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Diagnostics and repair of motor vehicles with electric or hybrid drive

- Students workbook -

A textbook for the professions of 2487 H car technician, 01 car mechanic, 03 car body mechanic, 04 and 2495 K car mechatronic.

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INTRODUCTION

A workbook „Diagnostics and repair of motor vehicles with electric or hybrid drive„ is a part of the texbook for the professions of 2487 H car technician, 01 car mechanic, 03 car body mechanic, 04 and 2495 K car mechatronic. This workbook is an intellectual output of the project **"Innovations in car service of hybrids and electric vehicles" 2017-1-SK01-KA202-035399**, and it was created in cooperation with the partner organizations Stredná odborná škola dopravná Kvačalova 20, 82108 Bratislava, Slovakia, Homola sro 763/43, 61900 Brno, Czech Republic, and Industrijsko-obrtnička škola Pula, Rizzijeva 40, 52100 Pula, Croatia.

It fully respects the requirements of the Innovation Program for School Education for the year 2018.

The workbook provides advice on the knowledge gained in the primary school and a first year of secondary vocational schools and vocational schools in the fields of study and study no. 23, and no. 24 Mechanical engineering and metal production. The didactic concept was created in accordance with the requirements of the VET. Working with the workbook is clear and focused on the procedures of most VET schools in Slovak Republic. The handyness of the tutorial also facilitates navigation through colors, links and symbols that a student will quickly adopt. Format A4 gives authors the ability to provide enough material to enable a teacher to have the choice for all students, taking into account the individual requirements of each individual. The textbook and workbook are closely interlinked with a series of topics, and a way of presenting content. The basic idea is that the textbook contains all the important informationstudents needs to learn. They gradually practice and consolidate knowledgefrom the textbook and at the same time solve the tasks in the worksbook of this series.

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Content

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BASICS OF DIAGNOSTICS AND REPAIR OF ELECTRIC AND HYBRID DRIVES

Safety when working with an electric car

1. Mark the correct answer to the question: "What is an electric car and who can repair electric cars?"

a. An electric car is an electric vehicle that contains components under different but mostly high voltages, some of which are technical or specific technical equipment, and therefore a person who has received instructions from a car electrician performing the work always required to carry out work on those parts, other mechanical repairs can be performed by any automobile mechanic.

b. An electric car is an electric vehicle which contains components under different but mainly high voltages, some of which are technical or special technical equipment, and therefore these vehicles must be operated by a qualified person who fulfills the requirements of the Ministry of Labor, Social Welfare and Family of the Slovak Republic no. 508/2009 valid from 1.9.2014.

c. An electric car is an electric vehicle containing components under different, but generally low, safe voltages, some of which are technical or specific technical equipment, and are therefore not required by an expert to operate on these parts;

2. Describe the images of the tools and equipment needed to work with electric cars:

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3. Write the correct answers:

3.1 Which three VDE procedures must be performed by a high-voltage mechanic before starting work on electrical equipment?

a. _____
b. _____
c. _____

3.2 What are the hazards of high voltage operation of mechanics?

a. _____
b. _____
c. _____
d. _____

4. Add the correct voltage values and missing data to the text.

! For persons, a dangerous alternating voltage is _____V or a DC voltage _____ is. Therefore, follow the safety instructions in the vehicle service booklet for troubleshooting and warning of the vehicle.

! Vehicle with a voltage of installation> _____V DC and> _____ V AC are considered high-voltage motor vehicles.

! Only _____ mechanics working on the _____ voltage can perform high performance work on the high-voltage equipment.

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5. Describe images and signs:

a)

b)

c)

d)

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ORGANIZATION OF A SERVICE WORKSHOP

6. Write at least four diagnostic devices in the workshop:

.....

.....

.....

.....

7. Write the equipment and supplies that are used in the electric car repair workshop.

Equipment:

.....

.....

.....

.....

Supplies:

.....

.....

.....

.....

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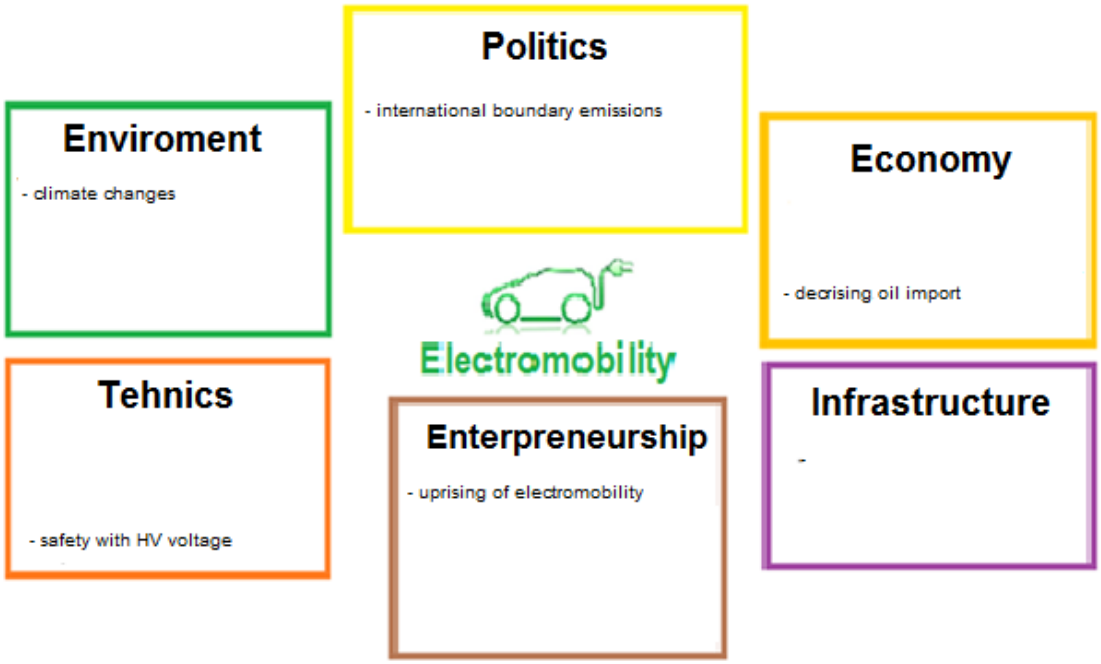
TYPES AND VERSIONS OF ELECTROMOBILITY

1. Add the effects of electromobility to the environment.



• Reducing global CO_2 emissions
• Reduced noise polution
• Consciousness of raw material consumption
• The technical advantages of an electric motor compared to an internal combustion engine
• Increased efficiency
• Introduction of low or no emission zones
• Development plans and subsidies
• Increased acceptance of electromobility
• Increased demand for vehicles with lower fuel consumption and lower emissions
• Increased urbanization (big cities)
• Unused oil reserves
• Increasing the price of fossil fuels
• Surface Infrastructure for Electric Power Charging (Household, Workplace, Road)

2. Identify the advantages and disadvantages of electric vehicles:

.....

.....

.....

.....

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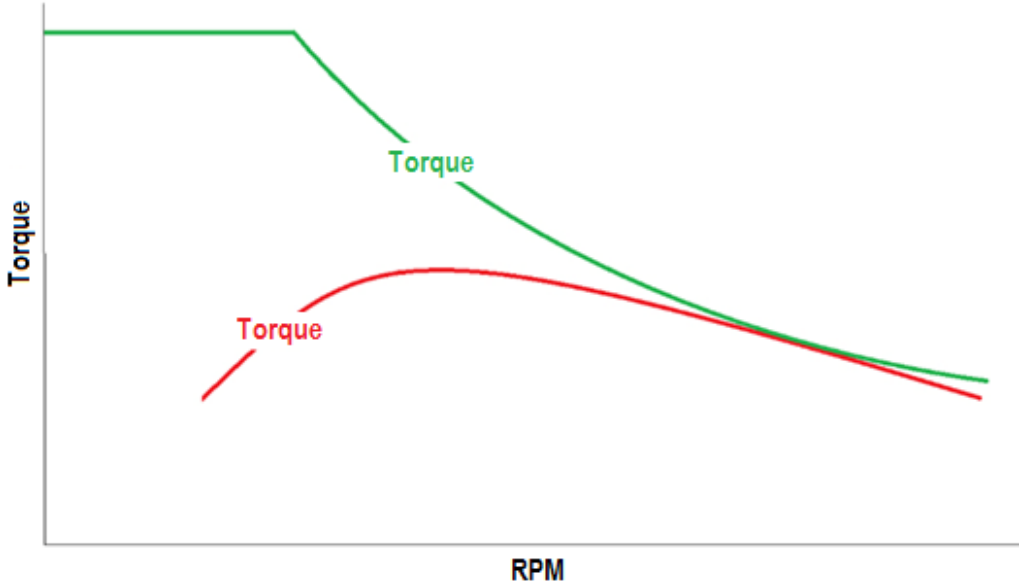
3. Highlight the curve on the graph to display:

A. Torque of the electric motor
B. torque of the internal combustion engine



4. Add the correct words missing in the text:

(combustion motor / electric motor, minimum / maximum, dropping / rising, decrising / rising)

_____ reaches its _____ moment from the idling. No startup phase is required to achieve a idle speed. With _____ RPMs to a certain speed, torque is _____ (at about 14000 rpm). An additional advantage of these features is the ability to keep the entire conventional vehicle transmission.

