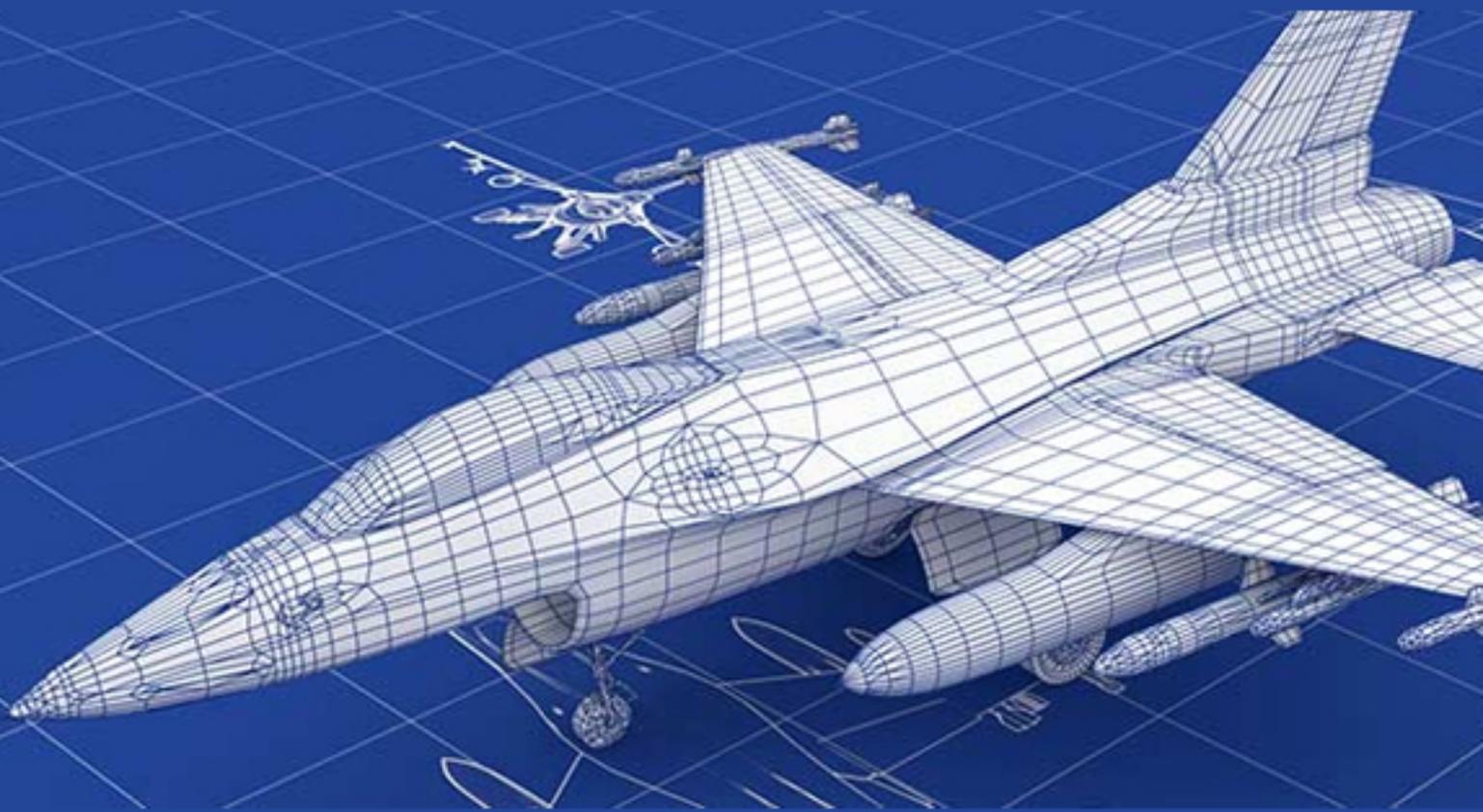


GATE



**Aerospace Engineering
Previous Year Question Papers
With Answers
(2016-2012)**

Q. 1 – Q. 5 carry one mark each.

Q.1 The chairman requested the aggrieved shareholders to _____ him.

