HOLY CROSS COLLEGE

Life to the Full

Western Australian Certificate of Education
ATAR course examination, 2017

Question/Answer Booklet

11 PHYSICS

Name SOLUTIONS

Evaluation 2 - Radioactivity

Student Number: In figures | | | | | | | | |

Mark: ___/25

In words _____

_____

Time allowed for this paper

Reading time before commencing work: 5 minutes
Working time for paper: 70 minutes

Materials required/recommended for this paper

To be provided by the supervisor

This Question/Answer Booklet
Formulae and Data Booklet

To be provided by the candidate

Standard items: pens, (blue/black preferred), pencils (including coloured), sharpener, correction fluid/tape, eraser, ruler, highlighters

Special items: non-programmable calculators satisfying the conditions set by the School Curriculum and Standards Authority for this course

one A4 page of notes - handwritten

Important note to candidates

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

Structure of this paper

Section	Number of questions available	Number of questions to be answered	Suggested working time (minutes)	Marks available	Percentage of exam
Section One: Short Answers	-	-	-	-	-
Section Two: Problem-solving	8	8	70	25	100
Section Three: Comprehension	-	-	-	-	-
				Total	100

Instructions to candidates

1. The rules for the conduct of examinations at Holy Cross College are detailed in the College Examination Policy. Sitting this examination implies that you agree to abide by these rules.

2. Write your answers in this Question/Answer Booklet.

3. Working or reasoning should be clearly shown when calculating or estimating answers.

4. You must be careful to confine your responses to the specific questions asked and to follow any instructions that are specific to a particular question.

5. Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.

   - Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
   - Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

6. Answers to questions involving calculations should be ***evaluated and given in decimal form.*** It is suggested that you quote all answers to ***three significant figures***, with the exception of questions for which estimates are required. Despite an incorrect final result, credit may be obtained for method and working, providing these are ***clearly and legibly set out***.

7. Questions containing the instruction "estimate" may give insufficient numerical data for their solution. Students should provide appropriate figures to enable an approximate solution to be obtained. Give final answers to a maximum of two significant figures and include appropriate units where applicable.

8. Note that when an answer is a vector quantity, it must be given with magnitude and direction.

9. In all calculations, units must be consistent throughout your working.

A sample of thorium-234 was placed in storage for nearly 1 year. While it was in storage, its activity was monitored regularly by an automatic sensor that was placed 10 cm from the sample.