(combustion motor / electric motor, minimum / maximum, raise / drop, dropping / rising, don't require / requires)

_____ for torque transfer reqiures _____ of RPMs at idling. With a _____ of engine speed the torque is also _____. For this feature of the internal combustion engine _____ multi-gear transmission. The torque is transmitted to the transmission via the clutch or torque converter.

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5. Mark the correct answers.

5.1 Micro-hybrid means:

a. The electrical component is only used to perform the start-stop function.

b. An electric motor also supports an internal combustion engine. Clean electric driving is not possible. The system supports recovery.

c. The high voltage accumulator can be charged extra from the outside network.

5.2 Plug-in-Hybrid (PHEV) means:

a. Car is moving only with an electric drive. Energy is supplied from a high-voltage accumulator that is charged in the power supply.

b. The high voltage accumulator can be charged extra from the outside network.

c. Drive is possible only with electric drive. Energy for the drive is produced by fuel cells. The hydrogen is used as a fuel.

5.3 A full hybrid vehicle is designated as:

a. HEV - hybrid electric vehicle

b. BEV - battery electric vehicle

c. PHEV - Plug-in hybrid electric vehicle

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TECHNICAL DOCUMENTATION FOR DIAGNOSTICS AND REPAIR OF ELECTRIC/HYBRID VEHICLES

Enter the correct answer.

1. Write the types of media used to transfer information in communication processes?

.....

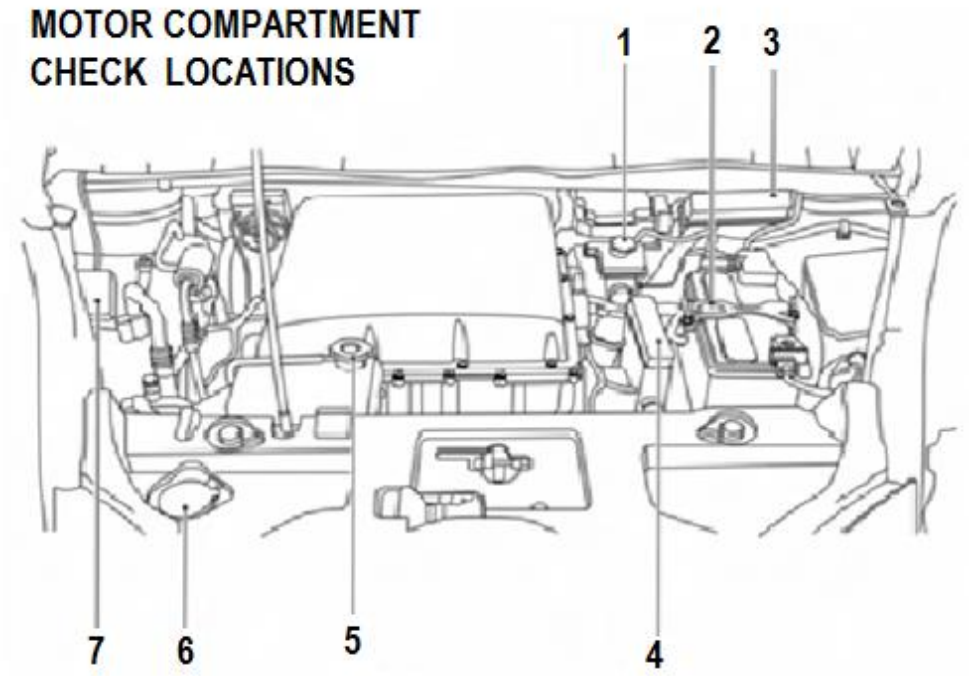
.....

2. Define the term technical documentation of a motor vehicle with electric or hybrid drive?

.....

.....

3. Add the engine section names to the text as shown. / 12 V accumulator, brake fluid reservoir, coolant fluid reservoir, fuse holder, fluid reservoir, fusebox /



1. _____ 5. _____

2. _____ 6. _____

3., 4. _____ 7. _____

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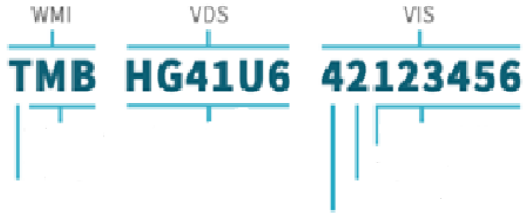
4. Add the correct answer to the text:

identification, letters and numbers, colors and lines, coded, non-coded

The VIN (Vehicle Identification Number) is a combination of _____ in accordance with ISO 3779-1983, which serves as a reliable _____ of the vehicle. It is assigned to personal cars, buses, trucks and motorcycles. It consists of 17 characters, in which are _____: country of origin, type and engine content, color, number of seats, electrical and other special equipment, etc.

5. Describe the meaning of the characters in the picture.



6. The VIN number is set at many places of the car to prevent counterfeiting. Where is the VIN most commonly found?

- .....
- .....
- .....
- .....
- .....

7. VIN is also quoted on all documents pertaining to a particular vehicle. Write the names of the relevant documents:

- .....
- .....
- .....
- .....
- .....

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8. Fill out the type and meaning of the signs.

Round shape, red frame, white background, and black symbol are referred to as:

Signs .....

			
			
			

Warning Signs - a triangle shape, a yellow background, a black symbol

	

Command signs - round shape, blue background, white symbol

			

Rescue Signs - square shape, green background, white symbol

	

Fire Signs - square form, red background, white symbol

			

9. Write which drawings contains the CMV technical documentation.

a) _____ b)_____ c) _____

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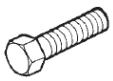
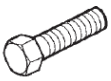
10. According to the table, determine the maximum torque in Nm if there is a sign on the bolt:

a) 8.8 is on the screw head,has a diameter of 10 mm and the material is steel - max. torque will be _____

b) 12.9 is on the screw head,has a diameter of 7 mm and the material is aluminum - max. torque will be _____

c) 10.9 is on the screw head,has a diameter of 12 mm and the material is steel - max. the torque will be _____

Bolt Markings and Torque - Metric

Commercial Steel Class	8.8				10.9				12.9			
Bolt Head Markings												
Body Size	Torque				Torque				Torque			
Diam.	Cast Iron		Aluminum		Cast Iron		Aluminum		Cast Iron		Aluminum	
mm	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb
6	9	5	7	4	14	9	11	7	14	9	11	7
7	14	9	11	7	18	14	14	11	23	18	18	14
8	25	18	18	14	32	23	25	18	36	27	28	21
10	40	30	30	25	60	45	45	35	70	50	55	40
12	70	55	55	40	105	75	80	60	125	95	100	75
14	115	85	90	65	160	120	125	95	195	145	150	110
16	180	130	140	100	240	175	190	135	290	210	220	165
18	230	170	180	135	320	240	250	185	400	290	310	230

11. In the text add the true term:

production, construction, service, dimensions, must, service, shape, production, repair, assembly, design

The technical drawing is the most important means of communication between the designer, _____ and _____ regardless of the field, its origin or its use. He has a technical idea.

The technical drawing contains all the necessary information for _____ or _____ parts or CMV. It prescribes _____ and _____ but also the type of material, allowed dimensional deviations and so on. The _____ of a product depends on accuracy and precision of the data shown in the drawing. On the other hand, the workshop which manufacture the part or appliance just _____ exactly follow a technical drawing.

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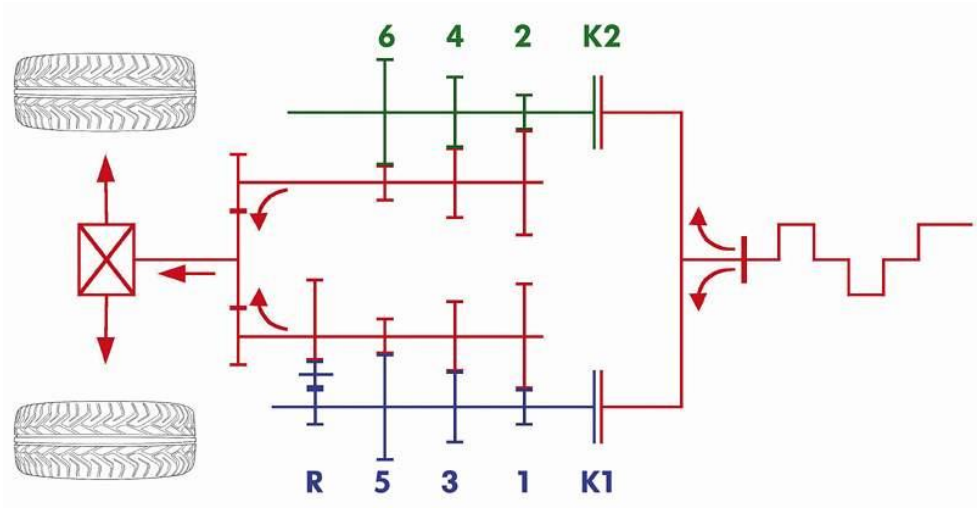
12. Complete the text with the correct term:

interconnection, relations, mobile, kinematic, static,

Kinematic schemes are used to show connections of _____ elements in the mechanical system (axles, levers, axes, wheels, sources of motion, ...) or display the way in which settings, controls, controls and so on. _____

Kinematic signs of mechanical elements are used where it is necessary to express mechanical, hydraulic or electrical _____ between parts of the whole or part of the vehicle's equipment, including electrical, hydraulic pneumatic schemes. _____ signs are simple and resemble the right elements.

