COMPETITIVE ENTRANCE EXAMINATION INTO THE FIRST YEAR OF THE FIRST CYCLE
DEPARTMENT: PHYSICS

Instructions: Answer all the questions by writing the letter corresponding to the most correct answer in your Answer Booklet.

SECTION A: PHYSICS (MAJOR) [COMPULSORY]

Q1:A typical adult ear has a surface area of $2.0 \times 10^{-3} m^2$ .The sound intensity during a normal conversation is about $4.0 \times 10^{-3} w/m^2$ at the listener's ear. Assume that the sound strikes the surface of the ear perpendicularly. The power intercepted by the ear is

A) $8.0 \times 10^{-6} w$ B) $2.0 w$ C) $0.5 w$ D) None of these

Q2: The half-life of a radioactive specimen is 120 days. If a sample contains a mass m_0 of polonium today, what will be its mass after 360 days?

A $m_0/2$ B) $m_0/16$ C) $m_0/8$ D) $m_0/3$

Q3: The photoelectric doorstep of cesium is $\lambda_0 = 0.5\mu m$. What is the work of extraction of an electron of this metal?

A) $9.93 \times 10^{-19} joule$ B) $8.9 \times 10^{-19} joule$ C) $3.9 \times 10^{-19} joule$
D) $7.6 \times 10^{-19} joule$

Q4: Determine the kinetic energy of a ball of mass 1.0 kg rolling without slipping with a linear speed $10\ m/s$ on a horizontal plane

A) $700\ joules$ B) $70\ joules$ C) $50\ joules$ D) $100\ joules$

Q5: From an altitude of 80 m, an object is abandoned from rest. The equation giving the position of the object with reference to the ground

A) $-5t^2$ B) $-5t^2 - 80$ C) $-5t^2 + 80$ D) $5t^2$

A geostationary satellite is placed at 750 km above the surface of the earth at a position where the acceleration of the gravity is $9.8\ m/s^2$. *If the satellite moves at a speed of* $60\ m/s$ *and the radius of the earth is 3600 km*

Q6: The acceleration of the gravity as experienced by the satellite

A) $9.6\ m/s^2$ B) $6.71\ m/s^2$ C) $8.7\ m/s^2$ D) $5.71\ m/s^2$

Q7: And the angular speed of the satellite is

A $1.37 \times 10^{-5}\ rad/s$ B) $-1.7 \times 10^{-5}\ rad/s$ C) $1.37 \times 10^{-3}\ rad/s$ D) $2.5 \times 10^{-4}\ rad/s$

Q8: What is the root-mean-square voltage of an alternating current $(t) = 4\sin 100\pi t$?

A) 2.0 A   B) 1.828 A   C) 3.820 A   D) 2.823 A

Q9: The momentum of a car of mass 2.5 tones moving at the speed $100\ m/s$ is

A) $2500\ kg/s$ B) $2.5 \times 10^5\ kg/s$ C) $250\ kg/s$ D) $2.5 \times 10^7\ kg/s$

Q10: A football player places the ball at a distance of 11 m from the goal and shoots a penalty by communicates to the ball a speed V_0 making an angle of 30° with the upward vertical. For which speed ranges of V_0 will the ball enter the goal if the height of the goal is 2.40 m? $(g = 10\ m/s^2)$

A $V_0\ \leq 11.2\ m/s$ B) $V_0\ \leq 8.5\ m/s$ C) $V_0\ \leq 12.05\ m/s$ D) $V_0\ \leq 14.25\ m/s$

Q11: In an electromagnetic field, the magnetic force of an electron neutralizes the electric force. What is the speed of the electron in this field if the strength of the electric field is $E = 400\ V/m$ and the magnetic field intensity in B= 100T ?

A) $4\ m/s$ B) $40\ m/s$ C) $4 \times 10^5\ m/s$ D) $400\ m/s$

Q12: What is the half-life period of a radioactive particle with a constant of disintegration= $3 \times 10^{-8} s^{-1}$?

