Q3

Desflurane requires a heated, pressurized vaporizer because:

- **A.** It is highly soluble in blood
- **B.** Its vapor pressure at room temperature is very high (669 mmHg)
- **C.** It decomposes in the presence of metal
- **D.** Its boiling point is below room temperature at sea level

Q4

In a circle breathing system, rebreathing of exhaled gas is prevented primarily by:

- **A.** Unidirectional (inspiratory/expiratory) valves
- **B.** The APL valve
- **C.** The fresh gas flow rate alone
- **D.** The reservoir bag

Q1

A full E-cylinder of oxygen reads 2000 psi at room temperature. Approximately how many liters of oxygen does it contain?

- **A.** 1100 L
- **B.** 660 L
- **C.** 300 L
- **D.** 1590 L

Q2

At 20°C, the saturated vapor pressure of isoflurane is 238 mmHg. What fraction of gas leaving an isoflurane vaporizing chamber is isoflurane vapor (barometric pressure 760 mmHg)?

- **A.** 44%
- **B.** 31%
- **C.** 16%
- **D.** 23%

A4: A
Unidirectional valves prevent rebreathing; FGF only matters if valves fail.

A3: B
Desflurane VP 669 mmHg at 20°C (near boiling); requires heated pressurized vaporizer to keep output constant.

A2: B
238/760 ≈ 31%.

A1: B
E-cylinder: full pressure ~2000 psi ≈ 660 L O2 (psi × 0.33 ≈ liters).

Q7

A patient with a pneumothorax under general anesthesia receives nitrous oxide. The most important concern is that N2O:

- **A.** Decreases the inspired oxygen concentration via the second gas effect
- **B.** Is combustible and supports combustion in the chest
- **C.** Is 35 times more soluble than nitrogen and diffuses into the air-filled space, expanding it
- **D.** Increases pulmonary vascular resistance and worsens the pneumothorax

Q8

Boyle's law states that at constant temperature:

- **A.** Pressure is inversely proportional to volume
- **B.** The total pressure of a gas mixture is the sum of partial pressures
- **C.** Volume is directly proportional to temperature
- **D.** Pressure is directly proportional to absolute temperature

Q5

During general anesthesia, the capnograph suddenly shows a flat line with an unchanged ventilator pressure waveform and the SpO2 beginning to fall. The most likely diagnosis is:

- **A.** Circuit disconnection or loss of sampling line
- **B.** Endobronchial intubation
- **C.** Bronchospasm
- **D.** Malignant hyperthermia

Q6

A "shark-fin" capnograph waveform with a prolonged upslope is most consistent with:

- **A.** Hyperventilation
- **B.** Pulmonary embolism
- **C.** Circuit leak
- **D.** Bronchospasm / obstructive lung disease

A8: A
Boyle: $P \propto 1/V$ at constant T. (B = Charles, C = Gay-Lussac, D = Dalton.)

A7: C
N_2O is ~35× more soluble than N_2; expands compliant air-filled spaces; avoid in pneumothorax, bowel obstruction, middle ear disease, retinal surgery bubbles.

A6: D
Obstruction (bronchospasm, ETT kink) prolongs upslope → shark fin.

A5: A
Sudden total loss of $EtCO_2$ with unchanged airway pressures → disconnection/sampling failure. (PE gives abrupt $EtCO_2$ drop but pressures change; bronchospasm changes waveform.)

Q11

Etomidate is favored in patients with cardiac disease because it is hemodynamically stable, but its major limiting side effect is:

- **A.** Histamine release
- **B.** Prolonged apnea
- **C.** Adrenocortical suppression (inhibition of 11β-hydroxylase)
- **D.** Pain on injection only

Q12

A patient with 40% TBSA burns sustained 2 days ago should NOT receive succinylcholine because:

- **A.** Burns prolong the duration of succinylcholine
- **B.** Upregulation of extrajunctional acetylcholine receptors can cause life-threatening hyperkalemia
- **C.** Succinylcholine is a trigger for malignant hyperthermia in burn patients only
- **D.** Burns cause hypersensitivity to succinylcholine

Q9

According to ASA fasting guidelines, a healthy patient may ingest clear liquids up to how long before elective anesthesia?

- **A.** 4 hours
- **B.** 6 hours
- **C.** 2 hours
- **D.** 1 hour

Q10

Which induction agent is most appropriate for a hemodynamically unstable patient in septic shock who needs rapid sequence intubation?