13. On the diagram, mark the transmission of the crankshaft torque to the wheel when the fourth gear is engaged.



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14. Fill in the text with the correct terms:

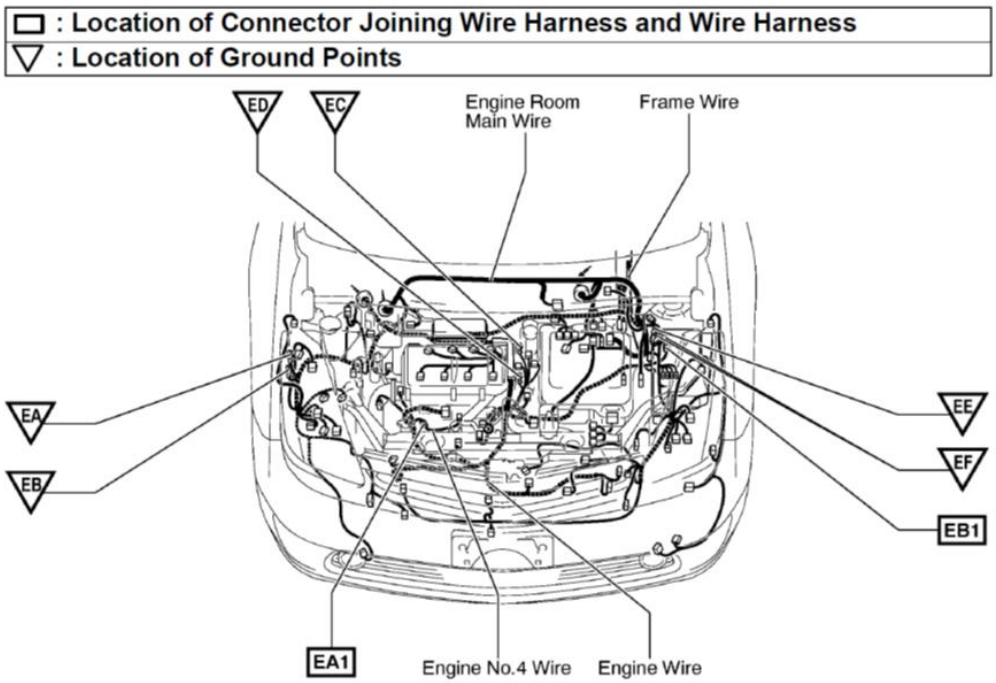
pneumatic, electrical, layout, electric, hydraulic, reciprocal, mutual, thin line, dashed line

Electrotechnical schemes are the basic graphic document where the functional parts of the vehicle/device and the _____ connection between them are represented by symbols or simple graphic images. According to them, the installation, repair and adjustment of equipment in vehicles is carried out.

Schematic symbols and link lines are shown in the schematic drawing to get the best picture of _____ CMV system and _____ relations of his parts.

Electrotechnical schemes are usually drawn with one line thickness (_____) exceptionally thick and very thick lines can be used in the thickness ratio of 1 : 2 : 4 and 1 : 3 : 6. Thickness of lines are selected so that the drawing is easily read and understood.

15. Circumcise the terminals in the picture and mark the earthning (ground) points.



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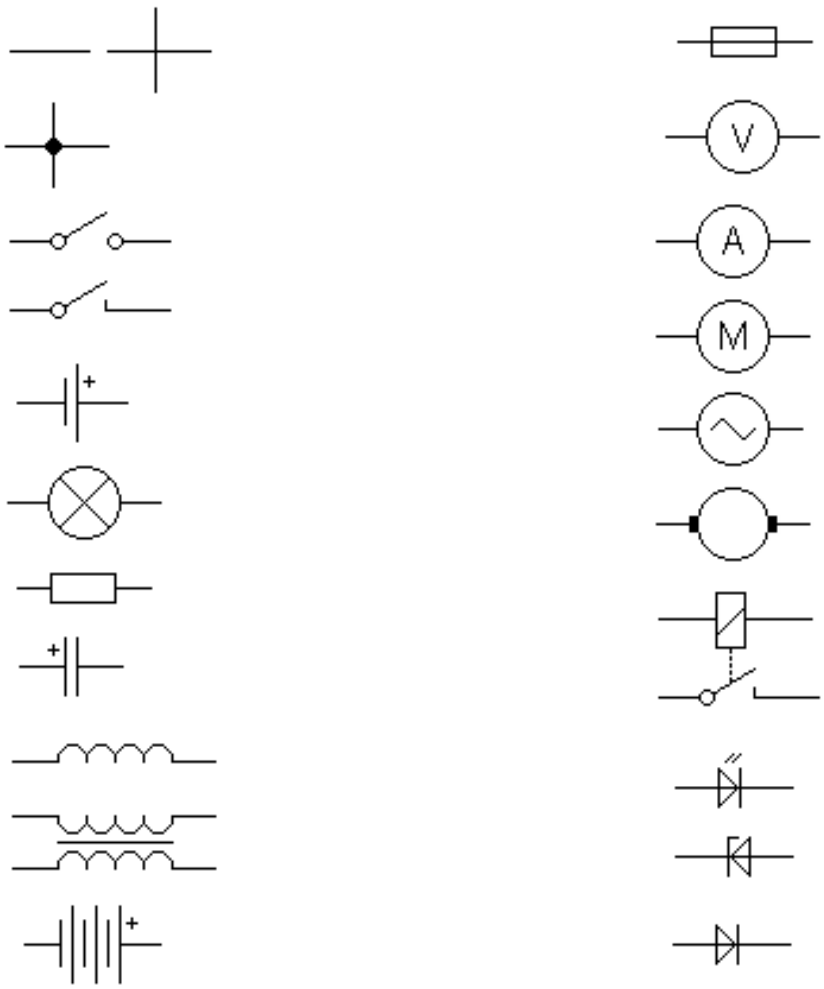
16. Add the meaning of the signs.



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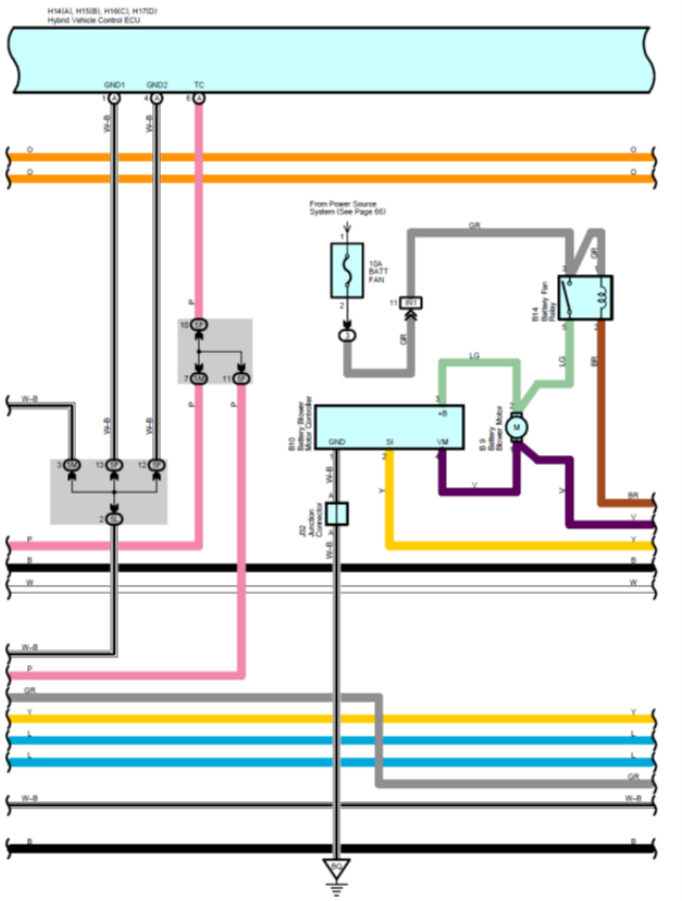
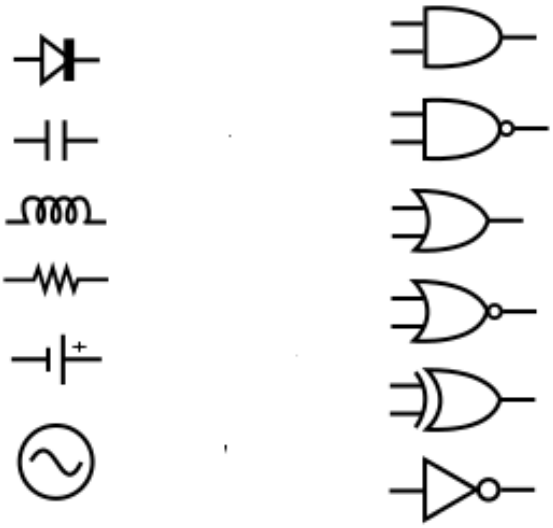
17. *In the electrical diagram, check the current flow when the electric motor is switched on.*

Mark: relay, fuse, motor and ground in the diagram.