- (A) bare with (B) bore with (C) bear with (D) bare

Q.2 Identify the correct spelling out of the given options:

- (A) Managable (B) Manageable (C) Mangaable (D) Managible

Q.3 Pick the odd one out in the following:

13, 23, 33, 43, 53

- (A) 23 (B) 33 (C) 43 (D) 53

Q.4 R2D2 is a robot. R2D2 can repair aeroplanes. No other robot can repair aeroplanes.

Which of the following can be logically inferred from the above statements?

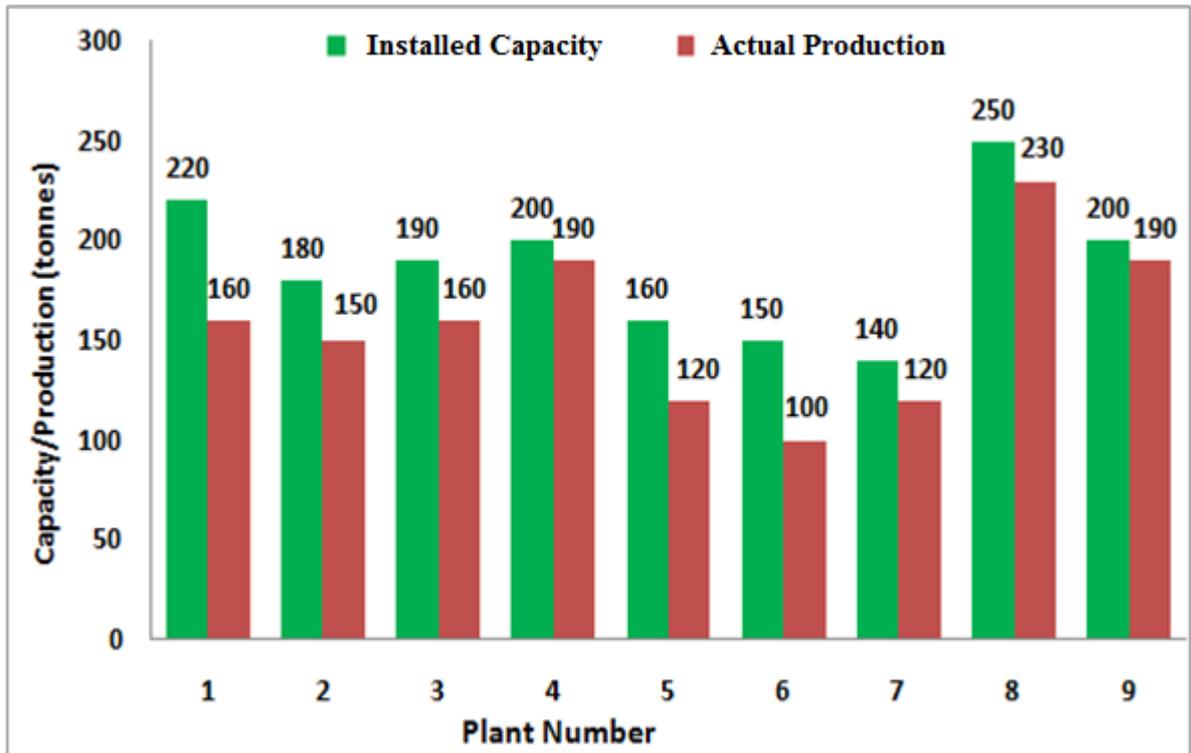
- (A) R2D2 is a robot which can only repair aeroplanes.
(B) R2D2 is the only robot which can repair aeroplanes.
(C) R2D2 is a robot which can repair only aeroplanes.
(D) Only R2D2 is a robot.

Q.5 If $|9y-6|=3$, then $y^2 - 4y/3$ is _____.

- (A) 0 (B) +1/3 (C) -1/3 (D) undefined

Q. 6 – Q. 10 carry two marks each.

Q.6 The following graph represents the installed capacity for cement production (in tonnes) and the actual production (in tonnes) of nine cement plants of a cement company. Capacity utilization of a plant is defined as ratio of actual production of cement to installed capacity. A plant with installed capacity of at least 200 tonnes is called a large plant and a plant with lesser capacity is called a small plant. The difference between total production of large plants and small plants, in tonnes is _____.



Q.7 A poll of students appearing for masters in engineering indicated that 60 % of the students believed that mechanical engineering is a profession unsuitable for women. A research study on women with masters or higher degrees in mechanical engineering found that 99 % of such women were successful in their professions.

