to
   (A) 6.25%   (B) 15%
   (C) 25.5%   (D) 29%

Ans. (A)
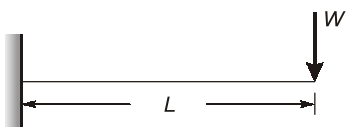
$$I_1 = \frac{bd^3}{12}$$

$$I_2 = \frac{(2b)(2d)^3}{12} = \frac{16bd^3}{12}$$

$$I_2 = 16I_1$$

Deflection in Ist case,

$$\delta_1 = \frac{WL^3}{3EI_1}$$

Deflection in IInd case,

$$\delta_2 = \frac{WL^3}{3EI_2} = \frac{WL^3}{3E \times (16I_1)}$$

$$= 0.0625\left(\frac{WL^3}{3EI_1}\right) = 6.25\% \text{ of } \delta_1$$

52. The ratio of maximum shear stress to average shear stress in a beam of rectangular cross-section is
   (A) 3.0   (B) 2.5
   (C) 2.0   (D) 1.5

Ans. (D)
   For rectangular cross-section

$$\tau_{max} = \frac{3}{2}\tau_{avg}$$

$$\frac{\tau_{max}}{\tau_{avg}} = \frac{3}{2}$$

53. In a symmetrical I-section beam, the bending stress will be maximum at
   (A) the neutral axis
   (B) the top and bottom of the beam section
   (C) $\frac{1}{4}$th depth from top and bottom of section
   (D) the junction of flange and web

Ans. (B)

$$\frac{\sigma}{y} = \frac{M}{I}$$

$$\sigma = \left(\frac{M}{I}\right)y$$

$$\sigma \propto y$$

∵ Bending stress is maximum where 'y' i.e. distance from neutral axis is maximum. So, bending stress is maximum at the top and bottom of the beam section.

54. A circular shaft is subjected to a twisting moment M_t and bending moment M. The ratio of maximum stress developed due to bending moment and that due to twisting moment is equal to

(A) $\dfrac{2M}{3M_t}$ (B) $\dfrac{2M}{M_t}$

(C) $\dfrac{M}{M_t}$ (D) $\dfrac{M}{2M_t}$

Ans. (B)

Maximum stress due to bending,

$$\sigma_b = \frac{32M}{\pi d^3}$$

Maximum shear stress due to twisting moment M_t.

$$\tau = \frac{16M_t}{\pi d^3}$$

Now, $\dfrac{\sigma_b}{\tau} = \left(\dfrac{32M}{\pi d^3}\right) \times \left(\dfrac{\pi d^3}{16M_t}\right)$

$$\frac{\sigma_b}{\tau} = \left(\frac{2M}{M_t}\right)$$

55. If a simply-supported beam of span L carries a moment force at its mid-span, then the shear force diagram will be
(A) triangular (B) rectangular
(C) parabolic (D) cubic parabolic

Ans. (B)

56. According to maximum shear stress criterion, yielding in material occurs when
(A) maximum shear stress = 2 yield stress
(B) maximum shear stress = 0.5 yield stress
(C) maximum shear stress = $\sqrt{2}$ yield stress
(D) maximum shear stress = $\sqrt{\dfrac{2}{3}}$ yield stress

Ans. (B)

Maximum stress in shear

$$= \frac{\text{Yield stress in tension}}{2}$$

Maximum stress in shear
= 0.5 (yield stress in tension)

57. A frictionless pin joint transmits a
(A) force which passes through the pin
(B) torque about the pin
(C) moment about the pin
(D) All of the above

Ans. (A)

58. A bar held between two rigid supports will be subjected to tensile stress if it is
(A) heated
(B) cooled
(C) heated or cooled
(D) heated beyond the melting point

Ans. (B)

59. A linear helical spring with spring constant K is cut into two equal halves. The spring constants of the individual halves will be

(A) $\dfrac{K}{2}$ (B) $\dfrac{K}{\sqrt{2}}$

(C) $\sqrt{2}K$ (D) $2K$

Ans. (D)

When a spring is cut into 'n' equal parts, the spring constant becomes 'n' times of spring constant of original spring. So, spring constant will be $2K$.

