FIRE SERVICES EXAMINATIONS BOARD

STUDY NOTE

EXAMINATION	SUB-OFFICERS EXAMINATION
PAPER	BUSINESS ADMINISTRATION
SUBJECT	KEY SKILLS
ITEM	APPLICATION OF NUMBER
STUDY NOTE No.	2401

INTRODUCTION TO THE STUDY NOTE

This study note has been prepared as the basis of study in connection with the qualifying examinations for promotion. Unfortunately, due to copyright issues part of the Note has now been removed.

However, candidates will be expected to demonstrate knowledge of the information contained in the study note and understand how it should be applied:

The 'References' made at the end of the Study Note are included for information only and candidates will not be expected to study these as part of the bibliography.

KEY SKILLS - APPLICATION OF NUMBER

1. Introduction

One of the key skills that a Sub-Officer requires in order to carry out the role is the ability to use numbers.

Numbers are used in all sorts of situations in both ordinary everyday life and at work.

Information on the fireground, on the station and in other workplace areas usually involves using numbers in one way or another.

(a) On the fireground

Measurement of area, distances, height, capacities etc.
Reference numbers of hazardous materials and action codes etc.
Time related references - fire investigation etc
Estimating resources to deal with incident - pumps, water, personnel, BA etc

(b) On the Station

Completion of fire reports, fire brigade incident costs, fire losses etc,
Staffing requirements etc.
Station management statistics such as sickness, categories of fire calls etc.
Orders and requisitions for goods and services.
Station accounts.

(c) In the Fire Safety Environment

Calculating travel distances for means of escape.
Reading plan drawings.
Calculating the area of coverage of fire extinguishers.

The above examples show the importance of the Key Skills, both to the Fire Service as the employer and to you as a potential Sub-Officer, and why they are included in the examination process.

2. Business Administration Paper

This section of the Business Administration Paper is different from the other written examination papers in that it tests your ability to tackle and solve problems involving numbers, rather than your technical knowledge and expertise in the field of fire fighting.

It is intended to test your ability to use numbers to describe situations, make estimations, make calculations and present the results in a manner that is appropriate to the level of numeracy that is expected of a Sub-Officer in the course of normal day to day duties. Where possible the questions will be framed in a fire service situation so that you can understand the setting.

There are two compulsory questions set out to test your ability to do the following.

(a) Question 1. Tackle Problems.

The key skills that will need to be demonstrated are that you can:

(a) Choose and use techniques, which suit the problem

(b) Do things in the right order

(c) Choose and use appropriate units

(d) Do things to the level of accuracy needed

(e) Use mathematical terms correctly

(f) Carry out your calculations correctly

(g) Make checks to confirm your results

(h) Check your results make sense.

The question may include the requirement to tackle a problem using at least two of the following techniques:

Number: numbers of any size (+ - × ÷), fractions, decimal fractions, percentages, ratios, simple formulas.

Shape, space and measurement: common units of measurement, perimeters, areas, volumes of shapes and cylinders.

Handling data: converting between common units using scales and tables, converting using calculations, calculating and using mean, median, mode, range.

Using Formula: manipulate, rearrange and transpose formula to calculate a volume, an area or a quantity etc.

(b) Question 2. Interpret and present data.

The key skills that will need to be demonstrated are that you can:

(a) Explain the main features of the data

(b) Choose techniques, which present your data well

(c) Use appropriate axes and labels

(d) Present your results to the level of accuracy needed and

(e) Explain how your results relate to the problem.

This question will expect candidates to either present written data in a form such as:

A plan, a drawing, a pictogram, a bar chart, a pie chart or a graph or explain the main features of the data and how it relates to a problem if presented in the above form.

(c) General

Your answers will be expected to show that you can work to a high level of accuracy in a range of settings that could be used at work. For example, when handling the station budget or when processing stores and petty cash, where mistakes could cost money and be time consuming.

The examination may include the requirement to

(1) Work out the cost of items

(2) Work out areas and volumes

(3) Work out survey results

(4) Present a graph or bar chart etc and explain its features

(5) Interpret a graph or plan etc showing its main features

(6) Make a calculation from a given formula

(7) Make a calculation after transposing a simple formula.