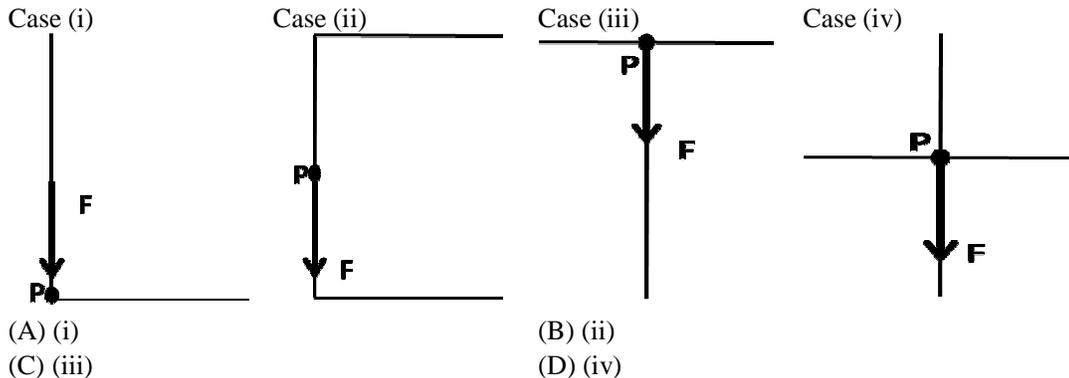
Which of the following can be logically inferred from the above paragraph?

- (A) Many students have misconceptions regarding various engineering disciplines.
- (B) Men with advanced degrees in mechanical engineering believe women are well suited to be mechanical engineers.
- (C) Mechanical engineering is a profession well suited for women with masters or higher degrees in mechanical engineering.
- (D) The number of women pursuing higher degrees in mechanical engineering is small.

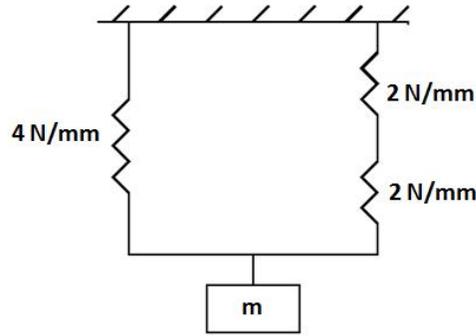
Q. 1 – Q. 25 carry one mark each.

- Q.1 With increase in airfoil thickness, the critical Mach number for an airfoil is likely to
(A) decrease. (B) increase. (C) remain unchanged. (D) be undefined.
- Q.2 Due to a body in potential flow, the velocity at a point A in the flow field is 20 m/s while the free stream velocity is only 10 m/s. The value of coefficient of pressure (C_p) at the point A is _____.
- Q.3 Which of the following airfoil will have location of the maximum camber at half chord length from the leading edge?
(A) NACA 5212 (B) NACA 1225 (C) NACA 2215 (D) NACA 2512
- Q.4 For a laminar incompressible flow past a flat plate at zero angle of attack, the variation of skin friction drag coefficient (C_f) with Reynolds number based on the chord length (Re_c) can be expressed as
(A) $C_f \propto \sqrt{Re_c}$
(B) $C_f \propto Re_c$
(C) $C_f \propto \frac{1}{\sqrt{Re_c}}$
(D) $C_f \propto \frac{1}{Re_c}$
- Q.5 Which of the following statement is NOT TRUE across an oblique shock wave?
(A) Static temperature increases, total temperature remains constant.
(B) Static pressure increases, static temperature increases.
(C) Static temperature increases, total pressure decreases.
(D) Static pressure increases, total temperature decreases.
- Q.6 For a completely subsonic isentropic flow through a convergent nozzle, which of the following statement is TRUE?
(A) Pressure at the nozzle exit > back pressure.
(B) Pressure at the nozzle exit < back pressure.
(C) Pressure at the nozzle exit = back pressure.
(D) Pressure at the nozzle exit = total pressure.
- Q.7 Which of the following aircraft engines has the highest propulsive efficiency at a cruising Mach number of less than 0.5?
(A) Turbofan engine (B) Turbojet engine
(C) Turboprop engine (D) Ramjet engine
- Q.8 Air, with a Prandtl number of 0.7, flows over a flat plate at a high Reynolds number. Which of the following statement is TRUE?
(A) Thermal boundary layer is thicker than the velocity boundary layer.
(B) Thermal boundary layer is thinner than the velocity boundary layer.
(C) Thermal boundary layer is as thick as the velocity boundary layer.
(D) There is no relationship between the thicknesses of thermal and velocity boundary layers.

