

ECAT 2015 — Engineering Entry Test

University of Engineering & Technology (UET) Lahore

Total Questions: 72 | Subjects: Physics · Mathematics · Chemistry

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— PHYSICS —

Q1. A thermistor with a negative temperature coefficient is placed inside a furnace. As the furnace temperature rises, the resistance of the thermistor will:

- (a) Decrease
- (b) Increase
- (c) Remain unchanged
- (d) None of the above

Q2. The logic gate circuit shown (two NOT gates feeding a NAND gate) is equivalent to which single gate?

- (a) NOR
- (b) NAND
- (c) OR
- (d) XOR

Q3. Reception of a particular radio station is selected by adjusting the tuning knob of a radio. What does turning the knob change?

- (a) Inductance
- (b) Capacitance
- (c) Impedance
- (d) All of the above

Q4. An AC voltage is passed through a single diode rectifier. What is the output waveform?

- (a) Full-wave DC voltage
- (b) Half-wave DC voltage
- (c) Double-frequency AC voltage
- (d) None

Q5. In amplitude modulation (AM), the amplitude of the carrier wave varies in proportion to:

- (a) The amplitude of the modulating signal
- (b) The sign of the modulating signal
- (c) The frequency of the modulating signal
- (d) All of the above

Q6. As water falls freely from a tap and its speed increases, the cross-sectional area of the stream decreases. This follows from:

- (a) Bernoulli's Equation
- (b) The Equation of Continuity
- (c) Venturi's Relation
- (d) None

Q7. The density of oxygen is approximately 16 times that of hydrogen. If the speed of sound in hydrogen is x , what is the speed of sound in oxygen?

- (a) Greater than x
- (b) Less than x
- (c) The same as x
- (d) Depends on gas pressure

Q8. A police motorcycle travelling at 140 km/h sounds a siren of 10 kHz while chasing a car moving at 150 km/h. What apparent frequency does the car driver hear?

- (a) Greater than 10 kHz
- (b) 10 kHz
- (c) The siren will not be heard
- (d) Less than 10 kHz

Q9. For a single-input NAND gate (X connected to both inputs), the relationship between input X and output Y is:

- (a) $y = x$
- (b) $y' = x$
- (c) $y = x'$
- (d) Both b and c

Q10. You have 20 inductors, each of 15 H. To obtain an effective inductance of 1 H, you should connect:

- (a) 15 inductors in parallel
- (b) 20 inductors in series
- (c) 15 inductors in series
- (d) 20 inductors in parallel

Q11. Circuit X has $L = 100$ mH and $C = 100$ μ F in series. Circuit Y has $L = 100$ mH and $C = 10$ μ F in parallel. How are the resonant frequencies f_x and f_y related?

- (a) $f_x = f_y$
- (b) $f_x = 10 f_y$
- (c) $f_x = 0.01 f_y$
- (d) Cannot be determined

Q12. A transformer has 100 turns on the primary and 500 turns on the secondary. The primary RMS voltage is 220 V and primary current is 5 A. What is the output power (assuming ideal transformer)?

- (a) 500 W
- (b) 1100 W
- (c) 1440 W
- (d) 50 W

Q13. When a ball is dropped it accelerates at 9.8 m/s^2 . If instead you throw it downward, its acceleration immediately after release (assuming no air resistance) is:

- (a) 9.8 m/s^2
- (b) More than 9.8 m/s^2
- (c) Less than 9.8 m/s^2
- (d) Depends on throwing speed

Q14. A truck of mass 5000 kg and a car of mass 1000 kg both travel at 36 km/h. The force X to stop the truck in 10 s and force Y to stop the car in 10 s differ by:

- (a) 4 MN
- (b) 4 kN
- (c) 14.4 kN
- (d) 14.4 MN

Q15. A tight wire is clamped at two points 2 m apart and plucked near one end. The three longest wavelengths produced are:

- (a) 2 m, 1 m, 0.67 m
- (b) 4 m, 2 m, 1.33 m
- (c) 4 m, 2 m, 1 m
- (d) 1 m, 0.5 m, 0.33 m

Q16. When using an optical fibre for data transmission, the angle of incidence of light at the glass–air interface must be:

