Structure of the Question Paper for

Medical and Dental Colleges Admission Test (MDCAT) 2020

Sr. No.	Subject	No. of Questions
1	Biology	80
2	Chemistry	60
3	Physics	40
4	English	20
	Total	**200**

- **Note:**
  - *Time duration to attempt the paper shall be 150 minutes (2hrs 30 minutes).*
  - *Each question shall carry one mark with no negative marking.*

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BIOLOGY

Table of Contents

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1 The Cell

COURSE CONTENT

- Light and Electron Microscope (Magnification and Resolution)
- Structure of Typical Animal and Plant Cell
- Fluid Mosaic Model of Cell Membrane
- Transport of Material across the Cell Membrane: Active transport, Passive transport, Endocytosis and Exocytosis
- Eukaryotic Cell Structures: Endoplasmic reticulum (RER & SER), Ribosomes, Golgi apparatus, Lysosomes, Vacuoles, Centrioles & Microtubules, Mitochondria, Chloroplast and Nucleus (nuclear membrane, nucleolus and chromosomes)
- Prokaryotic Cell & Eukaryotic cell

2 Biological Molecules

COURSE CONTENT

- Carbohydrates: Monosaccharides, Disaccharides and Polysaccharides (Starch, Glycogen & Cellulose)
- Lipids: Triglycerides, Phospholipids and their functions.
- Proteins: Amino Acids & Peptide bond formation, Structures of Proteins (primary, secondary, tertiary and quaternary structures) and Globular & Fibrous Proteins
- Nucleic acids: DNA, RNA and Types of RNA
- Water: Heat of vaporization, Specific Heat Capacity and Solvent Action
- Enzyme: Definition, Characteristics of, Mechanism of Enzyme Action Enzymes (Lock & key model and Induced fit model), Factors affecting the rate of Enzyme Action, Inhibitors

3 Chromosomes and DNA

COURSE CONTENT

- Chromosome: Nucleosome, DNA, Histone Proteins, Chromatids, Centromere and Telomeres

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- Gene as a Basic Unit of Genetic Information
- DNA Replication: Hypothesis of DNA Replication, Meselson & Stahl's experiment and Replication
- Transcription
- Genetic Code
- Translation

4 Cell Division

COURSE CONTENT

- Cell Cycle: Interphase (G1, S and G2 phases), Mitotic phase and Cytokinesis
- Mitosis: Process of Mitosis, Significance of Mitosis and Cancer
- Meiosis: Process of Meiosis and Significance of Meiosis

5 Variety of Life

COURSE CONTENT

- Kingdoms: Protoctista, Fungi, Plantae and Animalia
- Viruses: Structure of Viruses
- AIDS: Causative Agent, Modes of Transmission and Prevention & Control

6 Bioenergetics

COURSE CONTENT

- Photosynthetic Pigments (Chlorophylls and Carotenoids)
- Absorption and Action Spectra
- Light-Dependent Reactions (cyclic and non-cyclic phosphorylation) and Light-Independent Reactions (Calvin cycle).
- Cellular Respiration: Glycolysis, Link reaction / Pyruvic Oxidation, Kreb's Cycle (with reference to production of NADH, FADH and ATP) and ETC
- Anaerobic Respiration and its Types (Alcoholic and Lactic Acid Fermentation).

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7 Gas Exchange

COURSE CONTENT

- Anatomy of Human Respiratory System.
- Transport of Respiratory Gases: O_2 & CO_2 and Role of Haemoglobin as Respiratory Pigment.
- Respiratory Disorders: Tuberculosis, Emphysema and Lung Cancer

8 Transport in Plants

COURSE CONTENT

- Transport of Water and Minerals: Apoplast & Symplast Pathway and Cohesion, Transpiration Pull / Tension & Adhesion
- Transpiration, Factors affecting it and opening and closing of Stomata.
- Translocation according to Pressure Flow Theory
- Xerophytes

9 Transport in Human

COURSE CONTENT

- Heart: Structure of heart, Cardiac Cycle, Control of Heart Beat, ECG and Blood Pressure
- Blood Vessels: Arteries, Veins and Capillaries
- Blood: Plasma and Blood Cells (RBCs, WBCs and platelets).
- Lymphatic System

10 Immunity

COURSE CONTENT

- Immune System and its Components
- Types of Immunity
- Vaccination

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11 Homeostasis

COURSE CONTENT

- Homeostasis
- Thermoregulation in Mammals
- Human Urinary System

12 Muscles and Movement

COURSE CONTENT

- Structure and Function of Skeletal Muscle
- Mechanism of Skeletal Muscle Contraction; Sarcomere, Ultrastructure of Myofilaments, Sliding Filament, Control of Actin-Myosin Interaction and Use of Energy for Muscle Contraction.

