Eton College King’s Scholarship Examination 2017

GENERAL I

(One and a half hours)

Remember to write your candidate number on every sheet of answer paper used.

You must answer all three questions. Each of the three questions is worth the same number of marks.

Question 1 and 2 should be answered on writing paper. You should start each of these questions on a separate piece of paper. Question 3 should be answered on the question paper.

If you have not finished a question after 30 minutes, you are strongly advised to leave it and go on to another. Return to any unfinished questions if you have time left at the end of the paper.

You are permitted fifteen minutes’ reading time before starting this paper. It is recommended that you use this time to familiarise yourself with the outline of the questions rather than trying to work out any of the answers in detail. You may not write anything during this period.

ADDITIONAL MATERIALS: TWO-PAGE DOUBLE-SIDED A4 INSERT

Do not turn over until told to do so.
Question 1: START A NEW SHEET OF PAPER NOW

THIS QUESTION REFERS TO SOURCES ON THE INSERT

Source 1: 1st example of a possible General I King’s Scholarship Paper Question 1
Source 2: 2nd example of a possible General I King’s Scholarship Paper Question 1

Look at sources 1 and 2 on the insert. These are two imaginary examples of a possible Question 1 for a General I King’s Scholarship Paper.

The following are the criteria for a suitable Question 1 on the General I King’s Scholarship Paper:

This question tests the candidates’ ability to respond to unfamiliar problems in an imaginative way. It requires them to read source material (which may be text or non-text based) closely and carefully, to think analytically and logically, and to advance a clear argument. The question does not have to take a set form, and should have a degree of unpredictability.

Now answer the following question:

Which example of General I Question 1 is better in fulfilling the criteria above, in your opinion – the question on René Magritte, or the question on bitcoin? Explain your reasoning.

[25]

[Total marks for Question 1: 25]
Question 2: START A NEW SHEET OF PAPER NOW

This question looks at how space and time are perceived by people undergoing different motion. All the information required to answer the question is provided in the question.

Newton looked in great detail at the motion of objects. His first law states:
- An object will remain at rest, or moving at a constant speed in a straight line, unless acted upon by a force (a push or a pull)

Consider a spacecraft located in deep space (so there are negligible gravitational forces acting on it). The pilot of the spacecraft is using a pencil and paper to do some calculations. The pilot places the pencil in the air in front of him and releases it so that it is momentarily stationary. The pilot is facing the same direction the spacecraft is moving.

Describe, and explain, how the pencil moves from the perspective of the pilot if the spacecraft is:

a) travelling at a constant speed

b) accelerating (increasing in speed)

The spacecraft is travelling towards a space-station as shown in figure 1 below. An officer on the space-station measures the spacecraft travelling at a constant speed of 30 m/s (meters per second) towards the space-station. The pilot of the spacecraft sends a capsule towards the space-station. The officer on the space-station measures the speed of the capsule to be 40 m/s towards the space-station.

c) How fast is the capsule travelling from the perspective of the pilot of the spacecraft? Explain your answer.

At the start of the 20th century, Einstein made the discovery that:
- Light travels at the same constant speed from the perspective of any observer no matter how fast they are travelling.

d) By considering your answer to part c), explain why this was an unexpected discovery.
The space-station and the spacecraft both have very precise light clocks of identical construction. Time is measured by a photon (a massless particle of light) bouncing between the centres of two perfectly reflective mirrors. Each tick of the clock is the time it takes for the light to travel from one mirror to the other and back again (see figure 2). The distance between the mirrors is 1 m.

![Figure 2: A light clock composed of a photon bouncing between the centres of two mirrors. The mirrors are placed 1 m apart.](image)

The officer on the space-station measures how long one tick of the space-station’s clock takes using a standard clock.

e) If the speed of light is 100 m/s (in reality it is much faster), calculate the time the officer measures.

Figure 3 shows the spacecraft just about to pass the space-station. The clock in the space-station is drawn from the perspective of the officer in the space-station, and the clock in the spacecraft is drawn from the perspective of the pilot of the spacecraft.

![Figure 3: The moment just before the spacecraft passes the space-station. The light clocks are both drawn from the perspective of the observers closest to them.](image)
The officer on the space-station can see into the spacecraft and observe the light clock on the spacecraft as it passes.

f) Explain, with the aid of a diagram, why the spacecraft clock seems to tick more slowly than the space-station clock from the perspective of the officer on the space-station. [Hint: consider the path the officer would see the photon take.]

Einstein also provided an explanation for why objects fall at the same rate when under the influence of gravity. He did this using the following idea:

- A person in a windowless box would not be able to tell if they were stationary in deep space or falling under gravity towards a planet.

For the next parts of the question we will place the light clock on its side as shown in figure 4. A photon still bounces between the centres of the two mirrors.

![Figure 4: An observer is standing in a box with a photon bouncing between the centres of two mirrors placed vertically.](image)

The box is accelerated downwards by applying a rocket to the top of the box. Explain, with the aid of a diagram, the path the photon would take from the perspective of:

h) a stationary observer outside the box and looking in;

i) the observer standing inside the box.

