

European School Luxembourg

Summer 2006

European Schools Harmonized Physics exam

Year Five Attempt all questions. Write the answers in the spaces provided on the question paper

Name..... Class

Electricity

1. You are given three resistances - **R1, R2 and R3**, each one of value **12 Ω**.

There are **4** different ways of connecting them, using **all** the resistances. Draw the **4** possible networks of resistances and to show that the possible values of total resistance are:-

A 36Ω B. 4Ω C. 18Ω D. 8Ω

8

2. The electric wires of the de-icing element for the rear glass of a car, are all connected in parallel with the **12V** battery of the car.

The de-icing element has **6** identical electric wires of resistance **6Ω**.

a. Calculate the Size of the current which passes through one of these wires.

2

b. Calculate the power output of one of these wires

2

c. Calculate the total power output of the **6 wires** of the element.

2

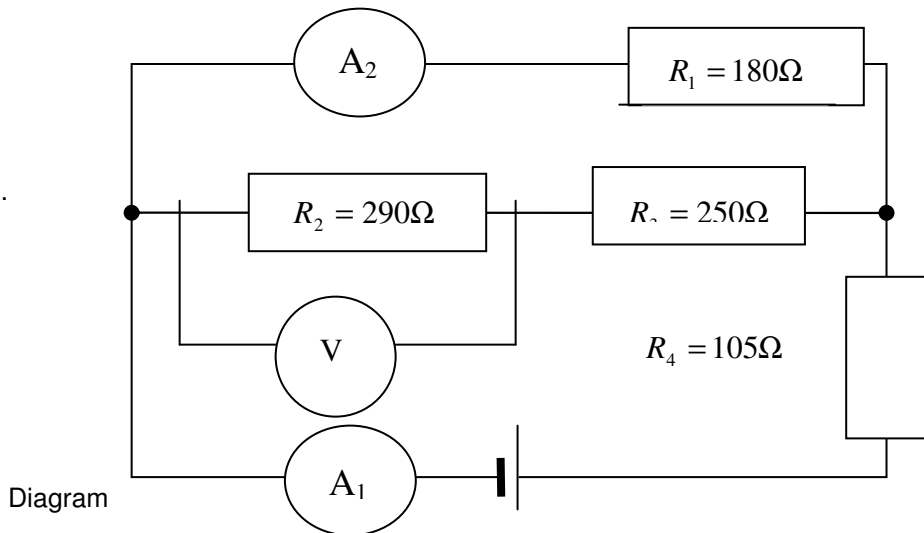
d. How much energy, in Joules, is consumed by the **6 wires in 5 minutes?**

2

3. Calculate the resistance of a high voltage cable made out of aluminium. The length of this cable is **10.0 km** and the cross sectional area is **100 mm²**. given that the resistivity of aluminium is $\rho(\text{Al})=0,0272\Omega \text{ mm}^2/\text{m}$.

4

4. The following diagram shows an electric circuit with 4 resistances.



3

a. Describe how **4** resistances are connected .

3

b. Show that the three resistances, **R1, R2 and R3** can be replaced by an equivalent resistance of **135Ω**.

2

c. Check that the total resistance of the circuit is **240Ω**.

If the Voltage supplied by the power supply is **30V**, determine

2

d. The size of the current which one can read on the **ammeter A1**;

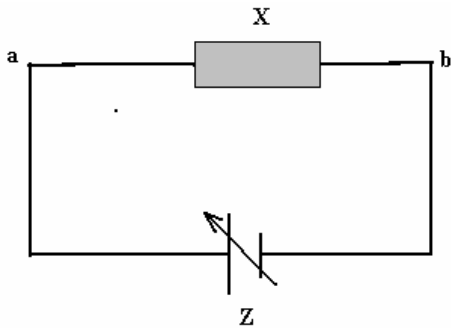
3

e. The size of the current which one can read on the **ammeter A2**;

3

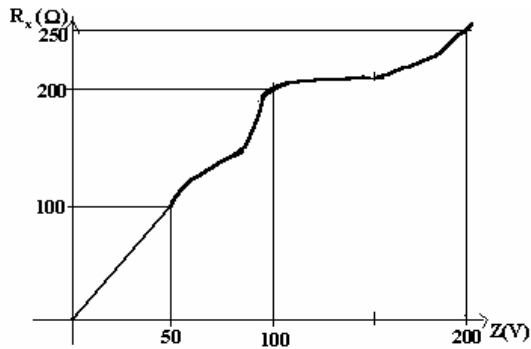
f. The voltage which one can read on the **Voltmeter V**.

5. The diagram shows a circuit where a non-ohmic conductor X is connected to a variable voltage power supply.



Diagram

The resistance of X is plotted on the graph against the voltage Z.



a. In which voltage interval is the component behaving as an ohmic conductor? To justify your answer.

2

b. To determine the value of the current **through X**

if:

i. **Z = 50 V**

2

ii. **Z = 200 V**

2

c. Calculate the electrical power output if **Z = 100 V**.

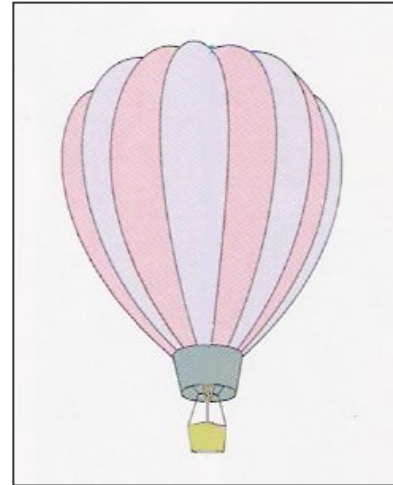
2

MECHANICS

For all the questions consider gravitational Acceleration to be $g=10\text{m/s}^2$

1. The figure shows a Montgolfier balloon of total **mass $m = 450\text{kg}$** .
After rising, two forces operate the Montgolfier balloon: gravity and upthrust due to flotation.

a. Draw the two forces which act on the Montgolfier balloon.



