

Name of the Student: _____

Max. Marks : 24 Marks

Time : 24 Minutes

Q1.

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

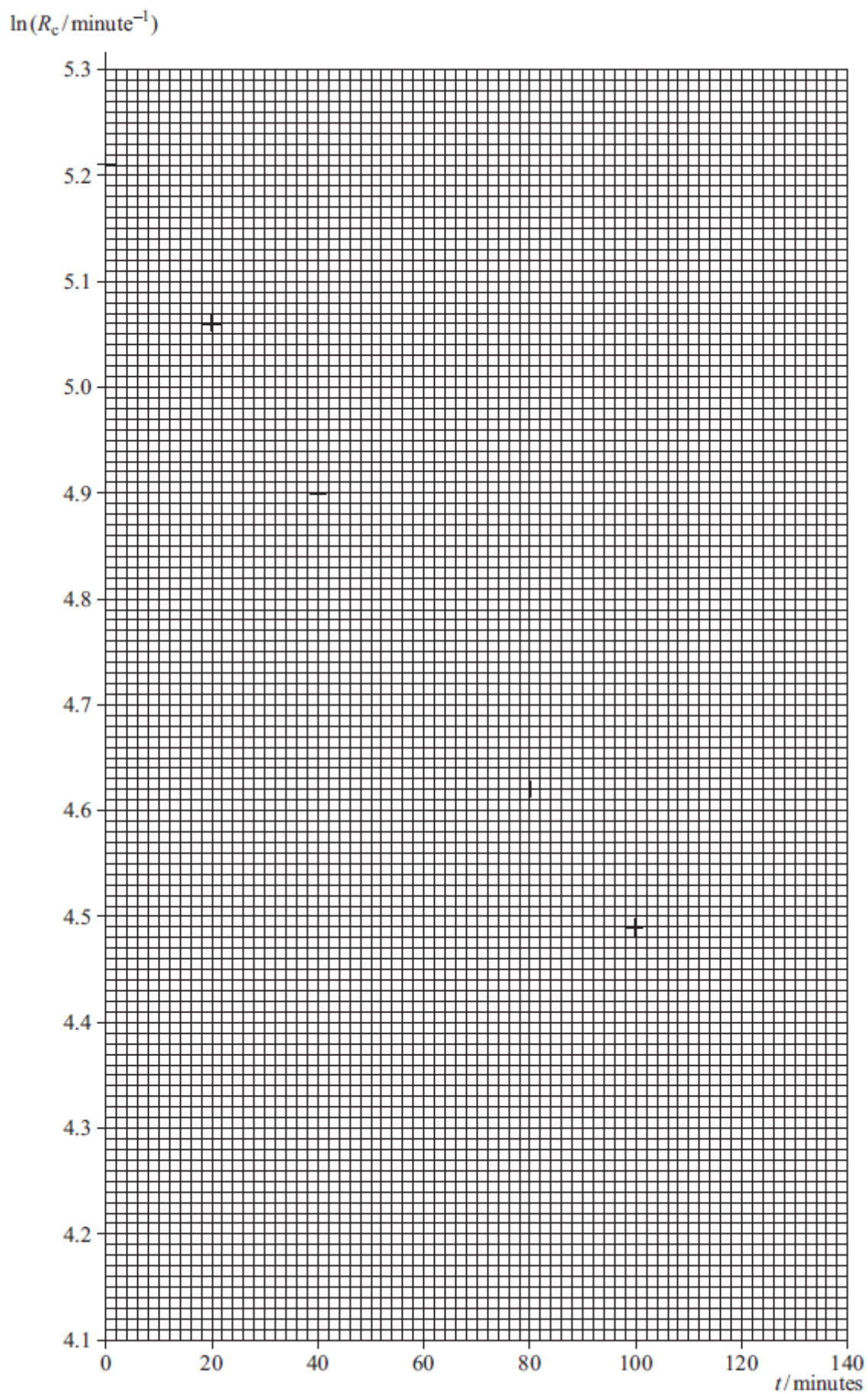
The half life, $T_{1/2}$ of the radioactive substance is given by

$$T_{1/2} = \frac{\ln(2)}{\lambda}$$

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	$\ln(R_c / \text{minute}^{-1})$
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.



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

- (c) Determine the gradient G of your graph.

(3)

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

half-life, $T_{1/2}$ _____ 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

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

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.