- **A.** Propofol 2 mg/kg
- **B.** Ketamine 1.5 mg/kg
- **C.** Midazolam 0.3 mg/kg
- **D.** Thiopental 4 mg/kg

A12: B
Burns/denervation/CRPS/immobility upregulate extrajunctional ACh receptors → severe hyperkalemia. Peak risk ~48 h to months.

A11: C
Etomidate inhibits 11β-hydroxylase → transient adrenal suppression; also myoclonus and pain on injection.

A10: B
Ketamine: sympathomimetic, maintains SVR/BP; avoid propofol/thiopental (vasodilation). (Caveat: in catecholamine-depleted myocardium ketamine can still drop BP.)

A9: C
2-4-6-8 rule: clear liquids 2 h, breast milk 4 h, light meal 6 h, fatty/fried/meat 8 h.

Q15

Remifentanil is unique among opioids because it is:

A. Excreted unchanged by the kidney

B. Highly lipid soluble with a long context-sensitive half-time

C. Metabolized by CYP3A4

D. Metabolized by nonspecific blood and tissue esterases, making its half-time independent of infusion duration

Q16

The maximum safe dose of plain lidocaine without epinephrine is approximately:

A. 7 mg/kg

B. 2 mg/kg

C. 9 mg/kg

D. 4–5 mg/kg

Q13

Rocuronium is reversed by sugammadex, which works by:

A. Selective binding/encapsulation of rocuronium in plasma

B. Calcium replacement

C. Inhibiting acetylcholinesterase

D. Blocking presynaptic calcium channels

Q14

Neostigmine reversal of nondepolarizing blockade can cause significant bradycardia because it:

A. Increases acetylcholine at muscarinic receptors

B. Stimulates nicotinic receptors

C. Causes histamine release

D. Blocks vagal afferents

A16: D
Plain lidocaine 4–5 mg/kg; with epinephrine ~7 mg/kg. (ASRA anti-infection guidance allows up to ~11.7 mg/kg with epi in some contexts, but classic board answer is 7.)

A15: D
Remifentanil: ester hydrolysis by nonspecific esterases; context-sensitive half-time ~3–4 min regardless of infusion length.

A14: A
Neostigmine increases ACh at both nicotinic AND muscarinic sites → bradycardia, salivation, GI motility; co-administer glycopyrrolate/atropine.

A13: A
Sugammadex is a modified γ-cyclodextrin that encapsulates aminosteroid NDMBs (rocuronium > vecuronium) in plasma.

Q19

Local anesthetics with a pKa close to physiologic pH (e.g., lidocaine, pKa 7.9) have:

A. Slower onset because more drug is ionized

B. Greater protein binding

C. Faster onset because a greater fraction is uncharged and crosses the nerve membrane

D. Longer duration

Q20

Which local anesthetic has the highest risk of fatal cardiotoxicity relative to its anesthetic potency?

A. Bupivacaine

B. Mepivacaine

C. Lidocaine

D. Chloroprocaine

Q17

Early signs of local anesthetic systemic toxicity (LAST) typically include:

A. Perioral numbness, tinnitus, agitation, and seizures

B. Wheezing and urticaria

C. Hypertension and bradycardia

D. Hyperthermia and rigidity

Q18

The first-line treatment for confirmed LAST after bupivacaine infiltration is:

A. Amiodarone 300 mg IV

B. 20% lipid emulsion 1.5 mL/kg IV bolus

C. Propofol infusion for seizure suppression

D. Epinephrine 1 mg IV bolus

A20: A
Bupivacaine binds cardiac Na channels avidly and dissociates slowly ("cardio:CN ratio"); use lipid emulsion; ropivacaine safer.

A19: C
Lower pKa (closer to pH 7.4) → more unionized (RNH+ ■ RN) fraction → faster membrane penetration and onset.

A18: B
20% lipid emulsion 1.5 mL/kg bolus over 1 min, then 0.25 mL/kg/min infusion. Avoid high-dose epinephrine (>1 mcg/kg) and vasopressin; propofol NOT a substitute.

A17: A
LAST prodrome: circumoral numbness, tinnitus, metallic taste, agitation, seizures; then CV collapse. IV route can present with CNS or CV signs first.

Q23

Ketamine is the induction agent of choice in an asthmatic because it:

A. Suppresses the hypothalamic-pituitary axis

B. Decreases airway secretions

C. Produces bronchodilation via sympathomimetic effects

D. Blocks histamine release

Q24

Dexmedetomidine provides sedation attractive for awake fiberoptic intubation because it:

A. Causes profound respiratory depression

B. Increases heart rate and blood pressure

C. Causes reliable amnesia

D. Provides sedation and analgesia with minimal respiratory depression

Q21

MAC (minimum alveolar concentration) is best described as:

A. The alveolar concentration that produces loss of consciousness in 95% of patients

B. The blood:gas partition coefficient

C. The concentration at which EEG burst suppression occurs

D. The alveolar concentration preventing movement in response to surgical stimulus in 50% of patients

Q22

Which factor INCREASES MAC?

