Guide to MITRE/Educational Testing Service (ETS) Inductive Reasoning Battery for a High Ability Population

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McLean, VA

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Disclaimer

This document summarizes key information concerning a family of reasoning tests developed by MITRE and the Educational Testing Service (ETS) and intended for use in research applications, particularly research focused on intervention-driven improvements in fluid reasoning performance. As a research instrument, the test is not intended for use in personnel or academic selection or evaluation, nor for training or self-assessment: its intended use is in the production of reasoning performance scores in the context of research investigations. Further, note that this document includes technical information on test properties, administration, and scoring, including test answer keys. As such, this material must remain secure with distribution limited to those with need-to-know, and its use and interpretation must be limited to those with both need-to-know *and* appropriate technical qualifications (i.e., experience or coursework in research, psychometrics, and/or cognition). Questions about the test battery can be directed to Dr. Amber Sprenger (asprenger@mitre.org) or Dr. Robert Hartman (rhartman@mitre.org). Matrix reasoning image files can be obtained by contacting Dr. Sprenger or Dr. Hartman.

Abstract

MITRE and the Educational Testing Service (ETS) developed a suite of tests to measure the core inductive reasoning component of fluid reasoning (Gf) for research applications focusing on high-ability adults. This Guide provides a short overview of the test development approach, followed by detailed descriptions of each test. A set of appendices provides general test administration information for researchers (Appendix A), as well as test instructions for participants, test items, item parameters, and scaled-scoring conversion tables for each test (Appendices B through I).

The inductive reasoning tests provided in this guide include three classes of "series completion" tests (figure series (FS), number series (NS), and letter series (LS)); a matrix reasoning (MR) test; and multiple "composite" test form options, each of which includes a mix of FS, NS, and/or LS items. Each test includes two parallel forms that are:

- highly reliable: marginal reliability ≥ 0.87;
- difficult: have maximum possible scores at least four observed sample standard deviations (SDs) above the observed sample means based on a highly educated sample;
- essentially unidimensional.

All tests were developed using large samples ($n \geq 2000$ participants) with an equal representation of the following non-overlapping highest-educational-attainment groups: a) 3rd or 4th year college students; b) college graduates; c) master's degree students; d) completed a master's degree but not yet obtained a doctorate; e) doctorate degree-holders. This is in keeping with the test's intended use: high-ability participants in research studies where a high test ceiling is of critical importance and where the trade-off of potential "floor effects" is an acceptable one. All tests include 30-35 items and are administered with a 30- or 32-minute time limit, except for the FS-NS-LS composite which includes 40 test items and is administered with a 45-minute time limit. Each test also requires a 1-2 minute *per-item* time limit (limits vary by test), which helps participants set expectations regarding how much time to spend per item, so as to avoid running out of time at the test level.

Overview of MITRE/ETS Fluid Reasoning Tests

MITRE and the ETS developed a suite of tests to measure the core inductive reasoning component of fluid reasoning (Gf[1]) for research applications focusing on high-ability adults[2]. These tests include three classes of "series completion" tests (figure series (FS), number series (NS), and letter series (LS)); a matrix reasoning (MR) test; and multiple "composite" test form options, each of which includes a mix of FS, NS, and/or LS items. Further, for each of these test types, we designed two parallel equated test forms. The selection of series and matrix as focal item classes was motivated by their wide recognition as canonical Gf induction tasks. For example, they often are cited as among the most g-loaded of all cognitive ability measures (Carroll, 1993; Lohman & Lakin, 2011; Carpenter, Just, & Snell, 1990; Stankov, 2005), and they are widely represented in prominent cognitive ability test batteries, such as the Wechsler scales (Wechsler, 2008), the Woodcock-Johnson (Mather & Woodcock, 2001), Raven's Advanced Matrices (Raven, Raven & Court, 1998), and the Shipley-2 Institute of Living Scale 2 (Shipley, Gruber, Martin, & Klein, 2009).

Table 1 presents an overview of the psychometric and test-administration characteristics of each MITRE/ETS Gf test. In particular, note that each test includes two parallel forms that are:

- highly reliable: marginal reliability ≥ 0.87;
- difficult: have maximum possible scores at least four observed sample standard deviations (SDs) above the observed sample means based on a highly educated sample;
- essentially unidimensional[3].

Table 1. Overview of MITRE/ETS Gf Tests

Test	Expected Reliability	Test Ceiling	Essentially Unidim?	Parallel Forms?	Admin. Time (min.)	Per-item Limit (min.)	Number of Items
Figure Series (FS)	0.95-0.96	>4 SD	Y	Y	30	1	30
Number Series (NS)	0.87-0.88	>4 SD	Y	Y	30	1.5	35
Letter Series (LS)	0.96	>4 SD	Y	Y	30	1	30
Matrix Reasoning (MR)	0.98	>4 SD	Y	Y	32	2	30
FS-NS Composite	0.94	>4 SD	Y	Y	30	1 / 1.5	30
FS-LS Composite	0.97	>4 SD	Y	Y	30	1 / 1	30
NS-LS Composite	0.98	>4 SD	Y	Y	30	1.5 / 1	30
FS-NS-LS Composite	0.98-0.99	>4 SD	Y	Y	45	1 / 1.5 / 1	40

Note: Essentially Unidim. = Essentially Unidimensional; Admin. Time = Administration Time; min. = minutes

[1] *Fluid reasoning* reflects individuals' ability to solve a wide range of novel problems that typically cannot be solved by relying on previously acquired knowledge (Cattell, 1987; Schneider & McGrew, 2012). Gf is not associated with any specific sensory system or brain structure; rather, it is a general capacity that infuses a wide range of cognitive problem-solving activities. Contemporary Gf formulations highlight *induction* as the conceptual core of Gf (Schneider & McGrew, 2012). Induction is the ability to discover underlying rules and relationships that govern phenomena. Individuals who are strong in induction are often able to perceive meaningful patterns and solve problems in situations that others find unpredictable or unintelligible.

[2] The MITRE/ETS Gf tests are intended for use in studies of adults operating at high levels of cognitive ability, ranging from average college students through extremely high-ability individuals. The tests are particularly well-suited to examining whether experimental manipulations improve inductive Gf among high-ability adults, but note that the **tests are not intended for use in employment selection, promotion, or retention decisions or any other non-research applications.**

[3] Real-world data are rarely strictly unidimensional in practice. Psychometricians have therefore developed statistics to determine whether tests are "essentially unidimensional" meaning that they have dominant factors that are so strong that examinee trait level estimates are unaffected by (or are "robust to") the presence of smaller specific factors and influences (Stout, 1987).

All tests displayed in Table 1 were developed using large samples (n≥2000 participants) with an equal representation of the following non-overlapping highest-educational-attainment groups: a) 3rd or 4th year college students; b) college graduates; c) master's degree students; d) completed a master's degree but not yet obtained a doctorate; e) doctorate degree-holders. This is in keeping with the test's intended use: high-ability participants in research studies where a high test ceiling is of critical importance and where the trade-off of potential "floor effects" is an acceptable one.

All tests include 30-35 items and are administered with a 30- or 32-minute time limit, except for the FS-NS-LS composite which includes 40 test items and is administered with a 45-minute time limit. Each test also requires a 1-2 minute *per-item* time limit (limits vary by test), which helps participants set expectations regarding how much time to spend per item, so as to avoid running out of time at the test level. Per-item and per-test time limits were carefully determined to prevent the Gf tests from becoming excessively "speeded" (Swineford, 1974; Rindler, 1979).

In the next sections we provide a short overview of the general test development approach, followed by detailed descriptions of each test. Finally, a set of appendices provide general test administration information for researchers (Appendix A), as well as test instructions for participants, test items, item parameters, and scaled-scoring conversion tables for each test (Appendices B through I).

Test Development Approach

Item response theory (IRT) methods were used to develop, evaluate, calibrate, and equate all items and test forms. MITRE/ETS conducted all necessary ethics and fairness board approvals for data collection, and their test development efforts complied with the most recently published version of the *Joint Test Standards* (AERA, APA, & NCME, 1999). Key psychometric concepts and design choices underlying our approach are summarized as follows:

Assessment Design. Once items were generated, items were administered to participants using a balanced incomplete block design, whereby each participant completed a subset of items from a larger item pool, and each item subset included "linking" items to allow for comparative analysis across all items.

Dimensionality. Dimensionality was examined using principal components analysis (PCA), exploratory factor analysis, and confirmatory factor analysis (the latter two were implemented within a multidimensional item response theory framework).

Item Analysis. IRT was used to estimate item parameters. Using the pool of candidate items compiled after the dimensionality analyses, item parameters were estimated separately for each skill area using marginal maximum likelihood estimation via a multi-group extension of the 2PL (Bock & Zimowski, 1997) using the software program IRTPRO (Cai, Du Toit, & Thissen, 2011). Parameter estimates for each test are included in Appendices B through I).

Test Form Assembly. To create parallel test forms with equivalent statistical specifications, a linear programming approach was used (van der Linden, 2005). We started with the full set of item parameters from the IRT estimation. As a first step, any items with a difficulty parameter greater than 5 logits were excluded from the pool of candidate items. The linear programming then proceeded by identifying two sets of items – based on the estimated item parameters – with equivalent test information and test characteristic curves. The similarity of test information curves ensured that the forms had comparable reliabilities, and the similarity of test characteristic curves ensured that the overall difficulty and discrimination of the items was comparable.

Plausible Values. Final test forms built from a design in which various clusters of items (subsets from a larger item pool) were administered to participants in different clusters during data collection. Therefore, all of the examinees had missing responses to multiple items. Given the item design, these values were missing at random; however, they pose a challenge for computing summary statistics. We addressed this issue by computing imputed "plausible values" for the missing item responses in order to obtain expected values for ability. We used multiple imputation via the EM algorithm to generate ten sets of item responses for items on each test. No demographic variables were used for the imputation. The imputation was done using the Amelia II package in R (Honaker, King, & Blackwell, 2011). The imputed data were used to estimate expected abilities for each examinee (on the tests for which they took items) and to compute expected marginal reliabilities.

Marginal Reliability. After assembling the forms for each test and imputing item responses, expected IRT marginal reliabilities were estimated for each form. When an examinee has item responses that are missing at random, the maximum likelihood estimate of ability will be unbiased, but the associated standard error will be larger relative to an estimate based on a complete response string. As such, if estimated abilities and standard errors for the observed responses were used to compute marginal reliability – for a given form – the error variance would be artificially inflated and the reliability would be lower relative to the expected reliability. For this reason, the marginal reliability was computed for each form for each of the imputed datasets. The mean reliability across imputations was then computed to identify the expected reliability for each form.

Scaling. Once all the forms were assembled, score scales were established for each of the skill area tests and the composite tests. When using the 2PL there is not a one-to-one correspondence between observed scores and scale scores; however, Thissen and Orlando (2001) describe a procedure for relating observed scores and expected *a posteriori* (EAP) ability estimates. The raw-score to scale-score score conversion tables (with associated standard errors) are included in the appendices for each respective test. To make the interpretation of the scale scores more intuitive, we transformed them to a z-score metric and included associated percentiles. The mean for each scale corresponds to expected performance for first-year college students (Liu, 2010). Since the mean does not correspond to the empirical mean, this is referred to as a modified z-score.

Expected Response Time. Because items that constituted final test forms were administered to participants in different clusters during test development data collection, it was not possible to calculate the total time required to complete each test in its final form. However, it was possible to estimate an expected total time based on aggregation of item-specific response times. First, the response time for a given set of quantiles was determined for each item. We then summed the response times across items at the 75th percentile to provide an expected time for examinees who consistently respond to each item in the same, relative amount of time (e.g., at the 75th percentile). The expected response time at the 75th percentile was used as the test time limit[4].

[4] A standard criterion for establishing that a test is unspeeded is that virtually all examinees complete at least three-fourths of the test (Swineford, 1974; Rindler, 1979). Assuming time needed to complete the test is linear with the percentile, methodology to establish total test time based on the summed 75th per-item time percentiles achieves the unspeeded criterion. The estimate is likely conservative because participants who go slowly on one item do not go slowly on all items; it is likely that the 75th percentile of completion on an intact, fixed form would be a lower value than the 75th percentile established in our development studies.

Tests

Figure Series

The Figure Series (FS) test includes two, 30-item parallel test forms which assess inductive reasoning using figural stimuli (Carroll, 1993; Keith & Reynolds, 2012). FS items present 6-14 arrows pointing in one of eight possible orientations, and test-takers must induce the rules that define the arrow-sequence to determine the next arrow orientation. In order to solve FS items, test-takers have to identify the relational representations between elements (i.e., identify the rules used in that item and the principles how they are combined) and apply the corresponding relation to continue the series.

Item development. FS item difficulty was varied by manipulating the number of working memory placekeeper levels (WMPs; Holzman, Pellegrino, & Glaser, 1983). WMPs refer to the number of times per cycle an element has to be updated or held in working memory. FS items have one, two, or three, WMPs per cycle (where a cycle is the section of the item sequence that defines the pattern that is repeated across the sequence). Possible operations include rotating 90 or 135 degrees in the clockwise direction through the eight possible orientations (North, Northeast, East, Southeast, South, Southwest, West, and Northwest). The FS test uses multiple choice item type where response options for each item include all eight possible orientations. We developed 100 FS items using the above rules and operators, and based on expert review of the items, a subset of 80 items were selected for pilot testing.

Test form development. The FS test was developed by administering 80 items (19% easy; 44% moderate; 37% difficult[5]) to a large sample (n=2031) of high-ability adults (an equal proportion of: third or fourth year college students; college graduates; master's degree students; individuals with a master's degree, and doctorate degree-holders; age range 19-92; self-reported U.S. citizens). Note that each participant completed a *subset* of items, not all 80 questions. Items were divided into clusters of 16 items with three (3) easy items, seven (7) moderately difficult items, and six (6) hard items. Item clusters were administered using a partially balanced incomplete block design across 15 test forms; each test form included three item clusters (one cluster of each series type: letter series, number series, figure series). IRT methods were used to develop, evaluate, and calibrate items and test forms as described in the general test development approach described above.

Test properties: The FS test forms:

- Include 30 items
- Are essentially unidimensional
- Have a high ceiling (highest observed score for each form is > 4 SD above the sample mean)
- Have good marginal reliability (0.95-0.96)
- Are equivalent
- Demonstrate strong convergent validity: FS factor correlates 0.57 with NS factor and 0.77 with LS factor
- Discriminate examinees at ability levels ranging from high to extremely high (by restricting our sample to college juniors and above and by including substantial numbers of bachelor's and advanced degree holders).

The FS test is administered in 30 minutes, and each question has a one (1) minute time limit. The dependent variable is scaled scores based on the number of correctly solved FS items.

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[5] Easy, medium, and hard designations are relative to the sample of high ability participants who took part in the test development study. "Easy" items had one working memory placekeeper (WMP); "medium" items had two WMPs, and "hard" items had three WMPs.

Appendix B includes FS instructions, items, answer key, item parameters (discrimination and difficulty), scaled scoring tables, and a screen shot.

Number Series

The Number Series (NS) test includes two, 35-item parallel test forms which assess inductive reasoning using quantitative stimuli (Carroll, 1993; Keith & Reynolds, 2012). NS items present eight natural numbers with the ninth number missing and test-takers must induce the arithmetic rules that define the number sequence to determine the missing number. In order to solve NS items, test-takers have to identify the relational representations between elements (i.e., identify the rules used in that item and the principles how they are combined) and apply the corresponding relation to continue the series.

Item development. NS items have two different types of difficulty generating rules: rules that define how the variables in the formula are derived, and principles that define how variables can be combined mathematically. Variable-derivation rules include:

- Constant: When this rule is applied, the test-taker has to identify a constant number c that is introduced as an element of the formula needed to continue a given number series. For example, in the sequence 51, 46, 41, 36, 31, 26, 21, 16, the next number would be 11 because each term of the series is derived by subtracting 5 from the previous term.
- Checksum: When this rule is applied, the test-taker has to calculate the sum of the digits of an element (the current and/or the previous element) of the number series. For example, in the sequence, 10, 11, 13, 17, 25, 32, 37, 47, the next number would be 58 because the checksum of 47 is 11 (4+7) and 11+47 = 58.
- Fibonacci: When this rule is applied, the test-taker has to calculate the sum of the two previous elements of the number series ($F_n=F_{n-1} + F_{n-2}$). For example, in the sequence 2, 3, 5, 8, 13, 21, 34, 55, the next number would be 89 since 34+55=89.

Use of three different combination principles (addition, subtraction, application of a rule to the result of another rule) and the possibility of combining three or more rules in an item allowed for generation of items covering the continuum from easy (e.g., when only one rule was applied) to very hard (e.g., when three or more rules are combined using several combination principles in one item) items. NS item difficulties were not defined by mathematical complexity, but rather by relational complexity and working memory load of the items. Rules were limited to simple arithmetic operations as the goal of test development was to develop fluid reasoning markers, not items of mathematical proficiency.

The NS test uses the constructed response series item type (i.e., fill-in-the-blank). The series length of eight elements allowed us to generate sufficiently difficult items with complex rule-combinations for a high-ability target population. We developed 140 NS items using the above rules and rule combination principles, and based on expert review of the items, a subset of 120 items were selected for pilot testing.

Test form development. The NS test was developed by administering 120 items (19% easy; 44% moderate; 37% difficult) to two large samples (n=2031; n=1036) of high-ability adults (an equal proportion of: third or fourth year college students; college graduates; master's degree students; individuals with a master's degree, and doctorate degree-holders; age range 19-92; self-reported U.S. citizens). Note that each participant completed a *subset* of items, not all 120 questions. Items were divided into clusters of 16 items with three (3) easy items, seven (7) moderately difficult items, and six (6) hard items. Item clusters were administered using a partially balanced incomplete block design across 15 test forms; each test form included three item clusters (one cluster of each series type: letter series, number series, figure series). IRT methods were used to develop, evaluate, and calibrate items and test forms.

Test properties: The NS test forms:

- Include 35 items
- Are essentially unidimensional
- Have a high ceiling (highest observed score for each form is > 4 SD above the sample mean)
- Have good marginal reliability (0.87-0.88)
- Are equivalent
- Demonstrate strong convergent validity: NS factor correlates 0.61 with LS factor and 0.57 with FS factor
- Discriminate examinees at ability levels ranging from high to extremely high (by restricting our sample to college juniors and above and by including substantial numbers of bachelor's and advanced degree holders).

The NS test is administered in 30 minutes, and each question has a 1.5 minute time limit. The dependent variable is scaled scores based on the number of correctly solved NS items.

Appendix C includes NS instructions, items, answer key, item parameters (discrimination and difficulty), scaled scoring tables, and a screen shot.

Letter Series

The Letter Series (LS) test includes two, 30-item parallel test forms which assess inductive reasoning using verbal stimuli (Carroll, 1993; Keith & Reynolds, 2012). LS items present 7-17 letters and test-takers must induce the rules that define the letter sequence to determine the next letter. In order to solve LS items, test-takers have to identify the relational representations between elements (i.e., identify the rules used in that item and the principles how they are combined) and apply the corresponding relation to continue the series.

Item development. LS item difficulty was varied by manipulating the number of working memory placekeeper levels (WMPs; Holzman, Pellegrino, & Glaser, 1983). WMPs refer to the number of times per cycle an element has to be updated or held in working memory. LS items have one, two, or three, WMPs per cycle (where a cycle is the section of the item sequence that defines the pattern that is repeated across the sequence). Possible operations include moving forward two or three places through the alphabet. The LS test uses the constructed response series item type (i.e., fill-in-the-blank). We developed 100 LS items using the above rules and operators, and based on expert review of the items, a subset of 80 items were selected for pilot testing.

Test form development. The LS test was developed by administering 80 items (19% easy; 44% moderate; 37% difficult[6]) to a large sample (n=2031) of high-ability adults (an equal proportion of: third or fourth year college students; college graduates; master's degree students; individuals with a master's degree, and doctorate degree-holders; age range 19-92; self-reported U.S. citizens). Note that each participant completed a *subset* of items, not all 80 questions. Items were divided into clusters of 16 items with three (3) easy items, seven (7) moderately difficult items, and six (6) hard items. Item clusters were administered using a partially balanced incomplete block design across 15 test forms; each test form included three item clusters (one cluster of each series type: letter series, number series, figure series). IRT methods were used to develop, evaluate, and calibrate items and test forms as described in the general test development approach described above.

[6] Easy, medium, and hard designations are relative to the sample of high ability participants who took part in the test development study. "Easy" items had one WMP; "medium" items had two WMPs, and "hard" items had three WMPs.

Test properties: The LS test forms:

- Include 30 items
- Are essentially unidimensional
- Have a high ceiling (highest observed score for each form is > 4 SD above the sample mean)
- Have good marginal reliability (0.96)
- Are equivalent
- Demonstrate strong convergent validity: LS factor correlates 0.61 with NS factor and 0.77 with FS factor
- Discriminate examinees at ability levels ranging from high to extremely high (by restricting our sample to college juniors and above and by including substantial numbers of bachelor's and advanced degree holders).

The LS test is administered in 30 minutes, and each question has a one (1) minute time limit. The dependent variable is scaled scores based on the number of correctly solved LS items.

Appendix D includes LS instructions, items, answer key, item parameters (discrimination and difficulty), scaled scoring tables, and a screen shot.

Matrix Reasoning

The Matrix Reasoning (MR) test includes two, 30-item parallel test forms which assess inductive reasoning using figural-spatial stimuli (Carroll, 1993; Keith & Reynolds, 2012). MR items present 3 x 3 matrices with the bottom right grid-cell missing, and test-takers must induce the rules that define the matrix to determine the missing element. In order to solve MR items, test-takers have to identify the relational representations between elements (i.e., identify the rules used in that item and the principles how they are combined) and apply the corresponding relation to complete the matrix.

Item development. We used only figural-objects with "high element salience" (low figural complexity). Some objects had separate edges (e.g., squares, circles, diamonds, isosceles triangles, right triangles, rectangles, ovals, long diamonds, rounded squares, rounded rectangles, and rounded triangles. For objects with separate edges, the following attributes were manipulated:

- numerosity (1, 2, 3)
- relative size (small, medium, large)
- shading (filled, unfilled, grey)
- orientation (up, diagonal up, right, diagonal down, down, left)
- edge type (solid, dashed, dotted)
- edge thickness (thin, medium, thick)
- pattern (horizontal, vertical, left diagonal, right diagonal)

Other objects did not have separate edges (e.g., vertical lines, horizontal lines, diagonal lines, wavy vertical lines, wavy horizontal lines, wavy diagonal lines). For objects without separate edges, the following attributes were manipulated:

- numerosity (1, 2, 3)
- relative size (small, medium, large)

MR item difficulty was varied by manipulating a) the number of rule tokens (number of distinct relationships that must be held in working memory), b) the type of rules relating elements to each other, and c) the number of elements.

The number of rule tokens refers to the number of relationships existing among the different elements or attributes (Primi, 2001). When the number of elements and number of rules increases, the processing time increases simultaneously beyond what a simple additive function would predict. Increases in the number of elements and rules lead to increased demands on WM (Primi, 2001). Numerous studies have found that the number of rule tokens is one of the main drivers of construct-relevant increased difficulty in matrix reasoning tests.

Rule type refers to the fact that some rules require only basic perceptual comparison of two elements in order to induce a rule, whereas other items require simultaneous consideration of all elements to induce a rule. Some rules are based on conceptual similarity rather than perceptual similarity (Primi, 2001). Embretson (1998) argued that different types of rules impose differential demands on WM. Different types of rules require different levels of selective encoding to ignore irrelevant attributes during the inference process (Primi, 2001). Carpenter et al. (1990) and Primi (2001) classified problem rules, including:

a. Simple, quantitative pairwise progression (size, shading, number, shape, added element)
b. Spatial, quantitative pairwise progression (movement on a plane, flip over, reversal)
c. Complex (figure addition and subtraction; elements of a set; unique addition; attribute addition)
d. Conceptual (elements of a set, attributes: shading, inclination, color, size, outline, and shape)

We developed items that adhere to 20 unique rules based on the following four general principles and combinations thereof: (1) Addition of elements across rows and columns, (2) rotation of elements clockwise or counter-clockwise, (3) position changes of elements within a given cell of a matrix, and (4) distribution of a set of elements across rows and columns of a matrix. In all items, rules were applied both horizontally (i.e., from the left column to the right column) and vertically (i.e., from top row to the bottom row). Up to three rules could be combined in any given item. In order to create phenotypically different items, the translation of these rules into the matrix items was based on a selection of graphical elements like circles, triangles, segmented lines, which in combination are referred to as graphical families. Items were developed using 26 unique graphical families

The number of elements for matrix reasoning tests refers to the number of geometric figures or attributes in an existing matrix problem (Primi, 2001). When the number of elements and number of rules increases, the processing time increases simultaneously beyond what a simple additive function would predict. Increases in the number of elements and rules lead to increased demands on WM (Primi, 2001).

The MR test uses the multiple choice item type; participants select one of eight alternatives presented below the matrix. We developed 120 MR items using the above rules and rule combination principles, and based on expert review of the items, a subset of 80-100 items were selected for pilot testing and the main test development study.

Test form development. The MR test was developed by administering 80-100 items (12% easy; 48% moderately difficult; 40% difficult) to two large samples (n=499; n=2012) of high-ability adults (an equal proportion of: third or fourth year college students; college graduates; master's degree students; individuals with a master's degree, and doctorate degree-holders; age range 19-92; self-reported U.S. citizens). Note that each participant completed a *subset* of items, not all 80-100 questions. Items were divided into forms of 33 items that were designed to be equivalent with respect to theoretical difficulty and representation of item rules and graphical families. Each examinee completed one randomly assigned form, followed by a demographic questionnaire and a post-test survey. IRT methods were used to develop, evaluate, and calibrate items and test forms.

Test properties: The MR test forms:

- Include 30 items

- Are essentially unidimensional
- Have a high ceiling (highest observed score for each form is > 4 SD above the sample mean)
- Have excellent marginal reliability (0.98)
- Are equivalent
- Discriminate examinees at ability levels ranging from high to extremely high (by restricting our sample to college juniors and above and by including substantial numbers of bachelor's and advanced degree holders).

The MR test is administered in 32 minutes, and each question has a two (2) minute time limit. The dependent variable is scaled scores based on the number of correctly solved MR items.

Appendix E includes MR instructions, the answer key, item parameters (discrimination and difficulty), scaled scoring tables, and a screen shot. Item image stimuli are included in the accompanying zip file, "matrixReasoning.zip."

Composites

In addition to the stand-alone test forms, MITRE/ETS assembled four composite tests, each of which includes a mix of item-types. These composite versions may be attractive in circumstances where researchers desire a single reasoning score based on multiple classes of Gf stimuli (e.g., letters, figures), and where it is infeasible to administer the full battery of stand-alone MITRE/ETS Gf tests. The composite tests are:

- Figure-Number Series Composite (F-N; Appendix F)
- Figure-Letter Series Composite (F-L; Appendix G)
- Number-Letter Series Composite (N-L; Appendix H)
- Figure-Number-Letter Series Composite (F-N-L; Appendix I)

For each composite test, parallel forms were assembled. Additionally, for the F-N, F-L, and N-L composite tests, a single "best of" form was identified which included the best items overall when the constraint to divide items across two parallel forms was relaxed. Each F-N, F-L, and N-L test form includes 30-items, while the F-N-L form includes 40 items. Composite test forms were assembled using linear programming with items and item parameter estimates from the above-described test development effort.

Test properties: The composite test forms:

- Are essentially unidimensional
- Have a high ceiling (highest observed score for each form is > 4 SD above the sample mean)
- Have excellent marginal reliability (0.94-.99)
- Have equivalent parallel forms
- Discriminate examinees at ability levels ranging from high to extremely high (by restricting our sample to college juniors and above and by including substantial numbers of bachelor's and advanced degree holders).

The F-N, F-L, and N-L composite tests are administered in 30 minutes, and the F-N-L form is administered in 40 minutes. FS and LS items should each have a one (1) minute time limit, and NS items should each have a 1.5 minute time limit. The dependent variable is scaled scores based on the number of correctly solved items.

Appendices F through I include composite form items, answer keys, item parameters (discrimination and difficulty), and scaled scoring tables.

References

Bock, R. D., & Zimowski, M. F. (1997). Multiple group IRT. In *Handbook of modern item response theory* (pp. 433-448). New York, NY: Springer.

Bridgeman, B., & Rock, D. A. (1993). Development and Evaluation of Computer-Administered Analytical Questions for the Graduate Record Examinations General Test. GRE Board Professional Report No. 88-06P.

Cai, L., Du Toit, S. H. C., & Thissen, D. (2011). IRTPRO: Flexible, multidimensional, multiple categorical IRT modeling [Computer software]. *Chicago, IL: Scientific Software International.*

Carpenter, P. A., Just, M. A., & Shell, P. (1990). What one intelligence test measures: A theoretical account of the processing in the Raven Progressive Matrices test. *Psychological Review, 97*, 404-431.

Carroll, J. B. (1993). *Human cognitive abilities: A survey of factor analytic studies.* New York: Cambridge University Press.

Ekstrom, R. B., French, J. W., Harman, H. H., & Dermen, D. (1976). Kit of factor-referenced cognitive Tests. Educational Testing Service. *Princeton, NJ.*

Embretson, S. E. (1998). A cognitive design system approach to generating valid tests: application to abstract reasoning. *Psychological Methods, 3*, 380-396.

Emmerich, W., Enright, M. K., Rock, D. A., & Tucker, C. (1991). The development, investigation, and evaluation of new item types for the GRE analytical measure. Princeton, NJ: Educational Testing Service.

Holzman, T. G., Pellegrino, J. W., & Glaser, R. (1983). Cognitive variables in series completion. *Journal of Educational Psychology, 75*, 603-618.

Honaker, J., King, G., & Blackwell, M. (2011). Amelia II: A program for missing data. R Package version 1.5–5.

Jäger, A. O., Holling, H., Preckel, F., Schulze, R., Vock, M., Süß, H. M., & Beauducel, A. (2006). Berliner Intelligenzstrukturtest für Jugendliche (BIS-HB).*Begabungs-und Hochbegabungsdiagnostik. Göttingen: Hogrefe*.

Keith, T. Z., & Reynolds, M. R. (2010). Cattell-Horn-Carroll abilities and cognitive tests: What we've learned from 20 years of research. *Psychology in the Schools, 47,* 635-650.

