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Abstract

A series of pilot and regular experiments were conducted to investigate memory checking processes. The first set of experiments developed a set of six different tests for the measurement of memory checking. Correlational studies of these tests demonstrated that they could be used reliably and that the different tests are measuring the same basic processes. The second set of experiments examined the correlations between memory checking and other measures of personality and cognition. No important relationships between memory checking and other individual differences were found. The third set of experiments related memory checking to the clinical meaning of repression. It was found that subjects who underwent an intensive abreactive form of psychotherapy showed significant and lasting increases in their memory monitoring scores. A psychophysiological theory of the meaning of memory monitoring was developed to explain these clinical findings.

Introduction

The purpose of this research was to investigate basic memory searching and memory checking processes. Specifically, it sought to: a) develop special tests of memory checking accuracy, b) relate these tests to the measures of personality and cognition, c) find experimental means of varying the memory checking process, and d) develop a theory of the psychological meaning of memory checking.

Detailed background discussion and references on the type and development of appropriate materials to be used in this study were presented in previous Progress Reports (December 1969, June 1970) and in the Grant Proposal. Only a brief review of studies on memory checking will be given here.

The first research studies demonstrated that people are often able to check upon the contents of their memories even when they are unable to retrieve those contents (Hart, 1965, 1966, 1967B, 1967C). The cognitive process yielding content predictions was called the memory-monitoring process. The same research also indicated that the checking that occurs after memories are retrieved is also of significance; this post-retrieval process is called answer-evaluation.

These experiments developed a basic test paradigm for the assessment of memory-monitoring accuracy. Use was made of one of the best established facts of verbal learning: recognition exceeds recall. People can almost always recognize more correct answers than they can produce.

From this fact the following RJR (recall-judgment-recognition) paradigm was applied as a way of studying the accuracy of memory-monitoring experienced: a) Ss were given a test of recall and, for those items they cannot answer, they were instructed to make a judgment about whether or not they felt they knew the correct answer well enough to recognize it among several wrong alternatives; b) they were then given a multiple choice recognition test covering the same items that appeared in the test of recall. When the memory-monitoring process is accurate Ss do better on those recognition test items which they felt they knew but couldn't recall than on those items which they felt they didn't know.

Memory checking accuracy scores were obtained in all these experiments by segregating the items, according to the Ss judgments and the recall and recognition outcomes, into true positives, false positives, true negatives and false negatives. These raw scores were then combined into proportions and differences to yield a single accuracy index. For example, memory-monitoring accuracy = [TP/TP + FP) - (FN/TN + FN)]. All of the cited experiments provided convincing evidence for the accuracy of memory checking processes when they are evaluated in this way.

Other investigators supplied converging evidence through other methods of assessing memory checking accuracy. Brown and McNeill (1966) related the memory monitoring process to the retrieval products of a memory search. They demonstrated that, while in a feeling-of-knowing state, and before recall occurred, Ss had knowledge of: a) some of the letters of the missing word, b) the number of syllables in it, and c) the location of the primary stress. Also, as Ss came closer to successful recall, their information becomes more accurate.

Freedman and Landauer (1966) applied the RJR paradigm to another set of recall and recognition questions and replicated my findings. They also found that "providing the initial letter of the correct answer significantly facilitated recall as compared to provision of an incorrect first letter or no letter clue" (p. 329). This means that feeling-of-knowing experiences are not merely the outcomes of fixated searches.

Other research (Hart, 1967a) has examined individual differences in memory checking accuracy. In this investigation the answer-evaluation process was found to operate with exquisite accuracy for some Ss; they could say almost without error whether their retrievals were right or wrong. Nonetheless, there were individual differences. Some Ss were actually more often wrong than right in evaluating the correctness of their answers. Statistics indicate that the two memory checking processes, answer-evaluation and memory-monitoring, are basically different. The correlations between them average only $r = .22$ while, on the same tests, correlations between recall and recognition scores average $r = .90$.

These results on individual differences are followed up and elaborated in the research to be presented.

In summary, the evidence suggests that memory checking is an accurate and important cognitive process on which Ss differ. The evidence does not provide empirical or theoretical links between the memory checking processes and other psychological variables.

Methods and Results

This presentation of what was done on the project and the results obtained will be divided into three sections corresponding to the three major thrusts of the research program: a) the development of memory checking tests, b) the connections between memory checking tests and measures of personality and cognition, and c) ways of experimentally altering memory checking scores. These researches and results will then be brought together in the discussion section.

The Development of Memory-Checking Tests

We found that the memory-checking tests that were available, which

had been used in previous studies, were not sufficiently flexible to provide the range of applications that were needed. So a complete battery of memory checking tests was developed.

These tests are:

a) Two matched forms of a 150-item General Information Test.

b) A 100-item General Information Test (Revised) that contains no questions about current events and is comparatively free of age bias for adults.

c) A word-trigram Paired Associates Tests with 48 items for laboratory studies of verbal learning in relation to memory checking.

d) A short form Reading Test.

e) A 100-item Free-Association Test for clinical applications.

All of these tests can be administered in any one of three modes:

a) self-paced recall-recognition,

b) speeded recall-recognition, and

c) second-try recall-recognition.

(Samples of all of these tests were submitted with previous reports. Copies of the two most reliable and widely used tests, Form 1 of the 200-item General Information Test and the short form Reading Test are included in the Appendix for reference.)

Five investigations were undertaken to study the reliability and score interchangeability of these tests. Basically, all of these investigations sought to answer two questions: 1) is this test reliable? and 2) does it give memory-checking scores that are similar to those of the other memory-checking tests?

The subjects in all of the studies were from the same pool of volunteers--undergraduate students enrolled in an introductory psychology course at the University of California, Irvine. The volunteers were fulfilling a class requirement by participating in the experiment. We used subjects of both sexes since pilot studies had indicated that there were no sex differences in memory checking scores.

The procedure for each investigation was essentially the same. Each S was asked to supply some biographical information prior to receiving the memory-checking tests. All of the tests except the word-trigram Paired Associates Test and the Free Association Test were administered to a group. The subject would, in each experiment, take one

or more memory-checking tests on day one and then, after a period of two days, take the other memory-checking tests. The only variation in the procedure involved which tests were administered.

Experiment One involved the correlation of Forms I and II of the matched 200-item General Information Tests. Fifty subjects were administered both forms of the test according to the procedure outlined above. The results showed that the inter-test reliability for memory-monitoring scores was r = .80 and for answer-evaluation scores, r = .89. Both of these scores are adequate and indicate that Forms I and II can be used interchangeably.

Experiment Two involved the correlation of three of the memory-checking tests: Form I of the 200-item General Information Test, the 100-item General Information Test, and the short form Reading Test. Fifty subjects were administered Form I, and then, two days later, the remaining two tests were given. Table 1 shows the inter-test correlations.

Again, the inter-test correlations are substantial and indicate that the memory-checking score obtained on one test is a good predictor of the score that will be obtained on the other tests.

Experiment Three correlated the 100-item General Information Test with the word-trigram Paired Associates Test. The General Information Test was administered first to a group of 26 volunteers and then two to four days later the subjects were scheduled for an individual administration of the Paired Associates Test. The inter-test reliabilities were r = .68 for memory monitoring scores and r = .83 for answer-evaluation scores. The memory-monitoring inter-test reliability is statistically significant at the .01 level, but is low for routine use of the tests. Part of the difficulty is attributable to the underlearning that occurred on the paired-associates task. This resulted in very few feeling-of-knowing responses.

Experiment Four correlated the 100-item General Information Test with the Free Association Test. The General Information Test was administered to a group of 32 volunteers who were then scheduled for an individual administration of the Free Association Test within four days. Originally 40 Ss were scheduled for the two tests but 5 did not return for the second testing session and 3 did not correctly complete the test materials.

The results were similar to those obtained in Experiment Three, with inter-test correlations of r = .70 for memory-monitoring and r = .85 for answer-evaluation scores. In all of the correlational studies it was found that the General Information and Reading Tests showed the highest memory-checking inter-correlations and the Free Association and Paired Associates test the lowest. However, all inter-correlations are statistically significant and usable, depending upon the score accuracy required.