- Q.9 Consider an eigenvalue problem given by $\mathbf{Ax} = \lambda_i \mathbf{x}$. If λ_i represent the eigenvalues of the non-singular square matrix \mathbf{A} , then what will be the eigenvalues of matrix \mathbf{A}^2 ?
- (A) λ_i^4 (B) λ_i^2 (C) $\lambda_i^{1/2}$ (D) $\lambda_i^{1/4}$
- Q.10 If \mathbf{A} and \mathbf{B} are both non-singular $n \times n$ matrices, then which of the following statement is NOT TRUE. Note: \det represents the determinant of a matrix.
- (A) $\det(\mathbf{AB}) = \det(\mathbf{A})\det(\mathbf{B})$
 (B) $\det(\mathbf{A+B}) = \det(\mathbf{A}) + \det(\mathbf{B})$
 (C) $\det(\mathbf{AA}^{-1}) = 1$
 (D) $\det(\mathbf{A}^T) = \det(\mathbf{A})$
- Q.11 The total number of material constants that are necessary and sufficient to describe the three dimensional Hooke's law for an isotropic material is ____.
- Q.12 Determine the correctness or otherwise of the following statements, [a] and [r]:
- [a]: In a plane stress problem, the shear strains along the thickness direction of a body are zero but the normal strain along the thickness is not zero.
- [r]: In a plane stress problem, Poisson effect induces the normal strain along the thickness direction of the body.
- (A) Both [a] and [r] are true and [r] is the correct reason for [a].
 (B) Both [a] and [r] are true but [r] is not the correct reason for [a].
 (C) Both [a] and [r] are false.
 (D) [a] is true but [r] is false.
- Q.13 Consider four thin-walled beams of different open cross-sections, as shown in the cases (i-iv). A shear force of magnitude ' \mathbf{F} ' acts vertically downward at the location ' \mathbf{P} ' in all the beams. In which of the following case, does the shear force induce bending and twisting?



Q.14 The effective stiffness of the spring-mass system as shown in the figure below is ____ N/mm.



Q.15 A structural member supports loads, which produce at a particular point, a state of pure shear stress of 50 N/mm^2 . At what angles are the principal planes oriented with respect to the plane of pure shear?

- (A) $\pi/6$ and $2\pi/3$ (B) $\pi/4$ and $3\pi/4$ (C) $\pi/4$ and $\pi/2$ (D) $\pi/2$ and π

Q.16 Let x be a positive real number. The function $f(x) = x^2 + \frac{1}{x^2}$ has its minima at $x = \underline{\hspace{2cm}}$.

Q.17 The vector \vec{u} is defined as $\vec{u} = y\hat{e}_x - x\hat{e}_y$, where \hat{e}_x and \hat{e}_y are the unit vectors along x and y directions, respectively. If the vector $\vec{\omega}$ is defined as $\vec{\omega} = \vec{\nabla} \times \vec{u}$, then $\left| (\vec{\omega} \cdot \vec{\nabla}) \vec{u} \right| = \underline{\hspace{2cm}}$.

Q.18 The partial differential equation $\frac{\partial u}{\partial t} = \alpha \frac{\partial^2 u}{\partial x^2}$, where α is a positive constant, is

- (A) circular. (B) elliptic. (C) hyperbolic. (D) parabolic.

Q.19 Combustion in gas turbine engines is ideally represented as the following process:

- (A) Adiabatic (B) Isentropic (C) Isobaric (D) Isochoric

Q.20 For a given chamber pressure, the thrust of a rocket engine is highest when

- (A) the rocket is operating at its design altitude.
 (B) the rocket is operating in vacuum.
 (C) the rocket is operating at sea-level.
 (D) there is a normal shock in the rocket nozzle.

Q.21 The damping ratio in phugoid motion for gliders is usually less compared to powered aircraft because

- (A) gliders are unpowered.
 (B) gliders are light.
 (C) lift to drag ratio is higher for gliders.
 (D) gliders fly at low speed.