Liu, O. L. (2010). Measuring value-added in higher education: Conditions and caveats –results from using the Measure of Academic Proficiency and Progress (MAPP). *Assessment & Evaluation in Higher Education, 36,* 81-94.

Lohman, D. F., & Lakin, J. M. (2011). Reasoning and Intelligence. In R. J. Sternberg and S. B. Kaufman (Eds.), *Handbook of Intelligence* (2nd ed.). New York: Cambridge University Press.

Mather, N. & Woodcock, R. W. (2001). *Tests of cognitive abilities: Examiner's manual Standard and Extended Batteries.* Boston: Houghton Mifflin Harcourt.

Primi, R. (2001). Complexity of geometric inductive reasoning tasks: Contribution to the understanding of fluid intelligence. *Intelligence, 30*, 41-70.

Raven, J., Raven, J. C., & Court, J. H. (1998). *Manual for Raven's Progressive Matrices and Vocabulary Scales: Section 4: Advanced Progressive Matrices Sets I & II.* San Antonio TX: Pearson.

Rindler, S. (1979). Pitfalls in assessing test speededness. *Journal of Educational Measurement, 16*, 261–270.

Shipley, W. C., Gruber, C. P., Martin, T. A., & Klein, A. M. (2009). *Shipley-2 Manual.* Western Psychological Services, Los Angeles, CA.

Stankov, L. (2005) 'g' factor: Issues of design and interpretation. In O. Wilhelm & R. Engle (Eds) *Understanding and Measuring Intelligence.* Thousand Oaks, CA: Sage Publications.

Stout, W. F. (1987). A nonparametric approach for assessing latent trait unidimensionality.

Psychometrika, 52, 589-617.
Swineford, F. (1974). The test analysis manual (ETS Statistical Report SR-74-06). Princeton, NJ: Educational Testing Service.
Thissen, D., & Orlando, M. (2001). Item response theory for items scored in two categories. In D. Thissen & H. Wainer (Eds), *Test Scoring* (pp. 73-140). Hillsdale, NJ: Lawrence Erlbaum Associates
Thorndike, R., & Hagen, E. (1971). Cognitive Abilities Test, Verbal, Nonverbal, and Quantitative Batteries: Form 1, Levels AH.
Thurstone, L. L., & Thurstone, T. G. (1941). Factorial studies of intelligence. *Psychometric monographs*.
van der Linden, W. J. (2005). *Linear models for optimal test design*. New York, NY: Springer.
Wechsler, D. (2008). *Wechsler Adult Intelligence Scale – 4th edition: Technical and interpretive manual.* San Antonio TX: Pearson.

Appendix A. MITRE/ETS Fluid Reasoning Test Administration Instructions for Researchers

Test Administration
MITRE/ETS tests should be administered in proctored settings with trained test proctors. Proctors should be given training on standardized test administration protocol and should be familiar with test instructions, computer settings, and the general procedures to be adhered to during the test administration. Specific test-session instructions include:

- Test settings should be quiet and free of all distractions.
- Proctors should ask participants to turn off their cell phones and leave them and other personal belongings in a secure location separate from the testing workstation.
- Participants should not write anything down during testing and should not have access to paper/pencils during testing.
- Participants should not talk with other participants during testing.
- Participants should not open web browsers or tabs during the testing session.
- If administering multiple MITRE/ETS tests to participants, participants should receive 5-10 minute breaks between each test, and should not complete more than four hours of testing (ideally much less) in one testing session.
- Each MITRE/ETS test requires implementing per-question and per-test time limits. Those time limits are presented in Table 1.
- Test administrators should disable computers' automatic virus checks, automatic back-up processes, automatic software updates, and/or any other applications on testing computers that might disrupt the testing session.

Software Requirements
This protocol assumes that MITRE/ETS tests will be instantiated in a computer-administered format. While it is conceivable that the test battery could be adapted for paper-and-pencil-based administration, this would require consideration of various factors. For instance, it would be difficult to implement precise item-level time limits, and would likely be impossible to do so for multiple concurrent test-takers. Adaptation issues like this could be addressed by, e.g., instructing participants about the overall time limit and the suggested maximum amount of time to spend per question before moving on to the next question. Nevertheless, strictly speaking, the comparability of this approach to a software-based approach (with built-in timers) is unknown and should not be assumed.

Software-based administration of the tests requires the following functionalities:

- Implement per-question time limits
- Implement per-test time limits
- Display images, letters, numbers
- Allow users to input numeric or letter responses
- Allow users to select one of several possible options
- Record data
- Implement proctor, computer programmer, and test-taker log-in and passwords
- Strong information security to protect government-owned tests and participants' data
- Robust test randomization functionalities (if administering multiple tests and where test fatigue or order effects may be of concern)
- Cross-session workflow management (if administering multiple versions of the same tests across multiple sessions where the system must "remember" who took which test form when)

Scoring

MITRE/ETS tests are each scored using the following steps. First, for each question compare test-takers' responses with the correct response (indicated in the "key" column for each test in remaining Appendices). Next, sum the total number of correct responses. Finally, compare the summed raw score against the standardized scale score in each test's "Scaled Score Concordance Tables" in the following appendices. The scale score should be used for all data analyses.

Appendix B: Figure Series Materials

Figure Series Instructions for Participants

In this test you will be shown a series of arrows. The orientation of the arrows in the series changes according to a fixed pattern. The orientation of an arrow at any point is indicated by one of the following arrows:

↑ ↗ → ↘ ↓ ↙ ← ↖

Your task is to determine what should be the next arrow in the series according to the pattern.

Here are three examples:

Example 1: What is the next arrow in the series?

↖ ↑ ↗ → ↘ ↓ ↙ ← ↖ ↑ ↗

↑
↗
→
↘
↓
↙
←
↖

In this example, the series starts with ↖, and then rotates the arrow clockwise in 45 degree increments. Thus, the correct answer is → and you should select that option.

Some items may contain multiple rules, such as the example below.

Example 2: What is the next arrow in the series?

↑ ← → ← ↓ ← ← ← ↑ ← → ←

↑
↗
→
↘
↓
↙
←
↖

In this example, there are two rules involved.

Rule 1: The first arrow of the series (↑) rotates clockwise in 90 degree increments.

Rule 2: The second arrow of the series (←) is restricted from rotating.

These rules alternate back and forth throughout the arrow series. Since the series ends on Rule 2 (←), the following arrow would use Rule 1. Thus, Rule 1 would rotate → to ↓. Therefore, the correct answer is ↓ and you should select that option.

Example 3: What is the next arrow in the series?

↑ ↓ → ← ↓ ↑ ← → ↑ ↓ → ←

↑
↗
→
↘
↓
↙

←
↖

In this example, there are two rules involved.
Rule 1: The first arrow of the series (↑) rotates clockwise in 90 degree increments.
Rule 2: The second arrow of the series (↓) rotates clockwise in 90 degree increments.
These rules alternate back and forth throughout the arrow series. Since the series ends on Rule 2 (←), the following arrow would use Rule 1. Thus, Rule 1 would rotate → to ↓. Therefore, the correct answer is ↓ and you should select that option.

Please work carefully, but do not spend too much time on any one question. The time for each item is limited to one (1) minute, and the total time allotted for all 30 questions is 30 minutes. Try to answer as many questions as you can within the time limit.

You will not be able to go back once you submit your answer for each question.

Figure Series Items, Item Parameters, and Answer Key
Form 1

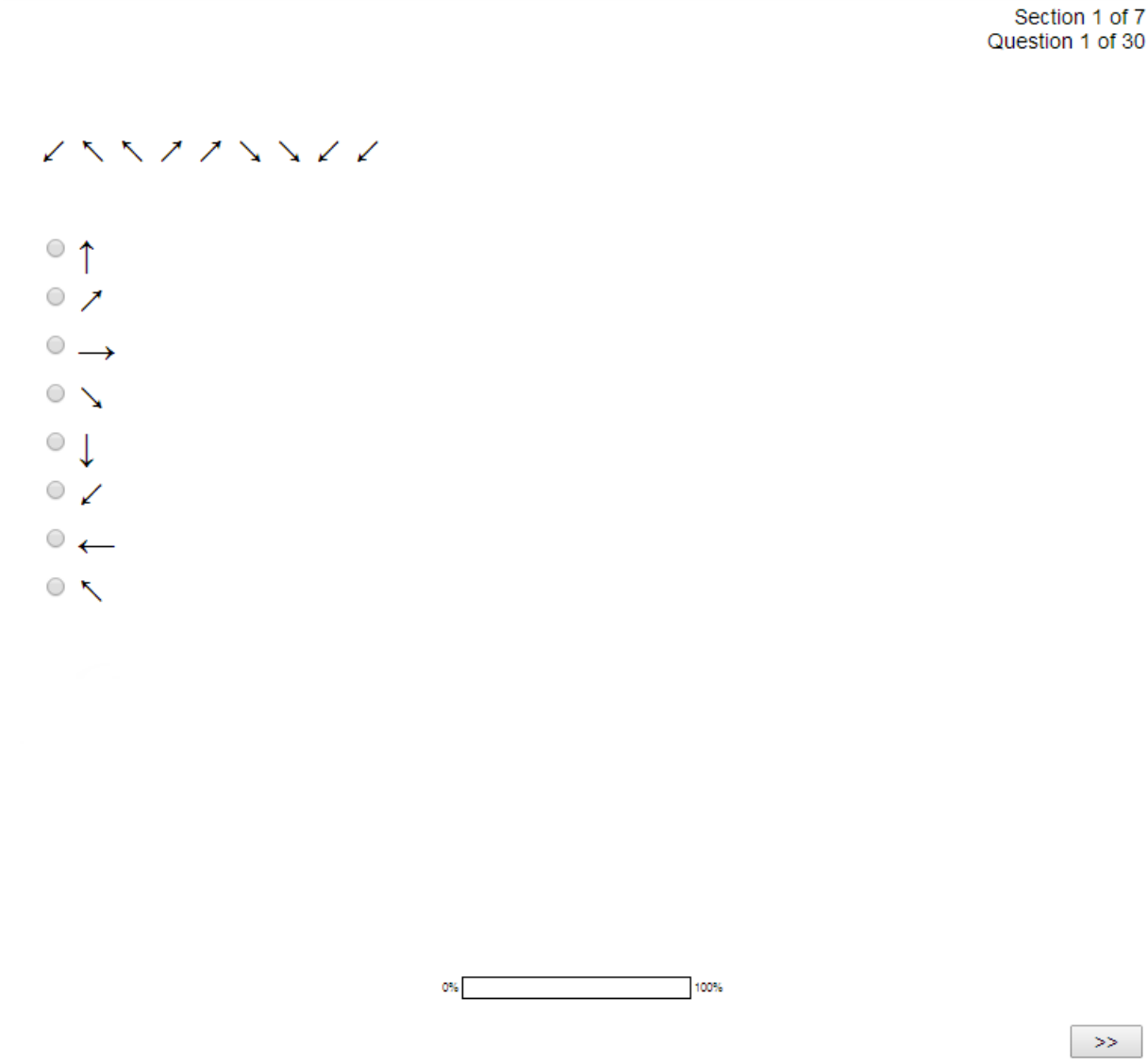
Item Label	Disc.	Diff.	Item														Key
as_b1i11	0.64	-0.14	←	→	→	↗	↑	↓	↓	↘	→	←	←	↙	↓		↑
as_b1i2	1.06	-0.62	↓	↖	↘	←	↖	↘	↑	↖	↘						→
as_b1i5	0.84	0.67	↙	↖	←	↖	↖	↖	↑	↖	↗	↖	→	↖			↘
as_b1i7	1.08	0.36	↓	↙	↑	↙	←	↙	→	↙	↑	↙	↓	↙			→
as_b1i13	1.23	-0.37	↗	↗	↑	↖	↘	↘	→	↗	↙	↙	↓	↘	↖	↖	←
as_b1i3	1.40	1.84	↓	↗	←	↖	↗	←	→	↗	←						↙
as_b1i15	0.66	-0.64	↑	↗	←	→	↘	↑	↓	↙	→						←
as_b1i16	1.07	0.57	↓	↙	↓	←	↖	←	↑	↗	↑	→					↘
as_b1i10	0.85	-1.77	↖	↘	↓	↗	↙	↓	↘	↖	↓	↙					↗
as_b2i2	0.80	1.38	↖	↑	↗	↗	↑	↗	↘	↑	↗						↙
as_b2i5	0.50	0.40	↖	↙	↗	↖	↘	↗	↙	↘	↖						↙
as_b2i12	1.17	0.28	↓	↗	↗	↙	←	↘	↘	↖	↑	↙	↙	↗	→		↖
as_b2i13	0.50	-2.19	←	←	↓	→	↑	↑	←	↓	→	→	↑	←	↓	↓	→
as_b2i3	1.21	2.12	↗	↙	↑	↓	↙	↑	↖	↙	↑						→
as_b2i14	0.50	0.91	→	↑	↘	↖	↓	→	↙	↖	←	↓	↖	↖			↑
as_b2i10	0.75	0.24	↗	→	←	↘	↓	←	↙	←	←	↖					↑
as_b3i1	0.99	0.68	↖	↘	↗	↘	↘	↘									↙
as_b3i4	0.90	-0.31	↓	↘	←	↙	↑	↖	→	↗	↓						↘
as_b3i7	1.59	-1.12	↘	↘	↑	↙	↙	→	↖	↖	↓	↗	↗				←
as_b3i13	0.78	-1.04	↘	↘	↙	↗	↙	↙	↖	↘	↖	↖	↗	↙			↗
as_b3i8	0.93	-1.25	↑	↑	↖	→	→	↗	↓	↓	↘						←
as_b3i15	0.75	-0.68	↘	←	↗	↙	↑	↘	↖	→	↙	↗					↓
as_b3i16	0.58	-1.19	→	↘	↑	↓	↙	→	←	↖	↓						↑
as_b3i10	1.25	-0.80	↑	↙	↗	→	↖	↗	↓	↗	↗						←
as_b4i11	0.39	2.06	→	↓	↓	←	↓	←	←	↑	←	↑	↑	→			↑
as_b4i2	0.46	0.96	←	→	←	↑	→	←	→	→	←						↓
as_b4i3	0.32	3.30	→	←	↓	↙	←	↓	↑	←	↓						↘
as_b5i2	0.82	-1.76	↘	↓	↑	↙	↓	↑	↖	↓	↑						↗
as_b5i8	0.81	-2.43	→	→	←	↓	↓	↑	←	←	→						↑
as_b5i16	0.19	0.51	←	↑	→	↑	→	↓	→	↓	←	↓					←

Figure Series Items, Item Parameters, and Answer Key Form 2																	
Item Label	**Disc.**	**Diff.**	**Item**														**Key**
as_b1i4	0.63	-1.02	↙	↖	↖	↗	↗	↘	↘	↙	↙						↖
as_b1i12	0.77	0.71	↙	↖	↖	↑	↖	↗	↗	→	↗	↘	↘	↓			↘
as_b1i6	0.73	1.80	←	↑	↙	↑	↑	↑	↖	↑	→	↑	↗	↑			↓
as_b1i8	0.68	-1.15	↖	↖	↓	↗	↗	←	↘	↘	↑						↙
as_b2i1	0.58	-2.50	↓	→	←	→	↑	→	→	→							↓
as_b2i4	0.73	-1.44	←	→	↑	↓	→	←									↓
as_b2i11	0.78	0.22	↗	↑	↑	→	↘	→	→	↓	↙	↓	↓	←			↖
as_b2i6	1.16	1.62	↗	↙	←	↙	↘	↙	↑	↙	↙	↙	→	↙			↖
as_b2i8	1.17	-0.27	←	←	↗	↑	↑	↘	→	→	↙	↓	↓				↖
as_b2i15	1.05	1.96	↗	↓	↙	↘	↘	←	↖	↘	↙	↑	↗	↘			↖
as_b2i9	1.02	-0.21	↓	↙	↖	←	↖	↖	↑	↗	↖						→
as_b2i16	0.68	-0.86	↗	→	↙	↘	↓	↖	↙	←	↗	↖					↑
as_b3i11	0.90	-0.31	↑	↘	↘	↖	→	↙	↙	↗	↓	↖	↖	↘			←
as_b3i2	0.98	0.29	→	↑	↖	↓	↑	↖	←	↑	↖						↑
as_b3i12	1.12	-0.41	→	→	↘	↑	↓	↓	↙	→	←	←	↖	↓	↑	↑	↗
as_b3i6	0.97	1.60	↑	→	↖	→	→	→	↗	→	↓	→	↘	→			←
as_b3i3	0.58	2.27	↑	↓	↑	↘	↓	↑	←	↓	↑						↗
as_b3i9	1.18	-1.28	↗	↗	←	↘	↘	↑	↙	↙	→	↖	↖				↓
as_b4i4	0.53	-4.48	↗	→	↘	↓	↙	←	↖	↑	↗						→
as_b4i5	1.10	-0.35	↖	←	↗	↑	↘	→									↙
as_b4i7	1.25	-1.62	↗	↗	↓	↘	↘	←	↙	↙	↑	↖	↖				→
as_b4i8	0.60	-2.45	↓	↓	↗	←	←	↘	↑	↑	↙						→
as_b4i15	0.29	2.74	↓	↘	↗	↙	←	↙	↘	↙	↑	↖	↙	↙	→		↗
as_b4i9	0.76	0.08	↑	→	↙	→	↓	↙	↓	←	↙						←
as_b4i10	0.95	-0.03	↗	↖	←	↘	↗	←	↙	↘	←						↖
as_b5i4	0.86	-1.50	↑	↓	→	←	↓	↑									←
as_b5i11	0.68	1.31	↖	←	←	↓	↗	↑	↑	←	↘	→	→	↑			↙
as_b5i7	0.58	0.63	↖	←	↙	←	↗	←	↖	←	↘	←	↗	←			↙
as_b5i13	0.98	-0.99	↖	↖	↘	↑	↗	↗	↙	→	↘	↘	↖	↓			↙
as_b5i15	0.70	1.94	↙	←	→	↖	↖	↑	↓	↖	↗	→	←	↖			↘

Figure Series Scaled Score Concordance Tables

Raw Score	Form 1 Scale Score	Form 1 SE	Form 2 Scale Score	Form 2 SE
0	-3.97	0.93	-4.04	0.92
1	-3.64	0.95	-3.70	0.94
2	-3.28	0.95	-3.33	0.93
3	-2.93	0.93	-2.96	0.92
4	-2.58	0.91	-2.59	0.89
5	-2.23	0.89	-2.24	0.87
6	-1.90	0.87	-1.89	0.84
7	-1.58	0.85	-1.56	0.82
8	-1.26	0.83	-1.24	0.81
9	-0.96	0.82	-0.93	0.79
10	-0.65	0.81	-0.63	0.78
11	-0.36	0.80	-0.34	0.77
12	-0.06	0.79	-0.05	0.77
13	0.23	0.79	0.24	0.77
14	0.52	0.79	0.53	0.76
15	0.80	0.79	0.82	0.77
16	1.09	0.80	1.10	0.77
17	1.38	0.80	1.39	0.77
18	1.68	0.81	1.68	0.78
19	1.98	0.82	1.98	0.79
20	2.28	0.83	2.28	0.80
21	2.59	0.84	2.59	0.81
22	2.92	0.86	2.91	0.83
23	3.25	0.87	3.24	0.84
24	3.59	0.89	3.58	0.86
25	3.95	0.92	3.93	0.89
26	4.31	0.94	4.30	0.91
27	4.69	0.96	4.69	0.93
28	5.06	0.97	5.08	0.96
29	5.43	0.97	5.47	0.96
30	5.76	0.96	5.85	0.95

Figure Series Screen Shot



Appendix C: Number Series Materials

Number Series Instructions for Participants

In the following you will be asked to answer a set of number series items. Each series consists of 8 numbers. Your task is to enter the number that comes next in the series. Each number in the series can be one- or two-digit positive integers. This applies to numbers in the series as well as the answer.

Every series is based on a mathematical formula composed of one or more of three specific rules (multiple rules can be combined on one item):

- Adding or subtracting a constant less than or equal to 20.
- Adding the two previous terms of the series.
- Calculating the checksum (the sum of the digits). For example, the checksum of 15 is 6.

You can make yourself familiar with the principles of this test by looking at the following three example items.

Example 1 (Subtracting a constant):

51, 46, 41, 36, 31, 26, 21, 16, ?

Each term of the series is derived by subtracting 5 from the previous term. Hence the next term of the series is 16 – 5 = 11.

Example 2 (Adding the two previous terms of the series):

2, 3, 5, 8, 13, 21, 34, 55, ?

Each term after the second is obtained by adding the two previous terms. Thus the next term is 34 + 55 = 89.

Example 3 (Add the checksum):

10, 11, 13, 17, 25, 32, 37, 47, ?

Each term of this series is derived by adding the checksum of the previous term to the previous term. So for example, the checksum of the first term, 10, is 1, and 10 + 1 = 11. The checksum of 11 is 2, and 11 + 2 = 13. The checksum of 13 is 4, and 13 + 4 = 17. And so on. The checksum of 47 is 11 and 47 + 11 = 58. Thus the next term of the series is “58”.

Please keep the following in mind when working on the items:

- There is exactly one solution for each item.

- Only the three specific rules listed above should be used to find the correct solution to a series. No credit is given for suggested solutions to the series based on different principles than the ones defined here.

- An item can be based on one rule or on a combination of several rules.

- Do not spend too much time on solving a specific item. The time for each item is limited to 1.5 minutes, and the total time allotted for all 35 questions is 30 minutes

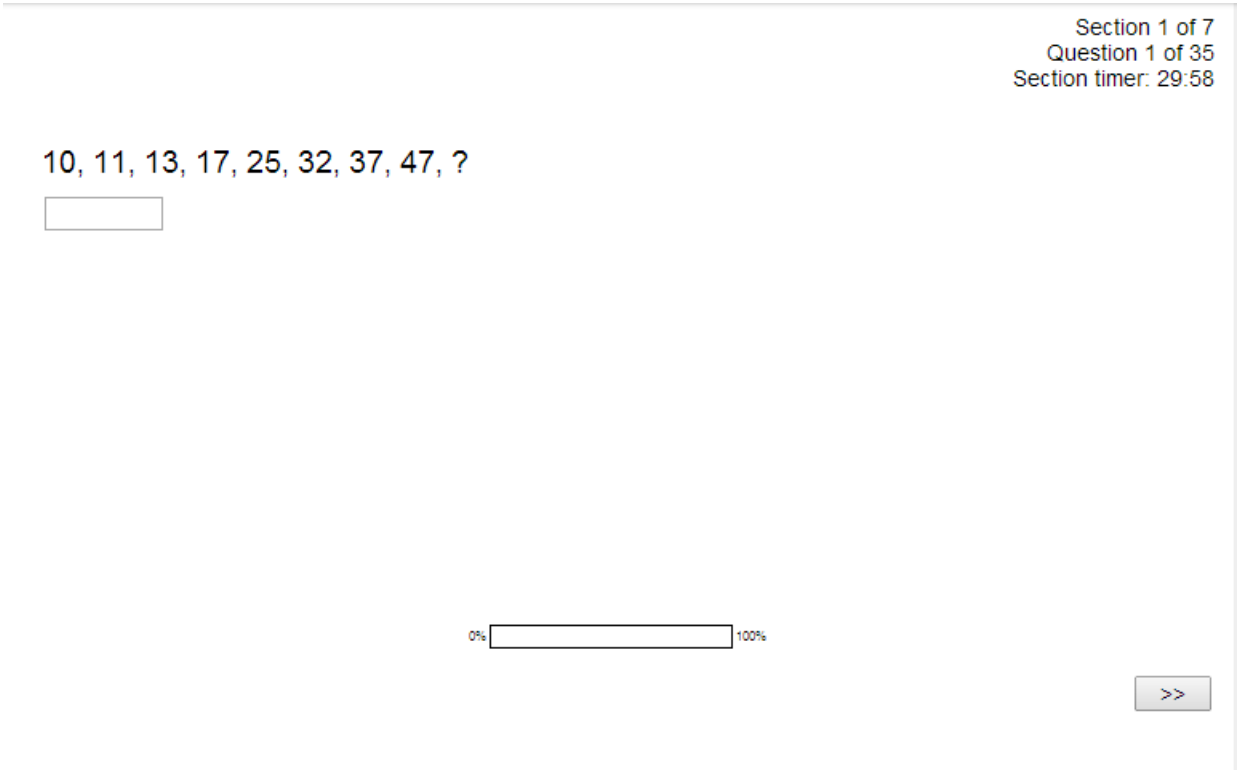
Number Series Items, Item Parameters, and Answer Key Form 1											
Item Label	**Disc.**	**Diff.**	**Item**								**Key**
nst_f03i1	1.30	1.59	2	3	4	6	9	14	22	35	**56**
nst_f06i4	0.97	3.03	68	57	43	31	24	20	14	12	**7**
nst_f03i3	1.02	3.19	10	12	12	14	16	20	26	36	**52**
nn_f08i12	3.19	0.97	12	20	23	25	30	37	40	50	**54**
nst_f03i5	1.12	2.32	21	22	23	25	28	33	41	54	**75**
nst_f07i3	0.83	3.28	7	12	10	4	5	9	14	14	**10**
nst_f15i1	2.15	2.42	11	10	2	2	3	4	6	9	**14**
nn_f03i8	0.86	2.85	15	17	18	21	25	32	43	61	**90**
nst_f06i2	0.94	1.46	58	43	30	23	20	15	13	7	**3**
nn_f08i10	2.24	1.16	11	20	22	24	28	34	44	51	**59**
nst_f03i2	1.62	1.38	2	4	5	8	12	19	30	48	**77**
nst_f9i6	1.21	2.52	11	12	14	18	26	33	38	48	**59**
nst_f08i4	1.64	1.37	26	32	40	45	49	58	71	84	**92**
nst_f9i4	0.77	3.29	16	20	19	26	31	32	34	38	**46**
nst_f06i3	1.30	1.36	77	61	47	40	29	25	14	7	**2**
nst_f01i1	1.57	-0.15	10	11	13	17	25	32	37	47	**58**
nst_f08i5	1.94	1.50	21	28	31	41	45	50	59	64	**78**
nst_f02i1	0.86	3.39	3	7	15	22	27	37	48	61	**69**
nst_f04i2	0.57	4.73	2	13	6	10	7	8	6	5	**2**
nn_f06i12	1.72	1.30	88	74	58	47	34	23	16	11	**4**
nst_f02i4	1.04	2.57	13	18	28	39	52	60	67	81	**91**
nst_f06i6	2.85	1.30	62	51	43	37	30	20	17	15	**7**
nst_f15i2	0.74	4.25	7	8	14	12	7	9	15	14	**10**
nn_f07i8	0.93	3.25	11	10	3	4	7	11	9	11	**11**
nst_f06i5	1.35	1.44	65	50	39	34	22	15	11	5	**3**
nst_f08i1	2.70	1.26	15	17	23	31	36	40	49	53	**66**
nn_f06i7	2.25	1.66	93	76	64	51	41	35	30	22	**19**
nn_f04i6	0.68	3.68	4	7	2	9	2	2	4	6	**1**
nn_f03i10	0.77	3.33	13	15	16	19	23	30	41	59	**88**
nn_f08i6	0.89	1.41	11	17	19	27	37	46	56	66	**77**
nn_f04i8	0.57	4.58	13	5	9	5	5	1	6	7	**4**
nn_f02i8	0.56	2.63	8	18	29	42	50	57	71	81	**92**
nst_f04i3	1.01	3.32	10	11	3	5	8	4	3	7	**1**
nst_f01i4	1.73	0.97	13	17	25	32	37	47	58	71	**79**
nn_f08i9	1.02	1.64	3	5	8	13	21	25	28	35	**45**

Number Series Items, Item Parameters, and Answer Key Form 2											
Item Label	**Disc.**	**Diff.**	**Item**								**Key**
nn_f03i11	1.29	2.21	6	7	9	12	17	25	38	59	**93**
nst_f06i1	1.52	1.76	71	58	50	37	32	22	17	13	**5**
nst_f01i5	1.65	0.95	22	26	34	41	46	56	67	80	**88**
nn_f04i9	1.15	3.31	16	8	6	5	2	7	9	7	**7**
nn_f03i7	0.59	4.21	18	20	20	22	24	28	34	44	**60**
nst_f01i3	1.68	0.95	14	19	29	40	44	52	59	73	**83**
nst_f08i2	1.55	1.55	6	10	16	17	24	32	38	43	**54**
nn_f06i6	1.95	1.63	85	76	63	50	41	36	31	22	**18**
nn_f08i13	1.06	0.97	12	19	22	32	36	41	50	55	**60**
nn_f02i10	1.02	4.61	1	6	16	27	40	48	64	78	**97**
nn_f03i13	1.33	1.96	4	6	7	10	14	21	32	50	**79**
nst_f08i3	2.60	1.12	16	20	27	29	38	49	60	73	**79**
nst_f08i6	2.82	1.30	16	24	31	37	41	51	56	62	**73**
nst_f9i1	0.83	4.22	11	10	8	13	14	16	20	19	**26**
nn_f06i8	2.01	1.21	87	73	58	48	35	23	15	10	**4**
nn_f08i8	1.54	1.16	7	11	18	20	29	31	42	46	**52**
nst_f07i6	0.70	4.94	16	21	22	24	28	36	43	48	**58**
nst_f02i5	0.76	1.88	9	19	30	34	42	49	63	73	**84**
nst_f07i1	1.43	2.41	10	6	7	13	11	6	8	14	**13**
nn_f03i9	1.39	1.91	15	16	17	19	22	27	35	48	**69**
nn_f02i6	1.82	4.35	16	25	34	43	52	61	70	79	**97**
nn_f08i11	1.57	1.13	15	18	24	33	39	45	57	66	**78**
nst_f10i3	1.89	3.09	76	68	57	45	35	28	22	14	**12**
nn_f06i11	1.69	1.68	92	75	64	52	42	35	29	21	**10**
nst_f04i4	0.94	3.56	9	2	2	4	6	1	7	8	**6**
nn_f06i10	1.14	-1.10	81	72	63	54	45	36	27	18	**9**
nn_f06i13	2.74	1.27	74	66	55	43	33	26	20	12	**10**
nst_f07i2	1.36	3.22	14	16	12	10	4	5	9	14	**14**
nn_f08i7	1.74	1.47	14	17	22	30	34	37	44	54	**62**
nn_f03i6	0.81	2.10	12	12	13	14	16	19	24	32	**45**
nn_f07i7	0.68	3.58	22	21	7	10	8	9	17	17	**16**
nn_f06i9	1.33	0.96	70	62	55	47	37	26	16	8	**1**
nst_f01i2	1.11	0.89	8	16	23	28	38	49	62	70	**77**
nst_f03i4	0.78	4.40	5	6	6	7	8	10	13	18	**26**
nst_f02i2	0.99	4.11	6	14	21	26	36	47	60	68	**84**

Number Series Scaled Score Concordance Tables

Raw Score	Form 1 Scale Score	Form 1 SE	Form 2 Scale Score	Form 2 SE
0	-3.25	1.35	-3.05	1.24
1	-2.37	1.22	-2.21	1.11
2	-1.65	1.08	-1.52	0.99
3	-1.05	0.97	-0.94	0.88
4	-0.55	0.87	-0.46	0.79
5	-0.12	0.79	-0.05	0.72
6	0.25	0.73	0.31	0.66
7	0.58	0.68	0.62	0.61
8	0.87	0.64	0.89	0.57
9	1.14	0.61	1.14	0.55
10	1.39	0.59	1.38	0.53
11	1.63	0.57	1.60	0.51
12	1.85	0.56	1.81	0.50
13	2.07	0.56	2.01	0.50
14	2.29	0.56	2.21	0.50
15	2.50	0.57	2.41	0.51
16	2.72	0.58	2.62	0.51
17	2.93	0.59	2.82	0.52
18	3.15	0.60	3.03	0.53
19	3.38	0.62	3.24	0.55
20	3.61	0.64	3.46	0.57
21	3.84	0.65	3.69	0.58
22	4.08	0.67	3.93	0.60
23	4.33	0.70	4.17	0.62
24	4.59	0.72	4.43	0.64
25	4.86	0.74	4.70	0.66
26	5.13	0.76	4.97	0.68
27	5.41	0.78	5.26	0.69
28	5.69	0.78	5.54	0.69
29	5.96	0.77	5.81	0.67
30	6.22	0.75	6.05	0.63
31	6.45	0.71	6.25	0.58
32	6.64	0.65	6.42	0.52
33	6.80	0.60	6.55	0.45
34	6.93	0.54	6.66	0.39
35	7.03	0.48	6.73	0.34

Number Series Screen Shot



Appendix D: Letter Series Materials

Letter Series Instructions for Participants

In this test you will be given a series of letters. The letters in each series change according to a fixed pattern. Your task will be to write down what should be the next letter in the series.

