MHT CET 2020 Mathematics Answer Key PDF

Section 1: Physics

Question 1 Option: (D) – $\sqrt{3}:2$
Explanation: Since the spring constant k is directly proportional to Young's modulus (Y), the ratio of spring constants is $k_1/k_2 = 4/3$. The time period of oscillation is inversely proportional to the square root of the spring constant, yielding $T_1/T_2 = \sqrt{k_2/k_1} = \sqrt{3}/2$.

Question 2 Option: (B) – $(16.2)R$
Explanation: Using Stefan's Law, the rate of radiation of a black body is $R = \sigma AT^4$. For another body of emissivity $e = 0.2$ at temperature $3T$, the rate of radiation is $R' = e\sigma A(3T)^4 = 0.2 \times 81 \times \sigma AT^4 = 16.2R$.

Question 3 Option: (D) – $40\,\Omega$
Explanation: The impedance Z of a series LCR circuit is given by the relation $Z = \sqrt{R^2 + (X_L - X_C)^2}$. Since the inductive and capacitive reactances are equal $(X_L = X_C = 30\,\Omega)$, the circuit is in resonance and $Z = R = 40\,\Omega$.

Question 4 Option: (A) – $\left[\frac{h\lambda}{2mc}\right]^{1/2}$
Explanation: The kinetic energy of the photoelectrons is approximately equal to the incident photon energy, K.E. $= hc/\lambda$. The de-Broglie wavelength of the emitted electron is $\lambda_{dB} = \frac{h}{\sqrt{2m(\text{K.E.})}} = \frac{h}{\sqrt{2m(hc/\lambda)}} = \left[\frac{h\lambda}{2mc}\right]^{1/2}$.

Question 5 Option: (B) – decreases slightly, increases slightly.
Explanation: An increase in the doping level of the base increases the rate of charge carrier recombination within the base region. This results in an increase in the base current (I_B) and a corresponding slight decrease in the collector current (I_C).

Question 6 Option: (B) – $4\,\Omega$
Explanation: Initially, the balance condition is $X/R = 40/60 = 2/3$. When $2\,\Omega$ is added in series, the new balance is $(X+2)/R = 50/50 = 1$. Solving these simultaneous equations yields the value of the unknown resistance as $X = 4\,\Omega$.

Question 7 Option: (C) – 6 m/s
Explanation: By the law of conservation of linear momentum, the initial momentum of the system is equal to the final momentum, $m_b v_b + m_g v_g = 0$. Solving for the recoil velocity of the gun yields $v_g = \frac{0.02 \times 750}{2.5} = 6$ m/s.

Question 8 Option: (C) – A = 1, B = 1, C = 1
Explanation: Analyzing the logic gate combinations of the circuit shows that when all inputs are high, the intermediate gates produce complementary signals. This results in a final output Y of logic state zero (0) under this specific input condition.

Question 9 Option: (B) – M
Explanation: The resultant magnetic moment of two identical magnets inclined at an angle of 120° is $M_{\text{net}} = \sqrt{M^2 + M^2 + 2M^2\cos 120°}$. Substituting $\cos 120° = -1/2$ simplifies the expression directly to $M_{\text{net}} = M$.

Question 10 Option: (B) – 50 cm
Explanation: The wavelength of the stationary wave is $\lambda = v/f = 330/165 = 2$ m. The distance between a node and its adjacent antinode is a quarter of a wavelength, which equals $\lambda/4 = 2/4 = 0.5$ m $= 50$ cm.

Question 11 Option: (B) – 6 mg
Explanation: For a body performing vertical circular motion, the tension is minimum at the highest point and maximum at the lowest point. Resolving the equations of motion at both positions yields a constant difference in tension of $T_{\text{lowest}} - T_{\text{highest}} = 6mg$.

Question 12 Option: (C) – $\mu_r = 1 + \chi$
Explanation: The total magnetic induction in a material is the sum of the magnetic field in vacuum and the field due to magnetization. This relationship establishes the fundamental equation connecting relative permeability and susceptibility: $\mu_r = 1 + \chi$.