60. In a body, loaded under plane stress conditions the number of independent stress components in order to completely specify the state of stress at a point is
(A) 1 (B) 3
(C) 4 (D) 6

Ans. (B)

61. A shaft of 60 mm diameter is subjected to torsion has a shear strain of 0.0006. The rate of twist will be equal to
(A) 0.00002 (B) 0.00025
(C) 0.0036 (D) 0.00001

Ans. (A)

We know that,

$$\frac{\tau}{r} = \frac{G\theta}{L}$$

Given, $\phi = \dfrac{\tau}{G} = 0.0006$, if $L = 1m$

Now, $\theta = \left(\dfrac{\tau L}{Gr}\right) = \dfrac{(0.0006)}{(30)}$

$$\theta = 2 \times 10^{-5} = 0.00002 \text{ radian}$$

62. The equivalent spring constant for a bar of length L, cross-sectional area A and modulus of elasticity E is subjected to an axial force P is

(A) $\dfrac{AE}{L}$ (B) $\dfrac{L}{AE}$

(C) $\dfrac{PL}{A}$ (D) $\dfrac{P^2L}{2AE}$

Ans. (A)

63. The no-slip boundary condition applied in a fluid
(A) is a consequence of laminar behaviour of fluid
(B) because the fluid is treated as continuous
(C) because the fluid is incompressible
(D) because the fluid is viscous

Ans. (D)

64. When a liquid rotates at constant angular velocity about a vertical axis as a rigid body, the pressure intensity
(A) decreases as the square of radial distance
(B) increases linearly as radial distance
(C) varies inversely as the elevation along any vertical line
(D) varies as square of radial distance

Ans. (D)

65. A small plastic boat loaded with nuts and bolts is floating in a bathtub, if the cargo is dumped into water, allowing the boat to float empty, the water level in the tub will
(A) rise   (B) fall
(C) remain same   (D) None of the above

Ans. (B)

66. Nusselt number is the ratio of
(A) temperature gradient of wall to that across the entire pipe
(B) temperature difference to the temperature gradient at the wall
(C) heat flux at the wall to that across the entire pipe
(D) None of the above

Ans. (D)

67. The momentum correction factor for laminar flow through a circular pipe is

(A) 1.67   (B) 3.0
(C) 0.85   (D) 1.33

Ans. (D)

68. The velocity distribution for laminar flow between two parallel plates
(A) is constant over the whole cross-section
(B) is zero at the boundary and increases linearly towards the centre line
(C) varies linearly across the section with a maximum at the centre line
(D) varies parabolically across the section with a maximum at the centre line

Ans. (D)

69. The growth of boundary layer is supported when (p is the pressure and x is the distance from the leading edge)

(A) $\dfrac{\partial p}{\partial x}$ is positive   (B) $\dfrac{\partial p}{\partial x}$ is zero

(C) $\dfrac{\partial p}{\partial x}$ is negative   (D) None of the above

Ans. (A)

70. Turbulent boundary layer thickness is proportional to

(A) $\dfrac{1}{x}$ (B) $x^{1/5}$

(C) $x^{2/5}$ (D) $x^{4/5}$

Ans. (D)
Turbulent boundary layer thickness,

$$\delta \propto \frac{x}{(\mathrm{Re}_x)^{1/5}}$$

$$\mathrm{Re} = \frac{\rho V x}{\mu}$$

$$\delta \propto \frac{x}{(x)^{1/5}}$$

$$\delta \propto x^{4/5}$$

71. The value of fraction factor for smooth pipes for Reynolds' number equal to 106 is approximately
(A) 0.0001   (B) 0.001
(C) 0.01   (D) 0.1

Ans. (C)

If, Re = 10^6

For turbulent flow,

$$f = \frac{0.316}{(Re)^{1/4}} = \left(\frac{0.01}{Re}\right)^{1/4}$$

$$f = \left(\frac{0.01}{10^6}\right)^{1/4} = (10^{-8})^{1/4} = 10^{-2} = 0.01$$

Friction factor,
  $f = 0.01$

72. The time constant of an R-C circuit is one second. Then in one second the capacitor is charged to
(A) about 66% (B) about 98%
(C) 100% (D) None of the above

Ans. (A)

In one time constant, the capacitor charged to $(1 - e^{-1})$ times the final value
  $(1 - e^{-1})$ = 0.632 or 63.2%
Answer is closer to option (a)

73. A linear circuit must obey
(A) superposition theorem
(B) superposition theorem and Thevenin's theorem
(C) superposition, Thevenin's theorem and Norton's theorem
(D) superposition and Norton's theorem

Ans. (C)

74. In a parallel R-L-C circuit, the values of R, L and C are 40 ohms, 2 Henries and 1/2 Farad respectively. The quality factor Q of the circuit will be

(A) $\frac{1}{20}$ (B) 20
(C) 40 (D) 80

Ans. (B)

For a parallel RLC circuit,
Quality factor,

$$Q = R\sqrt{\frac{C}{L}} = 40\sqrt{\frac{1/2}{2}} = \frac{40}{2} = 20$$

75. A negative resistance is an element
(A) that can act only as a source of active power
(B) that can act as a source of both active as well as reaction power