Here is an example:

A C E G I K ?

The pattern here is that each letter is two letters in the alphabet beyond the previous. The next letter in this series is “M”.

A pattern can involve more than one rule. For example, in this series

W B Y B A B C B ?

the letters in the odd positions (W, Y, A, etc.) advance by two letters while the letters in the even positions (B, B, B, etc.) remain constant. Since the next letter in this series must be two letters in the alphabet beyond C, the next letter is “E”. (Note the when the end of the alphabet is reached the series starts over again at the beginning of the alphabet.)

A pattern can also involve several rules in which the letters vary. For example, consider the series

B V D X F Z H B ?

In this series, the letters in the odd positions advance by two letters, starting with B, while the letters in the even positions advance by two letters, starting with V. Also, when the letters in the even positions reach Z, they cycle back to the beginning of the alphabet. The next letter in the series will be two letters beyond H; hence the next letter in the series is “J”.

Please work carefully but do not spend too much time on any one question. The time for each item is limited to one (1) minute, and the total time allotted for all 30 questions is 30 minutes.

You will not be able to go back once you submit your answer.

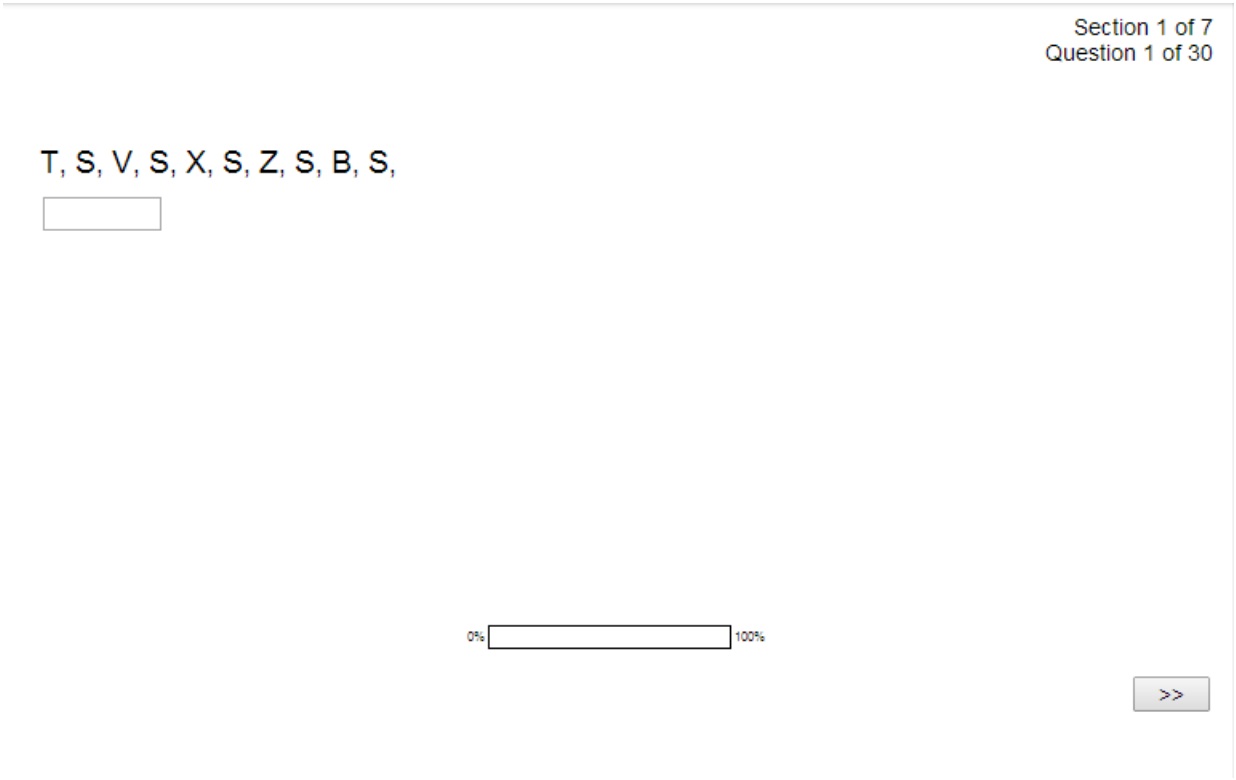
Letter Series Items, Item Parameters, and Answer Key Form 1				
Item Label	**Disc.**	**Diff.**	**Item**	**Key**
ls_f01i1	0.56	-1.62	U, F, W, F, Y, F, A,	**F**
ls_f01i5	0.85	-3.21	Z, U, B, U, D, U, F, U, H, U,	**J**
ls_f02i1	0.75	-1.06	T, C, V, C, X, C, Z, C,	**B**
ls_f02i2	0.86	-0.81	N, U, S, P, U, S, R, U, S, T, U,	**S**
ls_f02i5	0.73	-0.98	D, K, J, F, K, J, H, K, J, J,	**K**
ls_f03i1	1.15	0.34	Z, D, L, C, D, L, F, D, L, I, D, L, L, D, L,	**O**
ls_f03i2	1.02	-0.40	P, Q, O, S, Q, O, V, Q, O, Y, Q, O, B, Q, O,	**E**
ls_f03i5	0.43	-0.92	D, X, P, A, X, P, X, X, P, U, X, P, R,	**X**
ls_f04i1	1.08	-0.15	M, T, O, V, Q, X, S, Z, U, B,	**W**
ls_f04i3	0.94	-0.78	P, J, R, L, T, N, V, P, X, R,	**Z**
ls_f05i1	0.74	2.16	W, N, A, N, Y, N, C, N, A, N, E, N, C, N,	**G**
ls_f06i1	1.20	0.18	N, I, B, I, P, I, D, I, R, I, F, I, T, I,	**H**
ls_f06i6	1.10	-1.19	F, F, C, H, H, E, J, J, G, L, L,	**I**
ls_f07i1	1.06	-0.95	V, V, F, X, X, H, Z, Z, J, B, B, L, D, D,	**N**
ls_f07i5	1.36	-2.00	F, F, O, H, H, Q, J, J, S, L, L,	**U**
ls_f08i1	1.55	0.32	B, M, N, D, O, N, F, Q, N, H,	**S**
ls_f08i2	1.72	-0.12	U, F, R, W, H, R, Y, J, R, A,	**L**
ls_f08i3	1.28	-1.33	O, O, I, Q, Q, K, S, S, M, U, U,	**O**
ls_f10i1	0.75	-0.58	Z, I, I, G, B, K, K, I, D, M, M, K, F, O,	**O**
ls_f10i2	1.40	0.59	B, H, H, S, D, J, J, U, F, L, L, W, H, N, N,	**Y**
ls_f10i3	0.68	-1.55	D, Y, Y, W, F, A, A, Y, H, C, C, A, J, E,	**E**
ls_f11i1	1.08	1.63	Q, G, G, N, S, I, I, P, U, K, K, R, W, M, M, T,	**Y**
ls_f11i2	1.74	0.35	N, A, A, U, P, C, C, W, R, E, E, Y, T, G, G,	**A**
ls_f12i1	0.89	-2.11	D, D, T, L, F, F, V, N, H, H, X, P, J,	**J**
ls_f12i5	1.59	-1.10	F, F, R, V, H, H, T, X, J, J, V, Z, L, L,	**X**
ls_f13i1	1.49	-0.17	N, N, F, S, P, P, H, U, R, R, J, W, T, T,	**L**
ls_f14i2	1.47	0.63	L, B, F, S, N, D, H, S, P, F, J, S, R, H, L, S, T,	**J**
ls_f15i5	1.72	-0.99	T, C, L, V, E, N, X, G, P, Z,	**I**
ls_f9i2	1.66	-0.10	X, J, P, Z, L, P, B, N, P, D,	**P**
ls_f9i6	1.49	-0.70	F, K, B, H, M, B, J, O, B, L,	**Q**

Letter Series Items, Item Parameters, and Answer Key Form 2				
Item Label	**Disc.**	**Diff.**	**Item**	**Key**
ls_f01i2	0.87	-1.74	T, S, V, S, X, S, Z, S, B, S,	**D**
ls_f01i3	0.58	-2.77	V, G, X, G, Z, G, B,	**G**
ls_f01i4	0.81	-2.71	J, Q, L, Q, N, Q, P, Q, R, Q,	**T**
ls_f02i3	1.05	-0.69	B, J, Q, E, J, Q, H, J, Q, K, J, Q, N, J, Q,	**Q**
ls_f02i4	0.35	-4.19	Z, X, B, X, D, X, F,	**X**
ls_f04i4	0.98	-0.14	Y, R, A, T, C, V, E, X, G, Z, I,	**B**
ls_f04i6	1.18	-0.46	C, L, E, N, G, P, I, R, K, T, M, V, O, X,	**Q**
ls_f05i3	1.21	-1.00	X, E, Z, G, B, I, D, K, F, M,	**H**
ls_f05i4	1.22	-0.48	L, V, C, V, N, V, E, V, P, V, G, V, R, V,	**I**
ls_f05i5	1.18	-1.58	Y, P, A, R, C, T, E, V, G, X, I,	**Z**
ls_f06i2	1.29	0.41	G, Y, L, Y, I, Y, N, Y, K, Y, P, Y, M, Y,	**R**
ls_f06i3	1.16	0.20	Y, W, H, W, A, W, J, W, C, W, L, W, E, W,	**N**
ls_f06i4	1.13	-1.01	R, Q, B, Q, T, Q, D, Q, V, Q, F, Q, X, Q,	**H**
ls_f06i5	1.38	-1.02	A, K, O, K, C, K, Q, K, E, K, S, K, G, K,	**U**
ls_f07i2	1.37	-0.98	R, R, W, T, T, Y, V, V, A, X, X, C, Z, Z,	**E**
ls_f07i3	1.46	0.24	I, E, B, E, K, E, D, E, M, E, F, E, O, E,	**H**
ls_f08i4	1.20	-2.07	L, L, F, N, N, H, P, P, J, R, R, L, T, T,	**N**
ls_f08i6	1.13	-1.57	Y, Y, L, A, A, N, C, C, P, E, E,	**R**
ls_f11i3	1.35	-0.07	P, P, B, L, R, R, D, N, T, T, F, P, V, V, H,	**R**
ls_f11i4	1.35	-0.11	P, V, V, M, R, X, X, O, T, Z, Z, Q, V, B, B, S,	**X**
ls_f11i5	1.54	-0.99	W, W, P, F, Y, Y, R, H, A, A, T, J, C, C,	**V**
ls_f13i2	1.03	0.47	K, A, C, F, M, C, E, F, O, E, G, F, Q, G, I, F,	**S**
ls_f13i4	1.14	0.36	D, S, L, Z, F, U, N, Z, H, W, P, Z, J, Y, R, Z, L,	**A**
ls_f14i3	1.62	0.38	L, T, D, N, V, F, P, X, H, R, Z,	**J**
ls_f14i4	0.33	1.45	L, P, B, R, N, R, D, R, P, T, F, R, R, V, H,	**R**
ls_f15i1	1.17	1.66	P, D, N, R, F, P, T, H, R, V, J,	**T**
ls_f15i2	1.29	0.35	B, N, W, D, P, Y, F, R, A, H, T,	**C**
ls_f15i4	1.48	0.20	G, W, A, I, Y, C, K, A, E, M,	**C**
ls_f9i1	0.85	0.76	V, O, D, X, Q, D, Z, S, D, B, U, D, D, W,	**D**
ls_f9i3	1.33	-0.51	C, U, O, E, W, O, G, Y, O, I,	**A**

Letter Series Scaled Score Concordance Tables

Raw Score	Form 1 Scale Score	Form 1 SE	Form 2 Scale Score	Form 2 SE
0	-4.04	0.86	-4.10	0.86
1	-3.71	0.87	-3.73	0.86
2	-3.35	0.85	-3.35	0.84
3	-2.98	0.81	-2.98	0.81
4	-2.63	0.77	-2.63	0.78
5	-2.29	0.74	-2.31	0.74
6	-1.98	0.71	-2.00	0.71
7	-1.69	0.68	-1.71	0.69
8	-1.41	0.65	-1.43	0.67
9	-1.14	0.64	-1.16	0.65
10	-0.89	0.62	-0.91	0.63
11	-0.64	0.61	-0.66	0.62
12	-0.40	0.60	-0.42	0.61
13	-0.17	0.59	-0.19	0.60
14	0.06	0.58	0.05	0.59
15	0.29	0.58	0.28	0.59
16	0.52	0.58	0.50	0.59
17	0.74	0.59	0.73	0.59
18	0.97	0.59	0.97	0.59
19	1.21	0.59	1.20	0.60
20	1.45	0.60	1.44	0.61
21	1.69	0.61	1.70	0.62
22	1.95	0.63	1.96	0.64
23	2.23	0.65	2.24	0.66
24	2.52	0.68	2.53	0.69
25	2.83	0.71	2.85	0.72
26	3.18	0.75	3.20	0.76
27	3.55	0.80	3.58	0.81
28	3.97	0.86	4.00	0.87
29	4.43	0.93	4.46	0.93
30	4.90	0.97	4.95	0.98

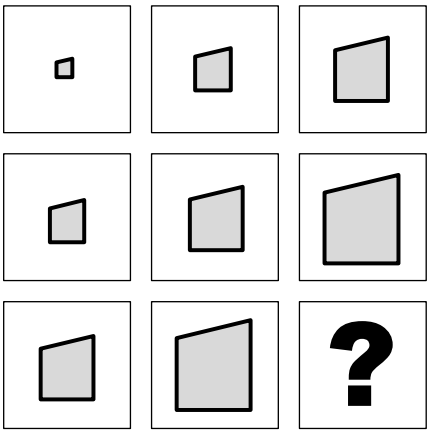
Letter Series Screen Shot

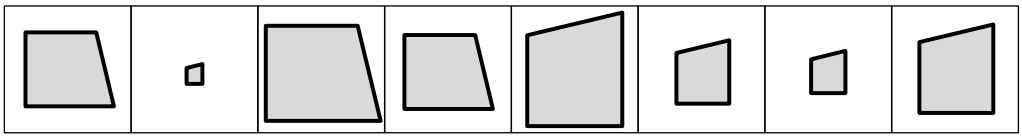


Appendix E: Matrix Reasoning Materials

Matrix Reasoning Instructions for Participants

This item set contains 30 matrix items of the 3×3 form shown below. For each item, please select from options A-H the response that completes the matrix according to the pattern or rule established by the other eight entries. Every item has exactly one correct solution.





In the example above, option E is the correct answer. The size of the shape increases from the left column to the right column and from the top row to the bottom row. The same rule applies to both rows and columns of the matrix. This principle that the same rule applies to rows and to columns, is true for all items in this set, although the rules will be more complex than the one in this example.

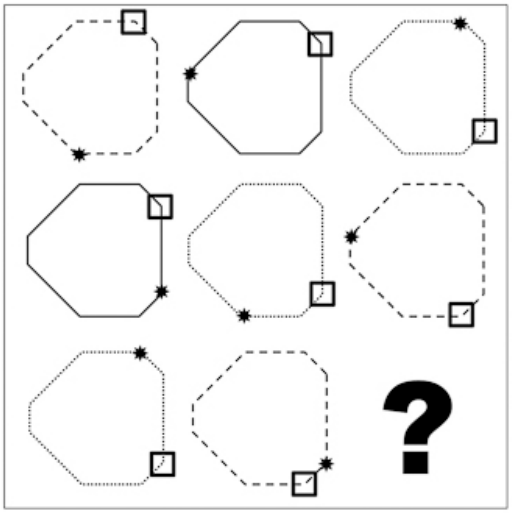
You will have 2 minutes to respond to each item. After 2 minutes you will be moved to the next item. You will have 32 total minutes to complete all 30 items. You should work accurately, but you should also work quickly.

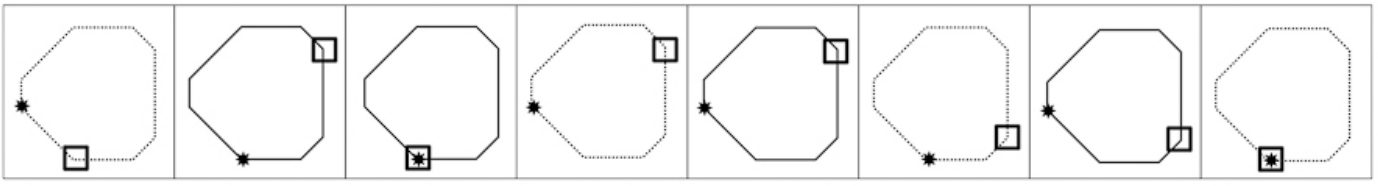
Matrix Reasoning Item Parameters and Answer Key							
Form 1				Form 2			
Item Label	Disc.	Diff.	Key	Item Label	Disc.	Diff.	Key
F15.2	1.11	1.15	C	F11.1	1.44	-0.23	D
F19.4	1.10	0.94	D	F6.4	0.79	2.16	A
F4.2	1.28	-1.22	D	F12.NEW1	1.90	-0.48	H
F18.3	1.09	1.33	C	F15.1	1.25	0.77	G
F10.NEW1	0.68	0.95	D	F20.3	1.51	0.41	F
F16.3	1.03	1.07	G	F19.2	0.97	1.57	C
F17.1	0.90	0.61	G	F20.4	0.96	1.39	H
F11.3	1.28	0.60	G	F16.NEW1	0.87	0.85	F
F20.1	1.16	1.88	B	F3.3	0.82	-0.71	H
F12.5	1.91	-0.03	D	F17.3	1.54	-0.11	D
F2.2	1.63	-0.34	H	F18.5	1.23	0.81	G
F15.4	1.53	-0.12	C	F2.3	1.16	0.57	E
F8.4	0.97	0.94	D	F5.NEW2	0.60	3.55	G
F14.4	0.47	2.36	E	F10.4	0.68	1.58	B
F6.NEW1	0.50	1.33	B	F12.1	1.12	0.21	A
F13.NEW2	1.11	2.15	F	F10.1	0.65	1.51	D
F12.4	1.41	0.84	C	F1.3	1.10	1.81	C
F16.2	1.81	0.31	B	F13.NEW1	1.01	1.37	F
F15.5	0.63	1.71	F	F14.NEW2	0.69	1.91	F
F1.NEW1	0.90	-0.68	C	F2.4	0.78	-0.24	B
F3.5	0.51	0.99	C	F1.5	0.58	2.25	E
F1.4	0.47	2.47	A	F2.1	1.53	-0.03	D
F13.NEW3	0.70	1.26	H	F4.1	0.79	-0.87	E
F16.5	1.04	0.94	D	F8.NEW2	0.96	1.33	G
F7.1	1.43	-0.79	D	F3.1	1.84	-0.81	A
F5.NEW1	0.36	3.98	G	F15.3	1.29	0.61	B
F10.NEW2	0.80	0.43	F	F9.NEW1	0.59	2.60	F
F19.1	0.92	0.81	E	F7.5	0.53	0.06	H
F11.6	1.71	-0.51	A	F9.3	1.27	0.74	D
F9.4	0.66	1.75	E	F13.4	0.73	1.78	H

Matrix Reasoning Scaled Score Concordance Tables

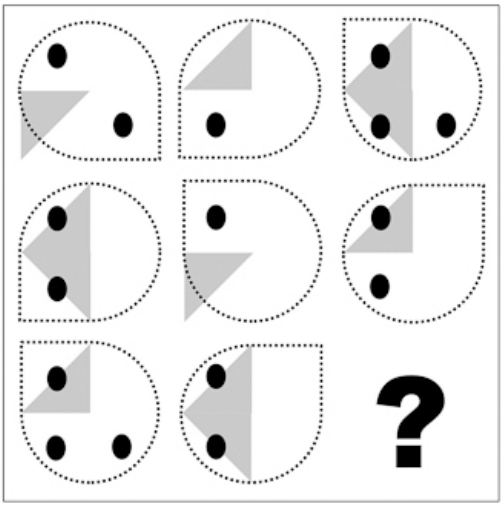
Raw Score	Form 1 Scale Score	Form 1 SE	Form 2 Scale Score	Form 2 SE
0	-1.19	0.58	-1.16	0.58
1	-0.90	0.55	-0.87	0.55
2	-0.64	0.52	-0.60	0.51
3	-0.39	0.49	-0.36	0.48
4	-0.17	0.46	-0.13	0.45
5	0.03	0.44	0.07	0.43
6	0.22	0.42	0.26	0.41
7	0.40	0.40	0.43	0.39
8	0.56	0.39	0.60	0.38
9	0.72	0.38	0.75	0.38
10	0.87	0.38	0.91	0.37
11	1.02	0.37	1.05	0.37
12	1.17	0.37	1.20	0.37
13	1.31	0.37	1.34	0.37
14	1.45	0.38	1.48	0.37
15	1.59	0.38	1.62	0.37
16	1.74	0.38	1.76	0.38
17	1.88	0.39	1.90	0.38
18	2.03	0.40	2.05	0.39
19	2.18	0.41	2.20	0.40
20	2.33	0.42	2.35	0.41
21	2.49	0.43	2.51	0.42
22	2.65	0.44	2.67	0.43
23	2.82	0.45	2.84	0.44
24	3.00	0.47	3.02	0.46
25	3.18	0.48	3.20	0.47
26	3.37	0.50	3.39	0.49
27	3.56	0.51	3.59	0.50
28	3.76	0.52	3.79	0.51
29	3.94	0.51	3.99	0.50
30	4.11	0.50	4.17	0.49

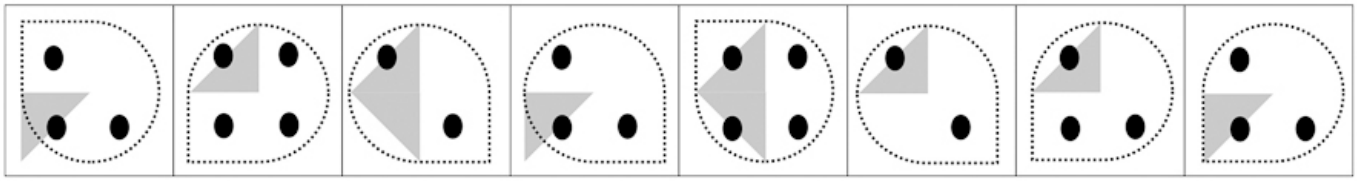
FORM A, ITEM 1 (F15.2)



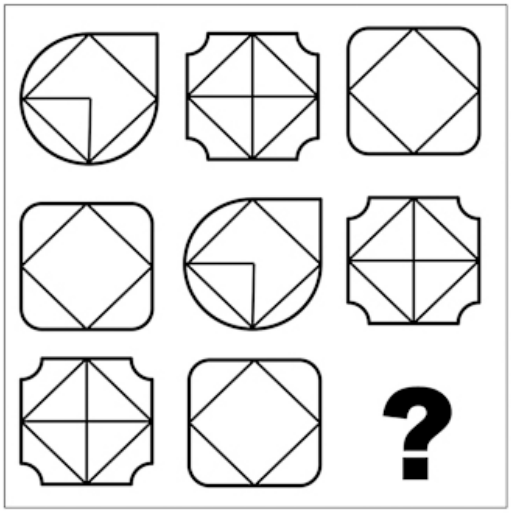


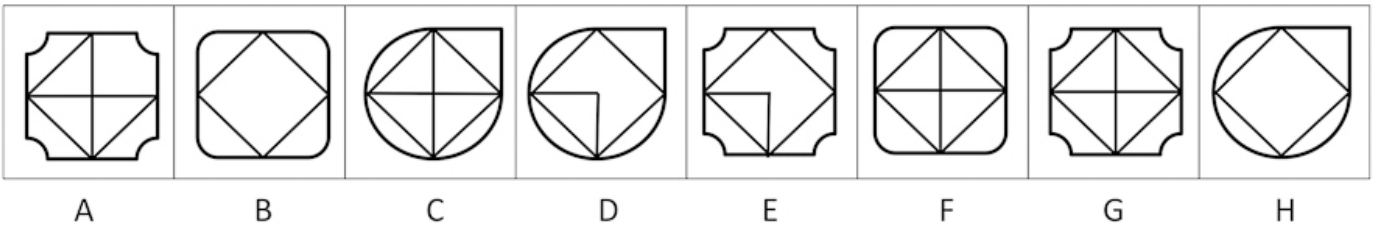
FORM A, ITEM 2 (F19.4)



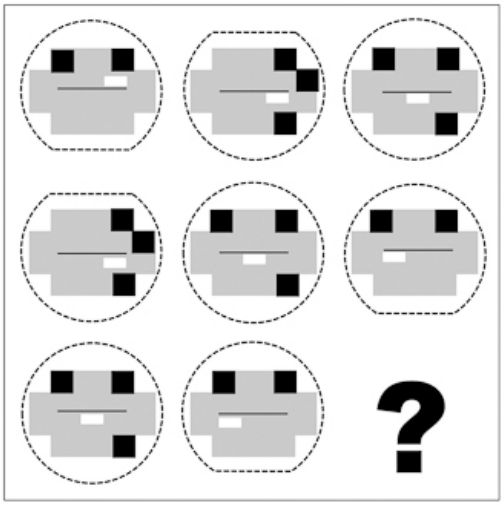


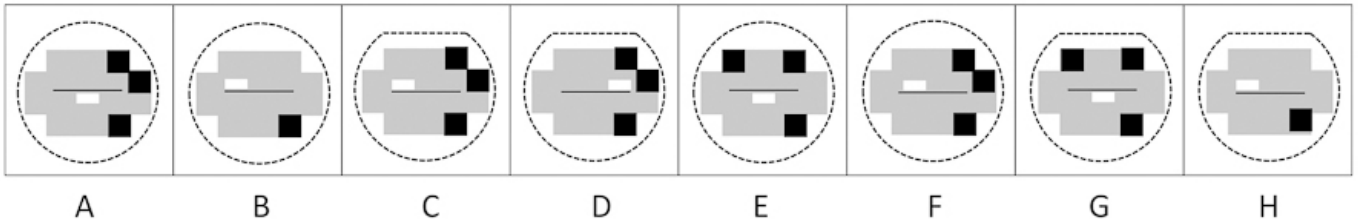
FORM A, ITEM 3 (F4.2)



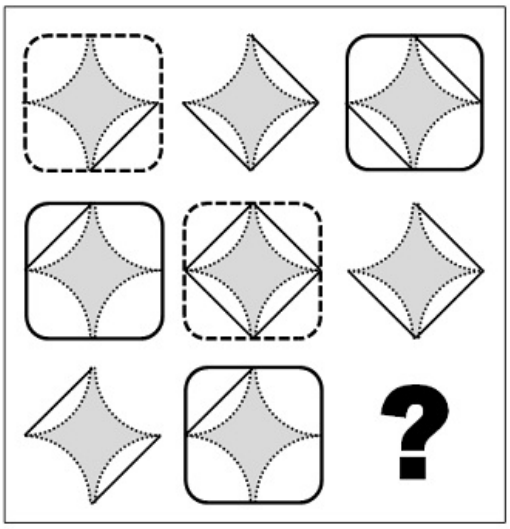


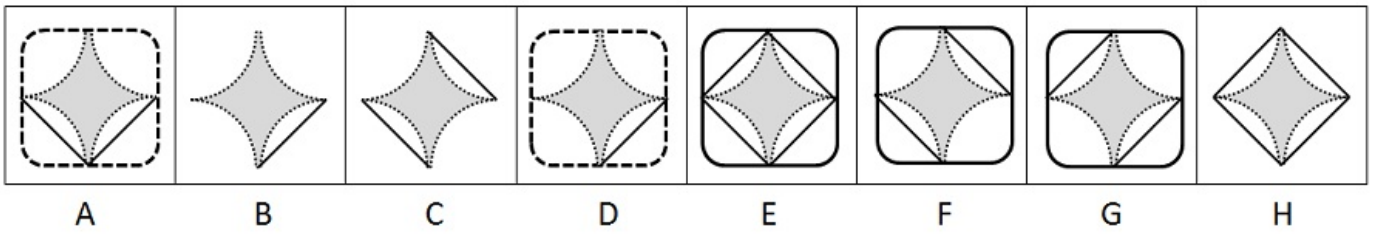
FORM A, ITEM 4 (F18.3)



