# NIPER JEE Pharmacy Subjects

## Sample Paper – 3

M.S.(Pharm) / M.Pharm Joint Entrance Examination

**Duration: 96 Minutes** **Maximum Marks: 80**

### Instructions

- This paper contains **160 single-correct Multiple Choice Questions** drawn from the pharmaceutical-sciences syllabus of the **NIPER Joint Entrance Examination** (M.S.(Pharm) / M.Pharm).
- Each correct answer carries **+0.5 marks**. **0.125 mark is deducted** for every wrong answer, and an unattempted question gets **0 marks**. Maximum marks: **80**.
- The paper runs continuously from **Q1 to Q160** across six parts: Pharmaceutics; Pharmacology & Toxicology; Pharmaceutical & Medicinal Chemistry; Pharmaceutical Analysis & QA; Pharmacognosy; and Pharmaceutical Biotechnology & Microbiology.
- Only **one** option is correct. Personal calculators, mobile phones, and other electronic gadgets are strictly prohibited.

## Part A: Pharmaceutics

**Q1.** The molar solubility of calcium fluoride ($CaF_2$) in water is $2.0 \times 10^{-4}$ mol/L at 25°C. Its solubility product $K_{sp}$ is:

(A) $4.0 \times 10^{-8}$

(B) $8.0 \times 10^{-8}$

(C) $3.2 \times 10^{-11}$

(D) $2.0 \times 10^{-4}$

**Q2.** When a weak base is shaken with 20 mL chloroform and 80 mL water, 80 mg is found in the chloroform layer and 20 mg in the water layer at equilibrium. The chloroform/water partition coefficient $P$ (concentration ratio) is:

(A) 4.0

(B) 16.0

(C) 1.0

(D) 0.25

**Q3.** For one liquid to spread spontaneously over the surface of another, the spreading coefficient $S = \gamma_a - (\gamma_b + \gamma_{ab})$ must be:

(A) Positive or zero

(B) Negative

(C) Exactly equal to $\gamma_{ab}$

(D) Independent of interfacial tension

**Q4.** A blend of $60\%$ Tween 80 (HLB $15$) and $40\%$ Span 80 (HLB $4.3$) is prepared. The required HLB of the final surfactant blend is approximately:

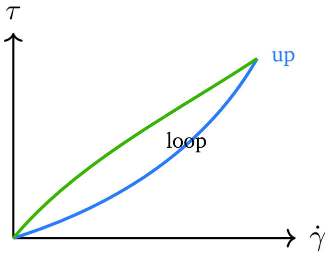
(A) 4.3

(B) 9.65

(C) 15.0

(D) 10.7

**Q5.** The rheogram below shows the up-curve and down-curve of a structured suspension not overlapping, forming a loop. This area between the two curves indicates:



(A) A simple Newtonian liquid

(B) Thixotropy (time-dependent reversible breakdown of structure)

(C) Dilatancy

(D) A negative yield value

**Q6.** Kinematic viscosity is defined as dynamic viscosity divided by density. Its CGS unit is the stokes. One stokes equals:

(A) $1$ poise

(B) $1$ Pa·s

(C) $1$ cm$^2$/s

(D) $1$ m$^2$/s

**Q7.** A spray-dried lactose blend has a bulk density of $0.55$ g/mL and a tapped density of $0.60$ g/mL. Carr's compressibility index (rounded) and the flow rating are:

(A) $8\%$, excellent flow

(B) $20\%$, passable flow

(C) $33\%$, very poor flow

(D) $50\%$, free flowing

**Q8.** For spherical particles, the specific surface area (surface area per unit volume) is related to particle diameter $d$ as:

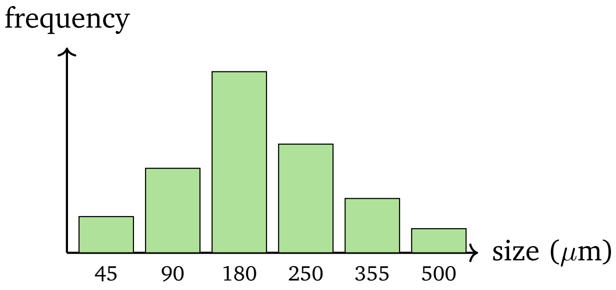
(A) Directly proportional to $d$

(B) Proportional to $d^2$

(C) Independent of $d$

(D) Inversely proportional to $d$ (i.e. $6/d$ for a sphere)

**Q9.** The frequency histogram of a sieved powder is shown. By number, the modal size class (in $\mu$m) is:



(A) 45 – 90

(B) 90 – 250 (peak at the 180 class)

(C) 250 – 355

(D) 355 – 500

**Q10.** A phosphate buffer contains $0.20$ M $Na_2HPO_4$ (salt) and $0.05$ M $NaH_2PO_4$ (acid), with $pK_{a2} = 7.2$. The pH of the buffer is approximately ($\log 4 \approx 0.60$):

(A) 6.60

(B) 7.20

(C) 7.80

(D) 8.40

**Q11.** A $1\%$ w/v solution of a drug depresses the freezing point of water by $0.20$°C. Blood plasma freezes at $-0.52$°C. The percentage concentration of this drug needed to make the solution isotonic with plasma is:

(A) $0.20\%$

(B) $0.52\%$

(C) $1.0\%$

(D) $2.6\%$

**Q12.** Caffeine forms a $1:1$ soluble complex with benzocaine, improving its apparent solubility. The equilibrium constant for the reaction $D + L \rightleftharpoons DL$ is termed the:

(A) Stability (formation) constant $K$

(B) Partition coefficient

(C) Distribution ratio

(D) Dielectric constant

**Q13.** A drug diffuses across a membrane of thickness $0.02$ cm and area $10$ cm$^2$. Diffusion coefficient $D = 1 \times 10^{-6}$ cm$^2$/s, partition coefficient $= 1$, and the concentration gradient across the membrane is $0.5$ mg/cm$^3$. The steady-state flux $J$ (in mg cm$^{-2}$ s$^{-1}$) by Fick's first law is:

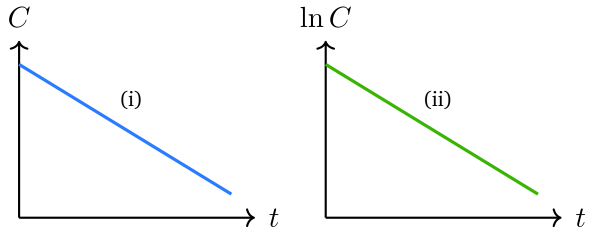
(A) $2.5 \times 10^{-3}$

(B) $2.5 \times 10^{-5}$

(C) $1.0 \times 10^{-6}$

(D) $5.0 \times 10^{-7}$

**Q14.** Two degradation data sets are plotted. Plot (i) is concentration $C$ versus $t$ giving a straight line; plot (ii) is $\ln C$ versus $t$ giving a straight line. The reaction following plot (ii) is:



(A) Zero order

(B) Second order

(C) First order

(D) Order cannot be determined

**Q15.** A drug degrades by first-order kinetics with a rate constant $k = 0.0021$ month$^{-1}$ at room temperature. Its shelf life $t_{90}$ (time for $10\%$ loss, $t_{90} = 0.105/k$) is approximately:

(A) 330 months

(B) 12 months

(C) 100 months

(D) 50 months

**Q16.** The Freundlich adsorption isotherm is written $x/m = k\,C^{1/n}$. A plot used to obtain the constants $k$ and $n$ is:

(A) $\log(x/m)$ versus $\log C$ (straight line)

(B) $x/m$ versus $C$ (straight line through origin)

(C) $1/(x/m)$ versus $1/C$

(D) $\ln(x/m)$ versus $1/C$

**Q17.** According to the Schulze–Hardy rule, the coagulating power of an electrolyte for a negatively charged sol increases sharply with the:

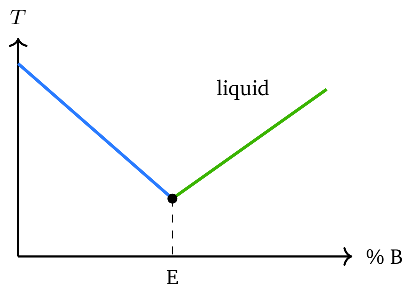
(A) Size of the anion

(B) Valency of the added cation

(C) Concentration of the dispersion medium

(D) Wavelength of incident light

**Q18.** The simple binary phase diagram below (temperature vs composition) shows two liquidus lines meeting at the lowest point E. Point E represents the:



(A) Melting point of pure component A

(B) Boiling point of the mixture

(C) Eutectic point (lowest melting composition)

(D) Critical solution temperature

**Q19.** According to the Noyes–Whitney equation, the dissolution rate $dC/dt = \dfrac{DA(C_s - C)}{h}$. To accelerate dissolution of a poorly soluble drug, the most effective formulation strategy is to:

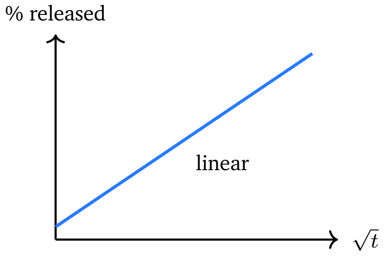
(A) Increase the diffusion-layer thickness $h$

(B) Decrease the saturation solubility $C_s$

(C) Compress the tablet to a higher hardness

(D) Reduce particle size to increase surface area $A$

**Q20.** The cumulative-release plot of a matrix tablet is linear when plotted against the square root of time, as shown. This release follows the:



(A) Higuchi (matrix diffusion) model

(B) Zero-order model

(C) First-order model

(D) Hixson–Crowell cube-root model

**Q21.** A drug shows high aqueous solubility but low intestinal permeability. According to the Biopharmaceutics Classification System (BCS), it belongs to:

(A) Class I

(B) Class III

(C) Class II

(D) Class IV

**Q22.** The USP dissolution Apparatus 2 (most widely used for conventional immediate-release tablets) is the:

(A) Rotating basket

(B) Reciprocating cylinder

(C) Paddle apparatus

(D) Flow-through cell

**Q23.** Croscarmellose sodium acts as a superdisintegrant chiefly by which mechanism?

(A) Effervescence on contact with water

(B) Melting at body temperature

(C) Forming an insoluble film barrier

(D) Rapid wicking and swelling (water uptake) to rupture the tablet

**Q24.** Among standard hard-gelatin capsule shells, the size with the *largest* fill volume routinely used for human oral products is:

(A) Size 000

(B) Size 0

(C) Size 3

(D) Size 5

**Q25.** The displacement value of zinc oxide in cocoa-butter suppositories is 4.7. This means that 4.7 g of zinc oxide displaces:

(A) 4.7 g of cocoa butter

(B) 1 g of cocoa butter

(C) 4.7 g of water

(D) Half its own weight of base

**Q26.** An emulsion stabilised with a high-HLB surfactant is diluted readily with water and conducts an electric current. The emulsion type is:

(A) Water-in-oil (w/o)

(B) Water-in-oil-in-water multiple

(C) Oil-in-water (o/w)

(D) A microemulsion with no continuous phase

**Q27.** In the USP friability test, $6.5$ g of tablets weigh $6.42$ g after the test. The percentage friability is approximately, and is it acceptable (limit $\leq 1\%$)?

(A) $0.08\%$, fail

(B) $8.0\%$, fail

(C) $1.2\%$, fail

(D) $1.23\%$, fail

**Q28.** White petrolatum (soft paraffin) is best classified as which type of ointment base?

(A) Oleaginous (hydrocarbon) base

(B) Absorption base

(C) Water-removable (o/w) base

(D) Water-soluble (PEG) base

**Q29.** The most sensitive and widely used in-vitro test for bacterial endotoxins in parenteral products is the:

(A) Rabbit pyrogen test

(B) Limulus Amebocyte Lysate (LAL) gel-clot test

(C) Sterility test by membrane filtration

(D) Weight-variation test

**Q30.** In a controlled-flocculation pharmaceutical suspension, flocculated systems are preferred over deflocculated ones mainly because the flocculated sediment:

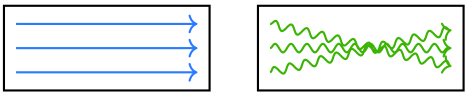
(A) Forms a hard, compact cake

(B) Has the slowest settling rate of all systems

(C) Is loose, redisperses easily on shaking, and does not cake

(D) Always remains permanently suspended without settling

**Q31.** The two pipe-flow profiles below are shown. Profile (i) has smooth parallel streamlines; profile (ii) shows chaotic eddies. For Newtonian flow in a circular pipe, profile (ii) (turbulent) is expected when the Reynolds number exceeds about:



(i) laminar (ii) turbulent

(A) 40

(B) 100

(C) 1000

(D) 4000

**Q32.** A ball mill achieves the most efficient grinding (cascading/cataracting of the balls) when operated at about $65–80\%$ of its critical speed. At the critical speed itself, the balls:

(A) Centrifuge and cling to the mill wall, doing no grinding

(B) Cascade gently and grind most effectively

(C) Remain stationary at the bottom

(D) Are thrown clear of the mill

**Q33.** In freeze-drying (lyophilisation), the bulk of the water is removed by sublimation of ice under vacuum during which stage?

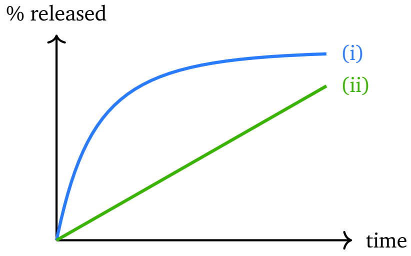
(A) Freezing (solidification) stage

(B) Primary drying (sublimation) stage

(C) Secondary drying (desorption) stage

(D) Reconstitution stage

**Q34.** The two dissolution profiles below are compared: profile (i) is a conventional immediate-release product reaching plateau quickly, while profile (ii) releases slowly and steadily. Profile (ii) is the intended behaviour of a:



(A) Fast-dissolving orodispersible tablet

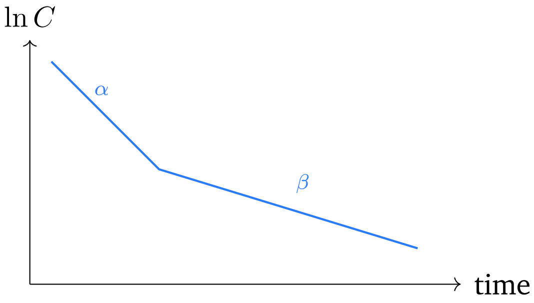
(B) Effervescent tablet

(C) Sustained-release (zero-order intent) dosage form

(D) Subcutaneous bolus injection

## Part B: Pharmacology & Toxicology

**Q35.** The semi-log plasma concentration-time plot below, obtained after a rapid IV bolus, is biphasic: a steep early segment followed by a shallower terminal segment. This pattern is the hallmark of:



(A) A single first-order elimination process with a constant half-life

(B) A two-compartment model: a rapid distribution ($\alpha$) phase followed by a slower elimination ($\beta$) phase

(C) Zero-order (saturable) elimination throughout

(D) Flip-flop kinetics where absorption is slower than elimination

**Q36.** A 70 kg patient receives a drug whose apparent volume of distribution is 0.6 L/kg. To achieve a target plasma concentration of 5 mg/L immediately, the IV loading dose (assuming complete bioavailability) is approximately:

(A) 42 mg

(B) 350 mg

(C) 210 mg

(D) 21 mg

**Q37.** A drug with a high hepatic extraction ratio (close to 1) given orally will characteristically show:

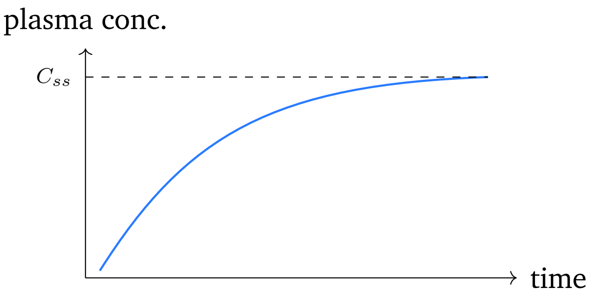
(A) High and reliable oral bioavailability independent of liver blood flow

(B) Clearance that is independent of hepatic blood flow and limited only by enzyme capacity

(C) No first-pass effect

(D) Low oral bioavailability due to extensive first-pass metabolism, with clearance approximating (flow-limited) hepatic blood flow

**Q38.** During a constant-rate IV infusion the plasma concentration rises toward a plateau as shown. The time taken to reach approximately 94% of the steady-state concentration corresponds to about:



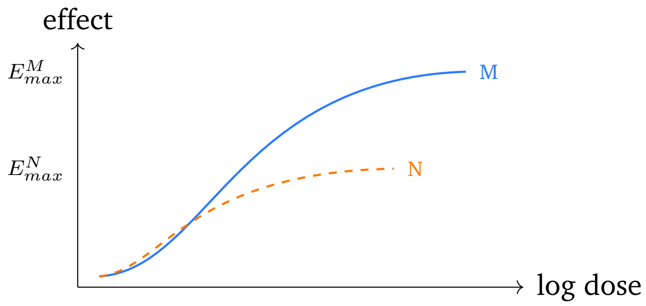
(A) About 4 elimination half-lives

(B) About 1 half-life

(C) About 10 half-lives

(D) Independent of half-life

**Q39.** The two graded log dose-response curves below belong to agonists M and N at the same receptor. M reaches a higher plateau than N, while N lies to the left at low doses. The correct interpretation is:



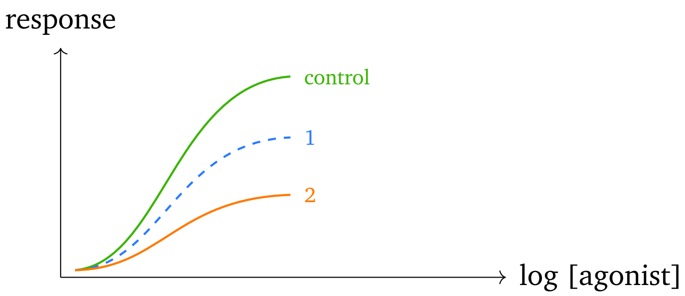
(A) M and N have identical efficacy

(B) M has greater efficacy (higher maximal effect) than N, which behaves as a partial agonist

(C) N is more efficacious than M

(D) Efficacy cannot be compared from such curves

**Q40.** The agonist concentration-response curves below show the effect of increasing concentrations of an antagonist (control, then 1, 2). The maximum response progressively falls and is not restored by adding more agonist. This identifies the antagonist as:



(A) A reversible competitive antagonist

(B) A chemical antagonist acting in the plasma

(C) An irreversible (non-competitive) antagonist that depresses the maximal response (insurmountable)

(D) A partial agonist

**Q41.** Repeated closely spaced doses of an indirectly acting sympathomimetic produce a rapidly diminishing response over minutes to hours. This phenomenon is best termed:

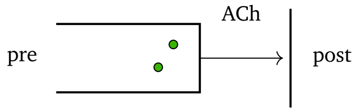
(A) Idiosyncrasy

(B) Cumulation

(C) Slow up-regulation of receptors

(D) Tachyphylaxis (acute desensitisation), here largely from depletion of the releasable neurotransmitter store

**Q42.** At the cholinergic effector synapse depicted, pilocarpine acts directly on the postjunctional receptor. Its principal therapeutic use in glaucoma is explained by its action as a:



(A) Direct muscarinic agonist that contracts the ciliary muscle and sphincter pupillae, opening the trabecular meshwork and lowering intraocular pressure

(B) Muscarinic antagonist causing mydriasis

(C) Nicotinic antagonist at the neuromuscular junction

(D) $\beta_2$-adrenergic agonist

**Q43.** Prazosin lowers blood pressure, and is also used in benign prostatic hyperplasia, because it is a selective:

(A) $\beta_1$-adrenergic antagonist

(B) $\alpha_1$-adrenergic antagonist, relaxing arteriolar/venous and prostatic-urethral smooth muscle

(C) Central $\alpha_2$-adrenergic agonist

(D) Non-selective $\beta$-blocker

**Q44.** Atracurium is often preferred over other non-depolarising neuromuscular blockers in patients with hepatic or renal impairment because it:

(A) Is a depolarising agonist hydrolysed by pseudocholinesterase

(B) Depends entirely on renal excretion for its elimination

(C) Undergoes spontaneous Hofmann elimination (and ester hydrolysis) at body pH and temperature, independent of hepatic or renal function

(D) Is reversed only by succinylcholine

**Q45.** Dobutamine is used as an inotrope in acute heart failure mainly because it is a relatively selective:

(A) $\alpha_1$-agonist raising peripheral resistance

(B) Central $\alpha_2$-agonist

(C) Muscarinic agonist increasing vagal tone

(D) $\beta_1$-adrenergic agonist that increases myocardial contractility with relatively little change in heart rate

**Q46.** Pyridostigmine is used in the chronic oral treatment of myasthenia gravis because it:

(A) Is a reversible carbamate cholinesterase inhibitor that raises synaptic acetylcholine at the neuromuscular junction, with a longer duration than neostigmine

(B) Is an irreversible organophosphate inhibitor

(C) Blocks nicotinic receptors at the motor end-plate

(D) Is a muscarinic antagonist

**Q47.** Zolpidem, a non-benzodiazepine hypnotic ("Z-drug"), produces sleep with relatively less anxiolytic and muscle-relaxant effect because it:

(A) Blocks histamine $H_1$ receptors only

(B) Acts at the benzodiazepine site of the GABA-A receptor with preference for $\alpha_1$-subunit-containing receptors

(C) Directly opens the chloride channel without GABA

(D) Is a melatonin $MT_1/MT_2$ agonist

**Q48.** Clozapine is reserved for treatment-resistant schizophrenia and requires regular blood monitoring chiefly because of the risk of:

(A) Severe extrapyramidal symptoms, which are very common with clozapine

(B) Hyperprolactinaemia from strong $D_2$ blockade

(C) Agranulocytosis (a potentially fatal fall in neutrophils), requiring white-cell count monitoring

(D) Irreversible retinal pigmentation

**Q49.** Bupropion differs from the SSRIs and is also used as an aid to smoking cessation because its main antidepressant mechanism is:

(A) Selective serotonin reuptake inhibition

(B) Irreversible monoamine oxidase inhibition

(C) Blockade of 5-$HT_2$ and $\alpha_2$ receptors

(D) Inhibition of noradrenaline and dopamine reuptake (an NDRI) with minimal serotonergic action

**Q50.** Tramadol provides analgesia through a dual mechanism that distinguishes it from morphine, namely:

(A) Weak $\mu$-opioid receptor agonism combined with inhibition of noradrenaline and serotonin reuptake

(B) Pure non-opioid COX inhibition

(C) Selective $\kappa$-receptor antagonism

(D) NMDA receptor agonism

**Q51.** Sodium valproate is effective across many seizure types (including absence and myoclonic) because it acts through several mechanisms, predominantly:

(A) Selective T-type calcium channel block alone

(B) Multiple actions: blockade of voltage-gated sodium channels, some T-type calcium block, and enhancement of GABA levels (inhibition of GABA transaminase)

(C) Pure NMDA-receptor antagonism

(D) Binding to the SV2A vesicle protein only

**Q52.** Ethosuximide is the drug of choice for uncomplicated absence (petit mal) seizures because it:

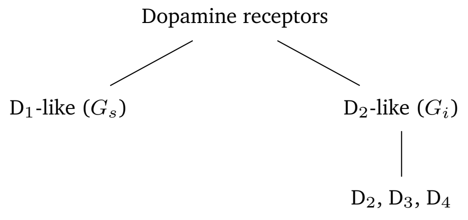
(A) Blocks voltage-gated sodium channels like phenytoin

(B) Enhances GABA-A chloride currents like barbiturates

(C) Blocks T-type calcium channels in thalamic neurons, suppressing the 3-Hz spike-and-wave rhythm

(D) Antagonises AMPA glutamate receptors

**Q53.** In the dopamine-receptor classification shown, the receptors of the $D_2$-like family ($D_2$/$D_3$/$D_4$) couple to $G_i$. Pramipexole is used in early Parkinson's disease (and restless-legs syndrome) because it acts as a:



