Model Answers: Hard

1

The correct answer is **C** because:

- **Competitive inhibitors** slow the **rate of reaction** and the rate can never be higher than the rate without an inhibitor (which rules out **B** and **D**)
- Although competitive inhibitors slow the rate of reaction, the rate of reaction will continue to **increase** as the **substrate concentration** increases (which rules out **A**)
- Competitive inhibition is usually **temporary**, so the inhibitor eventually leaves the enzyme. This means that the level of inhibition depends on the relative concentrations of substrate and inhibitor (as they are competing for places in enzyme active sites)
- Although the rate of reaction is slowed with a competitive inhibitor, the same amount of product is made in the end

A could be an example of a **non-competitive inhibitor** as it lowers the rate of reaction and never reaches the same rate even with increasing substrate concentration

2

The correct answer is **C** as enzyme 1 activity would be unaffected, therefore 'reactant' would be converted into 'intermediate X' at the same rate and there would be no increase in the amount of reactant

- **A** is true as there would be an increased amount of competitive inhibition for intermediate X, therefore less enzyme 2 activity
- **B** is true as less intermediate X will be converted (due to the competitive inhibition)
- **D** is true as the inhibition of enzyme 2 would cause intermediate X to increase in abundance

3

The correct answer is **C** as the ethanol is able to act as a **competitive inhibitor** to the ethylene glycol. As it is a competitive inhibitor the larger the dose of ethanol, the greater its **effectiveness** at preventing the breakdown of ethylene glycol

- **A** is not true as the similar structure between ethanol and ethylene glycol infers that it is a competitive inhibitor and therefore binds to the **active site**.
- For the same reason **B** is not true either, competitive inhibitors do not denature the enzyme. Instead they form short lived enzyme/inhibitor complexes that leave the enzyme fully functional after the inhibitor detaches

- **D** is not true as, while a large dose of ethanol will have a pain-relieving effect, this is not why this treatment is effective. The person would still be at risk of organ failure and death if the only benefit of the alcohol was pain relief.

4

The correct answer is **A** as enzyme 1 reaches its **half V_{max}** much quicker than enzyme 2 (this is shown by the **steeper** increase in the rate of reaction). **K_m** is the **concentration of substrate** which permits the enzyme to achieve half V_{max}, therefore a **low K_m** indicates a **high affinity for substrate**

5

The correct answer is **A** as, if both the **temperature** and **amount of substrate** have been increased, then there will be corresponding increases in both the **rate of production** and the **total amount of product made**. **A** is the only one that meets both of these criteria

- **B** could represent a scenario where only extra substrate was added and there was no increase in temperature
- **C** could represent a scenario where extra substrate was added and there was a decrease in temperature
- **D** could represent a scenario where only temperature was increased and there was no significant change in substrate concentration

6

The correct answer is **A** as, to get the rate of glucose production for method **A**, the amount produced in mg cm^{-3} is divided by the amount of time:

- 20/36 = 0.555` mg cm^{-3} sec^{-1}
- To convert this from mg cm^{-3} sec^{-1} to mg cm^{-3} min^{-1}, multiply by 60 (and then round the result to two significant figures):
- 0.5556 x 60 = 33.33 = **33 mg cm^{-3} min^{-1}**

7

The correct answer is **C** as the initial rate of reaction is slower than Z at all substrate concentrations and does not reach the same **maximum rate** (even with excess substrate abundance). The initial rate of reaction is always **slower** with a **non-competitive inhibitor** as the inhibitor has reduced the number of available active sites (by binding to the allosteric site). Even with more substrate available, the initial rate of reaction will never reach the same rate as the reaction without an enzyme as the there are **fewer active sites** available

- **A** is not correct as the rate ends up higher than the non-inhibitor reaction

- **B + D** are not correct as there would still be some reaction as the lower substrate concentrations

8

The correct answer is **C** as between X and Y, increasing **substrate** resulted in an increase in **reaction rate** (therefore substrate availability was the **limiting factor**). Between Y and Z increasing substrate no longer resulted in an increase in reaction rate, which meant that **enzyme availability** was now the limiting factor

9

The correct answer is **A** as, the enzyme 1 has the **higher affinity**. At low substrate concentrations enzyme 1 has a higher **rate of reaction**, which means the enzyme has bound to more substrate (hence has a higher affinity).

- **B** is true as the rate of reaction has plateaued (indicating the enzyme has been saturated with available substrate)
- **C** is true as a **low K_m** value indicates a **high affinity**. Enzyme 2 has a lower affinity and therefore a **higher K_m** value
- **D** is true as the graph shows the **rate is higher** at **low substrate** concentrations

10

The correct answer is **B** because:

- 0.05 mg of glucose is hydrolysed per second
- To get the amount per hour this figure should be multiplied by 60 (to get to minutes) and then by 60 again (to get to hours):
- 0.05 mg sec^{-1} x 60 x 60 = **180 mg $hour^{-1}$**
- Multiply this value by 2 as lactose has twice the starting mass of the glucose that is produced (lactose is a dissacharide composed of glucose and galactose)
- **= 360 mg $hour^{-1}$**