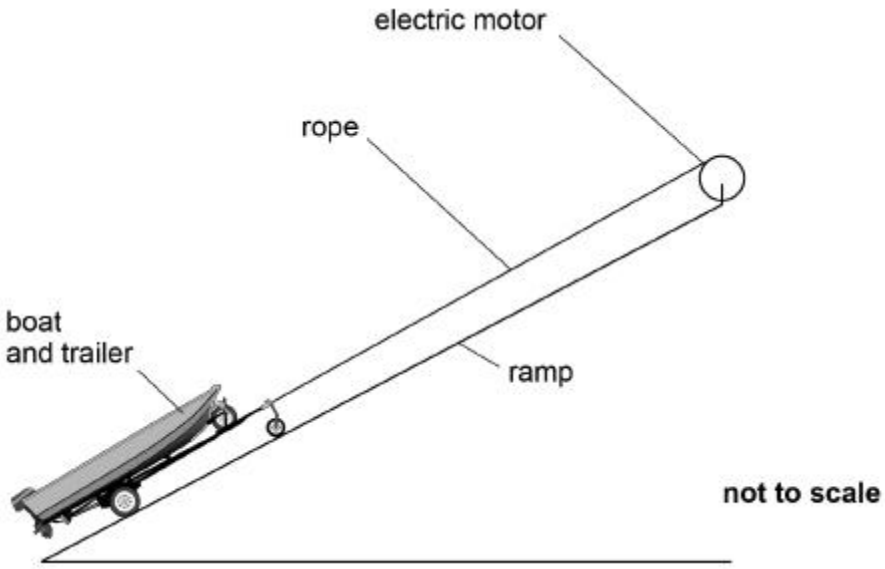
Name of the Student:_____
Max. Marks : 19 Marks **Time : 19 Minutes**

Q1.

This question is about the initial motion of a boat and trailer when pulled up a ramp as shown in **Figure 1**.

Figure 1



The boat and trailer are pulled by a motor which is connected to a 24 V battery of negligible internal resistance.

The motor is switched on at time $t = 0$
Figure 2 shows how the current in the motor's circuit varies with time.

Figure 2

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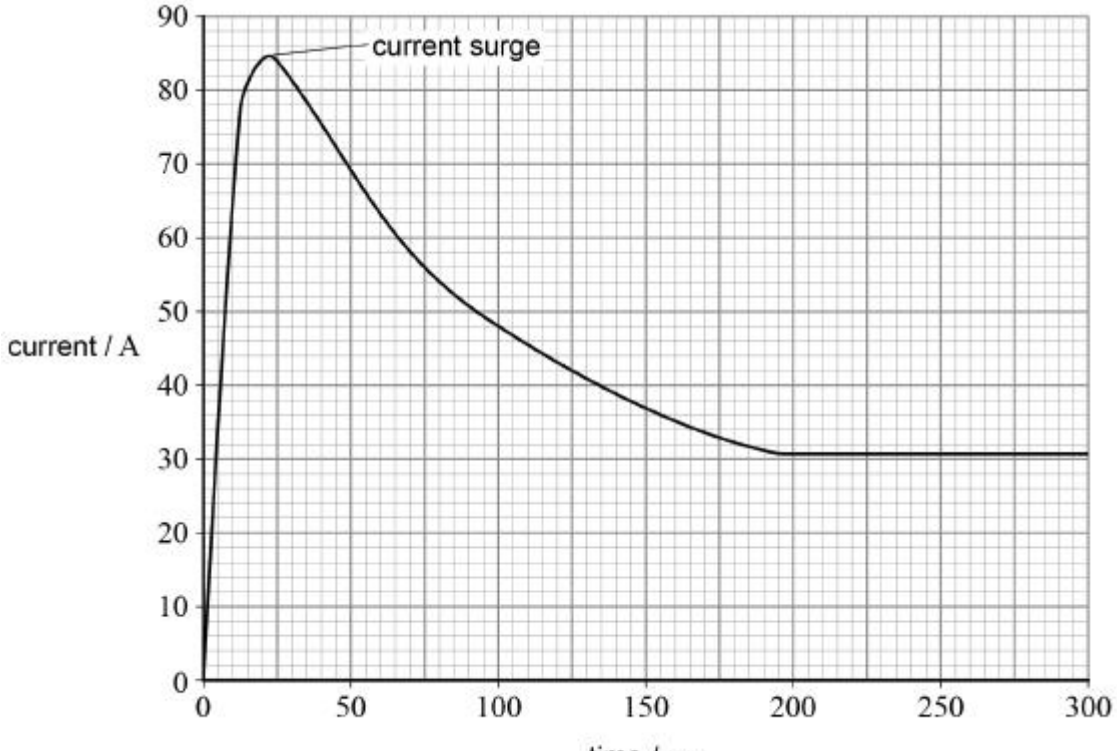

(a) Determine the total energy input by the 24 V battery to the motor in the first 200 ms.

total energy input = _____ J

(3)

(b) The boat and trailer are initially at rest. In the first 200 ms the boat and trailer are raised through a vertical height of 3.3×10^{-2} m and the speed increases to 0.85 m s^{-1}.