(A) Peripheral DOPA-decarboxylase inhibitor

(B) Catechol-O-methyltransferase inhibitor

(C) Irreversible MAO-B inhibitor

(D) Direct dopamine receptor agonist (preferentially $D_2/D_3$), stimulating striatal receptors without needing conversion

**Q54.** Candesartan controls hypertension and rarely causes the dry cough seen with ACE inhibitors because it:

(A) Selectively blocks the angiotensin II $AT_1$ receptor without raising bradykinin levels

(B) Inhibits angiotensin-converting enzyme

(C) Blocks L-type calcium channels

(D) Is a $\beta_1$-selective adrenergic blocker

**Q55.** Verapamil differs from amlodipine in that, besides arterial dilation, it has prominent direct cardiac effects, namely:

(A) Strong $\beta_2$-agonist bronchodilation

(B) Marked depression of SA-node automaticity and AV-node conduction (negative chronotropic/dromotropic effects), useful in supraventricular tachycardia

(C) Inhibition of the renin-angiotensin system

(D) Irreversible COX inhibition

**Q56.** Spironolactone is a potassium-sparing diuretic added in resistant hypertension and heart failure because it:

(A) Inhibits the $Na^+/K^+/2Cl^-$ cotransporter in the loop of Henle

(B) Inhibits carbonic anhydrase in the proximal tubule

(C) Competitively antagonises the aldosterone (mineralocorticoid) receptor in the collecting duct, reducing $Na^+$ reabsorption while retaining $K^+$

(D) Blocks the $Na^+/Cl^-$ symporter of the distal convoluted tubule

**Q57.** Rivaroxaban prevents thrombosis by a mechanism distinct from warfarin and heparin, acting as a:

(A) Vitamin-K epoxide reductase inhibitor

(B) Indirect activator of antithrombin

(C) Irreversible cyclooxygenase inhibitor in platelets

(D) Direct, reversible inhibitor of activated factor Xa, given orally without routine INR monitoring

**Q58.** Rosuvastatin lowers LDL cholesterol by the same class mechanism as other statins, namely:

(A) Competitive inhibition of HMG-CoA reductase, the rate-limiting enzyme of cholesterol synthesis, which up-regulates hepatic LDL receptors

(B) Binding bile acids in the intestine

(C) Inhibiting PCSK9 directly

(D) Activating lipoprotein lipase

**Q59.** Fexofenadine differs from chlorpheniramine, and from the $H_2$ blocker famotidine, because fexofenadine is a:

(A) Sedating first-generation $H_1$ antihistamine

(B) Non-sedating second-generation $H_1$ antihistamine that poorly crosses the blood-brain barrier

(C) Histamine $H_2$-receptor antagonist that reduces gastric acid

(D) Mast-cell stabiliser

**Q60.** Naproxen, a propionic-acid NSAID, relieves inflammation and pain by a mechanism that differs from aspirin in being:

(A) Selective COX-2 inhibition only

(B) Lipoxygenase inhibition

(C) Reversible (competitive) inhibition of cyclooxygenase (COX-1 and COX-2), reducing prostaglandin synthesis

(D) Irreversible acetylation of COX like aspirin

**Q61.** Febuxostat is used for chronic urate lowering in gout, particularly in patients intolerant of allopurinol, because it is a:

(A) Uricosuric that increases renal urate excretion

(B) Recombinant uricase that degrades urate

(C) Microtubule inhibitor like colchicine

(D) Non-purine selective inhibitor of xanthine oxidase, reducing uric-acid production

**Q62.** Sumatriptan aborts an acute migraine attack chiefly by acting as a:

(A) 5-HT$_{1B/1D}$ receptor agonist that constricts dilated cranial vessels and inhibits trigeminal neuropeptide release

(B) 5-HT$_3$ receptor antagonist

(C) Dopamine D$_2$ receptor antagonist

(D) Non-selective COX inhibitor

**Q63.** Doxycycline is bacteriostatic against a wide range of organisms because it:

(A) Inhibits bacterial cell-wall peptidoglycan synthesis

(B) Binds the 30S ribosomal subunit and blocks attachment of aminoacyl-tRNA to the acceptor site, inhibiting protein synthesis

(C) Inhibits DNA gyrase

(D) Inhibits dihydrofolate reductase

**Q64.** Vancomycin is bactericidal against Gram-positive organisms (including MRSA) because it:

(A) Binds penicillin-binding proteins like the $\beta$-lactams

(B) Inhibits the 50S ribosomal subunit
(C) Binds the terminal D-Ala-D-Ala of peptidoglycan precursors, blocking transglycosylation and cell-wall synthesis
(D) Disrupts the cytoplasmic membrane as a polymyxin

**Q65.** Amphotericin B is fungicidal in serious systemic mycoses because it:

(A) Inhibits fungal 14-$\alpha$-demethylase (ergosterol synthesis)
(B) Inhibits fungal $\beta$-1,3-glucan synthase
(C) Inhibits fungal squalene epoxidase
(D) Binds ergosterol in the fungal membrane and forms pores, causing leakage of intracellular ions

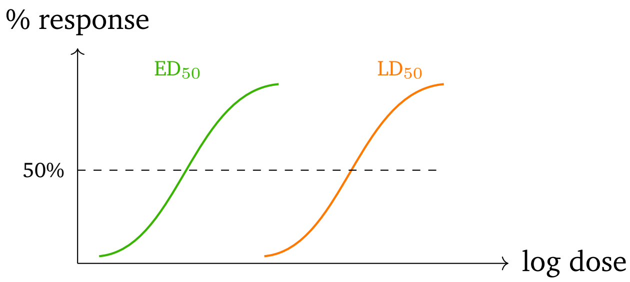
**Q66.** Oseltamivir shortens the course of influenza because it:

(A) Inhibits the viral neuraminidase, preventing release of newly formed virions from infected cells
(B) Acts as a chain-terminating reverse-transcriptase inhibitor
(C) Inhibits viral protease
(D) Blocks the CCR5 co-receptor

**Q67.** Metformin is first-line in type 2 diabetes and rarely causes hypoglycaemia because it:

(A) Closes ATP-sensitive $K^+$ channels in $\beta$-cells to release insulin
(B) Activates AMP-activated protein kinase, suppressing hepatic gluconeogenesis and improving peripheral insulin sensitivity, without directly stimulating insulin secretion
(C) Inhibits intestinal $\alpha$-glucosidase
(D) Is a GLP-1 receptor agonist

**Q68.** The therapeutic-index diagram below relates the median effective and median lethal doses. In poisoning practice, the preferred specific antidote for methanol or ethylene glycol poisoning is:



(A) Naloxone

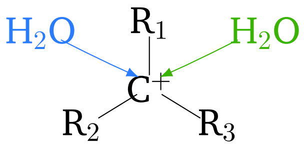
(B) Deferoxamine

(C) Fomepizole (an alcohol-dehydrogenase inhibitor; ethanol is the alternative), blocking formation of toxic metabolites

(D) Protamine sulfate

## Part C: Pharmaceutical & Medicinal Chemistry

**Q69.** Optically active (*R*)-3-bromo-3-methylhexane is heated in aqueous ethanol (a polar protic solvent) with no added nucleophile. The reaction proceeds through the planar carbocation intermediate shown, attacked from both faces.



What is the stereochemical outcome at the reacting carbon?

(A) Complete inversion of configuration only.

(B) Complete retention of configuration only.

(C) A racemic (or largely racemic) mixture, because the planar carbocation is attacked from both faces.

(D) No reaction, since tertiary halides are inert to solvolysis.

**Q70.** For an E1 elimination of a tertiary alkyl halide, which statement about the mechanism is correct?

(A) It is concerted and second order, with the rate depending on both substrate and base.

(B) The $\beta$-hydrogen is removed before the leaving group departs.

(C) It requires an anti-periplanar arrangement of H and the leaving group.

(D) The slow step is unimolecular ionisation to a carbocation; the rate depends only on the substrate.

**Q71.** When benzene is treated with 1-chloropropane and anhydrous $AlCl_3$ (Friedel–Crafts alkylation), the major aromatic product is isopropylbenzene (cumene) rather than *n*-propylbenzene. The best explanation is:

(A) the primary carbocation rearranges by a 1,2-hydride shift to the more stable secondary carbocation before attacking the ring

(B) benzene only reacts with secondary halides

(C) $AlCl_3$ reduces the alkyl chain

(D) *n*-propylbenzene is formed but immediately oxidised

**Q72.** The three-component condensation of a compound bearing an acidic C–H (e.g. a ketone), formaldehyde and a secondary amine to give a $\beta$-aminoketone (a Mannich base) is the:

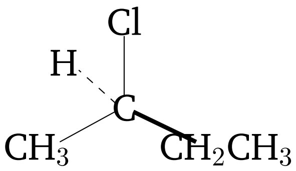
(A) Mannich reaction

(B) Reformatsky reaction

(C) Knoevenagel condensation

(D) Michael addition

**Q73.** The stereocentre below carries –Cl, $–CH_2CH_3$, $–CH_3$ and –H (the H pointing back, on the dashed bond). Looking with the lowest-priority group (H) away from the viewer, the sequence Cl → $CH_2CH_3$ → $CH_3$ runs clockwise.



The configuration at this stereocentre is therefore:

(A) ($S$), because the lowest priority group is in front

(B) ($S$), since $CH_2CH_3$ outranks Cl

(C) ($R$), since with H pointing away a clockwise 1→2→3 sequence is R

(D) meso, so no descriptor applies

**Q74.** For the alkene (Cl)($CH_3$)C=C(F)($CH_2CH_3$), the geometric descriptor is assigned by comparing CIP priorities on each carbon. On the left carbon Cl $>$ $CH_3$; on the right carbon Cl-side comparison gives $CH_2CH_3$ $>$ F? Evaluate carefully. The correct designation is:

(A) *E*, because Cl and F (the two halogens) are on opposite sides

(B) it cannot have E/Z isomerism

(C) *Z*, because the two carbons are identical

(D) *Z*, because the higher-priority groups (Cl on the left, F on the right, since F $>$ C) are on the same side

**Q75.** Which of the following is aromatic by Hückel's $(4n + 2)$ $\pi$-electron criterion?

(A) 1,3,5,7-cyclooctatetraene (planar form, 8 $\pi$ electrons)

(B) naphthalene (10 $\pi$ electrons, $n = 2$)

(C) cyclopentadiene (the neutral hydrocarbon)

(D) cyclobutadiene (4 $\pi$ electrons)

**Q76.** Among the following para-substituted benzoic acids, which is the **strongest** acid (lowest $pK_a$)?

(A) *p*-nitrobenzoic acid

(B) *p*-methoxybenzoic acid

(C) *p*-aminobenzoic acid

(D) *p*-methylbenzoic acid

**Q77.** The allyl cation is far more stable than a simple primary cation because the positive charge is delocalised over two carbons, as shown by the equivalent resonance structures below.

$$CH_2{=}CH{-}CH_2^+ \longleftrightarrow {}^+CH_2{-}CH{=}CH_2$$

Which order of carbocation stability is correct?

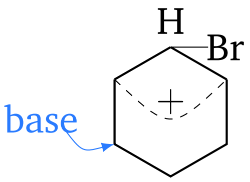
(A) allyl $<$ methyl $<$ ethyl

(B) primary $>$ allyl $>$ benzyl

(C) benzyl $\approx$ allyl $>$ secondary $>$ primary, because of resonance delocalisation

(D) all carbocations have equal stability

**Q78.** The bromination of benzene proceeds through the Wheland (arenium) intermediate shown, which then loses a proton to restore aromaticity.



In the rate-determining step of electrophilic aromatic bromination, what happens?

(A) The aromatic ring is permanently destroyed.

(B) A proton adds to the ring first.

(C) Bromide adds to give a non-aromatic dibromide.

(D) The electrophile $Br^+$ adds to the ring to form the resonance-stabilised arenium (sigma) complex.

**Q79.** Conversion of an aryl diazonium salt ($ArN_2^+$) to an aryl chloride or bromide using CuCl or CuBr is known as the:

(A) Sandmeyer reaction

(B) Gattermann–Koch reaction

(C) Rosenmund reduction

(D) Clemmensen reduction

**Q80.** A molecule contains two non-equivalent stereocentres (and no internal symmetry). What is the maximum number of stereoisomers it can have?

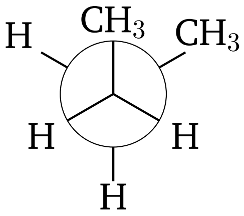
(A) 2

(B) 4

(C) 3

(D) 8

**Q81.** The Newman projection below (along the C2–C3 bond of butane) shows the two methyl groups separated by a dihedral angle of about 60°.



This staggered conformation, higher in energy than anti but lower than the eclipsed forms, is the:

(A) anti conformation

(B) fully eclipsed (syn) conformation

(C) gauche conformation

(D) the global energy minimum

**Q82.** Treatment of a carboxylic acid having an $\alpha$-hydrogen with $Br_2$ in the presence of a catalytic amount of red phosphorus gives the $\alpha$-bromo acid. This $\alpha$-halogenation is the:

(A) Hunsdiecker reaction

(B) Kolbe electrolysis

(C) Wolff–Kishner reduction

(D) Hell–Volhard–Zelinsky (HVZ) reaction

**Q83.** In the structure–activity relationship of morphine-type opioid analgesics, which structural feature is most critical for binding to the $\mu$-opioid receptor?

(A) a basic tertiary (protonatable) nitrogen separated from a flat aromatic ring by a quaternary carbon

(B) a free carboxylic acid group

(C) a $\beta$-lactam ring

(D) an aldehyde functional group

**Q84.** Replacing a benzene ring in a drug with a thiophene ring (a “ring equivalent”) while keeping similar size, shape and electronics is an example of:

(A) a prodrug approach

(B) ring (classical) bioisosteric replacement

(C) racemic resolution

(D) Phase II conjugation

**Q85.** Levodopa (L-DOPA) is administered instead of dopamine in Parkinson’s disease because, unlike dopamine, levodopa:

(A) is a prodrug that crosses the blood–brain barrier (via an amino-acid transporter) and is then decarboxylated to dopamine in the CNS

(B) is more potent at the receptor directly

(C) is a $\beta$-lactam antibiotic

(D) irreversibly inhibits monoamine oxidase

**Q86.** In Hansch QSAR, the hydrophobic substituent constant $\pi_X$ is defined relative to hydrogen by $\pi_X = \log P_X - \log P_H$. A substituent with a large **positive** $\pi$ value is:

(A) strongly electron-withdrawing
(B) sterically very small
(C) strongly hydrogen-bonding
(D) more hydrophobic (lipophilic) than hydrogen

**Q87.** In a Hammett study, a reaction is found to have a large **positive** reaction constant $\rho$. This indicates that the reaction:

(A) is accelerated by electron-donating substituents (builds positive charge in the transition state)
(B) is accelerated by electron-withdrawing substituents (negative charge develops in the transition state)
(C) is independent of substituent electronics
(D) depends only on substituent size

**Q88.** Which of the following is a Phase I oxidative metabolic transformation (typically CYP450-mediated)?

(A) conjugation with glutathione
(B) sulfate conjugation
(C) epoxidation of a carbon–carbon double bond
(D) acetylation of an amine

**Q89.** Which conjugation reaction, important for detoxifying reactive electrophilic metabolites (e.g. from paracetamol overdose), is a Phase II pathway?

(A) glutathione conjugation (mercapturic acid pathway)
(B) aromatic hydroxylation
(C) oxidative deamination
(D) reduction of a nitro group

**Q90.** Fluoroquinolone antibacterials (e.g. ciprofloxacin) inhibit bacterial DNA gyrase/topoisomerase. The structural feature that distinguishes the fluoroquinolone class is:

(A) a $\beta$-lactam fused to a thiazolidine ring

(B) a steroid nucleus

(C) a tetracycline naphthacene skeleton

(D) a 4-quinolone core bearing a 3-carboxylic acid, a 6-fluoro substituent and a piperazinyl group

**Q91.** For the NSAID naproxen, only the (*S*)-enantiomer is a potent COX inhibitor while the (*R*)-enantiomer is far less active (and the (*R*) form can be hepatotoxic). In this drug, the (*S*)-enantiomer is the:

(A) distomer

(B) eutomer

(C) racemate

(D) achiral form

**Q92.** Clavulanic acid is co-formulated with amoxicillin. Its pharmacological role is to act as a:

(A) potent antibacterial in its own right

(B) competitive PABA analogue

(C) “suicide” (irreversible) $\beta$-lactamase inhibitor that protects amoxicillin from enzymatic degradation

(D) DNA gyrase inhibitor

**Q93.** According to Lipinski’s “rule of five” for oral drug-likeness, a candidate is more likely to have poor oral absorption when its calculated $\log P$ (a lipophilicity measure):

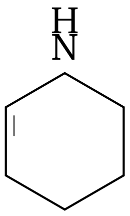
(A) exceeds 5 (too lipophilic)

(B) is exactly zero

(C) is negative by any amount

(D) equals the number of rotatable bonds

**Q94.** The dihydropyridine calcium-channel blockers (e.g. nifedipine, amlodipine) share the central heterocyclic ring drawn below, which is essential for activity.


(C4)

This essential central ring is a:

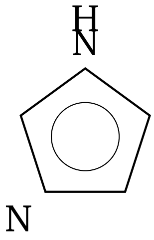
(A) pyrimidine ring

(B) furan ring

(C) benzene ring

(D) 1,4-dihydropyridine ring

**Q95.** The five-membered aromatic heterocycle drawn below contains two nitrogen atoms (one pyrrole-type N–H and one pyridine-type N) and is the core of histamine, histidine and antifungal azoles.



Identify this heterocycle.

(A) thiophene

(B) imidazole

(C) furan

(D) pyrrole

**Q96.** Which pharmaceutical inorganic compound is used (as an insoluble, non-absorbed suspension) as a radio-opaque contrast medium for X-ray examination of the gastrointestinal tract?

(A) sodium bicarbonate

(B) zinc oxide

(C) barium sulfate

(D) calcium gluconate

**Q97.** D-Penicillamine is used in the management of Wilson's disease and copper overload. Its mechanism is best described as:

(A) oxidising copper to a higher state

(B) precipitating copper as the sulfide

(C) competitively blocking copper absorption enzymes

(D) chelating copper (via thiol/amine/carboxyl donors) to form a soluble complex excreted in urine

**Q98.** A weakly acidic drug has p$K_a$ 4. In the gastric lumen (pH $\approx$ 2), according to the Henderson–Hasselbalch relationship, the drug will be predominantly:

(A) fully ionised, so it cannot be absorbed at all

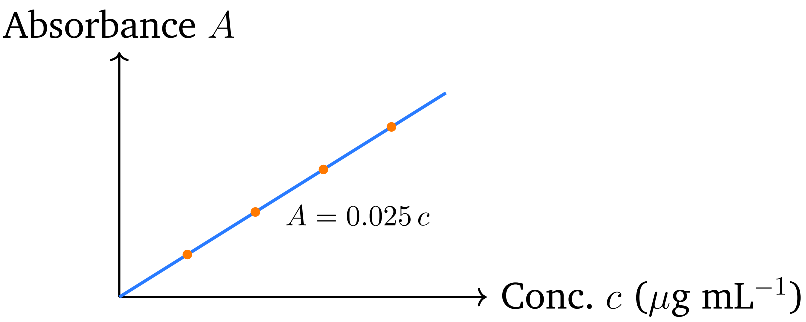
(B) largely un-ionised (since pH $<$ p$K_a$ for an acid), favouring passive absorption across the gastric mucosa

(C) converted to a salt that precipitates

(D) unaffected by pH

## Part D: Pharmaceutical Analysis & Quality Assurance

**Q99.** The Beer–Lambert calibration line below was prepared for a drug at its $\lambda_{max}$ and follows $A = 0.025\,c$, with $c$ expressed in $\mu$g mL$^{-1}$. An assay solution gives an absorbance of $A = 0.50$ under identical conditions. What is the concentration of the drug in the assay solution?



(A) 0.0125 $\mu$g mL$^{-1}$

(B) 20 $\mu$g mL$^{-1}$

(C) 12.5 $\mu$g mL$^{-1}$

(D) 0.50 $\mu$g mL$^{-1}$

**Q100.** In the non-aqueous titration of a weakly basic drug with perchloric acid in glacial acetic acid, the visual indicator most commonly employed to detect the end point is:

(A) Phenolphthalein

(B) Methyl orange

(C) Starch

(D) Crystal violet

**Q101.** Potassium dichromate ($K_2Cr_2O_7$) is favoured as a primary-standard oxidising titrant in redox titrimetry because it:

(A) Is obtainable in high purity, is stable on drying, and does not change strength on storage

(B) Is intensely coloured and therefore needs no indicator at all

(C) Is reduced to a colourless ion that makes the end point self-indicating

(D) Must be standardised daily against oxalic acid before use

**Q102.** In the Mohr method for the direct titration of chloride with silver nitrate, potassium chromate acts as indicator because, just after the equivalence point, the first slight excess of Ag$^{+}$:

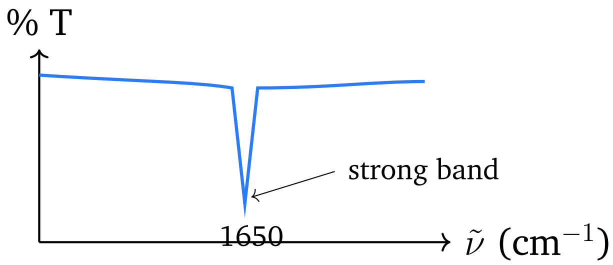
(A) Bleaches the yellow chromate to colourless

(B) Forms a soluble blue silver–chromate complex

(C) Forms a brick-red silver chromate ($Ag_2CrO_4$) precipitate

(D) Adsorbs onto AgCl and turns the surface pink

**Q103.** The schematic IR spectrum below shows a strong absorption marked near **1650 cm**$^{-1}$. In the spectrum of a primary amide, a strong band in this region is assigned principally to the:



(A) C–H bending of an aromatic ring

(B) C=O stretch (amide I band)

(C) O–H stretch of a carboxylic acid

(D) C≡C stretch of an alkyne

**Q104.** For the direct complexometric titration of calcium with EDTA in strongly alkaline medium (pH about 12), the indicator that gives a sharp pink-to-purple change at the end point is:

(A) Eriochrome Black T

(B) Ferroin

(C) Potassium chromate

(D) Murexide (ammonium purpurate)

**Q105.** On a TLC plate the solvent front travels 10.0 cm from the point of application while a drug spot travels 4.5 cm. The retardation factor $R_f$ of the drug is:

(A) 2.22

(B) 0.55

(C) 0.45

(D) 0.045

**Q106.** In HPLC, an analyte has a retention time $t_R = 9.0$ min and the unretained solvent (void) peak elutes at $t_0 = 1.5$ min. The capacity (retention) factor $k' = (t_R - t_0)/t_0$ of the analyte is:

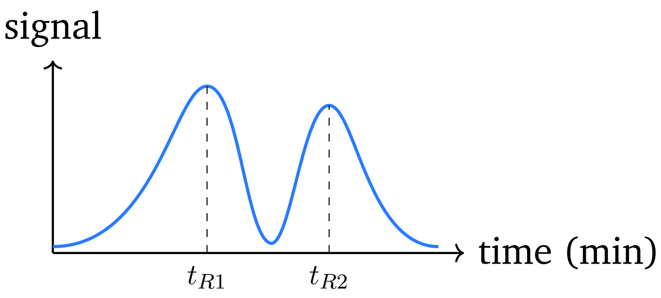
(A) 5.0

(B) 6.0

(C) 0.17

(D) 1.5

**Q107.** Two peaks in the chromatogram below elute at $t_{R1} = 6.0$ min and $t_{R2} = 7.5$ min with baseline widths $w_1 = 1.0$ min and $w_2 = 1.0$ min. Using $R_s = 2(t_{R2} - t_{R1})/(w_1 + w_2)$, the resolution is:



(A) 0.75

(B) 1.5

(C) 3.0

(D) 0.50

**Q108.** A strong anion-exchange resin bearing quaternary ammonium ($-NR_3^+$) groups separates a mixture chiefly on the basis of the analytes':

(A) Molecular size, with the largest eluting first

(B) Volatility under the carrier-gas stream

(C) Negative charge and affinity for the positively charged resin sites

(D) Refractive index relative to the eluent

**Q109.** In the $^1$H NMR spectrum of pure ethyl acetate ($CH_3COOCH_2CH_3$), the three sets of signals correspond to the acetyl $CH_3$, the $OCH_2$, and the terminal $CH_3$. The expected integration ratio of these three signals is:

