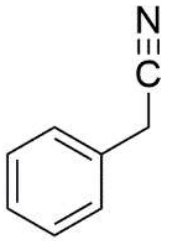
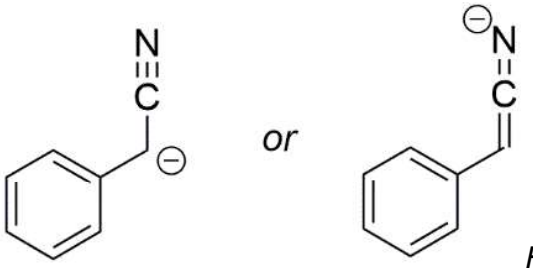
3. This question is about the performance-enhancing drug Ritalin®

(a) Compound **A**



1

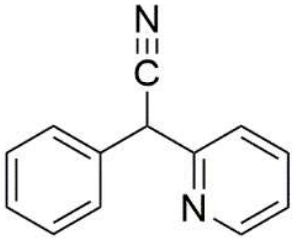
(b) Anion $\mathbf{B}^-$



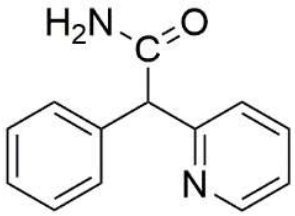
1

Full marks if both are drawn

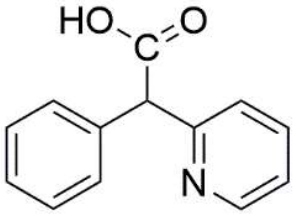
(c) Compound **C**



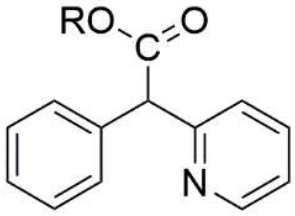
Compound **D**



Compound **E**



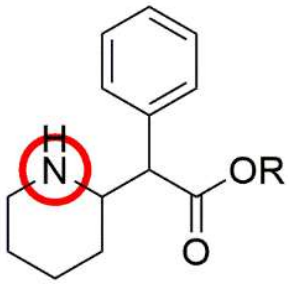
Compound **F**



4

*Each correct structure scores 1 mark. If the R group in Compound **F** is drawn in as CH_3 then this is also acceptable.*

(d)



1

The nitrogen atom must be the only atom circled.

(e) **(i)** Additional molar mass on forming HCl salt = (1.008 + 35.45) g mol^{-1}

= 36.458 g mol^{-1}

Number of moles of Ritalin must remain constant, therefore the following equation can be set up where M is the molar mass of Ritalin.

$$\frac{10.00}{M + 36.458} = \frac{8.647}{M}$$

$$10.00M = 8.647(M + 36.458)$$

$$10.00M - 8.647M = 315.252$$

$$1.353M = 315.252$$

M = 233.00 g mol^{-1}

3

Working must be shown to get credit. *This is because it is possible to work backwards from part (e)(ii) to get the mass. Award 1 mark if the concept of equating moles is shown, award the second mark if the equation above is written explicitly. The final mark is for the correct answer.*

(ii) Molar mass of molecule without R group = 218 g mol^{-1}

Molar mass of R group = (233 – 218) g mol^{-1} = 15 g mol^{-1}

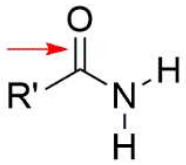
Indentity of R group = CH_3 *or* Methyl *or* Me

1

The observant student might notice that the chemical name for Ritalin (Methylphenidate Hydrochloride) on the box in the picture suggests the identity of R, hence it is possible to score credit here even if part (e)(i) is incorrect.

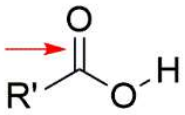
(f)

(i) 1655 cm^{-1}



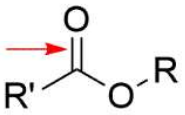
(C=O stretch in amide)

(ii) 1715 cm^{-1}



(C=O stretch in carboxylic acid)

(iii) 1740 cm^{-1}

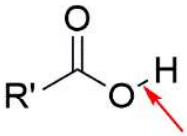


(C=O stretch in ester)

(iv) 2260 cm^{-1}

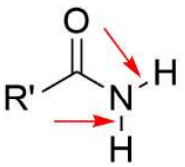
(C≡O stretch in nitrile)

(v) 3000 cm^{-1} (very broad)



(O–H stretch in carboxylic acid)

(vi) 3180 and 3390 cm^{-1} (sharp)



*(Symmetric **and** Asymmetric N-H stretches in amide)*

Must have both arrows

3

Award ½ mark for each. In each case must be both the correct functional group and have the arrow(s) pointing to the correct bond(s) to obtain the ½ mark. The words in brackets are not needed. In the case of the amide in part (vi) arrows must be drawn to both bonds to obtain the ½ mark.

(g)

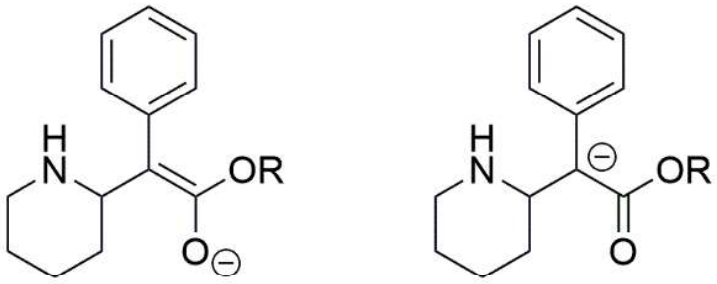
Pair of Stereoisomers	Enantiomers	Not Enantiomers
1 and 2		✓
1 and 3		✓
1 and 4	✓	
2 and 3	✓	
2 and 4		✓
3 and 4		✓

2

All correct 2 marks. For each mistake minus 1 mark, down to a minimum of zero. If both boxes have been ticked for any pair then 0 marks for this part.

(h)

Anion **G**$^-$



Worth 2 marks Worth 1 mark

2

Full marks if both are drawn.

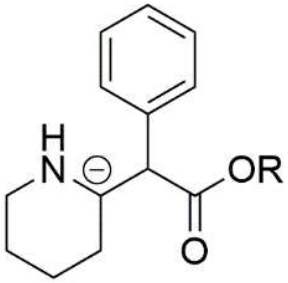
(i)

Pair of Stereoisomers	Intervconverted via Anion G^-	Not Intervconverted via Anion G^-
1 and 2		✓
1 and 3	✓	
1 and 4		✓
2 and 3		✓
2 and 4	✓	
3 and 4		✓

All correct 2 marks. For each mistake minus 1 mark, down to a minimum of 0. If both boxes have been ticked for any pair then 0 marks for this part.

2

*If the anion below was drawn in part (h) then error carried forward can be applied here, in which case the correct answers are **(1 and 2)** and **(3 and 4)**.*



Question Total 20