16. Add the meaning of the signs.



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19. *Add the correct answer to the text:*

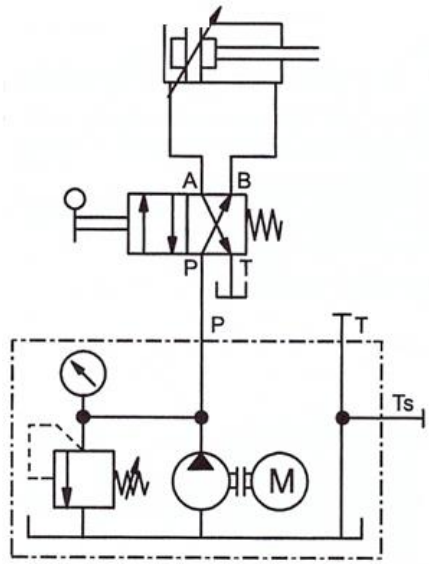
oil, water, pressure, electric, open, closed, full thick, thin line, dashed, straight

Hydraulic diagrams show systems that use _____ fluid energy, most commonly _____, eg. CMV drive circuits, hydraulic systems for controlling and controlling machines, sliding and rolling lubrication systems, ...

Liquid conduits (tubes, hoses, ...) are drawn with _____ with rectangular curved lines.

The pressurized fluid flow chart is pulled out with _____ lines. Liquid channels for other purposes (regulation, control, waste, ...) have been drawnwith _____ lines. Hydraulic devices always have closed circuits.

20. Identify the parts of the hydraulic circuit in the figure.



21. Add the correct answer to the text:

don't have, must, compressible, water, air, acceptable, harmful

Pneumatic diagrams show systems where pressure energy is used to transfer power or information, eg. drive circuits, pneumatic control of brakes, clutches… Unlike fluid, gas is _____ and can therefore accumulate energy otherwise in the pipeline. It is also ecologically _____. The pneumatic circuits _____ to be closed because the air can be released into the air after the job is completed.

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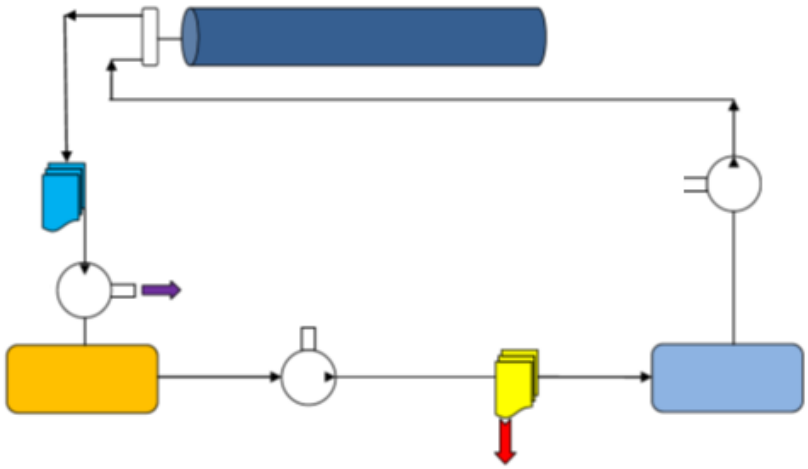
22. Mark:

compressor, pump, engine and pressure tank in the pneumatic diagram.



23. Add the correct answer to the text: *color and size, thick and thin, dotted and thin, density and contrast, linear, QR, sea, no need, letters, numbers, squares, graphs*

Barcode is machine-readable tagging of parts and spare parts by _____ line spaced apart. The most important practical barcode parameters are ... code. The amount of encoded information per unit length determines the density and type of code. Codes are used to encode less characters, and more information is encoded in two-dimensional codes _____ codes. QR code consists of white and black _____modules composed of square matrices. The QR code may contain _____ or Japanese characters. Colors _____ only white and black, its QR code recognition does not matter for its rotation, nor does it require a great color contrast.

24. Identify with the mobile application the exact specification of the QR code replacement part.

25. Add the correct meaning of pictures in the table.

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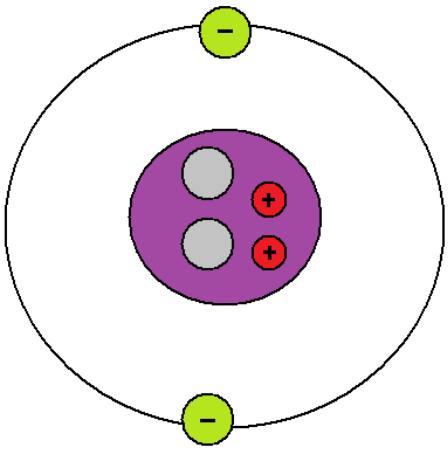
ELECTROTECHNICS

1.In the table add terms that are missing.

Name	Units of measurement	Quantity
		lenght
kilogram		
		time
amper		
		thermodynamic temperature
candela		
	mol	
watt		
		electric charge
volt		
		electric capacity
ohm		
		area
cubic meter		
		speed
newton		
		work

2. Structure of material

a. Highlight atom, electron shell, electrons, nucleus, protons, neutrons.



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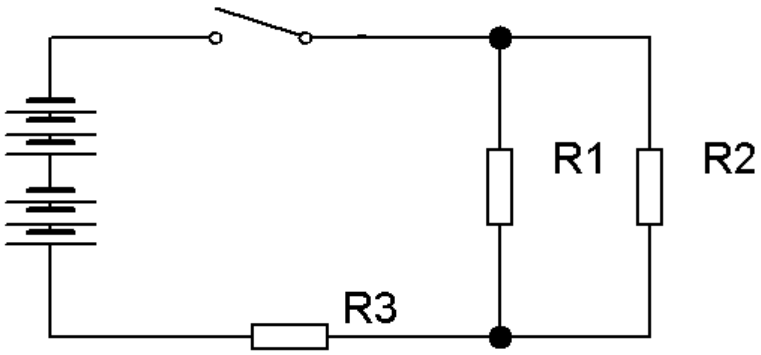
b. **Add the correct answer to the text:**
they do not have / they have, can / can not.

According to electron conductivity we distinguish:
Conductors - _____ valence belt fully occupied by electrons, the valence belt overlaps with conductive, or there is a very small distance between them (the bandwidth is very small).
Insulators - _____ valence belt fully occupied by electrons and bandwidth is 20 eV. Electrons can not overcome the barrier of the forbidden zone and enter the conductivity band.

Semiconductors
(a) intrinsic semiconductors - _____ valence belt fully occupied and limited bandwidth of 0.5 to 1.5 eV;
(b) in the case of extrinsic semiconductors, for certain conditions, between valentine and conductive strips, interconnections are provided for the transition. Electrons pass from the intermediate band to the conductive (N type semiconductor) or from the valentine to the intermediate (semiconductor P type).

3. In the figure, check the current flow I_R and total voltage U_R, current I_1, I_2, I_3 and voltage drops U_1, U_2, U_3 at resistances R_1, R_2, R_3. Calculate the strength of current I_1, I_2, I_3, voltage drops U_1, U_2, U_3 on resistors R_1, R_2, R_3. Resistor values are $R_1 = 10\Omega$, $R_2 = 20\Omega$, $R_3 = 30\Omega$, 12V source voltage. In calculating use the 1st and 2nd Kirchhoff's law.



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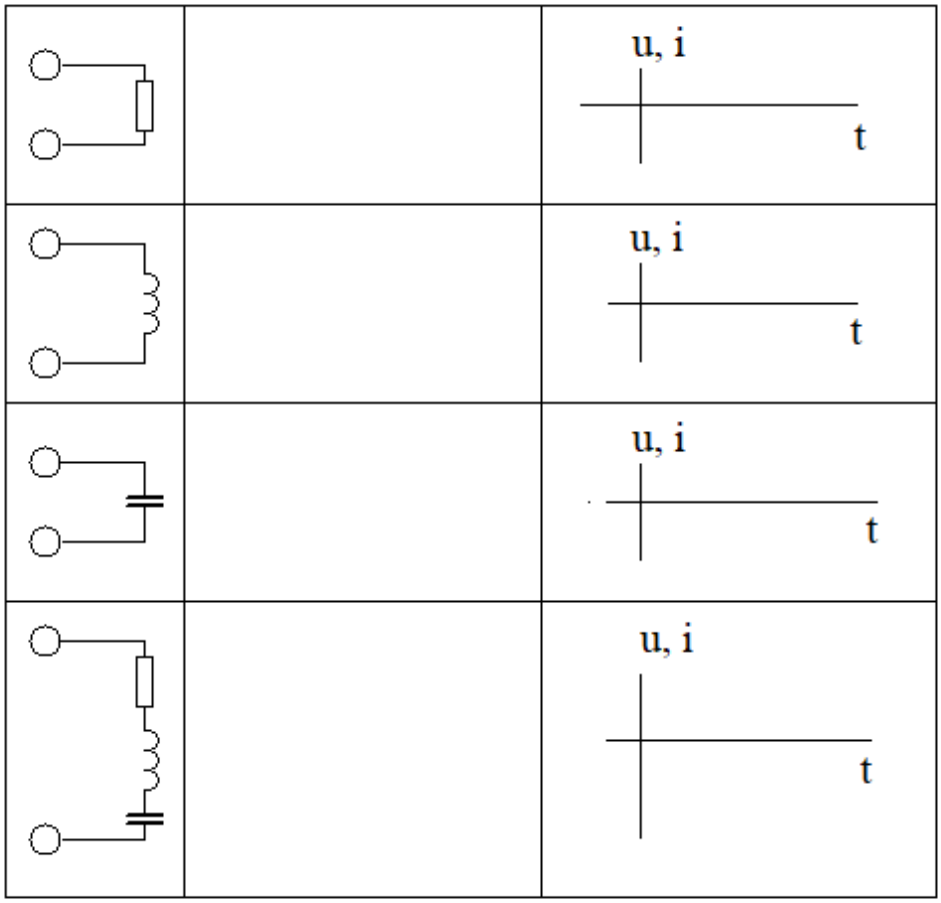
4. Mark in the picture:

a. Electrical resistance R, inductance L and capacity C,
b. phase shifts
c. waveforms in the R, X_L, X_C and alternating current circuits - RLC.



