

4-100

ENTRANCE EXAMINATIONS – 2020
(Ph.D. Admissions - January 2021 Session)

Ph.D. (Materials Engineering)

Marks: 70

Time: 2 h Hall Ticket No:

- I. Write your Hall Ticket Number on 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 1.75 marks each with no negative marking.
2. Part 'B': It consists of 35 objective questions of one mark each with no negative marking.
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:



No additional sheets will be provided. Rough work can be done in the question paper itself.

4. Hand over the OMR answer sheet at the end of the examination to the invigilator.
5. Mobile phones, log tables and calculators of any type are NOT permitted inside the Examination Hall.
6. This book contains 11 pages including this cover sheet.

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PART A

1. A scooter of mass 120 kg is moving with a uniform velocity of 108 km h⁻¹. The force required to stop the vehicle in 0.1 s is
 - A. 260N
 - B. 360N
 - C. 460N
 - D. 560N

2. A man of mass 60 kg climbs up a 20 m long staircase to the top of a building 10 m high. What is the work done by him? (Take $g = 10 \text{ ms}^{-2}$)
 - A. 12kJ
 - B. 6kJ
 - C. 18kJ
 - D. 3kJ

3. A body is acted upon by a force which is proportional to the distance covered. If distance covered is X, then work done by the force will be proportional to:
 - A. X
 - B. X²
 - C. X^{3/2}
 - D. X⁴

4. If the kinetic energy of a given particle is doubled, its momentum will be:
 - A. Doubled
 - B. Tripled
 - C. Increases by $\sqrt{2}$ times
 - D. Remains unchanged

5. Let $a=(4,5,6)$ and $b=(-1,2,-4)$ calculate the scalar product
 - A. -16
 - B. -20
 - C. 16
 - D. 10

6. A convex lens has a focal length of 150mm. If it is placed 180mm from mask on an optical bench, where must the screen be placed in order to focus the diffracted image into a sharp image?
 - A. 1100mm
 - B. 1080mm
 - C. 900mm
 - D. 1500mm

7. If a semiconductor is transparent only to wavelengths of radiation greater than the near infra-red region, then its band gap is likely to be
 - A. < 3.5 eV
 - B. < 3 eV
 - C. < 2.5 eV
 - D. < 1.5 eV

8. If a linear molecule rotates along two independent axes, then which of the following are its molar heat capacity at constant volume and constant pressure at temperature T (R being the ideal gas constant), respectively
- $(5/2)RT$ and $(7/2)RT$
 - $(5/2)R$ and $(7/2)R$
 - $(7/2)RT$ and $(5/2)RT$
 - $(7/2)R$ and $(5/2)R$
9. X-rays are
- Positively charged
 - Negatively charged
 - Neutral
 - Approximately 100 nm wavelength
10. The product of two complex numbers $(4+2i)$ and $(2+5i)$ is
- 2
 - $18+24i$
 - $-2+24i$
 - $8-10i$
11. The value of $\text{div}(\text{curl } \hat{C})$, where \hat{C} is a conservative vector field, is
- \hat{C}
 - 1
 - 0
 - i
12. If the trace of the given matrix is 16, then the value of n could be
- $$\begin{bmatrix} 6 & 5 & 8 \\ 2 & n^2 & 7 \\ 5 & 10 & 6 \end{bmatrix}$$
- +2, or -2
 - 2, or 0
 - 4 or -4
 - $+\sqrt{7}$ or $-\sqrt{7}$
13. Let $f(x) = 2x(x^2-5x+7)$, then the third derivative of $f(x)$ at $x=2$ is
- 24
 - 12
 - 2
 - 4
14. The first partial derivative of $f(x,y) = (xy)/(x^2+y^2)$ with respect to x is
- $y/(2x+y^2)$
 - $(x^2-y^2)/(x^2+y^2)$
 - $(x^2y-y^3)/(x^2+y^2)^2$
 - $(y^3-x^2y)/(x^2+y^2)^2$

