**5** The efficiency of an electric motor is investigated as shown in Figure 11.

The motor lifts a mass at a constant speed.

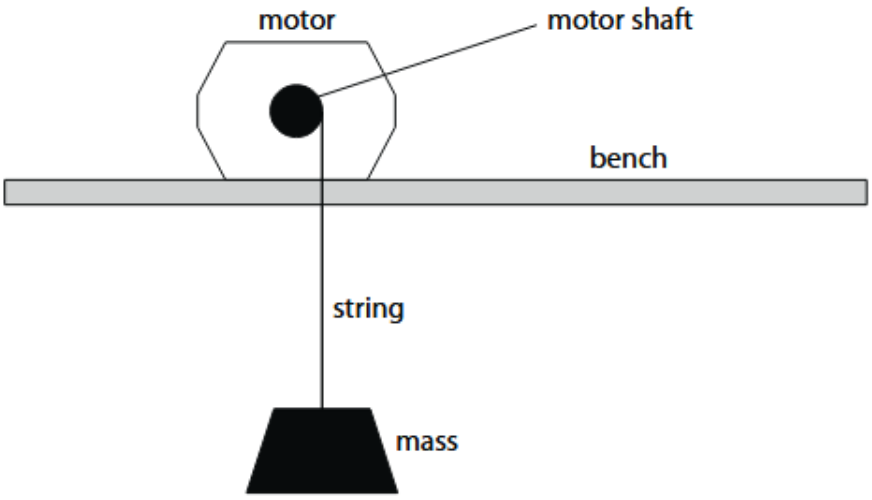


**Figure 11**

The results are shown in Figure 12.

| | |
|---|---|
| current in motor | 1.9 A |
| voltage across motor | 10.0 V |
| time taken to lift mass | 9.0 s |

**Figure 12**

(a) (i) Which of these changes would improve the results?

(1)

- ☒ **A** Repeating the investigation with different masses
- ☒ **B** Repeating the readings and calculating averages
- ☒ **C** Using a motor that works with a higher voltage
- ☒ **D** Using a shorter piece of string to lift the mass

(ii) Which of these best shows the energy stores as the mass is lifted?

**(1)**

| | kinetic energy of the mass | potential energy of the mass |
|---|---|---|
| ☒ **A** | constant | increasing |
| ☒ **B** | constant | decreasing |
| ☒ **C** | decreasing | increasing |
| ☒ **D** | decreasing | decreasing |

(b) (i) Show that the total energy supplied to the motor in the 9 s is about 170 J.

**(2)**

(ii) During the 9 s the efficiency of the motor is 70%.

Calculate the amount of useful energy transferred in the 9 s.

Use the equation

$$\text{efficiency} = \frac{\text{useful energy transferred}}{\text{total energy supplied}}$$

**(3)**

(c) Which row of the table is correct for the resistance of the motor?

**(1)**

| | resistance of motor = | resistance of motor = |
|---|---|---|
| ☒ **A** | $I \div V$ | $I^2 \div P$ |
| ☒ **B** | $V \div I$ | $P \div I^2$ |
| ☒ **C** | $V \div I$ | $P \times I^2$ |
| ☒ **D** | $I \times V$ | $P \div I^2$ |

(d) When the motor lifts the mass, the coil in the motor becomes warm.

Explain why the coil becomes warm.

**(3)**

**(Total for Question 5 = 11 marks)**

| Question number | Answer | Mark |
|---|---|---|
| 5(a)(i) | B | (1) |

| Question number | Answer | Mark |
|---|---|---|
| 5(a)(ii) | A | (1) |

| Question number | Answer | Mark |
|---|---|---|
| 5(b)(i) | substitution into correct equation (1)<br>= 1.9 × 10.0 × 9.0<br><br>answer (1)<br>171 (J)<br>(which is about 170 J)<br><br>Answer must be shown to<br>3 significant figures | (2) |

| Question number | Answer | Additional guidance | Mark |
|---|---|---|---|
| 5(b)(ii) | rearrangement (1)<br>(useful energy transferred) = efficiency × total energy supplied<br><br>substitution (1)<br>= (70 × 170)÷100<br><br>answer (1)<br>119 (J) | award full marks for correct numerical answer without working<br><br>accept (useful energy transferred)<br>= 170 × 0.7<br>OR<br>= 171 × 0.7<br><br>accept alternative answer from 171 (J) i.e. 120 (J) | (3) |

| Question number | Answer | Mark |
|---|---|---|
| 5(c) | B | (1) |

| Question number | Answer | Mark |
|---|---|---|
| 5(d) | An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (2 marks):<br>• the coil contains wires which have a resistance (1)<br>• and current in the wire is due to movement of electrons through (close-packed) lattice of positive ions (1)<br>• hence collisions between electrons and ions in the lattice transfer energy from electrons to the lattice (causing the temperature of the wires/coil to rise) (1) | (3) |