An odourless inhalational anaesthetic has the following properties:

oil: gas partition coefficient = 1.9
blood:gas partition coefficient = 0.14
MAC = 71%
boiling point = -108 °C
It is non-irritant to the airway and is not metabolised.

Which of the following is most likely to be true of this agent?

A   More likely to produce hepatotoxicity than desflurane
B   Less volatile than desflurane
C   Potency greater than isoflurane
D   Slower offset than sevoflurane
E   Speed of onset faster than nitrous oxide

Correct answer: E

Onset and offset time are related to the blood:gas partition coefficient; at 0.14 the agent should have a faster onset/offset than even nitrous oxide Hepatotoxicity is unlikely as the agent is not metabolised. Volatility is related to boiling point: the lower the BP, the higher the volatility. Potency relates to oil:gas partition coefficient and MAC. The higher the oil:gas partition coefficient/lower the MAC, the greater the potency; so the new agent (1.9/71%) is the least potent of the agents mentioned. It is, in fact, Xenon.

The non-depolarising neuromuscular blocker rocuronium is sometimes used for its rapid onset of action.

Which of the following is the most important reason for its more rapid onset compared with vecuronium?

A   Priming doses are not required for rocuronium B
Rocuronium has a lower volume of distribution C
Rocuronium has lower potency
D   Rocuronium has pre-junctional action at the NMJ
E   Rocuronium is an aminosteroid

Correct answer: C

The rapid onset of action of Rocuronium is because of its low potency, since the higher dose required for intubation will enhance the diffusion gradient between plasma and neuromuscular junction (Bowman principle).

A drug has an initial volume of distribution = 0.1 Litre Kg^{-1} and a rate constant of elimination k = 0.1 min^{-1}. It obeys a one-compartment model. An intravenous bolus dose of 500 mg is given to a healthy 50 Kg subject.

Which of the following is the most likely plasma drug concentration after two minutes?

A   1.0 $\mu g\ mL^{-1}$
B   25.2 $\mu g\ mL^{-1}$
C   81.9 $\mu g\ mL^{-1}$
D   98.8 $\mu g\ mL^{-1}$
E   100.0 $\mu g\ mL^{-1}$

Correct answer: C

The initial concentration = Dose/Vd = 500 000 μg/5 000 mL = 100 $\mu g.mL^{-1}$. Approximate calculation: after one minute, 10% (k expressed as %) of plasma will be cleared of drug, giving a concentration = 90 $\mu g.mL^{-1}$. Assuming a one compartment model, one minute later, a further 10% will give a concentration = 81 $\mu g.mL^{-1}$.

Exact calculation: ln (C/C_0) = -kt. C=81.9 $\mu g\ mL^{-1}$.

A 50-year-old woman is anaesthetised for cystoscopy and injection of botulinum toxin into the bladder for detrusor instability.

Which of the following best explains the therapeutic effect of botulinum toxin?

A   Antagonism of acetylcholine at the post-junctional receptor
B   Increased neuronal re-uptake of acetylcholine
C   Inhibition of acetylcholine release D
    Inhibition of acetylcholine synthesis
E   Potentiation of acetylcholinesterase

Correct answer: C

Botulinum toxin is an exotoxin produced by the anaerobic bacterium Clostridium botulinum and now used as a therapeutic drug. It inhibits acetylcholine release from nerve terminals.

A patient with atypical pneumonia is prescribed clarithromycin.

Inhibition of which of the following mechanisms best explains the antibiotic action of clarithromycin?

A Bacterial energy metabolism
B Cell wall synthesis
C DNA synthesis
D Protein synthesis
E RNA synthesis

Correct answer: D

Macrolides such as clarithromycin inhibit protein synthesis by binding to the ribosome and interfering with translocation. The other mechanisms are modes of action of other antibiotics.

You are comparing pressure-volume curves in patients during an asthma attack compared with healthy subjects.

Which of the following observed differences is the best indicator of the increased work of breathing in the patients with asthma?

A   Larger hysteresis loop
B   Longer expiratory time
C   Pressure-volume curve starts at a higher end-expiratory pressure
D   Slope of the inspiratory limb is initially less steep
E   Tidal volume is smaller

Correct answer: A

The work of breathing is best indicated by the area within the hysteresis loop.

In an experimental situation, a giant squid axon is bathed in an electrolyte solution containing chloride, potassium and sodium ions.

Which of the following changes would have the greatest effect in making the resting membrane potential less negative?

