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Model Practice Paper — Applied Chemistry

BTEUP Diploma • 1st Semester (First Year — Common Curriculum, All 41 Branches)
Session 2026-27

Practice Questions / Model Paper — NOT a BTEUP board paper

Time: 2.30 Hours

Max. Marks: 60

General Instructions:

- All questions are compulsory. Each question has three parts (a), (b) and (c) — **answer any two** of the three parts in every question.
- Each part carries 6 marks; each question carries 12 marks.
- Draw neat, labelled diagrams wherever they are asked or wherever they support your answer.
- Write your answers in your own words, in the same order as the questions.

About this paper: This is an original practice (model) paper prepared by KAMALDNP Academy from the official BTEUP 2026-27 syllabus topics for this subject. It is NOT a BTEUP board paper, and no question in it is promised to appear in your examination. Its structure follows the board's last published paper pattern (5 questions, each with three parts of which any two are to be answered), scaled to this subject's theory maximum of 60 marks (external) in the verified 2026-27 scheme; the printed time follows the same last published pattern. The 2026-27 scheme's own paper format has not been published yet — when your board paper is in your hand, its printed instructions govern.

Q1. (From: Atomic Structure & Bonding) — Answer any two of the following:

- (a) Describe the structure of an atom with a neat, labelled diagram. Define atomic number and mass number, and give both for one example, such as carbon. **(6)**
- (b) Differentiate between atoms, molecules and ions. Give two examples of each. **(6)**

- (c) Explain ionic bond and covalent bond with one example of each. State one main difference between the two types of bond. (6)

Q2. (From: Water Technology) — Answer any two of the following:

- (a) What is meant by hardness of water? Differentiate between temporary hardness and permanent hardness, stating the salts that cause each type. (6)
- (b) Describe briefly the main methods used in the treatment of water for public supply, covering screening, sedimentation, filtration and disinfection. (6)
- (c) Numerical: A sample of water contains 162 mg per litre of calcium bicarbonate, $\text{Ca}(\text{HCO}_3)_2$, and 136 mg per litre of calcium sulphate, CaSO_4 . Taking the molar masses as 162 for $\text{Ca}(\text{HCO}_3)_2$, 136 for CaSO_4 and 100 for CaCO_3 , calculate the temporary hardness, the permanent hardness and the total hardness of the sample, each expressed as CaCO_3 equivalent in mg per litre. (6)

Q3. (From: Fuels & Combustion) — Answer any two of the following:

- (a) Classify fuels into solid, liquid and gaseous fuels, giving two examples of each. State one advantage of gaseous fuels over solid fuels. (6)
- (b) Define calorific value of a fuel and state its unit. Differentiate between gross (higher) calorific value and net (lower) calorific value. (6)
- (c) Explain what combustion of a fuel is. State the conditions needed for combustion and describe briefly how combustion is controlled in a boiler furnace. (6)

Q4. (From: Corrosion & Its Prevention) — Answer any two of the following:

- (a) What is corrosion? Explain it with the rusting of iron as an example, and state why corrosion is harmful in engineering work. (6)
- (b) Differentiate between dry (chemical) corrosion and wet (electrochemical) corrosion, giving the conditions under which each takes place. (6)
- (c) Describe any three methods used for the prevention of corrosion of metals, stating where each method is commonly used. (6)

Q5. (From: Fuels & Combustion + Corrosion & Its Prevention (mixed)) — Answer any two of the following:

- (a) Numerical: A boiler burns 2.5 kg of a coal whose calorific value is 28,000 kJ per kg. Calculate the total heat produced by complete combustion. If only 70 percent of this heat is usefully absorbed by the water, calculate the useful heat. (6)
- (b) A steel fuel-storage tank is kept in the open and its outer surface has started rusting. Write a short note on the type of corrosion taking place and the steps you would take to prevent further corrosion of the tank. (6)
- (c) Describe briefly how proper control of combustion in a furnace saves fuel and also reduces damage to the metal parts of the furnace. (6)

Model Answer Outline — Applied Chemistry

The key points a full-marks answer contains, question by question.