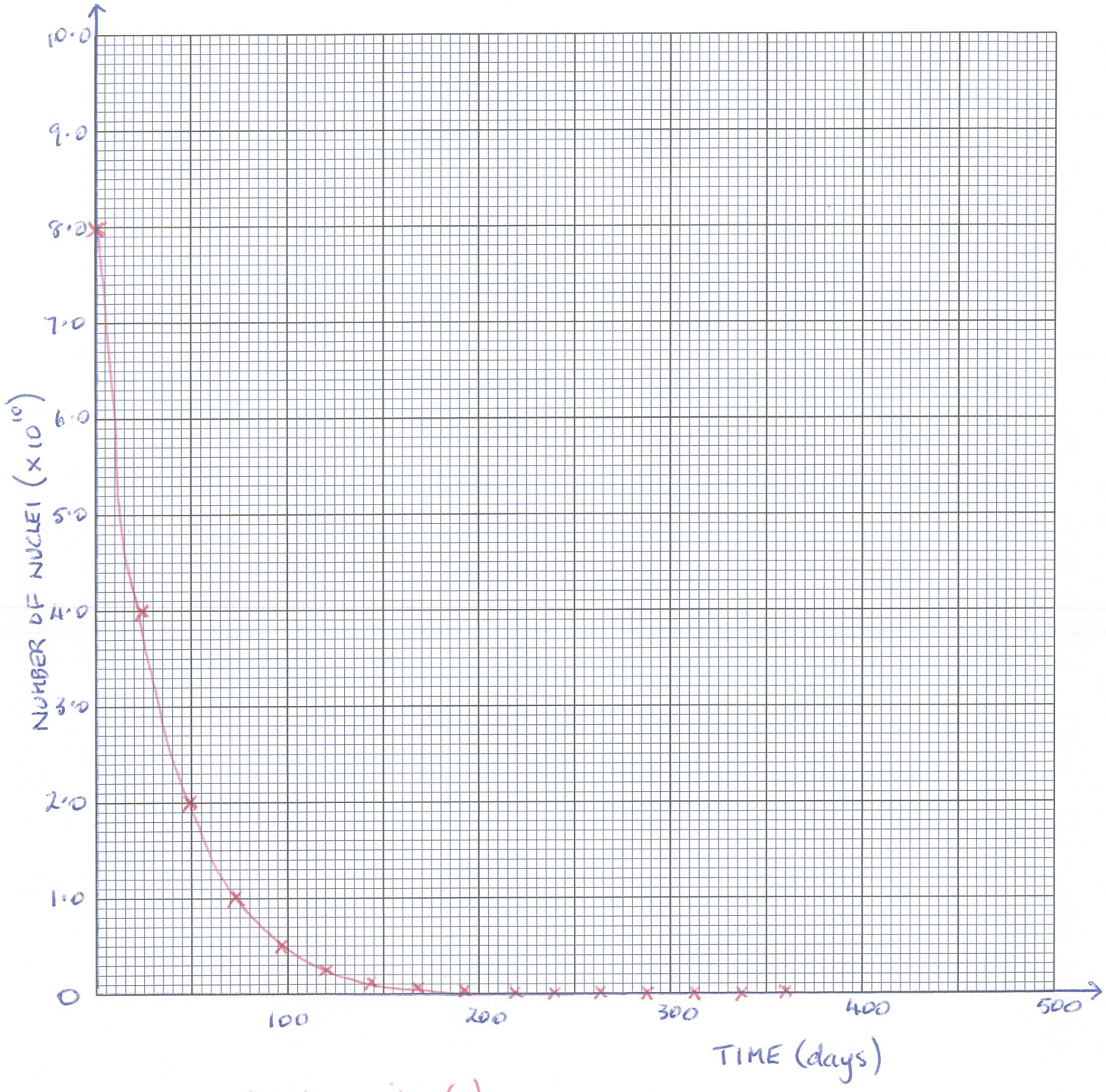
Let N_o = the original number of nuclei of radioactive material.
Let N = the number of nuclei of radioactive material present after n half-lives have passed.

Therefore: $N = \frac{N_o}{2^n}$

1. Use the above relationship to complete the data table below. (3 marks)

Time, *t* (days)	No. of half-lives, (*n*)	No. of nuclei of radioactive isotope (*N*)	Activity 10 cm from sample (Bq)
0	0	8.0×10^{10}	1900
24	1	4.0×10^{10}	950
48	2	2.0×10^{10}	475
72	3	1.0×10^{10}	238
96	4	5.0×10^{9}	119
120	5	2.5×10^{9}	60
144	6	1.2×10^{9}	30
168	7	6.2×10^{8}	15
192	8	3.1×10^{8}	8
216	9	1.6×10^{8}	4
240	10	8.0×10^{7}	2
264	11	4.0×10^{7}	1
288	12	2.0×10^{7}	0.5
312	13	1.0×10^{7}	0.2
336	14	5.0×10^{6}	0.1
360	15	2.5×10^{6}	0.05
	(1)	(1)	(1)

2. On graph paper below, produce a fully labelled graph of N versus t. (4 marks)



Labels + units (2)

