

## Option B: Drugs and Medicine: Exam Questions & Answers

**Question: 1.** (a) Many drugs are taken orally. State **three** other ways in which drugs may be taken by a patient. 2

(b) State what is meant by the term *side effect*. 1

**Answer: 1.** (a) rectally/by suppository, by inhalation, by injection (parenterally), by applying to skin/topically; 2

(b) an effect produced as well as the one intended/unwanted or undesired effect; 1

**Question: 2.** One common type of drug taken orally is the antacid. **Antacids** such as sodium hydrogencarbonate are taken to reduce stomach acidity.

(i) State the names of **two** metals, other than sodium, whose compounds are often used in antacids. 1

(ii) Give an equation for the neutralization of hydrochloric acid in the stomach by sodium hydrogencarbonate. 1

(iii) Explain how heartburn is caused. 1

(iv) Explain why dimethicone is added to some antacids. 1

**Answer: 2.** (i) magnesium/Mg, aluminium/Al, calcium/Ca; 1

(ii)  $\text{NaHCO}_3 + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O} + \text{CO}_2$  (*not*  $\text{H}_2\text{CO}_3$ ); 1

(iii) acid from the stomach rises into the esophagus; 1

(iv) as an anti-foaming agent/to prevent problem in (iii)/to prevent flatulence; 1

**Question: 3.** (i) State what is meant by the term **analgesic**. Explain the difference in the mode of action of mild and strong analgesics. 3

(ii) State the general names of the **two** functional groups attached to the benzene ring in a molecule of aspirin. 2

(iii) The use of aspirin can have beneficial effects for the user, but can also produce some unwanted side effects. State **one** beneficial effect (other than its analgesic action) and **one** unwanted side effect. 2

**Answer: 3.** (i) a substance that reduces pain;  
mild analgesics intercept pain at the source/interfere with production of substances that cause pain;  
strong analgesics bond to receptor sites in the brain/prevent the transmission of pain impulses; 3

(ii) carboxylic (acid)/alkanoic (acid); ester; 2

(iii) *Any one of the following [1]. beneficial effects*

used to treat mini-strokes;

prevents heart attacks/reduces risk of heart attack/thins the blood/

anti-coagulant;

relieves symptoms of rheumatological diseases/anti-inflammatory;

reduces fever;

Any one of the following [1]. side effects

stomach bleeding, allergic reaction; Reye's syndrome; hearing loss;  
tinnitus (ringing in the ears); gastrointestinal irritation (e.g. heartburn, nausea); 2

**Question: 4.** Morphine is a naturally occurring **analgesic** that can be converted into codeine.

- (i) Calculate the difference in relative formula mass between morphine and codeine. 1
- (ii) Explain what is meant by developing tolerance towards codeine and state why this is dangerous.

**Answer: 4.** (i) 14/14.03 (*ignore units*); 1

- (ii) increasing amounts needed to produce same effect;  
increasing amounts cause damage/death; 2

**Question: 5.** Discuss **two** arguments for and **two** arguments against the legalization of cannabis.

**Answer: 5.** Arguments *for*:

effective for certain named diseases;  
no more (or less) damaging than other drugs e.g. tobacco, alcohol;  
personal freedom argument/more taxes/frees police to deal with more serious crimes;

Arguments *for against*:

some harmful effects/specified example, e.g. increased risk of lung cancer;  
many users move on to more damaging/"harder" drugs;

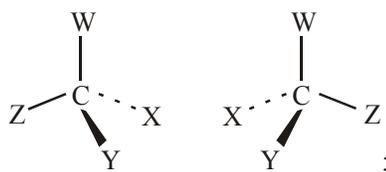
Arguments *against* [2 max]. 4

**Question: 6.** Some drug molecules contain a structure that can be represented as follows.



- (a) Draw the **two** enantiomeric forms of this structure.
- (b) Explain the term *racemic mixture*.

**Answer: 6.** (a)



*Must be clearly mirror images.*

- (b) an equimolar/50:50 mixture of two enantiomers; 1

**Question: 7.** **Caffeine and nicotine** are two **stimulants** whose structures are shown in Table 21 of the Data Booklet.

