

 $\langle R02140017 \rangle$ 

### 注意事項

- 1. この科目では、この問題用紙のほかに、マーク解答用紙を配布します。
- 2. 試験開始の指示があるまで、問題冊子および解答用紙には手を触れないでください。
- 3. 問題は2 ~ 11 ページに記載されています。試験中に問題冊子の印刷不鮮明、ページの落丁・乱丁及び解答用紙の 汚損等に気付いた場合は、手を挙げて監督員に知らせてください。
- 4. 解答はすべて、HBの黒鉛筆またはHBのシャープペンシルで記入してください。
- 5. マーク解答用紙記入上の注意
- (1) 印刷されている受験番号が、自分の受験番号と一致していることを確認したうえで、氏名欄に氏名を記入して ください。
- (2) マーク欄にははっきりとマークすること。また、訂正する場合は、消しゴムで丁寧に、消し残しがないようによく消してください。

マークする時	●良い	●悪い	◎悪い
マークを消す時	<b>O</b> 良い	●悪い	●悪い

- 6. 解答はすべて所定の解答欄に記入してください。所定の欄以外に受験番号・氏名を記入した解答用紙は採点の対象 外となる場合があります。
- 7. 試験終了の指示が出たら、すぐに解答をやめ、筆記用具を置き解答用紙を裏返しにしてください。
- 8. 問題冊子は持ち帰ってください。
- 9. いかなる場合でも、解答用紙は必ず提出してください。

# Part I. Read Text I, Text II, and Text III and choose the best option from a - d for questions 1 - 15.

### Text I

[1] Air transportation is the safest form of transportation per kilometer travelled. In the rare case of an accident, however, the results are often devastating. Accidents in aviation rarely have a single cause, and human errors are involved in the majority of them.

[2] In road transport, the link between human error and fatigue has been established in several studies. The main causes of sleepiness and fatigue are 1) circadian\* phase, 2) time awake, and 3) amount of prior sleep. In addition, time on task may induce fatigue when involving sustained attention. Individual differences are likely to play a role in sleepiness and fatigue related accidents, driving performance, as well as modify sleep length and performance during sleep deprivation. Individual differences in the circadian type are among the most systematically studied with several rating scales developed to assess an approximate phase in individuals.

[3] Also in aviation, human errors and improper decision-making are influenced by sleepiness and fatigue. Irregular working hours, working hours at inconvenient times of day, as well as frequent time zone crossings, characterize work life in aviation and all have a negative impact on alertness and may increase the risk of accidents.

[4] The problem of fatigue in pilots is almost as old as aviation itself. It was, however, not until the 1980s that Samn and Perelli (1982) developed a fatigue scale in order to subjectively measure fatigue levels in pilots, starting the investigation of the effect of multiple time zone crossings on pilot fatigue. Since then, several factors have been shown to play a role in pilot fatigue and performance, including the highly automated work environment of the cockpit, flying at night as well as flight duration, although it has been reported to be equally severe in short haul, as in long haul operations.

[5] One way of counteracting fatigue in aircrew is through flight and duty time limitations. However, regulatory bodies are currently discussing how to incorporate sleep and performance science directly into <u>their</u> fatigue risk management systems by means of bio-mathematical sleepiness and fatigue modeling. Several such models have been introduced over the past decades. Briefly, those include the two process model (2PM), the three process model of alertness (TPM, the subject of the present paper), the system for aircrew fatigue evaluation (SAFE), the interactive neurobehavioral model (INM), the sleep, activity, fatigue, and task effectiveness model (SAFTE), the fatigue audit inter dyne (FAID), and the circadian alertness simulator (CAS).

[6] The key processes in those models (except FAID) include, although with different parameters: 1) a homeostatic\* process that describes the decline of alertness with time awake and its recovery with time asleep 2) a circadian process that describes the diurnal\* variation in alertness 3) a sleep inertia process that describes the delay after wake up before alertness resumes. In addition, some models estimate the decline of alertness with time on task (SAFE, FAID, and CAS). As the generated fatigue output, most models predict subjective alertness, except SAFTE (predicting performance effectiveness) and FAID (predicting violations based on risk threshold levels).