13 Communication

COURSE CONTENT

- Nervous Coordination in Mammals
- Neurons: Sensory, Intermediate / relay and motor neurons
- Reflex arc / Reflex action
- Nerve impulse
- Synapse
- Hormones: Definition & Types of Hormones, Hormones of Islets of Langerhans (Insulin & Glucagon) and Role of ADH in Osmoregulation.
- Plants Hormones: Auxins, Gibberellins and Abscisic Acid

14 Reproduction

COURSE CONTENT

- Gametogenesis: Spermatogenesis and Oogenesis
- Hormonal control of Human Menstrual Cycle (FSH, LH, estrogen and progesterone)

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15 Genetics

COURSE CONTENT

- Basics of Genetics: Gene, Locus, Allele, Gene Pool, Phenotype, Genotype, Homozygous, Heterozygous, Dominant Allele, Recessive Allele, Complete Dominance, Codominance, Linkage, F_1 & F_2 Generations, Mutation and Multiple Allele.
- Gene Linkage: Crossing over and Recombination Frequency / Cross Over Value
- Continuous and Discontinuous Variations
- Punnet square, Test cross and Monohybrid & Dihybrid Crosses
- Gene Linkage and Sex Linkage in Human (Haemophilia and Colour Blindness)

16 Biotechnology

COURSE CONTENT

- Recombinant DNA Technology / Genetic Engineering: Principles of Recombinant DNA Technology and its Application, PCR & Gel Electrophoresis and DNA Analysis / Finger Printing
- Gene Therapy
- Transgenic Organisms (Bacteria, Plants and Animals)

17 Evolution

COURSE CONTENT

- Theory of natural selection
- Hardy-Weinberg theorem and factors affecting gene / allele frequency

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CHEMISTRY

TABLE OF CONTENTS

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PHYSICAL CHEMISTRY

1. FUNDAMENTAL CONCEPTS

COURSE CONTENT

- Relative Atomic and Isotope
- Mole in terms of Avogadro's number
- Empirical and Molecular formulae
- Stoichiometric Calculations
- Concentration units of solutions
  - i. Percentage composition
  - ii. Molarity
  - iii. Mole fraction

2. STATES OF MATTER

COURSE CONTENT

- Gaseous state
- General Gas Equation (PV=n RT).
- Liquid state:
  - i. Evaporation
  - ii. Vapor pressure
  - iii. Boiling
  - iv. Structure of ice
- Lattice structure of a Crystalline solid
- Hydrogen bonding

3. ATOMIC STRUCTURE

COURSE CONTENT

- Proton, Neutron and Electron
- Distribution of Mass and charges

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- Deduce the number of protons, neutrons and electrons from given proton number and nucleon number
- Number, Relative Energies and Shape of s, p and d- Orbitals
- Electronic configuration
- Ionization energy
- Electron affinity

4. CHEMICAL BONDING

COURSE CONTENT

- Ionic (Electrovalent) bond
- Use the "dot and cross" model for:

  i. Covalent bonding

  ii. Co-ordinate (dative covalent) bonding
- Shapes and Bond Angles of molecules
- Covalent Bonding.
- Hydrogen bonding
- Bond Energy, Bond length and bond Polarity (Electronegativity difference)
- Intermolecular Forces
- Interpret and Predict the effect of different types of bonding on physical properties of substances.

5. CHEMICAL ENERGETICS

COURSE CONTENT

- Concept of Energy changes during Chemical reactions
- Use the terms:

  i. Enthalpy change of reaction

  ii. Bond energy
- Numerical Magnitude of Lattice Energy
- Hess's law to construct simple energy cycles.

