



Unit Number

U3028611/KA4T

Key Skills

Application of Number

Level 4

Monday 14 November 2005

Total Marks: 50

No. of Questions: 5

Time: 2 hours 30 minutes

Materials required for examination

This test paper

An answer booklet

A pen with black or blue ink

A pencil and eraser

A ruler marked in mm and cm

2mm squared paper

A scientific calculator

You may use a bilingual dictionary

Instructions to Candidates

Do NOT open this test paper until you are told to do so by the supervisor.

In the boxes on the answer book, write your centre number, registration number, surname and initials. The paper reference is shown above.

Write in black or blue ink only.

At the end of the test, hand the test paper, the Answer Booklet(s) and all notes to the supervisor.

Information for Candidates

There are 5 questions to this test.

Question 1 - 6 marks

Question 2 - 10 marks

Question 3 - 8 marks

Try to answer ALL the questions.

Question 4 - 11 marks

Question 5 - 15 marks

Advice to Candidates

Make sure that your writing is clear, and show all your working.

Read each question carefully.

If you need extra paper, use a second answer booklet. Make sure you put your personal details on the front of this booklet too.

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Ref: AON/L4/3.2/P33/URN:434

- 1 A publishing company is launching a new book. The table below lists the activities that are involved in the production and launch of the book, along with the time allowed for each activity. Company policy dictates that certain activities must precede others during the project, as described below.

Activities involved in the launch of a new book

Activity	Time needed in days	Activities that need to be completed before proceeding
A - Check proofs of book	35	
B - Design and approve cover	60	
C - Produce cover	28	B
D - Production of books, first run	55	A and C
E - Send out promotion copies to TV, radio and book retailers	7	D
F - Arrange advertisements in the press	1	E
G - Arrange interviews on TV and radio	3	A and C
H - Accept orders, dispatch to the shops	21	E
I - Advertise in the press and arrange launch/book signing sessions	7	F and G
J - Filming/recording of interviews for TV and radio	4	I
K - Book launch with author present	1	H and J
L - Book signing sessions	2	K

- a Illustrate the above information using a suitable diagram, clearly showing the order in which the activities in the project should be carried out.

3 marks

- b Find the minimum number of days required for completion of the project, justifying your answer. State any assumptions made.

2 marks

The project is monitored as it progresses, and three changes are made to the schedule:

- More than one design is submitted for the cover, which means that activity B needs an extra 3 days for a decision to be reached.
 - Extra money becomes available to use a private carrier to deliver the books to the shops, so that activity H now needs 2 days less.
 - Technical difficulties experienced during filming of TV interviews result in activity J needing 3 additional days.
- c Explain the effect of these changes on the total time needed to complete the project.

1 mark

Total 6 marks

Please go on to the next page

2 The table below gives information about children held in secure accommodation.

Total places available, and children accommodated, in secure units by sex and by age, 1994–2003, England only

At 31 March	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Total places	290	265	275	330	415	435	435	430	425	425
Children accommodated	245	235	245	280	335	325	365	375	395	400
Male	190	190	195	235	275	230	265	285	285	275
Female	55	45	50	45	60	95	100	90	115	125
under 12	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	15	15	20	-	-	15
13	20	15	20	25	35	40	40	45	65	65
14	50	45	55	70	90	90	100	110	105	120
15	85	90	95	100	110	105	115	105	125	125
16	45	60	55	55	60	60	70	80	70	85
17	25	10	15	20	15	-	15	15	-	-
18+	10	-	0	-	-	0	-	0	0	0

Footnote: Numbers have been rounded to the nearest 5, numbers from 1 to 5 inclusive have been suppressed, being replaced in the table by a hyphen (-).
Source: www.dfes.gov.uk/statistics

a Describe, with supporting calculations, how the numbers of male and female children in secure accommodation have varied between the years 1994 and 2003.

2 marks

A report by the NSPCC included the statement:

'The number of children accommodated in secure units tends to peak at the age of 15 years'.