A) $52.0 \times 10^7 s$ B) $4.57 \times 10^7 s$ C) $7.8 \times 10^7 s$ D) $2.3 \times 10^7 s$

Q13: 20 capacitors of capacity $3\mu F$ each are connected in series. What is the equivalent capacity of this circuit?

A) $60\mu F$ B) $0.15\mu F$ C) $0.6\mu F$ D) $15\mu F$

Q14: Three capacitors of capacity $C_0 = 2 \times 10^{-3} \mu F$ each connected in parallel. If the charging voltage across these capacitors is 60000Volts when connected in series, calculate the energy available during the discharge.

A) $0.108\ joule$ B) $1.08\ joule$ C) $1008\ joules$ D) $10.8\ joules$

Q15: A wheel rotates at 360 rpm. Determine its period of rotation

A) $0.166s$ B) $6s$ C) $37.68s$ D) $3.768s$

Q16: The equation of motion of a moving object is given by $x = t^2 + 2$. Calculate its average speed between the instants t_1=2s and t_2=5s

A) $39\ m/s$ B) $29\ m/s$ C) $19.57\ m/s$ D) $49\ m/s$

Q17: The speed (in m/s) of ten molecules in a gas are as follows: 100, 200, 200, 300, 400, 400, 500, 500, 600, 800. The root-mean-square speed in m/s is

A) 400   B) 447   C) 1600   D) 1960   E) 19600

Q18: Suppose a miracle car has a 100% efficient engine and burns fuel that has a 40-megajoules-per-liter energy content. If the air drag and the overall frictional forces on this car is approximated to a force of 1000N, what is the maximum distance the car could travel with one liter of fuel?

A) 30km   B) 50 km   C) 40 km   D) more than 50 km

Q19: A certain current on passing through a galvanometer produces a deflection of 100 divisions. When a shunt of one ohm is connected, the deflection reduces to 1 division. The galvanometer resistance is

A) 100Ω   B) 99Ω   C) 10Ω   C) 9.9Ω

Q20: A typical red (visible) light has a wavelength of 702nm. What would be the energy of one photon having this wavelength?

A) $4.274 \times 10^{14} \ J$ B) $2.83 \times 10^{-19} \ J$ C) $2.83 \times 10^{-19} \ eV$ D) $2.83 \times 10^{-28} \ J$

Q21: What is the density of an object with a volume of 15mL and a mass of 42 grams?

A) $0.352 \ g/mL$ B) $630 \ g/mL$ C) $2.80 \ g/mL$ D) None of above

Q22: The blue color in fireworks is often achieved by hearing copper(I) chloride (CuCl) to about 1200°C. Then the compound emits blue light having a wavelength of 450nm. What is the increment of energy (the quantum) that is emitted a $4.50 \times 10^2 nm$ by CuCl?

A) $4.41 \times 10^{-19} \, J$ B) $4.43 \times 10^{-19} \, J$ C) $4.42 \times 10^{-19} \, J$ D) $5.51 \times 10^{-19} \, J$

Q23: A hydrogen atom absorbs a photon of visible light and its electron enters the n =4 energy level. Calculate the change in energy of the atom and the wavelength (in nm) of the photon.

A) $4.09 \times 10^{-19} \, J$ and $486 \, nm$ B) $4.09 \times 10^{-19} \, J$ and $487 \, nm$ C) $4.07 \times 10^{-19} \, J$ and $487 \, nm$ D) $4.08 \times 10^{-19} \, J$ and $488 \, nm$

Q24: A cook uses a microwave oven to heat a meal. The wavelength of the radiation is 1.20 cm. What is the energy of one photon of this microwave radiation?