- (a) Describe **two** similarities in their structures, not including the presence of double bonds, methyl groups and nitrogen atoms. 2
- (b) Discuss the problems associated with nicotine consumption, distinguishing between short-term and long-term effects. 6

**Answer: 7.** (a) *both contain* six-membered ring; five-membered ring; (tertiary) amine group;  
N- has methyl group attached; 2 max

(b) *short-term effects*  
increased heart rate/blood pressure/restriction of blood vessels;  
acts as an anti-diuretic/reduction in urine output;

*long-term effects*

increased risk of heart disease/coronary thrombosis;  
risk of becoming addicted/physically dependent;  
high cost;  
(increased risk of) (lung, mouth, throat) cancer;  
(increased risk of) bronchitis/emphysema;  
reduction in capacity of blood to carry oxygen;  
withdrawal symptoms/weight gain (on quitting);

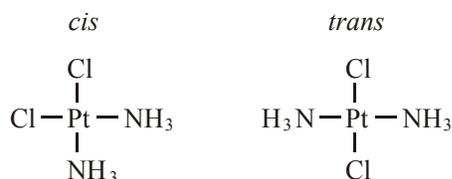
6 max

**Question: 8.** The effect of some drugs used to treat cancer depends on geometrical isomerism. One successful anti-cancer drug is cisplatin, whose formula is  $\text{PtCl}_2(\text{NH}_3)_2$ . Describe the structure of cisplatin by referring to the following:

- the meaning of the term *geometrical isomerism* as applied to cisplatin
- diagrams to show the structure of cisplatin and its geometrical isomer
- the types of bonding in cisplatin.

**Answer: 8.** *geometrical isomerism*

existence of compounds with the same molecular formula but with atoms/groups or  $\text{Cl}/\text{NH}_3$  arranged differently in space;

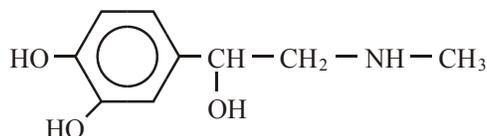


**both** structures correctly labelled as *cis* and *trans*;

covalent bonding/shared pairs of electrons; dative/coordinate/hydrogen/polar bonding; 4

**Question: 9.** Many drugs and other biologically important molecules consist of **chiral** species whose activity depends upon the enantiomer used. Adrenaline (a hormone that is also used as a drug) is a chiral molecule.

(a) Identify by means of an asterisk (\*) the chiral centre in adrenaline, the structure of which is given below.

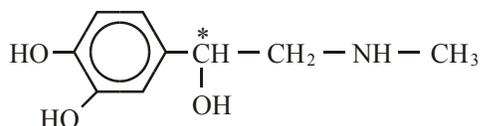


(b) Some enantiomers can be prepared by using a chiral auxiliary. Outline how a chiral auxiliary functions and state the advantage it provides.

5

Answer: 9. (a)

1



- (b) a chiral auxiliary is an optically-active species;  
that can be connected to a molecule (to make it optically-active);  
when this species is reacted further (then removed) only one enantiomer results;  
eliminates the need to carry out the separation of the desired enantiomer from a  
racemic mixture;

4

Question: 10. Magnesium hydroxide and aluminium hydroxide can act as **antacids**.

- (a) Write an equation for the reaction of hydrochloric acid with one of the above antacids.
- (b) Identify which antacid neutralizes the greater amount of hydrochloric acid if 0.1 mol of each antacid is used to neutralize the hydrochloric acid present in the stomach.
- (c) Give **one** reason why sodium hydroxide is not used instead of these antacids.

