This test includes four mandatory exercises in two pages.
The use of non-programmable calculators is allowed.

Exercise 1 (5 points)   Image given by a converging lens

The document (Doc. 1) represents an object AB and its image A'B' given by a converging lens (L).

Answer by true or false with justification.
1) The lens (L) has thin edges.
2) The image A'B', given by (L), is virtual.
3) The focal length of (L) is negative.
4) The points B', B and O are always collinear.
5) The lens (L) acts, in this case, as a magnifier.

Direction of propagation of light

(Doc. 1)
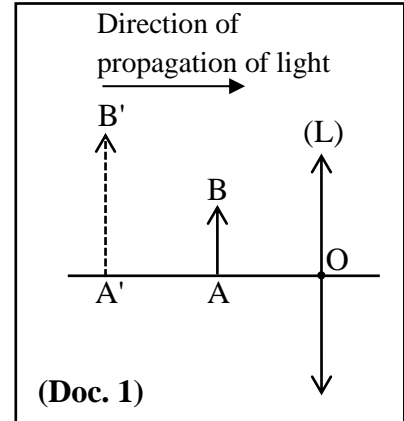
Exercise 2 (5 points)   Electric installation of a kitchen

The electric installation of a kitchen, represented in (Doc. 2), is fed by an alternating sinusoidal voltage, of effective value U = 220 V.
This installation contains the following electric devices:
- A lamp;
- A refrigerator;
- A washing machine.

Lamp (220 V ; 0.5 A)   Refrigerator (220 V ; 5.5 A)   Washing machine (220V ; 4.5 A)   Voltage of the mains   Circuit breaker   K   **(Doc. 2)**

1) All the electric devices function normally. Justify.
2) All the devices are functioning normally at the same time. Specify, among the circuit breakers marked 10 A, 15 A and 30 A, the one that is the most convenient to protect this installation.
3) At the end of 24 hours, the refrigerator, of power 990 W, consumes an electric energy of 9.9 kWh. Specify whether the compressor of this refrigerator is working permanently.
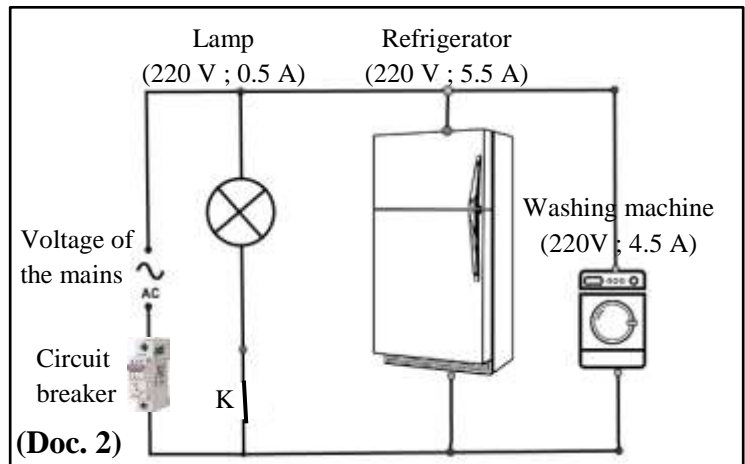
Exercise 3 (4 points)   **Electric circuit**

In a lab session, a lamp, considered as a resistor of resistance R = 450 Ω, is connected in parallel across the terminals of a generator as shown in (Doc. 3). A voltmeter, connected to the terminals of the lamp, reads U = - 9 V.
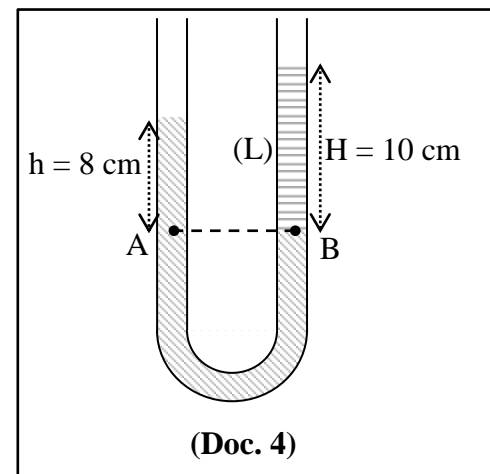1) Specify whether the voltmeter is used in DC mode or in AC mode.
2) How can one modify the voltmeter connections to obtain a positive reading?
3) Calculate the electric current carried by the lamp.
4) Redraw the diagram of the electric circuit represented in (Doc. 3), and insert an ammeter to measure the electric current carried by the lamp.