[7] As Matschnigg et al. (2011) state: "An important question to ask about any model is whether it has been validated against fatigue data from operations similar to those that you are interested in." To our knowledge, the only model that has been extensively validated in many occupational settings is the TPM, though the present study is the first attempt to validate it on aircrew. Many shift work studies have shown accurate alertness predictions at the group level. Although SAFE and SAFTE are specifically developed for use in aviation, those models still lack peer-reviewed validation.

[Adapted from Ingre, M., Van Leeuwen, W., Klemets, T., Ullvetter, C., Hough, S., Kecklund, G., Karlsson, D., & Torbjörn, Å. (2014) Validating and Extending the Three Process Model of Alertness in Airline Operations. *PLoS ONE* 9(10): e108679.]

\*circadian – showing a natural, internal process that regulates the sleep-wake cycle

\*homeostatic - relating to the ability to adjust one's internal environment to maintain a state of dynamic constancy

\*diurnal - daily

### Questions 1 - 9 refer to Text I.

- 1. How is aviation described, as compared to road transport?
  - a. It is much safer because pilots are less influenced by fatigue than drivers.
  - b. Human errors are frequently the sole cause of accidents in aviation as well as road transport.
  - c. It is much safer, but accidents are typically disastrous when they occur.
  - d. Working time determines pilot performance, while sleep length determines driving performance.
- 2. What do the authors imply about research on fatigue before the 1980s?
  - a. Flight duration was proven to be equally influential in short and long-haul flights.
  - b. The highly automated work environment of the cockpit was shown to contribute to accidents.
  - c. Multiple time zone crossings had been demonstrated as being an influential factor.
  - d. Researchers had not developed any formal models of fatigue.
- 3. In paragraph [5], what does their refer to?
  - a. limitations c. regulatory bodies
  - b. sleep and performance science d. aircrew
- 4. What do 2PM, TPM, SAFE, INM, SAFTE, and CAS have in common?
  - a. They include a cycle of alertness variation.
  - b. They predict subjective alertness.
  - c. They predict sleep duration.
  - d. They include risk threshold levels.
- 5. Which of the three processes below (described in paragraph [6]) depend(s) on the amount of time since waking up?
  - 1) the homeostatic process2) the circadian process3) the sleep inertia process
  - a. 1, 2, and 3 b. 1 and 3 only c. 2 and 3 only d. 1 only
- 6. Based on the information in the text, which of the following most clearly models pilots losing their concentration to a dangerous degree over the course of a flight?
  - a. 2PM b. TPM c. FAID d. INM
- 7. Which of the following is explicitly contradicted by the text?
  - a. Car, truck, and bus drivers are not affected by irregular work hours.
  - b. Several mathematical models of sleepiness have been introduced for use in the aviation industry.
  - c. The authors believe it is important to test theories in situations as close to real life as possible.
  - d. There has not been much study of how people differ from each other in their circadian cycles.
- 8. Which of the following is the most likely reason that the authors have focused on TPM in their paper?
  - a. TPM is the only model that encompasses three key processes in fatigue.
  - b. TPM outputs an objective but not a subjective prediction of alertness in pilots.
  - c. TPM has been widely tested in a variety of different work situations.
  - d. TPM is crucially based on circadian phase, time awake, and amount of prior sleep.
- 9. How is the present paper unique?
  - a. It is focused exclusively on TPM.
  - b. It compares TPM with other models of fatigue.
  - c. It is the first to evaluate TPM with aircraft crews.
  - d. It attempts to provide peer-reviewed validation for several models of fatigue.

## Text II(This text is a direct continuation from Text I.)

[8] Since its inception in 1990, the TPM has been extended with an extra component modeling a 12 h ultradian process and a "brake" function that modifies homeostatic recovery during sleep. The added predictive power of these modifications have, however, not been properly validated on empirical data. In addition, the TPM has also used several different linear transfer functions between the internal alertness score and empirical data using the Karolinska Sleepiness Scale that may give very different levels of sleepiness as the output. The TPM has also been extended with a model based sleep generator that can be used to insert sleep periods into the data when such data is not available. This sleep generator has been shown to predict sleep reasonably well in one specific compressed shift sequence but has otherwise not been validated.

