ENTRANCE EXAMINATIONS, 2017
QUESTION PAPER

Ph. D. (Materials Engineering)

Marks: 80
Time: 2.00 hrs   -   Hall Ticket no: [   ]

I. Write your Hall Ticket Number in the OMR Answer Sheet given to you. Also write the Hall Ticket Number in the space provided above.
II. Read the following instructions carefully before answering the questions.
III. This Question paper has TWO parts: PART A and PART B

1. Part A: It consists of 20 objective type questions of **two marks** each.
There is a negative marking of **0.66** marks for every wrong answer.
The marks obtained by a candidate in this part will be used for resolving tie cases.

2. Part B: It consists of 40 objective type questions of one mark each.
There is no negative marking in this part.

3. All questions are to be answered. Answers for these questions are to be entered on the OMR sheet, filling the appropriate circle against each question. For example, if the answer to a question is D., it should be marked as below:

(A)   (B)   (C)   ●

No additional sheets will be provided. Rough work can be done in the question paper itself/ space provided at the end of the booklet.

4. Hand over the OMR answer sheet to the invigilator at the end of the examination.

5. Any type of calculators, Log tables and Mobile phones are NOT permitted inside the Examination Hall.

6. This book contains 16 pages including this cover sheet.

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PART A

1. In the CGS system, the magnitude of force is F dynes. If in another system the fundamental physical quantities are kilogram, meter, and minute, then the magnitude of force is

    A. 36×10^{-3} F
    B. 3.6 F
    C. 10^{-3} F
    D. F

2. The errors in the measurement of length (L) and time period (T) in a simple pendulum experiment are 3% and 2%, respectively. The maximum percentage error in measurement of L/T^2 is

    A. 1.5%
    B. 5%
    C. 6%
    D. 7%

3. Two physical quantities A and B are related to each other by the equation, $A = K \exp(-T/B)$. If in an experiment A and B are the measured parameters, then the value of T can be determined from the slope of which of the following graphs

    A. A on Y-axis and B on X-axis
    B. A on Y-axis and exp(B) on X-axis
    C. lnA on Y-axis and B on X-axis
    D. lnA on Y-axis and 1/B on X-axis

4. A wire is bent to form a square and the area of the square is 100 cm^2, if the same wire is then used to form a circle, the radius of the circle will be

    A. 4.5 cm
    B. 5.6 cm
    C. 6.4 cm
    D. 10 cm

5. The next number in the following series is?

1-1-2-3-5-8-13

A. 21
B. 26
C. 31
D. 41

6. Roma's father is four times as old as her. In 20 years, he will be only twice as old as her. How old are Roma and her father now, respectively?

A. 8 and 32 years
B. 10 and 40 years
C. 9 and 36 years
D. 15 and 60 years

7. Find the odd one out from the following series,

10, 25, 45, 54, 60, 75, 80

A. 10
B. 45
C. 54
D. 75

8. In how many different ways can the letters of the word "MATHEMATICS" be arranged so that the vowels always come together?

A. 10080
B. 4989600
C. 120960
D. 580460

9. At an election involving two candidates 68 votes were declared invalid. If the winning candidate secured 52% of the votes and won by 98 votes, the total number of votes polled are

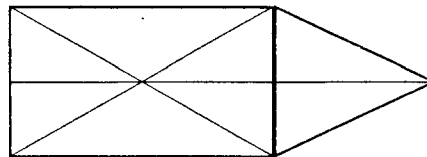A. 2382
B. 2450
C. 2518
D. 2650

10. Four different electronic devices make a beep after every 30 minutes, 1 hr, 1.5 hr, and 1 hr 45 minutes, respectively. If all the devices beeped together at 12:00 noon, then they will again beep together at

    A. 12 midnight
    B. 3 am
    C. 6 am
    D. 9 am

11. In an examination a student scores 4 marks for every correct answer and loses 1 mark for every wrong answer. If he attempts all 75 questions and scores 125 marks, the number of questions he attempts correctly is