Table 1

Inter-test Correlations for Memory Checking Scores

	Form I		100-item Test		Reading Test	
	M	AE	M	AE	M	AE
Form I	-	-	.73	.87	.76	.90
100-item Test			-	-	.75	.87
Reading Test					-	-

("M" refers to memory-monitoring and "AE" to answer evaluation.)

Experiment Five was a large study using 100 volunteers and four tests. The 200-item General Information Test Form I and the Reading Test were administered on day one and the Paired Associates and Form II of the 200-item General Information Test were administered within two days. Form II was administered in a second-try recall mode for the measurement of memory-monitoring scores.

The results are shown in Table 2. As previously, all the correlations are statistically significant at the .01 level. The high correlations between Forms I and II were sustained even when Form II was administered in the second-try recall mode. As in the previous studies the Paired Associates test again showed the lowest memory-monitoring inter-correlations. All of the other tests show very serviceable correlations.

These five correlational experiments provided baseline reliability information on the battery of memory-checking tests which was used in planning the next series of experiments.

Memory-Checking in Relation to Personality and Cognition

The second series of experiments sought to relate memory-checking tests to measures of personality and cognition. A variety of hypotheses were used in selecting tests of personality and cognition. Three basic investigations were undertaken as well as several pilot studies.

Experiment Six. It was hypothesized that Ss who report that they recall their dreams would have higher answer-evaluation and memory-monitoring scores than Ss who report that they do not recall their dreams. This hypothesis was based upon the supposition that the same feeling-of-knowing process is involved in attending to vague dream memories and unavailable items of recall.

Subjects were recruited from advertisements in the university newspaper. The 70 volunteers were administered the 150-item General Information Test and the Irvine Biographical Inventory. The question on the Inventory dealing with dreams was:

"Do you usually remember your dreams? Yes_____ No_____"

The Ss indicating "yes" were given a score of 1; those indicating "no", a score of 0.

The full breakdown of memory-checking and dream scores is given in Table 3 with intra-test correlations in Table 4. These detailed scores are statistically simplified in Tables 5 and 6 which show the T test values comparing Ss who do and who do not recall their dreams. The results did not support our hypothesis. There is no significant difference between either the answer-evaluation or memory-monitoring scores of subjects for the independent variable. It is possible that an elaborate dream inventory might tease out some relationships between

Table 2

Inter-test Correlations for Memory Checking Scores

	Form I		Reading Test		Paired Associates		Form II	
	M	AE	M	AE	M	AE	M	AE
Form I	-	-	.76	.93	.71	.87	.82	.91
Reading			-	-	.65	.85	.75	.89
Paired Associates					-	-	.74	.90
Form II							-	-

Table 3

Memo Intratest Means and Standard Deviations (N = 70)

	Mean	S.D.
Recognition Right	95.9	17.6
Recall Right	47.4	21.3
Answer Evaluation		
Accurate Positive	41.9	20.1
Inaccurate Negative	5.0	3.7
Inaccurate Positive	12.1	11.3
Accurate Negative	91.0	22.1
Feeling of Knowing		
Accurate Positive	27.5	7.7
Inaccurate Negative	17.4	7.3
Inaccurate Positive	16.2	7.5
Accurate Negative	30.4	16.4
Dream Recall	.69	.46
Answer Evaluation Score	.713	.122
Memo Score	.250	.160

Table 4

Memory-Checking Intratest Correlations (N = 70, df = 68)

		Cog. Right	Call Right	Answer Evaluation				Feeling of Knowing				Proph Dream	Ans Eval Score	Memo Score
				Ac Ps	In Ng	In Ps	Ac Ng	Ac Ps	In Ng	In Ps	Ac Ng			
	Call P.	.87												
Ans. Eval.	Ac Ps	.88	.95											
	In Ng	.23	.25	.04										
	In Ps	-.18	-.15	-.08	-.30									
	Ac Ng	-.75	-.83	-.88	-.05	-.38								
Memo	Ac Ps	.04	-.14	-.18	.00	-.40	.37							
	In Ng	-.18	-.38	-.38	.12	-.26	.46	-.23						
	In Ps	-.65	-.52	-.58	-.08	.02	.53	.28	-.11					
	Ac Ng	-.66	-.67	-.67	-.09	-.25	.75	.01	.27	.12				
	Dr Rc	-.06	-.06	-.07	-.05	-.15	.15	.13	.13	.06	.00			
	Eval	.54	.53	.53	.14	-.74	-.13	.28	-.01	-.33	-.11	-.19		
	Memo	.00	-.06	-.07	-.04	-.29	.21	.45	-.27	-.31	.47	.02	.26	-

Table 5

Memo Scores of Subjects for Dream Recall

	N	Mean	S.D.	t	df
Recall dreams	48	.258	.141		
				.626	68
Do not recall dreams	22	.232	.200		

Table 6

Answer Evaluation Scores of Subjects for Dream Recall

	N	Mean	S.D.	t	df
Recall dreams	48	.723	.104		
				1.001	68
Do not recall dreams	22	.691	.156		

dream recall and memory-checking, but we did not pursue this direction further.

Experiment Seven. Since the direct relationship between dream recall and memory-checking had proved invalid, another way was sought to relate memory-checking to modes of personal functioning. It was hypothesized that the mode of functioning required on hypnosis tests and creativity tests would positively relate to the mode of functioning needed for memory-checking.

The following battery of tests was administered to 51 volunteers from an introductory psychology class: Form II of the 200-item Memory Checking Test, the Harvard Group Scale of Hypnotic Susceptibility, the Mednick Remote Associates Test, the Preconscious Activity Scale and the Myers-Briggs Type Inventory. (Samples and descriptions of these tests were submitted with previous reports.)

Memory checking and personality test means and standard deviations are presented in Table 7 and test intercorrelations in Table 8. Highly significant ($p < .01$, $df = 49$) correlations were found between the following measures: RAT and Recall Right, $r = .38$; Intuition and Recognition Right, $r = .44$. Moderately significant ($p < .05$, $df = 49$) correlations were found between the following measures: RAT and Recognition Right, $r = .31$; RAT and Answer-Evaluation, $r = .34$; PAS and Recognition Right, $r = .33$, Intuition and Recall Right, $r = .30$; Perception and Recognition Right, $r = .28$.

These results show that some tests of cognitive creativity do relate to the kind of memory checking involved in answer evaluation, but not to memory-monitoring.

Experiment Eight. The test battery used in Experiment Seven was re-administered to another larger group of 109 Ss from the same subject pool. The purpose of this study was to cross-validate the previous findings. Essentially the same results were obtained: answer-evaluation scores correlated significantly with the RAT ($r = .31$, but memory-monitoring showed no significant correlations. The larger N permitted a detailed intercorrelation of the personality tests; these are shown in Table 9. The intercorrelations show that the PAS and some parts of the Myers-Briggs are measuring essentially the same characteristics.

Overall, the attempt to relate memory-checking measures to cognitive and personality measures was largely unproductive. Memory-monitoring scores showed no significant correlations with any other test, and answer-evaluation was related only to the Remote Associates Test. This latter correlation could be merely a function of the common dependence of both of these measures on verbal intelligence.

Since it was not found productive to relate memory-checking to other measures, a more direct experimental attempt was made to modify memory-checking scores and thereby learn more about what variables enter into high and low scores.

Table 7

Memo and Personality Test Means and Standard Deviations (N = 51)

	Mean	S.D.
Recognition Right	97.7	16.5
Recall Right	49.0	19.8
Answer Evaluation Score	.722	.123
Memo Score	.243	.176
Remote Associates Test	18.8	4.6
Preconscious Activity Scale	27.3	5.0
Hypnotic Susceptibility	7.3	2.8
Myers-Briggs		
Extraversion	-.6	25.0
Sensation	-26.4	20.3
Thinking	-10.8	19.7
Judgment	2.6	1.2

Note--Negative Extraversion, Sensation, Thinking and Judgment scores represent positive Introversion, Intuition, Feeling and Perception scores respectively.