(A) $1:1:1$

(B) $2:2:3$

(C) $3:3:3$

(D) $3:2:3$

**Q110.** A monochlorinated organic compound shows two molecular-ion peaks, M and M+2, in an approximate intensity ratio of about $\mathbf{3:1}$. This characteristic doublet arises because chlorine occurs naturally as:

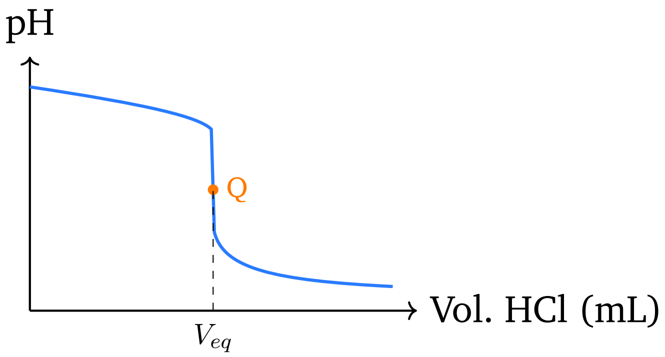
(A) Two isotopes, $^{35}$Cl and $^{37}$Cl, in roughly a 3:1 abundance ratio

(B) A single isotope that fragments into two ions

(C) Two isotopes of equal (1:1) abundance

(D) An isotope that captures a proton to give M+2

**Q111.** The curve below shows pH versus volume of HCl added during the titration of a *weak base* with a strong acid. The point marked **Q**, at the steep inflection, corresponds to the equivalence point. At this point the pH of the solution is:



(A) Exactly 7.0, because acid and base have reacted

(B) Below 7 (acidic), due to the salt of a weak base and strong acid

(C) Above 7 (basic), because excess base remains

(D) Equal to the $pK_b$ of the base

**Q112.** In atomic absorption spectroscopy, the role of the hollow-cathode lamp is to provide:

(A) A continuous broadband source covering all wavelengths

(B) The flame that atomises the sample

(C) A sharp line source emitting the resonance wavelength of the element being determined

(D) The monochromator that disperses the emitted light

**Q113.** In gravimetric analysis, the **gravimetric factor** is used to:

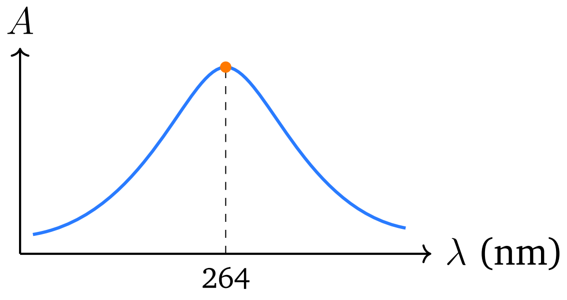
(A) Convert the weighed mass of the precipitate to the mass of the analyte sought

(B) Correct the burette reading for temperature

(C) Convert absorbance to concentration

(D) Express the conductance of the solution

**Q114.** The UV absorption curve below plots absorbance against wavelength, with the maximum marked at **264 nm**. In a validated assay this $\lambda_{max}$ is selected for measurement mainly because, at the peak:



(A) Transmittance is 100% and absorbance is least

(B) The molar absorptivity falls to zero

(C) Beer's law no longer applies

(D) Absorptivity is greatest and varies least with small wavelength errors, giving best sensitivity and reproducibility

**Q115.** In gas chromatography, the detector that is universal (responds to almost all analytes) by sensing the change in thermal conductivity of the carrier gas as solutes elute is the:

(A) Flame ionization detector (FID)

(B) Thermal conductivity detector (TCD)

(C) Electron-capture detector (ECD)

(D) Refractive-index detector (RID)

**Q116.** In molecular fluorescence spectroscopy, the emission (fluorescence) spectrum of a compound is observed at a *longer* wavelength than its excitation (absorption) spectrum. This wavelength difference between excitation and emission maxima is termed the:

(A) Bathochromic shift

(B) Isosbestic point

(C) Stokes shift

(D) Hyperchromic effect

**Q117.** In acidic medium, potassium permanganate is reduced from Mn(VII) to Mn(II), a 5-electron change. The normality of a 0.020 M $KMnO_4$ solution used in such titrations is therefore:

(A) 0.10 N

(B) 0.020 N

(C) 0.004 N

(D) 0.25 N

**Q118.** In the HPLC flow diagram below, identify the component labelled **P**, which sits between the reservoir and the injector and delivers the mobile phase at high, constant pressure:

(A) Detector

(B) High-pressure (solvent-delivery) pump

(C) Recorder

(D) Fraction collector

**Q119.** In size-exclusion chromatography a column is calibrated so that elution volume relates to molecular size. A protein of very high molecular weight that is completely excluded from the pores will elute at the:

(A) Total permeation volume (last to elute)

(B) A volume that depends only on its net charge

(C) Void (exclusion) volume, before smaller molecules

(D) Same volume as the smallest molecules

**Q120.** The van Deemter plot relates the plate height $H$ (HETP) to the linear flow velocity $u$ of the mobile phase. The practical significance of the *minimum* of this curve is that it identifies the flow velocity at which:

(A) The column back-pressure is highest

(B) Resolution is completely lost

(C) $H$ is maximal and efficiency is poorest

(D) $H$ is smallest, giving the greatest column efficiency (most plates)

**Q121.** In potentiometric pH measurement, the glass (indicator) electrode develops a potential that varies with hydrogen-ion activity, and its potential is measured against a:

(A) Reference electrode of constant potential, such as a calomel or Ag/AgCl electrode

(B) Second identical glass electrode

(C) Dropping-mercury electrode

(D) Platinum gauze electrode held at the equivalence potential

**Q122.** In ICH analytical method validation, the measure of a method's capacity to remain *unaffected by small, deliberate variations* in method parameters (such as minor changes in mobile-phase pH, flow rate, or column temperature) is termed:

(A) Specificity

(B) Robustness

(C) Accuracy

(D) Limit of detection

## Part E: Pharmacognosy & Natural Products

**Q123.** A pharmacognosist arranges crude drugs purely on the basis of the plant part used, such as "leaves", "barks", "roots and rhizomes", "seeds" and "flowers", regardless of their chemistry or therapeutic use. This basis of grouping is called:

(A) Chemical classification

(B) Taxonomical classification

(C) Pharmacological classification

(D) Morphological classification

**Q124.** Grouping crude drugs strictly according to their botanical position, for example placing *Datura*, *Hyoscyamus* and *Atropa* together because all three belong to the family Solanaceae, is an example of which classification?

(A) Taxonomical (botanical) classification

(B) Morphological classification

(C) Chemical classification

(D) Alphabetical classification

**Q125.** Among the morphological groups of crude drugs, which one of the following is an **organized** drug of *animal* origin?

(A) Beeswax

(B) Cantharides (dried blister beetle, *Cantharis vesicatoria*)

(C) Cod-liver oil

(D) Shellac

**Q126.** Hyoscyamine, a laevorotatory tropane alkaloid that partly racemises to atropine on extraction, is the chief alkaloid of the dried leaves and flowering tops of which official drug?

(A) *Cinchona officinalis*

(B) *Ephedra gerardiana*

(C) *Hyoscyamus niger*

(D) *Catharanthus roseus*

**Q127.** The dried ripe seeds of *Strychnos nux-vomica* contain two closely related indole alkaloids, the more toxic of which is a powerful CNS stimulant acting as a glycine antagonist at the spinal cord. This principal alkaloid is:

(A) Strychnine

(B) Reserpine

(C) Quinine

(D) Vincristine

**Q128.** The dried rhizome and roots of *Cephaelis ipecacuanha* yield an isoquinoline alkaloid that is used as an amoebicide and was formerly an emetic. This chief alkaloid of ipecacuanha is:

(A) Berberine

(B) Emetine

(C) Colchicine

(D) Caffeine

**Q129.** Berberine is a yellow, quaternary protoberberine isoquinoline alkaloid obtained from the roots of *Berberis aristata*. When an alkaloidal extract is treated with a few drops of potassium mercuric iodide solution and yields a **cream-coloured precipitate**, the test being performed is:

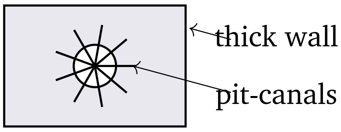
(A) Dragendorff's test (orange-brown precipitate)

(B) Bornträger's test

(C) Mayer's test

(D) Wagner's test (reddish-brown precipitate)

**Q130.** The labelled microscopical sketch below shows a strongly thickened, lignified isodiametric cell with a narrow lumen and conspicuous branched pit-canals, a characteristic powder element of many barks and fruits (for example *Cinchona* and pear).



lignified stone cell

This diagnostic cell type is correctly named a:

(A) Trichome

(B) Lignified vessel element

(C) Phloem fibre

(D) Sclereid (stone cell / brachysclereid)

**Q131.** Digoxin, a cardenolide cardiac glycoside chiefly obtained from the leaves of *Digitalis lanata*, carries the rare 2,6-dideoxy sugar 2,6-dideoxyhexose units. The presence of such deoxy-sugars is detected by a blue ring at the junction of two acid layers in which colour reaction?

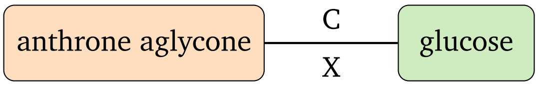
(A) Keller–Kiliani test

(B) Bornträger's test

(C) Molisch's test

(D) Liebermann–Burchard test for sterols only

**Q132.** The schematic below shows the glycoside present in the dried drug juice of *Aloe* species, in which an anthrone-type aglycone is C-linked to a sugar through the marked bond "X".



barbaloin / aloin (C-glycosidic bond)

The chief purgative C-glycoside of aloe represented here is:

(A) Sennoside A

(B) Barbaloin (aloin)

(C) Glycyrrhizin

(D) Digitoxin

**Q133.** Glycyrrhizin, the sweet principle of liquorice root (*Glycyrrhiza glabra*), is the potassium and calcium salt of glycyrrhizic acid. On hydrolysis it yields the triterpenoid aglycone glycyrrhetinic acid and two molecules of which sugar acid?

(A) D-galactose

(B) L-rhamnose

(C) D-glucuronic acid

(D) D-fructose

**Q134.** Black mustard seed (*Brassica nigra*) contains the sulphur-containing glucosinolate sinigrin. On contact with water the seed enzyme myrosinase hydrolyses sinigrin to liberate a pungent volatile principle. This pungent product is:

(A) Eugenol

(B) Anethole

(C) Sennoside

(D) Allyl isothiocyanate

**Q135.** The dried ripe fruit of *Coriandrum sativum* yields a carminative volatile oil whose chief constituent (60–70%) is a monoterpene alcohol that also dominates the oil. This principal constituent of coriander oil is:

(A) Linalool (coriandrol)

(B) Eugenol

(C) Thymol

(D) Cinnamaldehyde

**Q136.** Caraway fruit (*Carum carvi*) yields a volatile oil whose characteristic odour and flavour are due chiefly to a cyclic monoterpene ketone. This chief constituent is:

(A) Menthol

(B) Carvone

(C) Citral

(D) Borneol

**Q137.** Which of the following statements about plant exudates is **correct**?

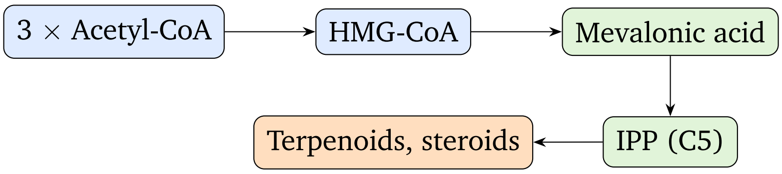
(A) Karaya (*Sterculia urens*) is a pure oleoresin free of carbohydrate

(B) Myrrh (*Commiphora molmol*) is a true gum that dissolves completely in water

(C) Guggul (*Commiphora wightii*) contains no resin fraction

(D) Myrrh and guggul are oleo-gum-resins, whereas karaya is a gum exudate that swells in water

**Q138.** Identify the biosynthetic pathway summarised in the scheme below and the class of secondary metabolites it primarily generates.



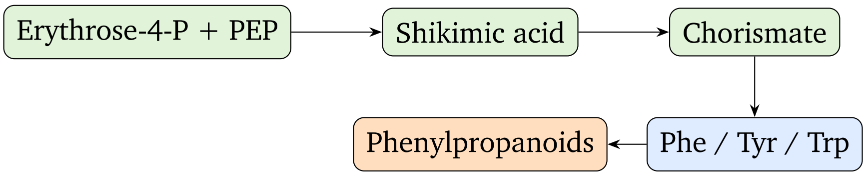
(A) Shikimic acid pathway giving aromatic amino acids

(B) Acetate–malonate pathway giving fatty acids

(C) Acetate–mevalonate pathway giving terpenoids and steroids

(D) Pentose phosphate pathway giving sugars

**Q139.** The biosynthetic scheme below condenses two glycolytic/pentose-phosphate intermediates and proceeds via an alicyclic acid and chorismate to aromatic amino acids. Name this pathway.



(A) Shikimic acid pathway

(B) Acetate–mevalonate pathway

(C) Acetate–malonate pathway

(D) Glyoxylate pathway

**Q140.** The percentage of constituents of a crude drug extractable by a given solvent (water, alcohol or ether), determined when no single chemical assay is available, is a measure of drug quality known as the:

(A) Extractive value

(B) Acid-insoluble ash value

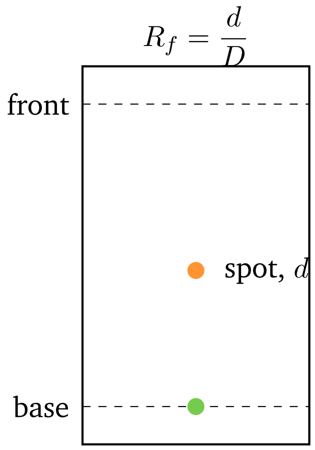
(C) Foreign organic matter

(D) Loss on drying

**Q141.** A modern green extraction technique uses carbon dioxide above its critical temperature and pressure as a tunable, residue-free solvent to extract thermolabile volatile oils and oleoresins. This method is:

(A) Continuous hot Soxhlet extraction
(B) Supercritical fluid ($CO_2$) extraction
(C) Cold maceration in ethanol
(D) Steam distillation

**Q142.** The TLC plate below is a fingerprint of a herbal extract, showing the baseline, a resolved spot at distance $d$ and the solvent front at distance $D$ from the baseline.



If the spot travels $d = 1.8$ cm while the solvent front travels $D = 4.0$ cm from the baseline, the $R_f$ value of the spot is:

(A) 0.72
(B) 2.22
(C) 0.45
(D) 0.18

## Part F: Pharmaceutical Biotechnology & Microbiology

**Q143.** The restriction endonuclease *Sau*3AI recognises the four-base sequence GATC and cleaves to leave a 5′-GATC overhang. Compared with a six-base cutter such as *Bam*HI, a four-base recogniser like *Sau*3AI will, on average, cut random DNA:

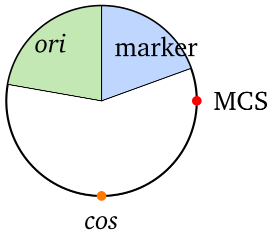
(A) Less often, because shorter sites are rarer

(B) More often (about every 256 bp), because the shorter site occurs more frequently

(C) At exactly the same frequency, since cutting depends only on the enzyme

(D) Only at methylated sites, regardless of length

**Q144.** A research group wishes to clone a 40 kb genomic insert, far larger than the few-kb limit of an ordinary plasmid. The circular vector shown below carries a plasmid origin (*ori*), a selectable marker, a multiple cloning site (MCS), and a phage $\lambda$ *cos* packaging site. The vector that combines these features to accept inserts of roughly 30–45 kb is a:



(A) Standard high-copy plasmid (e.g. pUC18)

(B) Single-stranded M13 phage vector

(C) Cosmid

(D) Expression plasmid with a T7 promoter only

**Q145.** Recombinant tissue plasminogen activator (tPA), a thrombolytic protein, is produced from a cDNA copy of its mRNA so that no introns are present. The enzyme used to synthesise this complementary DNA from the mRNA template is:

(A) DNA ligase

(B) Taq DNA polymerase

(C) Alkaline phosphatase

(D) Reverse transcriptase

**Q146.** Recombinant DNA technology has replaced several animal- or plasma-derived drugs. Which of the following correctly matches a recombinant therapeutic protein with its principal clinical use?

(A) Factor VIII — treatment of haemophilia A

(B) Somatostatin — thrombolysis in myocardial infarction

(C) Interferon-$\alpha$ — replacement therapy for type 1 diabetes

(D) Erythropoietin — digestion of dietary fat

**Q147.** In real-time quantitative PCR (qPCR) the amount of product is monitored **during** each cycle rather than only at the end. This is most commonly achieved by:

(A) Running the product on an agarose gel after 30 cycles

(B) Measuring fluorescence from a dye or labelled probe that increases as product accumulates

(C) Weighing the reaction tube after each cycle

(D) Sequencing the product manually

**Q148.** In industrial production of baker's yeast and many antibiotics, nutrient (often glucose) is added gradually to the bioreactor during the run to avoid substrate-excess effects such as the Crabtree effect, while no broth is removed until harvest. This mode of operation is called:

(A) Simple batch culture

(B) Continuous (chemostat) culture

(C) Fed-batch culture

(D) Solid-state fermentation

**Q149.** After a fermentation that secretes a recombinant protein into the broth, the sequence of recovery operations (cell removal → concentration → purification → polishing) is collectively termed:

(A) Inoculum development

(B) Media formulation

(C) Strain improvement

(D) Downstream processing

**Q150.** In a chemostat operating at steady state, fresh medium is fed and culture withdrawn at the same dilution rate $D$. At steady state the specific growth rate $\mu$ of the organism is:

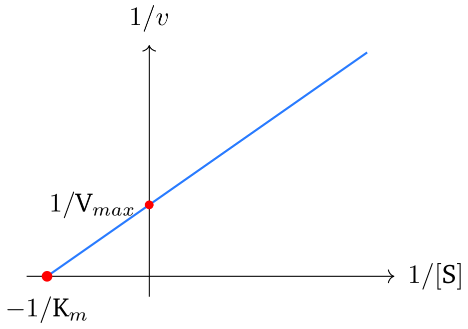
(A) Equal to the dilution rate $D$

(B) Always zero

(C) Twice the dilution rate $D$

(D) Independent of the dilution rate

**Q151.** The double-reciprocal (Lineweaver–Burk) plot of $1/v$ against $1/[\mathrm{S}]$ for an enzyme is shown. The intercept on the horizontal ($1/[\mathrm{S}]$) axis corresponds to:



(A) $+1/\mathrm{V}_{max}$

(B) $-1/\mathrm{K}_m$

(C) $+\mathrm{K}_m$

(D) $-\mathrm{V}_{max}$

**Q152.** A reversible inhibitor binds equally well to the free enzyme and to the enzyme–substrate complex at a site other than the active site. Increasing the substrate concentration does **not** relieve the inhibition. This describes:

(A) Competitive inhibition ($V_{max}$ unchanged, $K_m$ raised)

(B) Uncompetitive inhibition (both lowered)

(C) Non-competitive inhibition ($V_{max}$ lowered, $K_m$ unchanged)

(D) Irreversible suicide inhibition

**Q153.** In a sandwich ELISA used to quantify a protein antigen, the signal that is finally measured is generated by:

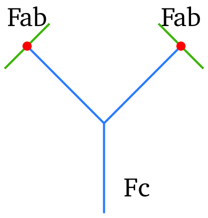
(A) Direct visual agglutination of red cells

(B) Precipitation of antigen in an agar gel

(C) Radioactivity from an iodinated antigen

(D) An enzyme conjugated to the detection antibody acting on a chromogenic substrate

**Q154.** The Y-shaped immunoglobulin monomer below has two identical antigen-binding (Fab) arms and an Fc stem. Which immunoglobulin class is the principal antibody of mucosal and external secretions (saliva, tears, colostrum, intestinal and respiratory mucus), where two such monomers join through a J chain and a secretory component to form a secretory dimer?



(A) IgA

(B) IgG

(C) IgM

(D) IgD

**Q155.** An immediate (within minutes) allergic reaction such as penicillin anaphylaxis or hay fever is mediated by IgE bound to mast cells, which degranulate and release histamine. In the Gell and Coombs classification this is:

(A) Type II (antibody-mediated cytotoxic) hypersensitivity

(B) Type I (immediate, IgE-mediated) hypersensitivity

(C) Type III (immune-complex) hypersensitivity

(D) Type IV (delayed, T-cell-mediated) hypersensitivity

**Q156.** A vaccine prepared by chemically inactivating a bacterial exotoxin (for example with formaldehyde) so that it loses toxicity but keeps its immunogenicity, as used against diphtheria and tetanus, is a:

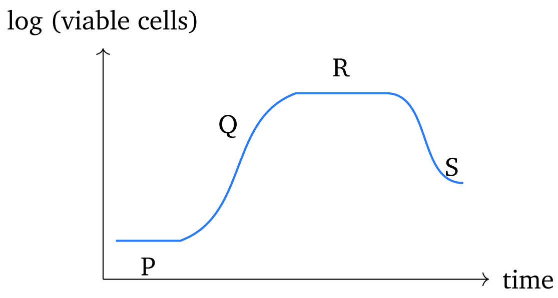
(A) Live attenuated vaccine

(B) Killed whole-cell vaccine

(C) Toxoid vaccine

(D) Conjugate polysaccharide vaccine

**Q157.** The bacterial batch-growth curve below plots log viable count against time. The phase in which secondary metabolites (such as many antibiotics) are chiefly produced, where the rate of cell division equals the rate of death and the viable count plateaus, is:



(A) Phase P (lag phase)

(B) Phase Q (log / exponential phase)

(C) Phase S (death / decline phase)

(D) Phase R (stationary phase)

**Q158.** Pre-packed, disposable plastic medical devices (syringes, catheters, surgical gloves) that cannot tolerate heat or moisture are most often sterilised on an industrial scale by:

(A) Ionising gamma radiation from a cobalt-60 source

(B) Autoclaving at 121°C for 15 min

(C) Boiling in water for 30 min

(D) Pasteurisation at 63°C for 30 min

**Q159.** The phenol coefficient is a classical measure used to express the bactericidal power of a disinfectant. A phenol coefficient **greater than 1** for a test disinfectant means that, under the test conditions, the disinfectant is:

(A) Less effective than phenol

(B) More effective than phenol

(C) Exactly as effective as phenol

(D) A sterilant that kills bacterial spores

**Q160.** In the cup-plate (agar diffusion) method for the microbiological assay of an antibiotic such as gentamicin, the potency of the sample is estimated by measuring:

(A) The turbidity of a broth after 24 h only

(B) The colour change of a pH indicator

(C) The diameter of the zone of growth inhibition around each cup, compared with a standard

(D) The number of colonies on a streak plate

# Detailed Solutions

## Q1.

### Solution

**Concept — Solubility product of a 1:2 salt:** For $\mathrm{CaF_2} \rightleftharpoons \mathrm{Ca^{2+}} + 2\mathrm{F^-}$, $\mathrm{K}_{sp} = [\mathrm{Ca^{2+}}][\mathrm{F^-}]^2 = (s)(2s)^2 = 4s^3$. **Reasoning:** $s = 2.0 \times 10^{-4}$, so $\mathrm{K}_{sp} = 4(2.0 \times 10^{-4})^3 = 4 \times 8.0 \times 10^{-12} = 3.2 \times 10^{-11}$. **Why the other options are wrong:**

- (A) $4.0 \times 10^{-8}$ wrongly uses $s^2$ ($= 4s^2$ style) instead of $4s^3$.
- (B) $8.0 \times 10^{-8}$ drops the factor 4 and the cube.
- (D) $2.0 \times 10^{-4}$ is the solubility $s$ itself.