Answer: 10.(a)  $\text{Mg}(\text{OH})_2 + 2\text{HCl} \rightarrow \text{MgCl}_2 + 2\text{H}_2\text{O}$  /  $\text{Al}(\text{OH})_3 + 3\text{HCl} \rightarrow \text{AlCl}_3 + 3\text{H}_2\text{O}$ ; 2

(b)  $\text{Al}(\text{OH})_3$ /aluminium hydroxide; 1

(c) corrosive to body/tissue/strong base/alkali; 1

Question: 11. (a) Describe the likely effect of a **depressant** taken in:

a moderate dose

a high dose

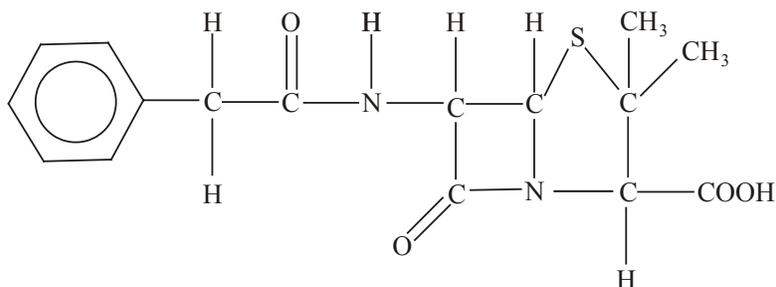
- (b) Ethanol in breath can be detected using a breathalyser containing potassium dichromate(VI) crystals. Describe the colour change that occurs in a positive test and identify the species responsible for the final colour.

Answer: 11.(a) a moderate dose may induce sedation/reduce anxiety or tension/slower mental activity/slows CNS/causes drowsiness;

a high dose may induce sleep/coma/unconsciousness/death; 1

(b) orange to green;  $\text{Cr}^{3+}$ /chromium(III); 2

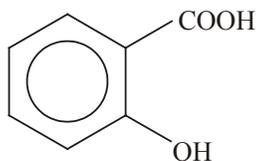
Question: 12. Penicillin G was the first **antibiotic** used to fight infections. The structure of this antibiotic is as follows:



- (a) Determine the molecular formula of penicillin G.

1

- (b) State **two** reasons for modifying the side chain in penicillin G 2
- (c) Describe the mode of action of penicillin in preventing the growth of bacteria. 2
- (d) Discuss **two** effects of over prescription of penicillin to humans. 2
- Answer: 12.** (a)  $C_{16}H_{18}O_4N_2S$ ; 1
- (b) prevents deactivation by stomach acid/more resistant to stomach acid;  
prevents deactivation by the enzyme penicillinase (produced by bacteria)  
/increases resistance/tolerance to penicillinase; 2
- (c) penicillin interferes with the cell wall formation;  
cells can expand/burst/disintegrate/bacteria die; 2
- (d) makes penicillin less effective;  
destroys useful/beneficial bacteria;  
allows resistant population to build up; 2
- 13.** (a) Describe the differences in the ways that **bacteria and viruses** multiply. 2
- (b) Outline **two** ways in which **antiviral drugs** work. 2
- (c) Explain why effective treatment of AIDS with antiviral drugs is difficult. 2
- Answer:13** (a) bacteria multiply by cell division/binary fission/mitosis;  
viruses insert DNA/RNA/genetic material into cells; 2  
*For "bacteria multiply by themselves but viruses require a host cell"/OWTTE award [1].*
- (b) block enzyme activity within host cell/block reverse transcriptase;  
alter host cell's genetic material;  
prevent virus from multiplying/replicating;  
alter virus's binding site on cell wall/prevent virus binding with cell wall;  
prevent virus from entering/leaving cell; 2
- (c) HIV virus mutates rapidly;  
HIV metabolism linked to that of host cell/HIV uses host cell;  
Drugs harm host cell as well as HIV/difficult to target HIV without damaging  
host cell; 2
- 14.** Refer to Table 21 in the Data Booklet when answering this question about **analgesics**.
- (a) Describe the different ways in which mild and strong analgesics prevent pain. 4
- mild analgesics:
- strong analgesics:
- (b) Some mild analgesics are derivatives of **salicylic acid**. The structure of salicylic acid is



- (i) Salicylic acid can be converted to aspirin. Give the formula of the group that replaces one hydrogen atom in a molecule of salicylic acid in this conversion. 1