[9] A main objective of the present study was to validate the TPM on a group of aircrew in real life situations, using observed sleep and sleepiness data. Our second objective with the present study was to extend the model with estimates of individual differences and probability of sleepiness for ecological estimates of risk. The circadian system is a large source of individual differences that may be of particular importance for aircrews that often travel across several time zones and become exposed to jetlag. Our third objective was to explore the feasibility of adjustment of the circadian phase according to circadian type and acclimatization to a different time zone for improved predictions of aircrews.

[Adapted from Ingre, M., Van Leeuwen, W., Klemets, T., Ullvetter, C., Hough, S., Kecklund, G., Karlsson, D., & Torbjörn, Å. (2014) Validating and Extending the Three Process Model of Alertness in Airline Operations. *PLoS ONE* 9(10): e108679.]

### Questions 10 - 12 refer to Text I and Text II.

- 10. Which of the following is TRUE of paragraph [8]?
  - a. It describes how TPM is superior to the other models listed and described in paragraphs [5]-[6].
  - b. It criticizes the various ways that TPM has been validated relative to the processes in paragraph [6].
  - c. It explains that research on TPM can be improved in a way also mentioned in paragraph [7].
  - d. It shows how TPM satisfies some of the fatigue problems outlined in paragraph [4].
- 11. Which of the authors' three objectives described in paragraph [9] is most directly associated with the main issue raised in paragraph [7]?
  - a. their main objective c. their second objective
  - b. their third objective d. cannot be determined from the texts
- 12. The paragraphs in Text I and Text II can be grouped into three parts: Part A = [1][2][3], Part B = [4][5][6], and Part C = [7][8][9]. Which of the following best describes the primary roles of each of these three parts?
  - a. Part A explains how human error causes accidents in air transportation; Part B explains how the FAID model differs from other fatigue models; and Part C explains how TPM is superior to other models.
  - b. Part A describes the transportation industry in detail; Part B introduces some models related specifically to air transportation; and Part C differentiates between TPM and both SAFE and SAFTE models.
  - c. Part A enumerates all of the factors that contribute to sleepiness and fatigue; Part B evaluates models of alertness to show which is best; and Part C explains a key quotation that criticizes the present study.
  - d. Part A introduces the problem of fatigue in transportation; Part B describes several theoretical models of fatigue; and Part C describes why the present research will focus on TPM.

### Text III

Biomathematical fatigue models are designed to take into account a range of factors relating to fatigue and to convert these into simple numerical scores representing fatigue risk. These scores can be used for performing comparisons (of schedules, for instance) or for evaluating a schedule against an upper fatigue limit. However, it is vital to avoid overly simplistic interpretations of the numerical estimates provided by the models.

Specifically, it is essential for any specified upper limit for fatigue scores to be validated in the operational environment in which they are to be used. The failure to validate limits or 'cut-off' scores in this manner could result in practices that undermine the quality of the fatigue risk management system (FRMS) and result in operational staff having minimal confidence in the system. In the worst case overreliance on biomathematical models could result in an FRMS that actually degrades fatigue management (Civil Aviation Safety Authority, 2010).

When a biomathematical model is included in an FRMS, complementary strategies to pro-actively identify and manage fatigue must also be considered. Flight crews and operational decision makers need to be educated to interpret the biomathematical model's output appropriately. The outputs of such models can give the illusion of being precise and quantitative despite the fact that they simply predict a qualitative measure such as subjective fatigue. Education, audits and the use of additional objective measures should ensure that a balanced view of the opportunities and limitations of models is maintained within an organisation's fatigue risk management culture and operational practices. Scores derived from biomathematical fatigue models cannot provide a "green light" for operational safety, but should rather be used as one of a number of risk management controls and complemented, for example, by crew fatigue monitoring and practices for ensuring adequate rest and sleep (Civil Aviation Safety Authority, 2010). Finally the use of a model within an FRMS should be an iterative process, with fatigue measurements, task errors and incident data collected and used to refine both the model and the overall FRMS.