5. Mark the correct answer.

5.1 Electric machines are divided into:

A, rotary machines (motors, generators,...) and non-rotary (transformers, induction regulators, rectifiers,...).

B, only rotary machines (motors, generators,...) and rectifiers.

C, NO switches - contacts are normally disconnected, NC switches contacts are normally connected, combined - they have both NO and NC contacts.

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5.2 Generator (dynamo, alternator) is:

A. Non-rotating machine (transformer, regulators, rectifier).

B. only motors and rectifiers.

C. a rotating machine that converts mechanical energy into electrical energy.

5.3 The electric motor is a machine

A. which converts electrical energy into mechanical work.

B. which converts thermal energy into mechanical work.

C. a rotating machine that converts mechanical energy into electrical energy.

5.4 Transformer is an electric machine

A. which converts electrical energy into mechanical work.

B. which changes the AC voltage values on the principle of electromagnetic induction. It consists of primary, secondary coils and closed core.

C. which changes the values of DC current on the principle of electromagnetic induction. It consists of primary, secondary coils and closed core.

5.5 Autotransformer is

A. Transformer that uses a common coil and core for primary and secondary windings.

B. which changes the AC voltage values on the principle of electromagnetic induction. It consists of primary, secondary coils and closed core.

C. a machine that converts DC values based on electromagnetic induction. It consists of primary, secondary coils and closed core.

5.6 Electromagnetic relay is

A. switching device that uses the effects of an electromagnetic field. The base is the iron core electromagnet, which manages the anchor to which the contacts are placed (one or more).

B. a switching device controlling the rotor on which the diodes are located.

C. a machine that converts DC values based on electromagnetic induction. It consists of primary, secondary coils and closed core.

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5.7 The heater is a device

A. to change AC voltage to DC.
B. controlling the rotor on which the diodes are located.
C. which changes the values of DC current on the principle of electromagnetic induction. It consists of primary, secondary coils and closed core.

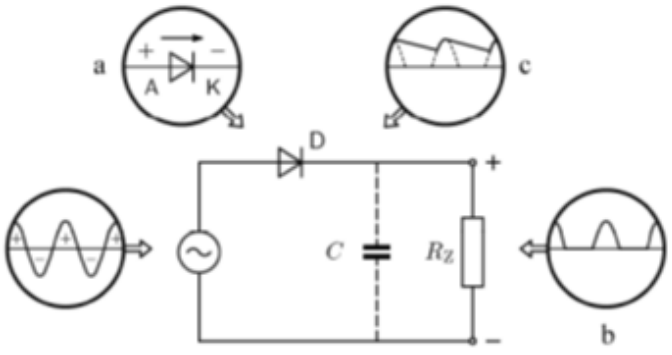
5.8 Distribution of electric motors to:

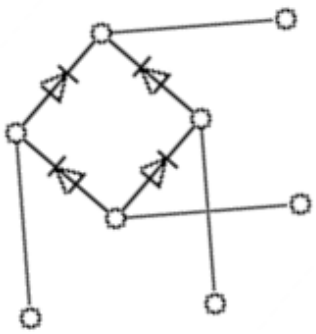
A. DC DC motors (with permanent magnets, electromagnets, serial motor, derivative motor (parallel), with external excitation, serial parallel motor (circuit)
B. Alternating current motors (synchronous, stepping, servomotor, asynchronous, single phase, three-phase)
C. Semiconductor, tubular, selenium, mercury and motor generators.

6. In the table, add missing values and battery names.

Typ	Cell voltage (V)	Voltage of full cell (V)	Lower limit of charge (V)	Specific capacity (Wh/kg)
_____ (Pb)	2	_____	1,8	20
Nickel iron (Ni-Fe)	1,3	_____	1	38
_____ (Ag-Zn)	_____	2,1	1	48-55
Nickel metalhydrid (Ni-MH)	1,2	_____	1	53
Nickel cadmium (Ni-Cd)	1,2	1,4	_____	31
Lithium ion (Li-Ion)	3,6	4,2	2,5	_____

7. Display the types of rectifiers and their main parts in the illustration.





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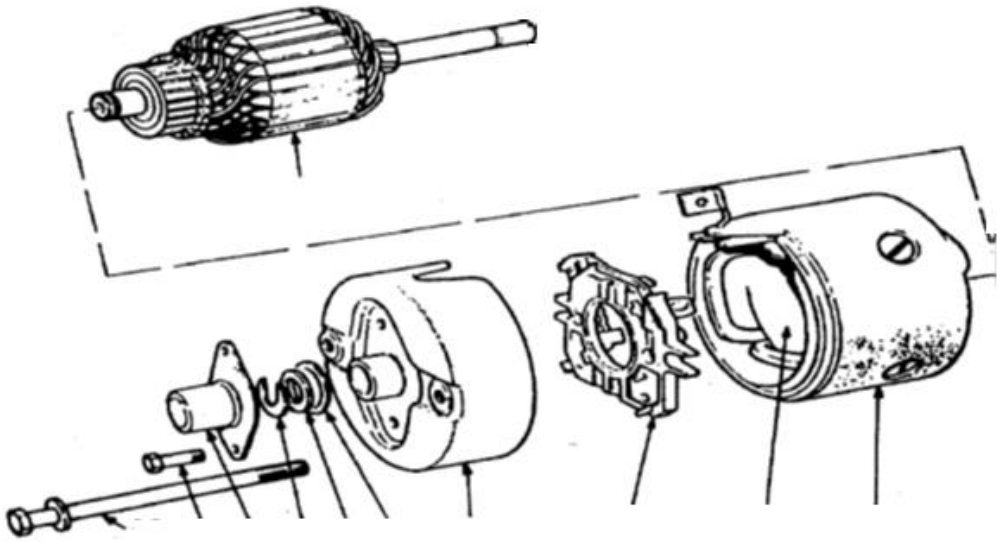
DC MOTORS

8. In the figure, describe the type of electric motor and its main parts.
The picture shows _____motor.



9. Add the advantages and disadvantages of each type of electric motor.

COMPAUND DC MOTOR	*DC MOTOR WITH PERMANENTNIM MAGNETS*	*ASYNCHRONOUS MOTOR*	*PMSM (Permanent magnet synchronous motor)*
	.		

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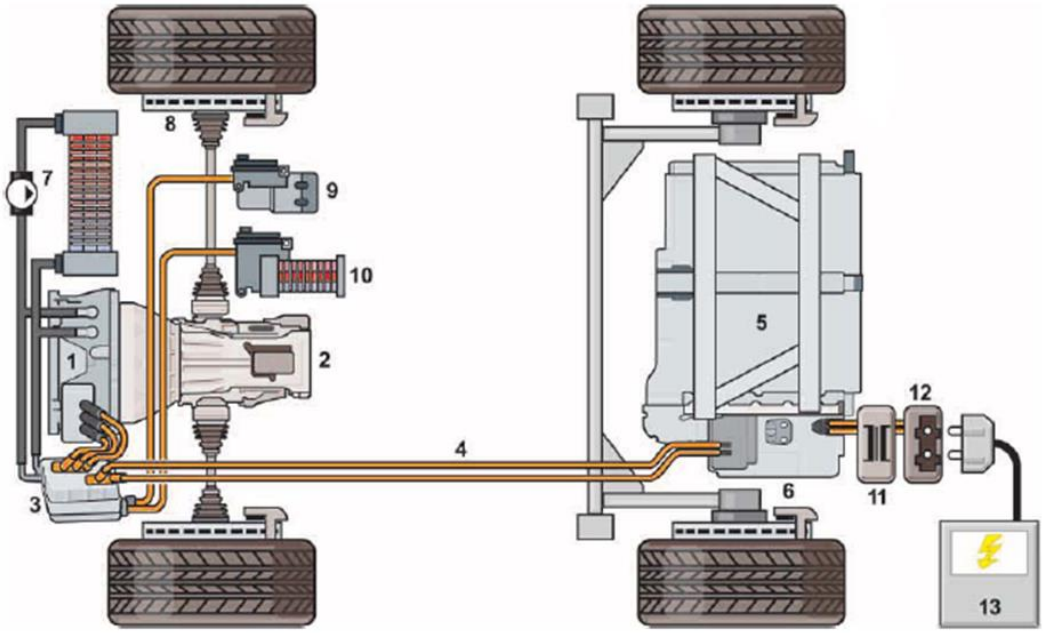
PARTS OF ELECTRIC VEHICLES, ELECTRICAL ACCESSORIES.