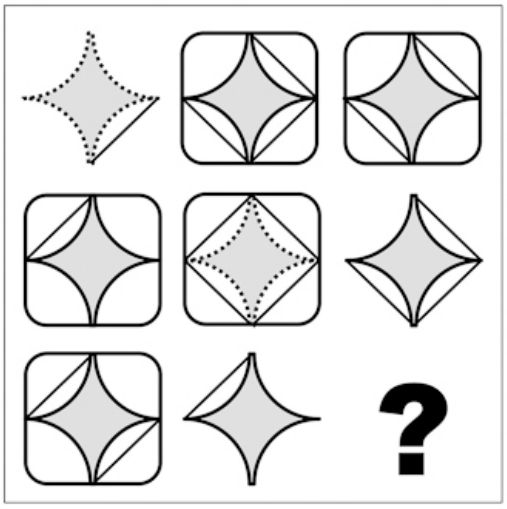


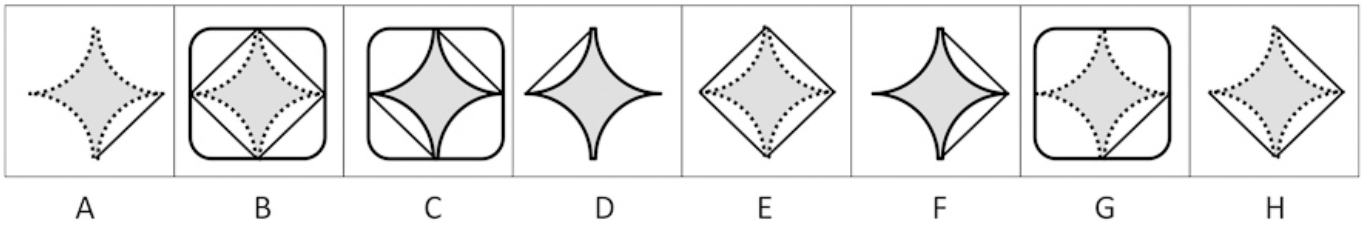
FORM A, ITEM 5 (F10.NEW1)



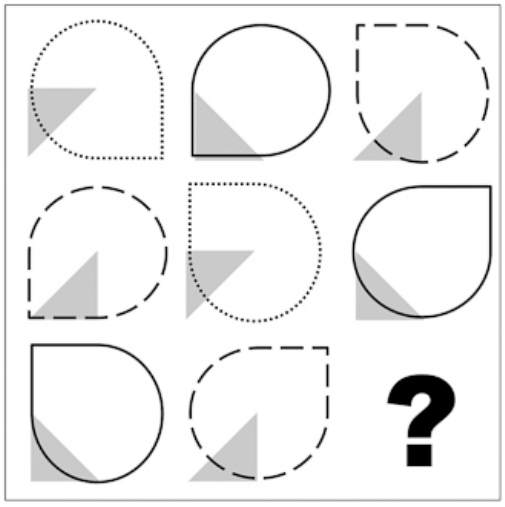


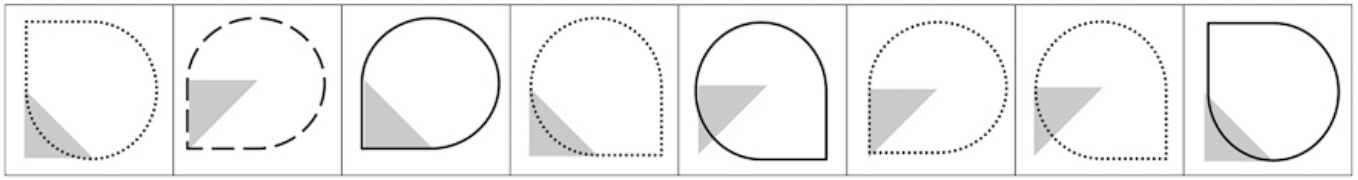
FORM A, ITEM 6 (F16.3)



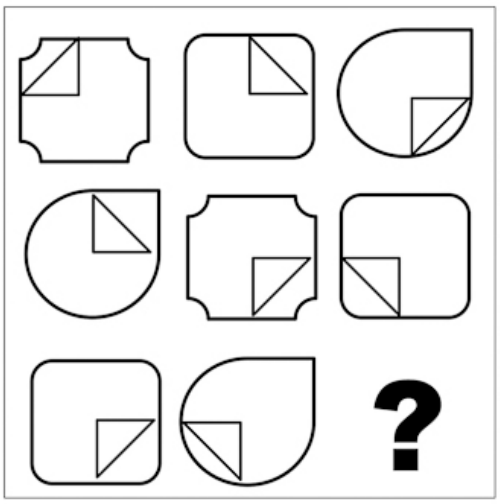


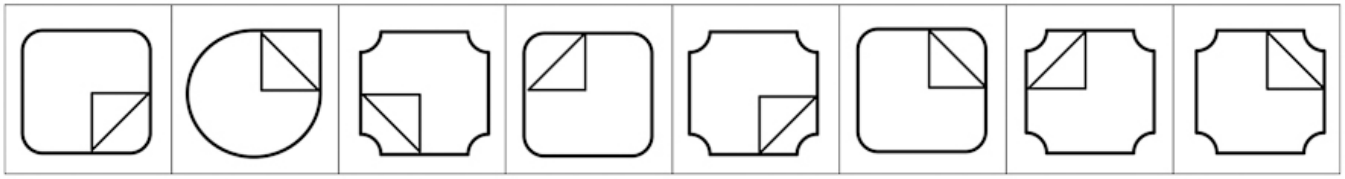
FORM A, ITEM 7 (F17.1)



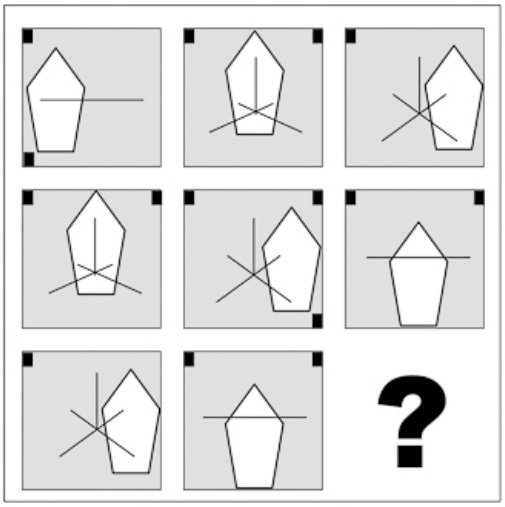


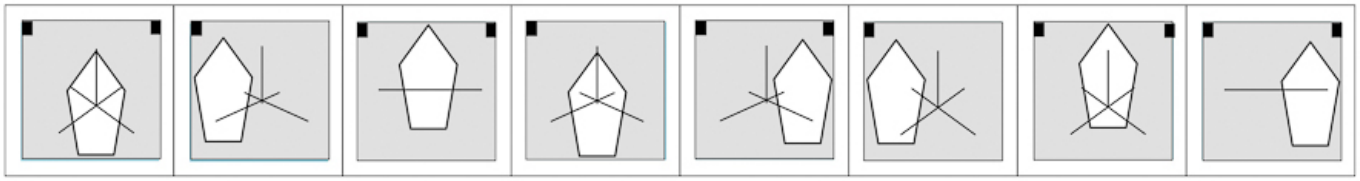
FORM A, ITEM 8 (F11.3)



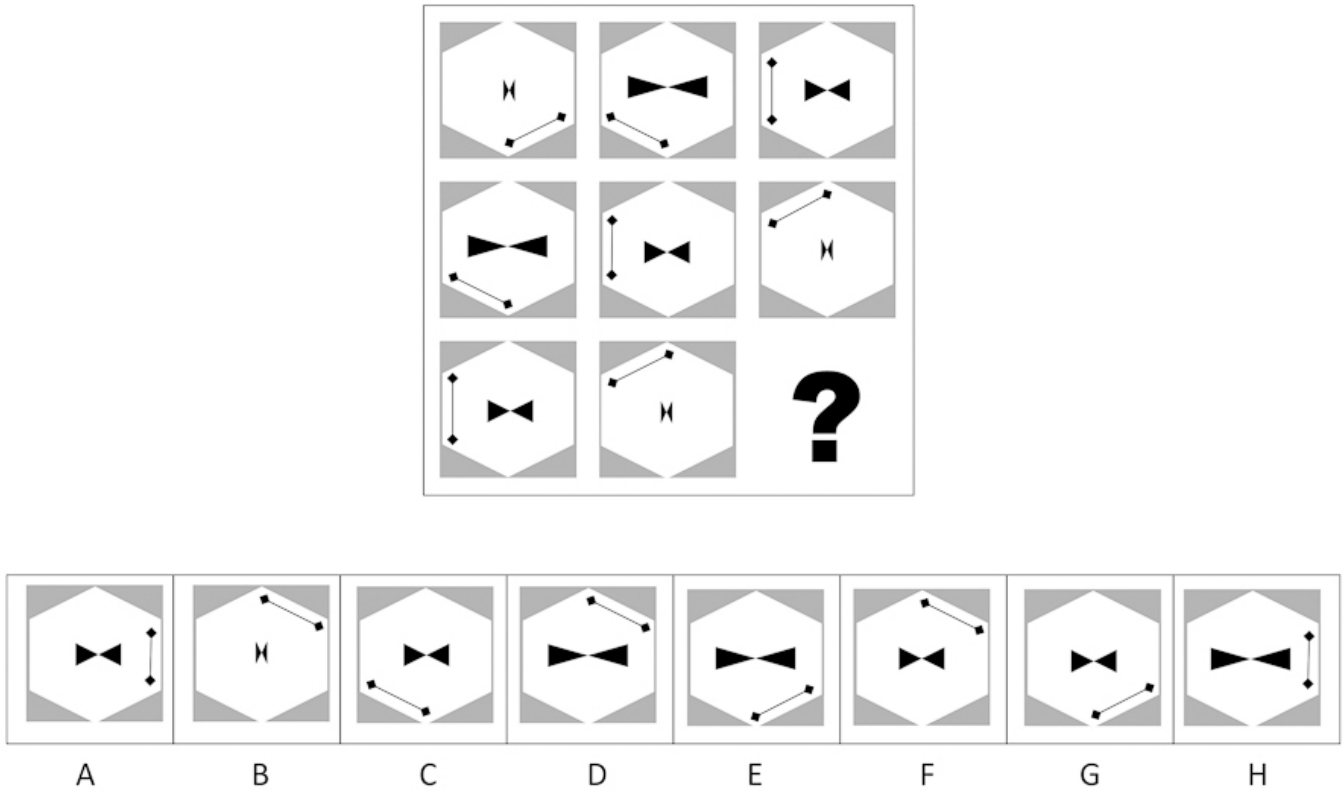


FORM A, ITEM 9 (F20.1)

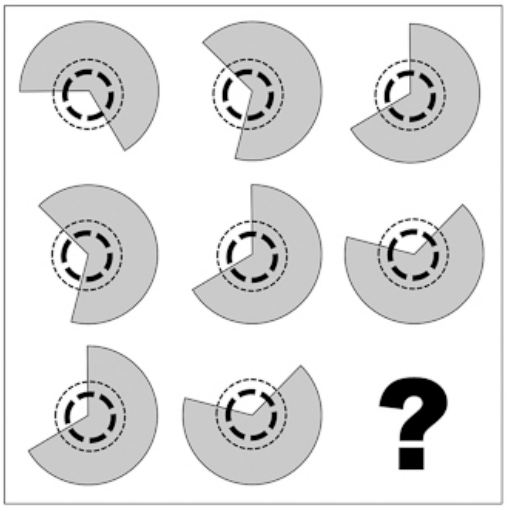


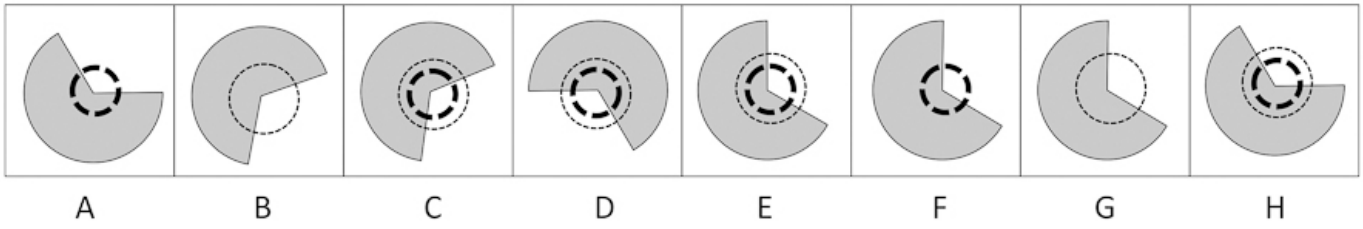


FORM A, ITEM 10 (F12.5)

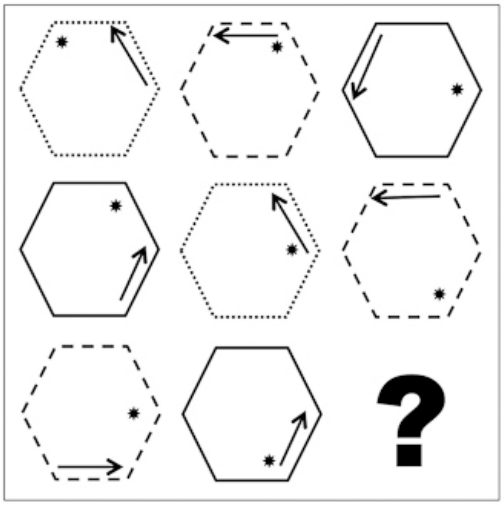


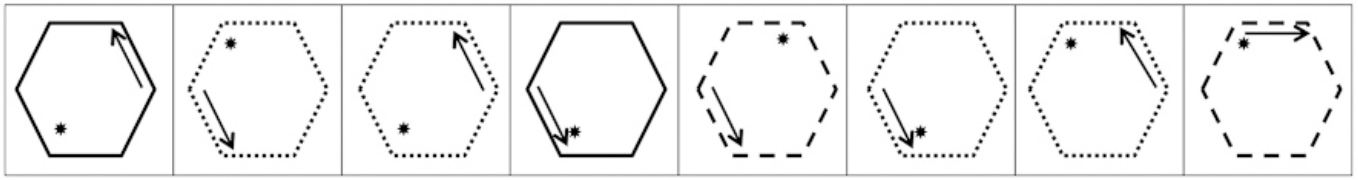
FORM A, ITEM 11 (F2.2)



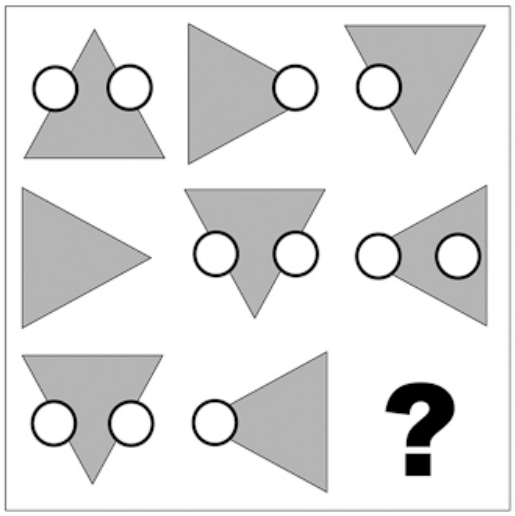


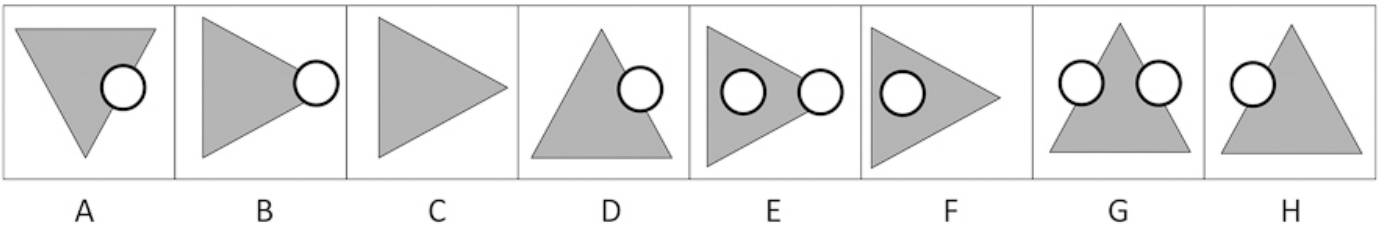
FORM A, ITEM 12 (F15.4)



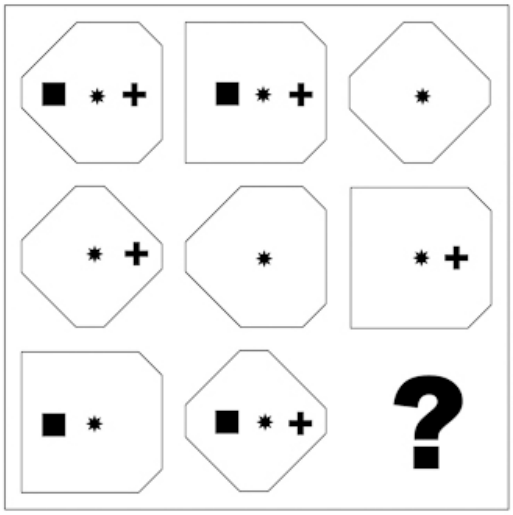


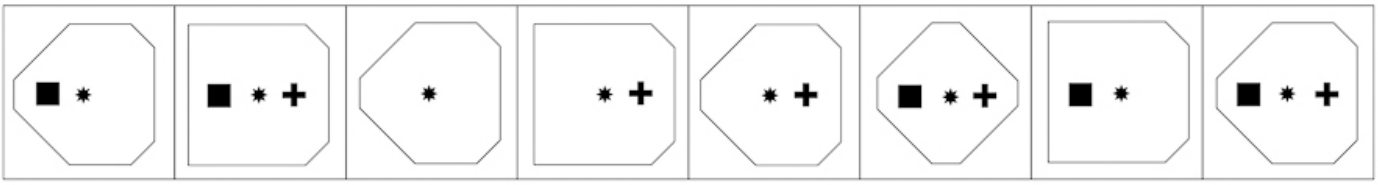
FORM A, ITEM 13 (F8.4)



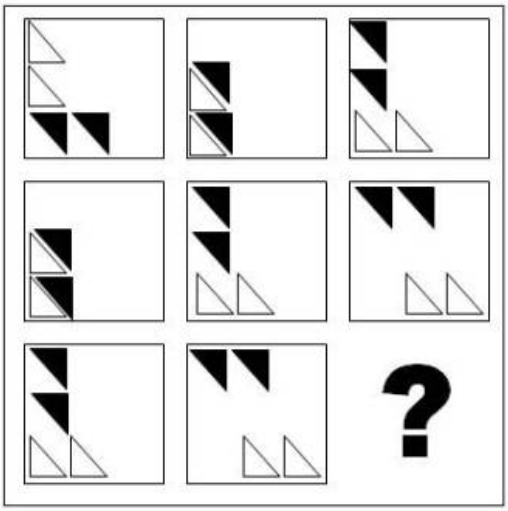


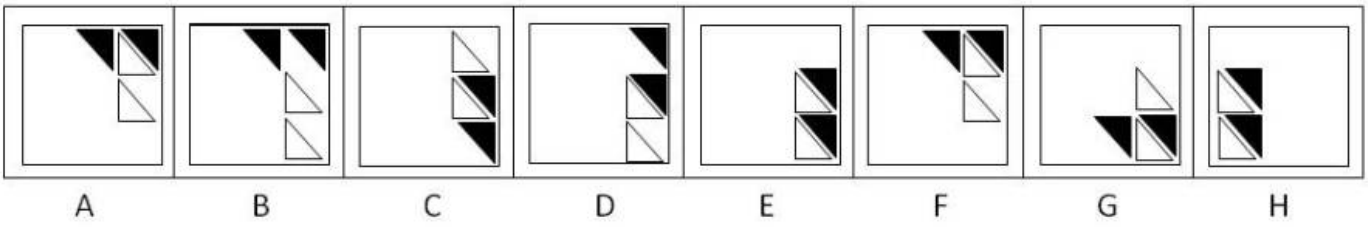
FORM A, ITEM 14 (F14.4)



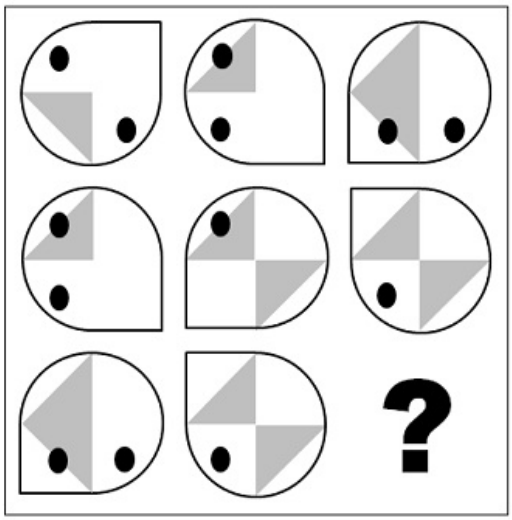


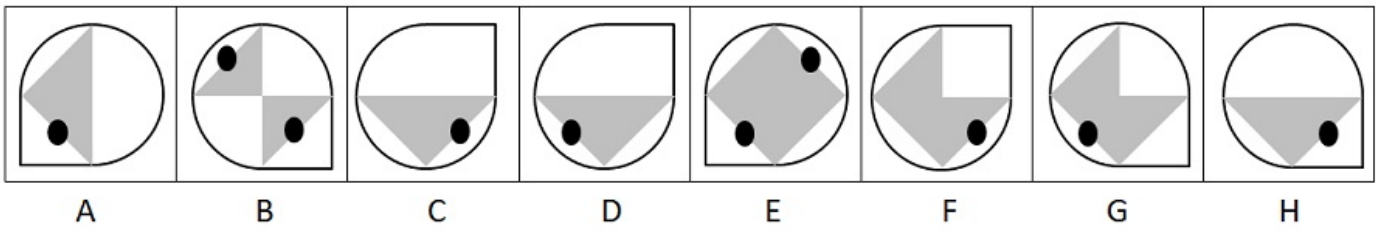
FORM A, ITEM 15 (F6.New1)



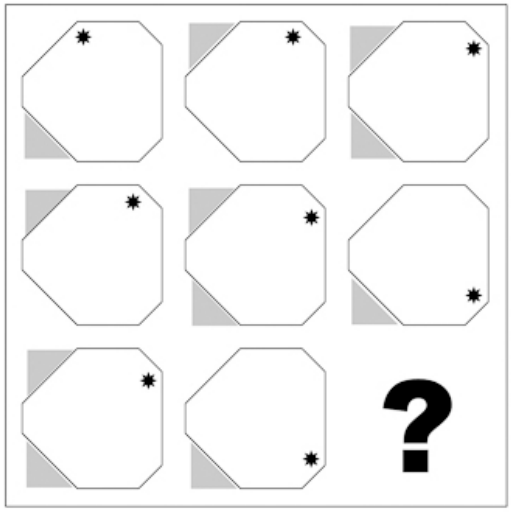


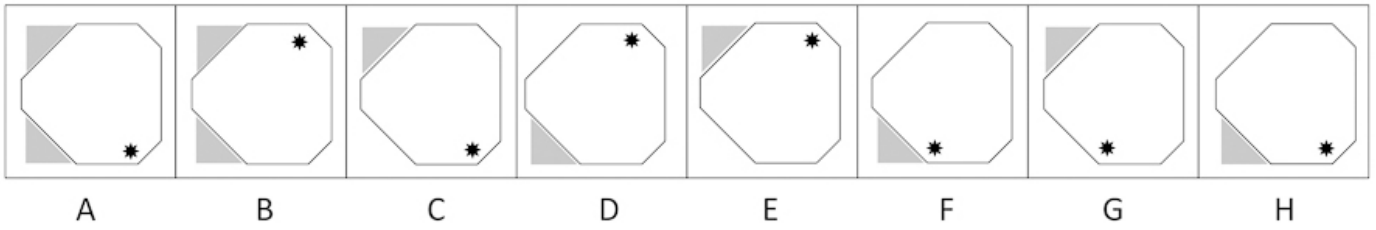
FORM A, ITEM 16 (F13.New2)



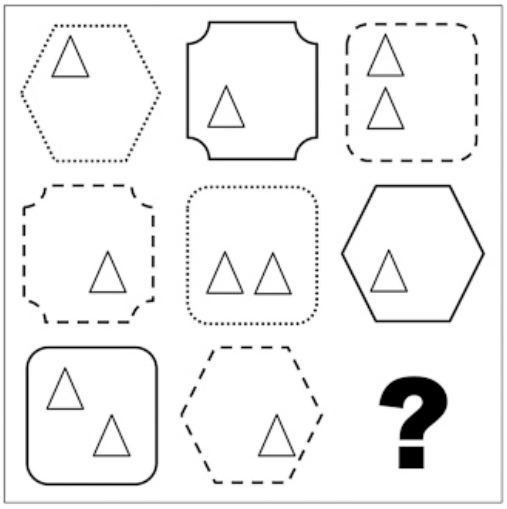


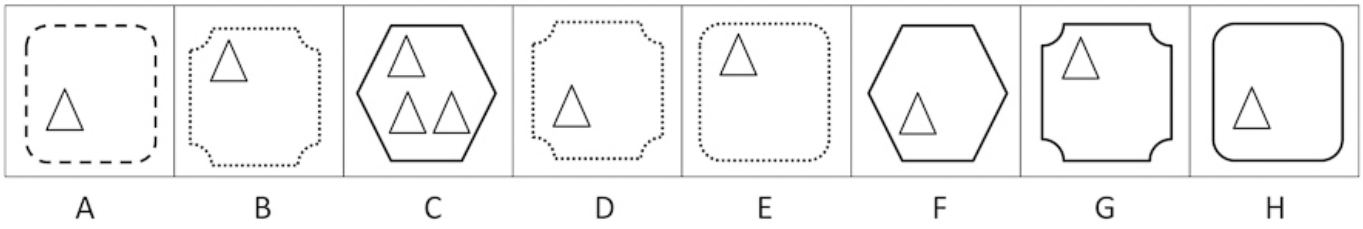
FORM A, ITEM 17 (F12.4)



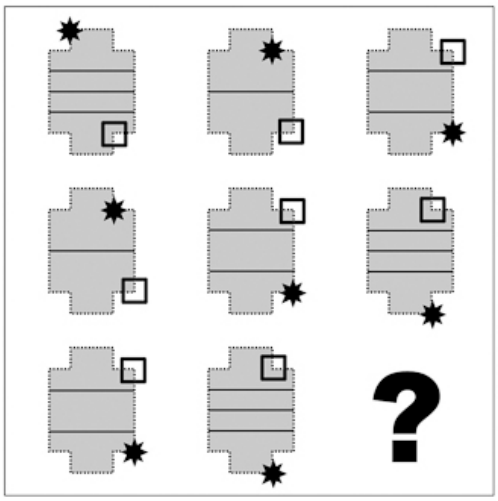


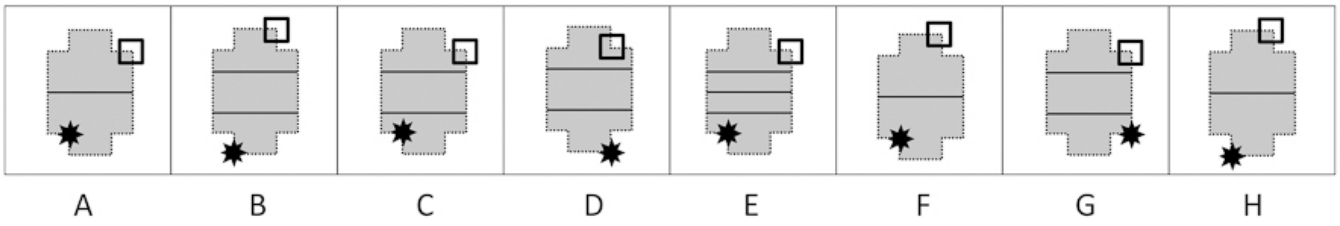
FORM A, ITEM 18 (F16.2)



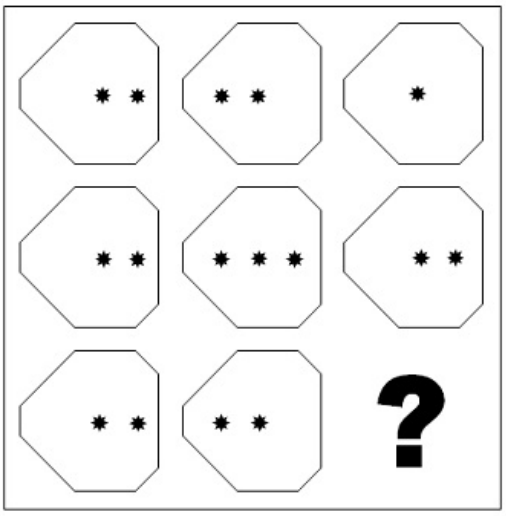


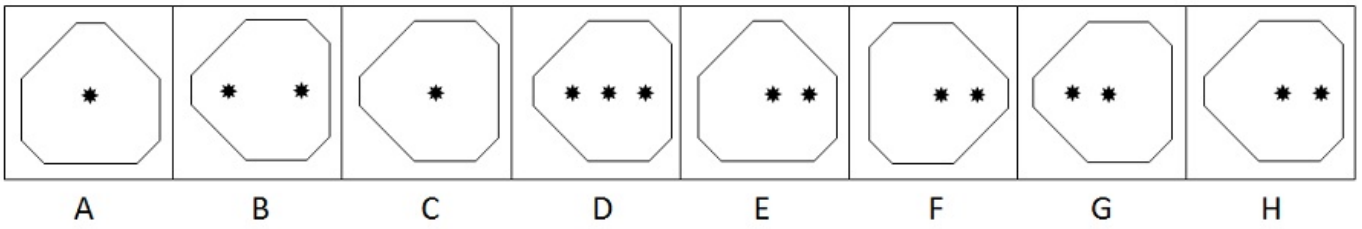
FORM A, ITEM 19 (F15.5)