(Doc. 3)
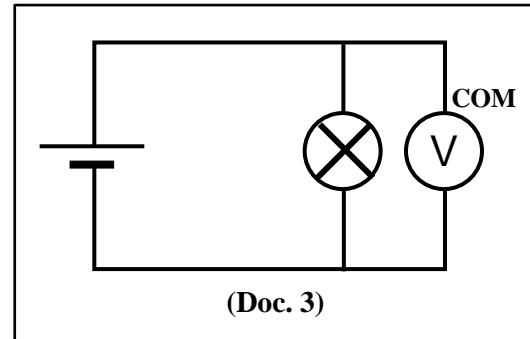
Exercise 4 (6 points)   **Determination of the density of a liquid**

To determine the density ρ of a liquid (L) immiscible with water, we pour a certain quantity of this liquid in one branch of a U shaped tube containing water as represented in (Doc. 4). The two sides of the tube are opened to the atmospheric pressure P_{atm}. At equilibrium, the height of the liquid is H = 10 cm and that of the water above the surface of separation of the two liquids is h = 8 cm.
Given:
- Density of water: ρ_{water} = 1000 kg/m³;
- g = 10 N/kg.
1) Determine, in terms of ρ, the pressure due to the liquid (L) at point B.
2) Calculate the pressure due to the water at point A.
3) The pressures at A and B are equal. Justify.
4) Deduce the value of ρ.

(Doc. 4)

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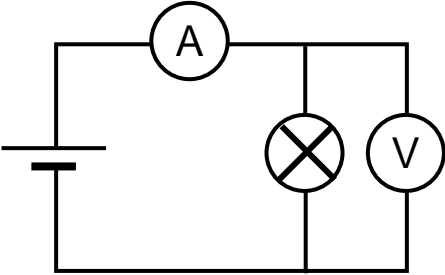
Exercise 1 (5 points) Image given by a converging lens

Question	Answer	Mark
1	True. The lens represented has thin edges because it is a converging lens.	1
2	True. The obtained image is virtual because it is on the same side as that of the object.	1
3	False. The focal length of a converging lens is always positive. (f = $\overline{OF'}$ > 0).	1
4	True. The ray issued from the point object B and passing through the optical center O of (L) continues its path as if it was coming from the point image B'.	1
5	True. The lens acts as a magnifier since the obtained image is virtual, erect and of size larger than that of the object.	1

Exercise 2 (5 points) Electric installation of a kitchen

Question	Answer	Mark
1	All the electric devices function normally since they are connected in parallel across the mains and thus fed by an alternating sinusoidal voltage of effective value 220 V.	1
2	The main current is written as: I = I_1 + I_2 + I_3 = 0.5 + 5.5 + 4.5 = 10.5 A.	1
	The most convenient circuit breaker should be marked 15 A, because the current 15 A is larger than the maximum current carried by the circuit when all the devices function normally, and it's the nearest value to it.	1
3	The power of the refrigerator is: P = 990 W = 0.99 kW. If the compressor functions permanently for Δt = 24 hours, it consumes the energy: E = P×Δt = 0.99×24 = 23.76 kWh	1
	This value is larger than the consumed energy which is 9.9 kWh, then we conclude that the compressor didn't function during the 24 hours.	1

Exercise 3 (4 points)   **Electric circuit**

Question	Answer	Mark
1	The voltmeter is used in the DC mode since the symbol is that of a constant voltage generator.	**1**
2	To obtain a positive reading on the screen of the voltmeter, we reverse the connecting wires.	**1**
3	Ohm's law, U = RI, then I = U/R = 9/450 = 0.02 A	**1**
4		**1**

Exercise 4 (6 points)   **Determination of the density of a liquid**

Question	Answer	Mark
1	The pressure due to the liquid of height H at point B: $P_{B(liquid)} = \rho \times g \times H = \rho \times 10 \times 0.1 = \rho$	**1½**
2	The pressure due to the water of height h at point A: $P_{A(water)} = \rho_{water} \times g \times h = 1000 \times 10 \times 0.08 = 800$ Pa.	**1½**
3	$P_A = P_B$ since A and B are at the same horizontal level and in the same liquid at rest.	**1½**
4	The total pressure at A being equal to that at B, we may write: $P_A = P_B$ $P_{atm} + 800 = P_{atm} + \rho$; then $\rho = 800$ kg/m³.	**1½**