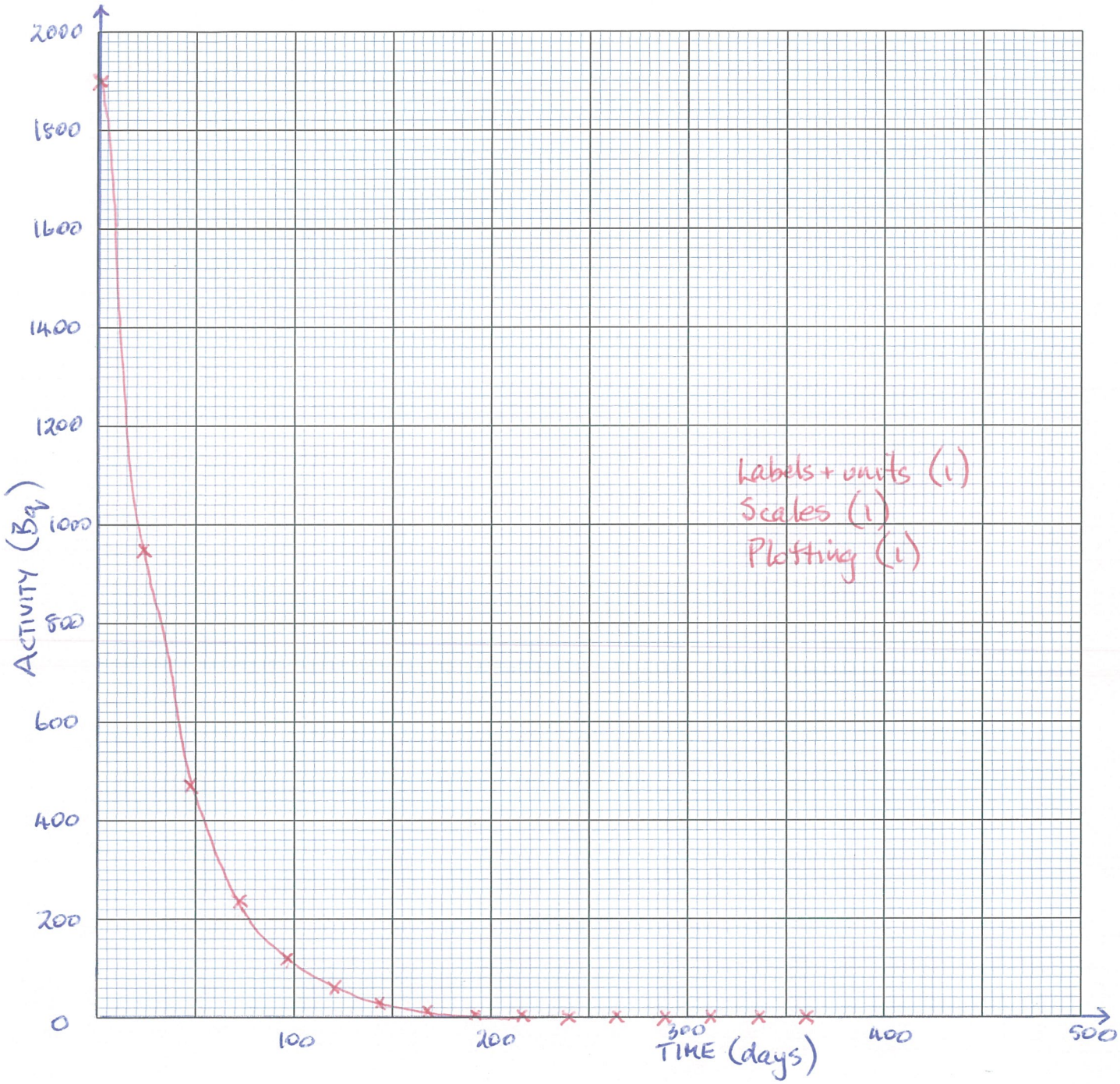
Plotting (1)

Scales (1)

3. What is the name for a curve of the shape shown in your graph of N versus t? (1 mark)

• Exponential decay (1)

4. On graph paper below, produce a fully labelled graph of activity versus time. (3 marks)



5. What is the half-life of thorium-234? 24 days (1 mark)

6. How many nuclei of thorium-234 decayed during the:

(a) first 24 days? $(8.0-4.0)\times10^{10} = 4.0\times10^{10}$ (1) (1 mark)

(b) first 96 days? $(8.0-0.5)\times10^{10} = 7.5\times10^{10}$ (1) (1 mark)

(c) last 96 days? $(4.0-0.25)\times10^{7} = 3.7\times10^{7}$ (1) (1 mark)