Table 8

Memo and Personality Test Intercorrelations (N = 51, df = 49)

	Recog Right	Recall Right	Ans Eval Score	Memo Score
Remote Associates Rest	.31*	.38**	.34*	.11
Preconscious Activity Scale	.33*	.15	-.02	.10
HGS	.17	.15	.16	.04
Myers-Briggs				
Extraversion	-.14	-.14	.09	-.07
Sensation	-.44**	-.30*	-.26	-.23
Thinking	-.02	.04	-.07	-.25
Judgment	-.28*	-.23	-.06	-.01

*$p < .05$, two-tailed

**$p < .01$, two-tailed

Note--Negative correlations on the Extraversion, Sensation, Thinking and Judgment scales represent positive correlations on the Introversion, Intuition, Feeling and Perception scales respectively.

Table 9

Personality and Creativity Intercorrelations (N=109, df = 107)

	RAT	PAS	HGS	Ext.	Sen.	Thk.	Jud.
RAT	-						
PAS	.18						
HGS	-.13	.02					
Ext.	.09	-.04	-.03				
Sen.	-.17	-.60**	.14	.13			
Thk.	-.13	-.18	.00	-.14	.08		
Jud.	-.20*	-.40**	.00	.14	.52**	.02	-

*p = .05

**p = .01

Note--Negative correlations on the Extraversion, Sensation, Thinking and Judgment scales represent positive correlations on the Introversion, Intuition, Feeling and Perception scales respectively.

Experimental Alteration of Memory-Checking

These experiments were based upon a theoretical rationale that was devised during the grant period. The rationale depends upon the distinction between repression and secondary repression. Secondary repression removes an item of mental content (a response, name, image, etc.) from response availability. Primary repression removes the item from recognition; it is amnesia. Under primary repression the person has no recall of the item and no recognition of the item. The typical instance of secondary repression is to fail to produce a familiar, emotionally tinged memory, but to feel strongly that one knows it. (Freud's Psychopathology of Everyday Life is filled with these examples.)

Repression can affect one or both of the two basic levels of cognitive functioning: 1) the secondary level of symbolic blocking (secondary repression) and 2) the primary level of experiential blocking (primary repression). What Freud and Jung explored in word association tests as repression is actually secondary repression. The more serious degree of repression is the kind measured by low scores on the Memo test because this indicates a generalized blocking of symbols and affective materials. In secondary repression the response is blocked - there is a content hole in awareness; in primary repression there is no feeling awareness at all. Neurologically, secondary repression may be caused by a functional split between the image hemisphere of the brain and the symbolic hemisphere, while primary repression represents a functional split between the cortical representational centers and the subcortical feeling centers.

Experiment Nine. An experiment based upon the above rationale must almost necessarily shift the arena of experimentation from the laboratory and classroom to the clinic. We established a field research unit at the Primal Institute in Los Angeles. In primal therapy (see Janov, 1970), patients undergo intense abreactive experiences that involve re-living childhood traumas. We hypothesized that a) if low memory-monitoring scores reflect a high level of primary repression, then b) patients who successfully undergo abreactive treatment should show higher memory-monitoring scores after treatment than they had before.

The experimental subjects in our experiment were 29 patients in therapy at the Primal Institute. They, and 30 control Ss were administered a test battery that included the Word Association Test, the Reading Test, Part I, and Form I of the 150-item General Information Test. (The Ss also received a psychophysiological battery of measurements that were not directly related to this experiment). Six months later the Word Association Test, Form II of the General Information Test, and Part II of the Reading Test were re-administered to both the patients and the controls. The controls were subjects who had applied to the therapy but had not yet been accepted.

The overall results are straightforward:

1) The experimentals and controls did not differ in memory checking prior to therapy.

2) After therapy the patients had higher memory-monitoring scores than the controls on the Reading Test and the Word Association Test but not on the General Information Test.

3) The post-therapy memory-monitoring scores of the patients were higher than their pre-therapy scores on all three memory-checking tests. The statistical details behind these summary results are presented in Table 10. In none of the comparisons did the patients and controls differ significantly on their answer-evaluation, recognition or recall scores.

These results impressively support the hypothesis that memory-monitoring scores reflect a primary repression and can be changed in a therapy that involves the abreactive lifting of internal repression. The results are consistent with the fact that answer-evaluation is a much more conscious cognitive process than memory-monitoring.

A number of follow-up experiments are now underway to replicate this experiment and to check in more detail upon the content of specific abreactive experiences and the accuracy levels of memory-monitoring for related affective contents.

Discussion

Two positive findings and one negative finding have emerged from this series of experiments in memory-checking processes. First, memory-checking can be reliably and flexibly assessed with the battery of instruments developed under the grant; both answer-evaluation and memory-monitoring scores are stable over repeated testing and across tests. Second, the memory-checking scores do not correlate appreciably with other tests of personality and cognition; this is especially true for memory-monitoring which consistently showed no significant correlations with other measures. Third, memory-monitoring scores do change when Ss undergo drastic forms of abreactive treatment.

The third finding provides a link between motivated forgetting (repression) and memory performance on non-threatening materials. It appears that memory-monitoring provides a mechanism for one kind of repression. The simplest way to repress an item is to simply not try to remember it, because there is no feeling-of-knowing experience. Subjects with a biased memory-monitor can avoid retrieving anxiety-provoking memories, but they suffer from a general decrement in memory-monitoring accuracy.

Answer-evaluation is a much more conscious process that seems, like other general measures of cognition, to be little influenced by unconscious motivation.

Table 10

Analysis of Variance for Memory-Monitoring Scores (Reading Test)

Source of Variation	df	MS	F
Therapy vs Control	1	200.5	5.0*
Pre vs Post	1	40.0	
(T vs C) X (P vs P)	1	500.5	9.2**
Within	55	52.0	
Total	58		

(* $p < .05$, ** $p < .01$)

It should be mentioned that we would not expect to find correlations between paper and pencil tests of psychopathology (such as the Cornell Medical Index and the MMPI) and memory-monitoring. Pilot studies of patients who participated in Experiment Nine did not show elevated scores on these psychopathology measures as compared to normals. The patients suffered from what might be called "normal neuroses". A person may be highly repressed and still function normally. This is the reason memory-monitoring does not correlate with general measures of personality and cognition. A really strong shift in functioning must occur before it is reflected in memory-monitoring scores. The shift in functioning that occurs in post-primal patients is toward feeling. What is felt in memory-monitoring is the unacted part of a patterned internal response (i.e., an answer feels possible because we feel some of the sensations that go along with the answer even when we cannot produce the symbol representation of the memory). A failure to remember, accompanied by the feeling (sensation) of knowing is a disruption between the sensations associated with what is represented by the answer and the response of pronouncing or writing or seeing the answer (secondary repression). A failure to remember that is unaccompanied by a feeling-of-knowing is a split between sensation and knowing (primary repression). The clinical significance of memory-monitoring is that it can be said to index the alteration of a neurotic split.

The educational significance of memory-monitoring was not explored directly in these investigations, but it can be understood if we consider that neurosis is not something that happens outside the classroom, and that neuroses start young. John Holt (1967) comments, "As I pointed out in How Children Fail, the children who always forget things in school may not forget so much because their memories are bad, as because they never dare trust their memories. Even when they are right they still feel wrong....Working with bad spellers, for example, I have often found that their first hunch about how to spell a word is often correct. But they don't trust that much." What Holt describes is faulty memory checking.

Conclusions

The investigations conducted under this grant provide clear evidence for the measurability and significance of memory-checking processes. The comparative independence of memory-checking from other tests of personality and cognition and the close connection between memory-monitoring and repression suggests that these measures of cognitive functioning may provide a link between the processes of ordinary forgetting and motivated forgetting. This link should prove to be of both clinical and educational significance.

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Appendix A

RECALL TEST

FORM I

1. How many feet are there in a mile?
2. What is the value of pi to the nearest 100th place?
3. What does a golfer shoot when he scores two under par on one hole?
4. What sea does Syria border?
5. How many planets are there in our solar system?
6. Who wrote History of the Peloponnesian War?
7. From what disease is a "bleeder" suffering?
8. Who wrote The Trial?
9. Who is the editor of Playboy?
10. What is the capital city of Columbia?
11. Who wrote Book of the Coutier?
12. What company has the Rock of Gibraltar as its symbol?
13. Who wrote The Tin Drum?
14. Who wrote David Copperfield?
15. Who was the 4th President of the U.S. ?
16. What is the average body temperature of man in degrees Fahrenheit (to the nearest tenth)?
17. Who is credited with developing the periodic table of elements?
18. What is the capital city of New Mexico?
19. Who composed "Boris Gudunov"?
20. Who painted Guernica?
21. What is the chemical symbol for lead?
22. What was the real name of the ship "Old Ironsides"?