Question 13 Option: (B) – $T^2F/4\pi^2x$
Explanation: The time period of a mass-spring system is $T = 2\pi\sqrt{m/k} \implies m = \frac{T^2k}{4\pi^2}$. Since the spring constant is defined by the applied restoring force per unit extension ($k = F/x$), substituting this gives $m = \frac{T^2F}{4\pi^2x}$.

Question 14 Option: (B) – 1.8 A
Explanation: The current through the shunt resistor is given by the current division formula: $I_s = I\left(\frac{G}{G+S}\right)$. Substituting the given values: $I_s = 2 \times \left(\frac{18}{18+2}\right) = 2 \times 0.9 = 1.8$ A.

Question 15 Option: (B) – 4 B
Explanation: The magnetic field at the center of a circular coil is $B \propto N/r$. When the same length is rewound into a coil of N turns, the radius becomes $r \propto 1/N$, leading to $B \propto N^2$. For $N = 2$, the new field is $4B$.

Question 16 Option: (D) – 60°
Explanation: At minimum deviation, the angle of refraction is $r = A/2$ and the angle of incidence is $i = 45°$. Applying Snell's law: $\sqrt{2} = \frac{\sin 45°}{\sin(A/2)} = \frac{1}{\sqrt{2}\sin(A/2)} \implies \sin(A/2) = 1/2 \implies A = 60°$.

Question 17 Option: (C) – solids only.
Explanation: Only solids possess a definite shape and volume, enabling them to resist tensile, compressive, and shear forces. Consequently, Young's modulus and the modulus of rigidity are defined only for solid materials.

Question 18 Option: (A) – $E \propto 1/\lambda$, $N \propto I$
Explanation: According to Einstein's photoelectric theory, the kinetic energy of emitted photoelectrons depends on the frequency of light ($E \propto 1/\lambda$), whereas the number of emitted photoelectrons depends on the intensity of the light ($N \propto I$).

Question 19 Option: (D) – $\frac{v}{3}\hat{i} + 2v\hat{j}$
Explanation: By conservation of linear momentum, the total initial momentum equals the total final momentum: $Mv\hat{i} + 2M(3v)\hat{j} = (M + 2M)\vec{v}_f$. Solving for the final velocity vector yields $\vec{v}_f = \frac{v}{3}\hat{i} + 2v\hat{j}$.

Question 20 Option: (D) – 25 cm
Explanation: The resonant wavelengths for a closed pipe are $\lambda = v/f = 340/340 = 1$ m $= 100$ cm. The air column lengths for resonance are 25 cm, 75 cm, and 125 cm, so the minimum height of water required is 150 cm − 125 cm = 25 cm.

Question 21 Option: (B) – QR
Explanation: The moment of inertia of a body is maximum about an axis where the mass is distributed furthest from the axis of rotation. For a right-angled triangle, this maximum occurs about the side QR.

Question 22 Option: (B) – $\left[\frac{gR^2}{\omega^2}\right]^{1/3}$
Explanation: Equating the gravitational force to the centripetal force yields $\frac{GMm}{r^2} = m\omega^2 r \implies r^3 = \frac{GM}{\omega^2}$. Substituting the acceleration due to gravity on the surface, $GM = gR^2$, gives the orbital radius $r = \left[\frac{gR^2}{\omega^2}\right]^{1/3}$.

Question 23 Option: (D) – closed pipe of 1.5 m length.
Explanation: The given frequencies 300 Hz, 420 Hz, and 540 Hz are in the ratio 5 : 7 : 9,

indicating odd harmonics of a closed pipe with a fundamental frequency of 60 Hz. This gives a length of $L = \frac{v}{4n} = \frac{360}{240} = 1.5$ m.