Practice Questions / Model Paper — NOT a BTEUP board paper

Q1(a)

- Atom has a small, heavy central nucleus containing protons (positive) and neutrons (no charge); electrons (negative) revolve around it in shells or orbits — a labelled diagram showing nucleus, protons, neutrons and electron shells earns the diagram marks
- Atomic number (Z) = number of protons in the nucleus = number of electrons in a neutral atom
- Mass number (A) = number of protons + number of neutrons in the nucleus
- Example: carbon has $Z = 6$ and $A = 12$, i.e. 6 protons, 6 electrons and 6 neutrons

Q1(b)

- Atom: the smallest particle of an element that takes part in a chemical reaction, e.g. an atom of iron (Fe) or of oxygen (O)
- Molecule: the smallest particle of a substance (element or compound) that can exist freely, made of two or more atoms joined together, e.g. O_2 and H_2O
- Ion: an atom or group of atoms carrying an electric charge, formed by loss or gain of electrons, e.g. Na^+ (cation, positive) and Cl^- (anion, negative)
- Key difference in one line: an atom is neutral and of one element, a molecule is a neutral joined group of atoms, and an ion is a charged particle

Q1(c)

- Ionic (electrovalent) bond: formed by complete transfer of electrons from a metal atom to a non-metal atom, and the oppositely charged ions attract each other
- Example: sodium transfers one electron to chlorine to form sodium chloride, Na^+ and Cl^- (both complete their outer shells)
- Covalent bond: formed by equal sharing of a pair of electrons between two atoms
- Example: two hydrogen atoms share one pair of electrons to form an H_2 molecule (or two chlorine atoms form Cl_2)
- Main difference: transfer of electrons in the ionic bond, sharing of electrons in the covalent bond

Q2(a)

- Hard water does not give a good lather with soap easily and forms scum instead; hardness is due to dissolved salts of calcium and magnesium in the water
- Temporary hardness: caused by dissolved bicarbonates of calcium and magnesium, $Ca(HCO_3)_2$ and $Mg(HCO_3)_2$; it is removed by simple boiling

- Permanent hardness: caused by dissolved chlorides and sulphates of calcium and magnesium, e.g. CaSO_4 , CaCl_2 and MgSO_4 ; it is not removed by boiling and needs chemical treatment or other softening methods
- Hardness is commonly expressed as CaCO_3 equivalent in mg per litre (ppm)

Q2(b)

- Screening: raw water is passed through screens to remove floating matter such as leaves, wood and other large objects
- Sedimentation: water is kept still in large tanks so that suspended mud and sand settle down by gravity; a coagulant may be added to help fine particles settle
- Filtration: water is passed through beds of sand and gravel, which remove the remaining fine suspended matter and much of the bacterial load
- Disinfection: germs are killed, commonly by chlorination (adding a controlled dose of chlorine), so that the water becomes safe for drinking

Q2(c)

- Rule: hardness as CaCO_3 = (mass of the salt in mg per litre $\times$ 100) / molar mass of the salt
- Temporary hardness is due to $\text{Ca}(\text{HCO}_3)_2$ only: $162 \times 100 / 162 = 100$ mg per litre as CaCO_3
- Permanent hardness is due to CaSO_4 only: $136 \times 100 / 136 = 100$ mg per litre as CaCO_3
- Total hardness = temporary + permanent = $100 + 100 = 200$ mg per litre as CaCO_3

Q3(a)

- Solid fuels: wood, coal (also coke, charcoal) — two examples are enough
- Liquid fuels: petrol, diesel (also kerosene, fuel oil)
- Gaseous fuels: LPG, CNG (also natural gas, coal gas)
- Advantage of gaseous fuels over solid fuels (any one): they burn completely with little smoke and leave no ash, they can be controlled easily by a valve, and they generally have a higher calorific value

Q3(b)

- Calorific value: the total amount of heat produced by the complete combustion of a unit mass (or unit volume) of the fuel
- Unit: kJ per kg for solid and liquid fuels (kJ per cubic metre is used for gaseous fuels)
- Gross (higher) calorific value: total heat obtained when the products of combustion are cooled so that the steam formed condenses and gives back its latent heat
- Net (lower) calorific value: gross value minus the latent heat carried away by the steam formed from the hydrogen in the fuel, which escapes as vapour in practice; net value is therefore always lower and is the practically useful value

