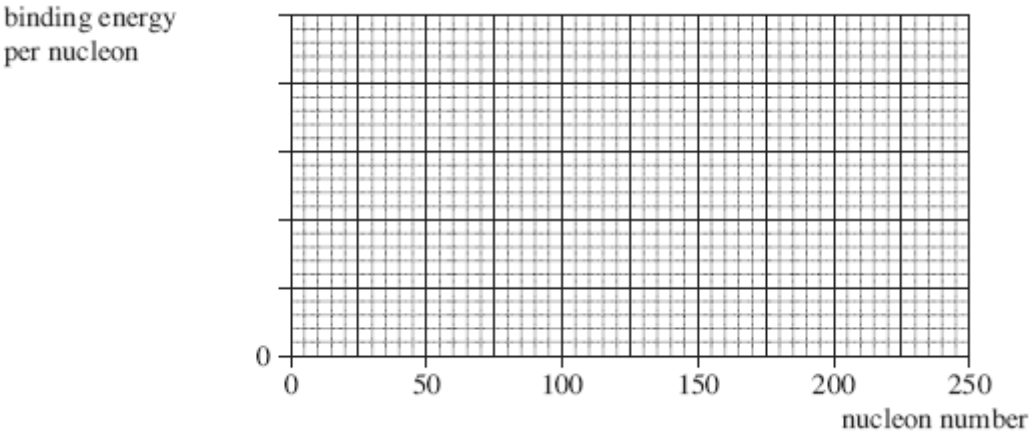
Name of the Student:_____
Max. Marks : 20 Marks **Time : 20 Minutes**

Q1.

(a) Sketch a graph of binding energy per nucleon against nucleon number for the naturally occurring nuclides on the axes given in the figure below. Add values and a unit to the binding energy per nucleon axis.



(4)

(b) Use the graph to explain how energy is released when some nuclides undergo fission and when other nuclides undergo fusion.

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(3)
(Total 7 marks)

Q2.

The decay of a radioactive substance can be represented by the equation

$$A = A_0 e^{-\lambda t}$$

where A = the activity of the sample at time t
A_0 = the initial activity at time $t = 0$

λ = the decay constant

The half life, $T_{½}$ of the radioactive substance is given by

$$T_{½} = \frac{ln(2)}{\lambda}$$

An experiment was performed to determine the half-life of a radioactive substance which was a beta emitter. The radioactive source was placed close to a detector. The total count for exactly 5 minutes was recorded. This was repeated at 20 minute intervals. The results are shown in the table below.

time, t / minutes	**total count, C, recorded in 5 minutes**	**count rate, R / counts minute^{-1}**	**corrected count rate, R_C / counts minute^{-1}**	**ln (R_C / minute^{-1})**
0	1016	203	183	5.21
20	892	178	158	5.06
40	774	155	135	4.90
60	665	133	113	4.73
80	608	122	102	4.62
100	546	109	89	4.49

(a) A correction has been made to the count rate, R, to give the corrected count rate, R_C. Explain why this correction has been made and deduce its value from the table.