A) $1.67 \times 10^{-22} \, J$ B) $1.66 \times 10^{-23} \, J$ C) $1.63 \times 10^{-23} \, J$ D) $1.69 \times 10^{-22} \, J$

An alternative voltage source if frequency 50 Hz and root-mean-square voltage 120 V is applied across the terminals of a serial RLC circuit. If the values of the inductance, resistance and capacitance are respectively L=0.25H, R= 500 Ω and C=4 µF

Q25: The impedance of the circuits

A) 975Ω   B) 875Ω   C) 775Ω   C) 675Ω

Q26: The quality factor of the circuit is:

A) 0.3   B) 1.0   C) 0.5   C) 0.8

Q27: A dental hygienist use x-rays with wavelength $\lambda = 1.0 \times 10^{-10} m$ to take a series of dental radiographs. The frequency of the electromagnetic radiation is

A) $1.0 \times 10^{18} Hz$ B) $1.50 \times 10^{15} Hz$ C) $3.0 \times 10^{18} Hz$ D) $6.0 \times 10^{21} Hz$

Q45: Hydrochloric acid reacts with calcium to form hydrogen and calcium chloride. If 100 grams of hydrochloric acid reacts with 100 grams of calcium chloride, what is the limiting feagent?

A) hydrochloric acid   B) hydrogen   C) calcium chloride   D) calcium

Q46: If I dilute 5 mL of 0.15 M NaCl to a final volume of 5 L, what's the final concentration of NaCl?

A) 0.00015 M,   B) 0.0015 M,   C) 15000 M,   D) None of these

Q47: What is the pH of a 0.001 M formic acid solution? Ka=1.8×10^{-4}

A) 3.74   B) 10.3   C) 3.37   D) 10.6

Q48: The critical temperature is the temperature

(A) at which three different phases (liquid, gas and solid) simultaneously coexist in equilibrium

(B) above which only the gas phase can exist no matter how high the pressure

(C) above which the surface between the two phases (liquid and gas) appears no matter how high the pressure

(D) above which a gas will not liquefy no matter how high the pressure

Q49: Which of the following names is correct according to IUPAC rules?

A) 2,3-dimethylcyclohexane   B) 3-ethyl-4,4-dimethylhexane   C) butylcyclopropane   D) 1,5-dimethylcyclohexane

Q50: Write down the electron structure of chromium (Z=24)

A $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^4$ B) $1s^2 2s^2 2p^6 3s^2 3p^5 4s^2 3d^5$

C) $1s^2 2s^2 2p^6 3s^2 3p^6 4s 3d^5$ D) A $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5$

Q51: Which of the following sentences is not correct?

(A) Ionisation energies increase across a Group and decrease down a Period

(B) benzene is more stable than hexa-1,3,5-triene because benzene is cyclic

(C) phosphate (V) ion has 6 resonance hybrid structures

(D) there is only one coordinate bond in $(CH_3)_3NHCl$

Q52: Which is the most stable among the following molecules?

A) bromobenzene   B) ortho-dibromobenzene   C) meta-dibromobenzene   D) para-dibromobenzene

Q53: Calculate the length of the unit cell of sodium chloride if the density of sodium chorideIs $2.17 \times 10^3 kg m^{-3}$ and its molar mass is M(NaCl)= $58.4 g.mol^{-1}$

A) 562 nm,   B) 0.562 pm   C) $562 \times 10^3 pm$ D) 562 pm

Q54: What is the composition of the medium in the closed vessel after mixing 1.4 g of N_2 and 0.2 g of H_2 ?

A 0.46 g of N_2 and 1.13 g of NH_3 B) 1.7 g of NH_3 C) 1.7 g of NH_3 with 0.46 g of H_2 D) 1.4 g of N_2 and 0.2 g of H_2

Q55: In an experiment, 28.0 mL of 0.250 MHNO3 and 53.0 mL of 0.320 MKOP are mixed. Calculate the amount of water formed in the resulting reaction. What is the composition of H^+ or OH^- ions in excess after the reaction goes to completion

A $7.00 \times 10^{-3} mol$ of H_2o and $0.123\ M$ of H^+

B) $1.7 \times 10^{-2} mol$ of H_2o and $0.123\ M$ of OH^-

C) $7.00 \times 10^{-3} mol$ of H_2o and $0.123\ M$ of OH^-

D) $7.00 \times 10^{-3} mol$ of H_2o and $0.32\ M$ of OH^-

Q56: Which of the following reactions is a redox reaction?