    A. 35
    B. 40
    C. 42
    D. 46

12. Find the number of triangles in the following figure
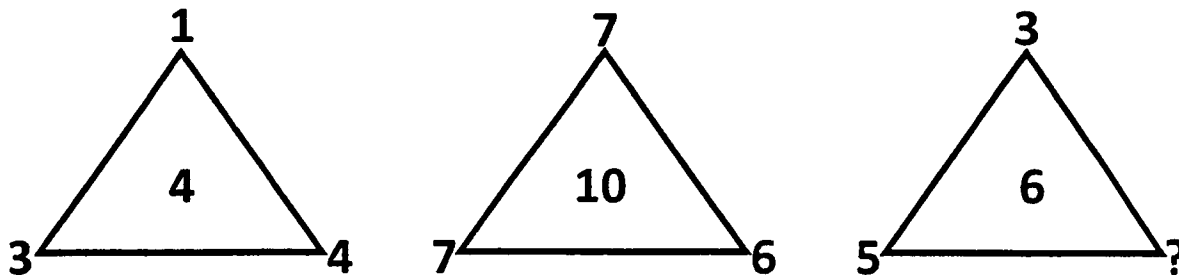

    A. 15
    B. 16
    C. 17
    D. 18

13. In a question paper, out of a total of 12 questions, only 6 are to be answered. 6 questions have one alternative each. Each question has 4 parts, only 3 of which are to be answered. How many questions (including parts) are there in the question paper?

