

| Question |         | Answer                                                                                                                               | Marks                                                     | AO                                              | Guidance                                                                                                                                                                                                                                                 |
|----------|---------|--------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|-------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 12       | (a)     | $\log M = \log(ak^t)$<br>$\log M = \log k^t + \log a$<br>$\log M = t \log k + \log a$                                                | <b>B1</b><br><b>[1]</b>                                   | <b>2.1</b>                                      | This line of working must be seen as well as the given result<br><b>AG</b>                                                                                                                                                                               |
| 12       | (b)(i)  | Intercept $\log a = -0.2403$<br><br>$a = 10^{-0.2403} = 0.575$<br><br>Gradient $\log k = -0.0214$<br><br>$k = 10^{-0.0214} = 0.9519$ | <b>M1</b><br><br><b>A1</b><br><br><b>A1</b><br><b>[3]</b> | <b>3.1a</b><br><br><b>3.3</b><br><br><b>3.3</b> | Equates $\log a$ to the intercept of the given line or equates $\log k$ to the gradient of the given line<br><br>Accept awrt 0.57 or 0.58 Accept one answer in index form<br><br>Accept awrt 0.95. Second value must be evaluated                        |
|          | (b)(ii) | This means that every minute, the mass of salt is reduced to 95% of its mass at the start of the minute                              | <b>B1</b><br><br><b>[1]</b>                               | <b>3.3</b>                                      | Also accept that the mass is reduced by 4.8% or 5% per minute<br>FT their value<br>Accept without a value for “the proportion of the mass of salt preserved each minute” oe                                                                              |
| 12       | (c)     | When $t = 0$ , $M[= a] = 0.575$<br><br>Which is quite close to the given value 0.5 kg                                                | <b>M1</b><br><br><b>A1</b><br><br><b>[2]</b>              | <b>3.4</b><br><br><b>3.5a</b>                   | Uses $t = 0$ and their positive value of $a$ .<br>Also allow for $\log 0.5 = -0.3010$<br><br>Compares their $M$ with 0.5 kg or their $\log 0.5$ with $-0.2403$ (must be seen)<br>Small percentage error so reasonable model. Allow for not very good fit |

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| 12 | (d) | $\log 0.01 = -0.0214t - 0.2403$<br>$t = 82.2$                                                                                                                                                                                                                                      | <b>M1</b><br><b>A1</b>                               | <b>3.4</b><br><b>3.4</b>  | Uses $\log 0.01$ in the given equation soi<br>Allow value between $82 \leq t \leq 83$                                                                                                                                                          |
|    |     | <b>Alternative method</b><br>When $0.01 = ak^t$<br><br>$t = 82.2$                                                                                                                                                                                                                  | <b>M1</b><br><b>A1</b>                               |                           | Uses their values of $a$ and $k$ to form an equation for $t$ and attempt to solve. May be implied by a value for $t$ seen<br>To allow for values of $a$ and $k$ rounded to 2 sf, allow value $78 \leq t \leq 83$                               |
|    |     |                                                                                                                                                                                                                                                                                    | [2]                                                  |                           |                                                                                                                                                                                                                                                |
| 12 | (e) | $M = ae^{-ht} = ak^t$<br>So $e^{-h} = k$<br>$h = -\ln k = 0.0493$<br>$M = 0.575e^{-0.0493t}$                                                                                                                                                                                       | <b>M1</b><br><b>A1FT</b>                             | <b>3.1a</b><br><b>1.1</b> | Equates expressions for $M$ soi FT their $k$ and $a$<br><br>FT their $a$ only. Allow $0.049 < h < 0.052$<br>Allow $M = 0.575 e^{-\ln 0.952t}$                                                                                                  |
|    |     | <b>Alternative methods</b><br>Uses given value for initial mass<br>$M = 0.01 = 0.5e^{-ht} = 0.5e^{-82h}$<br>$h = 0.0477$ so $M = 0.5e^{-0.0477t}$<br><br>Uses their $a$ as initial mass<br>$M = 0.575e^{-ht}$<br>$0.01 = 0.575e^{-82h}$<br>$h = 0.0494$ so $M = 0.575e^{-0.0494t}$ | <b>M1</b><br><b>A1</b><br><br><b>M1</b><br><b>A1</b> |                           | Allow the use of one of the data points from the table for M1 only<br><br>Allow $0.0471 < h < 0.0502$<br><br>Allow the use of one of the data points from the table for M1 only<br>Allow their value of $a$<br><br>Allow $0.0488 < h < 0.0519$ |
|    |     |                                                                                                                                                                                                                                                                                    | [2]                                                  |                           |                                                                                                                                                                                                                                                |
| 12 | (f) | Rate of decrease is $hae^{-ht}$<br>At $t = 10$ rate of decrease is<br>$0.0493 \times 0.575e^{-0.0493 \times 10} =$<br>$0.0173 \dots$ [kg per minute]                                                                                                                               | <b>M1</b><br><b>A1</b><br><br><b>[2]</b>             | <b>1.2</b><br><b>3.1a</b> | Soi Allow sign error. FT their $h$ (Q. asks for rate of <i>decrease</i> )<br>Accept values between 0.017 and 0.018                                                                                                                             |