A) $CaCO(s) + CO_2(g) \rightarrow CaCO_3(s)$

B) $NaHSO_4(aq) + NaOH(aq) \rightarrow Na_2SO_4(aq) + H_2O(l)$

C) $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

D) $4KNO_3(s) \rightarrow 2K_2O(s) + 2K_2(g) + 5O_2(g)$

Q57: The standard reaction enthalpy for the hydrogenation of propane is -124 kJ mol^{-1} the standard reaction anthalpy for the combustion of propane is -2220 kJ mol^{-1} the standard enthalpy of formation of liquid water is -286 kJmol^{-1}. Calculate the standard enthalpy of combustion of propane.

A) -2058 kJ mol^{-1} B) -2630 kJ mol^{-1} C) -1810 kJ mol^{-1} D) -2220 kJ mol^{-1}

Q58: $100cm^3$ of a solution was prepare by dissolving 1.1 g of a protein a solvent, the osmotic pressure at 25°C was measured as 1.15 kPa, l.e 1150 Nm^{-2}. What is the molar mass of the protein?
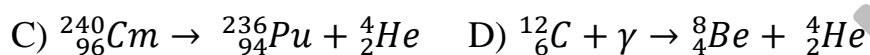
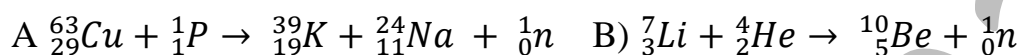A) $4.64 \times 10^{-5} gmol^{-1}$ B) $2.3700 \times 10^4 gmol^{-1}$ C) $2.3700 \times 1010\ gmol^{-1}$ D) $46.4 \times gmol^{-1}$

Q59: What will be the pH of a solution made from a mixture of 0.11 mol dm^{-3} of ethanoic acid and 0.32 mol dm^{-3} sodium ethanoate? The ka of ethanoic acid/ sodium is 1.8×10^{-5}

A) 4.2   B) 5.7   C) 5.2   D) 5.2

Q60: Which of the following nuclear equations is not correct?

A $^{63}_{29}Cu + ^{1}_{1}P \rightarrow ^{39}_{19}K + ^{24}_{11}Na + ^{1}_{0}n$ B) $^{7}_{3}Li + ^{4}_{2}He \rightarrow ^{10}_{5}Be + ^{1}_{0}n$

C) $^{240}_{96}Cm \rightarrow ^{236}_{94}Pu + ^{4}_{2}He$ D) $^{12}_{6}C + \gamma \rightarrow ^{8}_{4}Be + ^{4}_{2}He$

SECTION A: MATHEMATICS (MINOR) [ELECTIVE]

Q41: Solving for x in the set of real numbers the equation $2e^{2x} - 3e^x - 17 + 30e^{-x} = 0$ gives solutions:

   A) $\left\{2, -3, \frac{5}{2}\right\}$ B) $\left\{-ln2, ln \frac{5}{2}\right\}$ C) $\left\{-2, -3, -\frac{5}{2}\right\}$ D) $\left\{ln2, ln \frac{5}{2}\right\}$

Q42: Given the line L: x+y+1=0 and the point A(-1,-1). The perpendicular distance from A to L is:

   A) 0;   B) $\sqrt{2}$ C) $\frac{\sqrt{2}}{2}$ D) $\frac{1}{2}$

Q43: Given the function f(x)= $\frac{1}{x} + ln\left(\frac{x}{1+x}\right)$ which of the following statements is correct?

   A) The domain of definition of f is $]-\infty, -1] \cup]0, +\infty[$
   B) The domain of definition of f is $]-\infty, -1[\cup]0, +\infty[$
   C) The domain of definition of f is $]-\infty, -1[\cup]-1, 0[\cup]0, +\infty[$
   D) $\lim_{x \to 0^+} f(x)=0$, $\lim_{x \to +\infty} f(x) = -\infty$, $\lim_{x \to -1^-} f(x) = +\infty$
      $\lim_{x \to -\infty} f(x) = +\infty$

Q44: Given the function f(x)= $\frac{1}{x} + ln\left(\frac{x}{1+x}\right)$ which of the following statements is correct?