(C) that can act only as a source of reactive power
(D) that will store energy

Ans. (A)

76. In the Laplace transform

$$F(s) = \frac{(s+2)}{s(2s+1)}$$

the function $f(t)$ as $t \to \infty$ and $t \to 0$ respectively are
(A) 2, 0 (B) 0, 0.5
(C) 2, 0.5 (D) 0.5, 2

Ans. (C)

$$F(s) = \frac{(s+2)}{s(2s+1)}$$

$$\lim_{t \to \infty} f(t) = \lim_{s \to 0} sF(s) = 2$$

$$\lim_{t \to 0} f(t) = \lim_{s \to \infty} sF(s) = \frac{1}{2} = 0.5$$

77. Increasing the value of the coupling capacitor C_c in a common-emitter amplifier affects its
(A) mid-band voltage gain
(B) f_L (lower cut-off frequency)
(C) f_H (higher cut-off frequency)
(D) f_L and f_H both

Ans. (B)

The coupling capacitor (C_c) affects the lower cut-off frequency (f_L).

78. The base width of a junction transistor is chosen by design to be small so that
(A) the electric field becomes large
(B) the concentration gradient of injected carriers is small
(C) the recombination of injected minority carriers is reduced
(D) the majority carriers easily reach the collector

Ans. (C)

The base width of a junction transistor (BJT) is chosen to be small so that the recombination of injected minority carriers is reduced.

79. To increase the switching speed of a p^+n diode
(A) the n region width should be made larger
(B) the n region width should be made smaller

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RCC	: 8Q	HMT	: 6Q	Control Systems	: 8Q	Control Systems	: 8Q	Algorithm	: 8Q
Soil Mechanics	: 8Q	FM	: 6Q	Electrical Machines	: 8Q	EDC	: 6Q	Operating Systems	: 8Q
Environmental	: 8Q	Production	: 10Q	Power Systems	: 8Q	Analog Electronics	: 8Q	DBMS	: 8Q
FM	: 8Q	Industrial	: 6Q	Measurements	: 6Q	Digital Electronics	: 6Q	Computer Networks	: 6Q
Highway	: 5Q	SOM	: 8Q	Analog Electronics	: 6Q	Communications	: 8Q	Digital Electronics	: 6Q
Survey	: 5Q	TOM	: 8Q	Digital Electronics	: 6Q	Signal & Systems	: 6Q	Compiler Designs	: 6Q

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(C) the *p* region's bulk resistance should be larger

(D) None of the above is true

Ans. (B)

To increase the switching speed of a p^+n diode, the *n*-region width should be made smaller.

80. Threshold voltage of a MOSFET can be reduced by

(A) increasing the oxide thickness

(B) reducing the dielectric constant of oxide

(C) increasing the oxide thickness and increasing the oxide dielectric constant

(D) reducing the oxide thickness and increasing the oxide dielectric constant

Ans. (D)

The threshold voltage (V_T) of a MOSFET can be given by,

$$V_T = (2\phi_F) + \frac{\sqrt{2q\varepsilon_s N_A(2\phi_F)}}{C_{ox}}$$

$$C_{ox} = \frac{\varepsilon_{ox}}{t_{ox}}$$

$\varepsilon_{ox} \uparrow C_{ox} \uparrow V_T \downarrow$
$t_{ox} \downarrow C_{ox} \uparrow V_T \downarrow$

So, V_T can be reduced by reducing the oxide thickness (t_{ox}) and increasing the oxide dielectric constant (ε_{ox}).

81. A single-phase induction motor starts

(A) due to the development of rotating field for single-phase a.c. supply

(B) by applying voltage across the stator with the help of autotransformer

(C) by changing the number of poles in the stator winding

(D) None of the above

Ans. (D)

82. Transformer core is made of lamination to reduce

(A) eddy-current loss only

(B) hysteresis loss only

(C) both hysteresis and eddy-current loss

(D) None of the above

Ans. (A)

Laminations are used to reduce the eddy-current loss only in the transformer core.

83. When a two-winding transformer is connected as an autotransformer, its efficiency (full-load)

(A) remains the same

(B) increases

(C) decreases

(D) rises to 100%

Ans. (B)

84. Which of the following motors runs at constant speed at all loads?

(A) Synchronous motor

(D) Induction motor

(C) DC shunt motor

(D) DC series motor

Ans. (A)

Synchronous motor runs at constant speed at all loads.

85. Four-point starter is used for

(A) synchronous motor

(B) induction motor of large capacity

(C) DC shunt motor with wide range of speed

(D) DC series motor with heavy load

Ans. (C)

Four-point starter is used for DC shunt motor with wide range of speed.