    A. 24
    B. 48
    C. 72
    D. 96

14. Which number replaces the "?" mark in the following figure?

    A. 9
    B. 7
    C. 6
    D. 4

15. Find the odd one out

    A. 32:12
    B. 88:26
    C. 56:14
    D. 36:13

16. A train running at the speed of 60 km/hr. crosses a pole in 9 seconds. What is the length of the train?

    A. 120 meters
    B. 150 meters
    C. 180 meters
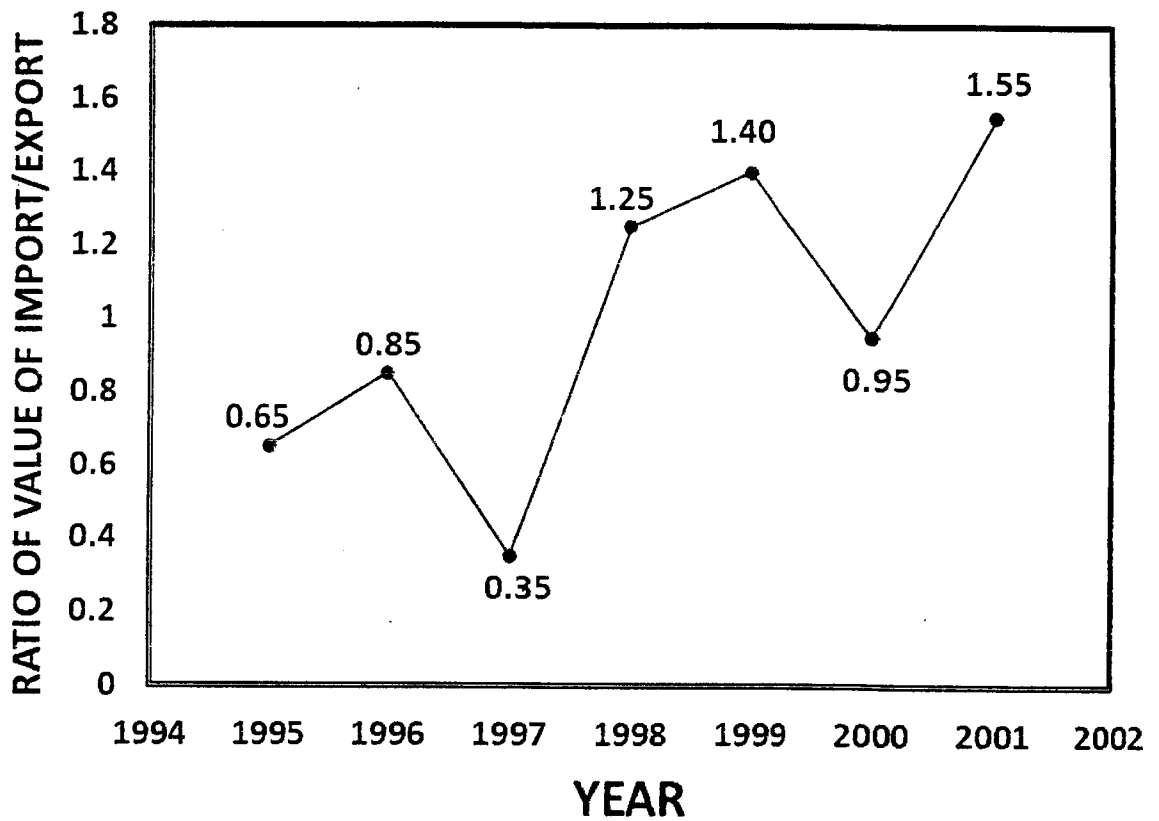   D. 324 meters

17. Consider the following statements-
    1. All birds are swans; 2. Some skirts are birds; 3. All swans are ducks
  Which of the conclusions given below are correct?
    I. Some ducks are birds; II. Some skirts are ducks; III. All birds are ducks
    IV. Some birds are not ducks

    A. Only I and II
    B. Only II and III
    C. Only III and IV
    D. I, II, and III

18. The ratio of value of imports to exports by a company over the years is given in the graph below. If the value of imports in 1998 was Rs. 250 crores and the total exports in the years 1998 and 1999 together was Rs. 500 crores, then the value of imports in 1999 was

A. Rs. 250 crores
B. Rs. 300 crores
C. Rs. 357 crores
D. Rs. 420 crores

19. If A+B means A is the mother of B; A÷B means A is the brother of B; A×B means A is the son of B and A-B means A is the daughter of B, which of the following means C is the niece of D?

A. D-C
B. D×P-C
C. C-P÷D
D. P+D÷C

20. Odometer: mileage as compass:

    A. speed
    B. hiking
    C. needle
    D. direction

PART B

21. If $M = \begin{bmatrix} 2 & 3 \\ 4 & 5 \end{bmatrix}$, then M^{-1} is given by

A. $\begin{bmatrix} 2/2 & 3/2 \\ 4/2 & 5/2 \end{bmatrix}$

B. $\begin{bmatrix} -2/2 & -3/2 \\ -4/2 & -5/2 \end{bmatrix}$

C. $\begin{bmatrix} 5/2 & 3/2 \\ 4/2 & 2/2 \end{bmatrix}$

D. $\begin{bmatrix} -5/2 & 3/2 \\ 4/2 & 2/2 \end{bmatrix}$

22. If $M = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$ and $N = \begin{bmatrix} 4 & 2 \\ 1 & 3 \end{bmatrix}$, then M×N is given by

A. $\begin{bmatrix} -6 & -8 \\ -16 & -18 \end{bmatrix}$

B. $\begin{bmatrix} 6 & 8 \\ 16 & 18 \end{bmatrix}$

C. $\begin{bmatrix} 16 & 18 \\ 6 & 8 \end{bmatrix}$

D. $\begin{bmatrix} -16 & -18 \\ -6 & -8 \end{bmatrix}$

23. If $y = ae^{x} + be^{-x} + c$, where a, b, c are constants, then y''' is equal to,

A. 0
B. y'
C. y''
D. 1

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24. The equation, $r = \dfrac{1}{8} + \dfrac{3}{8}\cos\theta$, represents

    A. a parabola
    B. an ellipse
    C. a hyperbola
    D. a rectangular hyperbola

25. If the uncertainty in position *(Δx)* and momentum *(Δp)* of a particle of mass "m" are related as, $\Delta x \Delta p \geq \dfrac{h}{4\pi}$ (h being Planck's constant), then the speed of the particle is