3

b. Calculate the force of gravity of the Montgolfier balloon

3

The upthrust or floating force is **$F=5119\text{N}$**

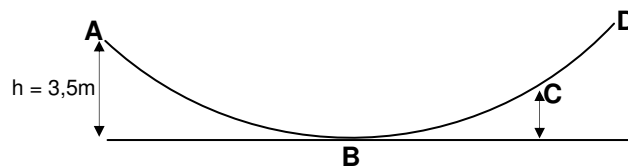
c. Calculate the total effective force acting on the Montgolfier balloon.

3

d. Calculate its acceleration

2

2. A roller of **60 kg mass** rolls on a semi circular



Friction (of both the track and of the air) is negligible between points A B C and D.

The roller starts at A, at a **height of 3.5m**.

3

a. Calculate its potential energy at position A

b. Determine the kinetic energy of the roller when it arrives at the position **B**

3

c. Calculate the speed of the roller at the position **B**

3

The position C is **2m above B**

d. Show by calculation that the speed of the roller when it passes by the point **C is $v=5.43$ m/s (approximately.)**

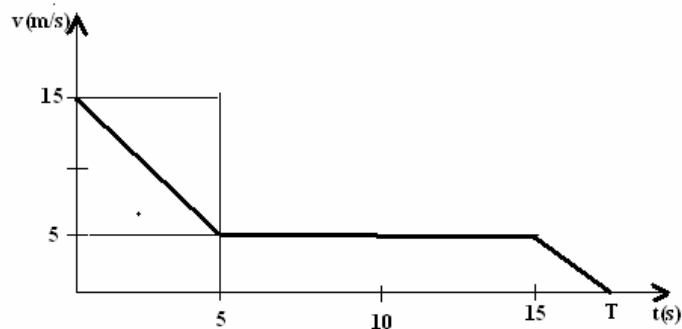
3

When the roller reaches **position B**, it has lost **20%** of its initial energy and it will never arrive at position **D**.

e. Calculate the vertical height to which it rises, while going up the track

3

3. The graph shows the variation speed of a motor cycle compared with time. The total mass of the system (rider + motor bike) is **$m=250$ kg**. At the start, the rider and his motor cycle have a speed of **$v=15$ m/s**.



3

a. Calculate the kinetic energy of the system.

By applying the brakes, speed drops, **in 5 s, to 5 m/s.**

b. Calculate the new value of the kinetic energy.

3

c. Determine the work done by the brakes to reduce the speed

3

d. Calculate the value of the average force (**F**) applied to the system.

3

The motor cycle continues at **5m.s⁻¹** for another **10 s.** then slows to a stop using a braking force of **500N.**

e. Calculate deceleration

2

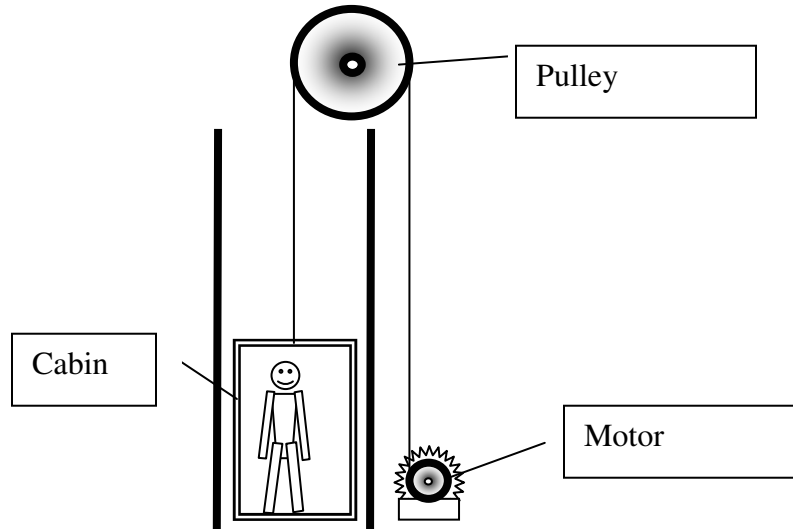
f. Determine the time T (see graph) at which they stop.

2

g. calculate the overall distance traversed from **t=0 to t=T.**

2

3. A person of **80 kg** is in the cabin of an elevator of mass **300kg**. The cabin can move in up and down, without friction, using an electric motor. The elevator is located in a building with **20 floors**. The height of each stage is **4m**. The masses of any other elements (cables etc.) are negligible compared to the masses of the elevator and the person.



a) Calculate the work done to raise the person and the elevator from the **3rd to the 20th** floor.

3

b) The electric motor has a power of **8kW**. To raise the person and the elevator from **3rd** to the **20th** floor takes **42s**. Calculate the energy used by the motor.

3

c) Calculate the energy output of the motor raising the elevator.

—

2

d) Work out the size of the force that the person exerts on the floor of the elevator in the following situations.

1. **The cabin is not moving**

1

1

2. The cabin is moving upwards with constant **acceleration of 3m/s^2**

1

3. The cabin is moving upwards with **constant speed of 27m/s**

1

4. The cord has broken and the cabin **is falling downwards.**

--	--