- (a) Less than the critical angle
- (b) Greater than the critical angle
- (c) Less than the angle of refraction
- (d) Greater than the angle of refraction

Q17. Two concentric spheres A (radius r_a) and B (radius r_b) surround a point charge Q, with $r_a > r_b$. The total electric flux through sphere A compared to sphere B is:

- (a) Greater through A
- (b) Equal through both spheres
- (c) May be greater or less depending on radii
- (d) Greater through B

Q18. A mixture of two gases at constant temperature has molecules of mass m_1 (rms speed c_1) and m_2 (rms speed c_2). The ratio c_1/c_2 equals:

- (a) m_1/m_2
- (b) m_2/m_1
- (c) $\sqrt{(m_1/m_2)}$
- (d) $\sqrt{(m_2/m_1)}$

Q19. In an inelastic collision between two bodies, which quantity is conserved?

- (a) Kinetic energy
- (b) Momentum
- (c) Both kinetic energy and momentum
- (d) Neither

— MATHEMATICS —

Q20. What is the valid value of x in the equation $\log_3(x^{\sqrt{27}}) = 0$?

- (a) $1/4$
- (b) $3/4$
- (c) $1/2$
- (d) $5/2$

Q21. The gradient of the curve $y = (ax + b)/x^2$ at the point $(2, 5)$ is 2. The values of a and b are:

- (a) $a = 7, b = 4$
- (b) $a = 7, b = 2$
- (c) $a = 7/3, b = 4/3$
- (d) $a = 7/3, b = 2/3$

Q22. Differentiating $e^{2x} / (x + 1)$ with respect to x gives:

- (a) $2e^{2x} / (x+1)^2$
- (b) $(2x+1)e^{2x} / (x+1)^2$
- (c) $2xe^{2x} / (x+1)^2$
- (d) $(x+1)e^{2x} / (x+1)^2$

Q23. If $dy/dx = x^2 + 2$, then y is given by:

- (a) $y = x^3/3 + 2x + c$
- (b) $y = 2x + c$
- (c) $y = 2x + 2 + c$
- (d) $y = x^3/3 + x + c$

Q24. Given $A = \begin{bmatrix} 3 & -4 \\ 2 & -2 \end{bmatrix}$ and $AB = I$ (identity matrix), the matrix B is:

- (a) $\begin{bmatrix} -1 & 2 \\ 2 & -2 \end{bmatrix}$
- (b) $\begin{bmatrix} 2 & -1 \\ 2 & -1 \end{bmatrix}$
- (c) $\begin{bmatrix} 3 & 4 \\ -2 & 2 \end{bmatrix}$
- (d) $\begin{bmatrix} 1 & 2 \\ -1 & 3/2 \end{bmatrix}$

Q25. Find all angles between 0° and 360° satisfying $\sin x = -1/2$.

- (a) $210^\circ, 330^\circ$
- (b) $30^\circ, 150^\circ$
- (c) $30^\circ, 210^\circ$
- (d) $330^\circ, 150^\circ$

Q26. Simplifying $(1 + \cos x) / (1 + \sec x)$ gives:

- (a) $\sin x$
- (b) $\cos x$
- (c) $\csc x$
- (d) $\sec x$

Q27. A binomial expansion gives $1 - 8x + 24x^2 - 32x^3 + 16x^4$. The original expression A is:

- (a) $(1 - 2x)^4$
- (b) $(1 - 4x)^2$
- (c) $(1 + 2x)^4$
- (d) $(1 + 4x)^2$

Q28. Differentiating $(x - 1)(x - 2)^3$ with respect to x gives:

- (a) $2x(x + 2)$
- (b) $2(x - 1)(2x - 5)$ — using product rule
- (c) $2(x - 1)$
- (d) $3x(x + 2)$

Q29. The equation $2^{2x} - 3 + 2^{x+1} + 32 = 0$ has solutions for x equal to:

- (a) (3, 4)
- (b) (8, 4)
- (c) (2, 3)
- (d) (5, 9)

Q30. The area enclosed by $y = \cos x$ and the x -axis from $x = 0$ to $x = \pi/2$ is equal to which of the following integrals?