**Final Answer:** $4s^3 = 3.2 \times 10^{-11} \Rightarrow \boxed{\text{C}}$

**Answer: (C)** Go Back to Q1

## Q2.

### Solution

**Concept — Partition coefficient with unequal volumes:** $P = C_{org}/C_{aq}$, where each concentration is mass divided by that phase's volume. **Reasoning:** $C_{chl} = 80/20 = 4.0$ mg/mL; $C_{aq} = 20/80 = 0.25$ mg/mL; $P = 4.0/0.25 = 16.0$. **Why the other options are wrong:**

- (A) 4.0 uses the raw mass ratio ($80/20$), ignoring the unequal volumes.
- (C) 1.0 implies equal partitioning, not the case here.
- (D) 0.25 is the water-phase concentration, not the ratio.

**Final Answer:** $P = 4.0/0.25 = 16.0 \Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q2

## Q3.

### Solution

**Concept — Spreading coefficient:** $S = W_a - W_c = \gamma_a - (\gamma_b + \gamma_{ab})$, the balance of adhesion (between the two liquids) against cohesion of the spreading liquid. **Reasoning:** Spreading is spontaneous only when adhesion to the substrate exceeds the cohesion of the spreading liquid, i.e. $S \geq 0$ (positive or zero). **Why the other options are wrong:**

- (B) A negative $S$ means the liquid forms a lens and does not spread.
- (C) $S = \gamma_{ab}$ is not a spreading criterion.
- (D) $S$ explicitly contains the interfacial tension $\gamma_{ab}$, so it cannot be independent of it.

**Final Answer:** spreading occurs when $S \geq 0 \Rightarrow \boxed{\text{A}}$

**Answer: (A)** **Go Back to Q3**

## Q4.

### Solution

**Concept — Required HLB of a blend:** The HLB of a surfactant mixture is the weighted average HLB $= \sum(f_i \times \text{HLB}_i)$. **Reasoning:** $= (0.60 \times 15) + (0.40 \times 4.3) = 9.0 + 1.72 = 10.72 \approx 10.7$. **Why the other options are wrong:**

- (A) 4.3 is Span 80 alone.
- (B) 9.65 is the simple (unweighted) average of 15 and 4.3.
- (C) 15.0 is Tween 80 alone.

**Final Answer:** $(0.60 \times 15) + (0.40 \times 4.3) = 10.7 \Rightarrow \boxed{\text{D}}$

**Answer: (D)** **Go Back to Q4**

## Q5.

### Solution

**Concept — Thixotropy:** A hysteresis loop between the up-curve and down-curve indicates a time-dependent, reversible breakdown of structure under shear. **Reasoning:** The down-curve lies below the up-curve because the gel structure broken by shear needs time to rebuild, so the material is less viscous on the return. This is thixotropy, desirable in suspensions and paints. **Why the other options are wrong:**

- (A) A Newtonian liquid gives a single straight line with no loop.
- (C) Dilatancy is shear-thickening, shown by an up-bowing curve, not a loop alone.
- (D) A yield value would offset the curve along the stress axis, not create a loop.

**Final Answer:** hysteresis loop $\Rightarrow$ thixotropy $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q5

## Q6.

### Solution

**Concept — Kinematic viscosity:** $\nu = \eta/\rho$. In CGS, $\eta$ is in poise (g $\text{cm}^{-1}$ $\text{s}^{-1}$) and $\rho$ in g $\text{cm}^{-3}$, so $\nu$ has units $\text{cm}^2$/s, called the stokes (St). **Reasoning:** 1 stokes $= 1$ $\text{cm}^2$/s; 1 centistoke $= 1$ $\text{mm}^2$/s, the kinematic viscosity of water near room temperature. **Why the other options are wrong:**

- (A) The poise is a unit of dynamic, not kinematic, viscosity.
- (B) Pa·s is the SI unit of dynamic viscosity.
- (D) $\text{m}^2$/s is the SI unit of kinematic viscosity, not the CGS stokes.

**Final Answer:** 1 stokes $= 1$ $\text{cm}^2/\text{s} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q6

## Q7.

### Solution

**Concept — Carr's index:** Carr's % $= \dfrac{\rho_{tapped} - \rho_{bulk}}{\rho_{tapped}} \times 100$; $\leq 10\%$ is excellent flow.

**Reasoning:** $= \dfrac{0.60 - 0.55}{0.60} \times 100 = \dfrac{0.05}{0.60} \times 100 \approx 8.3\% \approx 8\%$, i.e. excellent flow.

**Why the other options are wrong:**

- (B) 20% would need a far larger density gap.
- (C) 33% over-estimates the difference grossly.
- (D) A 50% index would mean extremely poor flow, not free flowing, so the rating is wrong too.

**Final Answer:** $(0.05/0.60) \times 100 \approx 8\%$, excellent $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q7

## Q8.

### Solution

**Concept — Specific surface of a sphere:** For a sphere, surface area $= \pi d^2$ and volume $= \pi d^3/6$, so surface per unit volume $S_v = (\pi d^2)/(\pi d^3/6) = 6/d$. **Reasoning:** $S_v = 6/d$ is inversely proportional to diameter, so smaller particles present far more surface area, which is why micronisation speeds dissolution. **Why the other options are wrong:**

- (A) Direct proportionality to $d$ is the opposite trend.
- (B) $d^2$ describes total surface area of one particle, not specific surface.
- (C) Specific surface clearly depends on $d$.

**Final Answer:** $S_v = 6/d$, inverse in $d \Rightarrow \boxed{\text{D}}$

**Answer: (D)** **Go Back to Q8**

## Q9.

### Solution

**Concept — Modal size class:** The mode is the size interval with the greatest frequency (tallest bar) in the histogram. **Reasoning:** The tallest bar is the 180 $\mu$m class, lying in the 90–250 $\mu$m band; this is the most frequent particle size by number. **Why the other options are wrong:**

- (A) The 45–90 class has the lowest frequency.
- (C) and (D) lie on the descending tail, with progressively smaller frequencies.

**Final Answer:** tallest bar $= 180$ class $\Rightarrow 90\text{–}250 \Rightarrow \boxed{\text{B}}$

**Answer: (B)** **Go Back to Q9**

## Q10.

### Solution

**Concept — Henderson–Hasselbalch:** $\text{pH} = \text{pK}_a + \log \dfrac{[\text{salt}]}{[\text{acid}]}$. **Reasoning:** $\dfrac{[\text{salt}]}{[\text{acid}]} = \dfrac{0.20}{0.05} = 4$, so $\text{pH} = 7.2 + \log 4 = 7.2 + 0.60 = 7.80$. **Why the other options are wrong:**

- (A) 6.60 subtracts the log term instead of adding it.

- (B) 7.20 ignores the unequal salt/acid ratio.
- (D) 8.40 doubles the log term wrongly.

**Final Answer:** $7.2 + \log 4 = 7.80 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q10

## Q11.

### Solution

**Concept — Isotonicity by freezing-point depression:** A solution is isotonic with plasma when its freezing-point depression equals $0.52$°C. Depression scales linearly with concentration. **Reasoning:** $1\%$ gives $0.20$°C. Required % $= 1\% \times \dfrac{0.52}{0.20} = 2.6\%$. **Why the other options are wrong:**

- (A) $0.20\%$ confuses the depression value with concentration.
- (B) $0.52\%$ uses the plasma depression value directly as a percentage.
- (C) $1.0\%$ gives only $0.20$°C, hypotonic.

**Final Answer:** $1\% \times (0.52/0.20) = 2.6\% \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q11

## Q12.

### Solution

**Concept — Complexation equilibrium:** For $D + L \rightleftharpoons DL$, the stability (formation) constant is $K = \dfrac{[DL]}{[D][L]}$; a larger $K$ means a more stable complex. **Reasoning:** The caffeine–benzocaine interaction is a soluble $1:1$ molecular complex characterised by its stability constant, which governs the apparent solubility increase. **Why the other options are wrong:**

- (B) Partition coefficient describes phase distribution, not complex formation.
- (C) Distribution ratio is again an inter-phase term.
- (D) Dielectric constant is a solvent property, unrelated to the equilibrium constant.

**Final Answer:** $K = [DL]/([D][L])$ is the stability constant $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q12

## Q13.

### Solution

**Concept — Fick's first law:** Steady-state flux $J = \dfrac{D\,K\,\Delta C}{h}$ (mass per unit area per unit time). **Reasoning:** $J = \dfrac{(1\times10^{-6})(1)(0.5)}{0.02} = \dfrac{5\times10^{-7}}{0.02} = 2.5\times10^{-5}$ mg cm$^{-2}$ s$^{-1}$. **Why the other options are wrong:**

- (A) $2.5\times10^{-3}$ drops the membrane thickness by two orders.
- (C) $1.0\times10^{-6}$ is just $D$, not the flux.
- (D) $5.0\times10^{-7}$ is the numerator before dividing by $h$.

**Final Answer:** $J = (10^{-6}\times0.5)/0.02 = 2.5\times10^{-5} \Rightarrow \boxed{\text{B}}$

**Answer: (B)** **Go Back to Q13**

## Q14.

### Solution

**Concept — Order from linear plots:** Zero order gives a straight line for $C$ vs $t$; first order gives a straight line for $\ln C$ vs $t$; second order for $1/C$ vs $t$. **Reasoning:** Plot (ii) ($\ln C$ vs $t$) is linear, which is the diagnostic of first-order kinetics (slope $= -k$). **Why the other options are wrong:**

- (A) Zero order is plot (i), the linear $C$ vs $t$.
- (B) Second order would need $1/C$ vs $t$ linear.
- (D) The order is clearly fixed by which transform linearises.

**Final Answer:** linear $\ln C$ vs $t \Rightarrow$ first order $\Rightarrow \boxed{\text{C}}$

**Answer: (C)** **Go Back to Q14**

## Q15.

### Solution

**Concept — Shelf life $t_{90}$ (first order):** For first-order decay, $t_{90} = \dfrac{0.105}{k}$ (time for the concentration to fall to $90\%$). **Reasoning:** $t_{90} = \dfrac{0.105}{0.0021} = 50$ months. **Why the other options are wrong:**

- (A) 330 months uses the $t_{1/2} = 0.693/k$ formula instead of $t_{90}$.
- (B) 12 months has no basis in the given $k$.

- (C) 100 months doubles the correct value.

**Final Answer:** $t_{90} = 0.105/0.0021 = 50 \text{ months} \Rightarrow \boxed{\text{D}}$

**Answer: (D)** **Go Back to Q15**

## Q16.

**Solution**

**Concept — Freundlich isotherm linearisation:** Taking logs of $x/m = kC^{1/n}$ gives $\log(x/m) = \log k + \frac{1}{n} \log C$. **Reasoning:** A plot of $\log(x/m)$ vs $\log C$ is a straight line of slope $1/n$ and intercept $\log k$, giving both constants. **Why the other options are wrong:**

- (B) $x/m$ vs $C$ linear is the Henry (low-coverage) limit, not the general Freundlich form.
- (C) $1/(x/m)$ vs $1/C$ is the linear form of the Langmuir, not Freundlich, isotherm.
- (D) $\ln(x/m)$ vs $1/C$ does not linearise the power-law expression.

**Final Answer:** $\log(x/m)$ vs $\log C \Rightarrow \boxed{\text{A}}$

**Answer: (A)** **Go Back to Q16**

## Q17.

**Solution**

**Concept — Schulze–Hardy rule:** The coagulating effectiveness of an electrolyte is governed by the valency of the ion carrying the charge opposite to that of the colloid; it rises steeply with valency. **Reasoning:** For a negative sol the counter-ion is the cation, so $\text{Al}^{3+} > \text{Ca}^{2+} > \text{Na}^{+}$ in coagulating power, increasing sharply with cation valency. **Why the other options are wrong:**

- (A) Anion size matters little for a negatively charged sol.
- (C) Dispersion-medium concentration is not the controlling factor in the rule.
- (D) Light wavelength relates to the Tyndall effect, not coagulation.

**Final Answer:** coagulating power rises with counter-cation valency $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** **Go Back to Q17**

## Q18.

### Solution

**Concept — Eutectic point:** On a simple binary solid–liquid phase diagram, the two liquidus lines meet at the eutectic point E, the composition with the lowest melting temperature. **Reasoning:** At E the liquid and both solids coexist; the mixture melts (and freezes) at a single, lowest temperature. Eutectics matter in suppository bases and solid dispersions. **Why the other options are wrong:**

- (A) Pure-A melting point is the upper end of one liquidus, not E.
- (B) The diagram is solid–liquid, not a boiling-point plot.
- (D) Critical solution temperature applies to partially miscible liquids, a different diagram.

**Final Answer:** lowest meeting point of liquidus lines = eutectic $\Rightarrow \boxed{\text{C}}$

$\boxed{\textbf{Answer: (C)}}$ **Go Back to Q18**

## Q19.

### Solution

**Concept — Noyes–Whitney equation:** $dC/dt = \dfrac{DA(C_s - C)}{h}$; dissolution rate rises with surface area $A$, solubility $C_s$ and $D$, and falls with diffusion-layer thickness $h$. **Reasoning:** Reducing particle size increases the effective surface area $A$ enormously, directly raising the dissolution rate; this is the standard strategy (micronisation, nanonisation) for poorly soluble drugs. **Why the other options are wrong:**

- (A) Increasing $h$ slows dissolution.
- (B) Decreasing $C_s$ reduces the driving force.
- (C) Higher tablet hardness slows disintegration and dissolution.

**Final Answer:** reduce particle size to raise $A \Rightarrow \boxed{\text{D}}$

$\boxed{\textbf{Answer: (D)}}$ **Go Back to Q19**

## Q20.

### Solution

**Concept — Higuchi model:** For a planar matrix, the amount released $Q = \sqrt{D\,C_s(2A - C_s)\,t}$, so $Q \propto \sqrt{t}$. **Reasoning:** A straight line of cumulative release vs $\sqrt{t}$ is the signature of Higuchi (diffusion-controlled) release from an insoluble matrix. **Why the other options are wrong:**

- (B) Zero order is linear against $t$, not $\sqrt{t}$.
- (C) First order is linear for $\log(\%\,\text{remaining})$ vs $t$.
- (D) Hixson–Crowell plots cube-root of remaining mass vs $t$.

**Final Answer:** linear vs $\sqrt{t} \Rightarrow$ Higuchi $\Rightarrow \boxed{\text{A}}$

**Answer: (A)** Go Back to Q20

## Q21.

### Solution

**Concept — BCS classes:** I high solubility/high permeability; II low solubility/high permeability; III high solubility/low permeability; IV low/low. **Reasoning:** High solubility with low permeability is precisely BCS Class III (e.g. atenolol-type profiles); absorption is permeability-limited. **Why the other options are wrong:**

- (A) Class I is high/high.
- (C) Class II is low solubility/high permeability, the reverse.
- (D) Class IV is low/low.

**Final Answer:** high solubility, low permeability $\Rightarrow$ Class III $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q21

## Q22.

### Solution

**Concept — USP dissolution apparatus:** Apparatus 1 is the rotating basket; Apparatus 2 is the paddle; Apparatus 3 the reciprocating cylinder; Apparatus 4 the flow-through cell. **Reasoning:** The paddle (Apparatus 2) is the most common choice for conventional immediate-release tablets and capsules. **Why the other options are wrong:**

- (A) The basket is Apparatus 1, used for floating or disintegrating dosage forms.
- (B) The reciprocating cylinder is Apparatus 3, for modified-release products.
- (D) The flow-through cell is Apparatus 4, for low-solubility drugs and implants.

**Final Answer:** Apparatus 2 is the paddle $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q22

## Q23.

### Solution

**Concept — Superdisintegrant mechanism:** Croscarmellose sodium (cross-linked carboxymethylcellulose) disintegrates tablets mainly by rapid water uptake (wicking) and pronounced swelling. **Reasoning:** Water is drawn in by capillary action

and the cross-linked fibres swell, generating internal stress that ruptures the tablet quickly even at low concentration. **Why the other options are wrong:**

- (A) Effervescence is the mechanism of bicarbonate/acid systems, not croscarmellose.
- (B) It does not melt at body temperature.
- (C) It does not form a film barrier; that would retard, not aid, disintegration.

**Final Answer:** wicking plus swelling ruptures the tablet $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q23

## Q24.

### Solution

**Concept — Hard-gelatin capsule sizes:** Sizes run 000 (largest) down to 5 (smallest); fill capacity decreases as the number increases. **Reasoning:** Of the options,

size 000 has the largest fill volume (about $1.37$ mL), used when a large powder dose must be accommodated. **Why the other options are wrong:**

- (B) Size 0 is smaller than 000.
- (C) Size 3 is a mid-small shell.
- (D) Size 5 is the smallest shell, the least fill volume.

**Final Answer:** 000 is the largest shell $\Rightarrow \boxed{\text{A}}$

**Answer: (A)** Go Back to Q24

## Q25.

### Solution

**Concept — Displacement value (DV):** DV is the weight of drug that displaces 1 g of the suppository base. A DV of 4.7 means 4.7 g of drug occupies the same volume as 1 g of cocoa butter. **Reasoning:** Therefore 4.7 g of zinc oxide displaces 1 g of cocoa butter; this lets the formulator subtract the correct base weight. **Why the other options are wrong:**

- (A) 4.7 g of base would imply a DV of 1.
- (C) DV refers to the base displaced, not water.
- (D) "Half its own weight" is an arbitrary value not matching DV 4.7.

**Final Answer:** DV 4.7 $\Rightarrow$ 4.7 g drug displaces 1 g base $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q25

## Q26.

### Solution

**Concept — Emulsion type tests:** The continuous (external) phase determines dilution and conductivity. An o/w emulsion has water outside, so it dilutes with water and conducts electricity. **Reasoning:** A high-HLB surfactant favours o/w; ready dilution with water plus electrical conductivity both confirm water is the continuous phase. **Why the other options are wrong:**

- (A) A w/o emulsion dilutes with oil and conducts poorly.
- (B) A multiple emulsion is more complex and not implied by these two simple tests.
- (D) Every emulsion has a continuous phase by definition.

**Final Answer:** dilutable in water and conducting $\Rightarrow$ o/w $\Rightarrow \boxed{\text{C}}$

**Answer: (C)** Go Back to Q26

## Q27.

### Solution

**Concept — Friability:** % friability $= \frac{W_{initial} - W_{final}}{W_{initial}} \times 100$, with a usual acceptance limit of $\leq 1\%$. **Reasoning:** $= \frac{6.50 - 6.42}{6.50} \times 100 = \frac{0.08}{6.50} \times 100 \approx 1.23\%$. Since $1.23\% > 1\%$, the batch fails. **Why the other options are wrong:**

- (A) $0.08\%$ forgets to divide by the initial weight.
- (B) $8.0\%$ misplaces the decimal.
- (C) $1.2\%$ is close but the precise value is $1.23\%$.

**Final Answer:** $(0.08/6.50) \times 100 \approx 1.23\%$, fail $\Rightarrow \boxed{\text{D}}$

**Answer: (D)** Go Back to Q27

## Q28.

### Solution

**Concept — Ointment base classes:** Oleaginous (hydrocarbon) bases such as white/yellow petrolatum are anhydrous, occlusive and emollient; they absorb little water. **Reasoning:** White petrolatum is the classic hydrocarbon (oleaginous) base, providing an occlusive emollient film. **Why the other options are wrong:**

- (B) Absorption bases (e.g. wool fat, hydrophilic petrolatum) take up water; plain petrolatum does not.
- (C) Water-removable bases are o/w creams.
- (D) Water-soluble bases are PEG-based, not hydrocarbon.

**Final Answer:** white petrolatum is an oleaginous base $\Rightarrow \boxed{\text{A}}$

**Answer: (A)** Go Back to Q28

## Q29.

### Solution

**Concept — Endotoxin testing:** The LAL test detects bacterial endotoxin (lipopolysaccharide) using lysate from horseshoe-crab amebocytes; it is far more sensitive and quantitative than the in-vivo rabbit test. **Reasoning:** The gel-clot LAL assay is the standard, sensitive in-vitro endotoxin test for parenteral products. **Why the other options are wrong:**

- (A) The rabbit pyrogen test is in-vivo, less sensitive, and being phased out.
- (C) The sterility test detects viable microbes, not endotoxin.
- (D) Weight variation is a uniformity, not a pyrogen, test.

**Final Answer:** LAL gel-clot is the sensitive endotoxin test $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q29

## Q30.

**Solution**

**Concept — Flocculated suspensions:** In controlled flocculation, particles form loose floccules that settle quickly but as a high-volume, loosely packed sediment that redisperses on shaking. **Reasoning:** Because the floccules do not pack tightly, no hard cake forms, so the suspension is easily re-uniformed before dosing, the key pharmaceutical advantage. **Why the other options are wrong:**

- (A) Hard caking is the problem of deflocculated systems.
- (B) Flocculated particles actually settle faster, not slowest.
- (D) No realistic suspension stays permanently suspended without settling.

**Final Answer:** loose, easily redispersed, non-caking sediment $\Rightarrow \boxed{\text{C}}$

**Answer: (C)** Go Back to Q30

## Q31.

**Solution**

**Concept — Reynolds number:** $Re = \rho v d/\eta$. For Newtonian flow in a circular pipe, flow is laminar below about $2100$, transitional between $2100$ and $4000$, and fully turbulent above about $4000$. **Reasoning:** The chaotic-eddy profile (ii) corresponds to turbulent flow, expected when $Re$ exceeds roughly $4000$. **Why the other options are wrong:**

- (A) and (B) $(40, 100)$ are well within the laminar regime.
- (C) $1000$ is still laminar (below $2100$).

**Final Answer:** turbulent above $Re \approx 4000 \Rightarrow \boxed{\text{D}}$

**Answer: (D)** Go Back to Q31

## Q32.

**Solution**

**Concept — Ball mill critical speed:** The critical speed is the rotational speed at which centrifugal force pins the balls against the mill wall, so they no longer cascade. **Reasoning:** At the critical speed the balls centrifuge and rotate with the shell, doing essentially no grinding; effective grinding occurs at $65–80\%$ of this speed. **Why the other options are wrong:**

- (B) Effective cascading grinding happens below the critical speed.
- (C) Balls are stationary only when the mill is nearly still.
- (D) Balls are not thrown clear; they stick to the wall.

**Final Answer:** at critical speed balls centrifuge to the wall $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q32

## Q33.

**Solution**

**Concept — Lyophilisation stages:** Freezing solidifies the water; primary drying removes the bulk of water by sublimation of ice under vacuum; secondary drying removes residual bound (adsorbed) moisture by desorption. **Reasoning:** The large mass of frozen water is removed during the primary drying (sublimation) stage. **Why the other options are wrong:**

- (A) Freezing only solidifies water; nothing is removed yet.
- (C) Secondary drying removes only the small fraction of bound water.
- (D) Reconstitution is performed at the point of use, not part of drying.

**Final Answer:** bulk ice sublimes during primary drying $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q33

## Q34.

**Solution**

**Concept — Release profile of sustained release:** A sustained-release dosage form aims to release drug slowly and steadily (ideally zero-order) to maintain plasma levels and reduce dosing frequency. **Reasoning:** Profile (ii) rises slowly and linearly, the hallmark of a sustained-release product, whereas profile (i) plateaus rapidly like a conventional release. **Why the other options are wrong:**

- (A) An orodispersible tablet releases very fast, like profile (i).
- (B) An effervescent tablet also dissolves rapidly.
- (D) A subcutaneous bolus is a route, not a dissolution profile, and would not give this controlled in-vitro curve.

**Final Answer:** slow, steady linear release $\Rightarrow$ sustained release $\Rightarrow \boxed{\text{C}}$

**Answer: (C)** Go Back to Q34

## Q35.

### Solution

**Concept — Two-compartment model:** After an IV bolus a drug first distributes from the central (blood) compartment into peripheral tissues, then is eliminated; on a semi-log plot this gives two log-linear phases. **Reasoning:** The steep early $(\alpha)$ segment is dominated by distribution into tissues; the shallower terminal $(\beta)$ segment reflects elimination once distribution equilibrium is reached. A biphasic semi-log decline is the signature of a two-compartment model. **Why the other options are wrong:**

- (A) A single first-order process gives one straight line, not two slopes.
- (C) Zero-order decline is curved (concave) on a semi-log plot, not biphasic-linear.
- (D) Flip-flop relates to oral absorption, not an IV bolus.