86. The electromechanical energy conversion is a/ an

(A) irreversible process

(B) reversible process

(C) isothermal process

(D) None of the above

Ans. (B)

The electrochemical energy conversion is a reversible process.

87. The synchronous speed of a 3-phase induction motor having 12 poles and running on 50 Hz supply is

(A) 1200 r.p.m.   (D) 1000 r.p.m.

(C) 800 r.p.m.   (D) 500 r.p.m.

Ans. (D)

Synchronous speed,

$$n_s = \frac{120f}{p} = \frac{120 \times 50}{12} = 500 \, rpm$$

88. A liquid has surface tension σ. The minimum work required to divide a spherical drop of this liquid of radius t into 8 equal-sized spherical drops is
    (A) $\pi t^2 \sigma$ (B) $2\pi t^2 \sigma$
    (C) $4\pi t^2 \sigma$ (D) $8\pi t^2 \sigma$

Ans. (C)

89. A metal block of heat capacity 1 J/K is cooled from 600 K to 300 K by placing it in a large heat reservoir at 300 K. The entropy change of the universe in this process is
    (A) –0.693 J/K   (B) 1 J/K
    (C) –1.693 J/K   (D) 0.307 J/K

Ans. (D)

$$(\Delta S)_s = mc\ln\left(\frac{T_2}{T_1}\right) = (1)\ln\left(\frac{300}{600}\right)$$

$$= -0.693147 \text{ J/K}$$

$$(\Delta S)_{surr.} = \frac{mc(600-300)}{300} = 1\times\left(\frac{300}{300}\right)$$

$$= 1 \text{ J/K}$$

Now, $(\Delta S)_{univ} = (\Delta S)_s + (\Delta S)_{surr.}$
$$= -0.693147 + 1 = 0.306853 \text{ J/K}$$

90. A frictionless piston slowly compresses a gas in an adiabatic cylinder. The entropy change will be
    (A) greater than zero (B) less than zero
    (C) equal to zero   (D) None of the above

Ans. (C)

91. A heat engine operates between 500 K and 300 K. The minimum heat absorption from the source for every kilojoule of work is
    (A) 1.5 kJ   (B) 1.7 kJ
    (C) 2.5 kJ   (D) 3 kJ

Ans. (C)
We know that,

$$\frac{W_{net}}{Q} = 1-\left(\frac{T_2}{T_1}\right) = 1-\left(\frac{300}{500}\right)$$

$$\frac{1}{Q} = \frac{200}{500}$$

$$Q = \frac{500}{200} = 2.5 \text{ kJ}$$

92. A refrigerator maintains a temperature of 270 K in a room at 300 K. If heat is removed from the interior at a rate of 900 J sec^{-1} and the refrigerator operates at 50% of its maximum thermal efficiency, the power requirement is
    (A) 100 W   (B) 150 W
    (C) 200 W   (D) 250 W

Ans. (C)

$$(COP)_{max} = \frac{T_L}{T_H - T_L} = \frac{270}{300-270} = 9$$

$$(COP)_{actual} = 0.5 \times 9 = 4.5$$

$$\frac{Q_{removed}}{W_{input}} = 4.5$$

$$W_{input} = \frac{900}{4.5} = 200 \text{ W}$$

93. Liquid water at 1 atmosphere and 0°C, freezes to ice, transferring heat to the surroundings, also at 0 °C. In this process
    (A) the entropy of the water decreases, but that of the universe increases
    (B) the entropy of water decreases, but that of the universe remains constant
    (C) the entropy of the water as well as that of the universe increase
    (D) the entropy of the water increases, but that of the universe decreases

Ans. (B)

94. q-w is a
    (A) path function
    (B) state function
    (C) path as well as state function
    (D) none of the above
    (where q is specific heat transfer and w is specific work done)

Ans. (B)

$$q = u + w$$
$$q - w = u$$
$$u = q - w$$

Internal energy is point function or state function.

95. Amorphous glass is expected to have zero value of entropy at 0 K. The statement is
    (A) true
    (B) false

(C) true if it is in the powder form

(D) None of the above

Ans. (B)

96. The efficiency of a reversible engine is maximum and depends only on the temperature of the source and the sink. The statement is
(A) correct
(B) wrong
(C) uncertain
(D) correct if it is irreversible process

Ans. (A)

97. Heat and work are examples of
(A) thermodynamic properties
(B) states of thermodynamic systems
(C) mode of energy transfer
(D) None of the above

Ans. (C)