[Adapted from Branford, K., Lowe, A., Hayward, B., Cabon, P. & Folkard S. (2014) *Biomathematical Fatigue Models: Guidance Document*. Australian Government Civil Aviation Safety Authority.]

## Questions 13 - 15 refer to Text I, Text II, and Text III.

- 13. What do all three texts have in common?
  - a. They describe specific models of fatigue and their most relevant factors and use contexts.
  - b. They emphasize that the models alone are not sufficient for controlling the risk of fatigue.
  - c. They emphasize the necessity to test fatigue models in realistic target environments of use.
  - d. They describe the specific investigative goals of their respective research papers.
- 14. Text III is taken from a guidance document provided by the Australian government to its aviation industry. This document is indirectly referenced in Text I or Text II. In which paragraph?
  - a. paragraph [2] b. paragraph [5] c. paragraph [6] d. paragraph [9]
- 15. Which of the following investigative questions is LEAST directly motivated by the texts?
  - a. In aviation accidents that are attributable to pilot fatigue, what proportion of cases were in contexts that had recently undergone an FRMS review?
  - b. Which individuals in a national agency that is responsible for civil aviation safety can best become model aviation pilots and crew?
  - c. How can individual differences in fatigue patterns best be represented in an extended TPM?
  - d. What would be a suitable validation method for uniform standardized testing of any of the models used in an FRMS?

## Part II. Read the passage and rearrange the seven words in 1 - 5 in the correct order. Then choose from a - d the option that contains the third and fifth words.

Real analysis stands as a beacon of stability in the otherwise unpredictable evolution of the mathematics curriculum. Amid the various pedagogical revolutions in calculus, computing, statistics, and data analysis, nearly every undergraduate program continues  $_1(at / to / of / one / least / require / semester)$  real analysis. My own department once challenged this norm by creating a mathematical sciences track that allowed students to replace our two core proof-writing classes  $_2(and / in / like / with / departments / electives / physics)$  computer science. Within a few years, however, we concluded that the pieces did not  $_3(together / in / a / without / analysis / hold / course)$ . Analysis is, at once, a course in philosophy and applied mathematics. It is abstract and axiomatic in nature, but is engaged with the mathematics used by economists and engineers. How then do we teach a successful course to students with such diverse interests and expectations? Our  $_4(for / to / required / analysis / desire / make / study)$  wider audiences must be reconciled with the fact that many students find the subject quite challenging and even a bit intimidating. One unfortunate resolution of this dilemma is to make the course easier by making it less interesting. The omitted material is inevitably what gives analysis its true flavor. A better solution is to find a way to make the more  $_5(and / effort / worth / topics / accessible / advanced / the)$ .

[Adapted from Abbott, S. (2015) Understanding Analysis. Second edition. Springer.]

1. a.	3rd: at	b. 3rd: one	c. 3rd: to	d. 3rd: of
	5th: one	5th: at	5th: of	5th: to
2. a.	3rd: in	b. 3rd: like	c. 3rd: with	d. 3rd: and
	5th: like	5th: in	5th: and	5th: with
3. a.	3rd: course	b. 3rd: without	c. 3rd: together	d. 3rd: in
	5th: without	5th: course	5th: in	5th: together
4. a.	3rd: analysis	b. 3rd: required	c. 3rd: make	d. 3rd: study
	5th: study	5th: make	5th: required	5th: analysis
5. a.	3rd: accessible	b. 3rd: accessible	c. 3rd: topics	d. 3rd: and
	5th: worth	5th: advanced	5th: and	5th: topics

## Part III. Answer the questions in Sections A and B. Section A: Read the text and choose the best option from a - d for questions 1 - 6.

So, here is a prescription for finding a black hole: start by looking for a star whose motion shows it to be a member of a binary star system. If both stars are visible, neither can be a black hole, so focus your attention on just those systems where only (A) star of the pair is visible, even with our most sensitive telescopes.

