5 / C: The Taxi Problem

Contents

1 Instructions

Do the preparations first. Then,

Group If you are on-campus, or can otherwise form a group of 3–4, do Variant A.

Solo If you are on your own, read the context in Variant A, then do the guiding questions as outlined in Variant B.

When you are finished, do the Specific Energy/ Energy Density section.

2 Preparations

1. **Stoichiometric calculations**

How would you do each of the following?

(a) Calculate the molar mass of a compound (*e.g.*, $C_2H_{6(g)}$)

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(b) Calculate the number of moles in a compound, given the mass (*e.g.*, 60 g of $C_2H_{6(g)}$)

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(c) Calculate the mass of a certain volume of liquid (*e.g.*, 250 cm^3 of ethanol)

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2. **Enthalpy calculations**

How would you do each of the following?

(a) Find the $\Delta H_c^{\ominus}$ of a "mainstream" compound (*e.g.*, ethanol).

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(b) Find the q from combustion of a certain number of moles of a compound (*e.g.*, 5.0 mol of ethanol)

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(c) Find the $\Delta H_c^{\ominus}$ of a compound that is not in the Data Booklet (*e.g.*, naphthalene).

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3 Variant A: Group

The year is 2000. You have been appointed as the Transport Secretaries of Hong Kong.

Your first task is to decide upon a suitable subsidy to help taxi owners convert their existing gasoline-consuming fleets to LPG-consuming ones.

It is believed that this change will be both **green** (environmentally friendly) and **economically viable** (LPG is cheaper as a fuel). However, changing out the engine is quite expensive and taxi owners request aid from the government to help them do so.

Some data your minions have collected for you:

Cost of gasoline HK$ 1.8 / dm^3

Cost of LPG HK$ 0.6 / dm^3

Fuel consumption of gasoline 13 dm^3 / 100 km

Fuel consumption of LPG Unknown

Cost of engine replacement HK$ 16000

Taxis Usually rented out and driven for two shifts of 10–12 h each.

Because your minions did not study chemistry, they are unable to help you locate other needed information. Use the internet to help you.

(If your group is absolutely stuck, use questions from Variant B to help you move forward.)

4 Variant B: Solo

Read the context in Variant A if you have not already done so.

3. (a) Identify the components in gasoline and LPG respectively.

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(b) For gasoline, assume it is pure octane.

i. Calculate the mass of 1.00 dm^3 gasoline.

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ii. Calculate the number of moles of octane present in 1.00 dm^3 gasoline.

ii. _____

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iii. Calculate the amount of energy when 1.00 dm^3 of gasoline is completely combusted.

iii. _____

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iv. Calculate the fuel consumption of gasoline, giving your answer in mol/km.

iv. _____

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v. Calculate the fuel cost of gasoline, giving your answer in HK$/km.

v. _____

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(c) Assuming that a car would take the same amount of energy to run, regardless of the fuel, calculate the fuel cost of LPG. Assume LPG is all propane.

(c) _____

(d) Calculate the fuel savings after an engine switch from gasoline to LPG. Assuming that a car would take the same amount of energy to run.

(d) _____

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(e) i. Estimate the distance a taxi travel in a day.

i. _____

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ii. Calculate the fuel saving each day.

ii. _____

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iii. Propose a reasonable subsidy for the engine change, outlining your reason.

iii. _____

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5 Energy Density and Specific Energy

4. **Energy density**

Energy density describes the energy contained in a fixed volume. A higher energy density source is more compact and more convenient to carry.

Energy density is calculated as $\frac{E}{v}$, where E is the amount of energy released and v is the volume occupied by the fuel. It is often given as the SI unit $\frac{\text{kJ}}{\text{m}^3}$

5. (a) State the amount of energy released by combusting 1.00 dm^3 of gasoline (octane).

(a) _____

(b) Convert the value into the SI unit of $\frac{\text{kJ}}{\text{m}^3}$

(b) _____

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6. Explain, showing your calculations, whether gasoline or LPG has a higher energy density.

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7. **Specific energy**

Specific energy describes the energy released from a fixed mass. A source with higher specific energy is lighter.

Specific energy is calculated as $\frac{E}{m}$, where E is the amount of energy released and m is the volume occupied by the fuel. It is often given as the SI unit $\frac{\text{kJ}}{\text{kg}}$

(a) State the amount of energy released by combusting 1.00 dm^3 of gasoline (octane).

(a) _____

(b) Calculate the specific density of gasoline.

(b) _____

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(c) Explain, showing your calculations, whether gasoline or LPG has a higher specific energy.

(c) _____

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