Worksheet answers

1. Take a look at the dashboard (at 0:10). Record the level of charge in the battery and what level you see on the energy use arrow.

   The level of the battery charge shows it's fully charged. The energy use arrow has half a green bar highlighted.

2. Look at the dashboard (at 0:31). Record the level of charge in the battery, speed the car is travelling and what level you see on the energy use arrow.

   The level of charge in the battery shows full charge. The car is travelling at 60 km/h. The energy use arrow shows four green bars.

3. Describe what you see happening to the energy use arrow in the interval: 0:10 to 0:31.

   The bars in the arrow increase from half a green bar, to four green bars, to four yellow bars, and then to two red bars. They disappear in reverse order. At 31 seconds the energy use arrow has four green bars.

4. Describe how the change in the energy use arrow relates to how the car's being driven.

   The car begins in a stationary position, idling, with half a green bar on the energy use arrow. As the lights turn green and the driver accelerates, the energy use arrow moves from green to yellow to red. Once the car reaches 60 km/h and is no longer accelerating, energy use reduces to four green bars.

Introducing the graph

5. Look at the time interval 0:00 to 1:00 on the graph. How much does the battery charge change during this time?

   Battery charge decreases by 1%.

6. Look at the time interval 0:15 to 0:30 on the graph and learning object.

   a. How much has the battery charge changed during this interval?

   Battery charge decreases by about 0.7%.

   b. What activity that uses most energy in this interval? (hint: What happens in the car journey when the energy use arrow goes into the red bars?)

   The activity that uses most energy is acceleration of the car from a stationary position at the red light.

7. Look at the time interval 1:00 to 1:15 on the graph and learning object. Explain with reference to the graph and the learning object what happens during this interval.

   The battery charge decreases by 1% in this 15 sec interval. The car drives around a corner at 20 km/h, then accelerates up a steep hill. The inclinometer shows the hill has an incline of about 20 degrees. During this time period, the energy use arrow completely lights up. It shows four green bars, four yellow bars and four red bars. The car uses a lot of energy to accelerate up the hill and reach a maximum travelling speed of 55 km/h.

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Tracking energy transformations during the drive

8. Explain the overall shape of the graph. What does it show?

   The overall shape shows a decrease in battery charge as we drive the electric car. This is because driving a car requires energy. The battery decrease indicates energy is being used to drive the car.

9. Complete this table to show which activity uses most energy in each given time interval, and the percentage decrease in the battery charge.

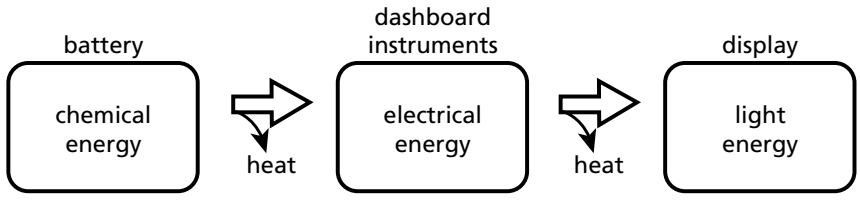
MARKER (on video)	**TIME INTERVAL**	**ACTIVITY THAT USES THE MOST ENERGY** (watch the learning object)	DECREASE IN BATTERY CHARGE (%) (use the graph)
A	0:15 – 0:30	*acceleration*	*about 0.7%*
B	1:00 – 1:15	*acceleration*	*1.0%*
D	3:30 – 3:45	*air-conditioning (cold) turned on*	*about 0.2%*
E	3:45 – 4:05	*constant speed uphill*	*about 0.8%*
F	5:15 – 5:30	*acceleration*	*about 0.3%*
H	6:22 – 6:30	*air-conditioning (heat) turned on*	*about 0.8%*

10. When stationary at traffic lights (0:10), the energy use arrow on the car's dashboard indicates the electric vehicle continues to use energy.

    a. What could be using energy within the car at this at this point?

    Energy could be used for the dashboard display and sensors in the car.

    b. Draw an energy flow diagram to show energy transformations that occur when the vehicle is stopped.



11. Watch these two segments on the learning object: marker B (1:00 to 1:15) and marker G (5:40 to 6:15).

    a. Explain why energy use by the electric car is greater when it accelerates hard up a hill than when it drives at a constant speed on a flat road.

    When the car drives on a flat road at a constant speed, the car uses a constant amount of energy. We can see this as the energy use arrow stays on four green bars and the car's speedo sits just under 40 km/h. However, when a car accelerates hard up a hill, the car needs extra energy to drive it up the hill against gravity. We see this as the energy use arrow goes into the red bars and the speedo increases from 20 km/h to 55 km/h.

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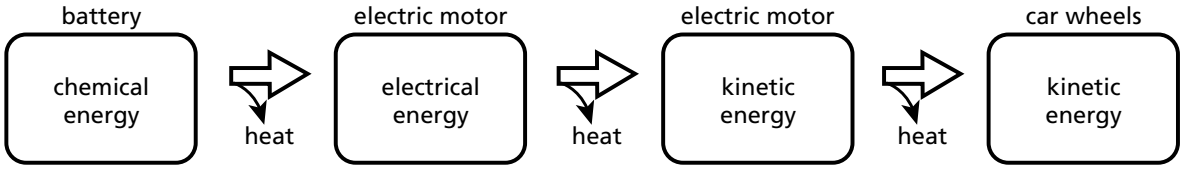
b. Draw an energy flow diagram to represent energy transformations when a car accelerates uphill.