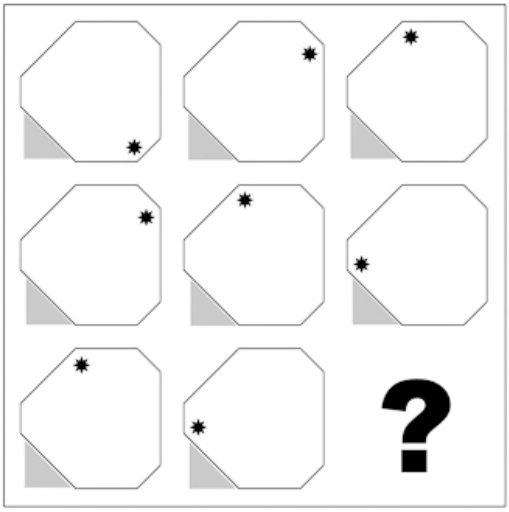


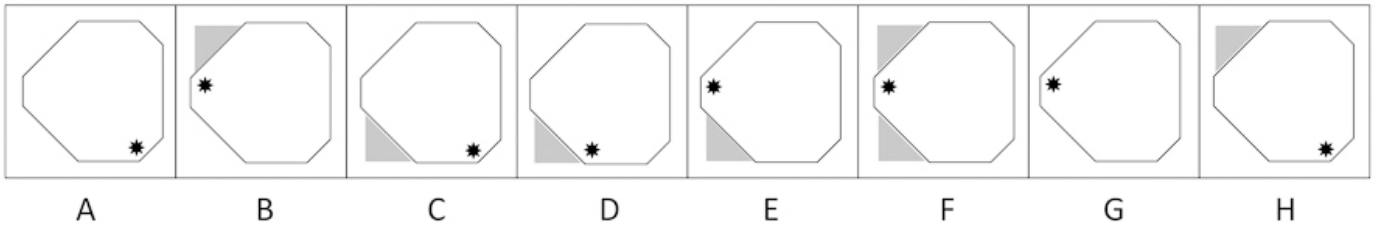
FORM A, ITEM 20 (F1.New1)



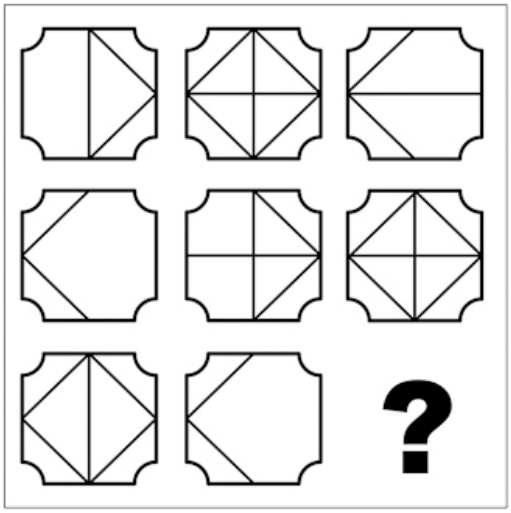


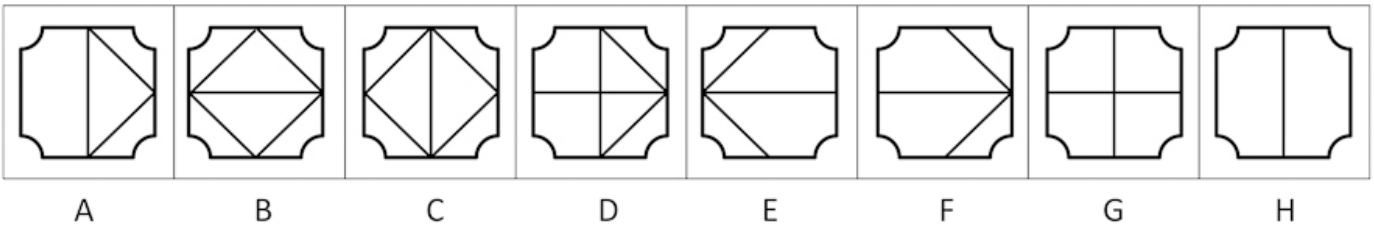
FORM A, ITEM 21 (F3.5)



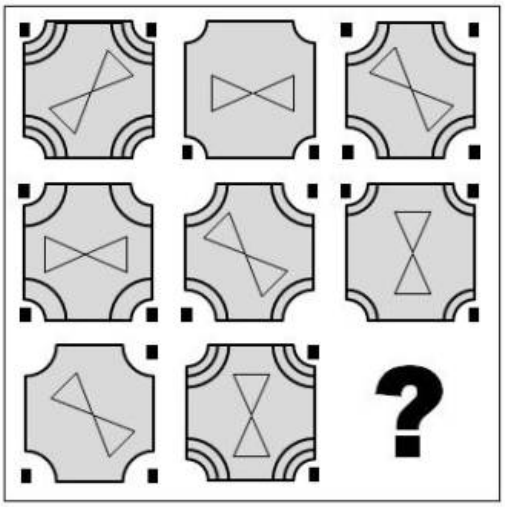


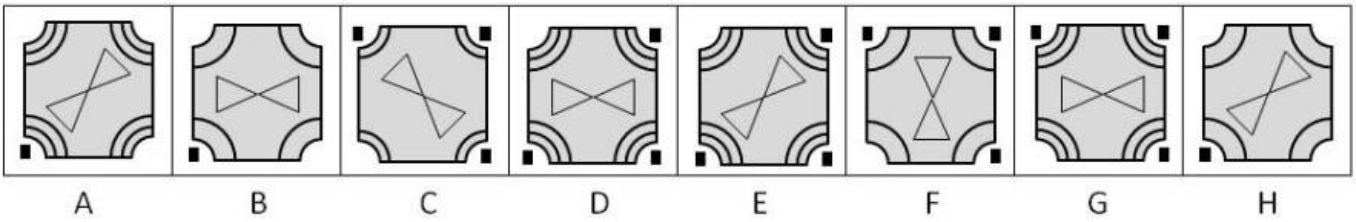
FORM A, ITEM 22 (F1.4)



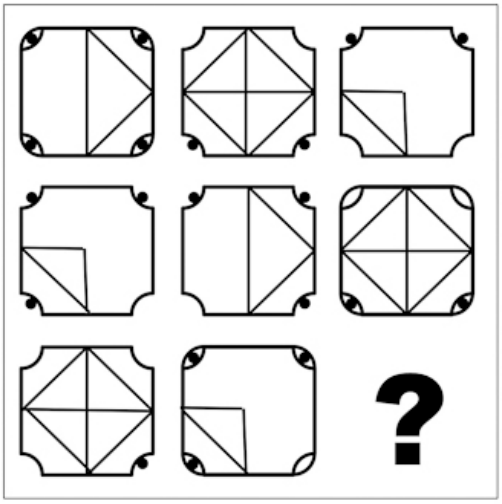


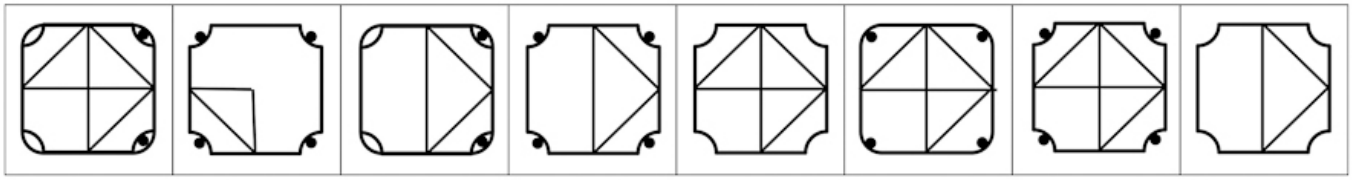
FORM A, ITEM 23 (F13.New3)



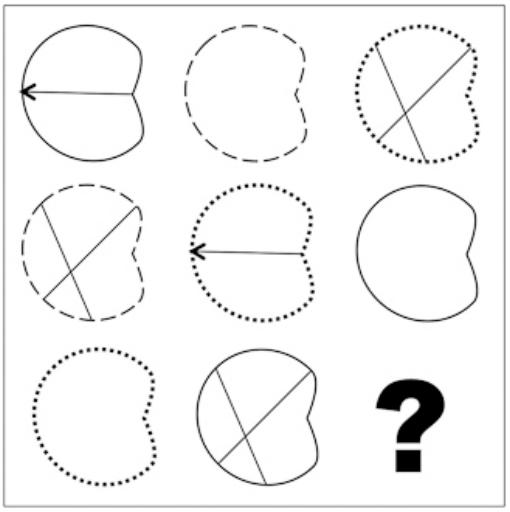


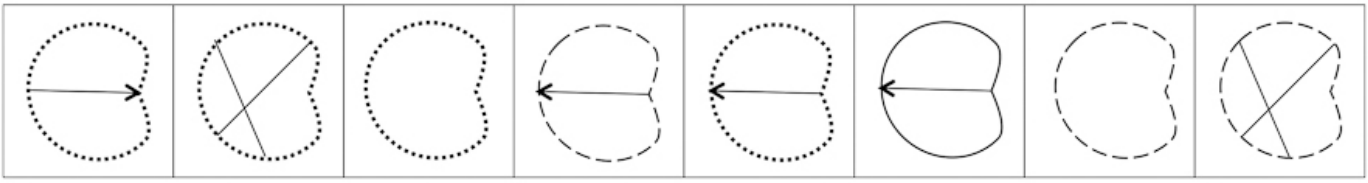
FORM A, ITEM 24 (F16.5)



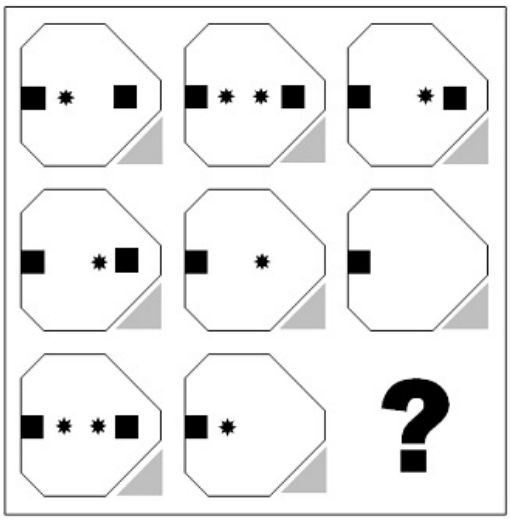


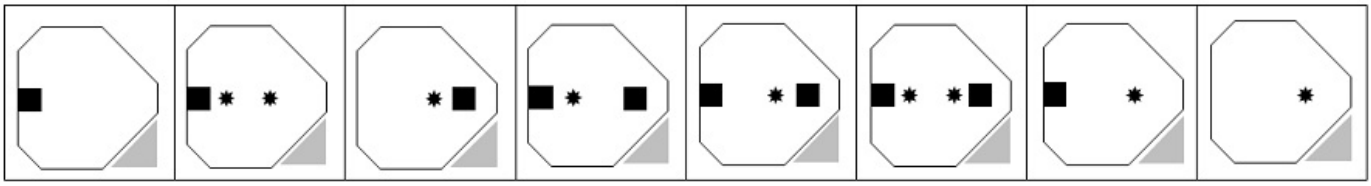
FORM A, ITEM 25 (F7.1)



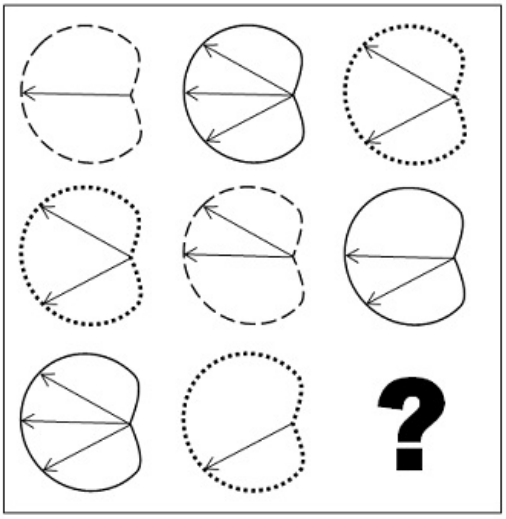


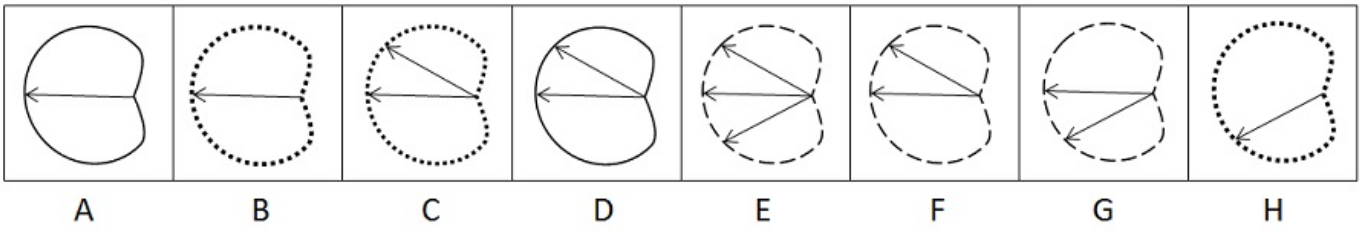
FORM A, ITEM 26 (F5.New1)



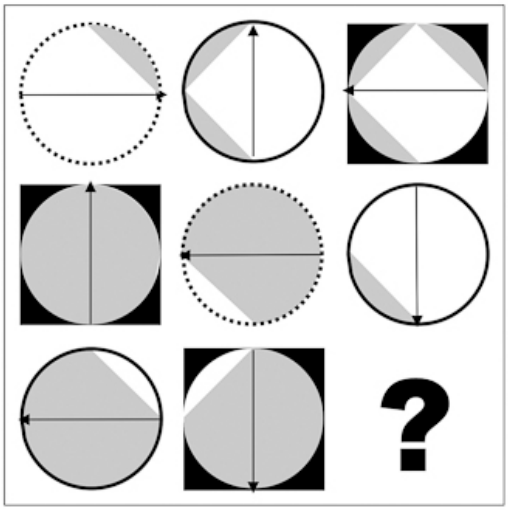


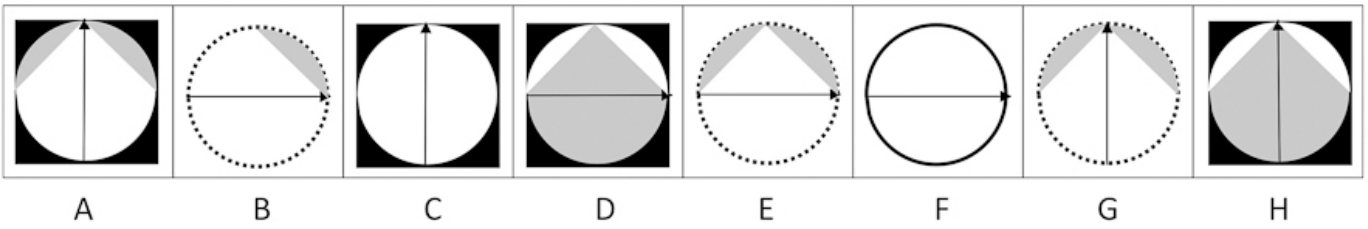
FORM A, ITEM 27 (F10.New2)



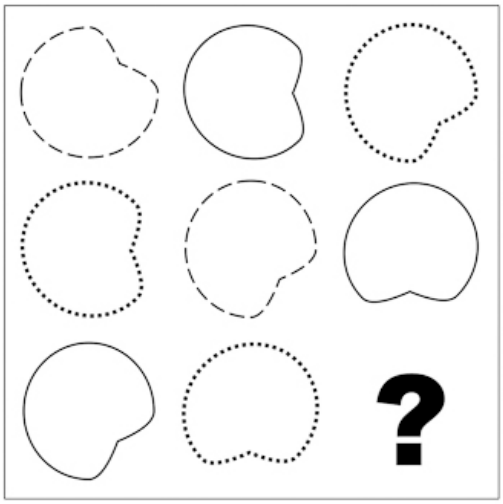


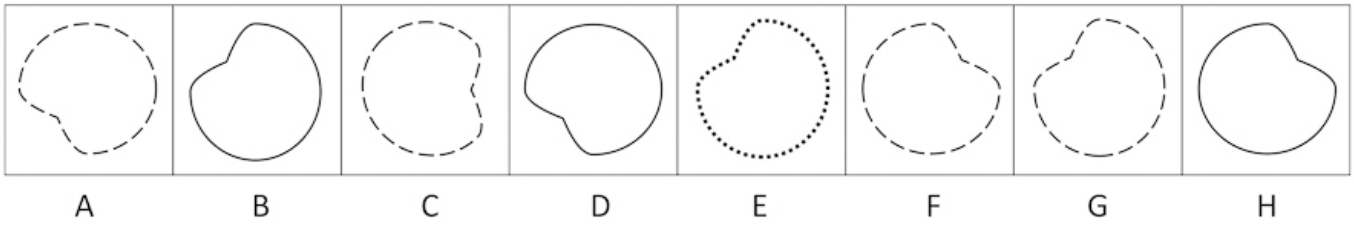
FORM A, ITEM 28 (F19.1)



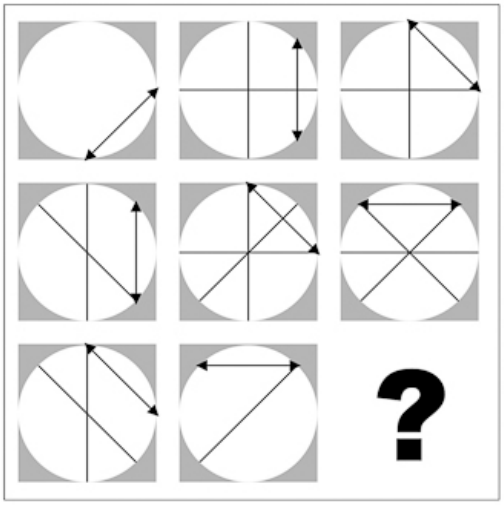


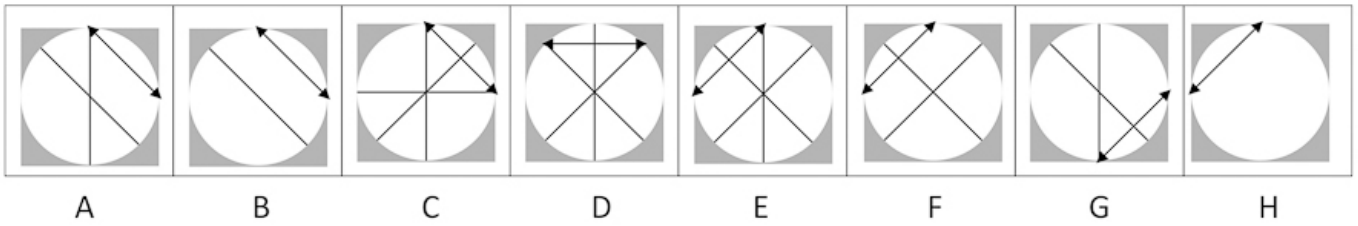
FORM A, ITEM 29 (F11.6)



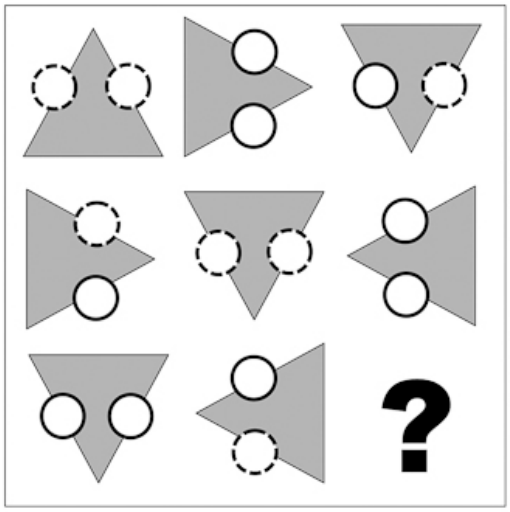


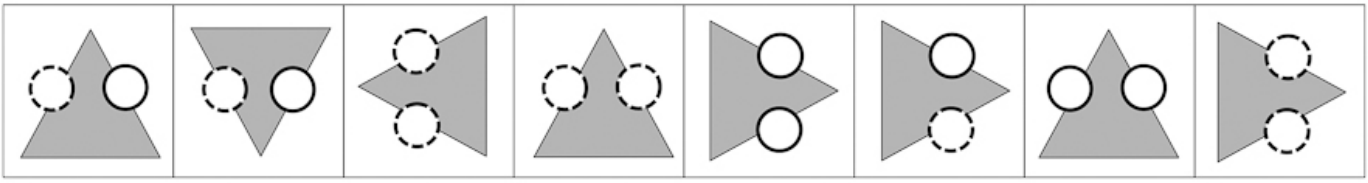
FORM A, ITEM 30 (F9.4)



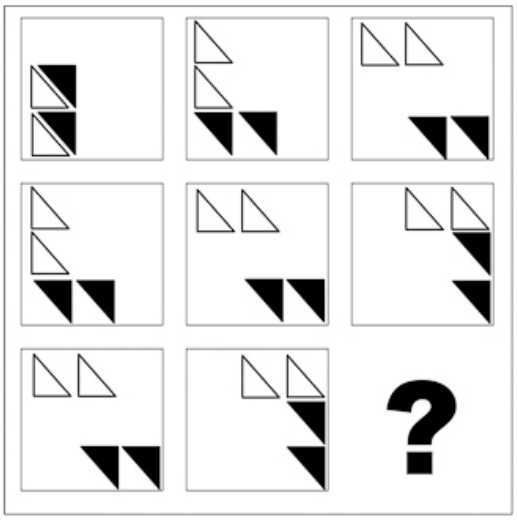


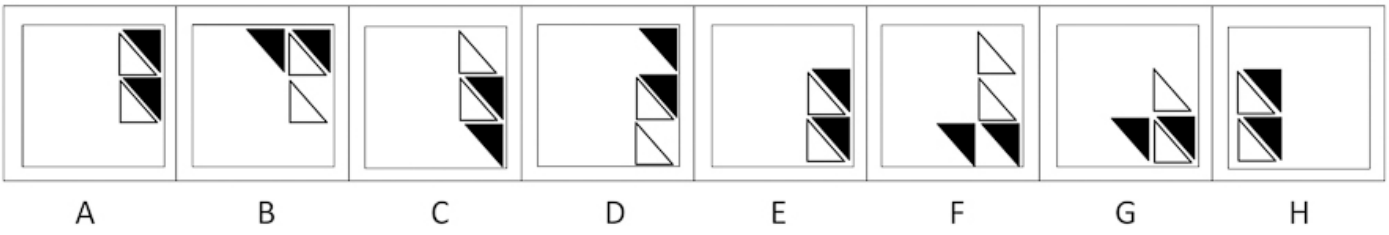
FORM B, ITEM 1 (F11.1)



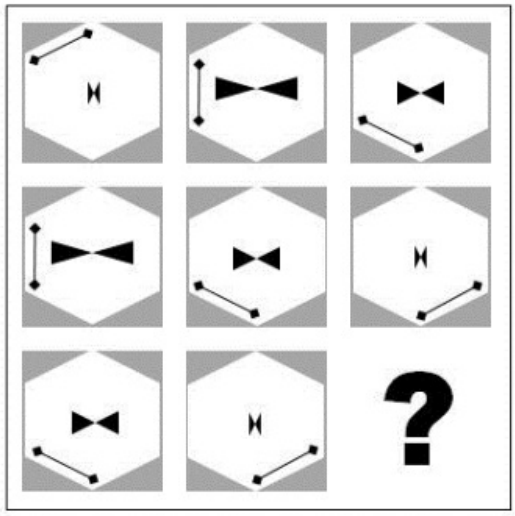


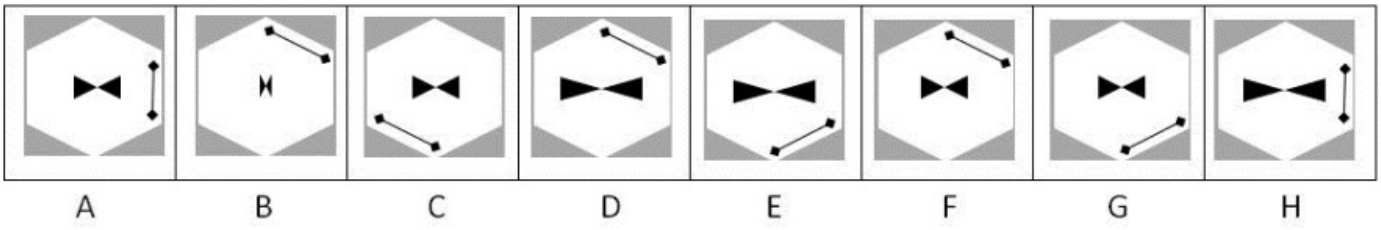
FORM B, ITEM 2 (F6.4)



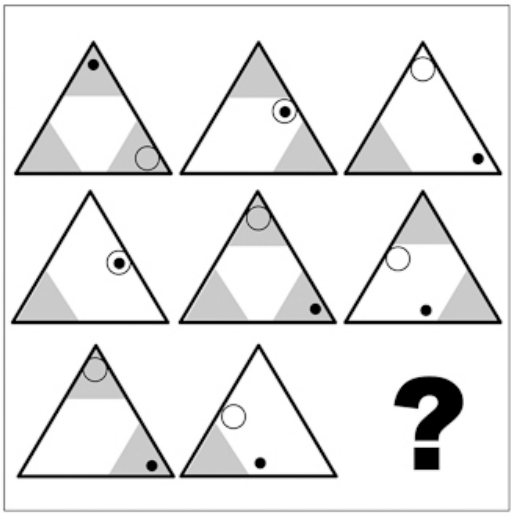


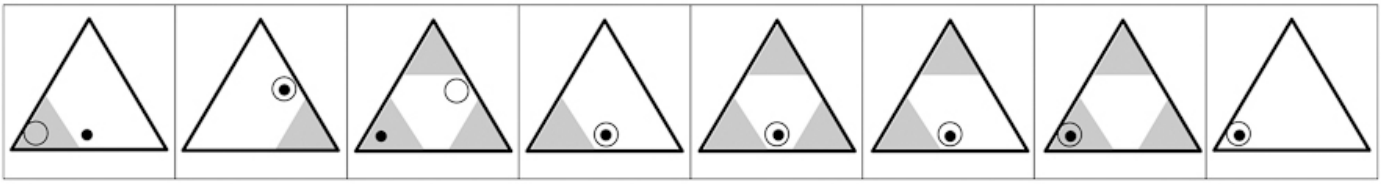
FORM B, ITEM 3 (F12.New1)



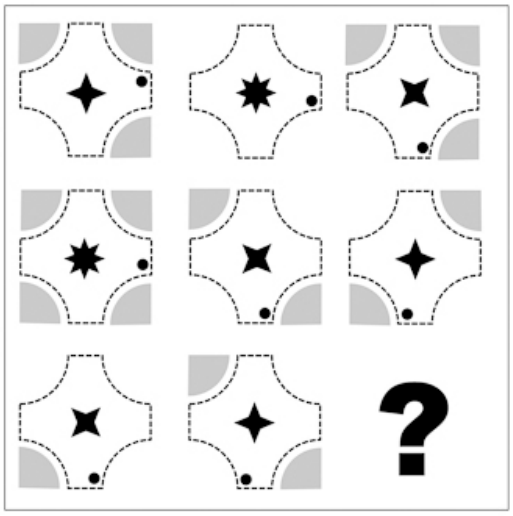


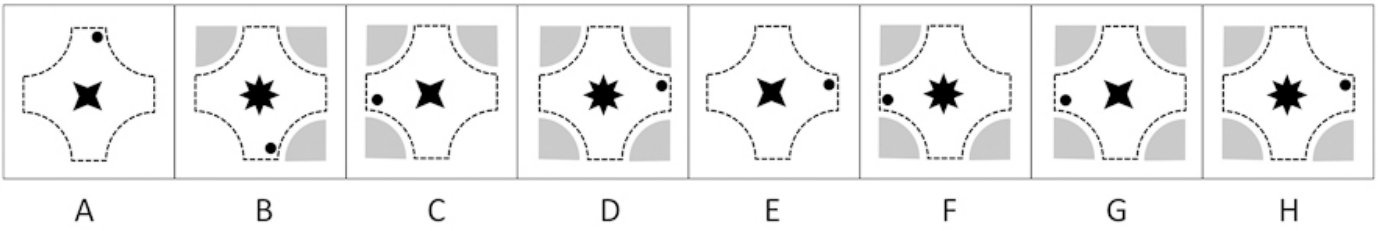
FORM B, ITEM 4 (F15.1)



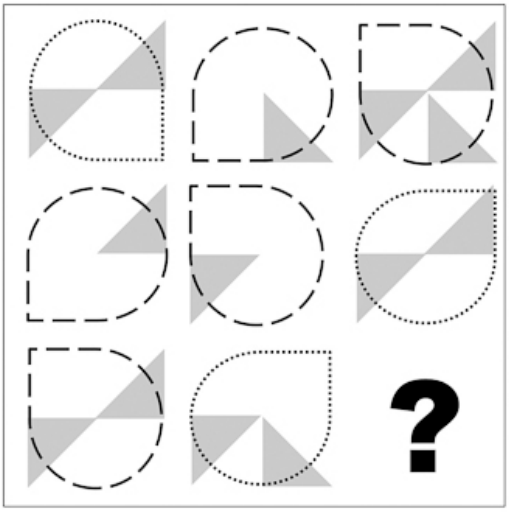


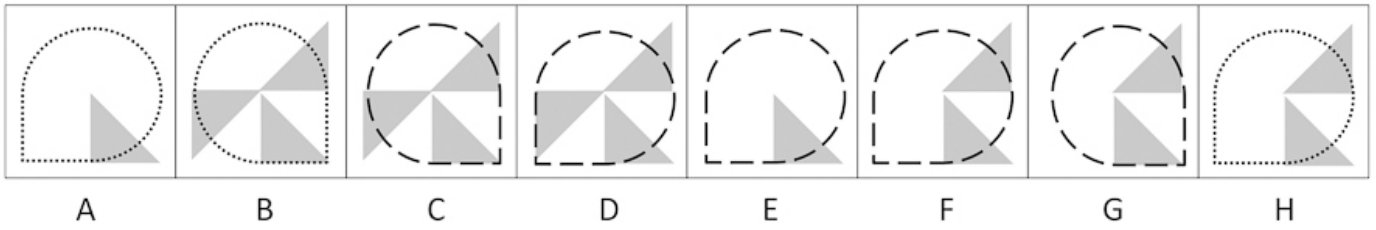
FORM B, ITEM 5 (F20.3)