1. Mach the exact number to the name of the electric vehicle part according to the position of the diagram.



.... High voltage compressor air conditioning,
.... Differential gearbox,
.... E-box with battery control unit
.... Cooling system,
.... High voltage heating,
.... External charge charging contact,
... Electronics
.... High voltage cables,
.... High-voltage battery,
.... Brake system,
.... Charger,
.... External charging source,

2. We have a high voltage accumulator of 85 kg, voltage U = 288 V and current I = 6.5 A. Calculate the energy density:

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3. Mark the cross that is wrong.

3.1 Electric Generator:

A. The power is used instead of the generator (alternator), the electric motor and the starter.
B. When the drive unit is operated mechanically, it supplies electrical power as a generator.
C. In a fully hybrid vehicle (HEV), the electric unit never serves as an starter for an internal combustion engine.
D. Three-phase alternating motors are used as a power generator and are supplied with a three-phase alternating current.
E. When used as a generator, the rotor motion in the wires induces a three-phase alternating voltage transformed into the DC voltage into the high voltage battery in the power electronics.

3.2 High Voltage Accumulator (HV - Accumulator)

A. The VN battery is the heart of an electric vehicle. It delivers DC voltage to the power electronics, which converts it to the AC voltage and supplies the power unit through three electrical phases with three cables (U, V and W).
B. Electrical parameters for VN accumulator are: rated voltage, efficiency and energy density. They depend on the type of chemicals used for the internal building of energy storage.
C. Energy density expresses battery performance in relation to its weight. The higher the energy density, the less energy we can store and release for work. The unit is hourly per kilogram (Wh x kg) and consists of electrical work (Wh) and weight (kg) of batteries. From the density of energy we can export the range of electric cars.
D. The lifetime of VN - batteries is described by the resistance of the cycle.
E. The efficiency of charged VN batteries is given in percent (%). Efficiency tells how much energy that is fed into the charge can be reused for battery discharge.

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3.3 Types of Rechargeable AccumulatorS

a. Lead accumulators - The charge status of the lead acid battery is determined by measuring the density of the sulfuric acid solution.
b. Nickel cadmium accumulators - have a memory effect. It is difficult to deal with deep emptying or excessive filling.
c. Lithium-ion accumulators contain very little water and have no memory effect. Compared to nickel-cadmium batteries, they have twice as much energy density.
d. Nickel-metal hydride accumulators - The electrode material is a nickel compound and another metal compound. Potassium hydroxide is used as an electrolyte. They have a higher energy density than NiCd batteries and are relatively resistant to damage. They are most often used in electric vehicles.
e. Accumulators that are still in development but can be replaced by: Li-Ion Li-Ion (Li-O2) Lithium Sulfur Batteries (Li-S), Zinc-Air Accumulators (Zn-Air), Hydrogen Rechargeable Batteries H2).

4. Calculate the electrical power when charging the electric car from the home network with a single-phase socket and compare the charging time with a three-phase socket.
Normal single-phase home outlet U = 230V, U = 400V, max. alternating current I = 16A

Electrical power when charging an electric car from a home network with a single-phase socket is _____.

Electrical power when charging an electric car from a home network with a three-phase socket is_____.

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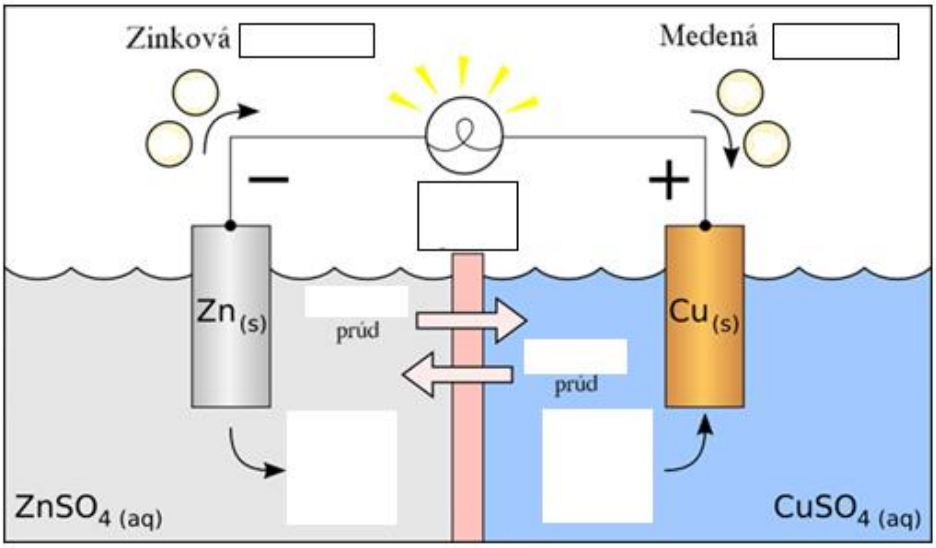
5. Add the missing fields to the image and indicate what the image shows:
Add: anode, cathode, porous plate, cationic, anionic, Zn +2 (aq), Cu +2 (aq), e-



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ELECTROMOBILITY

Construction of electric vehicles

1. In brackets below the text, complete the design for the following advantages and disadvantages:

A. electric aggregates in awheels,
B. central drive of the electric aggregate. Mark a or b for each statement.

Advantages:
( ) Differential gear is not required
( ) The hub engine thrusters are directly on the wheel
( ) Single-drive drive is easy to construct
( ) The hybrid drive combination is very good
( ) High drive efficiency, without mechanical losses
( ) Recovery option
( ) It is possible to integrate into an existing vehicle concept
( ) No drive shaft required

Disadvantages:
( ) A concept with a single hydraulic brake is required
( ) Greater mass of drive parts (impact on inertia and torque of the vehicle)
( ) A special vehicle concept is required
( ) Drive wheels are expensive. Both aggregates must work synchronously
( ) The wheel space is limited
( ) High rolling mass in the wheel
( ) The central shaft drive shaft is not on the drive shafts
( ) Differential is required
( ) Slow speed is needed

2. Mark the defective claim on the car's casing:

A. In order to create a space for mounting a high-voltage battery, the emphasis is on strengthening the floor of an electric car.
B. The emphasis on electric vehicles is also placed on the side impact reinforcement, ie reinforcement in B-pillar and wheel arches.
C. The high voltage battery is mounted in the cabinet under the vehicle.
D. The cabinet consists of two main parts - upper and lower shells.
E. The upper part is metal and lower plastic, which includes a wicker beam.

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3. Mark one correct statement.

A. The electric car has a mechanical-hydraulic braking system and must have a handbrake (electronic or mechanical) as a classic car.
B. The electric car has two independent braking systems. One system is a classic mechanical-hydraulic braking system. The second is the electric unit in terms of "motor brakes".
C. The energy returns to the electric unit while driving and leads to a high-voltage battery. This contributes to the high efficiency of electric vehicles in urban traffic.

4. Mark one correct statement.

A. The coolant temperature is up to 65 ° C and is electronically monitored and controlled by the engine control unit.
B. Cooling circuit includes: 2 coolant pumps, radiator, heat exchanger, tank, high-pressure heating, cooling line.
C. Always use compressor oil in the air conditioner labeled PAG-poly alkali glycol.
D. The air conditioner compressor is powered by an asynchronous three-phase motor.
E. Before any work on a high-voltage A / C compressor, it is necessary to disconnect the high-voltage system and verify that the system is free of voltage.

5. Mark one correct statement.

A. Gas pedal position sensor, coolant temperature sensor, ABS wheel sensor, cruise accelerator sensor.
B. Steering angle sensor, auxiliary systems - Adaptive cruise control and belt detection, air weight.
C. Accelerator position sensor, coolant temperature sensor, crankshaft speed sensor, transverse acceleration sensor.

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DIAGNOSTICS AND REPAIR OF ELECTRIC VEHICLES

1. Mark one correct answer.

1.1 What measurements do we use on an electric vehicle?

A. High Voltage Measurement and General Voltage Measurement.
B. High-voltage isolation resistance measurement (with HV systemoff).
C. Measurement of insulation resistance according to SAE J1766, ECE R100, ISO6469 with activated VN system).

1.2 What is the statement on starting the electric motor is correct?

A. Before switching off the service terminal, it is important that the vehicle is raised on the crane and does not touch the ground;
B. Pulling out the service plug disconnects the internal battery series of the VN battery and opens the MV contactors and creates a state of no potential.
C. After removing the service connector, it is necessary to check the disconnection of the high-voltage system using a multimeter. Then mark the vehicle as deactivated.

1.3 How is the insulation strength tested when the HV system is activated during driving?

A. Is tested automatically on every fifth vehicle start and is evaluated by the trip computer, giving the driver a signal.
B. Testing is carried out only in insulating strength tests, and is prescribed annually.
C. He cyclically examines the so-called. By means of insulation protection, in case of failure, the driver is alerted to a warning message as well as a fault log in the diagnostic system (OBD).

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1.4 What is the resistance equalization resistance measured between two earthing points according to ECE R100, ISO6469-3?

A. > 100 mΩ (0.1 Ohm).
B. = 100 mΩ (0.1 Ohm)
C. <100 mΩ (0.1 Ohm)

2. Measurement in idle state

(Use the AVL DiTEST HV Safety 1000 box, see the operation manual and description of the device.)