   A) $\lim_{x\to 0^+} f(x)=+\infty$, $\lim_{x\to+\infty} f(x) = 0$, $\lim_{x\to-1^-} f(x) = +\infty$
      $\lim_{x\to-\infty} f(x) = 0$

   B) The function f is positive and decreasing in $]0, +\infty[$

   C) The function f is negative and decreasing in $]-\infty, \ -1[$

   D) The function f is positive and increasing in its set of definition

Q45: Given the equation $x^2 - (a - 2)x - a - 1 = 0$, the value of a for which the sum of its roots is equal to the product of the roots is

   A) 1/2;   B)3/2   C) a   D) $-a/2$

Q46: The number of real solutions of the equation $x^2 - 3|x| + 2 = 0$ is

   A) 2;   B) 3   C) 4   D) 0

Q47: The characteristic equation of the differential equation $y'' - y' - 2y = 0$ is

   A) $r^3 - r^2 - 2r$;   B) 1 and -2   C) -1 and 2   D) $r^2 - r - 2 = 0$

Q48: if V is a vector such that $2V - 3(3, 2, -3) = (3, 2, 9)$ then

   A) $V = (6, 0, 4)$;   B) $V = (6, 4, 0)$ C) $V = (6, 4)$ D) V is not defined
      since we cannot solve an equation for vector

Q49: The length of the vector $V = (1, -2, \ 2)$ is

   A) $\sqrt{3}$;   B) 3   C) -3   D) 1

Q50: An orthogonal vector to $V = (1, -1, \ 4, \ 3)$ is

   A) $(2, 4, 5, -6)$;   B) $(1, 1, 3, -6)$ C) $(2, 4, 5, 6)$ D) $(0, 0, -5, 6)$

Q51: The system of equations $\begin{cases} 2x - y = 0 \\ -6x + 3y = -9 \end{cases}$ admits as solution set

A) $S = \{(1, -1)\}$ B) $\{\}$ C) The set of real numbers,   D) The set of positives integers

Q52: A vector normal to the plane $x + y + z = 1$ is

A) $n = (-1, -1, -1)$ B) $n = (1, 1, 1)$ C) $n = (-1, -1, 1)$ D) $n = (1, 1, -1)$

Q53: If $z = \cos\theta + \sin\theta$ then the real part of $Z = z^7 - \dfrac{1}{z^7}$ is

A) $\cos 7\theta$ B) 0 C) $cos^7\theta$ D) $\sin 7\theta + \sin 7\theta$

Q54: The product $(2, 1, 2) \times (3, 0, 5)$ is

A) A vector   B) A scalar   C)$(5, -4, -3)$ D) can be a vector or a scalar

Q55: If $\dfrac{x}{1+i} + \dfrac{y}{2-i} = 2 + 4i$ where i is the imaginary complex number then

A) $x = -4, y = 10$;   C) The value of x can be found if y is a square

B) $= 10, \; y = 4$;   D) x is a complex number but y is not defined

Q56: A square root of $35 - 12i$ is

A) $-6 - i$;   B) $-6 + i$;   C) $6 - i$;   D) $6 - i, 6 + i$

Q57: The roots of $z^2 - (1 - i)z + 7i - 4 = 0$ are

A) $3 - 2i \; and -2 - i$;   B) $3 - 2i \; and \; 2 - i$;   C) $3 - 2i \; and -2 + i$;   D) $3 + 2i \; and -2 - i$

Q58: The set of points M(z) such that $|z - 3| = 2$ is

A) a circle, centre at 3 and radius 3 units; B) a circle, centre at 2 and radius 3 units;

C) a circle, centre at 3 and radius 2 units; D) a disc, centre at 2 and radius 3 units

Q59: The complex number $\cos\frac{\pi}{2} + i\sin\frac{\pi}{2}$ is equal to

A) i;   B) 0;   C) 1;   D)-1

Q60: If the inner product of two vectors is equal to zero then

   A) The two vectors are collinear

   B) The two vectors are perpendicular

   C) The two vectors have opposite directions

   D) The two vectors have the same length