There is, however, a public perception that:

'The number of very young offenders is increasing'.

b Comment on the age distribution of children accommodated in secure units in 2003 compared with 1994, supporting your comments with appropriate calculations. Discuss whether the evidence from the table as a whole supports each of the statements above.

3 marks

The age distribution of children in secure accommodation needs to be considered for planning purposes.

- c Describe in detail one chart or graph that could be used to illustrate the changes in age distribution of children in secure accommodation over the time period.

2 marks

- d Estimate for the year 2008 the number of children that will need to be accommodated and the total places that should be provided by that date, justifying your answers.

2 marks

The footnote to the table details the rounding used in the numbers presented.

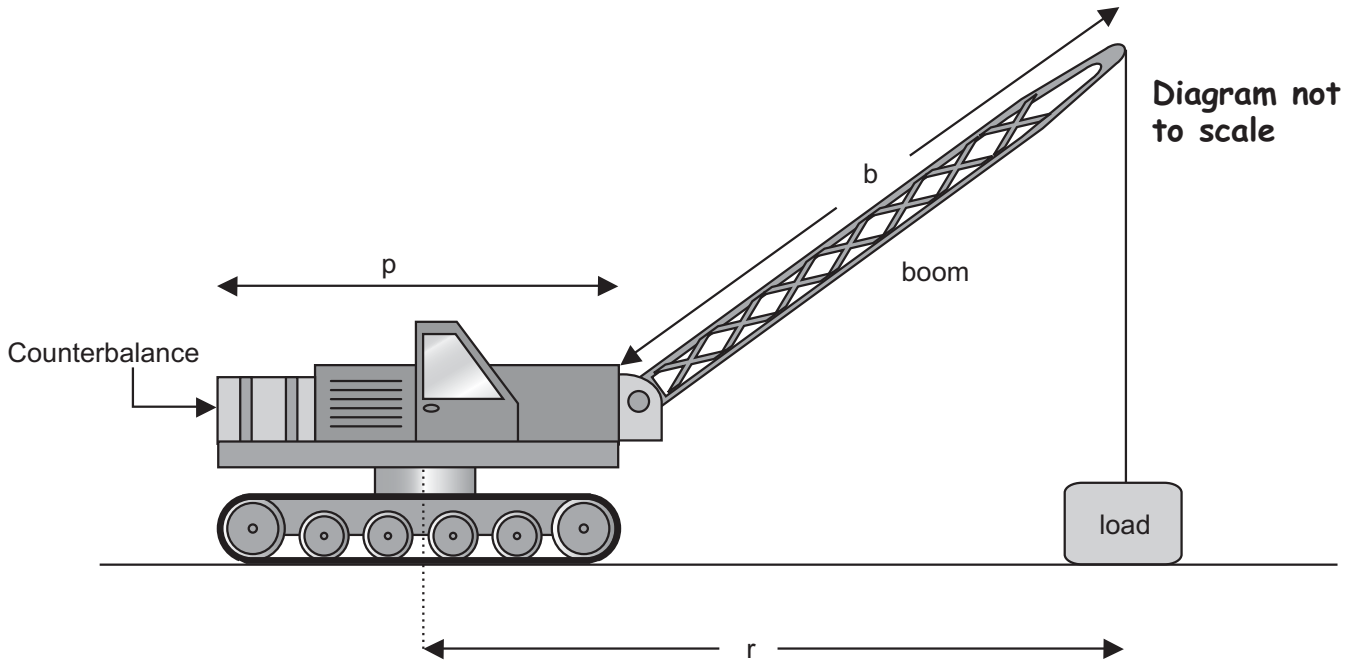
- e Comment on the effect that this approximation may have had on your analysis of the data.

1 mark

Total 10 marks

Please go on to the next page

- 3 A construction company uses a track-mounted mobile crane for lifting and moving heavy items. A simplified diagram of the crane is shown below. The crane platform can rotate on a central support.