2.1 If the HV service fuse is switched off and the 12 volt accumulator is off, perform the following tests for half without testing. Write the results in the tables below:

A. Measuring points: VN accumulator between + and - poles
B. Measuring points: VN accumulator between + poleand chassis
C. Measuring points: VN accumulator between - poleand chassis

Enter the measured values in the table:

a.	b.	c.

2.2 If the HV service fuse is switched off and the 12 volt accumulator is on, perform the following non-voltage tests. Write the results in the tables below:

Step 1: Measure the voltage at the 12V accumulator between + and - pole (active voltage)

Enter the measured value in the table**:**

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Step 2: Test all non-voltage poles (non-voltage measurements):
a. Measuring points: HVaccumulator between + and - poles
b. Measuring points: HVaccumulator between + pole and body
c. Measuring points: HV accumulator between - pole and body

Enter the measured values in the table:

a	b	c

Step 3: Measure the voltage at the 12V accumulator between + and –pole (active voltage).

Enter the measured value in the table**:**

Step 4: Explain and write down why the practice of a voltage free test is good in practice.

3. Measure and evaluate the high voltage isolation resistance (with HV systemoff). The actual (HV) of the vehicle is 400 V. Measure the insulation strength at the appropriate metering points.

To do this:
Step 1: Balanced Voltage Switching (Voltage): between + half and - half VN of battery
Step 2: Select the test voltage (greater than the rated voltage of the vehicle)
Step 3: Measure the insulation resistance: between + half the VN battery of the battery life (mass)
Step 4: Measure Insulation Resistance: Between HV Accumulator Battery (Mass)

Enter the measured values in the table and explain the results:

1.	2.	3.	4.

Explanation of measurement:

……
……
……

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4. Measure and explain the results of the isolation resistance measurement according to SAE J1766, ECE R100, ISO6469 (with VN).

To do this:
Step 1: Measure voltage values: between + pole and –pole HVaccumulator
Step 2: Measure voltage values: between + pole HVaccumulatorand body (mass)
Step 3: Measure voltage values: between -pole HVaccumulator and body (mass)

Enter the measured values in the table and explain the results:

1.	2.	3.

Explanation of measurement:

.....
.....
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5. Measure and evaluate potential equalization lines

To do this:
Step 1: Measure the resistance value with the appropriate tester
(test current 200 mA or 1 A) The measuring points are the ground of the front and rear chassis in the position of the first chassis switch.
Step 2: Measure the resistance value at the 2nd position of the chassis switch.
Step 3: Measure the resistance value at the 3rd position of the chassis switch.

Enter the measured values in the table and explain:

1.	2.	3.

Explanation of measurement:

.....
.....
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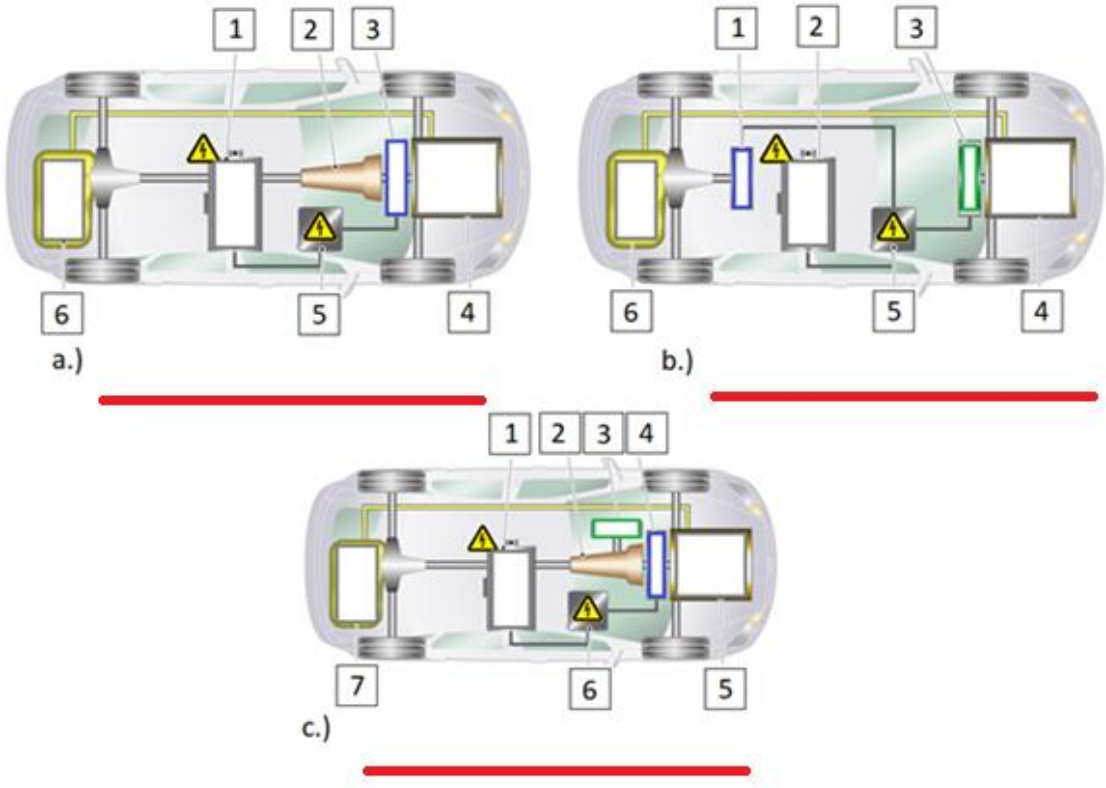
Construction of hybrid vehicles

1. Add the drive parts names in the table under a, b, c, depending on the type of drive, using the text below the image.



Number in picture a	Number in picture b	Number in picture c	Part Name
			HV accumulator
			Transmission assembly
			Internal combustion engine
			Electromotor,
			Power electronics
			Fuel tank
			Alternator

2. Highlight the letters a, b, c of the previous images to show which hybrid drive displays:

( ) Parallel hybrid drive
( ) Combined hybrid drive
( ) Serial Hybrid Drive

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3. Provide the correct statement of the structural changes of hybrid vehicles in relation to conventional vehicles.

a. Reinforced body in front of the car, machining on the internal combustion engine - cooling of the air filling system when the compressor motor is used.

b. Heated accumulator battery housing, internal combustion engine treatment - use of electric pumps in the cooling system, use of electric vacuum pumps for the braking system.

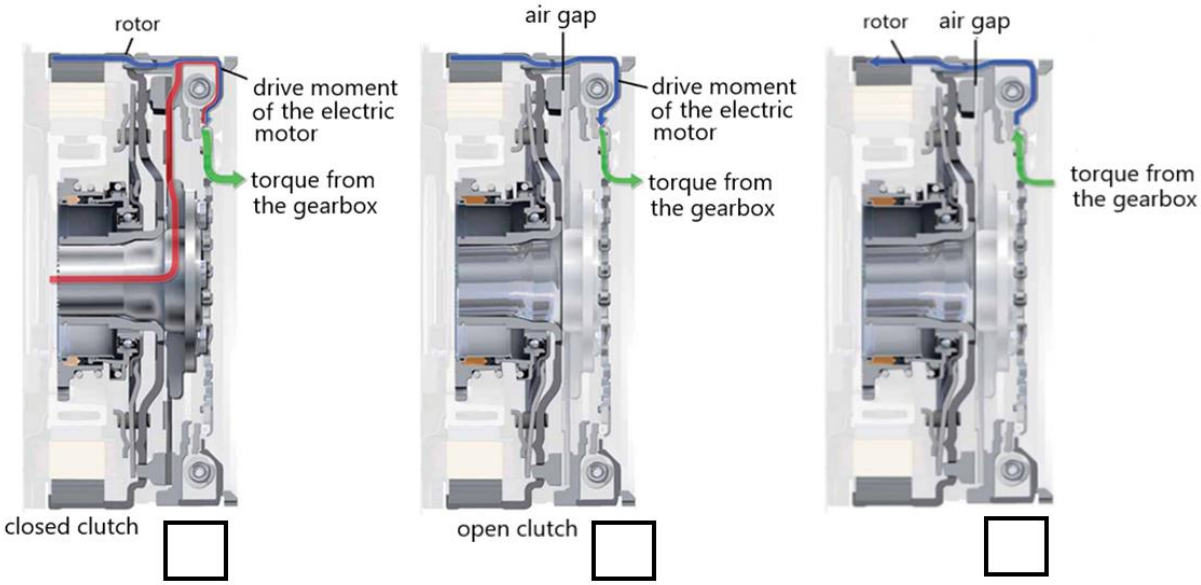
c. The overall strengthened body also in the battery battery area, the PTC heating element (element) is often used for heating.

4. In the picture box, type one of the three available options when releasing the coupling of the clutch:

a. Electric driving

b. Recuperation (Recovery)

c. Internal combustion engine and E-boost



5. Highlight one correct answer.

5.1 Describe the principle of accelerator pedal position sensor operation:

a. Measures the current load of the built-in network

b. sends information to the control unit about the driver's load requirement

c. is an additional value for the brake light switch.

5.2 Describe the dependence of the temperature sensor.

a. The temperature changes the resistance of the sensor.

b. The resistance of the sensor changes when the fluid density changes.

c. Changing the fluid level will change the resistance of the sensor.