Q.22 During an aircraft cruising flight, the altitude above the ground is usually measured using

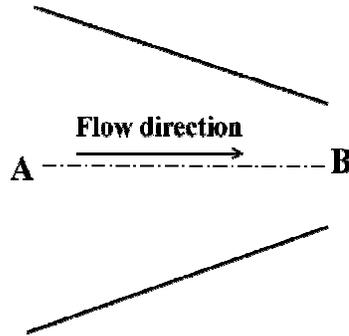
- (A) dynamic pressure. (B) static pressure.
 (C) radar. (D) laser range finder.

- Q.23 Indicated airspeed is used by a pilot during
(A) take-off. (B) navigation.
(C) setting the engine RPM. (D) setting the elevator angle.
- Q.24 The pitch angle and the angle of attack for a fixed wing aircraft are equal during
(A) wings level constant altitude flight.
(B) unaccelerated climb.
(C) unaccelerated descent.
(D) landing.
- Q.25 The load factor of an aircraft turning at a constant altitude is 2. The coefficient of lift required for turning flight as compared to level flight at the same speed will be
(A) same (B) half
(C) double (D) four times

Q. 26 – Q. 55 carry two marks each.

- Q.26 An un-mixed turbofan engine with a bypass ratio of 6.0, flies with a velocity of 200 m/s. The core and the bypass nozzles of the engine, that are both convergent nozzles, operate under choked condition and have exhaust static temperatures of 580 K and 295 K, respectively. The specific gas constant and the ratio of specific heats for both the streams are 287 J/kgK and 1.4, respectively. If the fuel-air ratio is negligible, the thrust per unit mass flow rate generated by the engine is _____Ns/kg.
- Q.27 A single-stage gas turbine operates with an axial absolute flow at the entry and exit from the stage. The absolute flow angle at the nozzle exit is 70° . The turbine stage generates a specific work of 228 kJ/kg when operating with a mean blade speed of 440 m/s. The absolute velocity at the rotor entry is
(A) 275.7 m/s (B) 551.5 m/s (C) 1103.0 m/s (D) 1654.5 m/s
- Q.28 An axial compressor operates such that it has an inlet and an exit total temperature of 300 K and 430 K, respectively. The isentropic efficiency of the compressor is 85 %. If the ratio of specific heats is 1.4, then the total pressure ratio across the compressor is _____.
- Q.29 The maximum value of coefficient of lift (C_L) for a 2D circular cylinder, provided at least one stagnation point lies on the cylinder surface, is predicted by the potential flow theory to be
(A) $\pi/2$ (B) π (C) 2π (D) 4π

- Q.30 The nozzle AB, as shown below, leading to the test section of a low speed subsonic wind tunnel, has a contraction ratio of 10:1. The pressure difference across the nozzle is maintained at 1000 N/m^2 and the density of air is 1.23 kg/m^3 . Assuming one-dimensional, steady, inviscid flow, the velocity in the test section as measured at point B is _____ m/s.



- Q.31 The rate of change of moment coefficient with respect to the angle of attack, $\frac{dC_m}{d\alpha}$, at half chord point of a thin airfoil, as per approximations from the thin airfoil theory is
 (A) $\pi/4 \text{ radian}^{-1}$ (B) $\pi/2 \text{ radian}^{-1}$ (C) $\pi \text{ radian}^{-1}$ (D) $2\pi \text{ radian}^{-1}$
- Q.32 An untwisted wing of elliptic planform and aspect ratio 6 consists of thin symmetric airfoil sections. The coefficient of lift (C_L) at 10° angle of attack assuming inviscid incompressible flow is
 (A) $\pi^2/16$ (B) $\pi^2/12$ (C) $\pi^2/8$ (D) $\pi/2$
- Q.33 A gaseous mixture of air and fuel enters a constant area combustion chamber at a velocity of 100 m/s and at a static temperature of 300 K . The heat release due to combustion is 1000 kJ/kg . The specific heat at constant pressure of the calorically perfect gas is 1000 J/kgK . The total temperature of air-fuel mixture after combustion is _____ K.
- Q.34 Consider 1-D, steady, inviscid, compressible flow through a convergent nozzle. The total temperature and total pressure are T_o , P_o respectively. The flow through the nozzle is choked with a mass flow rate of \dot{m}_o . If the total temperature is increased to $4T_o$, with total pressure remaining unchanged, then the mass flow rate through the nozzle
 (A) remains unchanged.
 (B) becomes half of \dot{m}_o .
 (C) becomes twice of \dot{m}_o .
 (D) becomes four times of \dot{m}_o .
- Q.35 Consider a second order linear ordinary differential equation $\frac{d^2y}{dx^2} - 4\frac{dy}{dx} + 4y = 0$, with the boundary conditions $y(0) = 1$; $\left. \frac{dy}{dx} \right|_{x=0} = 1$. The value of y at $x = 1$ is
 (A) 0 (B) 1 (C) e (D) e^2