A. Acute alcohol intoxication

B. Hyperthermia

C. Advanced age (>80)

D. Hypothermia

A24: D
Dexmedetomidine: α2 agonist, sedation+analgesia with minimal respiratory depression, BUT causes bradycardia/hypotension and poor amnesia.

A23: C
Ketamine causes bronchodilation (sympathetic stimulation + direct relaxation); increases secretions (give antisialagogue); useful in asthma, right-to-left shunts, hypovolemia.

A22: B
MAC ↑: hyperthermia, chronic EtOH/opioid use, hypernatremia, CNS stimulants, red hair. MAC ↓: hypothermia, acute EtOH, opioids, benzodiazepines, pregnancy, old age, hypoxia, hypercarbia, hypothyroid.

A21: D
MAC = alveolar concentration preventing movement to surgical stimulus in 50% of patients. MAC-awake ≈ 0.3–0.5 MAC; MAC-BAR ≈ 1.5–2 MAC.

Q27

A right-shifted oxyhemoglobin dissociation curve means:

A. Increased P50

B. Decreased affinity; oxygen unloads more readily at the tissue

C. B and C

D. Increased affinity of hemoglobin for oxygen; easier loading

Q28

In West's lung zones, blood flow is greatest in Zone 3 because:

A. Alveolar pressure exceeds arterial pressure

B. Pulmonary venous pressure exceeds alveolar pressure (Ppa > Ppv > PA)

C. Gravity is irrelevant in the upright lung

D. Pulmonary arterial pressure exceeds both alveolar and venous pressures

Q25

An otherwise healthy patient's room-air arterial blood gas shows PaO2 60 mmHg, PaCO2 32 mmHg, pH 7.48. A-a gradient is elevated. The most likely cause of hypoxemia is:

A. Low inspired FiO2

B. Increased cardiac output

C. Hypoventilation

D. V/Q mismatch or shunt

Q26

Which condition shifts the oxyhemoglobin dissociation curve to the LEFT?

A. Acidosis

B. Hyperthermia

C. Hypocapnia/alkalosis

D. Increased 2,3-DPG

A28: B
Zone 3: Ppa > Ppv > PA → continuous flow, greatest flow.
Zone 2: Ppa > PA > Ppv; Zone 1 (no flow): PA > Ppa > Ppv.

A27: C
Right shift = ↓ affinity = ↑ P50 = easier O2 unloading at tissues (slightly harder loading in lungs).

A26: C
LEFT shift: alkalosis, hypocapnia, hypothermia, ↓2,3-DPG, fetal Hb, CO poisoning.

A25: D
Hypoventilation (elevated PaCO2) and low FiO2 give NORMAL A-a gradient; patient is hypocapnic with normal FiO2 → elevated A-a gradient → V/Q mismatch/shunt/diffusion.

Q31

According to the Frank-Starling mechanism, increasing preload will:

A. Always decrease stroke volume

B. Decrease myocardial oxygen consumption

C. Only affect heart rate

D. Increase stroke volume until the plateau of the length-tension relationship is reached

Q32

Oculocardiac reflex is triggered by traction on extraocular muscles and is mediated by:

A. Vagal afferent → trigeminal efferent

B. Glossopharyngeal afferent → vagal efferent

C. Trigeminal (V1) afferent → vagal efferent

D. Facial afferent → glossopharyngeal efferent

Q29

The anatomic dead space in an adult is approximately:

A. 7 mL/kg

B. 2 mL/kg

C. 5 mL/kg

D. 1 mL/kg

Q30

In an elderly patient, closing volume exceeds FRC during tidal breathing. The physiologic consequence is:

A. Decreased work of breathing

B. Increased compliance

C. Improved oxygenation

D. Airway closure during normal tidal ventilation, causing increased A-a gradient and hypoxemia

A32: C
OCR: V1 afferent → ciliary ganglion → vagus efferent → bradycardia. Treat: stop stimulus, atropine/glycopyrrolate.

A31: D
Frank-Starling: ↑preload → ↑stroke volume up to plateau; beyond it, wall stress and O2 demand rise.

A30: D
When closing volume > FRC, airways close during tidal breathing → shunt-like units → hypoxemia, especially supine/anesthetized elderly.