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6. ELECTROCHEMISTRY

COURSE CONTENT

- Redox processes
- Oxidation numbers of Elements.
- Balancing chemical equations by redox method
- Standard electrode (redox) Potential
- Standard Hydrogen Electrode
- Methods used to measure the standard Electrode potentials of metals
- Standard Cell Potential
- Electrode Potential.
- Construct Redox equations
- Advantages of Developing the H_2/O_2 fuel cell

7. CHEMICAL EQUILIBRIUM

COURSE CONTENT

- Rates of forward and reverse Reactions and Dynamic Equilibrium
- Le- Chatelier's Principle.
- Deduce expression for Equilibrium constant
- Calculate the values of Equilibrium constants
- Calculate the equilibrium quantities
- Conditions used in Haber process.
- Qualitatively the differences in behavior of strong/weak acids and bases
- Terms: pH, K_a, pK_a, K_b, pK_b, K_w and K_{sp}.
- $[H^+_{(aq)}]$, $[OH^-_{(aq)}]$, pH and pOH values for strong and weak acids and bases.

8. REACTION KINETICS/ CHEMICAL KINETICS

COURSE CONTENT

- Rate of Reaction, Activation Energy, Catalysis, Rate Equation, Order of Reaction, Rate Constant

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- Collisions
- Enzymes as Biological Catalysts
- Construct and use rate equations with special emphasis on

  i. Zero order reaction

  ii. 1st order reaction

  iii. 2nd order reaction
- Half-life of a first order Reaction
- Calculate the order of reaction
- Calculate the rate constant
- Name a Suitable method for studying the rate of a Reaction

INORGANIC CHEMISTRY

1. PERIODS

COURSE CONTENT

- **Variation in the Physical properties of Elements Belonging to period 2 and period 3:**
  - **a.** Atomic Radius
  - **b.** Ionic Radius
  - **c.** Melting Point
  - **d.** Boiling Point
  - **e.** Ionization Energy
  - **f.** Electronegativity
  - **g.** Electron Affinity
  - **h.** Electrical Conductivity
  - **i.** Oxidation States
  - **j.** Hydration Energy
- Periodic Relationship in Binary compounds:
  - **a.** Halides (especially chlorides)
  - **b.** Oxides

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2. GROUPS:

COURSE CONTENT

- The variation in the properties of group II and VII Elements:
    - **a.** Reactions of group II elements.
    - **b.** Thermal decomposition.
    - **c.** Properties of Halogens.
    - **d.** Reaction of Chlorine
    - **e.** Comparison of Oxidizing power
    - **f.** Uses of Halogens and compounds of Halogens

3. TRANSITION ELEMENTS:

COURSE CONTENT

- Chemistry of Transition Elements of 3d series:
    - **a.** Electronic Configuration
    - **b.** Variable Oxidation states
    - **c.** Uses as a Catalyst
    - **d.** Formation of Complexes
    - **e.** Colour of Transition Metal Complexes
    - **f.** Geometry of complex ions with coordination number 4 and 6.

4. COMPOUNDS OF NITROGEN AND SULPHUR

COURSE CONTENT

- Nitrogenous fertilizers.
- Presence of Sulphur Dioxide in atmosphere
- Manufacturing of Sulphuric Acid.
- Sulphuric acid as Dehydrating agent and Oxidizing agent.

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ORGANIC CHEMISTRY

1. FUNDAMENTAL PRINCIPLES:

COURSE CONTENT

- The Organic compounds.
- Alkanes and Alkenes of lower masses.
- Nucleophiles, electrophiles and free radicals
- Isomerism.
- Functional group and Nomenclature of organic compounds.

2. HYDROCARBON:

COURSE CONTENT

Chemistry of Alkanes with emphasis on:

- Combustion.
- The Mechanism of free radical Substitution reaction.