(2)

(Total 13 marks)

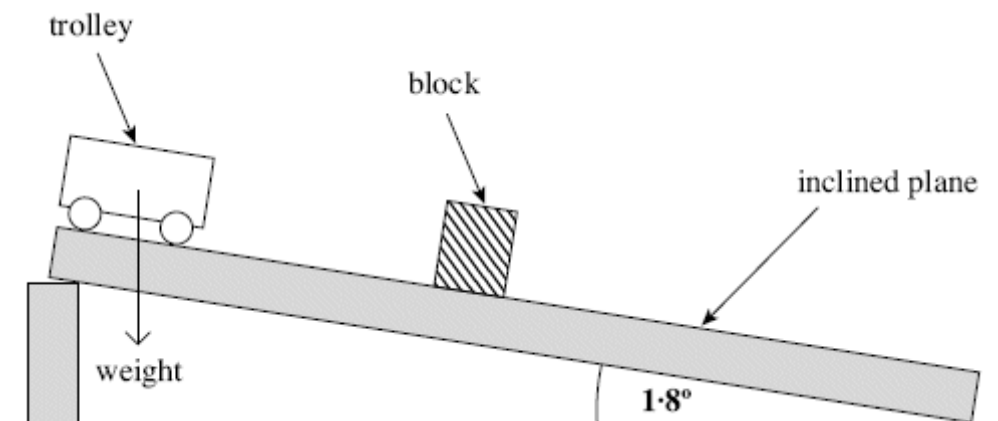
Q2.

Galileo used an inclined plane, similar to the one shown in the figure below, to investigate the motion of falling objects.

- (a) Explain why using an inclined plane rather than free fall would produce data which is valid when investigating the motion of a falling object.

(2)

- (b) In a demonstration of Galileo's investigation, the number of swings of a pendulum was used to time a trolley after it was released from rest. A block was positioned to mark the distance that the trolley had travelled after a chosen whole number of swings. See the figure below.



The mass of the trolley in the figure above is 0.20 kg and the slope is at an angle of 1.8° to the horizontal.

- (i) Show that the component of the weight acting along the slope is about 0.06 N.

(2)

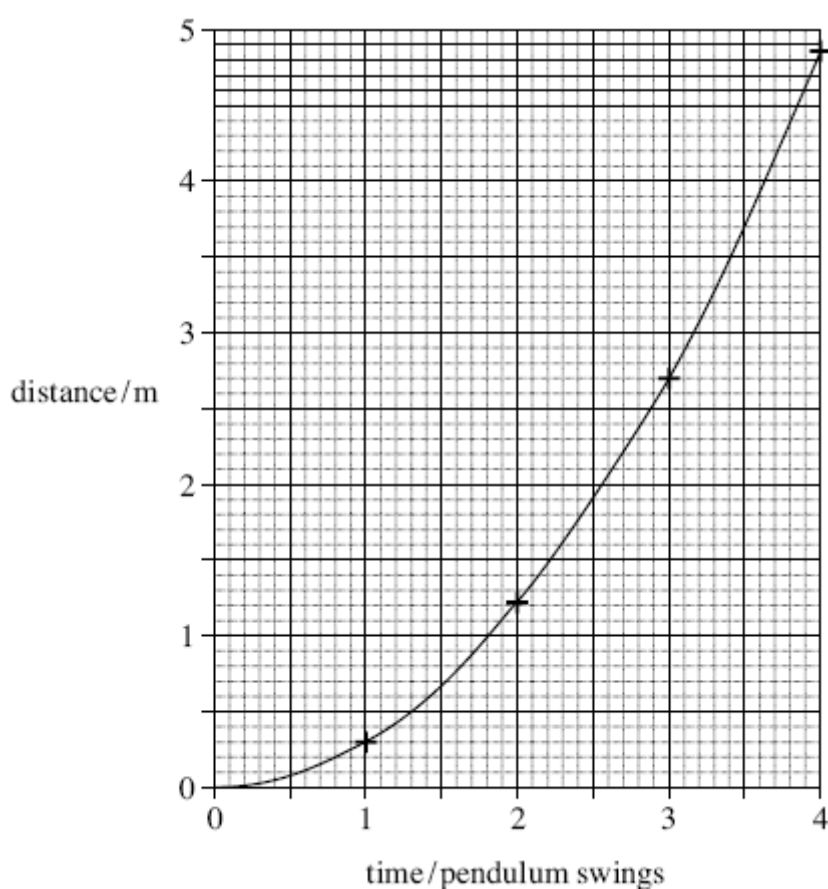
(ii) Calculate the initial acceleration down the slope.

answer = _____ m s^{-2}

(2)

(c) In this experiment, the following data was obtained. A graph of the data is shown below it.

time / pendulum swings	distance travelled /m
1	0.29
2	1.22
3	2.70
4	4.85



From the graph above, state what you would conclude about the motion of the trolley?

Give a reason for your answer.

(2)

- (d) Each complete pendulum swing had a period of 1.4 s. Use the graph above to find the speed of the trolley after it had travelled 3.0 m.

answer = _____ m s⁻¹

(3)

(Total 11 marks)