98. For an ideal gas, compressibility factor- should be
(A) 0   (B) 1
(C) −1   (D) close to 10

Ans. (B)

$$PV = ZRT$$

For ideal gas

$$Z = 1$$

99. The method which follows deterministic approach is
(A) CPM
(B) PERT
(C) both PERT and CPM
(D) None of the above

Ans. (A)

100. Direct cost of an activity
(A) increases with increase in duration
(B) decreases with increase in duration
(C) remains same
(D) Nothing can be said

Ans. (B)

101. Mean, median and the mode for the set of values— 10, 9, 8, 10, 12, 9, 9, 10, 11, 14 and 8 are

(A) 10, 8, 14   (B) 10, 9, 9
(C) 9, 10, 8   (D) 11, 9, 8

Ans. (∗)

8, 8, 9, 9, 9, 10, 10, 10, 11, 12, 14

Mean

$$= \frac{8+8+9+9+9+10+10+10+11+12+14}{11}$$

$$= 10$$

$$\text{Median} = \left(\frac{n+1}{2}\right)^{th} \text{term} = \left(\frac{11+1}{2}\right)^{th} \text{term}$$

$$= 6^{th} \text{ term} = 10$$

Mode = Number with maximum frequency

$$= 9 \text{ and } 10$$

102. In case of PERT, if most pessimistic, optimistic and likely time are 10, 2 and 8 days respectively, then the expected duration and variance are
(A) 8 and 4/3   (B) 20/3 and 16/9
(C) 7.33 and 16/9   (D) 7.67 and 20/3

Ans. (C)

$$T_e = \left(\frac{t_o + 4t_m + t_p}{6}\right)$$

where, T_e = Expected time
   t_o = Optimistic time
   t_m = Most likely time
   t_p = Pessimistic time
   V = Variance

$$T_e = \left(\frac{2 + 4 \times 8 + 10}{6}\right) = \frac{44}{6}$$

$$= \frac{22}{3} = 7.33$$

$$\text{Variance} = \left(\frac{t_p - t_o}{6}\right)^2 = \left(\frac{10-2}{6}\right)^2 = \left(\frac{8}{6}\right)^2$$

$$V = \frac{16}{9}$$

103. In case of cash-flow monitoring, it is recommended to draw
(A) histogram   (B) cumulative diagram
(C) bar chart   (D) homograph

Ans. (C)

104. The total cost of a building is ₹ 3,00,000. The depreciated cost of the building after 30 years, if the life span is 90 years and scrap value is ₹ 30,000, will be (by declining balance method)
(A) 2,10,000   (B) 1,39,504
(C) 1,75,254   (D) 2,50,000

Ans. (B)
We know that,

$$C\left(1-\frac{r}{100}\right)^n = S$$

$$300000\left(1-\frac{r}{100}\right)^n = 30000$$

$$10\left(1-\frac{r}{100}\right)^{90} = 1$$

$$\left(1-\frac{r}{100}\right) = \left(\frac{1}{10}\right)^{1/90}$$

$$1-\left(\frac{r}{100}\right) = 0.9747$$

$$r = 2.53\%$$

Depreciated cost after 30 years

$$= 300000\left(1-\frac{r}{100}\right)^{30} = 300000\left(1-\frac{2.53}{100}\right)^{30}$$

$$= ₹\ 139075.374$$

105. A owner has installed an air conditioner at the cost of ₹ 18,000. If the life of the conditioner is 18 years, the coefficient of sinking fund (rate of interest is 5%) is
(A) 0.055   (B) 0.0355
(C) 640   (D) 1.20

Ans. (B)

Coefficient of sinking fund $= \dfrac{i}{(1+i)^n - 1}$

where, $i = 5\% = 0.05$
              $n = 18$
Coefficient of sinking fund

$$= \frac{0.05}{(1+0.05)^{18}-1} = \frac{0.05}{(1.05)^{18}-1}$$

$$= 0.0355$$

106. The average life of Class-I timber is
(A) 60 months   (B) 90 months
(C) 120 months   (D) 150 months

Ans. (C)
The average life of first class timber is more than 10 years.

107. A good stone should have water absorption less than
(A) 0.4   (B) 0.6
(C) 0.8   (D) 0.9

Ans. (B)

108. The minimum crushing strength of brick should be
(A) 35 kg/cm²   (B) 50 kg/cm²
(C) 15 kg/cm²   (D) 20 kg/cm²

Ans. (A)
The minimum crushing/compressive strength of brick should be 35 kg/cm².

109. The proportion of cement mortar used for 1 and 2 storeyed structure is
(A) 1 : 2   (B) 1 : 3
(C) 1 : 6   (D) 1 : 1 : 2

Ans. (C)

110. The ingredient which imparts hardness and colour to cement is
(A) alkali   (B) alumina
(C) magnesia   (D) sulphur

Ans. (C)
Magnesia imparts hardness and colour to cement.