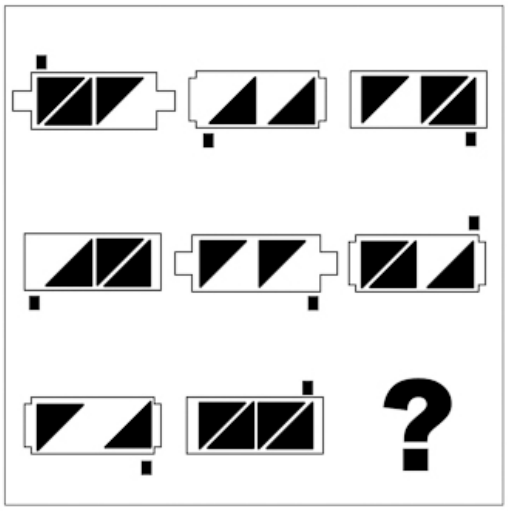


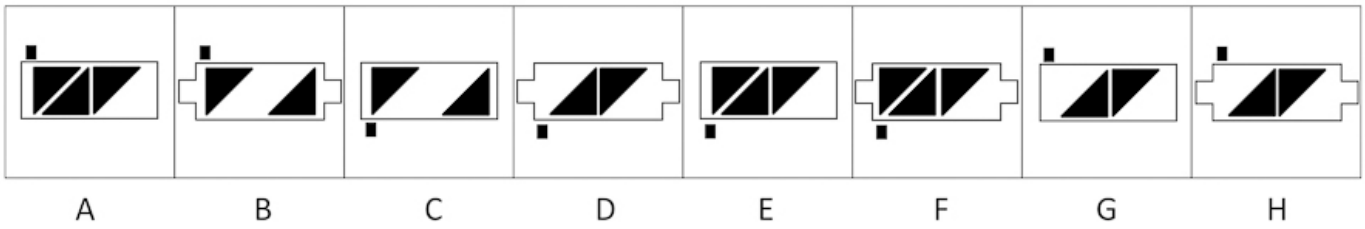
FORM B, ITEM 6 (F19.2)



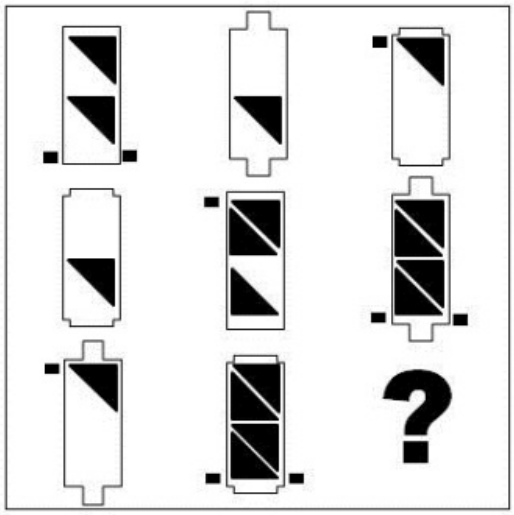


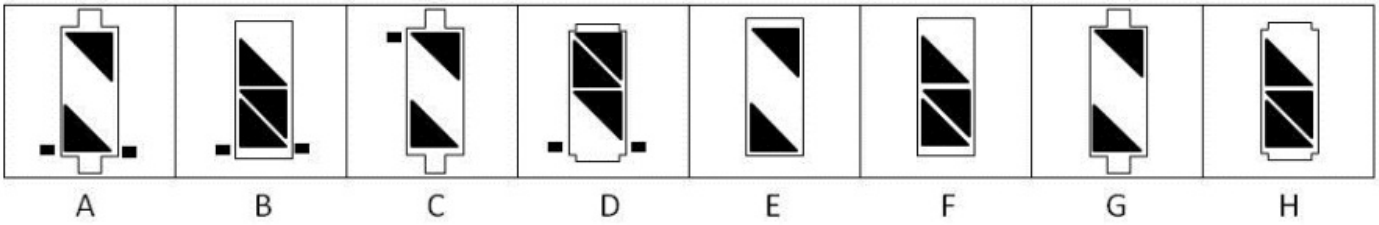
FORM B, ITEM 7 (F20.4)



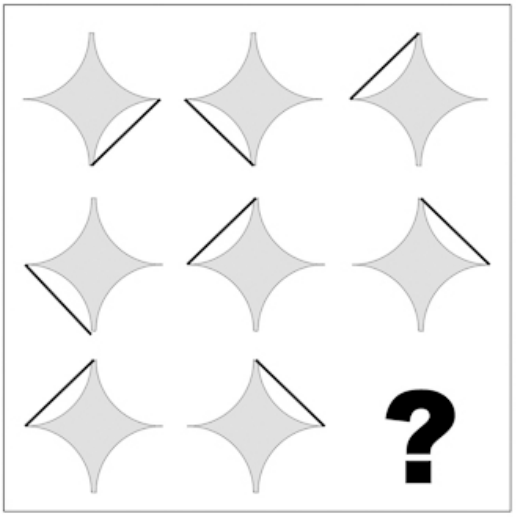


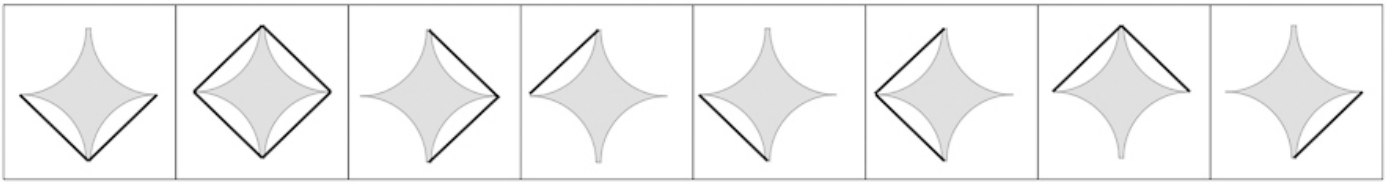
FORM B, ITEM 8 (F16.New1)



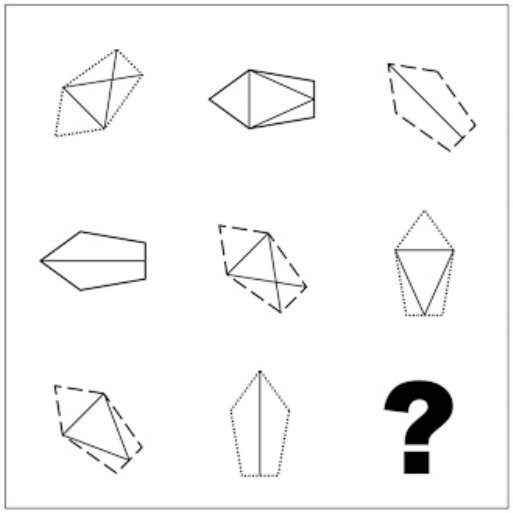


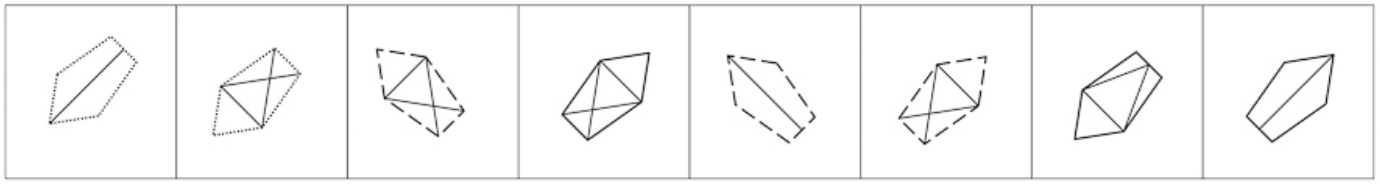
FORM B, ITEM 9 (F3.3)



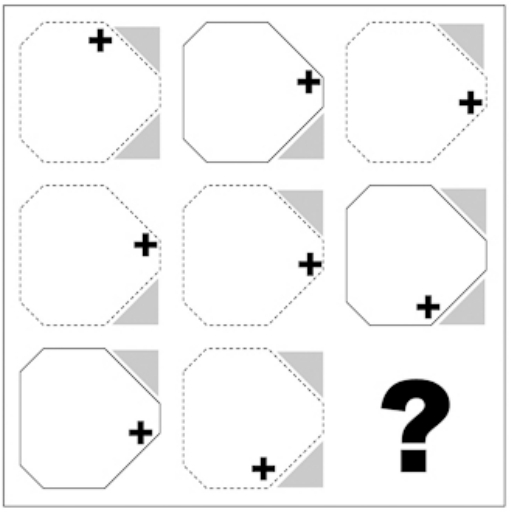


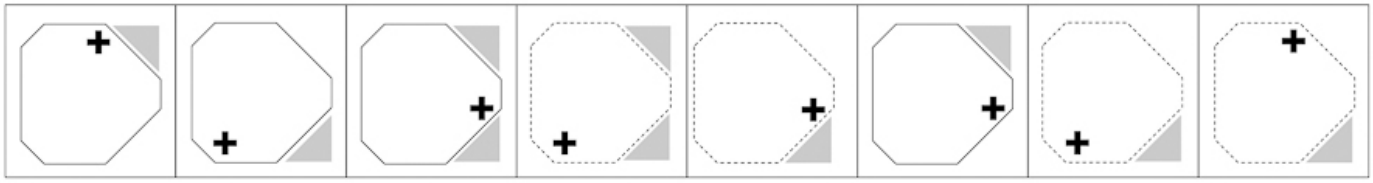
FORM B, ITEM 10 (F17.3)



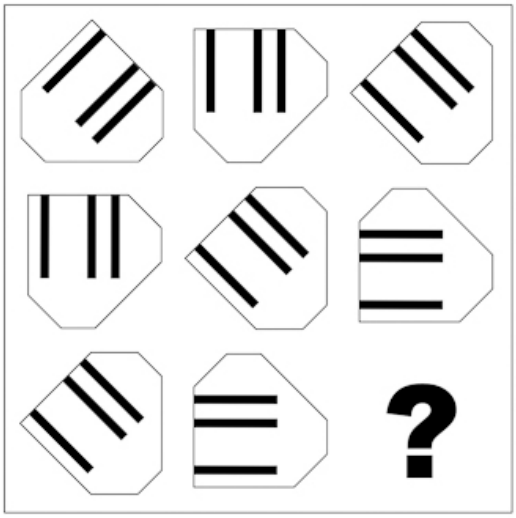


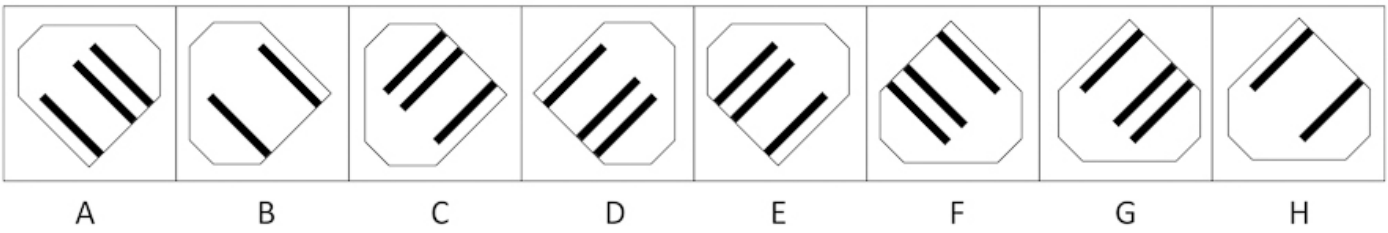
FORM B, ITEM 11 (F18.5)



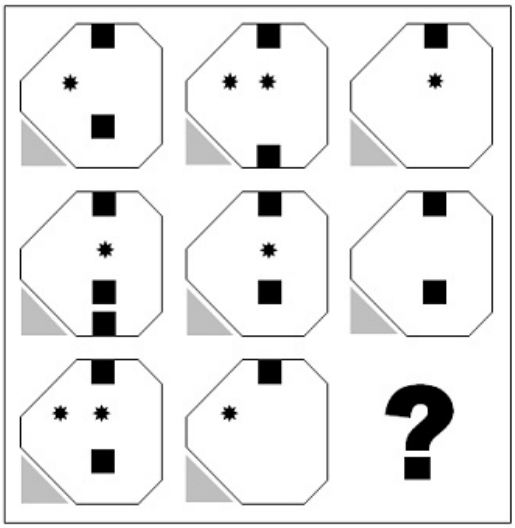


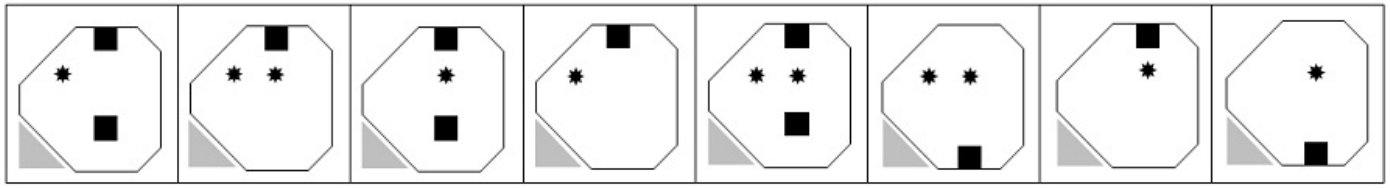
FORM B, ITEM 12 (F2.3)



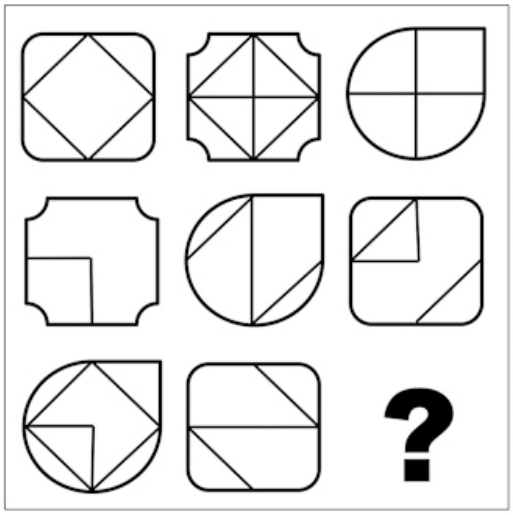


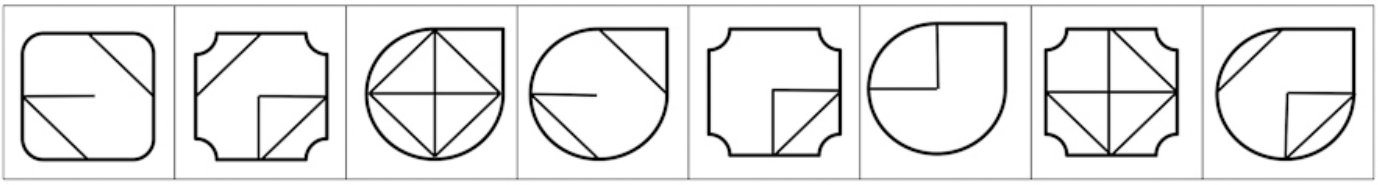
FORM B, ITEM 13 (F5.New2)



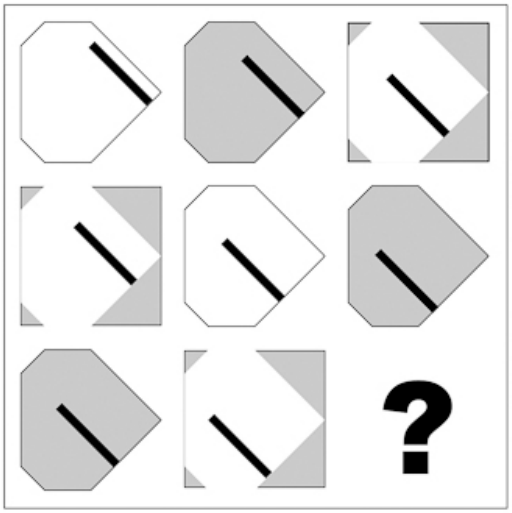


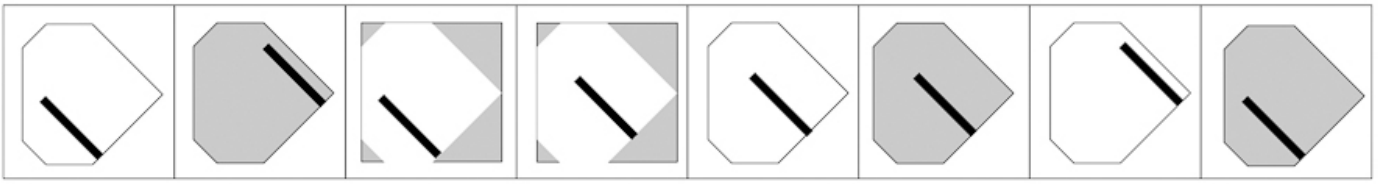
FORM B, ITEM 14 (F10.4)



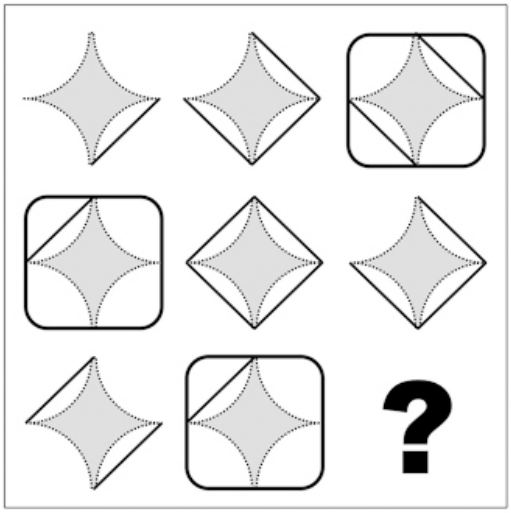


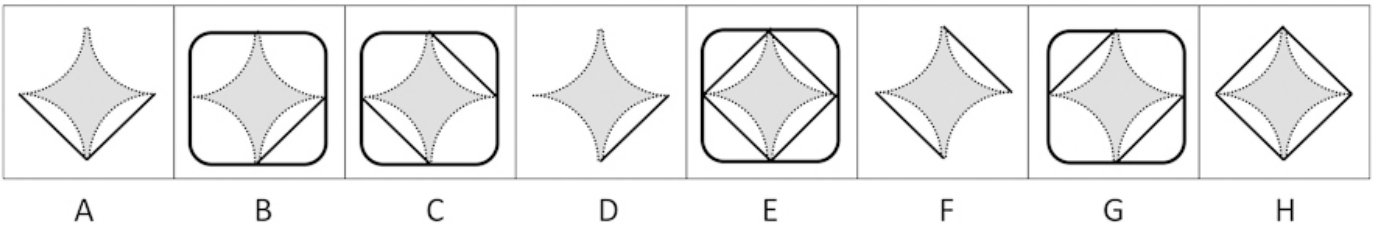
FORM B, ITEM 15 (F12.1)



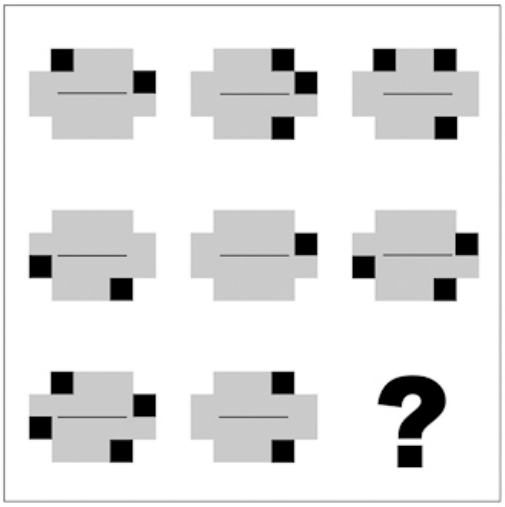


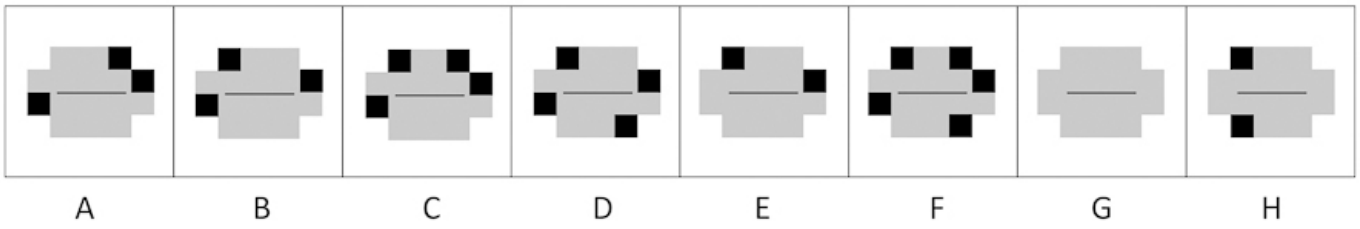
FORM B, ITEM 16 (F10.1)



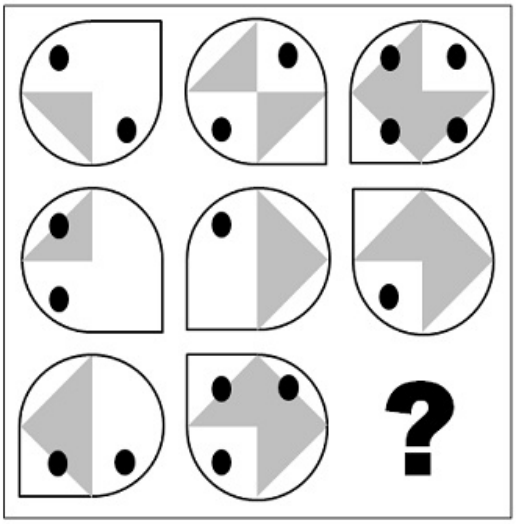


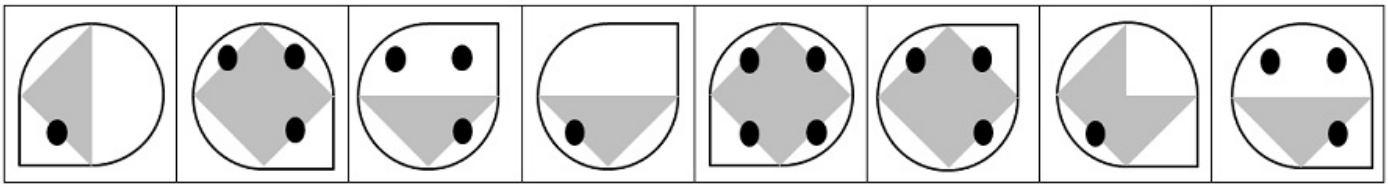
FORM B, ITEM 17 (F1.3)



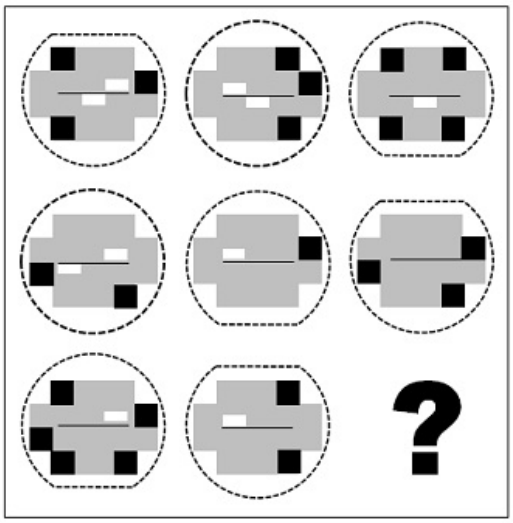


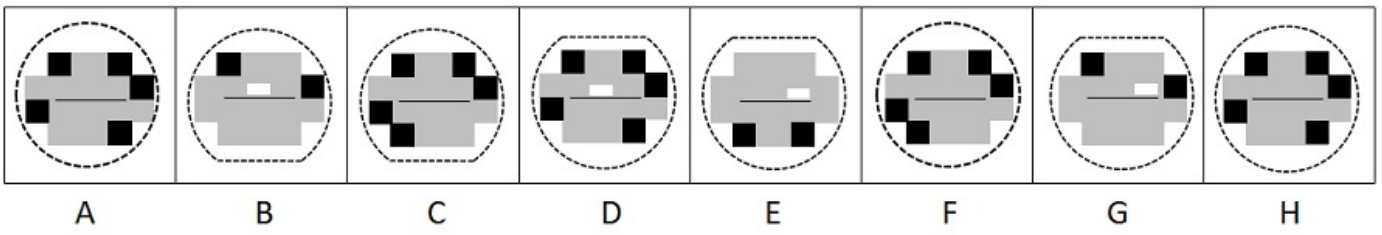
FORM B, ITEM 18 (F13.New1)



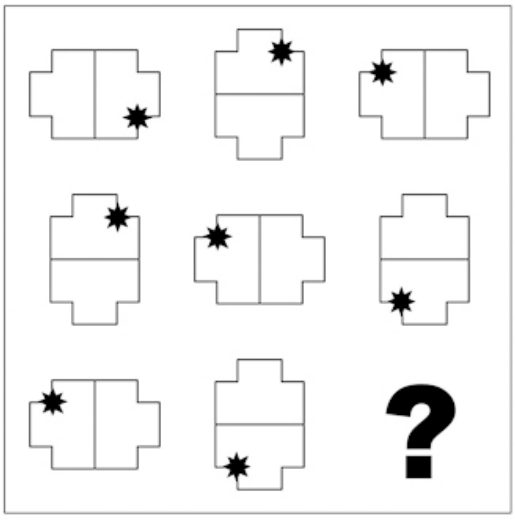


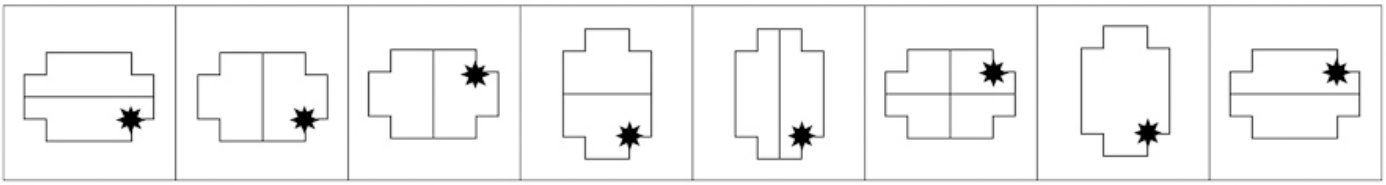
FORM B, ITEM 19 (F14.New2)



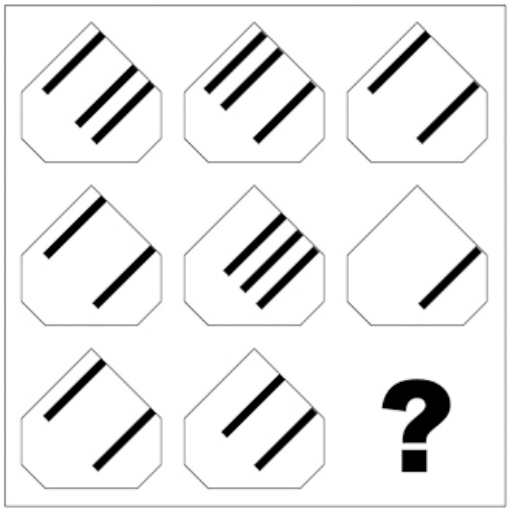


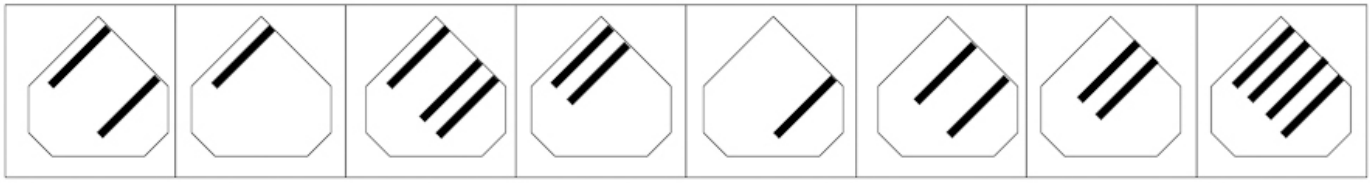
FORM B, ITEM 20 (F2.4)



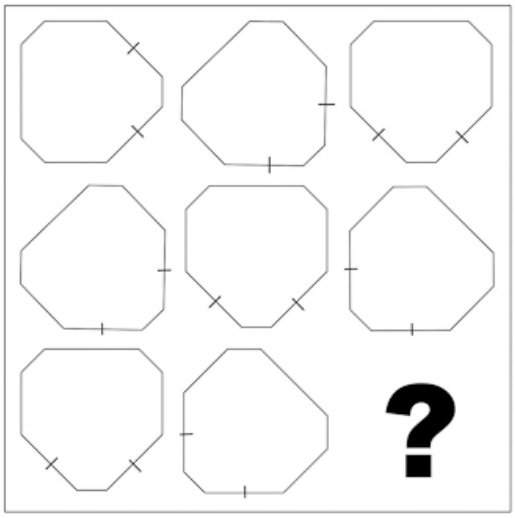


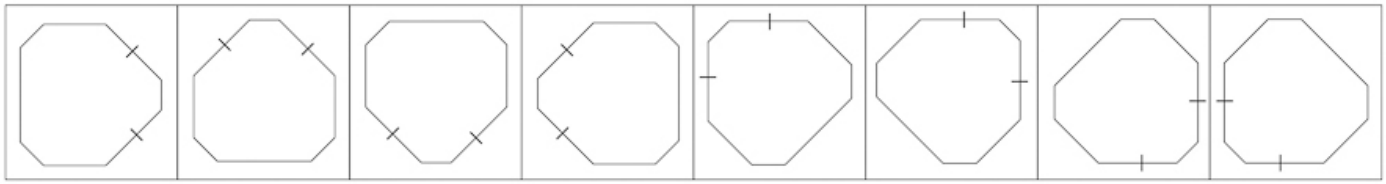
FORM B, ITEM 21 (F1.5)