Being invisible is not enough, however, because a relatively faint star might be hard to see next to the glare of a brilliant companion or if it is hidden from view by dust. And even if the star really is invisible, it could be a neutron star. Therefore, we must also have (I) evidence that the unseen star has a mass too high to be a neutron star and (B) it is a collapsed object—an extremely small stellar remnant.

We can use Kepler's law and our knowledge of the visible star to measure (II) mass of the invisible member of the pair. If the mass is greater than about 3 M<sub>Sun</sub>, then we are likely seeing (or, more precisely, not seeing) a black hole—as long as we can make sure the object really is (III) collapsed star.

If matter falls toward (IV) compact object of high gravity, the material is accelerated to high speed. Near the event horizon of a black hole, matter (C) at velocities that approach the speed of light. As the atoms whirl chaotically toward the event horizon, (D) against each other; internal friction can heat them (E) temperatures of 100 million K or more. Such hot matter emits radiation in the form of flickering Xrays. The last part of our prescription, then, is to look for a source of X-rays associated with the binary system. Since X-rays do not penetrate Earth's atmosphere, such sources must be found using X-ray telescopes in space.

> [Adapted from OpenStax Astronomy, Astronomy. OpenStax CNX. 17 April 2018 http://cnx.org/contents/2e737be8-ea65-48c3-aa0a-9f35b4c6a966@14.3]

1.	Which of the following	best fits in blank A?				
	a. each	b. either	c.	one	d.	the
2.	Which of the following	best fits in blank <b>B</b> ?				
	a. whitch	b. since	c.	where	d.	that
3.	Which of the following	best fits in blank C?				
	a. was moving	b. is moving	c.	had moved	d.	had been moving
4.	Which of the following	best fits in blank D?				
	a. they rub	b. one rubs	c.	it rubs	d.	those rub
5.	Which of the following	best fits in blank E?				
	a. from	b. to	c.	up	d.	at
6.	Which of the blanks I, I	II, III, and IV must be filled	d with	n <i>a</i> or <i>an</i> ?		
	a. I and II	b. I and IV	c.	II and III	d.	III and IV

## Section B: The six paragraphs [A] - [F] below make up a passage but are not properly ordered. Moreover, the five sentences (1) - (5) in paragraph [A] are not properly ordered, either. Read the passage and choose the best option from a - d for questions 7 and 8.

- [A] (1) When a 'standing wave' light pattern is formed in a light-sensitive polymer film, crosslinks between the polymer molecules form selectively in layers, which are separated by other layers in which no crosslinking has occurred; this causes tensile stress to build across the non-crosslinked layers.
  - (2) The authors exposed such layered films to a solvent, which releases the stress by causing crazes to form in the non-crosslinked layers.
  - (3) Light shining on the films is reflected at successive craze layers, leading to interference effects that cause structural coloration.
  - (4) The authors take advantage of a phenomenon that controls a polymer's stress field (the distribution of forces within it that balances external forces), and so controls craze generation.
  - (5) The resulting films therefore contained alternating dense and porous layers, generating periodic variations in the refractive index of the material.

[B] The authors report the production of only a few colours in their work, but a wide range should, in principle, be generated by carefully adjusting the spacing of the alternating layers. The spacing can, in turn, be controlled by altering several factors: the wavelength of light used to produce the layers and the amount of time used to irradiate the films; the type and molecular weight of the polymer; the initial thickness of the film; the type and temperature of the solvent used to produce crazing; and the period of time for which the film is immersed in the solvent.

[C] When a typical transparent, glassy polymer is bent or stretched, partial whitening of the material often occurs just before it cracks or fractures. This unpredictable phenomenon is called crazing, and has generally been seen as something to be avoided. But in a paper in *Nature*, Ito *et al.* report that crazing can be fully controlled, and can be used to endow transparent polymers with colour. Controlled crazing could therefore be developed as the basis of an inkless, high-resolution method for printing colour on various flexible and transparent polymer materials.