Chemistry of Alkenes with emphasis on:

- Preparation of Alkenes:
- Reaction of Alkenes:

Chemistry of Benzene

- Benzene.
- Electrophilic substitution Reactions:
- Hydrogenation of Benzene ring.
- Side chain Oxidation of Methyl Benzene (Toluene) and Ethyl Benzene.
- Benzene ring by 2,4 Directing and 3,5 directing groups

3. ALKYL HALIDES (HALOGENOALKANES)

COURSE CONTENT

- Importance of Halogenoalkanes.
- Reaction of Alkyl Halides:

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4. ALCOHOLS AND PHENOLS:

COURSE CONTENT

Alcohols with reference to:

- Alcohols: Primary, Secondary and Tertiary.
- Preparation of Ethanol
- Reaction of Alcohols
- Dehydration of Alcohols

Phenols

- Reactions of Phenol
- Acidity of Water, ethanol and phenol

5. ALDEHYDES AND KETONES:

COURSE CONTENT

- Structure of Aldehyde and Ketones.
- Preparation of Aldehydes and Ketones.
- Reactions of Aldehydes and Ketones:

6. CARBOXYLIC ACID:

COURSE CONTENT

- Ethanoic Acid.
- Reactions of Ethanoic acid
- Relative Acidic strength.

7. AMINO ACIDS:

COURSE CONTENT

- General Structure of -Amino Acids found in Proteins.
- Amino Acids on the basis of Nature of R-group.

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- Acid base properties of Amino Acids.
- Peptide bond formation.

8. MACROMOLECULES:

COURSE CONTENT

- Formation of Addition polymers.
- Formation of Condensation Polymers.
- Structure of Proteins.
- Structure and function of Nucleic acid (DNA).

9. ENVIRONMENTAL CHEMISTRY:

COURSE CONTENT

- Air Pollutants.
- Chemistry and cause of Acid Rain.
- Ozone layer by Chlorofluorocarbons (CFCs).

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PHYSICS

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1. MEASUREMENT

COURSE CONTENT

- Physical quantities, numerical magnitude and a proper unit.
- International System of Units, SI base units of physical quantities, and their derived units.
- Prefixes and symbols to indicate decimal, submultiples or multiples of both base and derived units:
- Errors and uncertainties
  - Systematic error and random error.
  - Fractional uncertainty and percentage uncertainty.
  - Assessment of total uncertainty in the final results (Understanding of total assessment about addition and subtraction, multiplication and division & power factor).

2. MOTION AND FORCE

COURSE CONTENT

- Displacement, Distance, Speed, Velocity and Acceleration.
- Velocity–Time Graph.
- Equations of motion.
- Newton's Laws of Motion.
- Momentum and law of conservation of momentum.
- Force and rate of change of momentum.
- Impulse and $I = F \times t = mv_f - mv_i$
- Elastic and in-elastic collisions
- Projectile Motion and its applications.
- Moment of force or torque and use of torque
- Equilibrium.

3. WORK, ENERGY AND POWER

COURSE CONTENT

- Work in terms of the product of a force and displacement in the direction of the force.
- Kinetic energy K.E = $\frac{1}{2} mv^2$
- Potential energy P.E = mgh
- Inter-conversion of kinetic energy and potential energy in gravitational field.
- Power in terms of work done per unit time and use power as product of force and

velocity P = $\frac{W}{t}$ and P = Fv

4. CIRCULAR MOTION

COURSE CONTENT

- Angular motion, angular displacement & angular velocity
- Centripetal Force and centripetal acceleration
  - F = $mr^2\omega$, F = $\frac{mv^2}{r}$ and $a_c = r\omega^2$ and $a_c = \frac{v^2}{r}$
- Geostationary orbits.
- Radian

5. OSCILLATIONS

COURSE CONTENT

- Simple harmonic motion
- Amplitude, Frequency, Angular Frequency, Phase Difference. Express the time period in terms of both frequency and angular frequency.
- Equations $x=x_o \sin\omega t$, $v = v_0 \cos\omega t$, $v = \pm\omega\sqrt{x_o^2 - x^2}$, $a = -\omega^2 x$ and its use
- Motion of simple pendulum and relation.
- Kinetic energy and potential energy during Simple harmonic motion.
- Free, Forced and Damped Oscillations
- Resonance

6. WAVES

COURSE CONTENT

- Progressive waves
- Transverse and longitudinal waves.
- Principle of superposition.
- Stationary waves and wavelength of sound waves in air columns and stretched strings
- Doppler's Effect
- Electromagnetic Spectrum.