The maximum load (L tonnes) that can be lifted by the crane is given by the following formulae:

$$L = \frac{0.5mp - 0.1bu}{r} \quad \text{where} \quad u = \frac{r - 0.5p}{2}$$

and:

m = mass of crane (including counterbalance) in tonnes

p = length of crane platform in metres

b = length of boom in metres

r = horizontal distance between the centre of the load and the centre of the crane platform, in metres

The construction company currently uses a crane of mass 15 tonnes (including counterbalance). Its platform is 3.0 metres long and has a fixed boom length of 10.7 metres. The height of the crane to the base of the boom is 1.75 metres.

The company needs to lift a 2.5-tonne concrete block across a building site. It is not possible to position the edge of the crane platform nearer than 6 metres away from the centre of the block to be lifted.

- a Verify that the crane can lift the concrete block and calculate an estimate of how far, vertically above its original position, the block can be lifted.

3 marks

For practical purposes, engineers within the company need the relationship between L and r presented in a format that will allow quick and easy reference. The maximum vertical height to which a load may be lifted is also required.

- b For the crane described above, demonstrate with the aid of examples, how this data could be suitably presented. Justify your choice of presentation.

3 marks

Two new track-mounted mobile cranes are being evaluated by the company. The first has a similar mass to their current crane but a longer boom and the second is heavier, but has the same boom length.

- c Comment on the advantages and disadvantages of changing to each of the two new cranes, in terms of lifting capability.

2 marks

Total 8 marks

- 4 An amateur cyclist is planning to complete a stage of the Tour de France, from Pau to Bayonne, in an event arranged by a French cycling magazine.

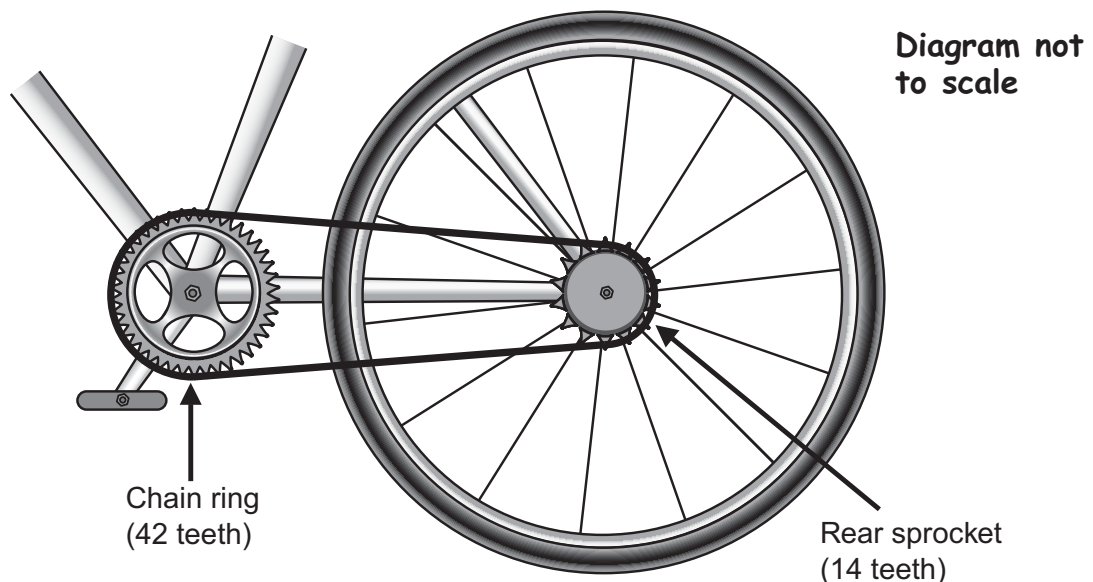
Diagram 1 shows a simplified version of the pedal system on his bicycle with one possible combination of chain ring and rear sprocket given. The pedals turn the chain ring, which is attached to a rear sprocket by a chain. The gear mechanism (not shown) involves changing combinations of different-sized rings and sprockets linked by the chain. This enables the cyclist to use different gear ratios to suit different conditions.

$$\text{Gear ratio} = \frac{\text{the number of teeth on the chain ring}}{\text{the number of teeth on the rear sprocket}}$$

The different-sized chain rings and rear sprockets for the cyclist's bicycle are as follows:

Chain rings (number of teeth)	52	42	30						
Rear sprockets (number of teeth)	25	23	21	19	17	15	14	13	12

Diagram 1



His bicycle has wheels that are 27 inches in diameter.