**Final Answer:** Biphasic decline = two-compartment $\alpha/\beta$ phases $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q35

## Q36.

### Solution

**Concept — Loading dose:** Loading dose = target concentration $\times$ volume of distribution (with $F = 1$ for IV). **Reasoning:** $V_d = 0.6\,\text{L/kg} \times 70\,\text{kg} = 42\,\text{L}$. Loading dose $= C_{target} \times V_d = 5\,\text{mg/L} \times 42\,\text{L} = 210\,\text{mg}$. **Why the other options are wrong:**

- (A) 42 mg uses $V_d$ alone, omitting the concentration.
- (B) 350 mg multiplies $5 \times 70$, ignoring the 0.6 L/kg.
- (D) 21 mg halves the correct value without basis.

**Final Answer:** $5 \times (0.6 \times 70) = 210 \text{ mg} \Rightarrow \boxed{\text{C}}$

**Answer: (C)** Go Back to Q36

## Q37.

### Solution

**Concept — Hepatic extraction ratio (ER):** A high-ER drug (ER $\to$ 1) is avidly removed in a single pass through the liver; its clearance is flow-limited. **Reasoning:**

Extensive first-pass metabolism removes most of an oral dose before it reaches the systemic circulation, giving low and variable oral bioavailability; systemic clearance approximates hepatic blood flow and is sensitive to changes in that flow. **Why the other options are wrong:**

- (A) High-ER drugs have low, not high, oral bioavailability.
- (B) Capacity-limited (flow-independent) clearance describes low-ER drugs.
- (C) High-ER drugs show a marked first-pass effect.

**Final Answer:** Low oral bioavailability, flow-limited clearance $\Rightarrow \boxed{\text{D}}$

**Answer: (D)** Go Back to Q37

## Q38.

### Solution

**Concept — Approach to steady state:** During a constant infusion the plasma level approaches $C_{ss}$ exponentially, gaining one half of the remaining gap each half-life. **Reasoning:** After 1 half-life the level is at 50%, 2 at 75%, 3 at 87.5%

and 4 at ≈94% of $C_{ss}$. Thus about 4 half-lives are needed to be effectively at steady state (and ≈5 for 97%). **Why the other options are wrong:**

- (B) 1 half-life reaches only 50%.
- (C) 10 half-lives is far more than needed.
- (D) The time to steady state scales directly with half-life, so it is not independent of it.

**Final Answer:** ≈94% of $C_{ss}$ at about 4 half-lives $\Rightarrow \boxed{\text{A}}$

**Answer: (A)** Go Back to Q38

## Q39.

### Solution

**Concept — Efficacy ($E_{max}$):** Efficacy is the maximal effect a drug can elicit; it is read from the plateau height of the graded dose-response curve, independent of where the curve sits on the dose axis. **Reasoning:** M reaches a higher plateau than N, so M has greater efficacy. N cannot reach M's maximum even at high doses, the defining behaviour of a partial agonist (lower intrinsic activity). **Why the other options are wrong:**

- (A) Different plateaus mean different efficacy.
- (C) The lower plateau (N) has the lower efficacy.
- (D) Efficacy is exactly what the plateau height reports.

**Final Answer:** M more efficacious; N a partial agonist $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q39

## Q40.

### Solution

**Concept — Irreversible (non-competitive) antagonism:** An antagonist that binds covalently or very tightly removes receptors from the available pool, lowering the achievable maximum response (insurmountable). **Reasoning:** As antagonist concentration rises (curves 1, 2) the plateau falls progressively and adding more agonist does not restore it. This depressed, non-restorable maximum identifies an irreversible/non-competitive antagonist. **Why the other options are wrong:**

- (A) A competitive antagonist shifts curves rightward but keeps the same maximum.
- (B) Chemical antagonism (drug binding drug in plasma) is not a receptor curve phenomenon.
- (D) A partial agonist would itself produce a sub-maximal response, not progressively depress the agonist maximum.

**Final Answer:** Depressed, insurmountable maximum = irreversible antagonist $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q40

## Q41.

### Solution

**Concept — Tachyphylaxis:** Tachyphylaxis is a rapidly developing tolerance over minutes to hours on repeated dosing. **Reasoning:** For an indirectly acting sympathomimetic the releasable noradrenaline store is progressively depleted, so each successive dose releases less transmitter and the response wanes quickly. Receptor desensitisation can also contribute. **Why the other options are wrong:**

- (A) Idiosyncrasy is a genetically determined abnormal response, not declining effect on repetition.
- (B) Cumulation is rising drug level from slow elimination, the opposite situation.
- (C) Up-regulation would increase, not decrease, responsiveness.

**Final Answer:** Rapid waning from store depletion = tachyphylaxis $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q41

## Q42.

### Solution

**Concept — Muscarinic agonist (pilocarpine):** Pilocarpine is a directly acting muscarinic agonist (a tertiary amine alkaloid). **Reasoning:** In the eye it contracts the ciliary muscle and the sphincter pupillae (miosis). Ciliary contraction puts tension on the scleral spur, opening the trabecular meshwork and increasing aqueous outflow, which lowers intraocular pressure in glaucoma. **Why the other options are wrong:**

- (B) It causes miosis, not the mydriasis of an antagonist.
- (C) It acts on muscarinic, not neuromuscular nicotinic, receptors.
- (D) It is cholinergic, not a $\beta_2$-agonist.

**Final Answer:** Muscarinic agonist opening outflow, lowering IOP $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q42

## Q43.

### Solution

**Concept — $\alpha_1$-blockade:** Prazosin selectively blocks postsynaptic $\alpha_1$-adrenergic receptors. **Reasoning:** Blocking vascular $\alpha_1$ receptors relaxes arterioles and veins, lowering peripheral resistance and blood pressure; blocking $\alpha_1$ receptors in the prostate and bladder neck relieves the obstruction of benign prostatic hyperplasia. **Why the other options are wrong:**

- (A) It is not a $\beta_1$-blocker.
- (C) Central $\alpha_2$ agonism describes clonidine.
- (D) It is $\alpha_1$-selective, not a non-selective $\beta$-blocker.

**Final Answer:** Selective $\alpha_1$-adrenergic antagonist $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q43

## Q44.

### Solution

**Concept — Atracurium elimination:** Atracurium is a non-depolarising blocker eliminated largely by organ-independent pathways. **Reasoning:** It undergoes spontaneous Hofmann elimination (a non-enzymatic breakdown at physiological pH and temperature) and ester hydrolysis, so its clearance does not rely on hepatic or renal function, making it suitable when these organs are impaired. **Why the other options are wrong:**

- (A) It is non-depolarising, not a pseudocholinesterase-hydrolysed depolariser (that is succinylcholine).
- (B) Its key feature is independence from renal excretion.
- (D) Non-depolarising block is reversed by anticholinesterases, not by succinylcholine.

**Final Answer:** Hofmann elimination, organ-independent $\Rightarrow \boxed{\text{C}}$

**Answer: (C)** Go Back to Q44

## Q45.

### Solution

**Concept — Dobutamine:** Dobutamine is a relatively selective $\beta_1$-adrenergic agonist. **Reasoning:** By stimulating cardiac $\beta_1$ receptors it increases myocardial contractility (positive inotropy) and cardiac output, with comparatively little reflex change in heart rate or peripheral resistance, which is why it is used in acute heart failure and cardiogenic shock. **Why the other options are wrong:**

- (A) It is not primarily an $\alpha_1$ vasopressor.
- (B) Central $\alpha_2$ agonism describes clonidine-type drugs.
- (C) It is adrenergic, not a muscarinic agonist.

**Final Answer:** Selective $\beta_1$-agonist inotrope $\Rightarrow \boxed{\text{D}}$

**Answer: (D)** Go Back to Q45

## Q46.

### Solution

**Concept — Pyridostigmine:** Pyridostigmine is a reversible carbamate cholinesterase inhibitor. **Reasoning:** By inhibiting acetylcholinesterase it raises acetylcholine at the neuromuscular junction, improving transmission across the depleted receptor population in myasthenia gravis. Its longer and smoother action than neostigmine makes it suitable for chronic oral maintenance. **Why the other options are wrong:**

- (B) It is reversible, not an irreversible organophosphate.
- (C) It does not block nicotinic receptors; it raises ACh that stimulates them.
- (D) It is not a muscarinic antagonist.

**Final Answer:** Reversible AChE inhibitor raising NMJ acetylcholine $\Rightarrow \boxed{\text{A}}$

**Answer: (A)** Go Back to Q46

## Q47.

### Solution

**Concept — Z-drug mechanism:** Zolpidem binds the benzodiazepine (allosteric) site of the GABA-A receptor but with subunit selectivity. **Reasoning:** It preferentially modulates $\alpha_1$-subunit-containing GABA-A receptors, which mediate sedation/hypnosis, while having less action at the $\alpha_2/\alpha_3$ receptors linked to anxiolysis and muscle relaxation, giving a more purely hypnotic profile. **Why the other options are wrong:**

- (A) It is not an $H_1$ antihistamine.
- (C) It needs GABA to act; it does not open the channel alone.
- (D) Melatonin-receptor agonism describes ramelteon.

**Final Answer:** $\alpha_1$-preferring GABA-A benzodiazepine-site modulator $\Rightarrow \boxed{B}$

**Answer: (B)** Go Back to Q47

## Q48.

### Solution

**Concept — Clozapine toxicity:** Clozapine is a highly effective atypical antipsychotic but carries a risk of agranulocytosis. **Reasoning:** Because it can cause a severe, potentially fatal drop in neutrophils, patients require regular white-cell (neutrophil) count monitoring. This haematological risk, not movement disorders, is the reason it is reserved for resistant cases. **Why the other options are wrong:**

- (A) Clozapine has a low risk of extrapyramidal symptoms.
- (B) It causes little hyperprolactinaemia (weak/transient $D_2$ occupancy).
- (D) Retinal pigmentation is associated with thioridazine, not clozapine.

**Final Answer:** Risk of agranulocytosis needing monitoring $\Rightarrow \boxed{C}$

**Answer: (C)** Go Back to Q48

## Q49.

### Solution

**Concept — Bupropion (NDRI):** Bupropion inhibits the reuptake of noradrenaline and dopamine. **Reasoning:** By raising synaptic noradrenaline and dopamine with minimal serotonergic effect, it gives an antidepressant action with little sexual dysfunction or weight gain, and its dopaminergic effect underlies its use in smoking cessation. **Why the other options are wrong:**

- (A) SSRI action is serotonin-selective, which bupropion is not.
- (B) It is not an MAO inhibitor.

- (C) 5-HT$_2$/$\alpha_2$ blockade describes mirtazapine.

**Final Answer:** Noradrenaline-dopamine reuptake inhibition $\Rightarrow \boxed{\text{D}}$

**Answer: (D)** Go Back to Q49

## Q50.

### Solution

**Concept — Tramadol dual action:** Tramadol combines a weak opioid effect with monoamine reuptake inhibition. **Reasoning:** It is a weak $\mu$-opioid agonist (partly via its active metabolite) and also inhibits noradrenaline and serotonin reuptake, enhancing descending pain modulation. This dual mechanism gives analgesia with less respiratory depression than strong opioids. **Why the other options are wrong:**

- (B) It does have an opioid component, so it is not purely a COX inhibitor.
- (C) It is not a $\kappa$-antagonist.
- (D) It does not act as an NMDA agonist.

**Final Answer:** Weak $\mu$-agonism plus NA/5-HT reuptake inhibition $\Rightarrow \boxed{\text{A}}$

**Answer: (A)** Go Back to Q50

## Q51.

### Solution

**Concept — Valproate (broad-spectrum):** Sodium valproate acts through several complementary mechanisms. **Reasoning:** It blocks voltage-gated sodium channels (limiting repetitive firing), has some T-type calcium channel block (effective against absence seizures), and raises brain GABA by inhibiting GABA transaminase. This combination explains its broad efficacy across seizure types. **Why the other options are wrong:**

- (A) T-type block alone describes ethosuximide, not the full valproate profile.
- (C) It is not a pure NMDA antagonist.
- (D) SV2A binding is the levetiracetam mechanism.

**Final Answer:** Multiple actions (Na$^+$, T-type Ca$^{2+}$, GABA) $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q51

## Q52.

### Solution

**Concept — Ethosuximide:** Ethosuximide selectively blocks low-threshold T-type calcium channels in thalamic neurons. **Reasoning:** The thalamocortical T-type calcium current generates the 3-Hz spike-and-wave discharge of absence seizures; blocking it suppresses this rhythm, which is why ethosuximide is first choice for uncomplicated absence epilepsy. **Why the other options are wrong:**

- (A) Sodium-channel block is the phenytoin/carbamazepine mechanism.
- (B) Enhancing GABA-A currents describes barbiturates/benzodiazepines.
- (D) It is not an AMPA antagonist.

**Final Answer:** Thalamic T-type $Ca^{2+}$ channel block $\Rightarrow \boxed{\text{C}}$

$\boxed{\textbf{Answer: (C)}}$ Go Back to Q52

## Q53.

### Solution

**Concept — Dopamine agonist:** Pramipexole directly stimulates dopamine receptors, preferentially the $D_2/D_3$ subtypes. **Reasoning:** As a direct agonist it does not depend on conversion by surviving dopaminergic neurons (unlike levodopa), so it remains effective as neurons are lost and is useful in early Parkinson's disease and in restless-legs syndrome. **Why the other options are wrong:**

- (A) Peripheral DOPA-decarboxylase inhibition describes carbidopa.
- (B) COMT inhibition describes entacapone.
- (C) MAO-B inhibition describes selegiline/rasagiline.

**Final Answer:** Direct $D_2/D_3$ dopamine agonist $\Rightarrow \boxed{\text{D}}$

$\boxed{\textbf{Answer: (D)}}$ Go Back to Q53

## Q54.

### Solution

**Concept — ARB (candesartan):** Candesartan is an angiotensin II $AT_1$-receptor antagonist. **Reasoning:** It blocks the vasoconstrictor and aldosterone-releasing actions of angiotensin II at the $AT_1$ receptor. Because it does not inhibit ACE, bradykinin is not accumulated, so the dry cough associated with ACE inhibitors is rare. **Why the other options are wrong:**

- (B) ACE inhibition (and bradykinin rise) describes enalapril-type drugs.
- (C) It does not block calcium channels.
- (D) It is not a $\beta$-blocker.

**Final Answer:** $AT_1$-receptor blockade without raising bradykinin $\Rightarrow \boxed{A}$

**Answer: (A)** Go Back to Q54

## Q55.

### Solution

**Concept — Non-dihydropyridine CCB:** Verapamil blocks L-type calcium channels with prominent cardiac selectivity. **Reasoning:** Beyond vasodilation it markedly slows SA-node firing and AV-node conduction (negative chronotropic and dromotropic effects) and reduces contractility, which is why verapamil is used to control rate in supraventricular tachycardia, unlike the vascular-selective dihydropyridine amlodipine. **Why the other options are wrong:**

- (A) It is not a $\beta_2$-agonist.
- (C) It does not act on the renin-angiotensin system.
- (D) It is not a COX inhibitor.

**Final Answer:** Slows SA/AV nodes (negative chronotropic/dromotropic) $\Rightarrow \boxed{B}$

**Answer: (B)** Go Back to Q55

## Q56.

### Solution

**Concept — Aldosterone antagonist:** Spironolactone competitively blocks the mineralocorticoid (aldosterone) receptor. **Reasoning:** In the collecting-duct principal cells it antagonises aldosterone, reducing expression of the epithelial sodium channel and the $Na^+/K^+$-ATPase. The result is increased sodium and water loss while potassium is retained (potassium-sparing diuresis). **Why the other options are wrong:**

- (A) $Na^+/K^+/2Cl^-$ inhibition is the loop diuretic action.
- (B) Carbonic anhydrase inhibition describes acetazolamide.
- (D) $Na^+/Cl^-$ symport block describes thiazides.

**Final Answer:** Mineralocorticoid-receptor antagonism, $K^+$-sparing $\Rightarrow \boxed{C}$

**Answer: (C)** Go Back to Q56

## Q57.

### Solution

**Concept — Direct factor Xa inhibitor:** Rivaroxaban directly and reversibly inhibits activated factor X (Xa). **Reasoning:** By blocking factor Xa it reduces the conversion of prothrombin to thrombin, preventing clot formation. Being orally active with a predictable response, it does not require routine INR monitoring, unlike warfarin. **Why the other options are wrong:**

- (A) Vitamin-K epoxide reductase inhibition describes warfarin.
- (B) Indirect antithrombin activation describes heparins.
- (C) Irreversible COX inhibition describes aspirin (an antiplatelet).

**Final Answer:** Direct reversible factor Xa inhibitor $\Rightarrow \boxed{D}$

**Answer: (D)** Go Back to Q57

## Q58.

### Solution

**Concept — Statin mechanism:** Rosuvastatin competitively inhibits HMG-CoA reductase. **Reasoning:** HMG-CoA reductase is the rate-limiting enzyme of hepatic cholesterol synthesis. Inhibiting it lowers intracellular cholesterol, which up-regulates hepatic LDL receptors and increases clearance of LDL from the blood, lowering plasma LDL cholesterol. **Why the other options are wrong:**

- (B) Bile-acid binding describes resins (colestyramine).
- (C) PCSK9 inhibition describes the monoclonal antibodies (e.g. evolocumab).
- (D) Lipoprotein-lipase activation is not the statin mechanism.

**Final Answer:** HMG-CoA reductase inhibition up-regulating LDL receptors $\Rightarrow \boxed{A}$

**Answer: (A)** Go Back to Q58

## Q59.

### Solution

**Concept — Second-generation $H_1$ antihistamine:** Fexofenadine is a non-sedating $H_1$ blocker. **Reasoning:** It antagonises peripheral histamine $H_1$ receptors to relieve allergic symptoms but, being poorly lipophilic and a P-glycoprotein substrate, it crosses the blood-brain barrier poorly and causes little sedation, unlike first-generation chlorpheniramine. **Why the other options are wrong:**

- (A) Sedating first-generation profile describes chlorpheniramine.
- (C) $H_2$ blockade reducing acid describes famotidine.
- (D) It is not a mast-cell stabiliser.

**Final Answer:** Non-sedating second-generation $H_1$ antihistamine $\Rightarrow \boxed{\text{B}}$

$\boxed{\textbf{Answer: (B)}}$ **Go Back to Q59**

## Q60.

### Solution

**Concept — Reversible NSAID:** Naproxen reversibly (competitively) inhibits cyclooxygenase. **Reasoning:** Like most NSAIDs it competitively and reversibly inhibits both COX-1 and COX-2, reducing prostaglandin synthesis and thereby inflammation, pain and fever. This contrasts with aspirin, which inhibits COX irreversibly by acetylation. **Why the other options are wrong:**

- (A) It is not COX-2 selective.
- (B) It does not inhibit lipoxygenase.
- (D) Irreversible acetylation is the aspirin mechanism, not naproxen's.

**Final Answer:** Reversible (competitive) COX inhibition $\Rightarrow \boxed{\text{C}}$

$\boxed{\textbf{Answer: (C)}}$ **Go Back to Q60**

## Q61.

### Solution

**Concept — Febuxostat:** Febuxostat is a non-purine selective inhibitor of xanthine oxidase. **Reasoning:** By inhibiting xanthine oxidase it blocks conversion of hypoxanthine and xanthine to uric acid, lowering urate production and serum urate for long-term gout control. Being non-purine, it is an option for patients intolerant of allopurinol. **Why the other options are wrong:**

- (A) Increasing renal excretion describes uricosurics (probenecid).
- (B) Urate degradation by uricase describes rasburicase/pegloticase.
- (C) Microtubule inhibition describes colchicine.

**Final Answer:** Non-purine xanthine oxidase inhibitor $\Rightarrow \boxed{\text{D}}$

**Answer: (D)** **Go Back to Q61**

## Q62.

**Solution**

**Concept — Triptan mechanism:** Sumatriptan is a 5-HT$_{1B/1D}$ receptor agonist. **Reasoning:** Activating 5-HT$_{1B}$ receptors constricts the dilated cranial/meningeal vessels, while 5-HT$_{1D}$ activation on trigeminal nerve endings inhibits release of vasoactive neuropeptides (e.g. CGRP) and reduces neurogenic inflammation, aborting the migraine. **Why the other options are wrong:**

- (B) 5-HT$_3$ antagonism is the antiemetic ondansetron action.
- (C) D$_2$ antagonism is not the triptan mechanism.
- (D) It is not an NSAID/COX inhibitor.

**Final Answer:** 5-HT$_{1B/1D}$ agonist constricting cranial vessels $\Rightarrow \boxed{\text{A}}$

**Answer: (A)** **Go Back to Q62**

## Q63.

**Solution**

**Concept — Tetracyclines:** Doxycycline is a protein-synthesis inhibitor acting on the 30S subunit. **Reasoning:** It binds reversibly to the 30S ribosomal subunit and blocks attachment of aminoacyl-tRNA to the A (acceptor) site, halting elongation of the peptide chain. This bacteriostatic action covers many Gram-positive, Gram-negative and atypical organisms. **Why the other options are wrong:**

- (A) Cell-wall inhibition describes $\beta$-lactams/glycopeptides.
- (C) DNA gyrase inhibition describes fluoroquinolones.
- (D) DHFR inhibition describes trimethoprim.

**Final Answer:** 30S binding blocking aminoacyl-tRNA attachment $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q63

## Q64.

**Solution**

**Concept — Glycopeptide:** Vancomycin inhibits cell-wall synthesis by a mechanism different from the $\beta$-lactams. **Reasoning:** It binds the terminal D-alanyl-D-alanine of the peptidoglycan precursor, sterically preventing transglycosylation and transpeptidation. This halts cell-wall assembly and is bactericidal against Gram-positive bacteria, including MRSA. **Why the other options are wrong:**

- (A) Binding penicillin-binding proteins is the $\beta$-lactam mechanism; vancomycin binds the substrate (D-Ala-D-Ala).
- (B) 50S inhibition describes macrolides/chloramphenicol.
- (D) Membrane disruption describes polymyxins.

**Final Answer:** Binds D-Ala-D-Ala, blocking cell-wall synthesis $\Rightarrow \boxed{C}$

Answer: (C) Go Back to Q64

## Q65.

**Solution**

**Concept — Polyene antifungal:** Amphotericin B targets the fungal cell membrane. **Reasoning:** It binds ergosterol, the principal sterol of fungal membranes, and forms transmembrane pores. The resulting leakage of potassium and other ions disrupts membrane integrity, killing the fungus. Its greater affinity for ergosterol than for cholesterol gives selectivity. **Why the other options are wrong:**

- (A) 14-$\alpha$-demethylase inhibition describes the azoles.
- (B) $\beta$-glucan-synthase inhibition describes the echinocandins.
- (C) Squalene epoxidase inhibition describes terbinafine.

**Final Answer:** Binds ergosterol and forms membrane pores $\Rightarrow \boxed{D}$

Answer: (D) Go Back to Q65

## Q66.

### Solution

**Concept — Neuraminidase inhibitor:** Oseltamivir inhibits the influenza viral neuraminidase. **Reasoning:** Neuraminidase cleaves sialic-acid residues to release newly assembled virions from the host cell surface. Inhibiting it traps the progeny virus at the cell, limiting spread and shortening the illness when given early. **Why the other options are wrong:**

- (B) Chain-terminating reverse-transcriptase inhibition describes zidovudine.
- (C) Protease inhibition describes the HIV protease inhibitors.
- (D) CCR5 blockade describes maraviroc.

**Final Answer:** Neuraminidase inhibition preventing virion release $\Rightarrow \boxed{\text{A}}$

**Answer: (A)** Go Back to Q66

## Q67.

### Solution

**Concept — Biguanide:** Metformin lowers glucose without stimulating insulin release. **Reasoning:** It activates AMP-activated protein kinase (AMPK), suppressing hepatic gluconeogenesis and improving peripheral insulin sensitivity and glucose uptake. Because it does not provoke insulin secretion, it carries little risk of hypoglycaemia when used alone. **Why the other options are wrong:**

- (A) Closing $\beta$-cell $K_{ATP}$ channels describes sulfonylureas.
- (C) $\alpha$-glucosidase inhibition describes acarbose.
- (D) GLP-1 agonism describes the incretin mimetics.