Q3(c)

- Combustion is a chemical reaction of the fuel with oxygen of the air, producing heat and light; carbon and hydrogen in the fuel form mainly CO_2 and water vapour

- Conditions needed: fuel, supply of air/oxygen, and heating the fuel to its ignition temperature
- Control in a boiler furnace: regulate the air supply (dampers and fans) to give enough air for complete burning but avoid large excess air, which carries heat away with the flue gases
- Control also includes proper fuel feed rate and fuel size, and watching the flame and flue-gas condition, so that fuel is neither wasted as smoke and unburnt carbon nor metal overheated

Q4(a)

- Corrosion is the slow eating away or destruction of a metal by the chemical or electrochemical action of its surroundings (air, moisture, gases or chemicals)
- Rusting of iron: in the presence of moist air, iron slowly forms a brown, flaky layer of rust (hydrated iron oxide) on its surface
- Harm: loss of metal and strength, machine and structure parts become weak and may fail
- Harm (contd.): increased maintenance and replacement cost, leakage in pipes and tanks, and stoppage of work — so corrosion causes both safety risk and money loss

Q4(b)

- Dry (chemical) corrosion: direct chemical attack by dry gases such as oxygen (and other gases) on the metal surface, forming an oxide or other compound film; no liquid is needed
- Wet (electrochemical) corrosion: takes place when the metal is in contact with moisture or an electrolyte solution; local anode and cathode areas form on the surface and the anodic part is eaten away, as in rusting of iron in moist air
- Conditions: dry corrosion needs a dry reactive gas and is faster at high temperature; wet corrosion needs moisture/an electrolyte and is the common type seen in service
- Rate: wet corrosion is generally faster and more harmful in ordinary engineering use

Q4(c)

- Protective coatings: applying paint, varnish, enamel, grease/oil or a plastic coating so the metal surface does not come in contact with air and moisture — used on bridges, machine bodies, vehicles
- Metallic coating / galvanisation: coating iron or steel with a more resistant metal, e.g. zinc coating (galvanised sheets, buckets, roofing) or tin coating for food containers
- Use of corrosion-resistant materials and alloying: e.g. stainless steel (iron alloyed with chromium and nickel) for utensils, chemical plant and surgical tools
- Any one other valid method may also be credited, e.g. cathodic protection of underground pipelines and ship hulls using a sacrificial anode, or keeping the surface clean and dry and using inhibitors in boiler water

Q5(a)

- Total heat produced = mass of fuel x calorific value = 2.5 kg x 28,000 kJ per kg = 70,000 kJ
- Useful heat = 70 percent of 70,000 kJ = 0.70 x 70,000 = 49,000 kJ

- State the result clearly with units: total heat 70,000 kJ, useful heat 49,000 kJ (the remaining 21,000 kJ is lost, e.g. with flue gases)

Q5(b)

- Type: wet (electrochemical) / atmospheric corrosion — rain and moist air attack the exposed steel surface and rust forms, worsened because the tank stands in the open
- First step: clean the surface properly — remove loose rust, dirt and old damaged paint by wire brushing or sanding, and let the surface dry
- Apply a protective coating: a suitable primer followed by anti-corrosive paint over the whole outer surface, so that air and moisture cannot reach the metal
- Regular care: inspect the tank at fixed intervals, repair any damaged or scratched coating at once, keep the surroundings drained so water does not collect near the base; a metallic coating such as galvanising may be mentioned for new tanks

Q5(c)

- With correct air supply the fuel burns completely to CO₂, so the full calorific value of the fuel is obtained from every kilogram burnt — less fuel is needed for the same steam output
- Too little air causes incomplete combustion: carbon monoxide, smoke and unburnt carbon are formed, which carry away heat and waste fuel
- Too much excess air also wastes fuel, because the extra air is heated and carries heat out with the flue gases
- Controlled, even firing avoids local overheating, scaling damage and thermal stress on furnace and boiler metal parts, so their life increases and repair cost falls

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