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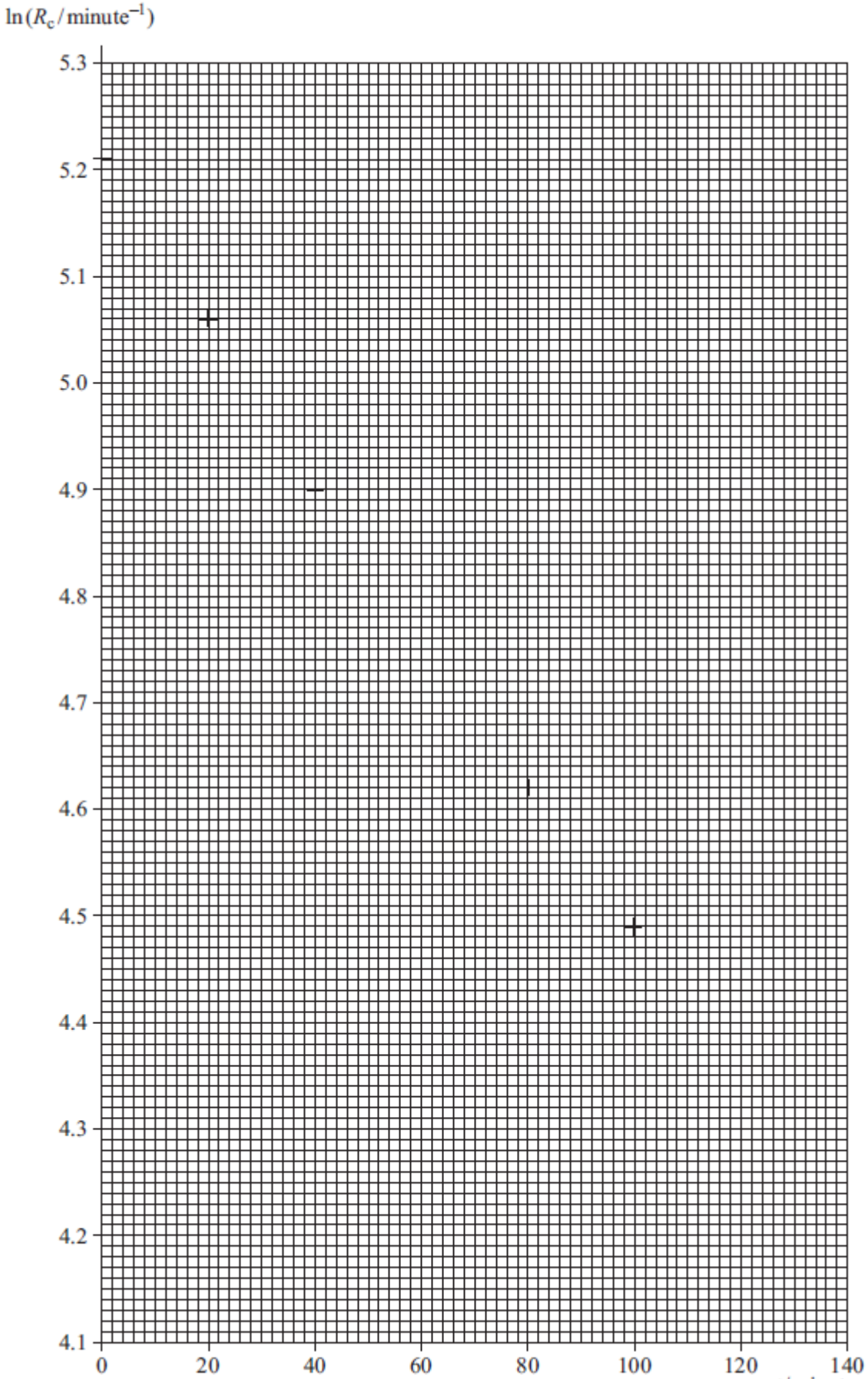
_____

(2)



(b) Draw an appropriate straight line through the plotted points.

(1)

(c) Determine the gradient G of your graph.

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(3)

(d) Use your graph to determine the half-life in minutes of the radioactive substance used in this experiment.

_____

_____

_____

_____

half-life, $T_{½}$ _____ minutes

(2)

(e) Due to the nature of a radioactive decay there will be an uncertainty in the total count recorded. What type of error is this called?

_____

(1)

(f) (i) It can be shown that the error in the total count C, is given by

uncertainty in total count $C = \pm \sqrt{C}$

Using data from the table, calculate the uncertainty **in the smallest total count, C**.

_____

_____

(1)

(ii) Hence calculate the percentage uncertainty **in the smallest total count, C**.

_____

_____

_____

(1)

(iii) Another student performed the same experiment with identical equipment but took total counts over a 1 minute period rather than a 5-minute period. The total count, C, at 140 minutes was equal to 84 counts. Estimate the percentage uncertainty in this total count, and hence explain the advantage of using a larger time.

_____

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(2)
(Total 13 marks)