**Final Answer:** AMPK activation, reduced hepatic gluconeogenesis $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q67

## Q68.

### Solution

**Concept — Toxic-alcohol antidote:** Methanol and ethylene glycol are themselves relatively non-toxic; their toxicity comes from metabolites formed by alcohol dehydrogenase (formic acid; oxalate/glycolate). **Reasoning:** Fomepizole inhibits alcohol dehydrogenase, halting formation of these toxic metabolites and allowing the parent alcohol to be excreted or dialysed. Ethanol, which competes for the same enzyme, is the alternative antidote. **Why the other options are wrong:**

- (A) Naloxone is the opioid antagonist.
- (B) Deferoxamine chelates iron.
- (D) Protamine reverses heparin.

**Final Answer:** Fomepizole (alcohol-dehydrogenase inhibitor) $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q68

## Q69.

**Solution**

**Concept — $S_N1$ solvolysis:** A tertiary halide in a polar protic solvent ionises to a planar ($sp^2$) carbocation in the slow step. **Reasoning:** The trigonal-planar cation can be attacked by the solvent water from either face with nearly equal probability. The two approaches give the two enantiomers, so the optically active starting material is converted to a racemic (or largely racemic) product. **Why the other options are wrong:**

- (A) Pure inversion is the hallmark of the concerted $S_N2$ pathway, not $S_N1$.
- (B) Pure retention does not occur in a free-carbocation mechanism.
- (D) Tertiary halides solvolyse readily; they are the best $S_N1$ substrates.

**Final Answer:** Racemisation via the planar carbocation $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q69

## Q70.

**Solution**

**Concept — E1 mechanism:** E1 is a two-step, unimolecular elimination paralleling $S_N1$. **Reasoning:** The slow, rate-determining step is ionisation of the C–LG bond to give a carbocation; a base then removes a $\beta$-hydrogen in a fast step. Hence the rate is first order and depends only on the substrate concentration. **Why the other options are wrong:**

- (A) A concerted, second-order, base-dependent process describes E2, not E1.
- (B) The leaving group departs first; the $\beta$-H is removed afterwards.
- (C) The strict anti-periplanar requirement applies to concerted E2.

**Final Answer:** Rate-determining unimolecular ionisation; rate depends only on substrate $\Rightarrow \boxed{\text{D}}$

**Answer: (D)** Go Back to Q70

## Q71.

### Solution

**Concept — Friedel–Crafts alkylation limitation:** Alkyl carbocations can rearrange to more stable isomers. **Reasoning:** The primary 1-propyl cation generated from 1-chloropropane/$AlCl_3$ undergoes a 1,2-hydride shift to the more stable secondary isopropyl cation, which then alkylates benzene to give cumene as the major product. **Why the other options are wrong:**

- (B) Benzene reacts with primary halides too; the issue is rearrangement.
- (C) $AlCl_3$ is a Lewis-acid catalyst; it does not reduce the chain.
- (D) No oxidation step is involved here.

**Final Answer:** Hydride shift to the secondary carbocation $\Rightarrow \boxed{\text{A}}$

**Answer: (A)** Go Back to Q71

## Q72.

### Solution

**Concept — Mannich reaction:** An aminomethylation joining an enolisable carbonyl, formaldehyde and an amine. **Reasoning:** Formaldehyde and the secondary amine form an iminium ion (Mannich electrophile); the enol of the ketone attacks it to give a $\beta$-aminoketone (the Mannich base). **Why the other options are wrong:**

- (B) Reformatsky uses an $\alpha$-haloester with zinc and a carbonyl.
- (C) Knoevenagel condenses an active-methylene compound with an aldehyde (no amine incorporation).
- (D) Michael addition is conjugate addition to an $\alpha, \beta$-unsaturated carbonyl.

**Final Answer:** It is the Mannich reaction $\Rightarrow \boxed{\text{A}}$

**Answer: (A)** Go Back to Q72

## Q73.

**Solution**

**Concept — R/S assignment:** Orient the lowest-priority group away, then read the 1→2→3 sense. **Reasoning:** Priorities are Cl (1) $>$ $CH_2CH_3$ (2) $>$ $CH_3$ (3) $>$ H (4). With H on the dashed bond pointing away from the viewer, the sequence Cl $\rightarrow$ $CH_2CH_3$ $\rightarrow$ $CH_3$ is clockwise, which defines the (*R*) configuration. **Why the other options are wrong:**

- (A) H is pointing back (away), not in front, so no descriptor reversal is needed.
- (B) Cl (Z=17) outranks the ethyl carbon (Z=6), so the stated ranking is wrong.
- (D) The molecule has a single stereocentre; it is not meso.

**Final Answer:** Clockwise with H away $\Rightarrow$ (*R*) $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q73

## Q74.

**Solution**

**Concept — E/Z assignment:** Compare the higher-priority group on each double-bond carbon; same side = Z, opposite = E. **Reasoning:** Left carbon: Cl $>$ $CH_3$, so Cl is the higher priority. Right carbon: F (Z=9) outranks the carbon of $CH_2CH_3$ (Z=6), so F is the higher priority. As drawn, Cl (left) and F (right) lie on the same side, making the alkene *Z*. **Why the other options are wrong:**

- (A) “Two halogens on opposite sides” is the wrong reasoning; F is higher priority than the ethyl carbon, and both top groups are on the same side.
- (B) Each carbon bears two different groups, so E/Z isomerism does exist.
- (C) The two carbons are not identical.

**Final Answer:** Higher-priority Cl and F on the same side $\Rightarrow$ *Z* $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q74

## Q75.

**Solution**

**Concept — Hückel aromaticity in fused rings:** A planar, fully conjugated system with $(4n+2)$ $\pi$ electrons is aromatic. **Reasoning:** Naphthalene has 10 $\pi$ electrons ($n=2$), is planar and fully conjugated, and is aromatic (a benzenoid polycyclic). **Why the other options are wrong:**

- (A) Cyclooctatetraene has 8 $(4n)$ $\pi$ electrons and is normally tub-shaped; even planar it would be antiaromatic.
- (C) Cyclopentadiene (neutral) has an $sp^3$ $CH_2$, breaking conjugation; only its anion is aromatic.
- (D) Cyclobutadiene (4 $\pi$) is antiaromatic.

**Final Answer:** Naphthalene (10 $\pi$ $e^-$) is aromatic $\Rightarrow \boxed{\text{B}}$

$\boxed{\text{Answer: (B)}}$ **Go Back to Q75**

## Q76.

**Solution**

**Concept — Substituent effects on benzoic-acid acidity:** Electron-withdrawing para groups stabilise the carboxylate and raise acidity (lower $pK_a$). **Reasoning:** The *p*-nitro group is strongly electron-withdrawing (by resonance and induction), best stabilising the conjugate base; *p*-nitrobenzoic acid is therefore the strongest acid of the set. **Why the other options are wrong:**

- (B) *p*-methoxy is electron-donating by resonance, weakening the acid.
- (C) *p*-amino is strongly electron-donating, the weakest acid here.
- (D) *p*-methyl is weakly donating (+I/hyperconjugation), so weaker than the parent.

**Final Answer:** *p*-Nitrobenzoic acid is the strongest acid $\Rightarrow \boxed{\text{A}}$

$\boxed{\text{Answer: (A)}}$ **Go Back to Q76**

### Q77.

**Solution**

**Concept — Resonance stabilisation of carbocations:** Delocalisation of the positive charge over more than one centre is strongly stabilising. **Reasoning:** Allyl and benzyl cations are resonance-stabilised (the two equivalent allyl forms are shown), placing them at or above the stability of simple secondary cations and well above primary cations. The order is benzyl $\approx$ allyl $>$ secondary $>$ primary. **Why the other options are wrong:**

- (A) Allyl is far more stable than methyl/ethyl, not less.
- (B) Primary cations are less stable than allyl/benzyl, not more.
- (D) Carbocations differ widely in stability.

**Final Answer:** benzyl $\approx$ allyl $>$ secondary $>$ primary $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q77

### Q78.

**Solution**

**Concept — Electrophilic aromatic substitution:** The slow step is electrophile addition to form the arenium (Wheland) intermediate. **Reasoning:** $Br^+$ (from $Br_2/FeBr_3$) adds to the ring to give the resonance-stabilised, non-aromatic sigma complex shown; loss of the ring proton then restores aromaticity. Formation of the arenium ion is rate-determining. **Why the other options are wrong:**

- (A) Aromaticity is restored after deprotonation, not permanently lost.
- (B) The electrophile adds first; the proton is lost afterwards.
- (C) A dibromide (addition product) is not formed; substitution occurs.

**Final Answer:** $Br^+$ adds to form the arenium (sigma) complex $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q78

### Q79.

**Solution**

**Concept — Sandmeyer reaction:** Cu(I) salts replace the diazonium group with a halide or pseudohalide. **Reasoning:** $ArN_2^+$ with CuCl or CuBr gives ArCl or ArBr (with loss of $N_2$) via a radical mechanism. This is the classic Sandmeyer reaction for installing halogens on an aromatic ring. **Why the other options are wrong:**

- (B) Gattermann–Koch formylates arenes with CO/HCl/$AlCl_3$.
- (C) Rosenmund reduces acid chlorides to aldehydes.
- (D) Clemmensen reduces carbonyls to methylene with Zn(Hg)/HCl.

**Final Answer:** It is the Sandmeyer reaction $\Rightarrow \boxed{\text{A}}$

**Answer: (A)** Go Back to Q79

## Q80.

**Solution**

**Concept — Counting stereoisomers:** With $n$ stereocentres and no symmetry, the maximum is $2^n$. **Reasoning:** For two non-equivalent stereocentres ($n = 2$) with no internal mirror plane, the maximum number of stereoisomers is $2^2 = 4$ (two pairs of enantiomers / diastereomers). **Why the other options are wrong:**

- (A) 2 would be the count for a single stereocentre.
- (C) 3 arises only when a meso form reduces the count (symmetry present).
- (D) 8 would require three stereocentres ($2^3$).

**Final Answer:** $2^2 = 4$ stereoisomers $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q80

## Q81.

**Solution**

**Concept — Conformations of butane:** Staggered forms are anti (180°) and gauche (60°); eclipsed forms are higher in energy. **Reasoning:** A 60° dihedral between the two methyl groups in a staggered projection is the gauche conformation. It is a local minimum, higher than anti (because of methyl–methyl gauche strain) but lower than any eclipsed form. **Why the other options are wrong:**

- (A) Anti has the methyls 180° apart.
- (B) Fully eclipsed (syn) has a 0° dihedral and is the highest-energy form.
- (D) The global minimum is the anti, not the gauche, conformation.

**Final Answer:** Gauche conformation $\Rightarrow \boxed{\text{C}}$

**Answer: (C)** Go Back to Q81

## Q82.

**Solution**

**Concept — Hell–Volhard–Zelinsky (HVZ):** $\alpha$-Halogenation of carboxylic acids via the acyl bromide enol. **Reasoning:** Red phosphorus and $Br_2$ form $PBr_3$, converting the acid to an acyl bromide; its enol is brominated at the $\alpha$-carbon, and exchange regenerates the $\alpha$-bromo carboxylic acid. This is the HVZ reaction. **Why the other options are wrong:**

- (A) Hunsdiecker degrades a silver carboxylate with $Br_2$ to an alkyl halide (one C shorter).
- (B) Kolbe electrolysis couples carboxylate radicals.
- (C) Wolff–Kishner reduces a carbonyl to methylene.

**Final Answer:** It is the HVZ reaction $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q82

## Q83.

**Solution**

**Concept — Opioid SAR (the morphine rule):** Key pharmacophore elements bind the $\mu$-receptor. **Reasoning:** Classic opioid SAR requires a basic, protonatable tertiary nitrogen, a flat aromatic ring, and a quaternary carbon spacer separating them (with the N at the correct distance). The protonated amine forms the crucial ionic interaction at the receptor. **Why the other options are wrong:**

- (B) A free carboxylic acid is not part of the opioid pharmacophore.
- (C) A $\beta$-lactam belongs to antibiotics, not opioids.
- (D) An aldehyde group is not required.

**Final Answer:** Basic N + aromatic ring + quaternary-carbon spacer $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q83

## Q84.

**Solution**

**Concept — Ring bioisosteres:** Replacing a ring with one of similar size/electronics that preserves activity. **Reasoning:** Benzene and thiophene are recognised ring equivalents (bioisosteres): similar shape, $\pi$ character and lipophilicity, so substitution often retains biological activity while tuning properties. This is classical (ring) bioisosterism. **Why the other options are wrong:**

- (A) A prodrug is metabolically activated, a different strategy.
- (C) Racemic resolution separates enantiomers, unrelated to ring swapping.
- (D) Phase II conjugation is a metabolic, not a design, concept.

**Final Answer:** Ring bioisosteric replacement $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** **Go Back to Q84**

## Q85.

### Solution

**Concept — Prodrug for CNS delivery:** Dopamine cannot cross the blood–brain barrier (BBB); its amino-acid precursor can. **Reasoning:** Levodopa is a prodrug carried across the BBB by the large-neutral-amino-acid transporter, then decarboxylated by aromatic L-amino-acid decarboxylase (DOPA decarboxylase) to dopamine inside the CNS, raising central dopamine. **Why the other options are wrong:**

- (B) Levodopa is not more potent directly; it is inactive until decarboxylated.
- (C) It is not a $\beta$-lactam antibiotic.
- (D) It is not an MAO inhibitor.

**Final Answer:** Prodrug crossing the BBB, decarboxylated to dopamine $\Rightarrow \boxed{\text{A}}$

**Answer: (A)** **Go Back to Q85**

## Q86.

### Solution

**Concept — Hansch $\pi$ constant:** $\pi_X = \log P_X - \log P_H$ measures a substituent's hydrophobic contribution. **Reasoning:** A large positive $\pi$ means the substituent raises log$P$ relative to hydrogen, i.e. it is more hydrophobic (lipophilic). Negative $\pi$ marks hydrophilic substituents. **Why the other options are wrong:**

- (A) Electron-withdrawal is described by the Hammett $\sigma$ constant.
- (B) Steric size is captured by Taft $E_s$.
- (C) Hydrogen-bonding is not what $\pi$ directly measures.

**Final Answer:** Large positive $\pi$ = more lipophilic $\Rightarrow \boxed{\text{D}}$

**Answer: (D)** Go Back to Q86

## Q87.

### Solution

**Concept — Hammett reaction constant $\rho$:** The sign and magnitude of $\rho$ reveal charge development in the transition state. **Reasoning:** A large positive $\rho$ means electron-withdrawing substituents (positive $\sigma$) increase the rate/equilibrium, i.e. negative charge builds up near the reaction centre in the transition state and is stabilised by such groups. **Why the other options are wrong:**

- (A) Acceleration by electron donors (positive-charge build-up) gives a negative $\rho$.
- (C) A non-zero $\rho$ shows clear substituent dependence.
- (D) Hammett $\rho$ reflects electronics, not steric size.

**Final Answer:** Positive $\rho$ = favoured by electron-withdrawing groups (negative charge in TS) $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q87

## Q88.

### Solution

**Concept — Phase I oxidation:** CYP450 introduces or unmasks polar groups, often by oxidation. **Reasoning:** Epoxidation of a C=C double bond is a CYP450-mediated oxidative (Phase I) reaction that produces a reactive epoxide intermediate. **Why the other options are wrong:**

- (A) Glutathione conjugation is a Phase II reaction.
- (B) Sulfate conjugation is Phase II.
- (D) Acetylation of an amine is Phase II conjugation.

**Final Answer:** Epoxidation is a Phase I oxidation $\Rightarrow \boxed{\text{C}}$

**Answer: (C)** Go Back to Q88

## Q89.

**Solution**

**Concept — Phase II conjugation:** Polar endogenous molecules are attached to detoxify reactive metabolites. **Reasoning:** Glutathione conjugation (leading to mercapturic acids) is a Phase II pathway that traps electrophilic species such as the reactive paracetamol metabolite NAPQI, preventing tissue damage. **Why the other options are wrong:**

- (B) Aromatic hydroxylation is a Phase I oxidation.
- (C) Oxidative deamination is a Phase I reaction.
- (D) Nitro-group reduction is a Phase I reductive reaction.

**Final Answer:** Glutathione conjugation is Phase II $\Rightarrow \boxed{\text{A}}$

**Answer: (A)** Go Back to Q89

## Q90.

**Solution**

**Concept — Fluoroquinolone chemistry:** A defined 4-quinolone pharmacophore drives DNA-gyrase inhibition. **Reasoning:** The class is built on a 4-oxo-quinoline (4-quinolone) ring bearing a 3-carboxylic acid (essential for target binding), a 6-fluoro substituent (boosting potency) and a piperazine at C7 (broadening the spectrum), as in ciprofloxacin. **Why the other options are wrong:**

- (A) The $\beta$-lactam/thiazolidine system defines penicillins.
- (B) A steroid nucleus belongs to corticosteroids.
- (C) The naphthacene skeleton defines tetracyclines.

**Final Answer:** 4-Quinolone with 3-COOH, 6-F and a piperazinyl group $\Rightarrow \boxed{\text{D}}$

**Answer: (D)** Go Back to Q90

## Q91.

**Solution**

**Concept — Eutomer vs distomer:** The more active enantiomer at the target is the eutomer. **Reasoning:** ($S$)-Naproxen is the potent COX inhibitor, so it is the eutomer; the much less active ($R$)-form is the distomer. Naproxen is marketed as the single ($S$)-enantiomer. **Why the other options are wrong:**

- (A) The distomer is the weaker ($R$)-enantiomer.
- (C) A racemate is the 50:50 mixture, not a single enantiomer.
- (D) Naproxen is chiral, not achiral.

**Final Answer:** ($S$)-Naproxen is the eutomer $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q91

## Q92.

### Solution

**Concept — $\beta$-Lactamase inhibitors:** Some $\beta$-lactams have negligible antibacterial activity but inactivate the resistance enzyme. **Reasoning:** Clavulanic acid is a mechanism-based ("suicide") inhibitor that irreversibly acylates the serine of $\beta$-lactamase, protecting co-administered amoxicillin from hydrolysis and restoring its activity against resistant bacteria. **Why the other options are wrong:**

- (A) Clavulanic acid has only weak intrinsic antibacterial action.
- (B) PABA mimicry describes sulfonamides.
- (D) DNA-gyrase inhibition describes fluoroquinolones.

**Final Answer:** Suicide $\beta$-lactamase inhibitor protecting amoxicillin $\Rightarrow \boxed{\text{C}}$

**Answer: (C)** Go Back to Q92

## Q93.

### Solution

**Concept — Lipinski's rule of five:** Empirical cut-offs predicting poor oral absorption/permeation. **Reasoning:** One criterion is calculated $\log P > 5$. Very high lipophilicity hampers aqueous solubility and oral absorption, so a candidate violating this limit is more likely to be poorly absorbed. **Why the other options are wrong:**

- (B) A $\log P$ of zero is well within the acceptable range.
- (C) Moderately negative $\log P$ is acceptable; the rule flags the high end.
- (D) Rotatable-bond count is a separate (Veber) descriptor, not $\log P$.

**Final Answer:** $\log P > 5$ flags poor oral absorption $\Rightarrow \boxed{\text{A}}$

**Answer: (A)** Go Back to Q93

## Q94.

### Solution

**Concept — Dihydropyridine CCBs:** The 1,4-dihydropyridine ring is the essential pharmacophore. **Reasoning:** Nifedipine, amlodipine and related agents share a 1,4-dihydropyridine ring (a partially reduced pyridine bearing N–H and an $sp^3$ C4 carrying the aryl group). This ring with its ester groups is required for L-type calcium-channel blockade. **Why the other options are wrong:**

- (A) Pyrimidine has two nitrogens, not the DHP system.
- (B) Furan is a five-membered oxygen heterocycle.
- (C) Benzene has no nitrogen and is fully aromatic.

**Final Answer:** The 1,4-dihydropyridine ring $\Rightarrow \boxed{\text{D}}$

**Answer: (D)** **Go Back to Q94**

## Q95.

### Solution

**Concept — Imidazole:** A five-membered aromatic ring with two nitrogens at the 1- and 3-positions. **Reasoning:** The ring has one pyrrole-type N–H (lone pair in the aromatic sextet) and one pyridine-type N (basic, in-plane lone pair). This 1,3-diazole is the core of histamine, histidine and azole antifungals. **Why the other options are wrong:**

- (A) Thiophene contains sulfur, not nitrogen.
- (C) Furan contains oxygen.
- (D) Pyrrole has only one nitrogen.

**Final Answer:** The heterocycle is imidazole $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** **Go Back to Q95**

## Q96.

### Solution

**Concept — Radio-opaque contrast media:** High-atomic-number, insoluble, non-absorbed solids attenuate X-rays. **Reasoning:** Barium sulfate is highly insoluble (so the toxic $Ba^{2+}$ is not absorbed) and its high electron density makes it radio-opaque, giving it as a suspension for GI-tract imaging. **Why the other options**

**are wrong:**

- (A) Sodium bicarbonate is an antacid/systemic alkaliser.
- (B) Zinc oxide is a topical protective/astringent.
- (D) Calcium gluconate is a calcium supplement/antidote.

**Final Answer:** Barium sulfate is the X-ray contrast medium $\Rightarrow \boxed{\text{C}}$

**Answer: (C)** Go Back to Q96

## Q97.

### Solution

**Concept — Chelation therapy:** A polydentate ligand sequesters a metal ion into a soluble, excretable complex. **Reasoning:** D-Penicillamine bears thiol, amine and carboxyl donor atoms that chelate copper, forming a water-soluble complex cleared in the urine; this lowers the copper burden in Wilson's disease. **Why the other options are wrong:**

- (A) It does not oxidise copper.
- (B) It does not precipitate copper sulfide.
- (C) Its action is direct chelation, not enzyme blockade of absorption.

**Final Answer:** Chelation of copper into a soluble complex $\Rightarrow \boxed{\text{D}}$

**Answer: (D)** Go Back to Q97

## Q98.

### Solution

**Concept — Henderson–Hasselbalch and absorption:** The ionised/un-ionised ratio of a drug depends on pH relative to p$K_a$. **Reasoning:** For a weak acid, $\text{pH} - \text{p}K_a = \log([\text{A}^-]/[\text{HA}])$. At pH 2 with p$K_a$ 4, pH $<$ p$K_a$, so the un-ionised HA form predominates (ratio about 1:100). The lipophilic un-ionised form is absorbed across the gastric mucosa. **Why the other options are wrong:**

- (A) The acid is mostly un-ionised here, not fully ionised.
- (C) No salt precipitation is implied.
- (D) Ionisation, and hence absorption, is strongly pH-dependent.

**Final Answer:** Largely un-ionised at pH 2, favouring gastric absorption $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q98

## Q99.

### Solution

**Concept — Beer–Lambert calibration:** $A = (\text{slope})\,c$, so $c = A/\text{slope}$. **Reasoning:** The slope is $0.025$ (in $A$ per $\mu$g mL$^{-1}$). For $A = 0.50$, $c = 0.50/0.025 = 20$ $\mu$g mL$^{-1}$. **Why the other options are wrong:**

- (A) 0.0125 multiplies $A$ by the slope instead of dividing.
- (C) 12.5 uses a slope of $0.04$, not $0.025$.
- (D) 0.50 just restates the absorbance value.

**Final Answer:** $c = 0.50/0.025 = 20$ $\mu$g mL$^{-1}$ $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q99

## Q100.

### Solution

**Concept — Non-aqueous titration indicator:** weak bases titrated with perchloric acid in glacial acetic acid need an indicator that changes in this medium. **Reasoning:** Crystal violet is the classical visual indicator for the titration of weak bases with perchloric acid in glacial acetic acid, giving a violet-to-blue-green (to yellow) sequence at the end point. **Why the other options are wrong:**

- (A) Phenolphthalein is for aqueous acid–base titrations of weak acids/strong bases.
- (B) Methyl orange is an aqueous strong-acid indicator, not used here.
- (C) Starch is the indicator for iodine (iodimetric/iodometric) titrations.