- (a) $\int(\pi/2 \text{ to } \pi) \sin x \, dx$
- (b) $\int(\pi \text{ to } \pi/2) \sin x \, dx$
- (c) $-\int(\pi/2 \text{ to } \pi) \cos x \, dx$
- (d) All of these

Q31. A particle moves in a straight line with velocity $v = (4 - t^2)$ m/s. The acceleration of the particle at $t = 4$ s is:

- (a) -8 m/s^2
- (b) -8 m/s
- (c) -4 m/s
- (d) -4 m/s^2

Q32. The complex number $(1 + i\sqrt{3})$ expressed in polar (modulus-argument) form is:

- (a) $2(\cos 30^\circ + i \sin 30^\circ)$
- (b) $\cos 60^\circ + i \sin 60^\circ$
- (c) $2(\cos 60^\circ + i \sin 60^\circ)$
- (d) $\sin 30^\circ + i \cos 30^\circ$

Q33. For a 2×2 matrix $A = \begin{bmatrix} 0 & 0 \\ 0 & p \end{bmatrix}$, the expression $A + A^{-1} = KI$ is valid for:

- (a) $K = 1$ (any $p \neq 0$)
- (b) $K = -1$
- (c) Not valid for any value of p
- (d) $K = 0, p = 1$

Q34. Given $y = x^2\sqrt{2x-1}$ and $dy/dx = x(2x+2)\sqrt{2x-1}$, the value of $\int \frac{1}{x(2x+2)\sqrt{2x-1}} dx$ is:

- (a) 78
- (b) 75
- (c) 33
- (d) 34

Q35. Which of the following is a valid root of $3x^3 - 8x^2 - 5x + 8$?

- (a) $x = 4$
- (b) $x = 3$
- (c) $x = 8$
- (d) Both a and b

Q36. Find the set of values of m for which $2x^2 - mx + 2 = 0$ has real roots.

- (a) $m \leq -4$
- (b) $-4 \leq m \leq 4$
- (c) $m \geq 4$
- (d) $m \leq -4$ or $m \geq 4$

Q37. 50 students: 38 use desktops, 16 use laptops, 5 use neither. Let A = students using both. The greatest possible value of A is:

- (a) 36
- (b) 4
- (c) 16
- (d) 9

Q38. Using the same data as Q37, the smallest possible value of A is:

- (a) 16
- (b) 8
- (c) 4
- (d) 9

Q39. Which of the following is a point of intersection of $x^2 + y^2 = 8$ and the line $2x - y = 2$?

- (a) $(-2, -2)$
- (b) $(2, 2)$
- (c) $(0.4, 2.8)$ approximately
- (d) $(0, 1)$

Q40. Two lines: $M: y = 3x + 1$ and $N: y = -(1/3)x + 2$. Which statement is correct?

- (a) M and N are parallel
- (b) M and N are perpendicular
- (c) M and N do not intersect
- (d) M and N intersect at multiple points

Q41. Given $f(x) = 2x + 1$ and $g(x) = x^2 - x$, the composite function $f(g(x))$ equals:

- (a) $2x^2 - x + 1$
- (b) $2x^2 - 2x + 2$
- (c) $2x^2 - 2x + 1$
- (d) $x^2 - 2x + 1$

Q42. The y-intercept and the slope of the line $3x - 2y + 6 = 0$ are respectively:

- (a) $3/2$ and -3
- (b) -3 and $-3/2$
- (c) $-3/3$ and $-3/2$
- (d) 3 and $3/2$

— CHEMISTRY —

Q43. In a microwave oven, which of the following polar molecules would absorb the maximum microwave energy?

- (a) SiO_2
- (b) $\text{C}_2\text{H}_5\text{OH}$
- (c) NaCl
- (d) None of these

Q44. Which statement about cathode rays is correct?

- (a) They can ionise gases
- (b) They carry momentum
- (c) They cannot cause chemical changes
- (d) Both (a) and (b)

Q45. Ionisation energy does NOT increase with:

- (a) Decreasing atomic radius
- (b) Increasing number of electron shells
- (c) Increasing proton number
- (d) None of these

Q46. Which of the following molecules does NOT exhibit a tetrahedral arrangement of electron pairs?