23. How many sides are there in a hexagon?

24. What is the boiling point of water (in Fahrenheit units) at standard pressure?

25. Who wrote the Dioptrice?

26. What is the capital of Peru?

27. What is the height of Mt. Everest (to the nearest thousand feet)?

28. The prefix "Hecto" indicates what decimal multiple?

29. Who wrote "Rubaiyat"?

30. What is the best known work of Chaucer?

31. Who wrote The Interpretation of Dreams?

32. Who is usually credited with developing the technique of operant conditioning?

33. Who composed the "Peer Gynt Suites"?

34. Who painted Afternoon at La Grande Jutte?

35. Who painted Wivenhoe Park?

36. Who painted The Creation of Adam?

37. The name of von Frisch is usually associated with biological studies of what animal?

38. In what sea is the island of Sardinia located?

39. What is the title of the poem from which these lines are taken: "I wandered lonely as a cloud that floats on high o'er vales and hills"?

40. Who wrote "Ode on a Grecian Urn"?

41. Who wrote the poem that begins; "The sea is calm tonight. The tide is full. The moon lies fair."?

42. Who wrote The Red Pony?

43. What was the name of the Russian Dynasty overthrown in the revolution of 1917?

44. Who wrote The Adventures of Tom Jones?

45. Who created Uncle Remus?

46. What is the first name of the main character in Catcher in the Rye?

47. Who wrote Pride and Prejudice?

48. Who wrote Candide?

49. What is the capital of Jamaica?

50. What ore is the source of aluminum?

51. Who wrote the Wealth of Nations?

52. Who invented the electric generator or dynamo?

53. What was the official position of Thomas a Becket?

54. What was the original name given to the island which contains the Dominican Republic and Haiti?

55. Who invented the reaper?

56. Who is considered the first Pope by Roman Catholic doctrine?

57. What instrument did Glen Miller play?

58. Who starred opposite Rock Hudson in Pillow Talk?

59. What was the name of the famous circus clown who dressed as a hobo?

60. Who wrote The Rights of Man?

61. What is the mountain range alone the French-Spanish border?

62. What is the radioactive debris from atomic explosions which becomes concentrated in milk?

63. In what city is Yale located?

64. Who was the biographer of Samuel Johnson?

65. On what river is Rome located?

66. The Suez Canal connects the Mediterranean Sea to what body of water?

67. Who said, "I regret that I have but one life to give for my country"?

68. What is the name of the collection of tall stones thought to be erected by pre-historic inhabitants of England?

69. Who created Dr. Doolittle?

70. What is the name of the body of water between Italy and Yugoslavia?

71. Aboard what ship did the Japanese surrender in 1945?

72. Who said, "Go west young man."?

73. What is the name of the river which forms the northern boundary of North Korea?

74. Who wrote Pygmalion?

75. Who created the literary character "Leatherstocking"?

76. What is Dagwood's last name?

77. What was the original name of Hoover Dam?

78. What was the name of the theatre where most of Shakespeare's plays were presented?

79. What was the common name for the followers of Oliver Cromwell?

80. Who is chief of state of Monaco?

81. Who wrote Of Human Bondage?

82. Who invented the vacuum tube?

83. What is the beer "that made Milwaukee famous"?

84. "Thanks for the Memories" is the theme song of what entertainer?

85. Who is the "Brown Bomber"?

86. Who wrote Praise of Folly?

87. What was the name of Jefferson's house?

88. Who was the "Desert Fox"?

89. Who wrote the Decline and Fall of the Roman Empire?

90. Who is the originator of Time?

91. Who ran for vice-president with Stevenson in 1952?

92. Name the group of philosophers who were diametrically opposed to Socrates when he lived?

93. Who wrote the Hunchback of Notre Dame?

94. Who commanded the armies who fought against Napolean at Waterloo?

95. Who invented bifocals?

96. Name Donald Duck's rich uncle?

97. Who sculptured David?

98. Who created Winnie-the-Pooh?

99. Who wrote Time Machine?

100. Who discovered the circulation of the blood?

101. Who wrote Coming of Age in Samoa?

102. Who pitched the only World Series perfect game?

103. Who painted Prima Ballerina?

104. Who wrote Don Juan?

105. Who recorded "Catch a Falling Star"?

106. Who gave the "Cross of Gold" speech?

107. Who wrote Silas Marner?

108. Who developed polio vaccine?

109. Who invaded England in 1066?

110. Who wrote the "Star Spangle Banner"?

111. Who wrote the Magic Mountain?

112. Who conquered Peru?

113. Who wrote The Sound and the Fury?

114. Who led the Mormons west?

115. Name the first U.S. Secretary of War?

116. Who painted The Old King?

117. Who wrote Death of a Salesman?

118. Who wrote The Devil and Daniel Webster?

119. Who recorded "Honeycomb"?

120. Who broke the 4-minute mile?

121. Who killed Alexander Hamilton in a duel?

122. Who wrote Robinson Crusoe?

123. Who painted the Naked Maja?

124. Who painted the Isenheim Altarpiece?

125. Who wrote Elmer Gantry?

126. Who wrote War and Peace?

127. Who wrote On the Road?

128. Who wrote Ivanhoe?

129. Who wrote "Stopping by the Woods on a Snowy Evening"?

130. Name the volcano that buried Pompeii.

131. Who wrote Around the World in 80 Days?

132. Whom did the Republicans run against Truman?

133. Who wrote Walden?

134. What is Superman's secret identity?

135. Who wrote The Group?

136. Who wrote The Brothers Karamazov?

137. Who developed Quantum Mechanics?

138. Who wrote Kidnapped?

139. Who wrote A Streetcar Named Desire?

140. What is the name for the theorem which gives the sides of a right triangle?

141. Name Porky Pig's girlfriend.

142. Who wrote "The Hollow Men"?

143. Who wrote Novum Organum?

144. Who wrote The Legend of Sleepy Hollow?

145. Who wrote The Way of All Flesh?

146. Who was the head of the Spanish Inquisition?

147. Who broke Babe Ruth's one-season home run record?

148. Who wrote The Good Earth?

149. Who invented the cotton gin?

150. Who wrote The Pilgrim's Progress?

Appendix A

RECOGNITION TEST

FORM I

1. How many feet are there in a mile?
   a. 5280
   b. 6710
   c. 2163
   d. 3744

2. What is the value of pi to the nearest 100th place?
   a. 4.07
   b. 3.57
   c. 3.14
   d. 2.14

3. What does a golfer shoot when he scores two under par on one hole?
   a. eagle
   b. birdie
   c. end-over
   d. bogie

4. What sea does Syria order?
   a. Mediterranean Sea
   b. Black Sea
   c. Arabian Sea
   d. Red Sea

5. How many planets are there in our solar system?
   a. 10
   b. 12
   c. 9
   d. 7

6. Who wrote History of the Peloponnesian War?
   a. Pericles
   b. Thucidides
   c. Gibbon
   d. Herodotus

7. From what disease is a "bleeder" suffering?
   a. Catonia
   b. Ricketts
   c. Hepatitis
   d. Hemophilia

8. Who wrote The Trial?
   a. Koestler
   b. Kafka
   c. Ibsen
   d. Mann

9. Who is the editor of Playboy?
   a. Silverstein
   b. Luce
   c. Saunders
   d. Hefner

10. What is the capital city of Columbia?
   a. Cuonta
   b. Tunja
   c. Santa Marta
   d. Bogota

11. Who wrote Book of the Courtier?
   a. Voltaire
   b. Castiglione
   c. Vandenburg
   d. Collier

12. What company has the Rock of Gibraltar as its symbol?
   a. Proctor and Gamble
   b. General Motors
   c. Prudential
   d. Colgate-Palmolive