Question 24 Option: (B) – 4λ
Explanation: Using the photoelectric equations, we have $3eV_0 = \frac{hc}{\lambda} - \frac{hc}{\lambda_0}$ and $eV_0 = \frac{hc}{2\lambda} - \frac{hc}{\lambda_0}$. Multiplying the second equation by 3 and equating both expressions yields the threshold wavelength $\lambda_0 = 4\lambda$.

Question 25 Option: (A) – θ is not constant for particular solid – liquid pair.
Explanation: The angle of contact is a characteristic thermodynamic constant for a specific pure solid-liquid pair at a given temperature and pressure, making Option (A) the incorrect statement.

Question 26 Option: (C) – 2 Nm^2/C
Explanation: The electric flux is given by the dot product $\Phi = EA\cos\theta$. Substituting the given values: $\Phi = 200 \times (200 \times 10^{-4}\ \text{m}^2) \times \cos 60^\circ = 4 \times 0.5 = 2\ \text{Nm}^2/\text{C}$.

Question 27 Option: (D) – 120 m
Explanation: The wavelength of the sound wave is $\lambda = v/f = 330/220 = 1.5$ m. The total distance travelled by the wave during 80 complete vibrations is $d = 80 \times \lambda = 80 \times 1.5 = 120$ m.

Question 28 Option: (A) – 10 m
Explanation: Using the banking of roads formula: $\tan\theta = \frac{v^2}{rg}$. Substituting $v = 36$ km/hr $= 10$ m/s, $g = 10\ \text{m/s}^2$, and $\theta = 45^\circ$ yields the minimum radius $r = \frac{10^2}{10 \times \tan 45^\circ} = 10$ m.

Question 29 Option: (C) – $20\sqrt{2}$ N
Explanation: Since the resultant vector $\vec{R}$ bisects the angle between the two forces, we must have $|\vec{P}| = |\vec{Q}|$ and the angle between them is 90°. Thus, $R^2 = P^2 + Q^2 = 2P^2 \implies 40^2 = 2P^2 \implies P = 20\sqrt{2}$ N.

Question 30 Option: (D) – attract N_1 strongly and N_2 weakly, repel N_3 weakly.
Explanation: Ferromagnetic materials (N_1) are strongly attracted by magnets, paramagnetic materials (N_2) are weakly attracted, and diamagnetic materials (N_3) are weakly repelled.

Question 31 Option: (B) – 10^{-11} s
Explanation: The speed of light in glass is $v = c/\mu = \frac{3\times10^8}{1.5} = 2 \times 10^8$ m/s. The time taken to travel a thickness of 2 mm is $t = \frac{d}{v} = \frac{2\times10^{-3}}{2\times10^8} = 10^{-11}$ s.

Question 32 Option: (D) – 0.08
Explanation: The deceleration is $a = v/t = 4/5 = 0.8\ \text{m/s}^2$. Since the frictional force is the sole retarding force, $\mu mg = ma \implies \mu = a/g = 0.8/10 = 0.08$.

Question 33 Option: (C) – diameter of the objective.
Explanation: The resolving power of an astronomical telescope is given by the formula R.P. $= \frac{D}{1.22\lambda}$, which is directly proportional to the diameter D of the objective lens aperture.

Question 34 Option: (C) – $[L^{-1}M^0T^0]$
Explanation: By the principle of homogeneity, the term xs must be dimensionless to be added to r ($[xs] = [L]$). Since $c\sin(\omega t + \phi)$ represents force, $[cs] = [F][s] = [MLT^{-2}][L^{-1}F^{-1}] = [L^{-1}M^0T^0]$.

Question 35 Option: (D) – $(1 - d/R)$
Explanation: The capillary rise is inversely proportional to gravity, $h \propto 1/g$. At a depth d inside a mine, the gravity is $g' = g(1 - d/R)$, yielding the ratio $h_1/h_2 = g'/g = (1 - d/R)$.

Question 36 Option: (B) – 80 km
Explanation: The maximum line-of-sight distance for a radar antenna is given by $d = \sqrt{2Rh}$. Substituting the given values: $d = \sqrt{2 \times (6.4 \times 10^6\ \text{m}) \times 500\ \text{m}} = 8 \times 10^4\ \text{m} = 80$ km.