(d) Preparation for the Examination

If you have not kept up to date in the key skills of using numbers, you may find that you are unprepared for this section of the examination.

It is important therefore that you familiarise yourself with the techniques of basic mathematics and practice their application.

3. Example Questions

On the following pages are a number of example questions together with model answers of a type that could be used in the examination. These questions use some of the techniques that have been described above and are set in a fire service scenario.

Additionally, Appendices A1 to A5 in the Fire Service Manual Volume 1, Hydraulics, Pumps and Water Supplies contain further areas for study and revision.

Example Question 1

A pre-planning assessment of an incident indicates that a continuous supply of 250 litres will be required for an indefinite period.

The nearest hydrant yields 600 litres/minute and involves a round trip travelling time of 15 minutes.

A water tender holds 1800 litres and a water carrier 9000 litres of water.

The appliances can discharge water at 900 litres/minute.

Allow a total of 1 minute for the connection and disconnection of hoses for each journey.

In order to meet the requirement of the planned assessment:

(a) **How many water tenders will be required to maintain a continuous supply at the incident?**

Action 1

To calculate how long the water supply of a water tender would last.

The answer will be in minutes.

So time will be $\frac{\text{water on water tender}}{\text{amount required/minute}} = \frac{1800}{250}$

$= $ **7.2 minutes (say 7 minutes).**

Action 2

To calculate time taken for one complete round trip.
(ie to refill the water tender, make journey and discharge).

The answer will be in minutes.

So (i) time taken to fill the tank =

$\frac{\text{capacity of water tender}}{\text{hydrant yield}} = \frac{1800}{600}$

$= $ **3 minutes.**

(ii) time taken to discharge the tank =

$\frac{\text{capacity of water tender}}{\text{rate of discharge}} = \frac{1800}{900}$

$= $ **2 minutes.**

So total time required is:

time to fill tank	=	3 minutes
+ time taken for round trip	=	15 minutes
+ time taken to connect and disconnect hoses	=	1 minute
+ time taken to discharge water	=	2 minutes
TOTAL	=	**21 minutes**

Action 3

To calculate number of water tenders required.

The answer will be in water tenders.

So $\frac{\text{total time taken to complete supply process from water tender}}{\text{time supply will last at incident}}$

$= \frac{21}{7}$

= **3 water tenders.**

(b) **How many water carriers are required to maintain a continuous water supply at the incident?**

Action 1

To calculate how long the water supply of a water carrier would last.

The answer will be in minutes.

So time will be $\frac{\text{water on water carrier}}{\text{amount required/minute}} = \frac{9000}{250}$

= **36 minutes.**

Action 2

To calculate time taken for one complete round trip.

The answer will be in minutes

So (i) time taken to fill the tank =

$\frac{\text{capacity of water carrier}}{\text{hydrant yield}} = \frac{9000}{600}$

= **15 minutes.**

(ii) time taken to discharge the tank =

capacity of water carrier / rate of discharge = 9000 / 900

= **10 minutes.**

So total time required is:

time to fill the tank	=	15 minutes
+ time taken for round trip	=	15 minutes
+ time taken to connect and disconnect hoses	=	1 minute
+ time taken to discharge water	=	10 minutes
TOTAL	=	**41 minutes**

Action 3

To calculate number of water carriers required.

The answer will be in water carriers.

So total time taken to complete supply process from water carrier / time supply will last at incident

= 41 / 36

= **1.14 water carriers.**

This would need to be rounded up to **2 water carriers** for practical purposes.

(c) **The round trip to the hydrant is 9km. A water tender averages 6km/litre and the water carrier averages 3km/litre. The fuel costs £0.60/litre. If the total amount of water used is 90,000 litres, all of which needs to be obtained from the hydrant, what will be the difference in the cost of fuel used by these appliances?**

Action 1

To calculate the number of round trips needs by each type of appliance to supply 90,000 litres of water.

The answer will be in trips.

(i) for water tender:

So number of trips =

$$\frac{\text{total amount of water required}}{\text{amount carried/trip}} = \frac{90000}{1800}$$

$$= \textbf{50 trips.}$$

(ii) for water carrier:

So number of trips =

$$\frac{\text{total amount of water required}}{\text{amount carried/trip}} = \frac{90000}{9000}$$

$$= \textbf{10 trips.}$$

Action 2

To calculate number of km travelled by each type of appliance.