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7. LIGHT

COURSE CONTENT

- Interference of light waves, constructive and destructive interference.
- Young's Double Slit experiment, fringe spacing, dark and bright fringes.
- Diffraction (basic principle)
- Diffraction grating

8. HEAT & THERMODYNAMICS

COURSE CONTENT

- Basic postulates of kinetic theory of gases
- Pressure exerted by a gas and derive the relation $PV = \frac{Nm}{3} < v^2 >$
- Equation of state for an ideal gas as PV = nRT
- $PV = \frac{Nm}{3} < v^2 >$ and PV = NkT and prove that K.E $\propto$T for a single molecule.
- Internal Energy.
- Specific Heat capacity.

9. ELECTROSTATICS

COURSE CONTENT

- Coulomb's Law
- Electric field strength.
- $E = \frac{\Delta V}{\Delta d}$ to calculate the field strength.
- Electric field lines.
- $E = \frac{Q}{4\pi\varepsilon_o r^2}$ for the field strength
- Gravitational force and electric force.
- Electric potential
- Capacitance of a capacitor
- Energy stored in capacitor

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10. CURRENT ELECTRICITY

COURSE CONTENT

- Current
- Ohm's Law
- Series and parallel Combination of resistors
- Resistance and resistivity
- Potential difference and e.m.f
- Power dissipation in resistors.
- Kirchhoff's First Law as conservation of charge.
- Kirchhoff's Second Law as conservation of energy.
- Potentiometer

11. ELECTROMAGNETISM

COURSE CONTENT

- Magnetic field
- Force on current carrying conductor in uniform magnetic field
- Force on a moving charge in magnetic field
- Motion of charge particle in uniform electric and magnetic field.
- e/m for an electron.

12. ELECTROMAGNETIC INDUCTION

COURSE CONTENT

- Magnetic flux
- Faraday's Law and Lenz's Law.
- Induced e.m.f and factors
- Alternating current and use V = Vo sinωt.
- Transformer and uses of $\frac{N_S}{N_P} = \frac{V_S}{V_P} = \frac{I_P}{I_S}$ and practical transformer.
- Period, frequency, peak value and root mean square value of an alternating current or

voltage.

13. DEFORMATION OF SOLIDS

COURSE CONTENT

- Stress, strain and Young's Modulus.
- Tensile stress and strain.
- Hook's Law.
- Elastic and plastic deformation of a material.
- Strain energy.
- Band Theory, valence band, conduction band and forbidden band.

14. ELECTRONICS

COURSE CONTENT

- Half and Full wave rectification
- Single diode for half wave rectification of an alternating current
- Four diodes for full wave rectification of an alternating current
- Operational amplifier and its characteristics

15. MODERN PHYSICS

COURSE CONTENT

- Energy of photon E = hf
- Photoelectric Effect, Threshold Frequency and Work Function Energy.
- Maximum photoelectric energy is independent of intensity whereas photoelectric current is proportional to intensity
- Einstein's Photoelectric equation $hf = \phi + \frac{1}{2} mv^2_{max}$
- de Broglie wavelength and use $\lambda = \frac{h}{p}$.
- Discrete energy levels of hydrogen atom and spectral lines.
- Relation $hf = (E_2 - E_1)$

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- Production of X-rays and features of X-rays tube.

16. NUCLEAR PHYSICS

COURSE CONTENT

- Nucleus, nucleon number and charge number.
- Radioactivity and emission of radiation.
- Activity, Decay constant and relation Activity = Nλ.
- Half-life of radioactive substance and relation $\lambda = \frac{0.693}{t_{1/2}}$
- Nuclear transmutation and conservation of mass, energy, momentum and charge during nuclear changes.
- Mass-defect, binding energy and relation E = mc2
- Nuclear fission and fusion.
- Hadrons, Leptons and Quarks.

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ENGLISH

Aim

The aim of the English section of MDCAT is to measure the applicants' skills in English language and to evaluate how prepared they are for undertaking graduate studies in medicine in English. The test applies a common standard to everyone to be able to evaluate the preparation of the applicants from different sectors, regions and socio-economic backgrounds. The benchmarks for the test have been developed in the light of the curriculum used in HSSC and CIE. Since the students who take the MDCAT come from a wide range of educational contexts, the test comprises items that may be applied to a broadband of language competencies that are not exclusive to one particular type of curriculum.