Question 37 Option: (C) – $\mu_1 = \mu_2$
Explanation: A lens disappears when placed in a liquid of the same refractive index because no refraction or reflection of light occurs at the lens-liquid boundary, making the lens invisible.

Question 38 Option: (B) – $\cos^{-1}(0.75)$
Explanation: The tensions are $T_{\max} = mg(3 - 2\cos\theta)$ and $T_{\min} = mg\cos\theta$. Setting the condition $T_{\max} = 2T_{\min} \implies 3 - 2\cos\theta = 2\cos\theta \implies \cos\theta = 3/4 = 0.75$.

Question 39 Option: (A) – $\sqrt{\frac{nA^2}{n+1}}$
Explanation: Given K.E. $= \frac{1}{n}$P.E. $\implies \frac{1}{2}k(A^2 - x^2) = \frac{1}{n}\left(\frac{1}{2}kx^2\right)$. Rearranging the terms yields $A^2 - x^2 = \frac{x^2}{n} \implies x = \sqrt{\frac{nA^2}{n+1}}$.

Question 40 Option: (C) – 1/800 rad/s
Explanation: For effective weightlessness at the equator, the apparent gravity must be zero: $g' = g - R\omega^2 = 0$. Solving for angular velocity gives $\omega = \sqrt{g/R} = \sqrt{\frac{10}{6.4\times10^6}} = \frac{1}{800}$ rad/s.

Question 41 Option: (C) – 81/16
Explanation: The orbital area is proportional to the square of the radius ($A \propto r^2 \propto n^4$). For the second excited state ($n = 3$) and the first excited state ($n = 2$), the ratio is $3^4/2^4 = 81/16$.

Question 42 Option: (D) – 0.96 kg $\cdot$ m^2
Explanation: Using the parallel axis theorem: $I = I_{cm} + MR^2 = \frac{1}{2}MR^2 + MR^2 = \frac{3}{2}MR^2$. Substituting $M = 4$ kg and $R = 0.4$ m yields $I = \frac{3}{2} \times 4 \times 0.16 = 0.96$ kg $\cdot$ m^2.

Question 43 Option: (C) – v/r^2
Explanation: The magnetic field at the center is $B = \frac{\mu_0 I}{2r}$. Since the current generated by the revolving electron is $I = \frac{ev}{2\pi r}$, substituting this yields the proportionality $B \propto \frac{v}{r^2}$.

Question 44 Option: (A) – J/(m^{2}s)
Explanation: Emissive power is defined as the total thermal energy radiated per unit surface area per unit time. Its SI unit is therefore Joules per square meter per second (J/(m^{2}s)).

Question 45 Option: (B) – $\left(\frac{\sqrt{n}+1}{\sqrt{n}-1}\right)^2$
Explanation: The ratio of maximum to minimum intensity in an interference pattern is given by $I_{\max}/I_{\min} = \left(\frac{\sqrt{I_1/I_2}+1}{\sqrt{I_1/I_2}-1}\right)^2$. Substituting $I_1/I_2 = n$ yields the required ratio.

Question 46 Option: (A) – 90°
Explanation: From the vector sum, $|\vec{A} + \vec{B}|^2 = C^2 \implies A^2 + B^2 + 2AB\cos\theta = C^2$. Since we are given $A^2 + B^2 = C^2$, we have $2AB\cos\theta = 0 \implies \theta = 90°$.

Question 47 Option: (C) – $\ell_1/2$
Explanation: Shunting the cell with $R = r$ reduces the terminal potential difference to $V = E\left(\frac{R}{R+r}\right) = E/2$. Since potential is proportional to balancing length, the new length is $\ell_1/2$.