The answer will be in km.

(i) by water tender:

So number of km = number of trips x number of km/round trip

$$= 50 \times 9$$

$$= \textbf{450 km.}$$

(ii) by water carrier:

So number of km = number of trips x number of km/round trip

$$= 10 \times 9$$

$$= \textbf{90 km.}$$

Action 3

To calculate number of litres of fuel used by each type of appliance.

The answer will be in litres.

(i) for water tender:

So number of litres used =

$$\frac{\text{number of km travelled}}{\text{average km/litre}} = \frac{450}{6}$$

= **75 litres.**

(ii) for water carrier:

So number of litres used =

$$\frac{\text{number of km travelled}}{\text{average km/litre}} = \frac{90}{3}$$

= **30 litres.**

Action 4

To calculate the cost of fuel used by each type of appliance.

The answer will be in £p.

(i) for water tender:

So cost of fuel = number of litres used x cost/litre of fuel

= 75 x 0.60

= **£45.00.**

(ii) for water carrier:

So cost of fuel = number of litres used x cost/litre of fuel

= 30 x 0.60

= **£18.00.**

Action 5

To calculate the difference in the cost of fuel used by the appliances.

The answer will be in £.

So the difference =

higher cost of fuel (water tender)	=	£45.00
minus lower cost of fuel (water carrier)	=	£18.00
	=	**£27.00**

Example Question 2

A storage tank measures 10 metres in diameter and 10 metres in height and is full of water.

(a) **How much water, in litres, is in the storage tank?**

Action 1

To calculate the volume of the tank.

This answer will be in cubic metres.

Volume of the tank = $\pi r^2 h$ where π = 3.142
r = radius of the tank
h = height of the tank

Radius of the tank = $\frac{\text{diameter of the tank}}{2}$ = $\frac{10 \text{ metres}}{2}$
= 5 metres

So Volume of the tank = 3.142 x 5 x 5 x 10 = **785.5 cubic metres.**

Action 2

To calculate how much water is in the tank.

This answer will be in litres.

As there are 1000 litres in a cubic metre, the total capacity of the tank, in litres, is obtained by multiplying the volume by 1000.

So, as the tank 'is full' of water,
amount in the tank = 785.5 x 1000

= **785,500 litres.**

(b) Using the water from this supply and given the following flow rates:

45mm diameter hose = 300 litres/minute
70mm diameter hose = 600 litres/minute
90mm diameter hose = 1200 litres/minute

(i) If 3 small jets attached to 45mm diameter hose and 6 large jets attached to 70mm diameter hose are got to work, how long would the water in the tank last (to the nearest 5 minutes)?

Action 1

To calculate water required for 3 small jets using 45mm diameter hose.

This answer will be in litres/minute.

So water required for 45 diameter hose (300) x number used (3) = 300 x 3

= 900 litres/minute.

Action 2

To calculate water required for 6 large jets using 70mm diameter hose.

This answer will be in litres/minute.

So water required for 70mm diameter hose (600) x number used (6)

= 600 x 6

= 3600 litres/minute.

Action 3

To add these amounts together to establish total demand in litres/minute for these jets.

= 900 + 3600

= 4500 litres/minute.

Action 4

To calculate the time that the water supply will continue to supply these jets.

The answer will be in minutes.

So time that the water supply will last =

$$\frac{\text{total water capacity of the tank}}{\text{required water supply/minute}} = \frac{785{,}500}{4500}$$

= 174.5 minutes.

Action 5

To express this 'to the nearest 5 minutes' = 175 minutes.

Should you wish to express this in hours and minutes, divide number of minutes by 60 minutes in the hour.

$$= \frac{175}{60}$$

= **2 hours and 55 minutes.**

(ii) **If it will take one hour to set up a water relay, calculate how much water would be left in the storage tank after one hour if you also got to work 4 small monitors attached to 90mm diameter hose.**

Action 1

To calculate how much water required by 4 small monitors using 90mm diameter hose.