    A. $\sim \dfrac{h}{4\pi m \Delta x}$

    B. $\dfrac{hm}{4\pi \Delta x}$

    C. $\dfrac{h\Delta x}{4\pi m}$

    D. $\dfrac{hm\Delta x}{4\pi}$

26. Which of the following is a non-contact type temperature sensor?

    A. Platinum resistance thermometer
    B. Thermocouple
    C. Optical pyrometer
    D. Bimetallic thermometer

27. If a capacitor of capacitance 1000 μF is charged at a steady rate of 200 μC/s, then the time required to produce a potential difference of 20V across it is

    A. 50 sec
    B. 100 sec
    C. 150 sec
    D. 200 sec

28. The total angular momentum quantum number of Cu^{+2} is

    A. 0
    B. 1
    C. 2
    D. -1

29. The thermal diffusivity of a solid object can be expressed in

    A. m^2/sec
    B. N/sec^2
    C. N/m^2
    D. m/sec^2

30. Diffusionless transformation in steels results in which of the following phases

    A. Ferrite
    B. Ledeburite
    C. Pearlite
    D. Martensite

31. For a reversible adiabatic process, if S is the entropy at temperature T, then

    A. $\Delta S > 0$
    B. $\Delta S < 0$
    C. $\Delta S = 0$
    D. $\Delta S = \infty$

32. In ionic crystals, a pair of cation vacancy and anion vacancy is called as,

    A. Pair of defects
    B. Schottky defect
    C. Frenkel defect
    D. Surface defect

33. A system absorbs X joules of heat from the surroundings and does Y joules of work on the surroundings. The net energy change in the system is

    A. (X+Y) Joules
    B. (X-Y) Joules
    C. (Y-X) Joules
    D. –(X+Y) Joules

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34. Fluctuation relative to the mean energy of a thermodynamic system consisting of an ensemble of "N' particles scales as,

A. N

B. N^2

C. $\dfrac{1}{N}$

D. $\dfrac{1}{\sqrt{N}}$

35. Which of the following four materials contains least amount of carbon wt.%?

A. Grey cast iron
B. Wrought iron
C. Pig iron
D. White cast iron

36. During the last stage of refining process re-oxidation is performed sometimes, to increase

A. Molten steel temperature
B. Steel cleanliness
C. Slag fluidity
D. Inclusions

37. During oxidation of iron which of the following does not form as a scale

A. Wustite
B. Ferrite
C. Hematite
D. Magnetite

38. Inoculation is often used in metal casting to control

A. Grain size
B. Solidification shrinkage cavity
C. Segregation
D. Homogenization

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39. The nature of mass transport during solidification in ingot casting reflects as

    A. Macro segregation
    B. Micro segregation
    C. Dendrites
    D. Micro porosity

40. Which of the following accounts for maximum energy loss in a boiler?

    A. Flue gases
    B. Ash content in the fuel
    C. Incomplete combustion
    D. Unburnt carbon in flue gases

41. With increase in calorific value of fuels, their adiabatic flame temperature

    A. only increases
    B. only decreases
    C. remains unchanged
    D. may increase or decrease depending on the quantity of products of combustion

42. The chemical formula of Mullite is

    A. $Al_2O_3.\ 2SiO_2$
    B. $3Al_2O_3.\ 2SiO_2$
    C. $Al_2O_3.\ SiO_2$
    D. $2Al_2O_3.\ 3SiO_2$

43. One million precipitate particles per unit volume of a precipitation hardened alloy coalesce into 1000 particles due to over aging. Assuming that the particles are uniformly distributed in the matrix and their volume is small compared to the volume of the matrix, then compared to initial value the yield strength due to coarsening

    A. would increase by 10%
    B. would decrease by 10%
    C. would remain unchanged
    D. cannot be estimated from the given information

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44. The initial concentrations of reactants A and B in a chemical reaction are C_{A0} and C_{B0}, respectively. A second order reaction of the form A + B → Y is called a pseudo-first order reaction, when