Question 48 Option: (D) – $\frac{QV'}{Q-Q'}$
Explanation: Initially, $Q = CV$. When potential is reduced by V', we have $Q' = C(V - V') = \frac{Q}{V}(V - V')$. Rearranging this expression to solve for V yields $V = \frac{QV'}{Q-Q'}$.

Question 49 Option: (A) – 3 : 1
Explanation: Rotational kinetic energy is $E = \frac{L^2}{2I} \implies L = \sqrt{2IE}$. Taking ratios: $L_1/L_2 = \sqrt{\frac{I_1E_1}{I_2E_2}} = \sqrt{\frac{1}{3} \times 27} = 3 \implies 3:1$.

Question 50 Option: (A) – 2.5×10^{-5} F, 400 W
Explanation: When current and voltage are in phase, resonance occurs: $\omega L = 1/(\omega C) \implies C = \frac{1}{\omega^2 L} = 2.5 \times 10^{-5}$ F. The power dissipated is $P = V^2/R = 200^2/100 = 400$ W.

Section 2: Chemistry

Question 51 Option: (D) – 4.85 kJ
Explanation: Using the Gibbs free energy relationship: $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$. Substituting the given values at 298 K gives $\Delta G^\circ = 57.24 \text{ kJ} - 298 \times (175.8 \times 10^{-3} \text{ kJ K}^{-1}) = 4.85 \text{ kJ}$.

Question 52 Option: (C) – Ti^{3+}
Explanation: Ti^{3+} has a $3d^1$ electron configuration with one unpaired electron, allowing $d-d$ transitions which absorb visible light to form colored compounds, unlike ions with d^0 or d^{10} configurations.

Question 53 Option: (C) – Vapour pressure of solvent.
Explanation: Colligative properties depend only on the concentration of solute particles, not their identity. While the relative lowering of vapour pressure is a colligative property, vapour pressure itself is not.

Question 54 Option: (B) – $-CONH_2$
Explanation: By Cahn-Ingold-Prelog (CIP) priority rules, carbon attached to atoms of lower atomic numbers has lower priority. Among the given groups, the amide group has the lowest assigned priority.

Question 55 Option: (A) – H_2O, CO_2, CH_4
Explanation: The law of multiple proportions states that when two elements combine to form more than one compound, the mass ratios are simple whole numbers. This set contains three elements, violating the definition.

Question 56 Option: (C) – o-nitrophenol
Explanation: In ortho-nitrophenol, the hydroxyl ($-OH$) and nitro ($-NO_2$) groups are adjacent, allowing the formation of an intramolecular hydrogen bond, forming a stable six-membered ring.

Question 57 Option: (C) – Siderite
Explanation: Siderite is a valuable carbonate mineral of iron with the chemical formula $FeCO_3$, whereas the other listed options are minerals of zinc or magnesium.

Question 58 Option: (C) – $\Delta H = \Delta U - RT$
Explanation: Using $\Delta H = \Delta U + \Delta n_g RT$, the change in the number of gaseous moles is $\Delta n_g = 2 \text{ (gas)} - 3 \text{ (gas)} = -1$. Substituting this yields $\Delta H = \Delta U - RT$.

Question 59 Option: (A) – 77.7%
Explanation: For $K_3[Fe(CN)_6]$, the number of ions is $n = 4$. Using the relation $i = 1 + (n-1)\alpha \implies 3.333 = 1 + 3\alpha \implies \alpha = 0.777$, which corresponds to 77.7% dissociation.

Question 60 Option: (A) – Willemite
Explanation: Willemite is an orthosilicate mineral containing zinc with the chemical formula Zn_2SiO_4, whereas the other options are ores of aluminium or copper.

Question 61 Option: (A) – +3
Explanation: Chlorous acid has the chemical formula $HClO_2$. Setting up the oxidation state equation: $+1 + x + 2(-2) = 0 \implies x = +3$, which is the oxidation state of chlorine.

Question 62 Option: (D) – +5
Explanation: In the divanadate ion $V_2O_7^{4-}$, let the oxidation state of vanadium be x. Thus, $2x + 7(-2) = -4 \implies 2x = 10 \implies x = +5$.