A   Decreasing the extracellular concentration of potassium ions
B   Decreasing the extracellular concentration of sodium ions
C   Increasing the extracellular concentration of chloride ions
D   Increasing the extracellular concentration of potassium ions
E   Increasing the extracellular concentration of sodium ions

Correct answer: D

The question simply tests knowledge of the Nernst equation and the fact that the resting membrane is relatively impermeable to sodium.

In the fetus, blood supplying the brain has a higher oxygen content than blood supplying the trunk and lower limbs.

Which of the following statements is the best explanation for this?

A   fetal haemoglobin has a higher oxygen affinity than adult haemoglobin, thereby maximising oxygen transfer in the placenta
B   metabolic autoregulation of the cerebral circulation
C   the fetal circulation is so arranged that blood with a higher oxygen content flows preferentially across the foramen ovale and is ejected via the left ventricle into the carotid arteries
D   the ductus arteriosus ensures that most of the blood ejected from the pulmonary artery bypasses the collapsed fetal lungs
E   the ductus venosus ensures that a majority of oxygenated blood from the umbilical vein bypasses the portal hepatic circulation

Correct answer: C

All the statements are true. However, only C answers the question directly.

The composition of fluid filtered at the glomerulus varies at different points along the nephron. A sample of fluid from a nephron is obtained experimentally from an otherwise healthy anaesthetised patient immediately after nephrectomy for a small localised transitional cell tumour of the renal pelvis. It has the following composition:

Na^+ concentration 140 mmol L^{-1}
K^+ concentration 4.5 mmol L^{-1}
Glucose concentration 4.8 mmol L^{-1}
Osmolality 285 mosm Kg^{-1}

From which of the following sites is the fluid most likely to have been obtained:

A   Ascending limb of loop of Henle
B   Bowman's capsule
C   Collecting duct
D   Distal convoluted tubule
E   End proximal convoluted tubule

Correct answer: B

Bowman's capsule is an ultrafiltrate of plasma and so will have a near identical composition excepting proteins. The values given are typical of normal plasma. There will be no glucose from the late PCT onwards as it is all normally reabsorbed.

A 72-year-old man complains of numbness in his feet and difficulty walking. On examination he has normal pain and temperature sensation in his lower limbs, but decreased appreciation of light touch and proprioception.

Which of the following is the most likely site of a neurological lesion?

A   Dorsal columns
B   Dorsal horn grey matter
C   Lateral corticospinal tracts
D   Lateral spinothalamic tracts
E   Spinocerebellar tracts

Correct answer: A

Fine touch, proprioception and vibration sensations are all conveyed in the dorsal column tracts.

A randomised prospective double-blind study is undertaken to determine the efficacy of a new drug to treat hypertension. 460 newly diagnosed hypertensive patients are assigned either to the treatment or placebo group. Measurements of arterial blood pressure are made after three months.

Which of the following statistical tests is most appropriate to determine whether the systolic blood pressure in the active treatment group is significantly lower than that in the placebo group at three months?

A   Chi-squared analysis
B   Fisher's Exact Test
C   Mann Whitney U-test
D   Student's unpaired t-test
E   Wilcoxon matched pairs test

Correct answer: D

The patients are not used as their own controls, so E is incorrect and is a non-parametric test in any case. C is reasonable but is not the statistically most powerful test as it is non-parametric and we may reasonably assume BP data are normally distributed from such a large sample. A & B are tests of association between groups of categorical data. These tests could be used if the patients were categorised as treatment success or failure.

At atmospheric pressure, the column height of a mercury barometer is approximately 760 mm whereas that of a water barometer is approximately 10 000 mm.

Which of the following statements best explains this?

A   A mercury barometer has a Torricellian vacuum above the meniscus
B   A mercury barometer measures absolute pressure
C   Mercury is denser than water
D   Mercury is less viscous than water
E   The SVP of mercury at a given temperature is less than that of water

Correct answer: C

The pressure exerted by a column of liquid is given by the equation: Pressure = density x acceleration due to gravity x height. Mercury is approximately 13 times denser than water. All the other statements are irrelevant.

You are using isoflurane (vaporizer dial setting 2.0%, end-tidal concentration = 1.2%) to maintain anaesthesia using a circle system with the vaporizer out-of-circuit and fresh gas flow (FGF) = 400 ml min^{-1} of an oxygen/air mixture.   It is now necessary to increase the depth of anaesthesia to 1.5 MAC equivalent.

Which of the following is the quickest method of increasing the depth of anaesthesia to 1.5 MAC equivalent?