- (a) H_2O
- (b) SiCl_4
- (c) NH_3
- (d) None of these

Q47. The enthalpy change of the reaction $\text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O}$ is called:

- (a) Heat of reaction
- (b) Heat of fusion
- (c) Heat of neutralization
- (d) Heat of combustion

Q48. In which of the following reactions does hydrogen act as an oxidising agent?

- (a) $\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$
- (b) $2\text{Na} + \text{H}_2 \rightarrow 2\text{NaH}$
- (c) $\text{CH}_3\text{CHO} + \text{H}_2 \rightarrow \text{C}_2\text{H}_5\text{OH}$
- (d) $\text{C}_2\text{H}_2 + \text{H}_2 \rightarrow \text{C}_2\text{H}_4$

Q49. How many carbon atoms are present in 18 g of glucose ($\text{C}_6\text{H}_{12}\text{O}_6$, molar mass = 180 g/mol)?

- (a) 6.02×10^{23}
- (b) 6.02×10^{22}
- (c) 3.6×10^{23}
- (d) 3.6×10^{22}

Q50. In an experiment, 0.10 g of a gas occupies 83.1 cm³ at standard pressure (1.0×10^5 Pa) and 27°C. Using $PV = nRT$, which expression correctly gives the relative molecular mass?

- (a) $(0.10)(8.31)(27) / [(1.0 \times 10^5)(83.3)]$
- (b) $(0.10)(8.31)(27) / [(1.0 \times 10^5)(83.1 \times 10^{-3})]$
- (c) $(0.10)(8.31)(300) / [(1.0 \times 10^5)(83.1 \times 10^{-3})]$
- (d) $(0.10)(8.31)(300) / [(1.0 \times 10^5)(83.1 \times 10^{-3})]$ — using m³

Q51. Which of the following consists of atoms and/or molecules held together primarily by van der Waals forces?

- (a) H_2O
- (b) Cu
- (c) CO_2
- (d) MgO

Q52. Which molecule will NOT form a hydrogen bond with other molecules in the list?

- (a) NH_3
- (b) CH_3NH_2
- (c) CH_3OH
- (d) CH_3CHO

Q53. Which of the following species is the strongest reducing agent?

- (a) Cl^-
- (b) Ar
- (c) K^+
- (d) Ca^{2+}

Q54. Which of the following hydrides is ionic in nature?

- (a) NaH
- (b) NH₃
- (c) CH₄
- (d) H₂S

Q55. Which equation correctly represents the thermal decomposition of lithium nitrate?

- (a) $2\text{LiNO}_3 \rightarrow \text{Li}_2\text{O} + \text{NO}_2$
- (b) $4\text{LiNO}_3 \rightarrow 2\text{Li}_2\text{O} + 4\text{NO}_2$
- (c) $4\text{LiNO}_3 \rightarrow 4\text{LiO} + 4\text{NO}_2 + \text{O}_2$
- (d) $4\text{LiNO}_3 \rightarrow 2\text{Li}_2\text{O} + 4\text{NO}_2 + \text{O}_2$

Q56. Which compound is used in breathing equipment because it simultaneously absorbs CO₂ and releases O₂?

- (a) Na₂O₂
- (b) MgO
- (c) KO₂
- (d) BaO

Q57. Which equation represents the reaction of red lead (Pb₃O₄) with concentrated nitric acid?

- (a) $\text{Pb}_3\text{O}_4 + 4\text{HNO}_3 \rightarrow 2\text{Pb}(\text{NO}_3)_2 + \text{PbO} + 2\text{H}_2\text{O}$
- (b) $\text{Pb}_3\text{O}_4 + \text{HNO}_3 \rightarrow \text{Pb}(\text{NO}_3)_2 + \text{H}_2\text{O}$
- (c) $\text{Pb}_3\text{O}_4 + 8\text{HNO}_3 \rightarrow 3\text{Pb}(\text{NO}_3)_2 + 4\text{H}_2\text{O}$
- (d) None of the above

Q58. The equilibrium constant expression for the rate of the forward reaction of $\text{A} + \text{B} \rightleftharpoons \text{C} + \text{D}$ is:

- (a) K_f
- (b) $K_r[\text{A}][\text{B}]$
- (c) $K_f[\text{C}][\text{D}]$
- (d) $K_r[\text{A}][\text{B}] / K_f[\text{C}][\text{D}]$

Q59. The primary function of the salt bridge in a galvanic cell is:

- (a) To prevent charge build-up (ion accumulation) in each half-cell
- (b) To block the flow of ions between the two half-cells
- (c) To add salt ions into both half-cells
- (d) None of these

Q60. In the reaction $6\text{NaOH} + 3\text{Cl}_2 \rightarrow 5\text{NaCl} + 3\text{H}_2\text{O} + \text{NaClO}_3$, chlorine is:

- (a) Oxidised
- (b) Reduced
- (c) Both oxidised and reduced (disproportionation)
- (d) Neither

Q61. Tetraethyl lead added to petrol acts as:

- (a) An auto-catalyst
- (b) An activator
- (c) An anti-knock agent (inhibitor)
- (d) All of these

Q62. The correct statement about the effect of a catalyst on a reversible reaction is:

- (a) It increases the equilibrium constant for the forward reaction
- (b) It increases the yield of products at equilibrium
- (c) It increases the rate constant for both forward and reverse reactions equally
- (d) It increases only the rate of the forward reaction

Q63. In the free-radical chlorination of methane under UV light, the propagation step is:

- (a) $\text{CH}_4 + \text{Cl}\cdot \rightarrow \text{CH}_3\cdot + \text{HCl}$
- (b) $\text{CH}_4 + \text{Cl}\cdot \rightarrow \text{CH}_3\text{Cl} + \text{H}\cdot$
- (c) $\text{CH}_3\cdot + \text{Cl}_2 \rightarrow \text{CH}_3\text{Cl} + \text{Cl}\cdot$
- (d) $\text{H}\cdot + \text{Cl}_2 \rightarrow \text{Cl}\cdot + \text{HCl}$

Q64. How many structural isomers are possible for $\text{C}_2\text{H}_4\text{Cl}_2$?

- (a) 1
- (b) 2
- (c) 3
- (d) 4

Q65. The reaction $\text{CH}_3\text{Br} + \text{OH}^- \rightarrow \text{CH}_3\text{OH} + \text{Br}^-$ is best described as:

- (a) Electrophilic substitution
- (b) Nucleophilic substitution bimolecular (SN2)
- (c) Nucleophilic substitution unimolecular (SN1)
- (d) An addition reaction

Q66. The most common reagent used for the oxidation of alcohols in the laboratory is:

- (a) $\text{K}_2\text{Cr}_2\text{O}_7$
- (b) H_2SO_4
- (c) $\text{K}_2\text{CrO}_4 / \text{H}_2\text{SO}_4$
- (d) $\text{K}_2\text{Cr}_2\text{O}_7 / \text{H}_2\text{SO}_4$

Q67. Complete reduction of carboxylic acids to alkanes is best carried out using:

- (a) Hydrogen iodide (HI)
- (b) Lithium aluminium hydride (LiAlH_4)
- (c) Red phosphorus
- (d) Both HI and red phosphorus

Q68. Which of the following oxides will NOT dissolve in sodium hydroxide solution?

- (a) Al_2O_3
- (b) MgO
- (c) SiO_2
- (d) NO_2

Q69. Which statement about oxygen and sulphur is NOT correct?

- (a) Both have the same outer electronic configuration (Group 16)
- (b) Both are typical non-metals
- (c) Both support combustion
- (d) Both exhibit allotropic forms

Q70. Which of the following is used as a dehydrating agent for drying gases?

- (a) Phosphoric acid
- (b) Carboxylic acid
- (c) Concentrated sulphuric acid
- (d) Nitric acid

Q71. When chlorine is bubbled into cool, dilute aqueous sodium hydroxide, the products are:

- (a) NaCl , NaClO and H_2O
- (b) NaClO and H_2O
- (c) NaCl , NaClO and H_2O
- (d) NaClO_2 and H_2O

Q72. A crystalline solid used in preparing yellow paint pigment due to its characteristic colour and low solubility is:

- (a) KMnO_4
- (b) PbCrO_4
- (c) $\text{Al}_2(\text{SO}_4)_3$
- (d) None of these

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