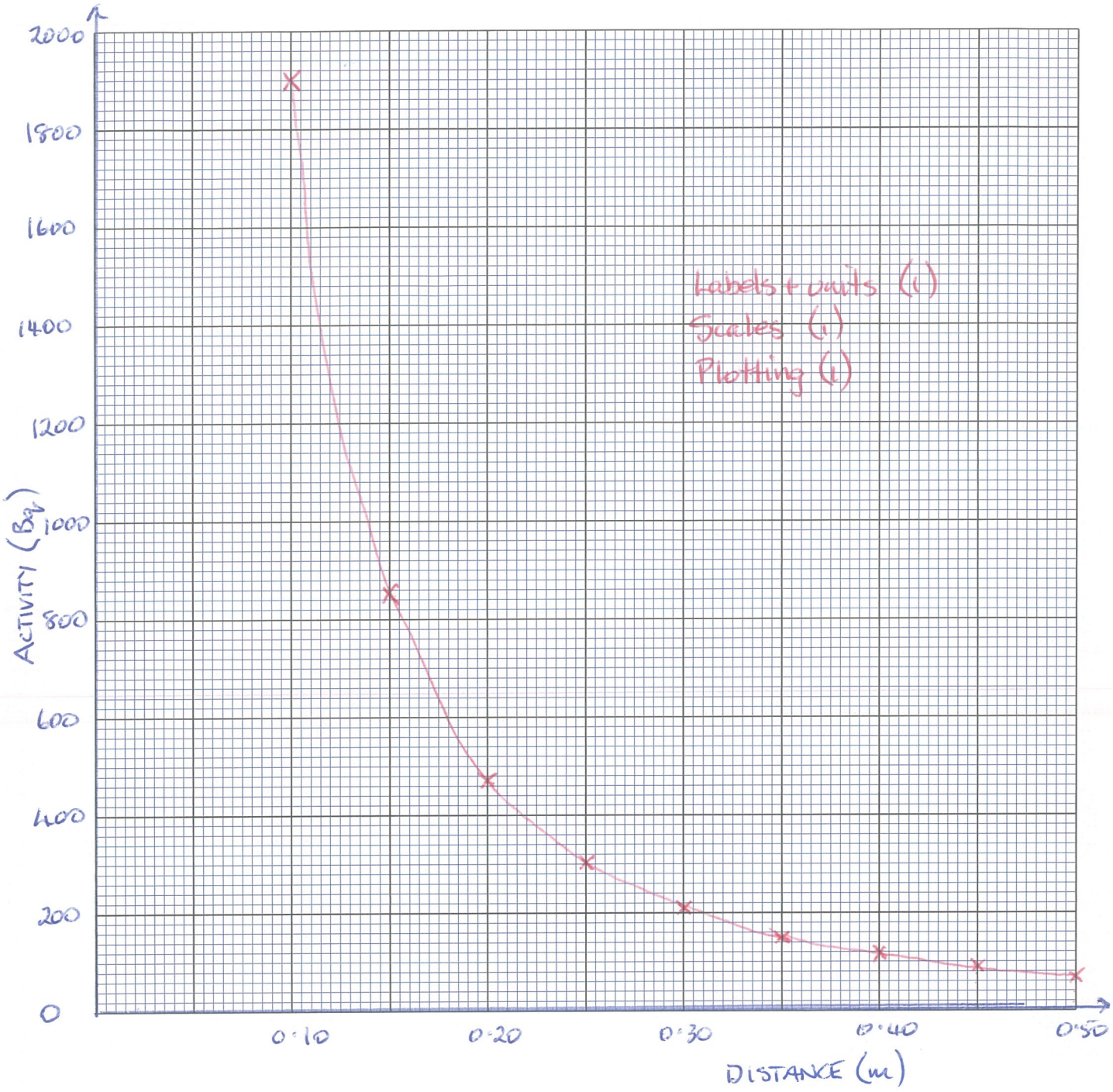
(d) last 24 days? $(5.0-2.5)\times10^{6} = 2.5\times10^{6}$ (1) (1 mark)

On the very first day, the activity of the same sample was measured at a range of distances from the source and the following results were obtained.

Distance from source (m)	Activity (Bq)	$\frac{1}{d^2}$ (m^{-2})
0.10	1900	100 (2sf)
0.15	844	44
0.20	475	25
0.25	304	16
0.30	211	11
0.35	155	8
0.40	119	6
0.45	94	5
0.50	76	4

(1)

7. On graph paper on the next page, plot a graph of activity versus distance from the source.
(3 marks)



8. You are required to construct a graph that will allow you to prove that the activity varies inversely with the square of the distance from the source. In doing this:

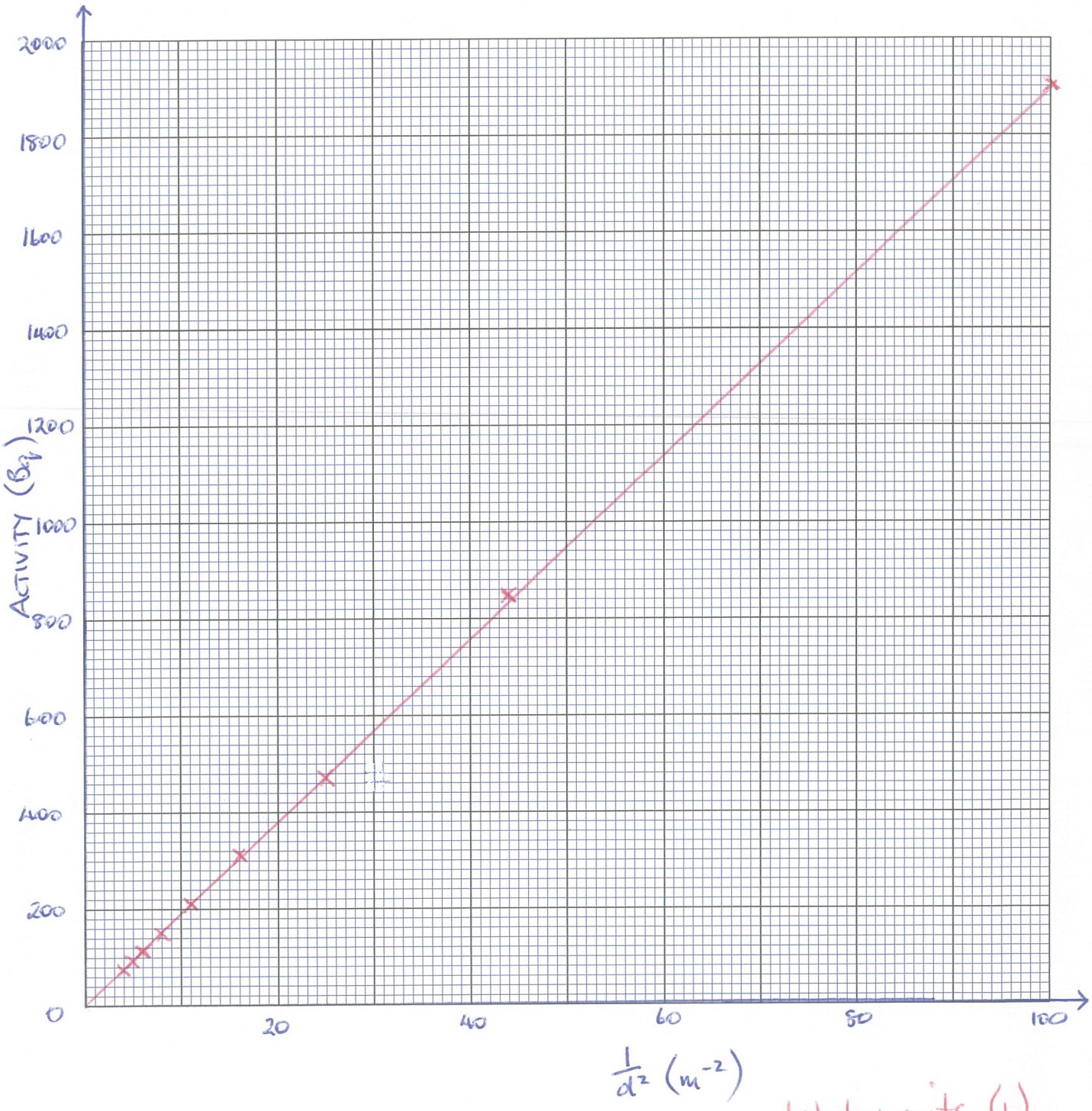
(a) What variables and units would you put on the y- and x-axes of a graph to confirm a relationship such as activity $\propto \frac{1}{d^2}$? (2 marks)

X-axis: $\frac{1}{d^2}$ (m^{-2}) (1) Y-axis: Activity (Bq) (1)

(b) If this relationship was confirmed, what shape would the graph take? (1 mark)

• linear (1)

(c) Manipulate your data and construct the graph that will allow you to prove that the activity varies inversely with the square of the distance from the source. (3 marks)



Labels + units (1)

Plotting (1)