A29: B
Anatomic dead space ~2 mL/kg (~150 mL in 70-kg adult).

Q35

The pulse oximeter reads 100% in a patient with severe carbon monoxide poisoning because:

A. CO-Hb reads as deoxyhemoglobin

B. CO-Hb absorbs light at the same wavelengths as oxyhemoglobin, so the device cannot distinguish them

C. CO increases blood flow to the finger

D. The probe cannot adhere to the skin

Q36

A patient with methemoglobinemia will typically show a pulse oximetry reading of:

A. ~70%

B. 50%

C. 100%

D. ~85%

Q33

A patient with a T4 sensory level spinal anesthetic develops profound hypotension and bradycardia. The bradycardia is best explained by:

A. Direct myocardial depression by local anesthetic

B. Bezold-Jarisch reflex only

C. Block of the cardioaccelerator fibers (T1–T4), leaving unopposed vagal tone

D. Vagal stimulation from visceral traction

Q34

Total oxygen content of arterial blood (CaO_2) is best calculated as:

A. $(0.003 \times Hb \times SaO_2) + (1.34 \times PaO_2)$

B. $1.34 \times Hb \times SaO_2$ only

C. $0.003 \times PaO_2$ only

D. $(1.34 \times Hb \times SaO_2) + (0.003 \times PaO_2)$

A36: D
Met-Hb absorbs equally at both wavelengths → reading locks at ~85% regardless of true SaO2.

A35: B
Conventional pulse oximetry uses 660/940 nm; CO-Hb mimics O2Hb at these wavelengths → falsely high SpO2. CO poisoning needs co-oximetry (ABG).

A34: D
CaO2 = (1.34 × Hb × SaO2) + (0.003 × PaO2). Normal ~20 mL/dL; dissolved O2 contribution is tiny.

A33: C
T1–T4 carry cardiac sympathetic accelerators; high neuraxial block leaves unopposed vagal tone → bradycardia + hypotension. Treat: ephedrine/epinephrine ± atropine.

Q39

In the CVP waveform, "cannon a waves" are seen with:

- **A.** Atrial fibrillation
- **B.** Tricuspid regurgitation
- **C.** Junctional rhythm / AV dissociation (right atrium contracts against a closed tricuspid valve)
- **D.** Cardiac tamponade

Q40

On a PA catheter, the normal wedge pressure closely approximates:

- **A.** Pulmonary arterial systolic pressure
- **B.** Right atrial pressure
- **C.** Left atrial pressure
- **D.** LV end-systolic pressure

Q37

NIBP cuff width should be approximately what fraction of limb circumference?

- **A.** 60%
- **B.** 80%
- **C.** 20%
- **D.** 40%

Q38

An over-damped arterial line waveform (slurred upstroke, absent dicrotic notch, prolonged flush test) is most commonly caused by:

- **A.** Air bubble or clot in the tubing, kinked catheter, or excessive tubing length/compliance
- **B.** Tachycardia
- **C.** Catheter whip
- **D.** Transducer placed below the phlebostatic axis

A40: C
PCWP ≈ LA pressure (via occluded branch PA, a static column of blood). Normal 8–12 mmHg.

A39: C
Cannon a waves = RA contracts against closed tricuspid valve (junctional rhythm, AV block, ventricular pacing). Absent a waves = AF. Giant v waves = TR/tamponade.

A38: A
Overdamping: air/clot in transducer or tubing, kink, excess tubing. Underdamping (catheter whip, long stiff tubing) → overshoot/artifactual systolic hypertension. Fast-flush test: overdamped = slurred, slow return.

A37: D
Cuff width ~40% of limb circumference; too narrow → falsely HIGH, too wide → falsely LOW.

Q43

A patient becomes hypotensive and bronchospastic 10 minutes after cefazolin administration. Urticaria appears. Most appropriate immediate treatment is:

- **A.** Epinephrine IM/IV per severity, stop the suspected agent, fluids, supportive care
- **B.** Diphenhydramine 50 mg IV alone
- **C.** Hydrocortisone 200 mg IV alone
- **D.** Albuterol inhaler only

Q44

Which is TRUE about magnesium sulfate therapy for preeclampsia?