This answer will be in litres/minute.

So water required for 90mm diameter hose(1200) x number used (4)

= 1200 x 4

= **4800 litres/minute.**

Action 2

To calculate how much water used by all the jets and monitors for one hour.

This answer will be in litres.

So amount used by each in one hour

= total amount used by each/minute x 60

= (900 + 3600 + 4800) x 60

= 9300 x 60

= **558 000 litres.**

Action 3

To calculate amount of water left in the storage tank after one hour.

This answer will be in litres.

Remaining water = original capacity – water used in one hour

= 785,500 – 558,000

= **227,500 litres.**

(iii) **Using the water at the rate identified in (ii) above, how much longer would the water supply in the tank last after the one hour should the water relay be delayed?**
(calculation to be to the nearest 5 minutes)

Action 1

To calculate how long the remaining water, as identified in (ii), would last.

This answer will be in minutes.

So time remaining:

$$= \frac{\text{amount of water remaining in the storage tank}}{\text{amount of water being used/minute}}$$

$$= \frac{227\ 500}{9300}$$

= **24.46 minutes.**

Action 2

To express this 'to the nearest 5 minutes' = **25 minutes.**

Example Question 3

(a) In calculating a brigade's standard spending assessment (SSA) the population based element is found by multiplying the rate per person by its population. From the information given below calculate the total population based element;

(b) From the total amount given for the fire safety element, work out the amount allocated per person for fire safety;

(c) If the difference between the total SSA and the sum of the population based element plus the fire safety element is the amount allocated for pensions, how much is allocated for pensions?

(d) Work out the percentage difference between brigade spend and SSA;

(e) If the difference between the brigade spend and SSA is divided equally amongst all the population, how much does this amount to per person?

(f) If the brigade reduced its spend by 2% but SSA remained the same, how much would be saved per person?

Information:

Population:	492,113
Rate per person:	£19.35
Fire safety element:	£1,181,190
Total SSA:	£12,666,776
Brigade spend:	£15,631,270

Model Answer

(a)	Rate per person:		£19.35
	Multiplied by population:		492,113
	Answer:		**£9,522,386**
(b)	Amount given for fire safety:		£1,181,190
	Divide by population:		492,113
	Answer:		**£2.40**
(c)	Total of population element:		£9,522,386
	and fire safety:		£1,181,190
			£10,703,576
	Gap = total SSA:		£12,666,776
	- 2 elements:		£10,703,576
	Answer:		**£1,963,200**
(d)	Difference between brigade spend:		£15,631,270
	and SSA:		- £12,666,776
			£2,964,494
	% = Difference calculated above	=	£2,964,494 x 100
	Divide by SSA/multiplied by 100 to obtain %		£12,666,776 1
	Answer:		**23.40%**
(e)	Gap = Difference calculated above		£2,964,494
	Divide by population:		492,113
	Answer:		**£6.02**

(f)	2% of spend	=	£15,631,270 x 2/100
		=	£312,625
	New spend: Brigade spend	=	£15,631,270
	-2% of spend	-	£312,625
		=	£15,318,645
	New gap: New brigade spend	=	£15,318,645
	- SSA	=	£12,666,776
		=	£2,651,869
	New cost per person: New gap	=	£2,651,869
	Divide by population:		492,113
		=	£5.39
	Saving: Old cost	=	£6.02
	- New cost	-	£5.39
	Answer:		**63p**

Example Question 4

Given the information in the attached table, work out the following:

(a) The average number of FDR1 fires per year for the years given;

(b) The percentage rise in small fires in 1995 from the 1991 base;

(c) The percentage reduction in malicious calls in 1995 from their peak year;

(d) In which year did the median occur in the numbers of:
(i) false alarms malicious;
(ii) chimney fires;

(e) If the average yearly increase in special service calls were added to the 1995 figure to predict the 1996 figure what would this be?