111. The compressive strength of the brick should not be less than
(A) 3.5 MPa   (B) 5 MPa
(C) 15 MPa   (D) 20 MPa

Ans. (A)
The compressive strength of the brick should not be less than 3.5 MPa.

112. Which one of the following is responsible for red colour of brick?
(A) Iron oxide   (B) Magnesia
(C) Silica   (D) Alumina

Ans. (A)

Iron oxide is responsible for red colour of brick.

113. Enamel paint is prepared by adding
     (A) white lead or zinc
     (B) alumina and zinc
     (C) magnesia and alumina
     (D) white lead and alumina

Ans. (A)

Enamel paint is prepared by white lead and zinc.

114. Pigments are added to
     (A) give colour to paint
     (B) reduce the cost of the paint
     (C) hold the ingredients of the paint
     (D) make the paint thinner

Ans. (A)

Pigments are added to give colour to paint

115. The base material of distemper is
     (A) iron oxide   (B) lithopone
     (C) chalk   (D) lime

Ans. (C)

Base material of distemper is chalk.

116. In industrial building, hard wearing surface can
     be achieved by
     (A) terrazzo flooring
     (B) granolithic flooring
     (C) mosaic flooring
     (D) tiled flooring

Ans. (B)

Granolithic flooring is hard and hence can be
used in industrial building to achieve hard wearing
surface.

117. Which one of the following is not true with respect
     to ribbed tiled floors?
     (A) Light in weight
     (B) Better soundproofing qualities
     (C) Poor fire resistance
     (D) Better thermal insulation

Ans. (C)

Ribbed file floors have good fire resistance. Also
their thermal conductivity is low.

118. Plywood is identified by
     (A) thickness   (B) volume
     (C) area   (D) weight

Ans. (A)

Plywood is made by compressing thin layers
over each other. Thickness is the criteria for its
identification.

119. It is required to produce a small-scale map of an
     area in a magnetic zone by directly plotting and
     checking the work in the field itself. Which one
     of the following surveys will be most appropriate
     for this purpose?
     (A) Chain   (B) Theodolite
     (C) Plane table   (D) Compass

Ans. (C)

For the given condition plane table is most
suitable because it can be efficiently used for
small scale maps and plotting and checking work
can be done simultaneously.

120. The technique of plotting all the accessible
     stations with a single setup of plane table is called
     (A) radiation   (B) intersection
     (C) resection   (D) traversing

Ans. (A)

Radiation technique can be used to plot all
stations from single setup of plane table. In
radiation, plane table is setup at single station
and lines are drawn towards other stations. Later
the distance between stations are measured and
plotted using scale on respective line.

121. A 30 m chain is found to be 0.1 m short
     throughout the measurement. If the distance
     measured is recorded as 300 m, then the actual
     distance will be
     (A) 300.1 m   (B) 301.0 m
     (C) 299 m   (D) 310.0 m

Ans. (C)

True length of chain × Actual distance
Faulty length of chain × Measured distance
$\Rightarrow \quad 30 \times L = 29.9 \times 300$
$\qquad\qquad L = 299$ m

122. Offsets are
     (A) lateral measurements made with respect to
         main survey lines.

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(B) perpendicular erected from chain lines.

(C) taken to avoid unnecessary walking between stations.

(D) measurements which are not made at right angles to the chain line.

Ans. (A)

Offsets are the linear measurements made with respect to main survey lines.

123. A fore-bearing of a line is S 49° 52′ E, then the back bearing will be

(A) S 49° 52′ E   (B) S 52° 49′ E

(C) N 49° 08′ E   (D) N 49° 52′ W

Ans. (D)

The WCB fore-bearing of line is

$\Rightarrow$ 180° − 49°52′

$\Rightarrow$ 130° 8′ 0″

So, back bearing

$\Rightarrow$ 180° + 130°8′0″

$\Rightarrow$ 310°8′

In quadrantal form

$\Rightarrow$ 360° − 310°8′

$\Rightarrow$ N 49°52′ W
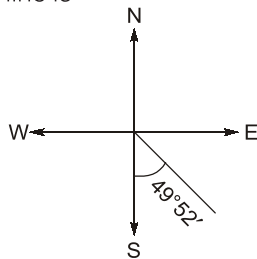
124. In a parabolic vertical curve, the rising grade $g_1 = +0.8\%$ and the falling gradient $g_2 = -0.7\%$. The rate of change of grade is 0.05 per chain. The length of the vertical curve is

(A) 30 chains   (B) 40 chains

(C) 50 chains   (D) 60 chains

Ans. (A)

