1* On a 20-km line, electrified with single-phase AC-current, 1600 t trains are hauled at 100 km/h by a *Class 185* from DB. We can find a 10 km ramp at 5 ‰. After an important incident on the substation, the power supply of the catenary is not available. The line has to be used provisory with Diesel locomotives. (Leaflets 8.5.13 & 8.10.23, fig. 4.229).
A How many *Class 285* from CBrail are necessary to haul the same trains?
B A question: repair or not repair? Explain choice arguments to the board office.

2* We want to order a serie of megatrolleybus for an urban line. Trolleybus will have 4 axles, 2 motor axles and 2 guiding axles. Continuous power: 2×160 kW. Maximal power: 2×240 kW. (Leaflet 8.6.38 for example).
A Analyze two drives: induction motors and synchronous motors with permanent magnets. Study normal operations, but also disturbance cases: short-circuit on a converter phase, short circuit on a motor phase.
B Compare two mechanic drives: longitudinal motors with hypoid drive and wheelmotors (4×40/120 kW) without axle through the vehicle.

3* After the commissioning of the new transit main station in Zürich (~2011), the ZVV (transport official organisation of region Zürich) wants trains without changes Uetliberg – Zürich HB – Uster. The Uetliberg line is now electrified under 1200 V= and all the remaining lines of the *S-Bahn* under 15 kV 16,7 Hz. Articulated EMUs are wanted for 55 cm-piers, with low floor at approximately 60 cm over the rail top.
A Choose an electric drive for 1500V=/15kV~, which can also operate on actual voltage 1200V=.
B Calculate the power to be installed for an EMU4 with 180 seats and so many standing places. A maximal speed of 140 km/h is required, and an acceleration of 1 m/s^2 until 60 km/h on flat line under single-phase voltage. Under DC-voltage, it is required to hold the actual time schedule of the Uetliberg line with a maximal speed of 70 km/h (see doc.).
C Study if the articulated configuration Bo'-2'-2'-2'-Bo' is relevant, or if more driving wheels have to be installed, for example Bo'-2'-Bo'+ Bo'-2'-Bo'. Is it possible to equip *Jacobs*-bogies with motors? In this case, where the converters can be installed?

5* It is planned change the voltage on Uetliberg from 1200V= to 1500V=, to have a standard value and reduce the power lost in the catenary. It is planned to buy new trains.
A Explain the impacts on fixed installations: objects to modify, change on operations?
B Explain the impacts on actual rolling stock. Modifications? Scrap?