13. Who wrote The Tin Drum?
   a. Updike
   b. Grass
   c. Mann
   d. Kesey

14. Who wrote David Copperfield?
   a. Harding
   b. Cather
   c. Jonson
   d. Dickens

15. Who was the 4th President of the U.S.?
   a. Jackson
   b. Madison
   c. Jefferson
   d. Monroe

16. What is the average body temperature of man in degrees Fahrenheit (to the nearest tenth)?
   a. 99.5
   b. 98.3
   c. 98.6
   d. 97.6

17. Who is credited with developing the periodic table of elements?
    a. Curie
    b. Mendelyeev
    c. Avogadro
    d. Boyle

18. What is the capital city of New Mexico?
    a. Albuquerque
    b. Santa Fe
    c. Los Alamos
    d. Carlsbad

19. Who composed "Boris Gudunov"?
    a. Borodin
    b. Tchaikovsky
    c. Massorgsky
    d. Prokoviev

20. Who painted Guernica?
    a. Matisse
    b. Chagall
    c. Picasso
    d. Orozco

21. What is the chemical symbol for lead?
    a. F
    b. Hg
    c. Pb
    d. Ld

22. What was the real name of the ship Old Ironsides ?
    a. Titanic
    b. Delaware
    c. Texas
    d. Constitution

23. How many sides are there in a hexagon?
    a. 8
    b. 9
    c. 6
    d. 7

24. What is the boiling point of water (in Fahrenheit units) at standard pressure?
    a. 200
    b. 100
    c. 241
    d. 212

25. Who wrote the Dioptrice?
    a. Kepler
    b. Galileo
    c. Descartes
    d. Ptolemy

26. What is the capital of Peru?
    a. Callco
    b. Lima
    c. Trujillo
    d. Cuzco

27. What is the height of Mt. Everest (to the nearest thousand feet)?
    a. 40,000
    b. 33,000
    c. 29,000
    d. 23,000

28. The prefix "Hecto" indicates what decimal multiple?
    a. 1000
    b. 1,000,000
    c. 100
    d. 10,000

29. Who wrote "Rubaiyat"?
    a. Seneca
    b. Ovid
    c. Khayyam
    d. Catullus

30. What is the best known work of Chaucer?
    a. "Romance of the Rose"
    b. "Paradise Found"
    c. "Book of the Duchess"
    d. "Canterbury Tales"

31. Who wrote The Interpretation of Dreams?
    a. James
    b. Freud
    c. Janet
    d. Mesmer

32. Who is usually credited with developing the technique of operant conditioning?
    a. Hull
    b. Pavlov
    c. Skinner
    d. James

33. Who composed the "Peer Gynt Suites"?
    a. Greig
    b. Sibelius
    c. Dvorak
    d. Khachaturian

34. Who painted Afternoon at La Grande Jutte?
    a. Monet
    b. Seurat
    c. Cezanne
    d. Dufy

35. Who painted Wivenhoe Park?
    a. Homer
    b. Constable
    c. Gainsborough
    d. Copley

36. Who painted The Creation of Adam?
    a. Rembrandt
    b. Da Vinci
    c. Raphael
    d. Michelangelo

37. The name of von Frisch is usually associated with biological studies of what animal?
    a. Bats
    b. Dogs
    c. Ants
    d. Bees

38. In what sea is the island of Sardinia located?
    a. Arabian Sea
    b. Mediterranean Sea
    c. Caspian Sea
    d. Black Sea

39. What is the title of the poem from which these lines are taken: "I wandered lonely as a cloud that floats on high o'er vales and hills"?
    a. "Ode to Autumn"
    b. "The Daffodils"
    c. "The Cloud"
    d. "Who is at My Window"

40. Who wrote "Ode on a Grecian Urn"?
    a. Keats
    b. Shelley
    c. Coleridge
    d. Blake

41. Who wrote the poem that begins: "The sea is calm tonight. The tide is full. The moon lies fair."?
    a. Williams
    b. Arnold
    c. Spender
    d. Dickinson

42. Who wrote The Red Pony?
    a. Hemingway
    b. Steinbeck
    c. Porter
    d. Crane

43. What was the name of the Russian Dynasty overthrown in the revolution of 1917?
    a. Romanov
    b. Stravinsky
    c. Bourban
    d. Ralenkov

44. Who wrote The Adventures of Tom Jones?
    a. Forster
    b. Chapel
    c. Fielding
    d. Carleton

45. Who created Uncle Remus?
    a. Disney
    b. Doppler
    c. Howe
    d. Harris

46. What is the first name of the main character in Catcher in the Rye?
    a. Harold
    b. Holden
    c. Michael
    d. Ralph

47. Who wrote Pride and Prejudice?
    a. Anderson
    b. Cooper
    c. Austen
    d. Douglas

48. Who wrote Candide?
    a. Voltaire
    b. Price
    c. Vashinsky
    d. Dante

49. What is the capital of Jamaica?
    a. San Salvador
    b. Kingston
    c. San Juan
    d. Montevideo

50. What ore is the source of aluminum?
    a. Borax
    b. Mangellum
    c. Lodestone
    d. Bauxite

51. Who wrote the Wealth of Nations?
    a. Smith
    b. Marx
    c. Conrad
    d. Canberra

52. Who invented the electric generator or dynamo?
    a. Michelson
    b. Cartier
    c. Faraday
    d. Clinton

53. What was the official position of Thomas a Becket?
    a. President of France
    b. Sultan of Bagdad
    c. Archbishop of Canterbury
    d. Prince of Wales

54. What was the original name given to the island which contains the Dominican Republic and Haiti?
    a. Isabella
    b. La Salle
    c. Italia
    d. Hispaniola

55. Who invented the reaper?
    a. Grimm
    b. Volta
    c. McCormick
    d. Vernier

56. Who is considered the first Pope by Roman Catholic Doctrine?
    a. St. Paul
    b. St. Mark
    c. St. Matthew
    d. St. Peter

57. What instrument did Glen Miller play?
    a. Trombone
    b. Violin
    c. Piano
    d. Trumpet

58. Who starred opposite Rock Hudson in Pillow Talk?
    a. Sandra Dee
    b. Debbie Reynolds
    c. Lee Remick
    d. Doris Day

59. What was the name of the famous circus clown who dressed as a hobo?
    a. Kelly
    b. Ronaldo
    c. Tiny Tim
    d. Thompson

60. Who wrote The Rights of Man?
    a. Pascal
    b. Rousseau
    c. Cato
    d. Paine

61. What is the mountain range along the Frenoh-Spanish border?
    a. Urals
    b. Pyrenees
    c. Alps
    d. Unterwalden

62. What is the radioactive debris from atomic explosions which becomes concentrated in milk?
    a. Varuim 139
    b. Lathuim 128
    c. Silicon 27
    d. Strontium 90

63. In what city is Yale located?
    a. New York
    b. New Haven
    c. Hartford
    d. Hannover

64. Who was the biographer of Samuel Johnson?
    a. Boswell
    b. Lawrence
    c. Bancroft
    d. Watson

65. On what river is Rome located?
    a. Rhone
    b. Tiber
    c. Rhine
    d. Tigress

66. The Suez Canal connects the Mediterranean Sea to what body of water?
    a. Red Sea
    b. Leyte Gulf
    c. Indian Ocean
    d. Ionion Sea

67. Who said, "I regret that I have but one life to give for my country"?
    a. Henry
    b. Webster
    c. Hale
    d. Washington

68. What is the name of the collection of tall stones thought to be erected by pre-historic inhabitants of England?
    a. Saxon Rock
    b. Victory Cleft
    c. Stonehenge
    d. Vichy

69. Who created Dr. Doolittle?
    a. Stevenson
    b. Lofting
    c. Steinmetz
    d. Laughton

70. What is the name of the body of water between Italy and Yugoslavia?
    a. Aegean Sea
    b. Adriatic Sea
    c. Gulf of Maracaibo
    d. Balkan Sea

71. Aboard what ship did the Japanese surrender in 1945?
    a. Arizona
    b. Savannah
    c. Missouri
    d. Mississippi

72. Who said, "Go west young man."?
    a. Monroe
    b. Mann
    c. Jackson
    d. Greeley

73. What is the name of the river which forms the northern boundary of North Koria?
    a. Yangtse
    b. Honshu
    c. Yalu
    d. Pingyuam