[D] Ito *et al.* carried out a series of experiments to investigate the physical mechanism of, and the optimum conditions for, periodic craze formation in various transparent polymer films. The microvoids in crazes are, effectively, tiny cracks, and the authors conclude that the formation of the cracks must be controlled to control the crazing process. Their method is therefore a real triumph: crack-formation processes are much more complex and difficult to manage in amorphous materials (such as polymer films) than in crystalline ones, because the microscopic structures of amorphous materials are more random.

[E] Crazing patterns in polymers form in a direction perpendicular to the applied stress, and consist of interpenetrating, micrometre-scale voids bridged by highly oriented polymer microfibrils. The microvoids and microfibrils in uncontrolled crazes vary widely in size, and reflect a broad range of wavelengths of light—which explains why crazes usually look white. Ito and colleagues have demonstrated that, if crazing is controlled to generate porous layers that alternate with compact, non-porous layers, this can reinforce interference of the light reflected from the different layers, thereby producing specific colours.

[F] Transparent polymers have conventionally been colorized by mixing them with pigments, or by printing pigment-containing ink on polymer surfaces. However, transparent polymers can also be colorized by producing microscopic structures within the materials—an effect known as structural coloration. Structural colours are frequently observed in nature, for example in butterfly wings. Ito and co-workers use crazing as the basis for structural colour.

[Adapted from Ko, S. H. (2019). Crazy colour printing without ink. Nature, 570(7761), 312-313.]

7. Which of the following shows the best (most coherent) sentence order for paragraph [A]?

a.	1-2-3-5-4	b.	3-1-2-4-5	c.	4-1-2-5-3	d.	3-2-5-4-1
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8. Which of the following shows the best (most coherent) paragraph order for the passage?

a. F-C-D-B-E-A b. F-A-C-E-D-B c. C-F-E-A-D-B d. C-B-D-F-E-A

## Part IV. Read the texts in Sections A and B, and answer the questions.

### Section A: Choose the best option from a - d for questions 1 - 5.

We all reason. An argument is a line of reasoning designed to prove a point. The central point of an argument is called the *conclusion*. Each piece of evidence to support the conclusion is called a *premise*. The way in which the premises are combined is called *reasoning*. Consider simple arguments (a) and (b), in which the conclusion is based on two premises:

- (a) All cats are mammals; the blue whale is a mammal; therefore, the blue whale is a cat.
- (b) All birds fly; penguins are birds; therefore, penguins fly.

In both (a) and (b), the conclusion is plainly wrong in the real world. (a) is an example of an *illogical* argument—it is logically *invalid*—since there is a mistake in the reasoning even if the initial premises are true. In some political or business arguments, this kind of flawed logic appears, and it can be much more difficult to be sure of right and wrong. (b), on the other hand, is an example of a *logical* argument—it is logically *valid* since the reasoning itself is sound and the conclusion follows from the initial premises even if they are not true. In logic, a premise does not have to be true, but a false premise can lead to a false conclusion.

One key reason why we make bad decisions is that we unconsciously allow emotions to interfere with our reasoning. Sometimes we have an emotional investment in reaching a particular conclusion that satisfies our personal preferences.

[Adapted from Phillips, C. (2011) Logical Thinking. London: Connections Book Publishing Limited.]