**Final Answer:** Crystal violet $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q100

## Q101.

### Solution

**Concept — Primary standard:** a primary standard is highly pure, stable, and of fixed composition. **Reasoning:** $K_2Cr_2O_7$ can be obtained in high purity, dried without decomposition, and is stable on storage, so its solutions of known molarity can be prepared directly by weighing, without later standardisation. **Why the other options are wrong:**

- (B) Dichromate's orange colour is not intense enough to act as a self-indicator; an indicator such as diphenylamine is normally used.
- (C) The reduced $Cr^{3+}$ ion is green, not colourless, so it is not self-indicating.
- (D) Needing daily standardisation describes a non-primary standard like $KMnO_4$, not dichromate.

**Final Answer:** High purity, stable, fixed strength $\Rightarrow \boxed{\text{A}}$

**Answer: (A)** Go Back to Q101

## Q102.

### Solution

**Concept — Mohr method:** chromate signals the end point by forming a coloured silver salt once chloride is consumed. **Reasoning:** $Ag^+$ first precipitates white AgCl. After the equivalence point the first slight excess $Ag^+$ reacts with chromate to give brick-red $Ag_2CrO_4$, marking the end point. **Why the other options are wrong:**

- (A) Chromate is not bleached; a coloured precipitate forms.
- (B) The silver chromate is an insoluble red solid, not a soluble blue complex.
- (D) Adsorption colour change describes the Fajans method, not Mohr.

**Final Answer:** Brick-red $Ag_2CrO_4$ precipitate $\Rightarrow \boxed{\text{C}}$

**Answer: (C)** Go Back to Q102

## Q103.

### Solution

**Concept — Amide IR bands:** the amide I band (mainly C=O stretch) appears near 1630–1700 $\text{cm}^{-1}$. **Reasoning:** A strong band around 1650 $\text{cm}^{-1}$ in a primary amide is the amide I band, dominated by the C=O stretch (with some C–N contribution). It is shifted to lower wavenumber than a simple ketone by resonance and hydrogen bonding. **Why the other options are wrong:**

- (A) Aromatic C–H bending is weaker and lies elsewhere (700–900 $\text{cm}^{-1}$).
- (C) Carboxylic O–H stretch is a broad band near 2500–3300 $\text{cm}^{-1}$.
- (D) Alkyne C≡C stretch appears near 2100–2260 $\text{cm}^{-1}$.

**Final Answer:** 1650 $\text{cm}^{-1}$ $\Rightarrow$ amide I (C=O) $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q103

## Q104.

### Solution

**Concept — Calcium–EDTA at high pH:** at pH about 12, $Mg^{2+}$ precipitates as hydroxide and $Ca^{2+}$ is titrated using murexide. **Reasoning:** Murexide forms a pink-red complex with $Ca^{2+}$; as EDTA removes the calcium, the free indicator turns purple, giving a sharp pink-to-purple end point in strongly alkaline solution. **Why the other options are wrong:**

- (A) EBT is used at pH 10 for combined Ca/Mg, and its Ca complex is weak at pH 12.
- (B) Ferroin is a redox indicator, not a metal-ion indicator.
- (C) Potassium chromate is an argentometric indicator, not complexometric.

**Final Answer:** Murexide $\Rightarrow \boxed{\text{D}}$

**Answer: (D)** Go Back to Q104

## Q105.

### Solution

**Concept — $R_f$:** $R_f = \dfrac{\text{distance travelled by solute}}{\text{distance travelled by solvent front}}$. **Reasoning:** The spot moved 4.5 cm and the front moved 10.0 cm, so $R_f = 4.5/10.0 = 0.45$. $R_f$ is dimensionless and lies between 0 and 1. **Why the other options are wrong:**

- (A) 2.22 is the inverse ratio (10/4.5); R$_f$ cannot exceed 1.
- (B) 0.55 is $5.5/10$, using the unmigrated distance.
- (D) 0.045 misplaces the decimal point.

**Final Answer:** $R_f = 4.5/10.0 = 0.45 \Rightarrow \boxed{\text{C}}$

**Answer: (C)** Go Back to Q105

## Q106.

**Solution**

**Concept — Capacity factor:** $k' = (t_R - t_0)/t_0$ measures retention relative to the void time. **Reasoning:** $k' = (9.0 - 1.5)/1.5 = 7.5/1.5 = 5.0$. A $k'$ of about 1–10 is the usual desirable range for good separations. **Why the other options are wrong:**

- (B) 6.0 uses $t_R/t_0$ instead of $(t_R - t_0)/t_0$.
- (C) 0.17 is the reciprocal $t_0/(t_R - t_0)$.
- (D) 1.5 is simply $t_0$, not the capacity factor.

**Final Answer:** $k' = (9.0 - 1.5)/1.5 = 5.0 \Rightarrow \boxed{\text{A}}$

**Answer: (A)** Go Back to Q106

## Q107.

**Solution**

**Concept — Resolution:** $R_s = \dfrac{2(t_{R2} - t_{R1})}{w_1 + w_2}$. **Reasoning:** $R_s = 2(7.5 - 6.0)/(1.0 + 1.0) = 2(1.5)/2.0 = 3.0/2.0 = 1.5$. A value of 1.5 indicates baseline resolution. **Why the other options are wrong:**

- (A) 0.75 omits the factor of 2 in the numerator.
- (C) 3.0 forgets to divide by the sum of widths.
- (D) 0.50 uses the wrong (reciprocal) arrangement.

**Final Answer:** $R_s = 2(1.5)/2.0 = 1.5 \Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q107

## Q108.

### Solution

**Concept — Anion exchange:** a resin carrying fixed positive ($-NR_3^+$) groups retains and separates anions. **Reasoning:** Analytes are separated by their negative charge and the strength of their electrostatic affinity for the positively charged resin sites; more strongly held anions elute later (typically with increasing eluent ionic strength). **Why the other options are wrong:**

- (A) Size-based, largest-first elution describes size-exclusion chromatography.
- (B) Volatility governs gas chromatography, not ion exchange.
- (D) Refractive index is a detection property, not the separation basis.

**Final Answer:** Separation by analyte negative charge/affinity $\Rightarrow \boxed{\text{C}}$

$\boxed{\textbf{Answer: (C)}}$ **Go Back to Q108**

## Q109.

### Solution

**Concept — NMR integration:** peak area is proportional to the number of protons in each environment. **Reasoning:** In ethyl acetate the acetyl $CH_3$ has 3 H, the $OCH_2$ has 2 H, and the terminal $CH_3$ has 3 H, giving an integration ratio of $3:2:3$. **Why the other options are wrong:**

- (A) 1:1:1 ignores the differing proton counts.
- (B) 2:2:3 mis-assigns the acetyl $CH_3$ as 2 H.
- (C) 3:3:3 wrongly gives the $OCH_2$ three protons.

**Final Answer:** $CH_3 : OCH_2 : CH_3 = 3:2:3 \Rightarrow \boxed{\text{D}}$

$\boxed{\textbf{Answer: (D)}}$ **Go Back to Q109**

## Q110.

### Solution

**Concept — Chlorine isotope pattern:** chlorine has two stable isotopes, $^{35}Cl$ and $^{37}Cl$. **Reasoning:** The natural abundances are about 75.8% $^{35}Cl$ and 24.2% $^{37}Cl$, roughly 3:1. A single Cl therefore gives M and M+2 peaks in about a 3:1 intensity ratio, a diagnostic fingerprint in mass spectra. **Why the other options are wrong:**

- (B) A single isotope could not produce two molecular-ion masses.

- (C) Equal 1:1 abundance is the signature of bromine, not chlorine.
- (D) Proton capture is not the origin of the M+2 isotope peak.

**Final Answer:** $^{35}\text{Cl}/^{37}\text{Cl} \approx 3{:}1$ abundance $\Rightarrow \boxed{\text{A}}$

**Answer: (A)** Go Back to Q110

## Q111.

### Solution

**Concept — Salt hydrolysis at equivalence:** the equivalence-point pH depends on the salt formed. **Reasoning:** Titrating a weak base with a strong acid produces the salt of a weak base and a strong acid. This salt hydrolyses to give an acidic solution, so the equivalence point lies below pH 7, as shown by point Q on the curve. **Why the other options are wrong:**

- (A) pH 7 is the equivalence point only for strong acid–strong base.
- (C) Above 7 would require a basic salt, the opposite case.
- (D) The equivalence-point pH is set by salt hydrolysis, not equal to $pK_b$.

**Final Answer:** Acidic, below pH 7 $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q111

## Q112.

### Solution

**Concept — AAS source:** AAS needs a narrow-line source matched to the analyte's resonance line. **Reasoning:** The hollow-cathode lamp has a cathode made of (or coated with) the element to be determined; it emits the sharp resonance lines of that element, which ground-state atoms in the flame absorb. This element-specific line source is essential for AAS selectivity. **Why the other options are wrong:**

- (A) A continuous broadband source is used in UV-Vis spectrophotometry, not line-source AAS.
- (B) Atomisation is done by the flame/graphite furnace, not the lamp.
- (D) Dispersion is the monochromator's job, not the lamp's.

**Final Answer:** Sharp resonance-line source for the element $\Rightarrow \boxed{\text{C}}$

**Answer: (C)** Go Back to Q112

## Q113.

**Solution**

**Concept — Gravimetric factor:** a stoichiometric ratio that converts precipitate mass to analyte mass. **Reasoning:** The gravimetric factor is the ratio of the formula mass of the analyte to that of the weighed precipitate (times the appropriate stoichiometric coefficients). Multiplying the precipitate mass by this factor gives the mass of analyte. **Why the other options are wrong:**

- (B) Burette/temperature corrections belong to volumetric work.
- (C) Converting absorbance to concentration is the role of a calibration slope.
- (D) Conductance relates to conductometry, not gravimetry.

**Final Answer:** Converts precipitate mass to analyte mass $\Rightarrow \boxed{\text{A}}$

**Answer: (A)** Go Back to Q113

## Q114.

**Solution**

**Concept — Why measure at $\lambda_{max}$:** the curve is flat-topped at its peak, so small wavelength errors barely change $A$. **Reasoning:** At $\lambda_{max}$ (264 nm here) the absorptivity is greatest, giving maximum sensitivity, and $dA/d\lambda \approx 0$, so minor monochromator errors cause minimal change in absorbance. This yields the most reproducible assay. **Why the other options are wrong:**

- (A) At the peak transmittance is least and absorbance greatest, not the reverse.
- (B) Molar absorptivity is maximal at $\lambda_{max}$, not zero.
- (C) Beer's law still applies at the peak within the linear range.

**Final Answer:** Greatest, flattest absorptivity gives best sensitivity and reproducibility $\Rightarrow \boxed{\text{D}}$

**Answer: (D)** Go Back to Q114

## Q115.

**Solution**

**Concept — GC detectors:** the TCD compares the thermal conductivity of pure carrier gas with that of carrier gas plus eluate. **Reasoning:** As solutes elute, the thermal conductivity of the gas stream changes, altering the temperature/resistance of a heated filament. Because nearly every analyte differs in conductivity from the carrier gas, the TCD is universal (though less sensitive than the FID) and is non-destructive. **Why the other options are wrong:**

- (A) The FID measures ions from a hydrogen flame and responds mainly to organics, not by conductivity.
- (C) The ECD is selective for electron-capturing (e.g. halogenated) species, not universal.
- (D) The RID is a liquid-chromatography detector, not used in GC.

**Final Answer:** Thermal conductivity detector (TCD) $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q115

## Q116.

**Solution**

**Concept — Stokes shift:** energy lost between absorption and emission shifts fluorescence to longer wavelength. **Reasoning:** After excitation, the molecule loses some energy by vibrational relaxation before emitting, so the emitted photon is of lower energy (longer wavelength) than the absorbed one. The gap between excitation and emission maxima is the Stokes shift. **Why the other options are wrong:**

- (A) Bathochromic shift describes a structural effect on absorption $\lambda_{max}$, not the excitation–emission gap.
- (B) An isosbestic point is a crossover wavelength in absorption spectra of interconverting species.
- (D) Hyperchromic effect refers to increased intensity, not a wavelength shift.

**Final Answer:** Stokes shift $\Rightarrow \boxed{\text{C}}$

**Answer: (C)** Go Back to Q116

## Q117.

**Solution**

**Concept — Normality from molarity:** $N = M\times$ (electrons exchanged per mole). **Reasoning:** In acid medium $\text{MnO}_4^-$ gains 5 electrons (Mn(VII) $\rightarrow$ Mn(II)), so the equivalence factor is 5. Thus $N = 0.020 \times 5 = 0.10$ N. **Why the other options are wrong:**

- (B) 0.020 N treats it as a 1-electron change.
- (C) 0.004 divides instead of multiplying by 5.
- (D) 0.25 uses an incorrect factor.

**Final Answer:** $N = 0.020 \times 5 = 0.10\text{ N} \Rightarrow \boxed{\text{A}}$

**Answer: (A)** Go Back to Q117

## Q118.

**Solution**

**Concept — HPLC flow path:** reservoir → pump → injector → column → detector. **Reasoning:** The component between the reservoir and the injector that delivers the mobile phase at high, constant pressure is the solvent-delivery pump. A steady, pulse-free flow is essential for reproducible retention times. **Why the other options are wrong:**

- (A) The detector sits after the column.
- (C) The recorder follows the detector.
- (D) A fraction collector is used after the detector in preparative work.

**Final Answer:** P is the high-pressure pump $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q118

## Q119.

**Solution**

**Concept — Size-exclusion elution order:** large molecules cannot enter the pores and pass through quickly. **Reasoning:** A very large molecule is excluded from the stationary-phase pores, so it travels only through the interstitial (void) volume and elutes first, at the void (exclusion) volume. Smaller molecules sample the pore volume and elute later. **Why the other options are wrong:**

- (A) Total permeation volume is where the smallest molecules elute last.
- (B) SEC separates by size, not net charge.
- (D) The largest molecule elutes well before the smallest, not at the same volume.

**Final Answer:** Elutes at the void (exclusion) volume, first $\Rightarrow \boxed{\text{C}}$

**Answer: (C)** Go Back to Q119

## Q120.

### Solution

**Concept — van Deemter curve:** $H$ versus $u$ passes through a minimum at the optimum flow velocity. **Reasoning:** The minimum of the van Deemter plot is where the plate height $H$ is smallest; since efficiency $N = L/H$, the smallest $H$ gives the largest plate number and the best separation efficiency. This identifies the optimum mobile-phase velocity. **Why the other options are wrong:**

- (A) Back-pressure rises with velocity but is not what the curve minimum represents.
- (B) Resolution is best, not lost, near the minimum $H$.
- (C) The minimum is where $H$ is smallest and efficiency is highest, not poorest.

**Final Answer:** Smallest $H$, greatest efficiency $\Rightarrow \boxed{\text{D}}$

**Answer: (D)** Go Back to Q120

## Q121.

### Solution

**Concept — Potentiometric cell:** a measurable cell potential needs an indicator electrode and a reference electrode of fixed potential. **Reasoning:** The glass electrode's potential responds to $H^+$ activity, but only the difference against a stable reference can be read. A calomel (or Ag/AgCl) reference electrode supplies the constant potential against which the glass-electrode potential is measured to give pH. **Why the other options are wrong:**

- (B) Two glass electrodes give no fixed reference.
- (C) A dropping-mercury electrode is for polarography, not pH reference.
- (D) A platinum gauze electrode is an inert redox electrode, not a fixed-

potential reference.

**Final Answer:** Constant-potential reference electrode (calomel or Ag/AgCl) ⇒ $\boxed{\text{A}}$

**Answer: (A)** Go Back to Q121

## Q122.

**Solution**

**Concept — Robustness (ICH Q2):** insensitivity to small, deliberate method changes. **Reasoning:** Robustness is the measure of a method's ability to remain unaffected by small, deliberate variations in parameters such as mobile-phase pH, flow rate, or column temperature, indicating reliability during normal use. **Why the other options are wrong:**

- (A) Specificity is the ability to measure the analyte amid interferents.
- (C) Accuracy is closeness to the true value.
- (D) Limit of detection is the lowest detectable amount, a different parameter.

**Final Answer:** Robustness ⇒ $\boxed{\text{B}}$

**Answer: (B)** Go Back to Q122

## Q123.

**Solution**

**Concept — Morphological classification:** Crude drugs are arranged according to the morphological (plant) part used, such as leaves, barks, roots and rhizomes, seeds, flowers and so on, irrespective of chemistry or therapeutics. **Reasoning:** Grouping by the part of the plant employed (leaf, bark, root, seed) is the defining feature of morphological classification, which is the basis described here. **Why the other options are wrong:**

- (A) Chemical grouping is by constituent class.
- (B) Taxonomical grouping is by botanical family/genus.
- (C) Pharmacological grouping is by therapeutic action.

**Final Answer:** Grouping by plant part is morphological classification ⇒ $\boxed{\text{D}}$

**Answer: (D)** Go Back to Q123

## Q124.

### Solution

**Concept — Taxonomical classification:** Drugs are grouped by their botanical position (family, genus, species) following the natural plant taxonomy. **Reasoning:**

*Datura*, *Hyoscyamus* and *Atropa* are grouped together purely because all belong to the family Solanaceae, which is a taxonomical (botanical) basis. **Why the other options are wrong:**

- (B) Morphological grouping is by plant part.
- (C) Chemical grouping is by constituent class (though all happen to give tropanes, the stated basis is the family).
- (D) Alphabetical grouping is by name order.

**Final Answer:** Grouping by botanical family is taxonomical classification $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q124

## Q125.

### Solution

**Concept — Organized animal drugs:** Organized drugs have a definite cellular structure; among animal-origin drugs, an entire organism or organ with cellular tissue is organized, whereas secretions and oils are unorganized. **Reasoning:**

Cantharides is the dried whole blister beetle *Cantharis vesicatoria* and retains a cellular/structural body, so it is an organized drug of animal origin. **Why the other options are wrong:**

- (A) Beeswax is an unorganized secretory product.
- (C) Cod-liver oil is an unorganized fixed oil.
- (D) Shellac is an unorganized resinous insect secretion.

**Final Answer:** Cantharides (dried beetle) is an organized animal drug $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q125

## Q126.

**Solution**

**Concept — Hyoscyamus alkaloids:** *Hyoscyamus niger* (henbane, Solanaceae) yields tropane alkaloids, chiefly hyoscyamine with some hyoscine (scopolamine). **Reasoning:** Hyoscyamine, the laevorotatory ester that partly racemises to (±)-atropine during extraction, is the principal alkaloid of *Hyoscyamus niger*. **Why the other options are wrong:**

- (A) *Cinchona* yields quinine.
- (B) *Ephedra* yields ephedrine.
- (D) *Catharanthus* yields vinca alkaloids (vincristine/vinblastine).

**Final Answer:** Source is *Hyoscyamus niger* $\Rightarrow \boxed{\text{C}}$

**Answer: (C)** Go Back to Q126

## Q127.

**Solution**

**Concept — Nux vomica alkaloids:** The seeds of *Strychnos nux-vomica* contain the indole alkaloids strychnine and brucine. **Reasoning:** Strychnine is the more toxic principal alkaloid, a CNS stimulant that antagonises glycine at spinal inhibitory synapses, producing convulsions. **Why the other options are wrong:**

- (B) Reserpine is from *Rauwolfia*.
- (C) Quinine is from *Cinchona*.
- (D) Vincristine is from *Catharanthus*.

**Final Answer:** The principal alkaloid is strychnine $\Rightarrow \boxed{\text{A}}$

**Answer: (A)** Go Back to Q127

## Q128.

**Solution**

**Concept — Ipecacuanha alkaloids:** The rhizome and roots of *Cephaelis ipecacuanha* contain isoquinoline alkaloids, chiefly emetine and cephaeline. **Reasoning:** Emetine is the chief alkaloid, used as an amoebicide and formerly as an emetic and expectorant. **Why the other options are wrong:**

- (A) Berberine is from *Berberis*.

- (C) Colchicine is from *Colchicum*.
- (D) Caffeine is a purine alkaloid from tea/coffee.

**Final Answer:** The chief alkaloid of ipecac is emetine $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q128

## Q129.

### Solution

**Concept — Alkaloid precipitating reagents:** Mayer's reagent is potassium mercuric iodide and gives a cream/white precipitate; Dragendorff's (potassium bismuth iodide) gives orange-brown; Wagner's (iodine in KI) gives reddish-brown. **Reasoning:** A cream-coloured precipitate produced by potassium mercuric iodide is the positive Mayer's test for alkaloids such as berberine. **Why the other options are wrong:**

- (A) Dragendorff's gives an orange-brown precipitate.
- (B) Bornträger's detects anthraquinones, not alkaloids.
- (D) Wagner's gives a reddish-brown precipitate.

**Final Answer:** Cream precipitate with KHgI is Mayer's test $\Rightarrow \boxed{\text{C}}$

**Answer: (C)** Go Back to Q129

## Q130.

### Solution

**Concept — Sclereids (stone cells):** Sclereids are heavily lignified sclerenchymatous cells with thick walls, narrow lumen and branched pit-canals; the isodiametric type is a brachysclereid or stone cell. **Reasoning:** The sketch shows a roughly isodiametric, thick-walled lignified cell with a narrow lumen and radiating branched pit-canals, which is the diagnostic stone cell (sclereid) seen in *Cinchona* bark and pear fruit. **Why the other options are wrong:**

- (A) Trichomes are surface hairs, not thick stone cells.
- (B) Vessel elements are elongated conducting tubes.
- (C) Phloem fibres are long, narrow, pointed sclerenchyma, not isodiametric.

**Final Answer:** The thick-walled pitted cell is a sclereid (stone cell) $\Rightarrow \boxed{\text{D}}$

**Answer: (D)** Go Back to Q130

## Q131.

### Solution

**Concept — Keller–Kiliani test:** This test detects 2-deoxy sugars (such as digitoxose) of cardiac glycosides, giving a blue colour in the glacial acetic acid layer and a reddish-brown ring at the junction with concentrated sulphuric acid. **Reasoning:** Digoxin from *Digitalis lanata* carries 2,6-dideoxy sugars; the Keller–Kiliani reaction confirms these deoxy-sugars by the characteristic blue acetic-acid layer and interface ring. **Why the other options are wrong:**

- (B) Bornträger's detects anthraquinones.
- (C) Molisch's is a general carbohydrate test.
- (D) Liebermann–Burchard detects sterols/triterpenes generally, not the deoxy-sugar specifically.

**Final Answer:** Deoxy-sugars are detected by the Keller–Kiliani test $\Rightarrow \boxed{\text{A}}$

$\boxed{\text{Answer: (A)}}$ Go Back to Q131

## Q132.

### Solution

**Concept — Aloe C-glycosides:** The dried drug juice of *Aloe* species contains anthrone C-glycosides, the chief being barbaloin (aloin), an aloe-emodin anthrone joined to glucose by a stable C-glycosidic bond. **Reasoning:** The schematic shows an anthrone aglycone C-linked to glucose, which is barbaloin (aloin), the principal purgative C-glycoside of aloe. **Why the other options are wrong:**

- (A) Sennoside A is a dianthrone O-glycoside of senna.
- (C) Glycyrrhizin is a triterpenoid saponin of liquorice.
- (D) Digitoxin is a cardiac glycoside of *Digitalis*.

**Final Answer:** The aloe C-glycoside is barbaloin (aloin) $\Rightarrow \boxed{\text{B}}$

$\boxed{\text{Answer: (B)}}$ Go Back to Q132

## Q133.

**Solution**

**Concept — Glycyrrhizin:** Glycyrrhizin is a saponin glycoside, the salt of glycyrrhizic acid, whose aglycone is glycyrrhetinic acid. **Reasoning:** On hydrolysis glycyrrhizic acid yields one molecule of glycyrrhetinic acid and two molecules of D-glucuronic acid, accounting for its acidic, sweet character. **Why the other options are wrong:**

- (A) Galactose is not the sugar of glycyrrhizin.
- (B) Rhamnose is not released here.
- (D) Fructose is not a hydrolysis product.

**Final Answer:** It yields two molecules of D-glucuronic acid ⇒ $\boxed{\text{C}}$

$\boxed{\textbf{Answer: (C)}}$ **Go Back to Q133**

## Q134.

**Solution**

**Concept — Glucosinolates:** Black mustard contains sinigrin, a glucosinolate that is hydrolysed by the seed enzyme myrosinase on wetting. **Reasoning:** Myrosinase cleaves sinigrin to glucose, sulphate and the pungent volatile allyl isothiocyanate (volatile oil of mustard), responsible for the rubefacient action. **Why the other options are wrong:**

- (A) Eugenol is from clove.
- (B) Anethole is from anise/fennel.
- (C) Sennoside is an anthraquinone glycoside of senna.