74. Who wrote Pygmalion?
    a. Diogenes
    b. Dostoevski
    c. Shaw
    d. Wilde

75. Who created the literary character "Leatherstocking"?
    a. Dickinson
    b. Cooper
    c. Hawthorne
    d. Crane

76. What is Dagwood's last name?
    a. Broadhead
    b. Dimple
    c. Slipshod
    d. Bumstead

77. What was the original name of Hoover Dam?
    a. Colorado
    b. Boulder
    c. Cascade
    d. Mammoth

78. What was the name of the theatre where most of Shakespeare's plays were presented?
    a. Grand
    b. Palladium
    c. Globe
    d. Rockingham

79. What was the common name for the followers of Oliver Cromwell?
    a. Brown Shirts
    b. Cavaliers
    c. Roundheads
    d. Cromwell's Cavalry

80. Who is chief of state of Monaco?
    a. Queen Wilhemena
    b. Prince Rainier
    c. Makarious
    d. Mendes

81. Who wrote Of Human Bondage?
    a. Madison
    b. Maugham
    c. Rousseau
    d. Adams

82. Who invented the vacumm tube?
    a. Doppler
    b. Maxwell
    c. De Forest
    d. Coulomb

83. What is the beer "that made Milwaukee famous"?
    a. Schlitz
    b. Blatz
    c. Budweiser
    d. Miller High Life

84. "Thanks for the Memories" is the theme song of what entertainer?
    a. Eddie Cantor
    b. Jack Benny
    c. Bob Hope
    d. Bing Crosby

85. Who is the "Brown Bomber"?
    a. Simpson
    b. Walcott
    c. Weston
    d. Louis

86. Who wrote Praise of Folly?
    a. Sophocles
    b. Erasmus
    c. Polycarp
    d. Epicurus

87. What was the name of Jefferson's house?
    a. Hyde Park
    b. Hellana
    c. Mount Vernon
    d. Montecello

88. Who was the Desert Fox?
    a. Montgomery
    b. Saladin
    c. Rommel
    d. Saunders

89. Who wrote the Decline and Fall of the Roman Empire?
    a. Gibbon
    b. Knox
    c. Toynbee
    d. de Tocqueville

90. Who is the originator of Time?
    a. Luce
    b. Lippmann
    c. Mathy
    d. Mathews

91. Who ran for vice-president with Stevenson in 1952?
    a. Mash
    b. Barkley
    c. Sparkman
    d. Kefauver

92. Name the group of philosophers who were diametrically opposed to Socrates when he lived?
    a. Chaldeans
    b. Empiricists
    c. Sophists
    d. Epicureans

93. Who wrote the Hunchback of Notre Dame?
    a. Hugo
    b. Nietzsche
    c. Joyce
    d. Nicbuhr

94. Who commanded the armies who fought against Napolean at Waterloo?
    a. Wellington
    b. Nelson
    c. Montgomery
    d. North

95. Who invented bifocals?
    a. Leuwenhoek
    b. Lorentz
    c. Fitch
    d. Franklin

96. Name Donald Duck's rich uncle.
    a. Louie
    b. Scrooge
    c. Marley
    d. Pincher

97. Who sculptured David?
    a. Da Vinci
    b. Myron
    c. Rodin
    d. Michelangelo

98. Who created Winnie-the-Pooh?
    a. Lofting
    b. Milne
    c. Stevenson
    d. Laughten

99. Who wrote Time Machine?
    a. Wells
    b. Orwell
    c. Huxley
    d. Lewis

100. Who discovered the circulation of the blood?
    a. Harvey
    b. Dalton
    c. Pasteur
    d. Priestley

101. Who wrote Coming of Age in Samoa?
    a. Stace
    b. Gratten
    c. Mead
    d. Hirey

102. Who pitched the only World Series perfect game?
    a. Ford
    b. Newcomb
    c. Larson
    d. Koufax

103. Who painted Prima Ballerina?
    a. Degas
    b. Goya
    c. Seurat
    d. Titian

104. Who wrote Don Juan?
    a. Byron
    b. Cervantes
    c. Shelley
    d. Keats

105. Who recorded "Catch a Falling Star"?
    a. Brenda Lee
    b. Frank Sinatra
    c. Perry Como
    d. Dean Martin

106. Who gave the "Cross of Gold" Speech?
   a. Bryan
   b. Roosevelt
   c. Dewey
   d. Coolidge

107. Who wrote Silas Marner?
   a. Eliot
   b. Irving
   c. Dickens
   d. Hawthorne

108. Who developed polio vaccine?
   a. Reed
   b. Pasteur
   c. Salk
   d. Priestley

109. Who invaded England in 1066?
   a. Alexander the Great
   b. Wm. the Conquerer
   c. Attila the Hun
   d. Edward the Elder

110. Who wrote the "Star Spangled Banner"?
   a. Franklin
   b. Smith
   c. Hale
   d. Key

111. Who wrote the Magic Mountain?
   a. Mann
   b. Goethe
   c. Rilke
   d. Ibsen

112. Who conquered Peru?
   a. Bolivar
   b. Pizarro
   c. Cortez
   d. Velezquez

113. Who wrote The Sound and the Fury?
   a. Joyce
   b. Hemingway
   c. Faulkner
   d. Steinbeck

114. Who led the Mormons west?
   a. Young
   b. Smith
   c. Whitmer
   d. Pratt

115. Name the first U.S. Secretary of War.
   a. Knox
   b. Hamilton
   c. Adams
   d. Jefferson

116. Who painted The Old King?
   a. Seurat
   b. Van Gogh
   c. Roualt
   d. El Greco

117. Who wrote Death of a Salesman?
   a. Miller
   b. O'Neill
   c. Faulkner
   d. Shaw

118. Who wrote The Devil and Daniel Webster?
   a. Tarkington
   b. O'Neill
   c. Benet
   d. O'Henry

119. Who recorded "Honeycomb"?
   a. Andrew Sisters
   b. Elvis Presley
   c. Jimmy Rodgers
   d. Jonny Cash

120. Who broke the 4-minute mile?
   a. Ryan
   b. Hayes
   c. Beatty
   d. Bannister

121. Who killed Alexander Hamilton in a duel?
   a. Madison
   b. Adams
   c. Burr
   d. Jackson

122. Who wrote Robinson Crusoe?
   a. Stevenson
   b. Cooper
   c. Defoe
   d. Scott

123. Who painted the Naked Maja?
   a. Goya
   b. Van Gogh
   c. Cezanne
   d. Seurat

124. Who painted the Isenheim Altarpiece?
   a. Grunewald
   b. Roualt
   c. Seurat
   d. Da Vinci

125. Who wrote Elmer Gantry?
   a. Wallace
   b. Lewis
   c. Miller
   d. Golden

126. Who wrote War and Peace?
   a. Austen
   b. Tolstoy
   c. Douglas
   d. Dostoevski

127. Who wrote On the Road?
   a. Steinbeck
   b. Maurois
   c. Zola
   d. Kerouac

128. Who wrote Ivanhoe?
   a. Longfellow
   b. Irving
   c. Scott
   d. Cooper

129. Who wrote "Stopping by the Woods on a Snowy Evening"?
   a. Sandburg
   b. Longfellow
   c. Wordsworth
   d. Frost

130. Name the volcano that buried Pompeii.
   a. Vesuvius
   b. Paracutin
   c. Fujiyama
   d. Kono

131. Who wrote Around the World in 80 Days?
   a. Stevenson
   b. Verne
   c. Norris
   d. Wells

132. Whom did the Republicans run against Truman?
   a. Stevenson
   b. Dewey
   c. Lodge
   d. Eisenhower

133. Who wrote Walden?
   a. Frost
   b. Blake
   c. Thoreau
   d. Coleridge

134. What is Superman's secret identity?
   a. White
   b. Olsen
   c. Wayne
   d. Kent

135. Who wrote The Group?
   a. Wallace
   b. McCarthy
   c. Miller
   d. Lewis

136. Who wrote The Brothers Karamazov?
   a. Tolstoy
   b. Dostoevski
   c. Douglas
   d. Austen

137. Who developed Quantum Mechanics?
   a. Einstein
   b. Maxwell
   c. Dirac
   d. Planck

138. Who wrote Kidnapped?
   a. Cooper
   b. Hemingway
   c. Stevenson
   d. Hawthorne

139. Who wrote A Streetcar Named Desire?
   a. Inge
   b. Miller
   c. Williams
   d. Shaw

140. What is the name for the theorem which gives the sides of a right triangle?
   a. Fermat
   b. Legrendre
   c. Pythagorean
   d. Euclidean