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Diagnostics and repair of hybrid vehicles

1. Highlight one correct answer.

1.1 By means of cylinder braking tests on vehicles we can measure:

a. Rolling resistance, acceleration of the vehicle, braking force and oval brake or drum braking.
b. Rolling resistance, vehicle slowness, braking force and ovality of brake discs or drums.
c. Resistance of rolling, braking force and overvoltage of brake discs or drums.

1.2 The operating principle of the throttle position sensor is:

a. measuring the load of the built-in network
b. sending information to the control unit on the request for theload of the conductor
c. is an additional value for the brake light switch.

1.3 Temperature sensor works depending on:

a. change its resistance to temperature,
b. changeover when changing the liquid density
c. change resistance to level change.

1.4 Side acceleration sensor operates at:

a. tempered by its resistance,
b. on the capacitive principle,
c. change the resistance of the resulting level.

1.5 Brake pedal sensor is used:

a. for measuring resistance,
b. for temperature measurement
c. to send the signal to the vehicle control unit.

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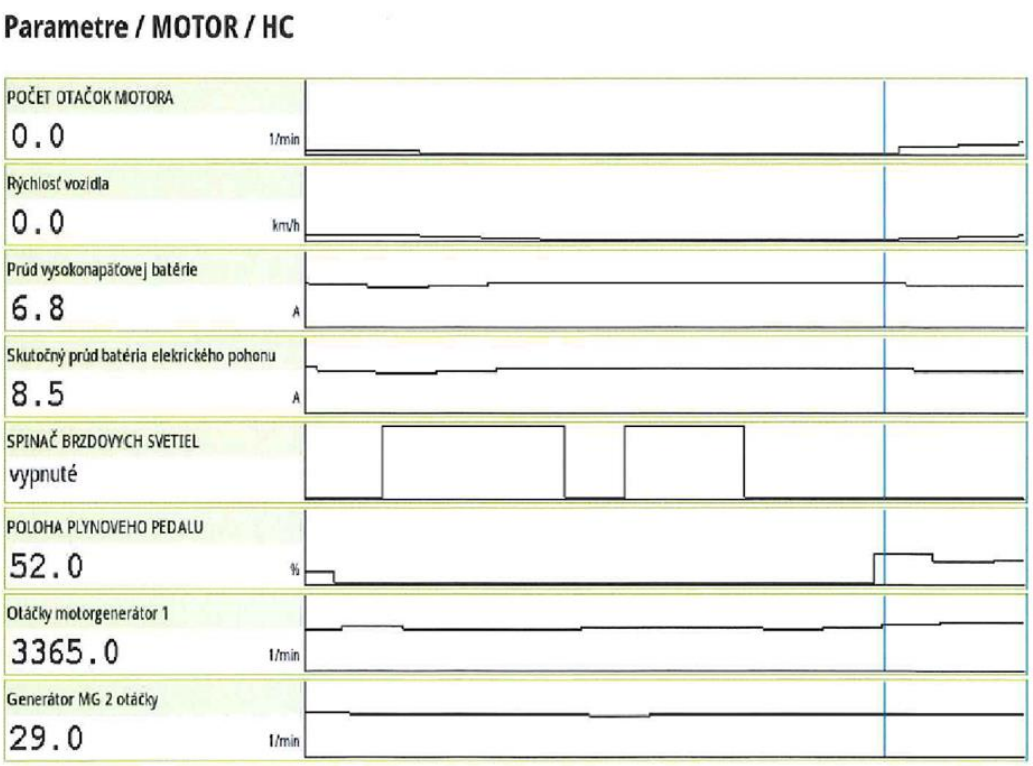
2. Describe the state of the vehicle according to measured values from the diagnostic device, see figure:



2.1 Based on the picture, describe how the motor generator 1 works during the measurement:

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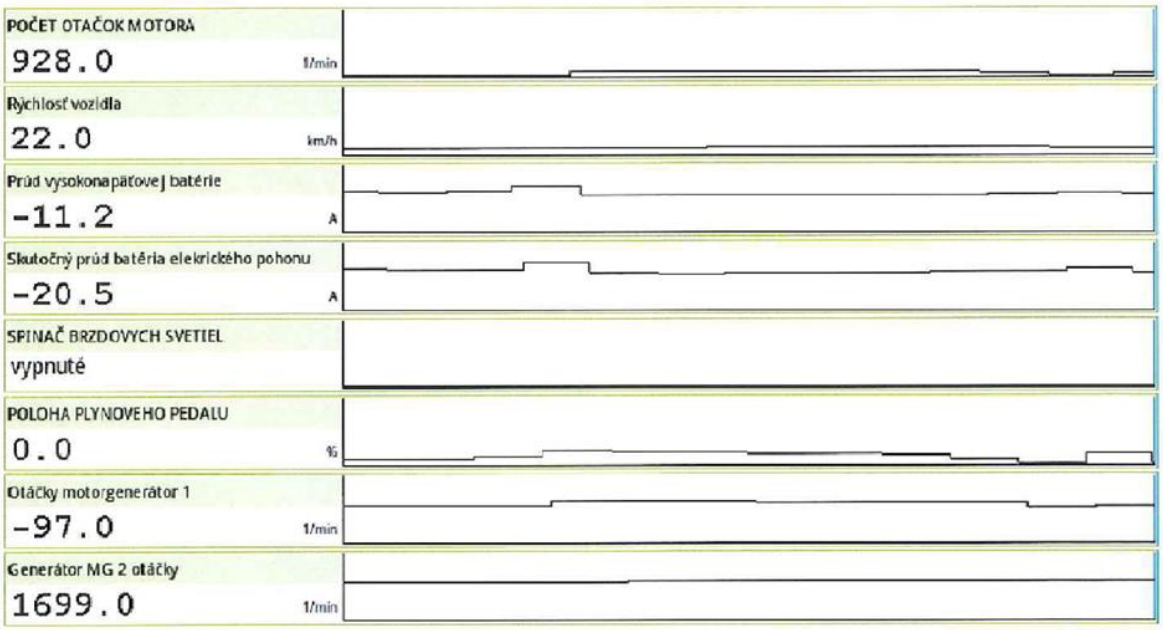
Parametre / MOTOR / HC



2.2 Describe the state of the vehicle by measuring the diagnostic device.

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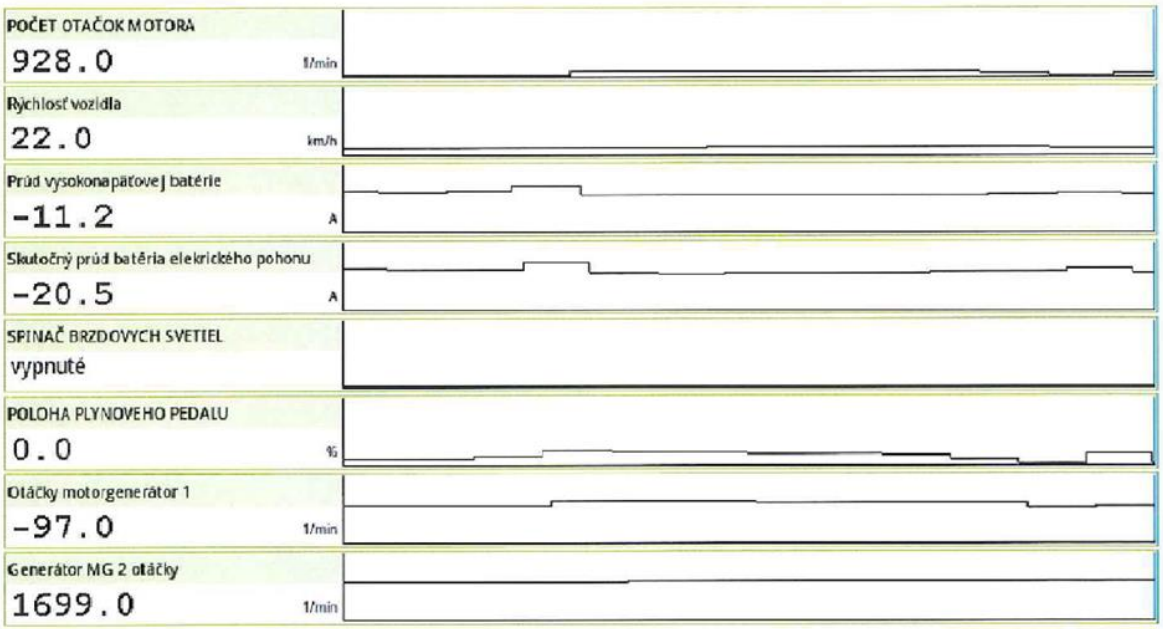
Parametre / MOTOR / HC



2.3 Describe the state of the vehicle by measuring the diagnostic device.

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3. Practical exercises

Tools: diagnostic instrument, hybrid car
Use the diagnostic measuring device for:
Gasoline engine speed, coolant temperature, throttle pedal position, engine speeds of generators 1 and 2.

Add the measured values to the table.

Parameter	Value
GASOLINE ENGINE SPEED	
COOLING TEMPERATURE	
POSITION OF THE THROTTLEPEDAL	
MOTOR GENERATOR 1 SPEED	
MOTOR GENERATOR 2 SPEED	

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