Difference in grade = +0.8(%) − (−0.7%)

        = (0.8 + 0.7) = 1.5%

Rate of change of grade per chain

$\Rightarrow$ 0.05

Length of vertical curve $\Rightarrow \dfrac{1.5}{0.05}$

$\Rightarrow$ 30 chains

125. An angle measuring instrument reading up to one-sixth of a degree on the main scale is equipped with a vernier having 19 main scale divisions divided into 20 parts. The correct least count for the instrument is

(A) 60 seconds   (B) 30 seconds

(C) 20 seconds   (D) 10 seconds

Ans. (B)

        1 degree $\Rightarrow$ 60 min

                1 min $\Rightarrow$ 60 seconds

So,   1 degree $\Rightarrow$ 60 × 60

        1 degree $\Rightarrow$ 3600 seconds

Reading of angle measuring instrument

$\Rightarrow$ $= \dfrac{3600}{6} = 600$

This reading is divided into 20 parts.

So, Least count $= \dfrac{600}{20} = 30$ seconds

126. For a simple circular curve, which one of the following gives the correct relation between the radius R and degree of curve D, for 20 m arc length?

(A) $R = 5729.6/D$ (B) $R = 1718.9/D$
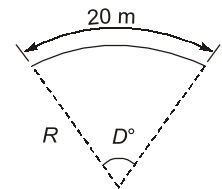
(C) $R = 1145.9/D$ (D) $R = 572.9/D$

126. (C)

For 2 Dm are length

$$\frac{2\pi R}{360°} = \frac{20}{D}$$

$$R = \frac{1145.195}{D}$$

So, $R \simeq \dfrac{1145.9}{D}$

127. The radius of curvature of an ideal transition curve should be

(A) inversely proportional to its length.

(B) directly proportional to its length.

(C) proportional to speed of vehicle.

(D) proportional to superelevation.

Ans. (A)

According to the relation:

The length of transition curve,

$$L = \frac{V^3}{CR}$$

The radius of curvature of an ideal transition

$$\text{Curve} \propto \frac{1}{\text{length of transition curve}}$$

128. If the difference of height between two points is 1 m and the slope distance between them is 100 m, then the accuracy of slope correction

determination could be 1 in 100000 provided the heights are measured with an accuracy of
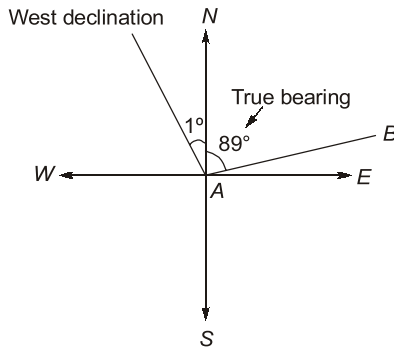
(A) ±0.1 cm   (B) ±0.5 cm

(C) ±1.0 cm   (D) ±5.0 cm

Ans. (A)

129. A and B are two traverse stations free from local attraction errors. If the true bearing of a line AB is 89° and the magnetic declination at point *A* is 1° wet, then the magnetic bearing of line *BA* would be

(A) 88°   (B) 90°

(C) 268°   (D) 270°

Ans. (D)

True bearing = magnetic bearing – Declination

So, the magnetic bearing of line *AB* is

$$\Rightarrow \qquad = 89° + 1° = 90°$$

The magnetic bearing of line *BA* would be

$$= 90° + 180°$$

$$= 270°$$

130. Which one of the following gives the correct distance between the lighthouse and a ship, when the lighthouse whose height is 100 m is visible just above the horizon from the ship?

(A) 30.68 km   (B) 36.50 km

(C) 38.54 km   (D) 40.54 km

Ans. (C)

Using relation,

$$D = 3.8553\sqrt{h}$$

$$= 3.8553\sqrt{100} = 38.55 \text{ km}$$

131. To find the RL of a roof slab of a building, staff readings were taken from a particular setup of the levelling instrument. The readings were

1.050 m with staff on the benchmark and 2.300 m with staff below the roof slab and held inverted. Taking the RL of the BM as 135.150 m, the RL of the roof slab will be

(A) 129.800   (B) 131.900

(C) 134.400   (D) 138.500

Ans. (D)

R.L. of roof slab:

= R.L. of BM + H.I – staff reading

= 135.15 + 1.050 – (– 2.3)

= 135.15 + 1.050 + 2.3 = 138.50 m

132. For the scale of plotting 1 in 400, the permissible error in centring of plane table is about

(A) 0.5 m   (B) 0.3 m

(C) 0.1 m   (D) 0.01 m

Ans. (C)

The permissible error in centering

$$= (0.25 \text{ mm} \times S)$$

$$= (0.25 \times 400) \text{ mm}$$

$$= 100 \text{ mm} = 0.1 \text{ m}$$

133. Ceylon Ghat Tracer is used to measure

(A) slope   (B) reduced levels

(C) distances   (D) depth of sea

Ans. (A)

Ceylon Ghat tracer is used for measuring the angle of slope for locating points on a given gradient in a preliminary survey.