- 1. Which of the following statements is true?
  - a. Logical validity depends on reasoning.
- b. Logic and validity mean the same thing.
- c. Reasoning and logical validity are unrelated.
- d. Logic and validity depend on emotions.
- Which of the following is the correct interpretation of the argument given below? 2. [If a phone is dropped into water, it is ruined; John dropped his phone into a river; therefore John's phone is ruined.]
  - a. It is logically valid.
  - b. It has a flawed logic similar to that of (a) in the text.
  - c. It is logically invalid but makes sense in the real world.
  - d. It is not a good argument because it has an emotional interference.
- Suppose you are a computer specialist in a shop and a customer brings in a computer, requesting virus 3. removal, with the argument given below. What is the most logical response to your customer? [Computer virus x causes symptom v; my computer has symptom v; my computer has virus x; therefore getting rid of virus x from my computer is necessary to remove symptom y.]
  - a. You are right. Virus x is the cause of the problem.
  - b. Getting rid of virus x won't necessarily solve the problem.
  - c. The problem is something other than virus x.
  - d. Symptom *y* attracted virus *x* into your computer.
- Which of the following is the best example of emotions interfering with reasoning? 4.
  - a. Tokyo is the capital of Japan, and my flight lands in Tokyo; so my flight lands in Japan.
  - b. My dog is faithful and lovable. Therefore, dogs make the best pets in the world.
  - c. A lot of people drink soda; therefore soda is good for you.
  - d. Mountains exist; therefore people climb them.
- Which of the following statements about logic is true? 5.
  - a. A logical argument can be made to support a false conclusion.
  - b. An illogical argument may have a conclusion that is true.
  - c. Logic is concerned with how an argument is made, not its content.
  - d. All of the above are true.

### Section B: Choose the best option from a - d for questions 6 - 10.

There is a quantitative tool that allows us to determine at what point we should choose one product or service over a (A) option. Let's look at an example.

Example: For \$1,000, we can buy copying machine #1, which costs 3 cents per copy to operate. We can buy copying machine #2 for only \$800, but it costs 4 cents per copy to operate. At what level of activity (number of copies made) does one option offer a cost advantage (**B**) the other? The formula for this calculation is:

$$N = \frac{FC2 - FC1}{VC1 - VC2}$$

where

N = crossover point,

FC1 = fixed cost of machine #1 (\$1,000),

FC2 = fixed cost of machine #2 (\$800),

VC1 = variable cost of machine #1 (\$0.03), and

VC2 = variable cost of machine #2 (\$0.04).

Fixed costs are those not sensitive to variations in volume. Variable costs are those sensitive to volume. Putting the variables from our hypothetical situation into the formula, we get:

N = (C) units

N, the crossover point, also known as the point of indifference, is equal to the fixed cost (or purchase price) of machine #2 (FC2) minus the fixed cost (or purchase price) of machine #1 (FC1) (D) the variable cost (cost per copy) of machine #1 (VC1) minus the variable cost (cost per copy) of machine #2 (VC2). We can see that, if we were to make exactly (C) copies, (E) which machine we would choose. In practice, the machine with a lower fixed cost would generally be preferred for quantities below the crossover point.

[Adapted from Sobel, M. (1994) The 12-Hour MBA Program, Prentice Hall.]

6	Which of the following b	oest fit	s in the blank labeled	<b>A</b> ?			
	a. buying	b.	competing	c.	matching	d.	qualifying
7	Which of the following b	est fit	s in the blank labeled	<b>B</b> ?			
	a. over	b.	across	c.	through	d.	with
8	Which of the following b	oest fit	s in the two blanks lab	beled	<b>C</b> ?		
	a. 200	b.	2,000	c.	20,000	d.	200,000
9	9 Which of the following best fits in the blank labeled <b>D</b> ?						
	a. added to	b.	subtracted from	c.	multiplied by	d.	divided by
10.	10. Which of the following best fits in the blank labeled E?						
	a. it would serve the p	urpose	e of c. we	wou	ld know exactly		

b. we would be concerned about d. it would make no difference

Part V. Answer the questions.

For questions 1 - 15, two definitions are given with one sample sentence each. Think of a word that matches both definitions and also fits in the blanks in both sentences. Convert each letter of the word into a number 1 to 4 according to the table below: number 1 represents letters a - g, 2 represents h - m, 3 represents n - s, and 4 represents t - z. Then choose the matching sequence of numbers from options a - d. For example, if the word you think of is *wise*, for which the first letter w is given, the remaining letters would be changed into 2 for i, 3 for s, and 1 for e. Hence, the correct answer would be w231.