Q.36 Consider the following system of linear equations:

$$2x - y + z = 1$$

$$3x - 3y + 4z = 6$$

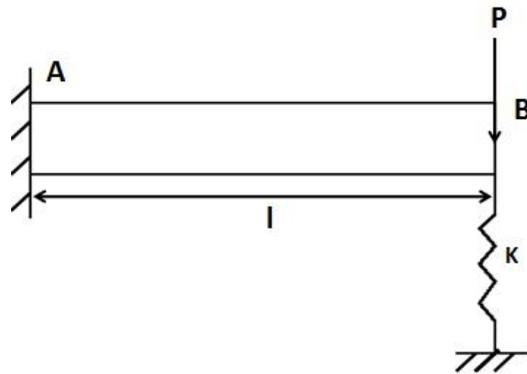
$$x - 2y + 3z = 4$$

This system of linear equations has

- (A) no solution.
- (B) one solution.
- (C) two solutions.
- (D) three solutions.

Q.37 A bar made of linear elastic isotropic material is fixed at one end and subjected to an axial force of 1 kN at the other end. The cross-sectional area of the bar is 100 mm^2 , length is 100 mm and the Young's Modulus is $1 \times 10^5 \text{ N/mm}^2$. The strain energy stored in the bar is ____ Nmm.

Q.38 A cantilever beam-spring system is shown in the figure. The beam is made with a material of Young's modulus $1 \times 10^5 \text{ N/mm}^2$ and geometry such that its moment of inertia is 100 mm^4 and length $l = 100 \text{ mm}$. It is supported by a spring of stiffness $K = 30 \text{ N/mm}$ and subjected to a load of $P = 100 \text{ N}$ at the point 'B'. The deflection at the point 'B' due to the load P is ____ mm.



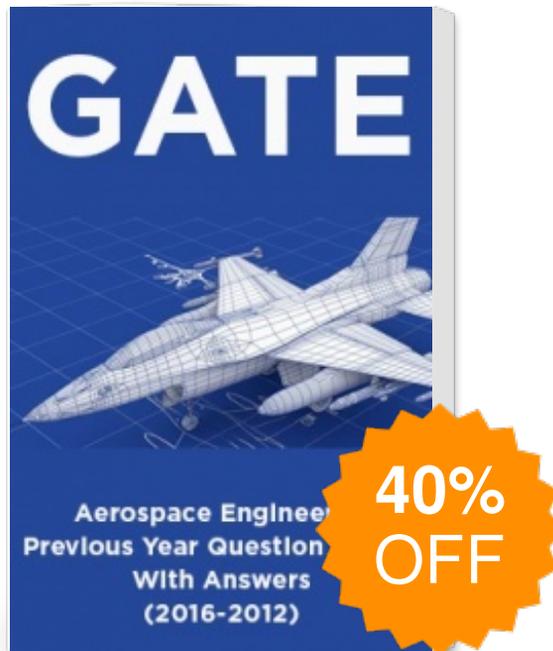
Q.39 Determine the correctness or otherwise of the following statements, [a] and [r],

[a]: Ribs, used in airplane wings, increase the column buckling strength of the longitudinal stiffeners.

[r]: Ribs distribute concentrated loads into the structure and redistribute stresses around discontinuities.

- (A) Both [a] and [r] are true and [r] is the correct reason for [a]
- (B) Both [a] and [r] are true but [r] is not the correct reason for [a]
- (C) Both [a] and [r] are false
- (D) [a] is true but [r] is false

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Publisher : Faculty Notes

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