A Change the vaporizer setting to isoflurane 1.5%
B Increase the FGF to 8 L min^{-1}
C Increase the vaporizer setting by 50%
D Switch to a nitrous oxide/oxygen mix with FiO_2 = 0.3
E Switch to a nitrous oxide/oxygen mix with FiO_2 = 0.5

Correct answer: B

Changing the composition of the inspired gas mixture will take a long time at such a low FGF rate due to the inertia of the circle system. The quickest option to increase the end-tidal isoflurane concentration is to increase the FGF rate. Option A does not achieve 1.5 MAC (MAC isoflurane = 1.2%). Option E does achieve this and option D overachieves but will take longer.

Energy exists in various forms, such as chemical energy within compounds, kinetic energy due to motion, electrical energy and potential energy due to an object's state or position.

Which of the following is associated with the most energy?

A   An object with a mass of 2000 Kg moving at 100 m s^{-1}
B   Energy released when 1 Kg glucose is metabolised to CO_2 and water (the metabolic energy content of glucose is approximately 16 kJ g^{-1})
C   Raising the temperature of 25 Kg water from 0 ℃ to 100 ℃ (the specific heat capacity of water is approximately 4 kJ per Kg per ℃)
D   Raising a 1000 Kg mass to a height of 1 Km against gravity (acceleration due to gravity = g = 10 m s^{-2})
E   The heat generated when a direct current of 10 amps flows through a heating element for 100 seconds when the potential difference across the element is 10 000 volts

Correct answer: B

This question requires knowledge of various energy equations.
A relates to kinetic energy = ½ m v^2 = 1000x10 000 = 10 MJ
B relates to the metabolic energy content of carbohydrate = 1000x16000=16 MJ
C relates to specific heat capacity and the relevant equation = mass x SHC x temperature change = 25x4x1000x100=10 MJ
D relates to potential energy = mgh=1000x10x1000=10MJ
E relates to electrical energy=IV x seconds = 10x10000x100=10MJ

A 40-year-old 70 Kg man presents to the Emergency Department with an estimated 30% body surface area severe thermal injury that occurred 1 h ago in a house fire. He smells strongly of alcohol and is violently agitated and confused.

Carboxyhaemoglobin (COHb) = 30% on arterial blood gas analysis. There is no evidence of an inhalational thermal injury. It is decided that he requires immediate intubation and ventilation.

Which of the following is the most appropriate technique for induction of anaesthesia?

A   Inhalational induction with sevoflurane in oxygen
B   Modified rapid sequence induction with sodium thiopental and rocuronium C   Rapid sequence induction with propofol and remifentanil
D   Rapid sequence induction with sodium thiopental and succinylcholine E   Fibreoptic intubation under local anaesthesia

Correct answer: D

Succinylcholine is safe for the first 24h after thermal injury. There is no contraindication to a standard RSI, which is the best technique to intubate the trachea rapidly because a full stomach (alcoholic beverage +/- food) is a distinct possibility.

1. A patient in hospital develops a tachycardia with a regular rate of 145 bpm and a blood pressure of 95/42 mm Hg. He denies chest pain, although he is acutely aware of his rapid heart rate. An ECG shows the duration of the QRS complex to be 0.10 s.

The single most appropriate immediate treatment is:

A. Adenosine 6mg

B. Amiodarone 300mg

C. DC Cardioversion

D. Digoxin 0.5mg

E. Esmolol 100 mg

Answer: A

2. The following arterial blood gas results were obtained from a 70 kg, 46 year-old patient breathing room air:
pH 7.31; p_aCO_2 3.5 kPa; p_aO_2 10.5 kPa; HCO_3^- 12 mmol L^{-1}; Hb 68 g L^{-1}

Which of the following is the single most likely physiological abnormality associated with these results:

A. A cardiac index of 2.8 L min^{-1} m^{-2}

B. A hydrogen ion concentration of 50 nmol L^{-1}

C. A minute volume of 3 L min^{-1}

D. A serum chloride of 108 mmol L^{-1}

E. A urine output of 30 ml h^{-1} for the last 6 hours

Answer: B

3. A 48-year old unemployed man who is being treated for depression was brought into the Emergency Department having taken an overdose. A 12-lead ECG is recorded that is abnormal.

   Which of the following abnormalities is the single best predictor of life-threatening arrhythmias occurring in this patient:

   A. Axis of +100 degrees

   B. QRS duration of 120 ms

   C. QT interval of 360 ms

   D. T-wave inversion in leads II and III

   E. Tachycardia of 120 bpm

   Answer: C

4. The context sensitive half-time of a new intravenous analgesic agent is found to be constant. It has a half-life of 5 minutes and a volume of distribution of 15 litres.