134. BOD test is standardized at

(A) 10°C and 10 days

(B) 20°C and 5 days

(C) 37°C and 3 days

(D) 50°C and 2 days

Ans. (B)

The BOD test is standardized at 20°C and 5 days.

135. Absolutely soft waters are required for

(A) drinking

(B) boilers

(C) washing with synthetic detergent soap

(D) prevention of corrosion in pipe

Ans. (B)

Absolutely soft waters are required for boilers which is done by zeolite process.

136. Permanent hardness of water is because of
    (A) $CaHCO_3$ (B) $NaHCO_3$
    (C) $MgHCO_3$ (D) $CaSO_4$

Ans. (D)
Permanent hardness in water is caused by sulphates chlorides and nitrates of multivalent cations.

137. Zeolite process is used
    (A) for disinfection of water
    (B) for colour removal from water
    (C) for water softening
    (D) for turbidity removal

Ans. (C)
Zeolites are natural or synthetic resins which are used for water softening purpose. They provide zero hardness water.

138. Blue baby disease results with
    (A) high fluoride content in water
    (B) high nitrate content in water
    (C) high chloride content in water
    (D) high iron content in water

Ans. (B)
Blue baby disease also termed as 'Methemoglobinemia' is a result of nigher nitrate content in water.

139. The major constituent which causes alkalinity in water is
    (A) dissolved O_2 (B) dissolved NH_3
    (C) dissolved CO_2 (D) All of the above

Ans. (C)
Major constituents which causes alkalinity are HCO_3^- and CO_3^{--} ions and these are the result to dissolved CO_2.

140. Sedimentation process is based on which of the following physical laws?
    (A) Newtons third law
    (B) Conservation of mass
    (C) Stokes law
    (D) Conservation of energy

Ans. (C)
Sedimentation process is based on Stoke's law.

141. Fine sand is used as media in case of
    (A) slow sand filter
    (B) rapid sand filter
    (C) pressure filter
    (D) All of the above

Ans. (A)
Fine sand is used in slow sand filter in upper layer so that maximum impurity can be trapped in upper layer only.

142. Sullage is
    (A) waste water from baths
    (B) drainage from road
    (C) industrial liquid waste
    (D) All of the above

Ans. (A)
Sullage is waste water from household sinks, shower and baths but not waste liquid or excreta from toilets.

143. The end product of decomposed organic matter is
    (A) CO_2 (B) H_2S
    (C) NO_3 (D) NH_3

Ans. (A)

144. Grit is
    (A) inert matter of specific I gravity > 2.65
    (B) organic matter of specific gravity 1
    (C) organic and inert matter combined
    (D) colloidal matter of heavy specific gravity

Ans. (A)
Grit is inert inorganic matter of specific gravity > 2.65.

145. Activated sludge process is a biological process involving
    (A) aerobic + anaerobic bacteria
    (B) aerobic bacteria + protozoa + algae
    (C) anaerobic bacteria + fungi
    (D) facultative bacteria + algae

Ans. (B)
ASP involves aerobic bacteria, protozoa and algae.

146. Sludge digestion is
    (A) disposal of sludge
    (B) dilution of sludge
    (C) stabilization of sludge
    (D) removal of sludge from waste

Ans. (C)
    Sludge digestion refers to decomposition of organic matter and getting stable end products.

147. Anaerobic sludge digestion mainly yields
    (A) methane   (D) ammonia
    (C) Both (A) and (B) (D) None of the above

Ans. (A)

148. Self-purification of water body is mainly due to
    (A) dissolved O_2 (B) dissolved NO_3
    (C) Both (A) and (B) (D) None of the above

Ans. (A)
    Self purification of water body mainly depends on the dissolved oxygen content.

149. When bleaching powder is added to water, its pH value
    (A) increases
    (B) decreases
    (C) remains unaffected
    (D) depends on characteristics of water

Ans. (A)
    Bleaching powder increases the pH value of water.

150. If the total hardness of water is greater than its alkalinity, the carbonate hardness will be equal to
    (A) total alkalinity
    (B) total hardness
    (C) total hardness - total alkalinity
    (D) non-carbonate hardness

Ans. (A)
    Carbonate hardness = min (Total hardness, alkalinity)

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