   A. $C_{A0} = C_{B0}$
   B. $C_{A0} > C_{B0}$
   C. $C_{B0} > C_{A0}$
   D. $C_{B0} \gg C_{A0}$

45. Which of the following refers to the ability of a material to absorb energy when deformed elastically?

   A. Toughness
   B. Fracture toughness
   C. Resilience
   D. Hardness

46. The total thermal conductivity, K, of a crystalline solid around room temperature can be expressed by (where K_e, K_p, K_h and K_l are the electron, proton, hole and lattice contributions to the total thermal conductivity)

   A. $K = K_e + K_p$
   B. $K = K_p + K_h$
   C. $K = K_e + K_l$
   D. $K = K_e$

47. Which of the following is **not** true for an intrinsic semiconductor?

   A. The product of electron and hole densities at room temperature is a function of the position of Fermi level.
   B. The electron and hole densities are equal.
   C. The Fermi level lies roughly halfway between the bottom of the conduction band and top of the valence band.
   D. The product of electron and hole densities at room temperature is independent of Fermi level.

48. If a semiconductor is n type, the Fermi energy will be

   A. close to the bottom of the conduction band.
   B. at the middle of the band gap.
   C. near the top of the valence band
   D. aligned with the top of the conduction band

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49. The [OH]⁻ concentration in a solution having pH value '3' is

    A. 10^{-3}

    B. 10^{-10}

    C. 10^{-11}

    D. 10^{-13}

50. Which of the following is used in industrial fermentation to produce food and drinks

    A. Yeast

    B. Bacteria.

    C. Virus

    D. Vitamins

51. In a DNA double helix, the two DNA chains are held together by

    A. Metallic bonds between the pair of bases

    B. Hydrogen bonds between the pair of bases

    C. Ionic bonds between the pair of bases

    D. Organometallic bonds between the pair of bases

52. The repeating units of Poly tetra fluoro ethylene are

    A. $Cl_2\text{-}CH\text{-}CH_3$

    B. $F_2C\text{ - }CF_2$

    C. $F_3C - CF_3$

    D. $FClC = CF_2$

53. How many independent elastic constants are required to characterize crystals?

    A. only 2

    B. less than 2

    C. only 1

    D. greater than 2 and the number increases with decrease in crystal symmetry

54. Both the creep resistance and the tensile strength of an alloy can be increased by

    A. increasing the grain size
    B. decreasing the grain size
    C. addition of dispersoids
    D. annealing

55. Which of the following does not improve the fatigue life of a steel component?

    A. Nitriding
    B. Decarburization
    C. Improving surface finish
    D. Shot peening

56. If the atomic diameter of an element which crystallizes in the fcc structure is 'a', then the interplanar spacing of (111) planes is

    A. a
    B. $a/\sqrt{3}$
    C. $\sqrt{3}a$
    D. $3a$

57. The yield strength of a polycrystalline metal increases from 100 MPa to 145 MPa on decreasing the grain diameter (assuming spherical grains) from 64 μm to 25 μm. The yield strength of the metal (in MPa) having a grain diameter of 36 μm is

    A. 120 MPa
    B. 130 MPa
    C. 135 MPa
    D. 140 MPa

58. The minimum number of slip systems that must be operative during plastic deformation is

    A. 3
    B. 4
    C. 5
    D. 6

59. During cathodic protection, the sacrificial anode

    A. accepts electrons from the protected metal
    B. reacts spontaneously with the protected metal
    C. oxidizes more readily than the protected metal
    D. causes the protected metal to become an anode

60. During the corrosion of Mg in a biomedical implant, the anode reaction is

    A. $Mg \rightarrow Mg^{2+} + 2e^-$
    B. $Mg^{2+} + 2e^- \rightarrow Mg$
    C. $4OH^- \rightarrow O_2 + 2H_2O + 4e^-$
    D. $O_2 + 2H_2O + 4e^- \rightarrow 4\ OH^-$