The rocket is removed from the box. The box is moved close to a planet and allowed to fall under gravity directly towards the surface. There are no other forces acting on it. At the moment it is released the photon is bouncing between the centres of the two mirrors.

Explain, with the aid of a diagram, the path the photon would take from the perspective of:

j) the observer in the box;

k) a stationary observer outside the box and looking in.
Question 3: **ANSWER THIS QUESTION ON THE QUESTION PAPER. FILL IN YOUR CANDIDATE NUMBER IN THE SLOTS PROVIDED AT THE TOP OF EACH PAGE.**

Czech is a heavily-inflected language, meaning that nouns have different endings depending on the role they fulfil in a sentence, much like Latin or Greek. Take a look at the information below which lists the “Locative” case of some Czech nouns; this is the form used to say “in” or “at” a place. Some nouns have two locative forms and both are correct. Be aware that letters with markings (such as š, ř and á) are not the same as those without, so “e” is not the same as “ě”.

a) Look at source 3 on the insert. Using the information you have been given in this table, what would you expect to be the ending for the following nominative nouns in the locative case? Write one word for each answer:

<table>
<thead>
<tr>
<th>Nominal Noun</th>
<th>English Meaning</th>
<th>Expected Ending</th>
</tr>
</thead>
<tbody>
<tr>
<td>Česko</td>
<td>(Czech Republic)</td>
<td></td>
</tr>
<tr>
<td>vlak</td>
<td>(train)</td>
<td></td>
</tr>
<tr>
<td>souduřka</td>
<td>(female comrade)</td>
<td></td>
</tr>
<tr>
<td>říjen</td>
<td>(October)</td>
<td></td>
</tr>
<tr>
<td>restaurace</td>
<td>(restaurant)</td>
<td></td>
</tr>
<tr>
<td>město</td>
<td>(city)</td>
<td></td>
</tr>
<tr>
<td>muž</td>
<td>(man, husband)</td>
<td></td>
</tr>
<tr>
<td>kniha</td>
<td>(book)</td>
<td></td>
</tr>
</tbody>
</table>

b) A large number of feminine nouns end in the letter –a. Give four rules that would help somebody to form the locative from a feminine noun ending in –a.

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[8]

[Page 6 of 8]
c) The gender of Czech nouns is often guessable by their ending in the nominative case:

- Nouns ending in a hard consonant (ie. a consonant without any markings like ř, š etc.) tend to be masculine.
- Nouns ending in –a and –e tend to be feminine.
- Nouns ending in –o tend to be neuter.

Use the information from the table in source 3 and the bullet points above to identify the gender of the following nouns which are shown in the locative case. Underline your choice.

<table>
<thead>
<tr>
<th>Rakousku</th>
<th>(Austria)</th>
<th>MASCULINE</th>
<th>FEMININE</th>
<th>NEUTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anglii</td>
<td>(England)</td>
<td>MASCULINE</td>
<td>FEMININE</td>
<td>NEUTER</td>
</tr>
<tr>
<td>kočce</td>
<td>(cat)</td>
<td>MASCULINE</td>
<td>FEMININE</td>
<td>NEUTER</td>
</tr>
<tr>
<td>bleše</td>
<td>(flea)</td>
<td>MASCULINE</td>
<td>FEMININE</td>
<td>NEUTER</td>
</tr>
</tbody>
</table>

Look at source 4 on the insert, which contains phrases written in pre-1917 Russian. They have been transliterated into the Latin script so that you do not have to worry about the Russian alphabet. Please be aware that all small marks are essential to the spelling of the word. This means that ’ / ’ / ͡ etc. are absolutely essential.

d) Write out in Latin script the correct pre-Revolution Russian for:

one old tsarina
three green forests
six good grandfathers
one green chair
e) Three of the expressions in the box below contain a mistake. Although some of the expressions contain new words, the rules governing how they are used are the same. Put a cross next to each sentence that is in error and highlight the error by circling it:

<table>
<thead>
<tr>
<th>Pre-Revolutionary Russian</th>
</tr>
</thead>
<tbody>
<tr>
<td>odna molodya dievushka</td>
</tr>
<tr>
<td>dva novyia tsaritsy</td>
</tr>
<tr>
<td>tri ogromnykh' liesa</td>
</tr>
<tr>
<td>tri novyh' rubli</td>
</tr>
<tr>
<td>dva dobykh' dieedushki</td>
</tr>
<tr>
<td>odin' novyi rubl'</td>
</tr>
<tr>
<td>shest' dobykh' dievushkek'</td>
</tr>
<tr>
<td>mnogie dobyia babushki</td>
</tr>
<tr>
<td>dva starykh' rubli</td>
</tr>
</tbody>
</table>

f) Give **two** ways in which the use of the numbers one, two, three and five differ.

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[Total Marks for Question 3 – 25 MARKS]

END OF PAPER