**Final Answer:** Sinigrin liberates allyl isothiocyanate ⇒ $\boxed{\text{D}}$

$\boxed{\textbf{Answer: (D)}}$ **Go Back to Q134**

## Q135.

**Solution**

**Concept — Coriander oil:** The volatile oil from *Coriandrum sativum* fruit is dominated by the monoterpene alcohol linalool (also called coriandrol). **Reasoning:** Linalool makes up roughly 60–70% of coriander oil and is its chief constituent, giving the carminative and flavouring properties. **Why the other options are**

**wrong:**

- (B) Eugenol is the chief constituent of clove oil.
- (C) Thymol is from thyme/ajowan.
- (D) Cinnamaldehyde is from cinnamon bark.

**Final Answer:** Chief constituent of coriander oil is linalool $\Rightarrow \boxed{\text{A}}$

**Answer: (A)** Go Back to Q135

## Q136.

### Solution

**Concept — Caraway oil:** Caraway fruit (*Carum carvi*) yields a volatile oil rich in the monoterpene ketone carvone (with limonene). **Reasoning:** Carvone (the d-isomer) is the chief constituent responsible for the characteristic odour and carminative action of caraway oil. **Why the other options are wrong:**

- (A) Menthol is from peppermint.
- (C) Citral is from lemongrass.
- (D) Borneol is a bicyclic monoterpene alcohol, not the chief constituent of caraway.

**Final Answer:** Chief constituent of caraway oil is carvone $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q136

## Q137.

### Solution

**Concept — Exudate classification:** Oleo-gum-resins contain volatile oil, gum and resin together; gums are carbohydrate exudates that swell or dissolve in water; oleoresins lack a gum fraction. **Reasoning:** Myrrh (*Commiphora molmol*) and guggul (*Commiphora wightii*) are oleo-gum-resins, while karaya (*Sterculia urens*) is a gum exudate that swells in water to a stiff gel rather than dissolving. **Why the other options are wrong:**

- (A) Karaya is a gum (carbohydrate), not a pure oleoresin.
- (B) Myrrh is an oleo-gum-resin and does not dissolve completely in water.
- (C) Guggul does contain a resin fraction (guggulsterones).

**Final Answer:** Myrrh and guggul are oleo-gum-resins; karaya is a swelling gum

$\Rightarrow \boxed{D}$

**Answer: (D)** Go Back to Q137

## Q138.

### Solution

**Concept — Acetate–mevalonate pathway:** Three acetyl-CoA units condense to HMG-CoA, which is reduced to mevalonic acid and converted to the C5 isoprene unit IPP. **Reasoning:** IPP and DMAPP are the universal building blocks of terpenoids and steroids; the scheme therefore depicts the acetate–mevalonate pathway giving terpenoids and steroids. **Why the other options are wrong:**

- (A) Shikimate yields aromatic amino acids, not isoprenoids.
- (B) Acetate–malonate yields fatty acids and polyketides.
- (D) Pentose phosphate yields sugars/NADPH.

**Final Answer:** It is the acetate–mevalonate pathway giving terpenoids $\Rightarrow \boxed{C}$

**Answer: (C)** Go Back to Q138

## Q139.

### Solution

**Concept — Shikimic acid pathway:** Erythrose-4-phosphate and phosphoenolpyruvate condense and proceed through shikimic acid and chorismate to the aromatic amino acids phenylalanine, tyrosine and tryptophan. **Reasoning:** From Phe/Tyr arise the phenylpropanoid (C6–C3) units that build coumarins, lignans and flavonoids, so the scheme is the shikimic acid pathway. **Why the other options are wrong:**

- (B) Acetate–mevalonate gives terpenoids.
- (C) Acetate–malonate gives fatty acids and polyketide phenols.
- (D) The glyoxylate cycle is a variant of the TCA cycle, not this aromatic route.

**Final Answer:** It is the shikimic acid pathway $\Rightarrow \boxed{A}$

**Answer: (A)** Go Back to Q139

## Q140.

**Solution**

**Concept — Extractive values:** Extractive values measure the amount of drug constituents soluble in a specified solvent (water-soluble, alcohol-soluble, ether-soluble extractives) and indicate quality where no chemical assay exists. **Reasoning:** Determining the percentage of matter extractable by water, alcohol or ether is the extractive value, a standardisation parameter useful for detecting exhausted or adulterated drugs. **Why the other options are wrong:**

- (B) Acid-insoluble ash measures siliceous contamination.
- (C) Foreign organic matter is unwanted material separated by inspection.
- (D) Loss on drying measures moisture/volatile content.

**Final Answer:** The solvent-extractable percentage is the extractive value $\Rightarrow \boxed{A}$

$\boxed{\text{Answer: (A)}}$ Go Back to Q140

## Q141.

**Solution**

**Concept — Supercritical fluid extraction:** Above its critical point (about 31 °C, 74 bar) carbon dioxide behaves as a tunable solvent with gas-like diffusivity and liquid-like density, leaving no residue on depressurisation. **Reasoning:** Supercritical $CO_2$ extraction is a green, low-temperature method ideal for thermolabile volatile oils and oleoresins, giving solvent-free extracts. **Why the other options are wrong:**

- (A) Soxhlet uses hot organic solvent, risking thermal damage and residue.
- (C) Cold maceration leaves solvent and is inefficient.
- (D) Steam distillation can degrade thermolabile components and gives only volatile fractions.

**Final Answer:** The method is supercritical fluid ($CO_2$) extraction $\Rightarrow \boxed{B}$

$\boxed{\text{Answer: (B)}}$ Go Back to Q141

## Q142.

### Solution

**Concept — Retardation factor ($R_f$):** $R_f$ is the ratio of the distance moved by the solute to the distance moved by the solvent front, both measured from the baseline. **Reasoning:** Here $R_f = d/D = 1.8/4.0 = 0.45$. The value is dimensionless and lies between 0 and 1, as required. **Why the other options are wrong:**

- (A) 0.72 does not match the given distances.
- (B) 2.22 is $D/d$ (the inverse) and exceeds 1, impossible.
- (D) 0.18 misplaces the decimal.

**Final Answer:** $R_f = 1.8/4.0 = 0.45 \Rightarrow \boxed{\text{C}}$

**Answer: (C)** Go Back to Q142

## Q143.

### Solution

**Concept — Recognition-site length and cut frequency:** A restriction site of $n$ specific bases occurs on average once every $4^n$ base pairs in random DNA, so shorter sites are cut far more often. **Reasoning:** *Sau*3AI recognises a 4-base site (GATC), expected once every $4^4 = 256$ bp, whereas a 6-base cutter like *Bam*HI cuts about once every $4^6 = 4096$ bp. The four-base cutter therefore fragments DNA into many more, smaller pieces. **Why the other options are wrong:**

- (A) Shorter sites are more, not less, frequent.
- (C) Frequency depends on site length, so it is not the same.
- (D) *Sau*3AI cutting is blocked by Dam methylation, but it does not cut only at methylated sites.

**Final Answer:** A 4-base cutter cuts about every 256 bp, more often $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q143

## Q144.

### Solution

**Concept — Choosing a vector by insert size:** Plasmids carry a few kb, phage $\lambda$ up to ~20 kb, cosmids 30–45 kb, and BAC/YAC even larger. The *cos* sites allow *in vitro* $\lambda$ packaging of large inserts. **Reasoning:** A cosmid is a plasmid that also contains $\lambda$ *cos* sequences. After ligation it is packaged into phage heads (which select for ∼40 kb of DNA between *cos* sites) and injected into *E. coli*, where it replicates as a plasmid. This matches the 40 kb requirement. **Why the other options are wrong:**

- (A) pUC18 accepts only a few kb.
- (B) M13 is for single-stranded DNA and small inserts.
- (D) A T7 expression plasmid is for protein expression, not 40 kb genomic clones.

**Final Answer:** A cosmid accepts 30–45 kb inserts $\Rightarrow \boxed{\text{C}}$

**Answer: (C)** Go Back to Q144

## Q145.

### Solution

**Concept — cDNA synthesis:** Reverse transcriptase is an RNA-dependent DNA polymerase that copies mRNA into complementary DNA (cDNA), which lacks introns. **Reasoning:** To express a human protein such as tPA in bacteria or mammalian cells, the intron-free coding sequence is needed. Reverse transcriptase synthesises a cDNA strand on the mature mRNA template; this cDNA is then cloned and expressed. **Why the other options are wrong:**

- (A) DNA ligase joins DNA ends, it does not copy RNA.
- (B) Taq polymerase uses a DNA, not RNA, template.
- (C) Alkaline phosphatase removes 5′-phosphates, an unrelated job.

**Final Answer:** cDNA is made from mRNA by reverse transcriptase $\Rightarrow \boxed{\text{D}}$

**Answer: (D)** Go Back to Q145

## Q146.

### Solution

**Concept — Recombinant therapeutic proteins:** Many drugs are now made by rDNA technology; each has a defined clinical indication tied to the natural function of the protein. **Reasoning:** Recombinant Factor VIII replaces the clotting factor missing in haemophilia A, removing the infection risk of plasma-derived concentrates. This pairing is correct. **Why the other options are wrong:**

- (B) Somatostatin inhibits growth-hormone/GI-hormone release; thrombolysis is the role of tPA/streptokinase.
- (C) Interferon-$\alpha$ is antiviral/antitumour; type 1 diabetes needs recombinant insulin.
- (D) Erythropoietin stimulates red-cell production; fat digestion is the role of lipase.

**Final Answer:** Recombinant Factor VIII treats haemophilia A $\Rightarrow \boxed{\text{A}}$

**Answer: (A)** Go Back to Q146

## Q147.

### Solution

**Concept — Real-time (quantitative) PCR:** qPCR follows amplification cycle by cycle using a fluorescent reporter, so the starting template amount can be quantified from the cycle threshold ($C_t$). **Reasoning:** A DNA-binding dye (e.g. SYBR Green) or a sequence-specific fluorogenic probe (e.g. TaqMan) emits light in proportion to the product made each cycle. A detector reads this fluorescence in real time, removing the need for end-point gels. **Why the other options are wrong:**

- (A) An end-point gel is conventional PCR, not real-time.
- (C) Mass change is far too small to weigh.
- (D) Manual sequencing does not give per-cycle quantitation.

**Final Answer:** Fluorescence monitored each cycle reports product accumulation $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q147

## Q148.

### Solution

**Concept — Fermentation modes:** In batch all nutrients are added at once; in continuous culture medium flows in and broth out; in fed-batch substrate is added gradually with no withdrawal until harvest. **Reasoning:** Feeding glucose slowly keeps its concentration low, which avoids the Crabtree (overflow) effect in yeast and prevents catabolite repression of antibiotic synthesis. Nothing is removed during the run, so biomass and product accumulate to high levels. This is fed-batch culture. **Why the other options are wrong:**

- (A) Batch adds all substrate initially, allowing excess.
- (B) Continuous culture removes broth at the feed rate.
- (D) Solid-state fermentation uses a moist solid substrate, not controlled liquid feeding.

**Final Answer:** Gradual nutrient feeding without withdrawal is fed-batch $\Rightarrow \boxed{\text{C}}$

**Answer: (C)** Go Back to Q148

## Q149.

### Solution

**Concept — Downstream processing:** The operations that recover and purify a product after fermentation, separation of cells, concentration, purification, and final polishing, constitute downstream processing. **Reasoning:** For a secreted

protein the broth is clarified (centrifugation/filtration to remove cells), the product is concentrated (e.g. ultrafiltration), purified (chromatography), and polished to pharmacopoeial purity. All of these post-fermentation steps are downstream processing. **Why the other options are wrong:**

- (A) Inoculum development precedes fermentation.
- (B) Media formulation is an upstream step.
- (C) Strain improvement is an upstream genetic/selection activity.

**Final Answer:** Post-fermentation recovery and purification is downstream processing $\Rightarrow \boxed{\text{D}}$

**Answer: (D)** Go Back to Q149

## Q150.

### Solution

**Concept — Chemostat steady state:** In a continuous stirred-tank culture the dilution rate $D = F/V$ (flow per volume) sets the growth rate. At steady state cell concentration is constant. **Reasoning:** The rate of change of biomass is $\frac{dx}{dt} = (\mu - D)x$. At steady state $dx/dt = 0$ with $x \neq 0$, so $\mu = D$. The operator thus controls the organism's specific growth rate simply by setting the medium flow rate. **Why the other options are wrong:**

- (B) Zero growth would wash out the culture only above $D_{crit}$.
- (C) There is no factor of two in the steady-state balance.

- (D) $\mu$ is precisely controlled by $D$, not independent of it.

**Final Answer:** At chemostat steady state $\mu = D \Rightarrow \boxed{\text{A}}$

**Answer: (A)** **Go Back to Q150**

## Q151.

### Solution

**Concept — Lineweaver–Burk plot:** Taking reciprocals of the Michaelis–Menten equation gives $\frac{1}{v} = \frac{K_m}{V_{max}} \cdot \frac{1}{[\text{S}]} + \frac{1}{V_{max}}$, a straight line. **Reasoning:** The $y$-intercept is $1/\text{V}_{max}$ and the $x$-intercept (where $1/v = 0$) is $-1/\text{K}_m$. Reading the horizontal-axis intercept in the figure therefore gives $-1/\text{K}_m$, from which $\text{K}_m$ is obtained. **Why the other options are wrong:**

- (A) $1/\text{V}_{max}$ is the vertical-axis intercept, not the horizontal one.
- (C) The intercept gives $-1/\text{K}_m$, not $\text{K}_m$ itself.
- (D) $-\text{V}_{max}$ is not a feature of this plot.

**Final Answer:** The $1/[\text{S}]$-axis intercept is $-1/\text{K}_m \Rightarrow \boxed{\text{B}}$

**Answer: (B)** **Go Back to Q151**

## Q152.

### Solution

**Concept — Non-competitive inhibition:** The inhibitor binds an allosteric site on both E and ES with equal affinity, lowering the amount of active enzyme. Adding substrate cannot displace it. **Reasoning:** Because the inhibitor does not compete at the active site, raising [S] gives no relief, so $\text{V}_{max}$ falls. Substrate binding itself is unaffected, so $\text{K}_m$ stays the same. This is the classic non-competitive pattern. **Why the other options are wrong:**

- (A) Competitive inhibition is reversed by excess substrate and raises $\text{K}_m$.
- (B) Uncompetitive inhibitors bind only ES and lower both $\text{K}_m$ and $\text{V}_{max}$.
- (D) Suicide inhibition is irreversible covalent inactivation, not this reversible case.

**Final Answer:** $\text{V}_{max}$ lowered, $\text{K}_m$ unchanged is non-competitive inhibition $\Rightarrow \boxed{\text{C}}$

**Answer: (C)** **Go Back to Q152**

## Q153.

### Solution

**Concept — ELISA detection:** The enzyme-linked immunosorbent assay uses an enzyme label (e.g. horseradish peroxidase or alkaline phosphatase) on the detection antibody to convert a colourless substrate into a coloured product. **Reasoning:** In a sandwich ELISA the antigen is captured between a coated antibody and an enzyme-conjugated detection antibody. Adding the chromogenic substrate produces colour whose intensity is proportional to antigen concentration, read in a microplate reader. **Why the other options are wrong:**

- (A) Visual agglutination is a different, semi-quantitative test.
- (B) Gel precipitation describes immunodiffusion, not ELISA.
- (C) Radioactivity is the basis of radioimmunoassay, not ELISA.

**Final Answer:** An enzyme-conjugated antibody acting on a chromogenic substrate gives the ELISA signal $\Rightarrow \boxed{\text{D}}$

**Answer: (D)** Go Back to Q153

## Q154.

### Solution

**Concept — Secretory immunoglobulin:** IgA is the dominant antibody in external secretions, where it occurs as a dimer linked by a J chain and protected by a secretory component. **Reasoning:** Secretory IgA coats mucosal surfaces of the gut, respiratory tract, and glandular secretions (saliva, tears, colostrum), neutralising pathogens before they invade. The secretory component shields it from proteolysis in these harsh environments. **Why the other options are wrong:**

- (B) IgG dominates serum and the secondary response, not secretions.
- (C) IgM is the pentameric first-response antibody in blood.
- (D) IgD is a membrane receptor on naive B cells, present in trace amounts.

**Final Answer:** The secretory mucosal antibody is IgA $\Rightarrow \boxed{\text{A}}$

**Answer: (A)** Go Back to Q154

## Q155.

**Solution**

**Concept — Gell and Coombs hypersensitivity:** Type I is immediate IgE-mediated; Type II is antibody-mediated cytotoxic; Type III is immune-complex; Type IV is delayed T-cell-mediated. **Reasoning:** In penicillin anaphylaxis or hay fever, allergen cross-links IgE pre-bound to mast-cell Fc$\epsilon$ receptors, triggering rapid degranulation and histamine release within minutes. This immediate, IgE-driven reaction is Type I hypersensitivity. **Why the other options are wrong:**

- (A) Type II involves IgG/IgM against cell-surface antigens (e.g. transfusion reactions).
- (C) Type III is due to deposited antigen–antibody complexes (e.g. serum sickness).
- (D) Type IV is delayed and T-cell-mediated (e.g. tuberculin reaction, contact dermatitis).

**Final Answer:** Immediate IgE/mast-cell anaphylaxis is Type I $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q155

## Q156.

**Solution**

**Concept — Toxoid vaccines:** A toxoid is an exotoxin treated (e.g. with formaldehyde) to abolish toxicity while preserving the epitopes that elicit neutralising antibodies. **Reasoning:** Diphtheria and tetanus vaccines are toxoids: the inactivated toxin induces antitoxin antibodies that neutralise the natural toxin during infection. The description of chemical inactivation of an exotoxin defines a toxoid. **Why the other options are wrong:**

- (A) Live attenuated vaccines use weakened replicating organisms (e.g. BCG, MMR).
- (B) Killed whole-cell vaccines use inactivated whole organisms, not just the toxin.
- (D) Conjugate vaccines link a polysaccharide to a carrier protein.

**Final Answer:** An inactivated exotoxin used as antigen is a toxoid vaccine $\Rightarrow \boxed{\text{C}}$

**Answer: (C)** Go Back to Q156

## Q157.

**Solution**

**Concept — Phases of the growth curve:** Lag (P), log/exponential (Q), stationary (R), and death/decline (S). Secondary metabolites accumulate mainly in the stationary phase (idiophase). **Reasoning:** In the stationary phase (Phase R, the plateau) nutrient depletion and waste accumulation balance division against death, so the viable count is constant. Nutrient limitation here switches on secondary pathways, making this the main phase for antibiotic production. **Why the other options are wrong:**

- (A) Phase P (lag) is adaptation with little division.
- (B) Phase Q (log) is rapid growth, producing mainly primary metabolites.
- (C) Phase S (death) shows falling viable counts.

**Final Answer:** The plateau where antibiotics are made is the stationary phase, Phase R $\Rightarrow \boxed{\text{D}}$

**Answer: (D)** Go Back to Q157

## Q158.

**Solution**

**Concept — Radiation sterilization:** Gamma rays from a cobalt-60 source are highly penetrating ionising radiation that sterilises pre-packed heat-sensitive items at ambient temperature (a cold method). **Reasoning:** Disposable plastics deform on autoclaving, so industry sterilises them by $^{60}$Co gamma irradiation (typically $\sim$25 kGy). The rays penetrate the final sealed package, killing microbes without heat or moisture, giving a terminally sterilised product. **Why the other options are wrong:**

- (B) Autoclaving melts or warps many plastics.
- (C) Boiling does not reliably kill spores and wets the item.
- (D) Pasteurisation only reduces vegetative bacteria; it does not sterilise.

**Final Answer:** Plastics are sterilised industrially by cobalt-60 gamma radiation $\Rightarrow \boxed{\text{A}}$

**Answer: (A)** Go Back to Q158

## Q159.

**Solution**

**Concept — Phenol coefficient:** It is the ratio of the highest dilution of a test disinfectant that kills a test organism in a set time to the corresponding killing dilution of phenol under identical conditions. **Reasoning:** If the disinfectant kills at a higher dilution than phenol, its ratio exceeds 1, meaning it is **more** effective than phenol. A coefficient of exactly 1 means equal potency, and less than 1 means weaker than phenol. **Why the other options are wrong:**

- (A) Less effective corresponds to a coefficient below 1.
- (C) Equal effectiveness gives a coefficient of exactly 1.
- (D) The phenol coefficient measures bactericidal potency against vegetative cells, not sporicidal (sterilant) activity.

**Final Answer:** A phenol coefficient $> 1$ means more effective than phenol $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q159

## Q160.

**Solution**

**Concept — Agar diffusion (cup-plate) assay:** An antibiotic diffuses from a cup into seeded agar, inhibiting growth around it; the zone diameter increases with potency and is compared against a reference standard. **Reasoning:** The test organism is uniformly seeded in the agar, sample and standard solutions are placed in cups, and after incubation the clear zones of inhibition are measured. Potency is read from a standard dose–response (zone vs log concentration) line. **Why the other options are wrong:**

- (A) Single 24 h turbidity without a standard is the turbidimetric method, and used alone it is not the cup-plate readout.
- (B) A pH indicator colour change is not the basis of this diffusion assay.
- (D) Counting colonies on a streak plate measures viable count, not antibiotic potency.

**Final Answer:** Potency is read from the inhibition-zone diameter versus a standard $\Rightarrow \boxed{\text{C}}$

**Answer: (C)** Go Back to Q160

# Answer Key

| Q | Ans | Q | Ans | Q | Ans | Q | Ans | Q | Ans |
|---|---|---|---|---|---|---|---|---|---|
| 1 | C | 2 | B | 3 | A | 4 | D | 5 | B |
| 6 | C | 7 | A | 8 | D | 9 | B | 10 | C |
| 11 | D | 12 | A | 13 | B | 14 | C | 15 | D |
| 16 | A | 17 | B | 18 | C | 19 | D | 20 | A |
| 21 | B | 22 | C | 23 | D | 24 | A | 25 | B |
| 26 | C | 27 | D | 28 | A | 29 | B | 30 | C |
| 31 | D | 32 | A | 33 | B | 34 | C | 35 | B |
| 36 | C | 37 | D | 38 | A | 39 | B | 40 | C |
| 41 | D | 42 | A | 43 | B | 44 | C | 45 | D |
| 46 | A | 47 | B | 48 | C | 49 | D | 50 | A |
| 51 | B | 52 | C | 53 | D | 54 | A | 55 | B |
| 56 | C | 57 | D | 58 | A | 59 | B | 60 | C |
| 61 | D | 62 | A | 63 | B | 64 | C | 65 | D |
| 66 | A | 67 | B | 68 | C | 69 | C | 70 | D |
| 71 | A | 72 | A | 73 | C | 74 | D | 75 | B |
| 76 | A | 77 | C | 78 | D | 79 | A | 80 | B |
| 81 | C | 82 | D | 83 | A | 84 | B | 85 | A |
| 86 | D | 87 | B | 88 | C | 89 | A | 90 | D |
| 91 | B | 92 | C | 93 | A | 94 | D | 95 | B |
| 96 | C | 97 | D | 98 | B | 99 | B | 100 | D |
| 101 | A | 102 | C | 103 | B | 104 | D | 105 | C |
| 106 | A | 107 | B | 108 | C | 109 | D | 110 | A |
| 111 | B | 112 | C | 113 | A | 114 | D | 115 | B |
| 116 | C | 117 | A | 118 | B | 119 | C | 120 | D |
| 121 | A | 122 | B | 123 | D | 124 | A | 125 | B |
| 126 | C | 127 | A | 128 | B | 129 | C | 130 | D |
| 131 | A | 132 | B | 133 | C | 134 | D | 135 | A |
| 136 | B | 137 | D | 138 | C | 139 | A | 140 | A |
| 141 | B | 142 | C | 143 | B | 144 | C | 145 | D |
| 146 | A | 147 | B | 148 | C | 149 | D | 150 | A |
| 151 | B | 152 | C | 153 | D | 154 | A | 155 | B |
| 156 | C | 157 | D | 158 | A | 159 | B | 160 | C |