Incident Type	1991	1992	1993	1994	1995
FDR1 Fires	121	129	136	145	162
Small Fires	207	211	286	271	587
Chimney Fires	25	31	27	38	26
False alarms (good intent)	156	186	193	195	202
False alarms (due to apparatus)	103	119	131	149	161
False alarms (malicious)	87	109	128	114	96
Special Service Calls	115	134	152	172	188
TOTALS	814	919	1,053	1,084	1,422

Model Answer

(a) Mean = total divided by N

$$= \frac{121 + 129 + 136 + 145 + 162}{5} = \frac{693}{5}$$

Answer: 138.6

(b) 1995 = 587
1991 = 207
difference = 380

$$\% \text{ rise} = \frac{380}{207} \%$$

Answer: 183.5%

(c) 1995 = 96
peak = 1993 = 128
difference = 32

$$\%\text{age} = \frac{32}{128} \%$$

Answer: 25%

(d) (i) = numbers are 87 109 128 114 96
arrange in order 87 96 109 114 128

median = 109

Answer: 1992

(ii) number 25 31 27 38 26
arrange in order 25 26 27 31 38

median = 27

Answer: 1993

(e) Average increase = $\frac{\text{total of increase each year}}{\text{N (number of years)}}$

	91-92	92-93	93-94	94-95
=	19	18	20	16

$$\text{total} = \frac{73}{4} = 18$$

1995 = 188 + 18

Answer: 206

Example Question 5

The attached chart shows the running costs of 6 retained stations. From the figures provided calculate the following:

(a) The cost of uniforms is a set amount per firefighter. Stations A3, A4, A5 and A6 all have the same number of firefighters, A2 has one less. How much is allowed per uniform?

(b) How many firefighters are there on each of the stations and what is the number of firefighters on these six stations?

(c) By what percentage does A6 exceed the average cost of heating and lighting all the stations?

(d) What is the median cost of telephone calls?

RETAINED FIRE STATION COSTS FOR 1998/99						
	A1 £	A2 £	A3 £	A4 £	A5 £	A6 £
Employee Costs – Basic	15,532	18,287	19,810	19,688	17,786	22,467
Employee Costs – Taxable Allowance	10,674	12,343	11,260	15,667	9,807	27,795
Employee Costs – N.Ins	113	582	324	388	118	1,407
Ground Maintenance	166	246	144	0	176	400
Heat and Light	1,364	835	962	788	695	2,060
Rent and Rates	3,472	1,767	1,976	923	1,152	8,157
Water Rates	218	359	94	40	32	443
Metered Water	74	0	60	230	71	204
Cleaning	0	0	0	0	0	406
Refuse Collection	0	122	0	0	0	54
Communications	165	203	165	171	164	167
Phones	164	122	171	171	170	251
Stock Issues	178.75	146.25	162.50	162.50	162.50	162.50
Uniforms	2,173.93	1,778.67	1,976.30	1,976.30	1,976.30	1,976.30
Capital Cost of Vehicles	6,690	6,690	6,690	6,690	6,690	6,690
Building Repairs	400	652	1,431	1,678	74	7,582
TOTAL ANNUAL COST	41,385	44,133	45,226	48,573	39,074	80,222

Model Answer

(a) Cost of uniforms A3, 4, 5, 6 = £1,976.30
Cost of uniforms A2 = £1,778.67

Answer: £197.63

(b) A1 $\frac{2,173.93}{197.63} = 11$

A2 $\frac{1,778.67}{197.63} = 9$

A3, 4, 5, 6 $\frac{1,976.30}{197.63} = 10$

Total = (4 x 10) + 9 + 11 = 60

Answer: 60

(c) Average cost of heating and lighting

= A1 + 2 + 3 + 4 + 5 + 6 ÷ 6

$= \frac{1,364 + 835 + 962 + 788 + 695 + 2,060}{6} = \frac{6,704}{6}$

= £1117.33

difference between A6 and the average

2,060 - 1117.33 = 942.67

$\therefore$ %age excess $= \frac{942.67}{1117.33} \times \frac{1}{100} = 84.37\ \%$

Answer: 84%

(d) Rank the costs

122 164 170 171 171 251

As there is an even number take the middle 2 and divide by 2

$\frac{170 + 171}{2} = 170.50$

Answer: £170.50

References

"Key Skills" Level 3, Published by the National Council for Vocational Qualifications.

Fire Service Manual Volume 1 Hydraulics, Pumps and Water Supplies.

Fire Services Examinations Board.