141. Name Porky Pig's girlfriend.
   a. Olive
   b. Petunia
   c. Lulu
   d. Clarabelle

142. Who wrote "The Hollow Men"?
   a. Eliot
   b. Sandburg
   c. Poe
   d. Whitman

143. Who wrote Novum Organum?
   a. Priestley
   b. Bacon
   c. Decateur
   d. Harvey

144. Who wrote The Legend of Sleepy Hollow?
   a. Longfellow
   b. Poe
   c. Stevenson
   d. Irving

145. Who wrote The Way of All Flesh?
   a. Austen
   b. Ferber
   c. Butler
   d. Scott

146. Who was the head of the Spanish Inquisition?
   a. Torquemada
   b. Villa
   c. Franco
   d. Greco

147. Who broke Babe Ruth's one-season home run record?
   a. Mantle
   b. Mays
   c. Maris
   d. Pepitone

148. Who wrote The Good Earth?
   a. Steinbeck
   b. Hemingway
   c. Buck
   d. London

149. Who invented the cotton gin?
   a. Whitney
   b. McCormick
   c. Vernier
   d. Priestley

150. Who wrote The Pilgrim's Progress?
   a. Williams
   b. Bunyan
   c. Bradford
   d. Flemming

Appendix B

MEMORY TEST

INSTRUCTIONS

Please read these instructions carefully because your test performance will be valid only if the rules are strictly followed.

The purpose of this test is to find out how much information you can remember after reading attentively an article of about 500 words.

Read the article very carefully with full attention and intention to remember it. Shut out all distracting thoughts and sounds, and concentrate on this task. The mind is capable of far more than we might expect, if we only push ourselves to the utmost and really concentrate on what we are doing. YOU WILL BE GIVEN FIVE MINUTES TO READ THE ARTICLE. I will indicate at the end of each minute the amount of time remaining. If you finish the article before the five minute period is over, you may go back and re-read all or part of the article as you desire. DO NOT UNDERLINE OR MARK IN ANY WAY THE ARTICLE (TEST MATERIAL).

The test of memory will be given to you immediately after you finish reading the article. Once you have started answering the questions you cannot go back and re-read any part of the article. YOU WILL BE GIVEN 8 MINUTES FOR THE TEST OF RECALL. It consists of 33 questions on which short, specific answers should be given. Do write down answers for every question, even if you must guess.

Example

In which year did Columbus discover America?

Answer 1492

IF YOU HAVE ANY QUESTIONS, PLEASE ASK NOW. SINCE THE TEST IS TIMED AND REQUIRES CONCENTRATION, ANY DISTURBANCE DURING TESTING MAY INVALIDATE SCORES OF THE ENTIRE GROUP.

See the rating instuctions on the next page.

Appendix B

Test Material (A)

In 1817 a German chemist by the name of Berzelius found what he supposed to be a new earth. He named it "thorium" from Thor, son of the god Odin. At first he thought that this new earth was a compound of yttrium, but this was proved incorrect.

The most important deposits of thorium are in India which accounts for 90% of the world production of this element. The Brazilian deposits are second in richness. In the United States of America, Idaho has the greatest amount of thorium, but the quality of the ore found in Flordia is better.

The element is silverly in color and it resembles platinum in appearance, hardness, and ductability. It melts at about 1,700 degrees C and in this respect it is also similar to platinum. Its chemical element number is 90 and its atomic weight is approximately 232. The greatest concentration of thorium is obtained from monazite sands which is found in the above mentioned places. The monazite is heavy and has a yellow color and peculiar luster. The chemical symbol of thorium is Th.

The first use of thorium was in production of incandescent gas mantles which were developed in the nineteenth century. The most important use of thorium at present is in the nuclear field, because it can be converted to an atomic fuel of uranium type. The energy available from the world's supply of thorium has been estimated as greater than the combined energy from all of the world's uranium, coal, and oil. The second major use of thorium is in magnesium technology, because it imparts to magnesium metal high-strength properties and creep resistance at elevated temperatures. The element has special use in ceramics since it enables the ceramic objects to resist high temperatures. In chemistry, thorium is used successfully as a catalyst in the synthesis of many organic compounds. In photography, thorium is added to preparations of flashlight powder to reduce the amount of smoke produced by such chemicals. Thorium has also found its application in medicine since its salts have a bacteriocidal action thus, guinea pigs survived twice the lethal dose of cholera when they were treated with thorium salts. Finally, application of thorium in electrical industry can be mentioned, because it is used in special welding electrodes. the world's need for it amounts to 3,000 tons a year.

The extraction of thorium is a complex process and there are several methods to accomplish it. One method utilizes sulfuric acid and the purified thorium is crystallized from the chemical solution. However, thorium can be prepared directly from its compounds by the method of electrolysis.

Thorium forms compounds easily with a number of elements and other chemical compounds. A compound formed with oxygen gives a powder of white color. Nitrogen unites directly with thorium creating a dark red powder, and with sulfur thorium forms large brown crystals.

Thorium can be easiest detected in nature by studying radioactivity of the ore. If chemical analysis is employed for detection, sulfuric acid is used.

END

Appendix B

Form A

TEST OF RECALL

1. What is the name of the discoverer of the element described in this article?
2. How can this element be most easily detected in nature?
3. After whom was the element named?
4. What is the color of the pure element?
5. At what degree of temperature (Celsius) does it melt?
6. For what is it used in chemistry?
7. Where are the most important deposits of the element found?
8. What was the nationality of the discoverer of the element?
9. Which acid is used in extraction of the element?
10. What is the color of the compound of the element with nitrogen?
11. What is the use of the element in medicine?
12. Which acid is used to detect the element in nature?
13. What is the most important use of the element?
14. What is the atomic weight of the element?
15. Where are the second most important deposits of the element found?
16. In which year was the element discovered?
17. What is its chemical number?
18. What was the first use of the element?
19. Why is it used in ceramics?
20. What is the color of the compound of this element and oxygen?
21. What is the name of the element described in this article?
22. The melting point of this element is as high as the melting point of what other element?
23. Where in the USA are the greatest deposits of the element?
24. Where in the USA are deposits of the best quality?
25. When the discoverer of the element first found it, he thought that it was a compound of which element?
26. What is the color of this element's compound with sulfur?
27. How else, besides by using an acid, can this element be extracted from its compound?
28. What is the chemical symbol of the element?
29. How many tons is the world's yearly need for this element?
30. What is the name of the mineral containing the greatest percentage of the element?
31. What is the name of the mineral which is the principal supply of this element?
32. For what is the element used in the electrical industry?
33. What other property besides resistance at high temperature does this element give to magnesium?

Test Material (B)

Up to the middle of the eighteenth century the minerals containing "tungsten" were considered to be compounds of tim. In 1783 two Spanish chemists, the brothers Elhujar, produced for the first time the metal tungsten. The name "tungsten" signifies "heavy stone."

China is the world's largest producer of tungsten; the Chinese deposits are located in four of her provinces. The Burma deposits are second in importance. Colorado produces most of tungsten in the United States and its ore is of the best quality known. Arizona is another state of importance in this country's tungsten production; deposits in other states are insignificant.

Tungsten is an element of steel-gray color and it is three times as hard as platinum. It has a very high melting point of about 3,400 degrees C, which is twice as high as that of platinum. Its atomic weight number is 184 and its chemical number is 74. Tungsten's official name is Wolfram and its symbol is W. The ores of commerical importance are of two general types, scheelite and wolframite. Separation of wolframite is easy from scheelite; scheelite is red in color and it is heavy and soft. Wolframite samples vary in purity.