15. Let (x_i, y_i) , where $i=1,2,\dots,n$, be the set of n observations of related data. If successive x values are equally spaced such that $x_{i+1}-x_i = h$, then the third moment of this set is
- $h\sum y$
 - $h\sum xy$
 - $h\sum x^2y$
 - $h\sum xy^2$
16. The value of $\int_{\pi/4}^{3\pi/4} \frac{dx}{1+\cos x}$ is equal to
- 2
 - 2
 - 4
 - 1
17. If an electron makes a transition from an excited state to the ground state of a hydrogen like atom/ion, then
- Kinetic energy, potential energy and total energy decrease
 - Kinetic energy decreases, potential energy increases but total energy remains same
 - Kinetic energy and total energy decrease but potential energy increases
 - Kinetic energy increases but potential energy and total energy decrease
18. Which one of the following compounds has sp^2 hybridisation
- CO_2
 - SO_2
 - N_2O
 - CO
19. The difference between the measured value x_m and the true value x_c with regard to sign is known as
- Relative error
 - Absolute error
 - Percent relative error
 - Error
20. If mean of a set of data is 61.37 and mean deviation is 0.12, then, the relative mean deviation is
- 0.20
 - 2.0
 - 0.02
 - 0.04

PART B

21. Iron or steel is used in reinforcement in concrete because:
- Concrete has high coefficient of expansion than iron or steel
 - Concrete has low coefficient of expansion than iron or steel
 - Both have nearly equal coefficient of expansions
 - Iron or steel is a good conductor of heat
22. Crucibles are made of mixture of quartz and silica since the linear coefficient of expansion is:
- Zero for that mixture
 - Infinity for that mixture
 - Negative for that mixture
 - Positive for that mixture
23. Thermal conductivity of copper is higher than iron. When a strip made of iron and copper is heated:
- Its length does not change
 - It gets twisted
 - It bends with iron on concave side
 - It bends with iron on convex side
24. All elastic waves in solid are:
- Always transverse
 - Always longitudinal
 - Either transverse or longitudinal
 - Neither transverse nor longitudinal
25. Two short magnets placed along the same axis with their like poles facing each other will repel each other with a force which varies inversely as:
- Distance
 - Square of distance
 - Cube of distance
 - Fourth power of distance
26. Magnitude of the cross product of two vectors $\vec{m} \times \vec{n}$ represents
- Area covered by \vec{m} and \vec{n}
 - Determinant of the product of two vectors
 - Magnitude of the projection of \vec{m} on \vec{n}
 - Determinant of the sum of two vectors

27. Some materials have the ability to absorb energy and then re-emitting visible light in a phenomenon called
- A. Photoelectric
 - B. Luminescence
 - C. Light amplification by stimulated emission of radiation
 - D. Total internal reflection
28. Coordinates in Fe-Fe₃C phase diagram are
- A. Composition and temperature
 - B. Composition and partial pressure
 - C. Temperature and pressure
 - D. Temperature and volume
29. Efficiency of an engine
- A. Work extracted – Heat supplied
 - B. Work extracted / Heat supplied
 - C. Work extracted + Heat supplied
 - D. Work extracted × Heat supplied
30. Which of the following is wrong with regard to a reversible process?
- A. Work-done is maximum
 - B. Entropy generation is maximum
 - C. Heat dissipation is minimum
 - D. Efficiency is maximum
31. Which process is used industrially to liquify gas?
- A. Temperature increment
 - B. Volume expansion
 - C. Pressure increment
 - D. Mass increment
32. Clausius Clapeyron equation does not explain
- A. Effect of pressure on transformation temperature
 - B. Effect of temperature on transformation stress
 - C. Relation between transformation strain and pressure
 - D. Relation between heat capacity on transformation strain
33. Which of the following statements is wrong about Ideal gas?
- A. Has no volume for individual atoms
 - B. Undergoes only elastic collisions
 - C. Does not follow ideal gas law at extremely high pressures
 - D. Follows ideal gas law at extremely high temperatures

34. What is the crystal structure of silicate glass?
- A. Body centered cubic
 - B. Body centered tetragonal
 - C. Simple cubic
 - D. Amorphous
35. Which of the following statement is true?
- A. Anisotropy means dependence of properties on direction
 - B. Metallic bond always requires atoms to stay in a crystalline structure
 - C. Covalent bond has no directionality
 - D. Solid solutions always have the crystal structure of solute
36. Which is true about work?
- A. Work done by a force over a potential
 - B. Rate of change of momentum
 - C. Rate of change of velocity
 - D. Work done against a force
37. A Tauc plot between the $h\nu$ on the X-axis and the quantity $(\alpha h\nu)^{1/2}$ on the Y-axis (where α is the absorption coefficient of the material, h is plank's constant and $h\nu$ is the energy of the light) is used to determine which one of the following
- A. Bandgap
 - B. Transmittance
 - C. Reflectivity
 - D. Mobility
38. Metals expand on heating due to
- A. Increase in the bond energy between atoms
 - B. Increase in the vibration wavelength of atoms
 - C. Increase in the Gibbs energy of the metal
 - D. Increase in the number of defects created
39. Energy source of star light
- A. Gravitational energy
 - B. Nuclear energy
 - C. Chemical energy
 - D. Heat energy
40. When a bottle of perfume is opened in one corner of a room the smell spreads soon throughout the room. This is an example of
- A. surface tension
 - B. capillarity
 - C. viscosity
 - D. diffusion