- (ii) State the names of **two** functional groups present in acetaminophen (paracetamol) and **one** functional group present in ibuprofen. 3

acetaminophen (paracetamol)

ibuprofen

**Answer 14.** (a) *mild analgesics*

they prevent/interfere with the production of substances/prostaglandins that cause pain;  
they intercept pain at its source;

*strong analgesics*

they bond to receptor sites in the brain;  
pain signals within brain/spinal cord blocked;

4

- (b) (i)  $\text{CH}_3\text{CO}$ ;

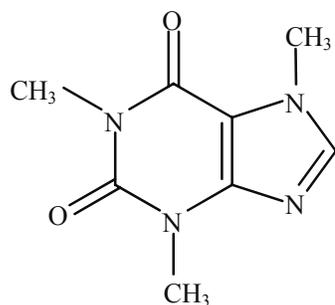
1

- (ii) *acetaminophen (paracetamol)*  
amide;  
hydroxy(l)/phenol/alcohol;

*ibuprofen*

carboxylic acid;

**Question: 15.** Caffeine is a **stimulant** with the following structure.

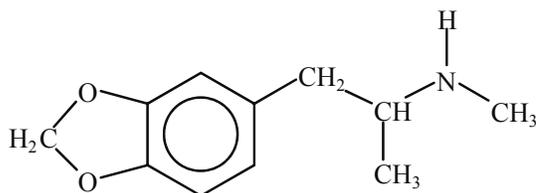


Caffeine

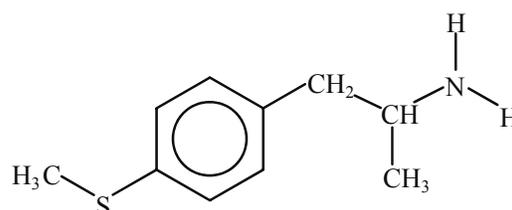
- (a) Determine whether both amine groups in caffeine are primary, secondary or tertiary. 1

- (b) Caffeine contains the group  $\text{—}\overset{\text{O}}{\parallel}{\text{C}}\text{—}\overset{\text{CH}_3}{\text{N}}\text{—}$ . State the general name for this functional group. 1

- (c) Tablets of the drug Ecstasy are sometimes contaminated with a substance called 4-MTA.



Ecstasy



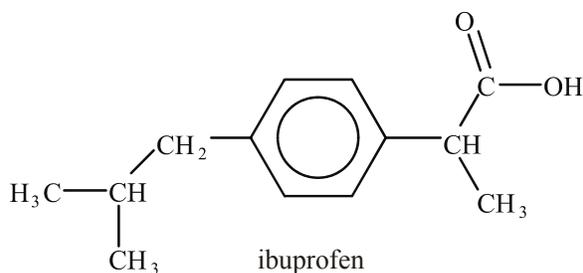
4-MTA

- (i) Ecstasy and 4-MTA are **sympathomimetic** drugs. Identify the structural similarity between the two drugs and epinephrine (adrenaline), the structure of which is given in Table 20 of the Data Booklet. 2
- (ii) Outline what is meant by the term *sympathomimetic drug* and state **two** examples of short-term effects sympathomimetic drugs have on the human body. 3
- (iii) State **one** example of a long-term effect of taking stimulants. 1

- Answer: 15.** (a) tertiary; 1
- (b) amide; 1
- (c) (i) all contain the phenylethylamine structure/contain an arene or benzene ring linked to two carbon atoms attached to an amine group; 1
- (ii) sympathomimetic drugs mimic the effect of adrenaline;  
*Any two of the following:*  
 stimulate the sympathetic nervous system; speed up the heart rate;  
 increase sweat production; increase rate of breathing; 3 max
- (iii) weight loss/constipation/emotional instability; 1

