

**Exam January 24<sup>th</sup> 2013. 8.45-12.15. Sports centre**

**Philosophy of Engineering: Science**

#### **Forms**

- Please fill out on each form: Your name, student number, subject (Philosophy of Engineering: Science), Code: **(191616040B EE and AM, 19161253 PSTS old style, Technolab for PSTS new style, 191616043 others)**. Please mark to which BOZ office this form needs to be send (MSc EE, MSc AM, PSTS, ..)!
- In case you have already passed the Ethics part, please write on the grading form "My mark for ethics was .."
- As the grading will be done by the philosophy and the history teacher, please tear the answering form apart: (1) Use one part for the philosophy questions 1-3, and (2) Use the other part for the history question (question 4).
- Please fill out the evaluation form.

#### **Regulations**

- Turn off your mobile phone etc.
- Place your student card visible on your desk (but don't panic if you have forgotten your card).
- Clear your desk and put all your stuff on the floor (except pen, paper and forms).
- It is not allowed to use books, notes, etc.

#### **When finished: Check and hand in personally**

1. Answer form for Philosophy part.
2. Answer form for History essay.
3. Evaluation form.
4. This questionnaire.

Use a clear handwriting and number your questions! Try to be concise and adequate in your answers, and make full sentences. Give arguments for your answers! Numbers in brackets are points that can be attained ("=number" signifies the total points of that question.) Total: 200 points. [See questions on the back!]. It is allowed to answer in Dutch!

**GOOD LUCK!**

1) Philosophers of science have aimed to articulate scientific methods for attaining true knowledge. Proper scientific reasoning is an important part of scientific methods:

(=50)

- a. Explain the meaning and usefulness of these three (technical) terms in evaluating an argument: true/false, valid/invalid, sound/unsound. (10)
- b. What is deductive reasoning? Present and explain an example of how deductive reasoning works (as a scientific method) in scientific research or in mathematical reasoning. Apply the three technical terms in explaining this example. (10)
- c. What is inductive reasoning (include formal explanation)? Present and explain an example of how inductive reasoning works (as a scientific method) in scientific research (do not use induction in mathematical reasoning). Apply the three technical terms in explaining this example. (10)
- d. Why is inductive inference (e.g., inference to a law of nature) problematic? Can you explain why scientists should be very cautious in applying this way of reasoning (what can go wrong if they do)? How would you deal with this problem in actual research? (10)
- e. Explain the so-called Hypothetico-deductive method of science. Why is it called 'deductive'? Explain by means of a logical analysis why this method is problematic from a logical point of view. Which forms of reasoning can be used in constructing the hypothesis – explain at least two different forms of reasoning that can be involved. (10)

2) Theories (or models) are not only supposed to be true (or empirically adequate), they also must be explanatory. (=50)

- a. In a common understanding of 'truth' (especially truth with a capital T), confusion often arises when *truth* is taken as synonymous with *existence*: a true theory means that it literally tells us what the world is like, i.e., describes what really exists 'out there'. How does Tarski's semantic notion of truth combined with Van Fraassen's notion of empirical adequacy solve this confusion (e.g., it presents us with a better understanding of where and how to apply 'truth')? (20)
- b. Explain what this alternative epistemic criterion means for the way you justify the use of fundamental theories such as Newton or Maxwell's theory? (10)
- c. Can you give an example of a scientific theory or law which you consider to be a good explanation of an observed phenomenon (e.g., the phenomena

observed in Boyle's or Faraday's or other experiments). What is the phenomenon? What is the explanation? What *is* an explanation – why is it explanatory? Develop and analyze your answer to the latter question in light of your answers to (a) and (b) – be very precise by taking small steps in your argument! (20)

- 3) Based on closer study of episodes in the history of science, Kuhn found that revolutionary changes occur in science (e.g., between Aristotle and Newton). (=50)
- a. Explain Kuhn's notion of paradigm (or, disciplinary matrix). Which are the elements of this matrix? Give examples. (10)
  - b. Crosby Smith, in the article called "Energy", describes what can be called a paradigm-shift: a shift of the metaphysical picture (or natural philosophy) from force to energy. Describe this shift in about 200-300 words. (30)
  - c. What is the traditional idea of rationality in science (mention two crucial aspects)? In what respect, according to Kuhn, is this idea of rationality in science untenable (onhoudbaar)? (10)