41. Which of the following is true with regard to chemical elements?
- A. Fire, water, land, wind and sky are the basic chemical elements
 - B. Periodic table of elements was incomplete when it was first made by Mendeleev
 - C. The change in atomic number means a change in number of neutrons
 - D. When light falls on elements, they do not observe any wavelength
42. Which of the following is true with regard to metabolisms in a biological creature?
- A. Chemical reactions can sometimes involve electron, proton and neutron exchanges
 - B. Chemical reactions can sometimes transmute certain elements to gold
 - C. Chemical reactions always involve only electron exchange and no neutron or proton exchange
 - D. Chemical reactions always take heat
43. Which of the following is the material used in the modern aircraft engines?
- A. Aluminum-Silicon-Magnesium alloy
 - B. Aluminum-Copper alloy
 - C. Ni-base superalloys
 - D. Stainless steel
44. To get the total magnification, the power of objective should be _____ to the objective lens power.
- A. Added
 - B. Multiplied
 - C. Divided
 - D. Subtracted
45. In scanning electron microscopy which of the following signals are preferred for imaging and analyzing a fracture surface
- A. Transmitted electrons
 - B. Auger electrons
 - C. Backscattered electrons
 - D. Secondary electrons
46. Why are thin sections of specimens necessary in transmission electron microscopy
- A. Electrons are negatively charged
 - B. Electrons have a wave nature
 - C. Electrons have no mass
 - D. Electrons have a poor penetrating power

47. What is meant by misfit strain in coating technology
- A. A strain corresponding to the difference in stress-free dimension of two constituents that are bonded together in some way
 - B. A strain resulting from imposition on a coating in order to make it stress free
 - C. A strain resulting from imposition of the condition that the coating and substrate remain bonded together
 - D. A strain that arises between coating and substrate as a result of temperature change
48. Lattice parameter of Monoclinic
- A. $a \neq b \neq c$ and $\alpha = \beta = 90 \neq \gamma$
 - B. $a \neq b \neq c$ and $\alpha = \beta \neq 90 \neq \gamma$
 - C. $a \neq b = c$ and $\alpha = \beta = 90 \neq \gamma$
 - D. $a = b = c$ and $\alpha = \beta = \gamma = 90$
49. Reaction of iron oxides by carbon monoxide and hydrogen with the formation of CO_2 and H_2O as final products is called as
- A. Direct reduction
 - B. Oxidation
 - C. Indirect Reduction
 - D. Metallization
50. Which one of the following defects does not occur during casting?
- A. Micro shrinkage
 - B. Porosity
 - C. Slag inclusion
 - D. Alligatoring
51. A piece of copper and germanium both are cooled from room temperature to 70°K . The resistance of
- A. Both copper and germanium increase
 - B. Both copper and germanium decrease
 - C. Copper increases and germanium decreases
 - D. Copper decreases and germanium increases
52. The magnitude of the diffusion coefficient increases
- A. Exponentially with increasing temperature
 - B. Linearly with increasing temperature
 - C. Inversely with increasing temperature
 - D. Remains constant with increasing temperature

53. Bulk modulus expression involves
- A. Linear stress
 - B. Shear stress
 - C. Hydrostatic stress
 - D. Poisson's ratio
54. SiO_2 refractories are not used in
- A. Coke oven walls
 - B. Dome & Upper portion of stoves
 - C. Open hearth furnace roof
 - D. Beehive coke ovens
55. Ceramic recuperators are generally made of
- A. Fireclay brick
 - B. Calcium Carbide
 - C. High Al_2O_3 basics
 - D. SiC

Key for ME_JAN 2021 (Y-100)

Q No	Ans	Q No	Ans	Q No	Ans
1	B	21	C	41	B
2	D	22	A	42	C
3	B	23	C	43	C
4	C	24	C	44	B
5	A	25	D	45	D
6	B	26	A	46	D
7	D	27	B	47	A
8	B	28	A	48	A
9	C	29	B	49	C
10	C	30	B	50	D
11	C	31	C	51	D
12	A	32	D	52	A
13	B	33	C	53	C
14	D	34	D	54	D
15	C	35	A	55	D
16	B	36	D		
17	D	37	A		
18	B	38	B		
19	B	39	B		
20	B	40	D		