- **A.** It prevents/treats eclamptic seizures; toxicity causes loss of deep tendon reflexes, respiratory depression, and treat with calcium gluconate
- **B.** It is contraindicated with neuraxial anesthesia
- **C.** It is an antihypertensive
- **D.** Its antidote is dantrolene

Q41

During general anesthesia with volatile agent, a patient's temperature rises to 39.5°C with EtCO2 68 mmHg, tachycardia, and masseter rigidity. First-line drug treatment is:

- **A.** Dantrolene 2.5 mg/kg IV
- **B.** Sodium bicarbonate 1 mEq/kg
- **C.** Acetaminophen 1000 mg
- **D.** Procainamide

Q42

During an MH crisis, which actions are correct? (Select the single BEST answer)

- **A.** Continue volatile anesthetic but switch to desflurane
- **B.** Stop triggering agents and observe for 30 minutes before treating
- **C.** Stop triggering agents, call for help, call MHAUS hotline, hyperventilate with 100% O2, dantrolene, cool if temp >39°C
- **D.** Give succinylcholine to relax masseter rigidity

A44: A

MgSO4 prevents/treats eclamptic seizures (not an antihypertensive). Toxicity sequence: DTR loss → respiratory depression → cardiac arrest. Antidote: calcium gluconate 1 g. Prolongs and potentiates NDMBs.

A43: A

Anaphylaxis: remove trigger, IM epinephrine 0.3–0.5 mg (anesthetized: IV titrated 10–100 mcg boluses), fluids, supportive; antihistamines/steroids are adjuncts only, never first-line.

A42: C

MH crisis management: stop triggers, get help + MHAUS hotline (1-800-644-9737), 100% O2 at high flow, dantrolene, treat hyperkalemia (CaCl2, insulin/dextrose), cool if >39°C, monitor for arrhythmias; avoid calcium channel blockers with dantrolene.

A41: A

Dantrolene 2.5 mg/kg IV, repeat until signs resolve (up to 10 mg/kg+); stop triggers, 100% O2 high flow, cool, treat hyperkalemia/acidosis. Acetaminophen is useless.

Q47

Epinephrine dosing for bradycardia/asystole in a pediatric arrest:

- **A.** 1 mcg/kg
- **B.** 10 mcg/kg (0.01 mg/kg)
- **C.** 100 mcg/kg
- **D.** 1 mg/kg

Q48

During RSI, cricoid pressure (Sellick maneuver) is intended to:

- **A.** Prevent regurgitation by occluding the esophagus
- **B.** Decrease lower esophageal sphincter tone
- **C.** Prevent tracheal collapse
- **D.** Improve laryngoscopic view

Q45

For a pregnant patient beyond ~20 weeks undergoing non-obstetric surgery, the table should be tilted left because:

- **A.** It reduces the risk of difficult intubation
- **B.** Supine positioning causes aortocaval compression by the gravid uterus, reducing venous return and uteroplacental perfusion
- **C.** It improves surgeon access
- **D.** It decreases aspiration risk

Q46

Appropriate uncuffed ETT size for a 4-year-old child:

- **A.** 3.5 mm
- **B.** 5.0 mm (4 + age/4)
- **C.** 6.5 mm
- **D.** 7.0 mm

A48: A
Cricoid pressure occludes the esophagus to reduce passive regurgitation (evidence debated; current practice varies — know both the intent and the controversy).

A47: B
Peds epinephrine arrest: 0.01 mg/kg = 10 mcg/kg (max 1 mg), q3–5 min.

A46: B
Peds ETT: uncuffed 4 + age/4 (5.0 mm at 4 y); cuffed 3.5 + age/4 (4.5–5.0 mm cuffed).

A45: B
Left uterine displacement relieves aortocaval compression → restores venous return and uteroplacental flow.

Q49

A difficult airway cannot be intubated after multiple attempts but the patient can be mask-ventilated. Per the ASA difficult airway algorithm, the next most appropriate step is:

A. Awakening the patient (if elective/non-emergent) or establishing a supraglottic airway (e.g., LMA) as a ventilatory bridge

B. Proceed with mask anesthesia for the case

C. Repeated attempts with the same laryngoscope

D. Immediate surgical airway

Q50

An ASA 1 patient scheduled for elective laparoscopic cholecystectomy takes metformin. Per most current guidance, metformin:

A. Requires perioperative insulin bridging

B. Must be held 72 hours preoperatively in all patients

C. Is absolutely contraindicated with general anesthesia

D. May be taken on the day of surgery in patients without renal impairment/contrasts (or held only the day of surgery per institutional policy)

A50: D

Metformin: no meaningful single-dose risk of lactic acidosis; current guidance = take day of surgery if no renal insufficiency/recent contrast (older blanket 48–72 h hold is outdated; follow institutional policy).

A49: A

Ventilate-but-can't-intubate (non-emergent): awaken or use supraglottic airway. Surgical airway is for CANNOT-ventilate-CANNOT-intubate emergency.