   Which of the following is the single most likely explanation for this pharmacokinetic behaviour:

   A. Hepatic extraction ratio of 0.3

   B. High lipid solubility

   C. High plasma protein binding

   D. Hofmann elimination

   E. The drug is an ester

   Answer: E

5. A fit 30-year old experiences a vaso-vagal attack at the sight of a needle used for taking a blood test.

Which of the following receptors is primarily responsible for his collapse:

A. Muscarinic receptors in the nucleus accumbens

B. Nicotinic receptors at the skeletal neuromuscular junction

C. Nicotinic receptors in the tractus solitarius

D. Post-ganglionic muscarinic receptors in the heart

E. Pre-ganglionic nicotinic receptors within the parasympathetic ganglion

Answer: D

6. A researcher is studying factors affecting skeletal muscle metabolism at rest under normal conditions of oxygen delivery in a laboratory setting.

Under these circumstances, which one of the following contributes most to energy production:

A. Anaerobic glycolysis

B. Creatine phosphorylation

C. Glycogenolysis

D. Oxidation of NADH

E. Oxidative phosphorylation

Answer: E

7. A patient is undergoing an emergency laparotomy for small bowel obstruction. Intra-operative temperature measured with an infrared tympanic thermometer is 35 C.

The single most important mechanism of this heat loss is:

A. Conduction

B. Convection

C. Evaporation

D. Radiation

E. Respiration

Answer: D

8. The results of a new rapid screening test designed to identify the H1N1 virus compared with the gold standard test, PCR (polymerase chain reaction), are given in the table below.

	PCR +ve	PCR -ve
New test positive	92.5	2.5
New test negative	7.5	97.5

Which one of the following statements best describes the performance of the new test:

A. The false positive rate is less than the false negative rate

B. The negative predictive value is 92.8%

C. The positive predictive value is 97.4%

D. The negative predictive value is less than the specificity

E. The sensitivity is 92.5% and the specificity 97.5%

Answer: E

9. A 78 year-old man is oliguric with a urine output of less than 0.5 ml kg^{-1} h^{-1} 48 hours after a laparotomy for colonic carcinoma.
Laboratory testing of his urine composition shows a specific gravity of 1.020, sodium of 1.8 mmol L^{-1}, and an osmolarity of 610 mOsm L^{-1}.

Which one of the following is the single most likely diagnosis:

A. Acute tubular necrosis

B. Analgesic nephropathy

C. Hypovolaemia

D. Inappropriate ADH secretion

E. Sepsis

Answer: C

10. You are about to pre-oxygenate a male patient, who has a BMI of 35 kg m^{-2}, prior to rapid sequence induction of anaesthesia. You are using a tightly fitting facemask and oxygen at 6 L min^{-1} and plan to continue this for three minutes.

Which is the single most efficient method of achieving this:

A. A Bain breathing system, with the patient sitting up at 30 degrees

B. A Bain breathing system, with the patient supine

C. A Mapleson A breathing system, with the patient sitting up at 30 degrees

D. A Mapleson A breathing system, with the patient supine

E. A Mapleson D breathing system, with the patient sitting up at 30 degrees

Answer: C

11.   A 20 year-old motorcyclist has fractured his femur one hour previously on the way home from the pub. He is in a cervical collar and his head is immobilised. He states he has no pain in his neck on palpation. Cervical spine radiography is unavailable for two hours and the surgeons wish to operate as soon as possible as his dorsalis pedis pulse is absent. The trauma theatre is free and a trained operating department assistant is available.

Which is the single most appropriate course of action:

A. Anaesthetise the patient as soon as possible using a rapid sequence induction retaining full cervical spine immobilisation

B. Delay the procedure for at least 5 hours so that the patient is appropriately fasted

C. Delay the procedure until the cervical spine is cleared by X-ray

D. Give ranitidine 50 mg IV and anaesthetise the patient in one hour with full cervical spine immobilisation and a rapid sequence induction

E. Transfer to theatre immediately, remove the collar and with in-line spinal stabilization perform a rapid sequence induction

Answer: E

12.   A fit 25-year old is asked to alter his respiratory rate and/or tidal volume. He starts with a respiratory rate of 15 per minute and a tidal volume of 450 ml. Physiological dead space and minute ventilation are measured for each manoeuvre.

Which one of the following results in the greatest increase in the ratio of physiological dead space to minute ventilation:

A. Doubling respiratory rate, no change in tidal volume

B. Doubling tidal volume, doubling respiratory rate

C. Doubling tidal volume, no change in respiratory rate

D. Halving respiratory rate, doubling tidal volume

E. Halving tidal volume, doubling respiratory rate

Answer: E