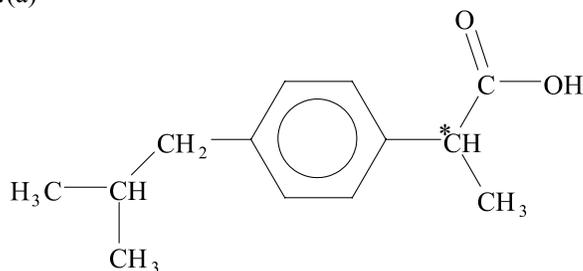
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**Question: 16.** Ibuprofen is an analgesic with the following structure:



- (a) Identify the chiral carbon atom in the structure of ibuprofen using an asterisk (\*). 1
- (b) Describe how **chiral auxiliaries** can be used to synthesize only the desired enantiomeric form of a drug from a non-chiral starting compound. Explain why it is important to use only the desired enantiomeric form of a drug and state an example of what can happen if a racemic mixture is used. 5

**Answer: 16.**(a)



1

- (b) a chiral auxiliary is itself an enantiomer; it is bonded to the reacting molecule to create the stereochemical conditions necessary to follow a certain pathway; once the desired enantiomer is formed the auxiliary is removed; different enantiomers may have different biological effects (some of which may be harmful); genetic defects/deformities; 5

7

**Question: 17.** (a) One method for detecting ethanol in breath involves blowing through a tube containing crystals of potassium dichromate(VI). The ethanol turns the crystals from orange to green.  
Explain what happens to both the dichromate(VI) ion and the ethanol in this reaction. 2

(b) A modern method for accurately determining the amount of ethanol in breath uses an **intoximeter**. Describe how an intoximeter works. 3

**Answer: 17.**(a) the dichromate(VI) ion is reduced/forms the  $\text{Cr}^{3+}$  ion;  
the ethanol is oxidized/forms ethanal/ethanoic acid; 2

(b) sample of breath passed into infrared spectrometer;  
ethanol in breath absorbs because of C-H bond;  
compares breath with air/reference sample with no ethanol; 3

**Question: 18.** (a) State the name of the class of drugs with effects similar to that of **adrenaline**.  
Outline **one** effect of these drugs on humans.

(b) (i) Identify the stimulant responsible for addiction to smoking tobacco. 1

(ii) Describe **two** short-term effects of smoking tobacco. 2

(iii) Describe **two** long-term effects of smoking tobacco, other than addiction. 2

**Answer: 18.**(a) amphetamines/stimulants;  
increased heart rate/increased blood pressure/increased breathing rate  
/dilation of pupils/constriction of arteries/sweating/increased alertness  
/decreased appetite; 2

(b) (i) nicotine; 1

(ii) increased heart rate; increased blood pressure; reduced urine output;  
increased concentration/stimulating effect; 2

(iii) increased risk of cancer; increased risk of stroke/(coronary) thrombosis/heart  
disease; ulcers; emphysema/bronchitis/shortage of breath;  
coughing/bad breath/yellowing of teeth or fingers; effect on pregnancy; 2

**Question: 19.** Diazepam and nitrazepam are two **depressants** that are very similar in their structures.  
State the name of **two** different functional groups present in both depressants.

**Answer: 19.** amide/ketone/carbonyl;  
(tertiary) amine;

- Question: 20.** (a) Lysergic acid diethylamide (also known as LSD or “acid”) and mescaline are both **mind-altering drugs**. State **one** effect caused by both substances and **one** effect caused by LSD or mescaline only. (*Specify the substance which causes the effect.*) 2
- (b) Outline the structural similarities and differences between LSD and mescaline. (Structures are given in Table 21 of the Data Booklet.) 2

**Answer: 20.**(a) cause changes in visual and sound perception/hallucinations;

LSD may cause a permanent effect of “flashbacks”/effects of LSD may be experienced a year or more after the last use of the drug/psychological dependence; 2

**OR**

mescaline may cause nausea/trembling/liver damage/reduce appetite;

- (b) both contain amines/aromatic (benzene) ring;

<i>mescaline</i>	<i>LSD</i>
primary amine	secondary and tertiary amine
ether groups	amide
one ring	alkene(s)
	indole ring
	four cyclic rings
	heterocyclic

2

*Accept any one clear difference from the above list.*

**[4]**