Assume that all the useful energy output by the motor is transferred into kinetic energy and gravitational potential energy of the boat and trailer.
The boat and trailer have a total mass of 180 kg.

Determine the average efficiency of the motor during these first 200 ms.

average efficiency = _____

(3)

(c) Either of the circuits shown in **Figure 3a** and **Figure 3b** could be used to reduce the initial current surge.

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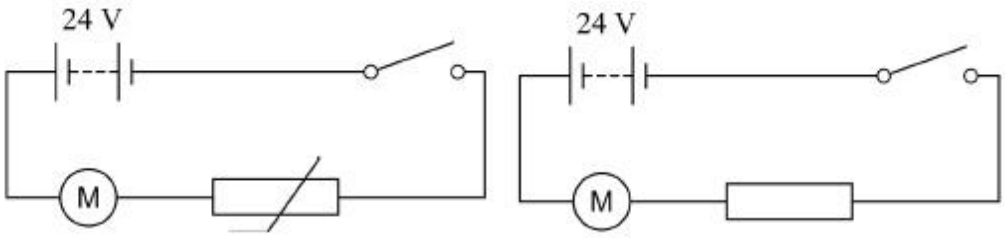
Figure 3a **Figure 3b**



The thermistor and the fixed resistor have the same resistance when they are at the temperature of the surroundings.

When the surge has ended, the boat and trailer continue to move at a constant speed to the top of the ramp.

Explain, with reference to the properties of the thermistor and the fixed resistor, why using the thermistor is preferable to using the fixed resistor.

_____

_____

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_____

(3)

(Total 9 marks)

Q2.

A student connects four lamps **A**, **B**, **C** and **D** in the circuit shown in **Figure 1**.
The battery has an emf of 9.0 V and negligible internal resistance.

Figure 1

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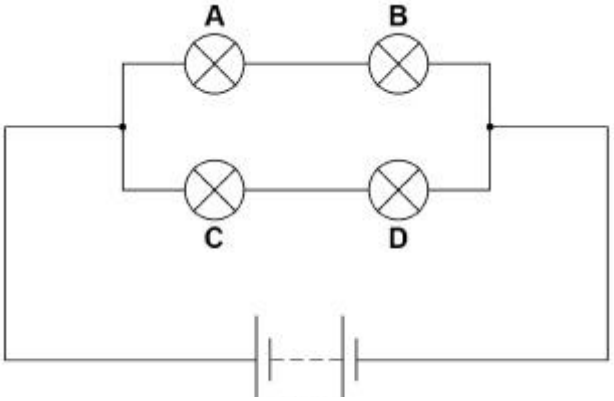

(a) The table shows the operating conditions for the lamps when they are at normal brightness.

Lamps	Operating voltage / V	Power / W
A and **C**	6.0	6.0
B and **D**	3.5	4.1

The student observes that **two** of the lamps are at their normal brightness.
Assume that any changes in resistance of the lamps are negligible.

Determine which **two** lamps are at their normal brightness.

Use calculations to support your answer.

_____

_____

_____

(4)

(b) The student connects another lamp **E** in the circuit as shown in **Figure 2**.
Lamp **E** is identical to lamps **A** and **C**.

Figure 2

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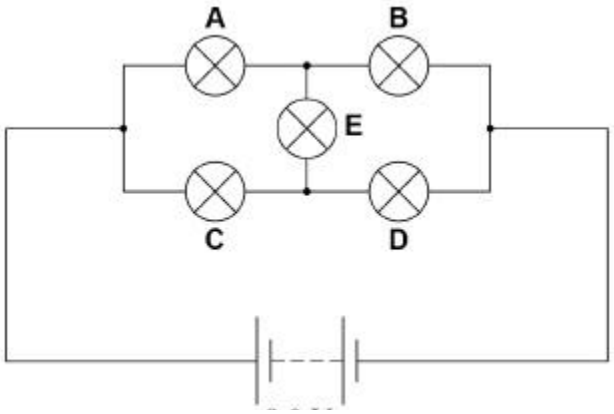

Explain what the student would observe regarding the brightness of the lamps.

Refer to potential differences across lamp **E** in your answer.

(3)

(c) Lamp **B** in **Figure 2** fails so that it no longer conducts. This change does not affect the resistance of the other lamps.

Deduce the effect on the current in the battery.

Use calculations to support your answer.

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_____

_____

_____

_____

(3)
(Total 10 marks)

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