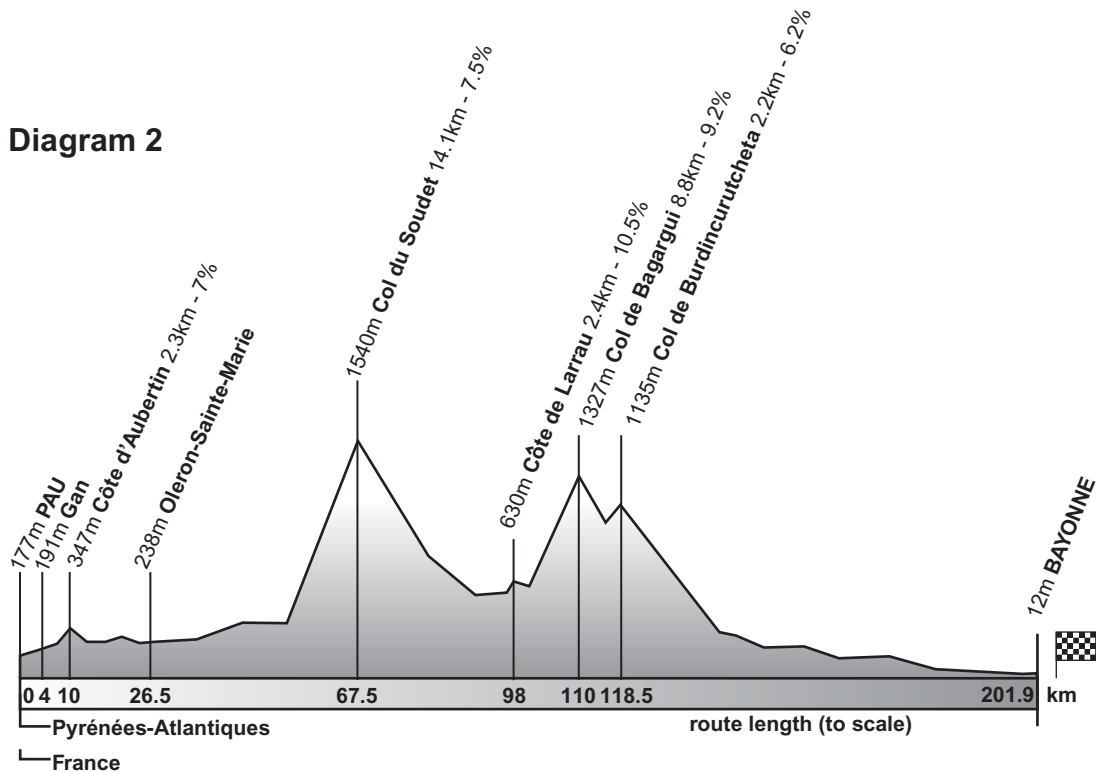
- a The cyclist's rate of pedalling is the number of complete revolutions the pedals make per minute. Explain why the speed of a bicycle can be found using the general formula:

$$\text{Speed} = \text{Circumference of wheel} \times \text{Rate of pedalling} \times \text{Gear ratio}$$

Use the formula for the bicycle described above to calculate the speed of this bicycle if the cyclist sustains a rate of pedalling of 70 revolutions per minute using the gear combination shown in Diagram 1.

3 marks

Diagram 2 shows a simplified profile of the stage with **route length (to scale)** along the base. For example, a competitor will cycle a distance of 10km from Pau to Côte d'Aubertin. The heights of selected points along the route are shown. For some of the peaks further information on the length and gradient of the climb is given.



Source: www.letour.fr/2003/presentationus/difficulties_07.html

- b Comment on the profile above in terms of the effectiveness of its presentation of information about the route for prospective competitors.