Objectives

i. To ensure complete alignment between the English curriculum used in various sectors at the HSSC and CIE level and the test items

ii. To create a balance of items from different benchmarks of the English curriculum outlined for MDCAT

iii. To make sure that difficult and ambiguous items beyond the scope of high school education are not included

iv. To design the test specifications

v. To design, select, and arrange test task items

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Objective	Benchmark	Contents
1. Comprehend key vocabulary	Use one or more of the following strategies to determine meaning of key vocabulary: 1.1 contextual clues and illustrations 1.2 background or prior knowledge 1.3 morphology, syntax, phonics, knowledge of word relationships 1.4 knowledge of synonyms, antonyms, homophones	High and low frequency words from the course book or to be selected from similar contexts or the contexts the HSSC and CIE students may be familiar with
2. Demonstrate control of tenses and sentence structure	2.1 Use correct tenses and sentence structure in writing 2.2 Identify mistakes in the use of tenses and sentence structure in written texts	• All the present tenses • All the past tenses • Four types of sentences • Conditionals • Types of clauses • Fragments
3. Demonstrate correct use of subject-verb agreement	3.1 use correct subject-verb agreement in written texts 3.2 Identify mistakes in the use of subject verb-agreement in written texts	Use the texts prescribed/used in HSSC or CIE for selecting test items as well as determining the degree of their complexity
4. Demonstrate correct use of articles and prepositions	4.1 Use appropriate articles and prepositions in different written contexts 4.2 Identify mistakes in the use of articles and prepositions in sentences or short texts 4.3 Select the appropriate article or preposition for a particular context	The test items to be selected from the contexts common to the texts at HSSC and CIE level
5. Demonstrate correct use of writing conventions of spelling, capitalization and punctuation to clarify meaning	5.1 Use capitalization and punctuation such as semi colons, commas in a series, apostrophes in possessives, proper nouns, and abbreviations 5.2 Avoid and identify the following punctuation	The test items to be selected from the type of texts written by HSSC and CIE students and from the contexts common to both the streams

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	mistakes in sentences or short written texts: 5.2.1. Run on sentences 5.2.2. Comma splices 5.2.3. Fragments 5.2.4 Faulty coordination	

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Vocabulary

A	B	C
appalling astounded apparently attached to appraised alas abruptly accentuated anxieties	boon bewilderment briskly bead brimming baffling bashful beckoned	coveted credentials capacious collided with crudely confront compelled crudely coaxed comprehension curious casually confining crammed confirm cautioned captivated condescended compelled criteria
D	**E**	**F**
daintily dispensing dispute distract drummed dilapidated disconsolately delicately dank dilapidated disguise definite	enchanted encouraged fringed exude eccentric excursion elaborate exasperation expansive exaggeration evaluates	fatality flicked flawlessly friction fluttered
G	**H**	**I**
gingerly glistening glared groggy	heap hideous habitat haggard haphazardly harmony haughty havoc hearsay	intended in vain illumination invariably irritable insinuated intently industry intolerable intolerable imperceptibly
J	**K**	**L**
judgment judicial	Kindred Knack	likelihood labyrinth

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junction juvenile jeopardy jealousy jubilant	knickers knickknack	ludicrous limp
M menaced mustered mean mass mounting minimum mayhem miniature mumbled meditated moulded menacing	**N** nuisance naïve native nauseous negate negligence nemesis neutral niggle	**O** opted for on the wrong foot occasionally operation
P plopped presume precautions panting purchase persisted pensively prime placidly peered propelling passion promptly practically prone to paraphernalia prerogative path precision pizzazz potential	**Q** qualitative qualm quantitative quarrel quench query queue quirk quiver quizzical quotation	**R** rituals reinforce reprimanded riot reluctantly refuge regret rarely reproachful ragged revolving resonant
S swarmed up scenario swathe subsequently struck up string sternly	**T** tentatively tackle tumultuous tomfoolery tangle troughs tangled	**U** urge unburdened unprovoked

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solemnly succulent shuffled sailed stunt sauntered splendour sagged off speckled with stable		
V ventured vulnerable	**W** whipped weighing up writhing waft	**Y** Yearning Yelp yield
Z zealous zenith zest		

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