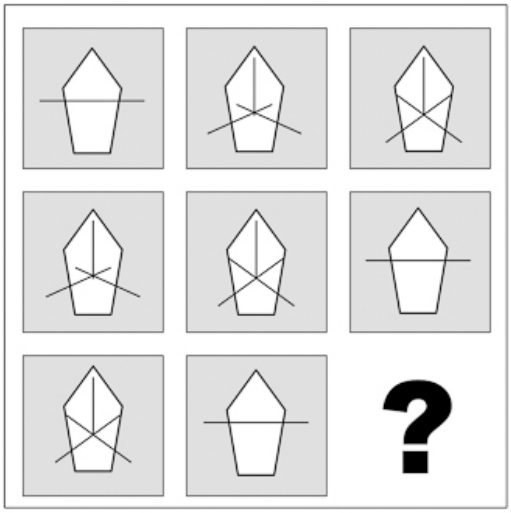


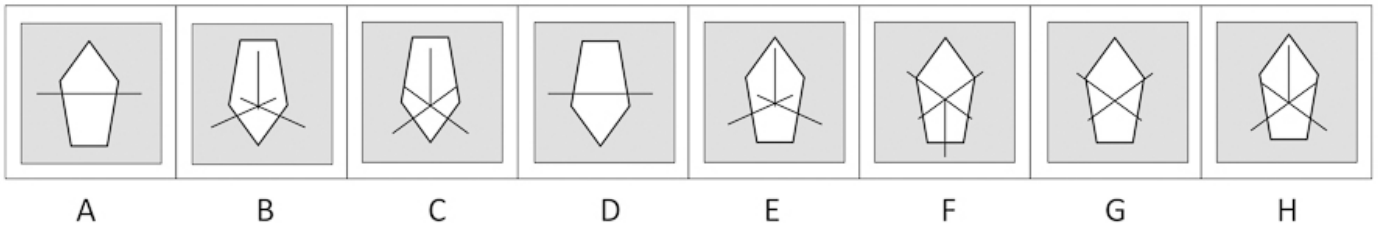
FORM B, ITEM 22 (F2.1)



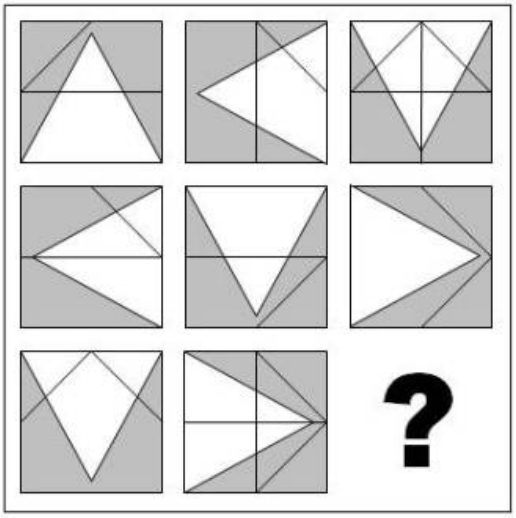


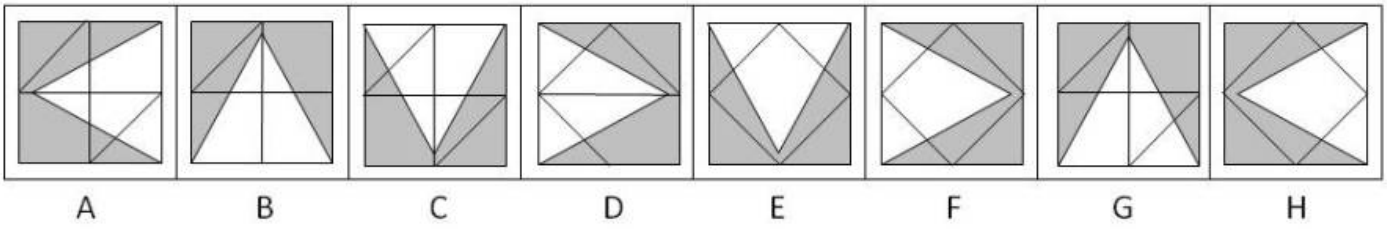
FORM B, ITEM 23 (F4.1)



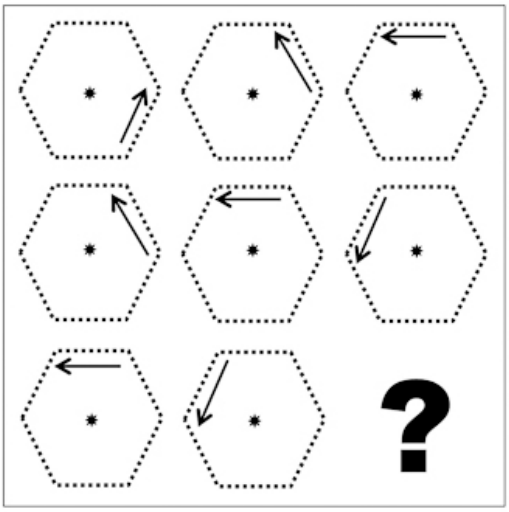


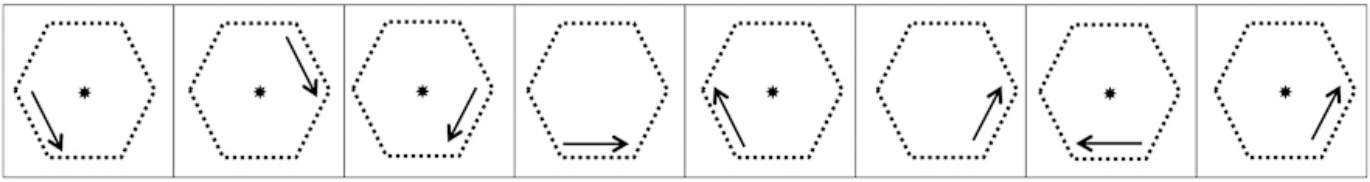
FORM B, ITEM 24 (F8.New2)



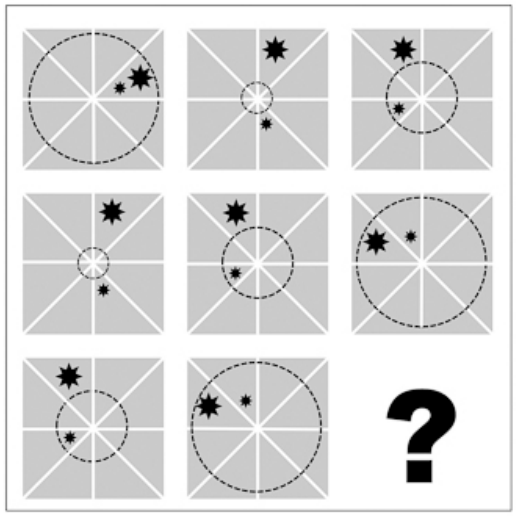


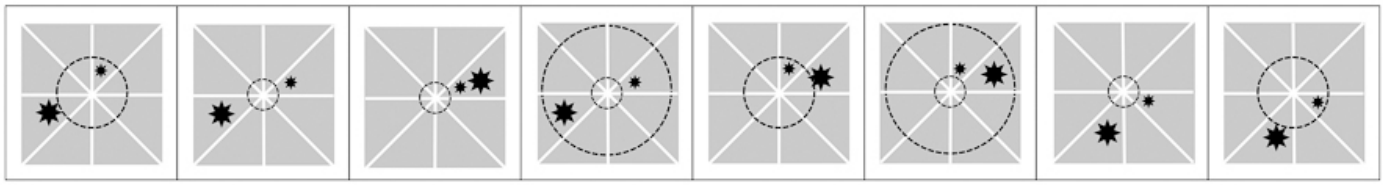
FORM B, ITEM 25 (F3.1)



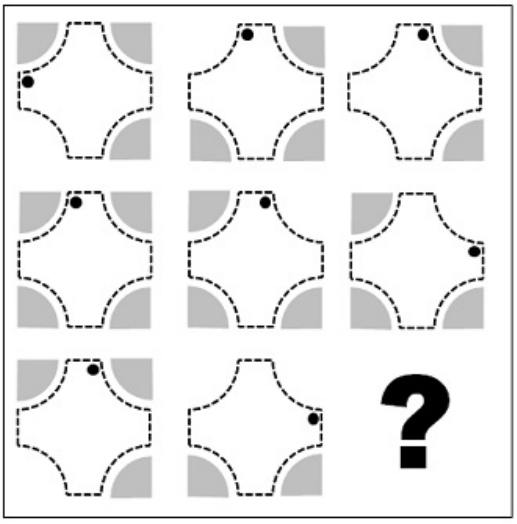


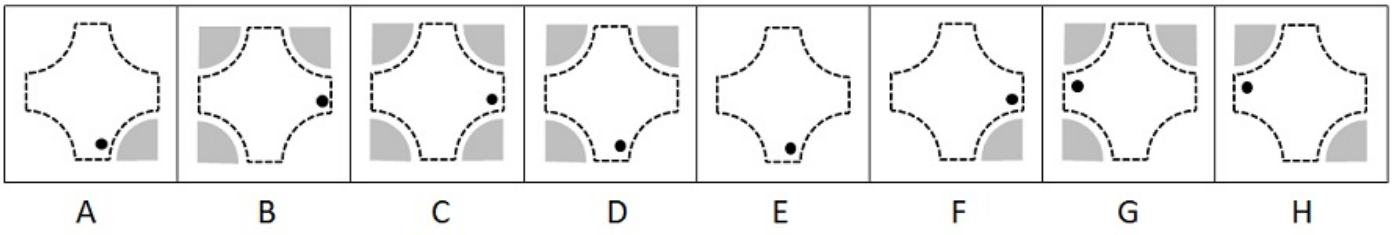
FORM B, ITEM 26 (F15.3)



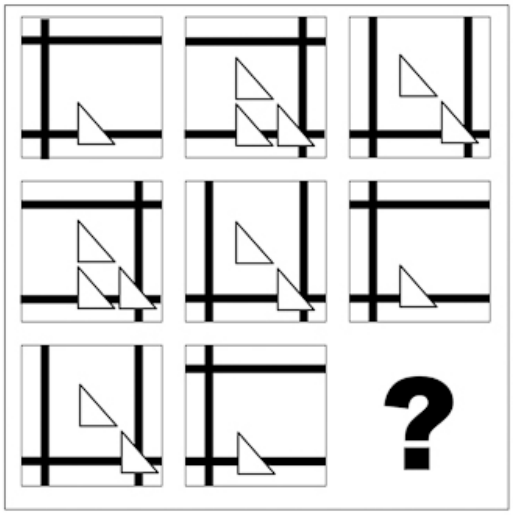


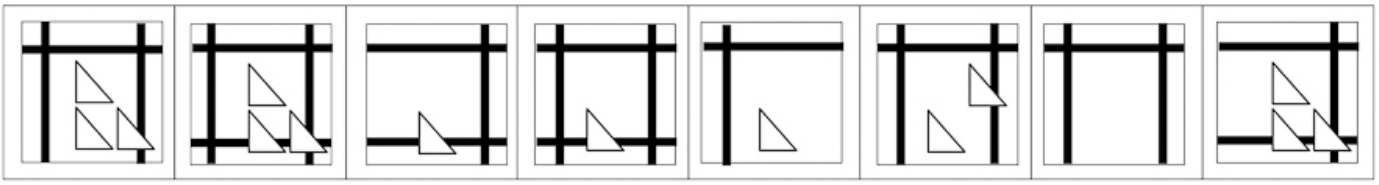
FORM B, ITEM 27 (F9.New1)



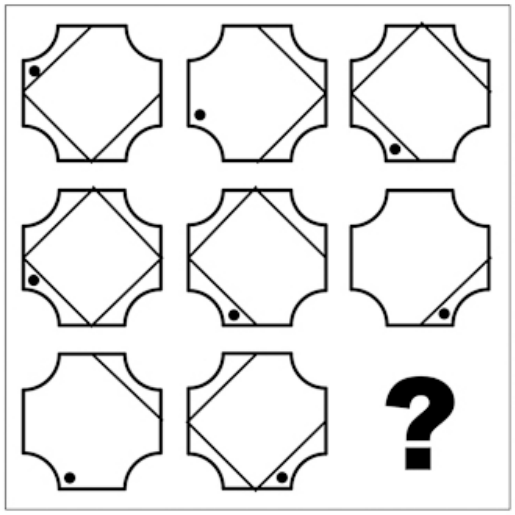


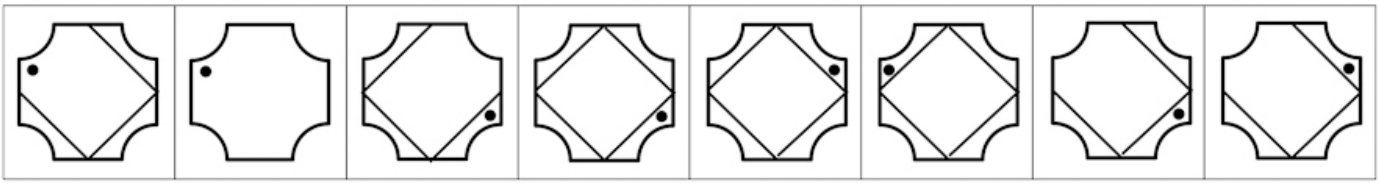
FORM B, ITEM 28 (F7.5)



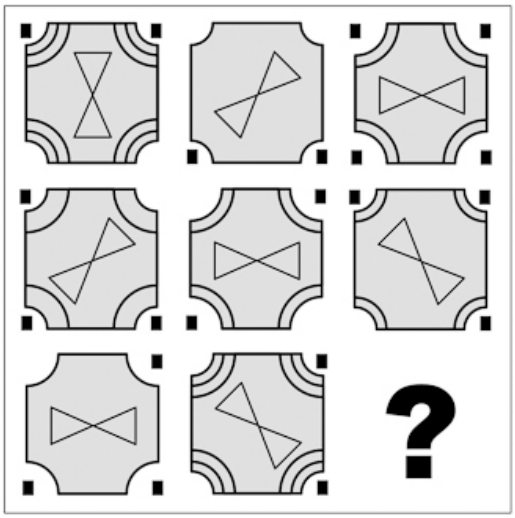


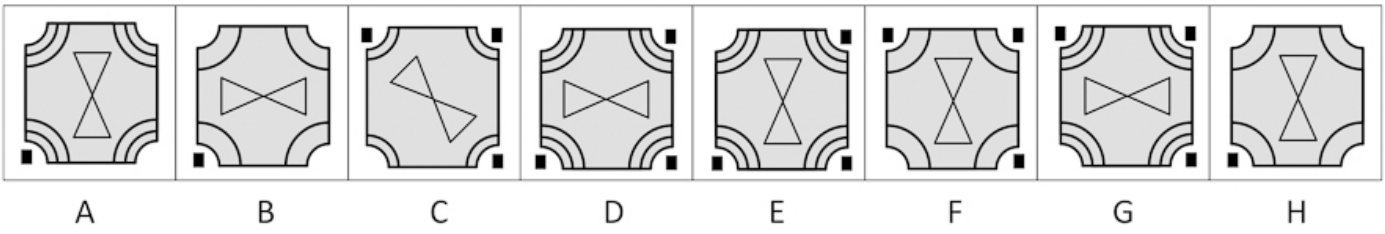
FORM B, ITEM 29 (F9.3)





FORM B, ITEM 30 (F13.4)





Appendix F: Figure-Number Series Composite Materials

Figure-Number Series Composite Test Items, Item Parameters, and Answer Key
Parallel Form 1

Item Label	Disc.	Diff.	Item														Key
as_b2i13	0.44	-2.70	←	←	↓	→	↑	↑	←	↓	→	→	↑	←	↓	↓	→
as_b1i11	0.47	-0.47	←	→	→	↗	↑	↓	↓	↘	→	←	←	↙	↓		↑
as_b2i12	0.99	0.15	↓	↗	↗	↙	←	↘	↘	↖	↑	↙	↙	↗	→		↖
as_b1i12	0.70	0.49	↙	↖	↖	↑	↖	↗	↗	→	↗	↘	↘	↓			↘
as_b3i12	0.93	-0.86	→	→	↘	↑	↓	↓	↙	→	←	←	↖	↓	↑	↑	↗
as_b4i4	0.34	-6.91	↗	→	↘	↓	↙	←	↖	↑	↗						→
as_b1i15	0.40	-1.23	↑	↗	←	→	↘	↑	↓	↙	→						←
as_b1i6	0.52	2.14	←	↑	↙	↑	↑	↑	↖	↑	→	↑	↗	↑			↓
as_b5i4	0.48	-2.05	↑	↓	→	←	↓	↑									←
as_b1i8	0.47	-1.86	↖	↖	↓	↗	↗	←	↘	↘	↑						↙
as_b2i5	0.40	0.26	↖	↙	↗	↖	↘	↗	↙	↘	↖						↙
as_b3i7	1.27	-1.66	↘	↘	↑	↙	↙	→	↖	↖	↓	↗	↗				←
as_b2i6	1.11	1.52	↗	↙	←	↙	↘	↙	↑	↙	↙	↙	→	↙			↖
as_b1i13	0.79	-0.77	↗	↗	↑	↖	↘	↘	→	↗	↙	↙	↓	↘	↖	↖	←
as_b3i16	0.44	-1.85	→	↘	↑	↓	↙	→	←	↖	↓						↑
nst_f08i3	1.07	1.36	16	20	27	29	38	49	60	73							**79**
nst_f07i1	0.70	3.78	10	6	7	13	11	6	8	14							**13**
nn_f08i13	0.53	0.86	12	19	22	32	36	41	50	55							**60**
nst_f03i3	0.55	4.70	10	12	12	14	16	20	26	36							**52**
nst_f08i4	0.79	1.75	26	32	40	45	49	58	71	84							**92**
nst_f01i1	0.61	-1.04	10	11	13	17	25	32	37	47							**58**
nst_f03i2	0.97	1.45	2	4	5	8	12	19	30	48							**77**
nst_f15i1	0.83	4.14	11	10	2	2	3	4	6	9							**14**
nst_f02i5	0.36	2.95	9	19	30	34	42	49	63	73							**84**
nst_f03i5	0.61	3.30	21	22	23	25	28	33	41	54							**75**
nst_f08i5	1.01	1.89	21	28	31	41	45	50	59	64							**78**
nst_f06i2	0.44	2.05	2	43	30	23	20	15	13	7							**3**
nst_f01i4	0.80	1.03	13	17	25	32	37	47	58	71							**79**
nst_f06i6	0.98	1.80	62	51	43	37	30	20	17	15							**7**
nst_f04i3	0.58	4.64	10	11	3	5	8	4	3	7							**1**

Figure-Number Series Composite Test Items, Item Parameters, and Answer Key
Parallel Form 2

Item Label	Disc.	Diff.	Item														Key
as_b3i1	0.87	0.39	↖	↘	↗	↘	↘	↘									↙
as_b1i7	0.73	0.23	↓	↙	↑	↙	←	↙	→	↙	↑	↙	↓	↙			→
as_b4i8	0.41	-3.66	↓	↓	↗	←	←	↘	↑	↑	↙						→
as_b2i1	0.38	-3.67	↓	→	←	→	↑	→	→	→							↓
as_b2i11	0.58	0.14	↗	↑	↑	→	↘	→	→	↓	↙	↓	↓	←			↖
as_b1i5	0.60	0.63	↙	↖	←	↖	↖	↖	↑	↖	↗	↖	→	↖			↘
as_b4i7	0.76	-2.50	↗	↗	↓	↘	↘	←	↙	↙	↑	↖	↖				→
as_b1i10	0.46	-3.17	↖	↘	↓	↗	↙	↓	↘	↖	↓	↙					↗
as_b3i9	0.97	-1.85	↗	↗	←	↘	↘	↑	↙	↙	→	↖	↖				↓
as_b3i11	0.77	-0.72	↑	↘	↘	↖	→	↙	↙	↗	↓	↖	↖	↘			←
as_b4i5	0.70	-0.62	↖	←	↗	↑	↘	→									↙
as_b3i4	0.43	-3.02	↓	↘	←	↙	↑	↖	→	↗	↓						↘
as_b1i3	1.20	1.86	↓	↗	←	↖	↗	←	→	↗	←						↙
as_b2i10	0.58	0.14	↗	→	←	↘	↓	←	↙	←	←	↖					↑
as_b3i10	1.02	-1.29	↑	↙	↗	→	↖	↗	↓	↗	↗						←
nn_f06i13	1.18	1.46	74	66	55	43	33	26	20	12							**10**
nn_f07i8	0.64	3.94	11	10	3	4	7	11	9	11							**11**
nn_f08i8	0.74	1.32	7	11	18	20	29	31	42	46							**52**
nn_f03i6	0.51	2.47	12	12	13	14	16	19	24	32							**45**
nn_f02i8	0.33	3.41	8	18	29	42	50	57	71	81							**92**
nn_f06i9	0.67	0.81	70	62	55	47	37	26	16	8							**1**
nn_f08i11	0.69	1.29	15	18	24	33	39	45	57	66							**78**
nn_f06i11	0.73	2.43	92	75	64	52	42	35	29	21							**10**
nn_f03i10	0.43	4.88	13	15	16	19	23	30	41	59							**88**
nn_f08i10	0.98	1.34	11	20	22	24	28	34	44	51							**59**
nn_f03i8	0.51	3.82	15	17	18	21	25	32	43	61							**90**
nn_f08i9	0.50	2.19	3	5	8	13	21	25	28	35							**45**
nst_f03i1	0.72	1.98	2	3	4	6	9	14	22	35							**56**
nst_f9i6	0.56	4.09	11	12	14	18	26	33	38	48							**59**
nn_f03i13	0.69	2.62	4	6	7	10	14	21	32	50							**79**

Figure-Number Series Composite Test Items, Item Parameters, and Answer Key
"Best of" Test Form

Item Label	Disc.	Diff.	Item														Key
as_b5i4	0.48	-2.05	↑	↓	→	←	↓	↑									←
as_b3i13	0.64	-1.57	↘	↘	↙	↗	↙	↙	↖	↘	↖	↖	↗	↙			↗
as_b1i8	0.47	-1.86	↖	↖	↓	↗	↗	←	↘	↘	↑						↙
as_b2i6	1.11	1.52	↗	↙	←	↙	↘	↙	↑	↙	↙	↙	→	↙			↖
as_b1i15	0.40	-1.23	↑	↗	←	→	↘	↑	↓	↙	→						←
as_b1i3	1.20	1.86	↓	↗	←	↖	↗	←	→	↗	←						↙
as_b1i4	0.51	-1.56	↙	↖	↖	↗	↗	↘	↘	↙	↙						↖
as_b2i12	0.99	0.15	↓	↗	↗	↙	←	↘	↘	↖	↑	↙	↙	↗	→		↖
as_b2i4	0.53	-2.03	←	→	↑	↓	→	←									↓
as_b3i11	0.77	-0.72	↑	↘	↘	↖	→	↙	↙	↗	↓	↖	↖	↘			←
as_b2i8	0.85	-0.48	←	←	↗	↑	↑	↘	→	→	↙	↓	↓				↖
as_b2i16	0.54	-1.22	↗	→	↙	↘	↓	↖	↙	←	↗	↖					↑
as_b1i11	0.47	-0.47	←	→	→	↗	↑	↓	↓	↘	→	←	←	↙	↓		↑
as_b5i13	0.84	-1.08	↖	↖	↘	↑	↗	↗	↙	→	↘	↘	↖	↓			↙
as_b2i5	0.40	0.26	↖	↙	↗	↖	↘	↗	↙	↘	↖						↙
nn_f08i13	0.53	0.86	12	19	22	32	36	41	50	55							**60**
nst_f06i6	0.98	1.80	62	51	43	37	30	20	17	15							**7**
nn_f03i10	0.43	4.88	13	15	16	19	23	30	41	59							**88**
nn_f06i11	0.73	2.43	92	75	64	52	42	35	29	21							**10**
nst_f01i1	0.61	-1.04	10	11	13	17	25	32	37	47							**58**
nn_f02i8	0.33	3.41	8	18	29	42	50	57	71	81							**92**
nn_f03i8	0.51	3.82	15	17	18	21	25	32	43	61							**90**
nst_f06i2	0.44	2.05	2	43	30	23	20	15	13	7							**3**
nst_f08i5	1.01	1.89	21	28	31	41	45	50	59	64							**78**
nst_f9i6	0.56	4.09	11	12	14	18	26	33	38	48							**59**
nn_f08i12	1.35	0.94	12	20	23	25	30	37	40	50							**54**
nst_f03i1	0.72	1.98	13	15	16	19	23	30	41	59							**88**
nst_f08i2	0.78	2.03	6	10	16	17	24	32	38	43							**54**
nst_f02i4	0.49	4.31	13	18	28	39	52	60	67	81							**91**
nst_f02i5	0.36	2.95	9	19	30	34	42	49	63	73							**84**

Figure-Number Series Composite Test Scaled Score Concordance Tables

Raw Score	Form 1		Form 2		"Best of" Single Form	
	Scale Score	SE	Scale Score	SE	Scale Score	SE
0	-1.88	0.72	-2.04	0.72	-1.98	0.76
1	-1.67	0.73	-1.79	0.74	-1.71	0.77
2	-1.42	0.73	-1.52	0.74	-1.44	0.77
3	-1.16	0.73	-1.25	0.74	-1.16	0.77
4	-0.90	0.72	-0.97	0.73	-0.89	0.75
5	-0.63	0.71	-0.69	0.72	-0.62	0.74
6	-0.37	0.70	-0.41	0.71	-0.35	0.73
7	-0.10	0.69	-0.14	0.69	-0.09	0.72
8	0.15	0.67	0.13	0.68	0.16	0.70
9	0.40	0.66	0.39	0.67	0.41	0.69
10	0.65	0.65	0.64	0.67	0.66	0.68
11	0.89	0.65	0.89	0.66	0.90	0.67
12	1.12	0.64	1.13	0.65	1.14	0.66
13	1.36	0.63	1.37	0.65	1.38	0.66
14	1.59	0.63	1.61	0.64	1.62	0.65
15	1.82	0.62	1.85	0.64	1.86	0.64
16	2.05	0.62	2.08	0.63	2.09	0.64
17	2.28	0.61	2.32	0.63	2.32	0.64
18	2.51	0.61	2.55	0.63	2.56	0.64
19	2.74	0.61	2.78	0.63	2.79	0.64
20	2.97	0.61	3.01	0.63	3.02	0.64
21	3.20	0.62	3.25	0.64	3.25	0.64
22	3.43	0.62	3.48	0.64	3.48	0.65
23	3.66	0.62	3.72	0.65	3.72	0.65
24	3.89	0.63	3.95	0.65	3.95	0.66
25	4.12	0.63	4.18	0.65	4.18	0.66
26	4.34	0.62	4.41	0.65	4.40	0.66
27	4.56	0.60	4.62	0.64	4.61	0.64
28	4.75	0.58	4.82	0.61	4.80	0.62
29	4.93	0.54	5.00	0.58	4.97	0.59
30	5.08	0.49	5.15	0.54	5.12	0.55

Appendix G: Figure-Letter Series Composite Materials

Figure-Letter Series Composite Test Items, Item Parameters, and Answer Key
Parallel Form 1

Item Label	Disc.	Diff.	Item	Key
ls_f13i1	1.40	-0.78	N, N, F, S, P, P, H, U, R, R, J, W, T, T,	**L**
ls_f03i5	0.29	-1.01	D, X, P, A, X, P, X, X, P, U, X, P, R,	**X**
ls_f15i1	1.30	1.00	P, D, N, R, F, P, T, H, R, V, J,	**T**
ls_f10i1	0.74	-1.19	Z, I, I, G, B, K, K, I, D, M, M, K, F, O,	**O**
ls_f05i3	1.19	-1.44	X, E, Z, G, B, I, D, K, F, M,	**H**
ls_f04i6	1.16	-1.07	C, L, E, N, G, P, I, R, K, T, M, V, O, X,	**Q**
ls_f01i1	0.56	-2.20	U, F, W, F, Y, F, A,	**F**
ls_f9i1	0.85	0.16	V, O, D, X, Q, D, Z, S, D, B, U, D, D, W,	**D**
ls_f08i1	1.48	-0.28	B, M, N, D, O, N, F, Q, N, H,	**S**
ls_f02i2	0.76	-1.42	N, U, S, P, U, S, R, U, S, T, U,	**S**
ls_f9i6	1.41	-0.88	F, K, B, H, M, B, J, O, B, L,	**Q**
ls_f14i4	0.34	1.20	L, P, B, R, N, R, D, R, P, T, F, R, R, V, H,	**R**
ls_f11i2	1.59	-0.15	N, A, A, U, P, C, C, W, R, E, E, Y, T, G, G,	**A**
ls_f14i2	1.42	0.12	L, B, F, S, N, D, H, S, P, F, J, S, R, H, L, S, T,	**J**
ls_f07i2	1.26	-1.55	R, R, W, T, T, Y, V, V, A, X, X, C, Z, Z,	**E**
as_b2i4	0.53	-2.03	↓ → ← → ↑ → → →	**↓**
as_b2i14	0.44	0.85	→ ↑ ↘ ↖ ↓ → ↙ ↖ ← ↓ ↖ ↖	**↑**
as_b2i1	0.38	-3.67	↓ → ← → ↑ → → →	**↓**
as_b2i5	0.40	0.26	↖ ↙ ↗ ↖ ↘ ↗ ↙ ↘ ↖	**↙**
as_b3i10	1.02	-1.29	↑ ↙ ↗ → ↖ ↗ ↓ ↗ ↗	**←**
as_b1i11	0.47	-0.47	← → → ↗ ↑ ↓ ↓ ↘ → ← ← ↙ ↓	**↑**
as_b3i4	0.43	-3.02	↓ ↘ ← ↙ ↑ ↖ → ↗ ↓	**↘**
as_b4i2	0.33	1.18	← → ← ↑ → ← → → ←	**↓**
as_b4i10	0.54	-0.10	↗ ↖ ← ↘ ↗ ← ↙ ↘ ←	**↖**
as_b3i15	0.61	-1.17	↘ ← ↗ ↙ ↑ ↘ ↖ → ↙ ↗	**↓**
as_b2i3	1.19	1.98	↗ ↙ ↑ ↓ ↙ ↑ ↖ ↙ ↑	**→**
as_b1i8	0.47	-1.86	↖ ↖ ↓ ↗ ↗ ← ↘ ↘ ↑	**↙**
as_b2i13	0.44	-2.70	← ← ↓ → ↑ ↑ ← ↓ → → ↑ ← ↓ ↓	**→**
as_b1i15	0.40	-1.23	↑ ↗ ← → ↘ ↑ ↓ ↙ →	**←**
as_b5i16	0.16	0.73	← ↑ → ↑ → ↓ → ↓ ← ↓	**←**