Question 63 Option: (C) – Two
Explanation: The structural formula is $CH_3 - CH^*(Cl) - CH^*(Cl) - CH(CH_3)_2$. Carbons C2 and C3 are asymmetric (chiral) because they are bonded to four different groups.

Question 64 Option: (C) – B
Explanation: Boron (B) is a trivalent group 13 element. Doping tetravalent silicon with boron introduces electron deficiencies (holes), creating a p-type semiconductor.

Question 65 Option: (B) – Volume
Explanation: An extensive property is a physical property whose value is directly proportional to the size or mass of the system. Volume is extensive, whereas specific heat, density, and surface tension are intensive.

Section 3: Biology

Question 66 Option: (A) – Orchids
Explanation: Self-incompatibility is a widespread genetic mechanism in flowering plants, notably in Orchids, that prevents self-fertilization and encourages genetic outcrossing.

Question 67 Option: (A) – Neutrophils
Explanation: Neutrophils are a class of granulocytes characterized by highly lobulated, multi-shaped nuclei, earning them the common name polymorphonuclear leukocytes (polymorphs).

Question 68 Option: (B) – 30%
Explanation: The prostate gland secretes a thin, milky, slightly alkaline fluid that accounts for approximately 30% of the total volume of human semen.

Question 69 Option: (C) – renal vein
Explanation: Blood pressure is highest in major arteries leaving the heart and drops progressively through the capillaries, reaching its lowest point in the venous system, such as the renal vein.

Question 70 Option: (C) – Homo neanderthalensis
Explanation: Fossils of Neanderthal man (*Homo neanderthalensis*) reveal a robust cranial capacity averaging 1450 c.c., which is comparable to or slightly larger than modern humans.

Question 71 Option: (A) – Gram
Explanation: Gram is a dicotyledonous non-endospermic seed because the endosperm is completely absorbed by the developing embryo before seed maturation, storing food in the cotyledons.

Question 72 Option: (D) – 23
Explanation: The secondary oocyte is formed after the completion of meiosis I, which is a reductional division. Consequently, it contains the haploid number of chromosomes, which is 23.

Question 73 Option: (D) – Mosquito
Explanation: Plasmids, bacteriophages, and cosmids are molecular cloning vectors used to carry DNA in genetic engineering, whereas a mosquito is a biological vector of pathogens in nature.

Question 74 Option: (D) – Monera
Explanation: Under Whittaker's five-kingdom classification system, all prokaryotic unicellular organisms, such as bacteria and blue-green algae, are placed in the kingdom Monera.

Question 75 Option: (B) – phospho - di - ester
Explanation: In a nucleic acid chain, consecutive nucleotides are covalently linked by $3' - 5'$ phosphodiester bonds to form the continuous sugar-phosphate backbone.

Question 76 Option: (B) – ovulation
Explanation: A rapid rise in luteinizing hormone (LH surge) in the middle of the menstrual cycle triggers the rupture of the mature Graafian follicle, leading to ovulation.

Question 77 Option: (D) – plasmid
Explanation: Plasmids have a small insert size limit (typically under 10 kb). Larger DNA fragments cannot be stably inserted and maintained, requiring cosmids or phages instead.

Question 78 Option: (C) – mature human R.B.Cs.
Explanation: To optimize space for carrying hemoglobin and oxygen, mature mammalian erythrocytes discard their nucleus, mitochondria, lysosomes, and other cytoplasmic organelles during erythropoiesis.

Question 79 Option: (C) – 9 and 4
Explanation: In the F_2 generation of a standard Mendelian dihybrid cross involving homozygous parents, the genotypic ratio yields 9 distinct genotypes, and the phenotypic ratio yields 4 distinct phenotypes.

Question 80 Option: (D) – crown
Explanation: Tooth enamel, the hardest substance in the human body, forms a protective outer layer covering the visible portion of the tooth, which is anatomically defined as the crown.