The most important use of tungsten is in the production of steel alloys that are used in manufacturing high-speed tools. Tungsten steel is hard and it does not lose hardness when it becomes hot. Therefore it is an ideal metal for cutting tools and drills. Tools made from ordinary steel become blunt at high temperatures. In electric industry tungsten is generally used for filaments in electric light bulbs, because of its high melting point, and in this it has replaced platinum. High density, tungsten-nickel-copper alloys have been utilized for radiation shielding in space travel. The element has been used in ceramics because it colors such products with shadows of yellow. Tungsten is used in chemistry to fireproof various fabrics and other materials exposed to high temperatures. In automobiles, tungsten is used for spark plugs because the mental resists corroding influence of many chemicals which destroy other metals. Since tungsten gives beautiful polish to alloys of which it is a part, tungsten is a highly valued metal in jewelry industry. Tungsten is, finally, also of importance in production of metal strings, because it gives them great strength; consequently, it is used in production of strings for musical instruments. About 20,000 tons of tungsten is used yearly in the world.

The best method of tungsten extraction consists in application of carbon sodium on the ore containing tungsten and then by purifying the obtained compound; the metallic tungsten can be obtained directly by simply melting the ore in vacuum by powerful electronic beams.

Tungsten has a remarkable ability to form complex compounds with several elements. When fluroine is applied on tungsten a yellow colored liquid is obtained. Phosphorus and tungsten compound is dark green in color. Sulfur combines directly with tungsten and forms black crystals.

Tungsten is easily detected in the ore by treating it with hydrocloric acid or by the microchemical evaluation of the ore's characteristic crystal structure.

END

Appendix B

Form B

TEST OF RECALL

1. What is the name of the chemist who produced the element described in this article in the matellic form?
2. Which acid is used for an easy detection of this element in the nature?
3. What is the meaning of the unofficial, general name of the element?
4. What is the color of the element in pure form?
5. At what degree of temperature (Celsius) does it melt?
6. For what is it used in chemistry?
7. Where is the most important deposit of the element found?
8. What was the nationality of the chemist who produced the element in its metallic form for the first time?
9. Which chemical is used in extraction of the element from the ore?
10. What is the color of the compound of the element with sulfur?
11. What is the use of the element in production of musical instruments?
12. What aspect of the element does the microchemical evaluation study?
13. What is the most important use of the element?
14. What is the atomic weight of the element?
15. Where are the second most important desposits of the element found?
16. In which year was the element first produced in its metallic form?
17. What is its chemical number?
18. For what type of shielding are dense alloys of this element with copper and nickel used?
19. Why is it used in ceramics?
20. What is the color of the compound of this element with phosphorus?
21. What is the general, unofficial name of this element?
22. The melting point of this element is twice as high as the melting point of what other element?
23. Where in the USA is the greatest production of the element?
24. Which state in the USA is second in importance in production of this element?
25. It was thought originally that the minerals containing this element were compounds of what other element?
26. What is the color of the compound of this element with fluorine?
27. How is the ore melted in order to extract from it the metallic form of this element?
28. What is the chemical symbol of the element?
29. How many tons is the world's yearly need for this element?
30. What is the name of the mineral from which this element is easily extracted?
31. You were asked above about the name of the ore from which this element is easily extracted. There is another ore of commerical importance. What is its name?
32. What is the element used for in the electrical industry?
33. Why is the element used for spark plugs?

FORM A - RECOGNITION TEST

DIRECTIONS: Draw a heavy X through the correct answer, either a, b, c, or d; e.g. red is the correct answer, so draw an X through d.
Sample: a. brown; b. green; c. blue; d. red

1. a. Bohr; b. Berzelius; c. Zirconius; d. Sibius
2. a. radioactivity; b. autoradiography; c. spectrophotometers d. absorption
3. a. Uranus; b. Odin; c. Thor; d. Tithonus
4. a. white; b. brown; c. red; d. silver
5. a. 1,700; b. 90; c. 232; d. 3,000
6. a. bacteriocidal; b. catalyst; c. electrolyte; d. conductor
7. a. India; b. Florida; c. South America; d. Germany
8. a. Greek; b. German; c. English; d. Spanish
9. a. nitric; b. hydrochloric; c. acetic; d. sulfuric
10. a. red; b. brown; c. yellow; d. silver
11. a. radioactive tracer; b. bacteriocidal; c. sterilizer; d. beta emitter
12. a. sulfuric; b. boric; c. nitric; d. hydrochloric
13. a. radioactive isotope; b. creep resistance for magnesium; c. atomic fuel; d. catalyst
14. a. 232; b. 1,700; c. 16; d. 209
15. a. Idaho; b. Florida; c. Brazil; d. India
16. a. 1817; b. 1902; c. 1890; d. 1832
17. a. 1,700; b. 190; c. 232; d. 90
18. a. atomic fuel; b. incandescent gas mantles; c. bacteriocidals d. catalysts in the synthesis of organic compounds
19. a. high temperature resistance; b. resistance against cracking due to external strains; c. rust prevention; d. increased tensile strength
20. a. yellow; b. white; c. brown; red
21. a. platinum; b. berzelium; c. thorium; d. yttrium
22. a. platinum; b. zirconium; c. yttrium; d. berzelium
23. a. Florida; b. Georgia; c. Iowa; d. Idaho
24. a. Florida; b. Iowa; c. georgia; d. Idaho
25. a. platinum; b. zirconium; c. thorium; yttrium
26. a. red; b. brown; c. yellow; d. white
27. a. electrolysis; b. tytration; c. crystallization; d. electromagnetic radiation
28. a. Th; b. Tm; c. Tl; d. T
29. a. 3,000; b. 900; c. 232; d. 1,700
30. a. uranium; b. platinum; c. monazite; d. manganate
31. a. platinum; b. uranium; c. manganate; d. monazite
32. a. nuclear fusion; b. flashlight powder preparation; c. special welding electrodes; d. magnesium metal welding
33. a. ductability; b. high strength; c. hardness; d. absorption

FORM B - RECOGNITION TEST

DIRECTIONS: Draw a heavy X through the correct answer, either a, b, c, or d; e.g. red is the correct answer, so draw an X through d.
Sample: a. brown; b. green; c. blue; d. red

1. a. Elcajon; b. Elhimenez; c. Elhujar; d. Ruhinez
2. a. nitric; b. hydrochloric; c. sulfuric; d. flourine
3. a. heavy stone; b. hard alloy; c. wolf stone; d. heat alloy
4. a. yellow; b. steel grey; c. dark red; d. black
5. a. 3,200; b. 20,000; c. 17,000; d. 3,400
6. a. catalyst; b. fire-proofing; c. conductor; d. resister
7. a. China; b. Burma; c. Colorado; d. Arizona
8. a. German; b. Spanish; c. French; d. Chinese
9. a. carbon sodium; b. hydrochloric; c. flourine; d. wolframite
10. a. yellow; b. red; c. green; d. black
11. a. metal picks; b. metal pegs; c. metal bars; d. metal strings
12. a. lattice structure; b. crystal structure; c. ion formations d. polar fields
13. a. steel alloys; b. electronic tools; c. radiation shielder; d. corrosion resister
14. a. 183; b. 184; c. 74; d. 134
15. a. China; b. Burma; c. Colorado; d. Arizona
16. a. 1783; b. 1784; c. 1874; d. 1816
17. a. 90; b. 83; c. 74; d. 134
18. a. high density shielding; b. radiation shielding; c. electronic shielding; d. heat shielding
19. a. adds gloss; b. increases temperature resistance; c. increases durability; d. produces yellow shadows
20. a. green; b. red; c. black; d. yellow
21. a. tin; b. wolframite; c. tungsten; d. scheelite
22. a. phosphorus; b. platinum; c. nickel; d. copper
23. a. Colorado; b. Arizona; c. New Mexico; d. Nevada
24. a. Idaho; b. Arizona; c. Colorado; d. Nevada
25. a. nickel; b. scheelite; c. wolfram; d. tin
26. a. yellow; b. white; c. red; d. green
27. a. tytration; b. melting with powerful electronic beams; c. electrolysis; d. radiation
28. a. W; b. Ti; c. S; d. Wo
29. a. 3,400; b. 20,000; c. 1,700; d. 200,000
30. a. scheelite; b. wolframite; c. tin; d. nickel
31. a. wolframite; b. scheelite; c. tin; d. phosphorus
32. a. for radiation shielding; b. for high density; c. white filaments for lightbulbs; for shock resistance
33. a. metal resists corroding influence; b. gives metal a high temperature resistance; c. gives metal a high density; d. gives metal a high melting point