1 mark

The cyclist anticipates that he will sustain an average rate of pedalling of 60 revolutions per minute using the lowest gear ratio during the ascent of Col du Soudet.

c Estimate the time it will take him to complete this part of the climb.

3 marks

The following information was obtained from the competition website:

AGE CATEGORIES

Participants shall be ranked into 7 categories as follows:

- cat. A: Males 18 to 29
- cat. B: Males 30 to 39
- cat. C: Males 40 to 49
- cat. D: Males 50 to 59
- cat. E: Males 60 and over
- cat. F: Females under 35
- cat. G: Females over 35

PRIZES

Participants shall be awarded medals: GOLD, SILVER and BRONZE according to their performance time.

Categories	Distance kilometres	GOLD MEDAL		SILVER MEDAL	
		Time	Speed km per hour	Time	Speed km per hour
Elite +A	201.9	07:15:00	27.85	08:25:00	23.99
B	201.9	07:30:00	26.92	08:46:00	23.03
C	201.9	07:46:00	26.00	09:10:00	22.03
D	201.9	08:04:00	25.03	09:37:00	20.99
E	201.9	08:25:00	23.99	10:06:00	19.99
F	201.9	08:46:00	23.03	10:37:00	19.02
G	201.9	09:10:00	22.03	11:13:00	18.00

Source: <http://www.letapedutour.com/2003/us/index.htm>

The cyclist is 45 years old. He estimates that he can sustain a pedalling rate of 60 revolutions per minute in the lowest gear ratio on the climbs marked with gradients on the profile, and achieve an average speed of 40 kilometres per hour on steep downhill stretches in the mountains and 70 revolutions per minute using an average gear ratio of 3 on the remainder of the course.

d Evaluate the likelihood of the cyclist gaining a silver medal.

4 marks

Total 11 marks

- 5 Sports scientists have suggested that the ideal weight for fit males can be calculated from their height according to Table 1.

Table 1

Height and weight of fit males	
Height	Weight
First 1.5m	50kg
Each extra 5cm	Add 5kg

Source: Peak Performance

Table 2 lists the height and weight of 12 runners who have all won an Olympic gold medal, together with a recognised measure of body size, the Body Mass Index (BMI).

Table 2

Gold Medal Runners					
Type of Event		Athlete	Height (m)	Weight (kg)	BMI
Sprint	100m/200m	Carl Lewis	1.88	80	22.6
	100m	Linford Christie	1.89	77	21.6
	100m	Maurice Greene	1.77	80	25.5
	200m/400m	Michael Johnson	1.87	80	22.9
Middle Distance	1 500m	Herb Elliot	1.79	67	20.9
	1 500m	Sebastian Coe	1.78	54	17.0
	1 500m	Noureddine Morceli	1.72	62	21.0
	1 500m	Kip Keino	1.75	66	21.6
Long Distance	10 000m	Haile Gebrselassie	1.60	54	21.1
	5 000m	Million Wolde	1.75	57	18.6
	Marathon	Emil Zatopek	1.74	70	23.1
	Marathon	Josiah Thugwane	1.58	45	18.0

Source: Peak Performance, UK & USA Track and Field, UK Athletics, Global Sports, Steybe, Ethiosports

- a Investigate graphically the relationship between height and weight for the gold medal runners listed in Table 2, and evaluate to what extent it conforms to the sports scientists' suggestion given in Table 1.

5 marks

The American Physiological Society has published research suggesting that for current elite athletes, their body size is related to the event in which they compete.

As their research project, a group of sports science students is to carry out further research into this relationship, and to develop a model that could be used to predict in what event an aspiring athlete might perform best.

b Suggest two hypotheses that would be suitable for the students to test.

2 marks

c Outline a strategy that will use Level 4 application of number techniques to test the hypotheses, and then to develop and present a suitable model. You should identify the stages required to complete the project and describe the skills and techniques which they involve.

8 marks

Total 15 marks

End of test