Figure-Letter Series Composite Test Items, Item Parameters, and Answer Key Parallel Form 2																
Item Label	**Disc.**	**Diff.**	**Item**													**Key**
ls_f03i2	0.91	-0.95	P, Q, O, S, Q, O, V, Q, O, Y, Q, O, B, Q, O,													**E**
ls_f15i4	1.46	-0.01	G, W, A, I, Y, C, K, A, E, M,													**C**
ls_f08i3	1.26	-1.75	O, O, I, Q, Q, K, S, S, M, U, U,													**O**
ls_f10i3	0.64	-2.02	D, Y, Y, W, F, A, A, Y, H, C, C, A, J, E,													**E**
ls_f14i3	1.48	-0.02	L, T, D, N, V, F, P, X, H, R, Z,													**J**
ls_f01i3	0.56	-3.14	V, G, X, G, Z, G, B,													**G**
ls_f02i5	0.56	-1.02	D, K, J, F, K, J, H, K, J, J,													**K**
ls_f07i5	1.22	-2.08	F, F, O, H, H, Q, J, J, S, L, L,													**U**
ls_f02i1	0.72	-1.70	T, C, V, C, X, C, Z, C,													**B**
ls_f9i2	1.61	-0.61	X, J, P, Z, L, P, B, N, P, D,													**P**
ls_f12i1	0.87	-2.75	D, D, T, L, F, F, V, N, H, H, X, P, J,													**J**
ls_f11i1	1.13	1.00	Q, G, G, N, S, I, I, P, U, K, K, R, W, M, M, T,													**Y**
ls_f08i6	1.10	-1.97	Y, Y, L, A, A, N, C, C, P, E, E,													**R**
ls_f06i4	1.01	-1.22	R, Q, B, Q, T, Q, D, Q, V, Q, F, Q, X, Q,													**H**
ls_f08i2	1.49	-0.66	U, F, R, W, H, R, Y, J, R, A,													**L**
as_b1i4	0.51	-1.56	↙	↖	↖	↗	↗	↘	↘	↙	↙						**↖**
as_b1i12	0.70	0.49	↙	↖	↖	↑	↖	↗	↗	→	↗	↘	↘	↓			**↘**
as_b1i13	0.79	-0.77	↗	↗	↑	↖	↘	↘	→	↗	↙	↙	↓	↘	↖	↖	**←**
as_b1i3	1.20	1.86	↓	↗	←	↖	↗	←	→	↗	←						**↙**
as_b2i11	0.58	0.14	↗	↑	↑	→	↘	→	→	↓	↙	↓	↓	←			**↖**
as_b2i10	0.58	0.14	↗	→	←	↘	↓	←	↙	←	←	↖					**↑**
as_b3i11	0.77	-0.72	↑	↘	↘	↖	→	↙	↙	↗	↓	↖	↖	↘			**←**
as_b3i12	0.93	-0.86	→	→	↘	↑	↓	↓	↙	→	←	←	↖	↓	↑	↑	**↗**
as_b3i16	0.44	-1.85	→	↘	↑	↓	↙	→	←	↖	↓						**↑**
as_b4i11	0.19	4.24	→	↓	↓	←	↓	←	←	↑	←	↑	↑	→			**↑**
as_b4i5	0.70	-0.62	↖	←	↗	↑	↘	→									**↙**
as_b4i3	0.25	4.02	→	←	↓	↙	←	↓	↑	←	↓						**↘**
as_b4i9	0.52	-0.05	↑	→	↙	→	↓	↙	↓	←	↙						**←**
as_b5i2	0.58	-2.21	↘	↓	↑	↙	↓	↑	↖	↓	↑						**↗**
as_b5i7	0.50	0.79	↖	←	↙	←	↗	←	↖	←	↘	←	↗	←			**↙**

Figure-Letter Series Composite Test Items, Item Parameters, and Answer Key
"Best of" Test Form

Item Label	Disc.	Diff.	Item	Key
ls_f08i2	1.49	-0.66	U, F, R, W, H, R, Y, J, R, A,	**L**
ls_f10i3	0.64	-2.02	D, Y, Y, W, F, A, A, Y, H, C, C, A, J, E,	**E**
ls_f04i3	0.92	-1.21	P, J, R, L, T, N, V, P, X, R,	**Z**
ls_f11i1	1.13	1.00	Q, G, G, N, S, I, I, P, U, K, K, R, W, M, M, T,	**Y**
ls_f14i3	1.48	-0.02	L, T, D, N, V, F, P, X, H, R, Z,	**J**
ls_f06i4	1.01	-1.22	R, Q, B, Q, T, Q, D, Q, V, Q, F, Q, X, Q,	**H**
ls_f14i2	1.42	0.12	L, B, F, S, N, D, H, S, P, F, J, S, R, H, L, S, T,	**J**
ls_f04i6	1.16	-1.07	C, L, E, N, G, P, I, R, K, T, M, V, O, X,	**Q**
ls_f02i2	0.76	-1.42	N, U, S, P, U, S, R, U, S, T, U,	**S**
ls_f02i3	1.03	-1.11	B, J, Q, E, J, Q, H, J, Q, K, J, Q, N, J, Q,	**Q**
ls_f01i1	0.56	-2.20	U, F, W, F, Y, F, A,	**F**
ls_f9i2	1.61	-0.61	X, J, P, Z, L, P, B, N, P, D,	**P**
ls_f13i1	1.40	-0.78	N, N, F, S, P, P, H, U, R, R, J, W, T, T,	**L**
ls_f02i1	0.72	-1.70	T, C, V, C, X, C, Z, C,	**B**
ls_f05i1	0.76	1.49	W, N, A, N, Y, N, C, N, A, N, E, N, C, N,	**G**
as_b2i16	0.54	-1.22	↗ → ↙ ↘ ↓ ↖ ↙ ← ↗ ↖	**↑**
as_b1i8	0.47	-1.86	↖ ↖ ↓ ↗ ↗ ← ↘ ↘ ↑	**↙**
as_b3i7	1.27	-1.66	↘ ↘ ↑ ↙ ↙ → ↖ ↖ ↓ ↗ ↗	**←**
as_b5i16	0.16	0.73	← ↑ → ↑ → ↓ → ↓ ← ↓	**←**
as_b3i8	0.75	-1.85	↑ ↑ ↖ → → ↗ ↓ ↓ ↘	**←**
as_b4i3	0.25	4.02	→ ← ↓ ↙ ← ↓ ↑ ← ↓	**↘**
as_b1i4	0.51	-1.56	↙ ↖ ↖ ↗ ↗ ↘ ↘ ↙ ↙	**↖**
as_b1i16	0.87	0.41	↓ ↙ ↓ ← ↖ ← ↑ ↗ ↑ →	**↘**
as_b2i13	0.44	-2.70	← ← ↓ → ↑ ↑ ← ↓ → → ↑ ← ↓ ↓	**→**
as_b3i4	0.43	-3.02	↓ ↘ ← ↙ ↑ ↖ → ↗ ↓	**↘**
as_b3i16	0.44	-1.85	→ ↘ ↑ ↓ ↙ → ← ↖ ↓	**↑**
as_b2i12	0.99	0.15	↓ ↗ ↗ ↙ ← ↘ ↘ ↖ ↑ ↙ ↙ ↗ →	**↖**
as_b2i15	0.90	2.04	↗ ↓ ↙ ↘ ↘ ← ↖ ↘ ↙ ↑ ↗ ↘	**↖**
as_b1i15	0.40	-1.23	↑ ↗ ← → ↘ ↑ ↓ ↙ →	**←**
as_b2i2	0.73	1.32	↖ ↑ ↗ ↗ ↑ ↗ ↘ ↑ ↗	**↙**

Figure-Letter Series Composite Test Scaled Score Concordance Tables

Raw Score	Form 1		Form 2		"Best of" Single Form	
	Scale Score	SE	Scale Score	SE	Scale Score	SE
0	-2.95	0.82	-2.96	0.74	-2.96	0.80
1	-2.72	0.85	-2.71	0.77	-2.71	0.83
2	-2.47	0.87	-2.43	0.80	-2.45	0.85
3	-2.21	0.87	-2.13	0.80	-2.17	0.85
4	-1.94	0.87	-1.84	0.79	-1.88	0.84
5	-1.66	0.86	-1.54	0.78	-1.60	0.82
6	-1.38	0.84	-1.25	0.76	-1.31	0.80
7	-1.10	0.82	-0.97	0.75	-1.03	0.78
8	-0.83	0.81	-0.70	0.73	-0.76	0.76
9	-0.55	0.79	-0.43	0.72	-0.49	0.74
10	-0.29	0.78	-0.17	0.71	-0.23	0.73
11	-0.02	0.76	0.09	0.70	0.03	0.71
12	0.25	0.75	0.34	0.70	0.29	0.70
13	0.51	0.75	0.60	0.69	0.54	0.70
14	0.78	0.74	0.85	0.69	0.80	0.69
15	1.04	0.74	1.10	0.69	1.05	0.69
16	1.31	0.75	1.36	0.70	1.31	0.69
17	1.58	0.75	1.62	0.71	1.57	0.70
18	1.85	0.76	1.89	0.72	1.83	0.71
19	2.13	0.78	2.16	0.73	2.10	0.72
20	2.42	0.79	2.44	0.74	2.38	0.74
21	2.72	0.81	2.73	0.76	2.67	0.75
22	3.02	0.83	3.03	0.78	2.96	0.78
23	3.33	0.86	3.34	0.81	3.27	0.80
24	3.65	0.88	3.66	0.83	3.59	0.83
25	3.98	0.91	4.00	0.86	3.93	0.86
26	4.32	0.94	4.34	0.90	4.28	0.89
27	4.66	0.96	4.70	0.93	4.64	0.92
28	5.01	0.98	5.07	0.95	5.00	0.95
29	5.36	0.99	5.41	0.96	5.36	0.97
30	5.69	0.99	5.73	0.96	5.70	0.97

Appendix H: Number-Letter Series Composite Materials

Number-Letter Series Composite Test Items, Item Parameters, and Answer Key
Parallel Form 1

Item Label	Disc.	Diff.	Item	Key
ls_f15i2	1.23	-0.15	B, N, W, D, P, Y, F, R, A, H, T,	**C**
ls_f08i6	1.10	-1.97	Y, Y, L, A, A, N, C, C, P, E, E,	**R**
ls_f06i1	1.23	-0.42	N, I, B, I, P, I, D, I, R, I, F, I, T, I,	**H**
ls_f08i3	1.26	-1.75	O, O, I, Q, Q, K, S, S, M, U, U,	**O**
ls_f01i3	0.56	-3.14	V, G, X, G, Z, G, B,	**G**
ls_f14i2	1.42	0.12	L, B, F, S, N, D, H, S, P, F, J, S, R, H, L, S, T,	**J**
ls_f07i1	0.99	-1.58	V, V, F, X, X, H, Z, Z, J, B, B, L, D, D,	**N**
ls_f08i2	1.49	-0.66	U, F, R, W, H, R, Y, J, R, A,	**L**
ls_f08i4	1.11	-2.24	L, L, F, N, N, H, P, P, J, R, R, L, T, T,	**N**
ls_f01i2	0.77	-2.42	T, S, V, S, X, S, Z, S, B, S,	**D**
ls_f06i6	1.05	-1.76	F, F, C, H, H, E, J, J, G, L, L,	**I**
ls_f13i1	1.40	-0.78	N, N, F, S, P, P, H, U, R, R, J, W, T, T,	**L**
ls_f07i2	1.26	-1.55	R, R, W, T, T, Y, V, V, A, X, X, C, Z, Z,	**E**
ls_f15i4	1.46	-0.01	G, W, A, I, Y, C, K, A, E, M,	**C**
ls_f9i2	1.61	-0.61	X, J, P, Z, L, P, B, N, P, D,	**P**
nst_f03i2	0.97	1.45	2 4 5 8 12 19 30 48	**77**
nst_f02i5	0.36	2.95	9 19 30 34 42 49 63 73	**84**
nst_f08i3	1.07	1.36	16 20 27 29 38 49 60 73	**79**
nn_f03i8	0.51	3.82	15 17 18 21 25 32 43 61	**90**
nst_f01i1	0.61	-1.04	10 11 13 17 25 32 37 47	**58**
nn_f03i6	0.51	2.47	12 12 13 14 16 19 24 32	**45**
nst_f08i2	0.78	2.03	6 10 16 17 24 32 38 43	**54**
nst_f06i2	0.44	2.05	58 43 30 23 20 15 13 7	**3**
nn_f03i10	0.43	4.88	13 15 16 19 23 30 41 59	**88**
nn_f08i12	1.35	0.94	12 20 23 25 30 37 40 50	**54**
nst_f06i6	0.98	1.80	62 51 43 37 30 20 17 15	**7**
nn_f08i10	0.98	1.34	11 20 22 24 28 34 44 51	**59**
nn_f02i8	0.33	3.41	8 18 29 42 50 57 71 81	**92**
nst_f03i1	0.72	1.98	2 3 4 6 9 14 22 35	**56**
nn_f08i9	0.50	2.19	3 5 8 13 21 25 28 35	**45**

Number-Letter Series Composite Test Items, Item Parameters, and Answer Key Parallel Form 2				
Item Label	**Disc.**	**Diff.**	**Item**	**Key**
ls_f12i1	0.87	-2.75	D, D, T, L, F, F, V, N, H, H, X, P, J,	**J**
ls_f07i3	1.42	-0.18	I, E, B, E, K, E, D, E, M, E, F, E, O, E,	**H**
ls_f11i2	1.59	-0.15	N, A, A, U, P, C, C, W, R, E, E, Y, T, G, G,	**A**
ls_f05i5	1.10	-1.62	Y, P, A, R, C, T, E, V, G, X, I,	**Z**
ls_f07i5	1.22	-2.08	F, F, O, H, H, Q, J, J, S, L, L,	**U**
ls_f11i3	1.36	-0.50	P, P, B, L, R, R, D, N, T, T, F, P, V, V, H,	**R**
ls_f05i3	1.19	-1.44	X, E, Z, G, B, I, D, K, F, M,	**H**
ls_f01i4	0.90	-2.66	J, Q, L, Q, N, Q, P, Q, R, Q,	**T**
ls_f12i5	1.16	-1.15	F, F, R, V, H, H, T, X, J, J, V, Z, L, L,	**X**
ls_f15i5	1.31	-1.01	T, C, L, V, E, N, X, G, P, Z,	**I**
ls_f01i5	0.77	-3.39	Z, U, B, U, D, U, F, U, H, U,	**J**
ls_f02i1	0.72	-1.70	T, C, V, C, X, C, Z, C,	**B**
ls_f08i1	1.48	-0.28	B, M, N, D, O, N, F, Q, N, H,	**S**
ls_f06i4	1.01	-1.22	R, Q, B, Q, T, Q, D, Q, V, Q, F, Q, X, Q,	**H**
ls_f14i3	1.48	-0.02	L, T, D, N, V, F, P, X, H, R, Z,	**J**
nn_f06i8	1.00	1.32	87 73 58 48 35 23 15 10	**4**
nn_f08i11	0.69	1.29	15 18 24 33 39 45 57 66	**78**
nst_f06i5	0.63	2.01	65 50 39 34 22 15 11 5	**3**
nst_f08i4	0.79	1.75	26 32 40 45 49 58 71 84	**92**
nst_f02i4	0.49	4.31	13 18 28 39 52 60 67 81	**91**
nn_f06i11	0.73	2.43	92 75 64 52 42 35 29 21	**10**
nn_f08i8	0.74	1.32	7 11 18 20 29 31 42 46	**52**
nn_f06i9	0.67	0.81	70 62 55 47 37 26 16 8	**1**
nn_f03i13	0.69	2.62	4 6 7 10 14 21 32 50	**79**
nn_f08i13	0.53	0.86	12 19 22 32 36 41 50 55	**60**
nn_f06i12	0.84	1.54	88 74 58 47 34 23 16 11	**4**
nst_f03i5	0.61	3.30	21 22 23 25 28 33 41 54	**75**
nst_f9i6	0.56	4.09	11 12 14 18 26 33 38 48	**59**
nst_f01i4	0.80	1.03	13 17 25 32 37 47 58 71	**79**
nn_f06i13	1.18	1.46	74 66 55 43 33 26 20 12	**10**

Number-Letter Series Composite Test Items, Item Parameters, and Answer Key "Best of" Test Form				
Item Label	**Disc.**	**Diff.**	**Item**	**Key**
ls_f13i1	1.40	-0.78	N, N, F, S, P, P, H, U, R, R, J, W, T, T,	**L**
ls_f06i4	1.01	-1.22	R, Q, B, Q, T, Q, D, Q, V, Q, F, Q, X, Q,	**H**
ls_f02i3	1.03	-1.11	B, J, Q, E, J, Q, H, J, Q, K, J, Q, N, J, Q,	**Q**
ls_f05i5	1.10	-1.62	Y, P, A, R, C, T, E, V, G, X, I,	**Z**
ls_f08i1	1.48	-0.28	B, M, N, D, O, N, F, Q, N, H,	**S**
ls_f9i6	1.41	-0.88	F, K, B, H, M, B, J, O, B, L,	**Q**
ls_f12i1	0.87	-2.75	D, D, T, L, F, F, V, N, H, H, X, P, J,	**J**
ls_f06i6	1.05	-1.76	F, F, C, H, H, E, J, J, G, L, L,	**I**
ls_f14i2	1.42	0.12	L, B, F, S, N, D, H, S, P, F, J, S, R, H, L, S, T,	**J**
ls_f9i3	1.30	-0.93	C, U, O, E, W, O, G, Y, O, I,	**A**
ls_f07i1	0.99	-1.58	V, V, F, X, X, H, Z, Z, J, B, B, L, D, D,	**N**
ls_f01i2	0.77	-2.42	T, S, V, S, X, S, Z, S, B, S,	**D**
ls_f11i2	1.59	-0.15	N, A, A, U, P, C, C, W, R, E, E, Y, T, G, G,	**A**
ls_f04i3	0.92	-1.21	P, J, R, L, T, N, V, P, X, R,	**Z**
ls_f06i2	1.23	-0.09	G, Y, L, Y, I, Y, N, Y, K, Y, P, Y, M, Y,	**R**
nn_f08i8	0.74	1.32	7 11 18 20 29 31 42 46	**52**
nst_f06i2	0.44	2.05	58 43 30 23 20 15 13 7	**3**
nn_f08i12	1.35	0.94	12 20 23 25 30 37 40 50	**54**
nn_f02i8	0.33	3.41	8 18 29 42 50 57 71 81	**92**
nst_f01i1	0.61	-1.04	10 11 13 17 25 32 37 47	**58**
nst_f02i5	0.36	2.95	9 19 30 34 42 49 63 73	**84**
nn_f03i6	0.51	2.47	12 12 13 14 16 19 24 32	**45**
nst_f08i3	1.07	1.36	16 20 27 29 38 49 60 73	**79**
nn_f03i13	0.69	2.62	4 6 7 10 14 21 32 50	**79**
nn_f08i13	0.53	0.86	12 19 22 32 36 41 50 55	**60**
nn_f06i11	0.73	2.43	92 75 64 52 42 35 29 21	**10**
nst_f08i2	0.78	2.03	6 10 16 17 24 32 38 43	**54**
nst_f03i1	0.72	1.98	2 3 4 6 9 14 22 35	**56**
nst_f01i4	0.80	1.03	13 17 25 32 37 47 58 71	**79**
nn_f03i11	0.72	2.92	6 7 9 12 17 25 38 59	**93**

Appendix I: Figure-Number-Letter Series Composite Materials

Figure-Number-Letter Series Composite Test Items, Item Parameters, and Answer Key
Parallel Form 1

Item Label	Disc.	Diff.	Item																Key
as_b1i16	0.87	0.41	↓	↙	↓	←	↖	←	↑	↗	↑	→							↘
as_b1i2	0.70	-1.12	↓	↖	↘	←	↖	↘	↑	↖	↘								→
as_b1i4	0.51	-1.56	↙	↖	↖	↗	↗	↘	↘	↙	↙								↖
as_b2i1	0.38	-3.67	↓	→	←	→	↑	→	→	→									↓
as_b2i12	0.99	0.15	↓	↗	↗	↙	←	↘	↘	↖	↑	↙	↙	↗	→				↖
as_b2i13	0.44	-2.70	←	←	↓	→	↑	↑	←	↓	→	→	↑	←	↓	↓			→
as_b2i4	0.53	-2.03	←	→	↑	↓	→	←											↓
as_b3i10	1.02	-1.29	↑	↙	↗	→	↖	↗	↓	↗	↗								←
as_b3i3	0.55	1.96	↑	↓	↑	↘	↓	↑	←	↓	↑								↗
as_b4i11	0.19	4.24	→	↓	↓	←	↓	←	←	↑	←	↑	↑	→					↑
as_b4i3	0.25	4.02	→	←	↓	↙	←	↓	↑	←	↓								↘
as_b5i11	0.37	2.59	↖	←	←	↓	↗	↑	↑	←	↘	→	→	↑					↙
as_b5i13	0.84	-1.08	↖	↖	↘	↑	↗	↗	↙	→	↘	↘	↖	↓					↙
as_b5i15	0.45	3.08	↙	←	→	↖	↖	↑	↓	↖	↗	→	←	↖					↘
as_b5i7	0.50	0.79	↖	←	↙	←	↗	←	↖	←	↘	←	↗	←					↙
ls_f01i2	0.77	-2.42	T	S	V	S	X	S	Z	S	B	S							D
ls_f01i5	0.77	-3.39	Z	U	B	U	D	U	F	U	H	U							J
ls_f02i2	0.76	-1.42	N	U	S	P	U	S	R	U	S	T	U						S
ls_f02i3	1.03	-1.11	B	J	Q	E	J	Q	H	J	Q	K	J	Q	N	J	Q		Q
ls_f02i4	0.32	-4.56	Z	X	B	X	D	X	F										X
ls_f03i1	1.11	-0.27	Z	D	L	C	D	L	F	D	L	I	D	L	L	D	L		O
ls_f04i6	1.16	-1.07	C	L	E	N	G	P	I	R	K	T	M	V	O	X			Q
ls_f06i3	1.10	-0.21	Y	W	H	W	A	W	J	W	C	W	L	W	E	W			N
ls_f06i4	1.01	-1.22	R	Q	B	Q	T	Q	D	Q	V	Q	F	Q	X	Q			H
ls_f07i1	0.99	-1.58	V	V	f	X	X	H	Z	Z	J	B	B	L	D	D			N
ls_f07i5	1.22	-2.08	F	F	O	H	H	Q	J	J	S	L	L						U
ls_f11i2	1.59	-0.15	N	A	A	U	P	C	C	W	R	E	E	Y	T	G	G		A

ls_f11i4	1.18	-0.31	P	V	V	M	R	X	X	O	T	Z	Z	Q	V	B	B	S		X
ls_f13i1	1.40	-0.78	N	N	F	S	P	P	H	U	R	R	J	W	T	T				L
ls_f15i2	1.23	-0.15	B	N	W	D	P	Y	F	R	A	H	T							C
nn_f03i13	0.69	2.62	4	6	7	10	14	21	32	50										79
nn_f03i6	0.51	2.47	12	12	13	14	16	19	24	32										45
nn_f06i8	1.00	1.32	87	73	58	48	35	23	15	10										4
nst_f01i4	0.80	1.03	13	17	25	32	37	47	58	71										79
nst_f02i4	0.49	4.31	13	18	28	39	52	60	67	81										91
nst_f04i3	0.58	4.64	10	11	3	5	8	4	3	7										1
nst_f06i5	0.63	2.01	65	50	39	34	22	15	11	5										3
nst_f08i3	1.07	1.36	16	20	27	29	38	49	60	73										79
nst_f08i4	0.79	1.75	26	32	40	45	49	58	71	84										92
nst_f08i5	1.01	1.89	21	28	31	41	45	50	59	64										78

Figure-Number-Letter Series Composite Test Items, Item Parameters, and Answer Key
Parallel Form 2

Item Label	Disc.	Diff.	Item																	Key
as_b1i15	0.40	-1.23	↑	↗	←	→	↘	↑	↓	↙	→									←
as_b1i5	0.60	0.63	↙	↖	←	↖	↖	↖	↑	↖	↗	↖	→	↖						↘
as_b1i7	0.73	0.23	↓	↙	↑	↙	←	↙	→	↙	↑	↙	↓	↙						→
as_b2i16	0.54	-1.22	↗	→	↙	↘	↓	↖	↙	←	↗	↖								↑
as_b2i3	1.19	1.98	↗	↙	↑	↓	↙	↑	↖	↙	↑									→
as_b2i6	1.11	1.52	↗	↙	←	↙	↘	↙	↑	↙	↙	↙	→	↙						↖
as_b2i9	0.75	-0.45	↓	↙	↖	←	↖	↖	↑	↗	↖									→
as_b3i15	0.61	-1.17	↘	←	↗	↙	↑	↘	↖	→	↙	↗								↓
as_b3i6	0.90	1.28	↑	→	↖	→	→	→	↗	→	↓	→	↘	→						←
as_b3i7	1.27	-1.66	↘	↘	↑	↙	↙	→	↖	↖	↓	↗	↗							←
as_b3i9	0.97	-1.85	↗	↗	←	↘	↘	↑	↙	↙	→	↖	↖							↓
as_b4i10	0.54	-0.10	↗	↖	←	↘	↗	←	↙	↘	←									↖
as_b4i8	0.41	-3.66	↓	↓	↗	←	←	↘	↑	↑	↙									→
as_b4i9	0.52	-0.05	↑	→	↙	→	↓	↙	↓	←	↙									←
as_b5i4	0.48	-2.05	↑	↓	→	←	↓	↑												←
ls_f03i5	0.29	-1.01	D	X	P	A	X	P	X	X	P	U	X	P	R					X
ls_f04i3	0.92	-1.21	P	J	R	L	T	N	V	P	X	R								Z
ls_f04i4	0.98	-0.34	Y	R	A	T	C	V	E	X	G	Z	I							B
ls_f05i3	1.19	-1.44	X	E	Z	G	B	I	D	K	F	M								H
ls_f05i4	1.16	-0.67	L	V	C	V	N	V	E	V	P	V	G	V	R	V				I
ls_f06i2	1.23	-0.09	G	Y	L	Y	I	Y	N	Y	K	Y	P	Y	M	Y				R
ls_f07i2	1.26	-1.55	R	R	W	T	T	Y	V	V	A	X	X	C	Z	Z				E
ls_f08i3	1.26	-1.75	O	O	I	Q	Q	K	S	S	M	U	U							O
ls_f08i6	1.10	-1.97	Y	Y	L	A	A	N	C	C	P	E	E							R
ls_f10i1	0.74	-1.19	Z	I	I	G	B	K	K	I	D	M	M	K	F	O				O
ls_f11i3	1.36	-0.50	P	P	B	L	R	R	D	N	T	T	F	P	V	V	H			R
ls_f12i5	1.16	-1.15	F	F	R	V	H	H	T	X	J	J	V	Z	L	L				X
ls_f14i2	1.42	0.12	L	B	F	S	N	D	H	S	P	F	J	S	R	H	L	S	T	J

ls_f14i3	1.48	-0.02	L	T	D	N	V	F	P	X	H	R	Z						J
ls_f9i2	1.61	-0.61	X	J	P	Z	L	P	B	N	P	D							P
nn_f02i8	0.33	3.41	8	18	29	42	50	57	71	81									92
nn_f06i11	0.73	2.43	92	75	64	52	42	35	29	21									10
nn_f06i12	0.84	1.54	88	74	58	47	34	23	16	11									4
nn_f08i11	0.69	1.29	15	18	24	33	39	45	57	66									78
nn_f08i13	0.53	0.86	12	19	22	32	36	41	50	55									60
nn_f08i9	0.50	2.19	3	5	8	13	21	25	28	35									45
nst_f02i5	0.36	2.95	9	19	30	34	42	49	63	73									84
nst_f06i2	0.44	2.05	58	43	30	23	20	15	13	7									3
nst_f07i1	0.70	3.78	10	6	7	13	11	6	8	14									13
nst_f08i2	0.78	2.03	6	10	16	17	24	32	38	43									54

Figure-Number-Letter Series Composite Test Scaled Score Concordance Tables

Raw Score	Form 1 Scale Score	Form 1 SE	Form 2 Scale Score	Form 2 SE
0	-4.520	0.807	-4.399	0.810
1	-4.280	0.848	-4.140	0.839
2	-4.009	0.874	-3.853	0.852
3	-3.715	0.884	-3.551	0.849
4	-3.408	0.880	-3.244	0.834
5	-3.098	0.865	-2.942	0.813
6	-2.791	0.846	-2.648	0.790
7	-2.491	0.824	-2.365	0.769
8	-2.199	0.804	-2.091	0.750
9	-1.916	0.785	-1.827	0.733
10	-1.640	0.769	-1.570	0.719
11	-1.372	0.754	-1.321	0.708
12	-1.109	0.742	-1.077	0.698
13	-0.852	0.732	-0.837	0.691
14	-0.599	0.724	-0.601	0.686
15	-0.349	0.719	-0.367	0.683
16	-0.101	0.715	-0.135	0.682
17	0.146	0.714	0.096	0.682
18	0.393	0.714	0.328	0.685
19	0.640	0.717	0.561	0.689
20	0.889	0.722	0.795	0.694
21	1.140	0.729	1.032	0.702
22	1.393	0.737	1.272	0.711
23	1.650	0.748	1.515	0.721
24	1.911	0.760	1.762	0.732
25	2.176	0.773	2.014	0.745
26	2.446	0.788	2.270	0.759
27	2.722	0.805	2.531	0.774

28	3.003	0.822	2.799	0.789
29	3.291	0.841	3.073	0.806
30	3.586	0.861	3.355	0.824
31	3.888	0.882	3.645	0.842
32	4.195	0.903	3.944	0.861
33	4.509	0.924	4.251	0.881
34	4.826	0.942	4.568	0.901
35	5.143	0.955	4.892	0.919
36	5.456	0.959	5.220	0.932
37	5.758	0.951	5.547	0.935
38	6.041	0.928	5.865	0.924
39	6.299	0.892	6.163	0.897
40	6.529	0.843	6.432	0.852