Number	Letters
1	a, b, c, d, e, f, g
2	h, i, j, k, l, m
3	n, o, p, q, r, s
4	t, u, v, w, x, y, z

- 1. (i) a helpful and useful effect that something has: This new regulation will be of (b) to everyone concerned.
  - (ii) the money you get from an insurance company: The insurance plan will provide substantial cash(b) s to your family in case of your death.
  - a. b132414 b. b231232231 c. b131124 d. b44132141
- 2. (i) to have something as the main part or the only part: True education does not (c) in simply being taught facts.
  - (ii) to be formed from the things mentioned: Our diet (c ) s largely of vegetables.
  - a. c412443 b. c3214 c. c13411242 d. c333234
- 3. (i) to give something to a large number of people: The organization will (d) food to the earthquake victims.
  - (ii) to send goods to stores so that they can be sold: Who will (d ) our products in China?
  - a. d12332322 b. d21344 c. d423111 d. d234321441
- 4. (i) one of several things that cause something: The closure of the factory was the single most important (f ) in the town's decline.
  - (ii) a number that divides into another number exactly: 1, 2, 3, 4, 6, and 12 are the (f) s of 12.
  - a. f3332134 b. f1321 c. f41332 d. f11433

5. (i) to recognize somebody and be able to say who they are: Mary was able to (i) her attacker. (ii) to discover something: The scientists were able to (i) a link between diet and cancer.

- a. *i*13222 b. *i*2444421 c. *i*322 d. *i*1134214
- 6. (i) a person or a thing that represents a particular idea or quality: The dove is a (s ) of peace.
  (ii) a letter or a mark that represents something: C is the chemical (s ) for carbon.
  - a. s42132 b. s33411 c. s213421 d. s1413141
- 7. (i) to produce something: The new government program will (g ) a lot of new jobs for young people.
  (ii) to produce a form of energy: Those wind turbines (g ) enough electricity for our community.
  - a. g1313141 b. g322214 c. g434211341 d. g23214112

- 8. (i) a number of people or things that are all different but are all of the same general type: This drug is effective against a wide (r) of bacteria.
  - (ii) the limits within which amounts or quantities vary: These toys are suitable for children in the pre-school age (r).
  - a. r12332 b. r41231 c. r42123 d. r1311
- 9. (i) a planned series of actions for achieving something: We need to devise an effective (*s*) to deal with hate crimes.
  - (ii) a skillful plan: The company must resolve questions about its sales (*s*).
  - a. s31243212 b. s4314114 c. s4121332 d. s32312321
- 10. (i) a way of thinking about something: We have to look at every domestic issue from an international (p ).
  - (ii) a sensible way of judging and comparing situations: It's important to keep things in (p) and not dwell on one particular incident.
  - a. p244311344 b. p1333114241 c. p3433224321 d. p432213321
- 11. (i) a machine or a tool that does a special job: This is our latest (d) for separating metal from garbage.
  - (ii) a method of doing something that produces a particular result: Sending advertisements by email is very successful as a marketing (d).
    - a. d1342113 b. d14211 c. d321224 d. d3422311
- 12. (i) to make something return to its former condition: The government has been promising to (r) the economy to full strength.
  - (ii) to bring back a positive feeling that a person felt before: These measures will (r) public confidence in the educational system.
  - a. r134331 b. r4233112 c. r3234231 d. r21344
- 13. (i) a long piece of writing about a particular subject that you write as part of the requirements for an academic degree: John wrote his graduation (t ) on the recent advances of AI technology.
  - (ii) an idea about something that you discuss in a formal way: Our main (t ) is that the rapid rise in earnings is due to improvements in education.
  - a. t211432 b. t432123 c. t41332 d. t21323
- 14. (i) to treat someone unfairly by asking them to do things for you but giving them very little in return: Employers must not (e) employees.
  - (ii) to use a situation in order to gain as much from it as possible: We need to (e) every opportunity for media coverage.
  - a. e3312411 b. e132133 c. e432324 d. e2442212
- 15. (i) to continue to do something in a determined way: Why do you (p ) in denying that it was your fault?
  (ii) to continue to exist: Call your doctor if the symptoms (p ) for more than three days.
  - a. p133234 b. p4312133 c. p21224 d. p3444221

### [End of Exam]