12. Watch the learning object from 1:40 to 2:00 where the electric car travels at a constant speed of 60 km/h. Then answer the following questions.

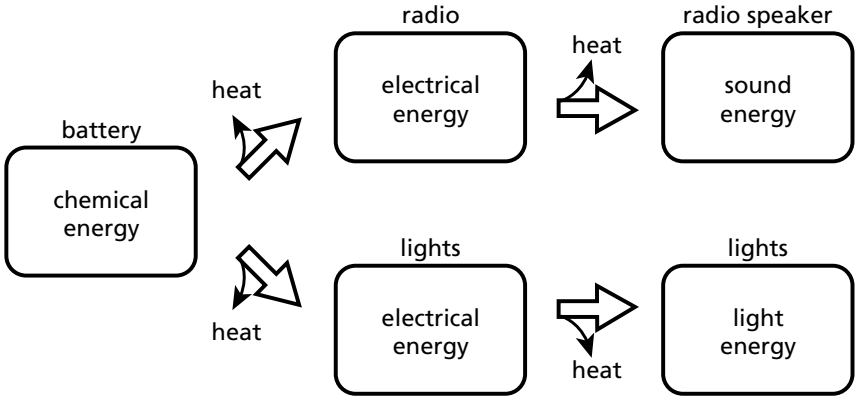
a. Explain what's happening to the energy use during this time interval.

The car drives down a slight incline and travels at 60 km/h. The driver turns on the radio and lights at 1:42 and the energy usage bar increases to one yellow. The accessories contribute to energy usage.

b. List two other accessories that greatly increase energy use when driving the electric car.

air-conditioning (cold), air-conditioning (heat)

c. Draw an energy flow diagram to represent energy transformations when radio and lights are turned on in an electric vehicle.



13. The air-conditioner is turned on twice during the drive, once for cooling (Marker D, 3:33) and once for heating (6:24).

a. What effect does turning on the air-conditioner have on energy use in the electric car?

Energy use increases. The graph shows increased energy use by a steeper negative slope. Energy is required to heat or cool an electric vehicle.

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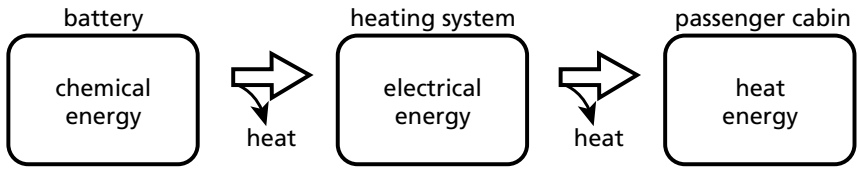
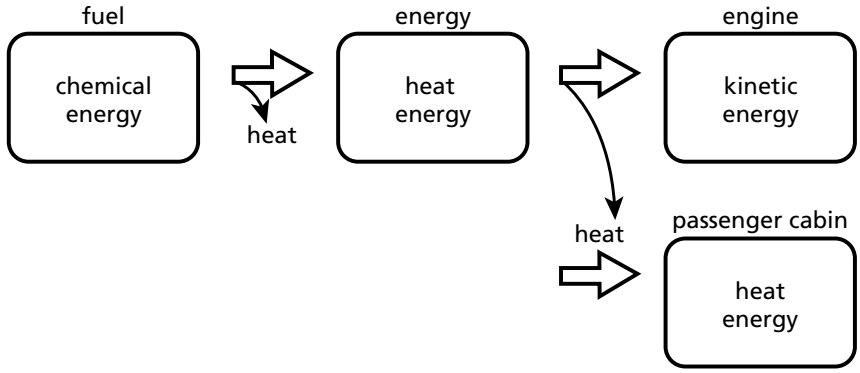
b. Draw an energy flow diagram to represent energy transformations when the heater is turned on in an electric vehicle.



c. A traditional combustion engine vehicle loses energy as heat and uses this for heating the car. Draw an energy flow diagram to represent energy transformations when the heater is on in a combustion engine car.



14. Describe conditions where the electric car is driving efficiently. Then identify a section of the learning object that illustrates this.

The electric car drives along a flat road at a constant speed. No accessories are on and there's no braking or accelerating. Section 0.31 – 0.41 min illustrates this. Driving downhill with no accessories on would also illustrate this.

15. Watch the learning object from 7:00 to 7:30 (Marker I), then answer the following questions.

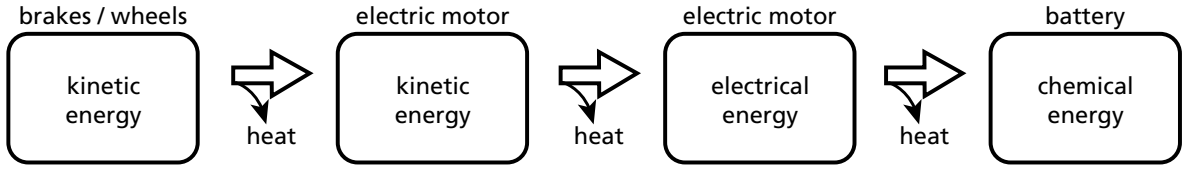
a. Explain what happens during this time interval when the car dashboard looks like this (7:20). The *Renewable Energy Vehicle* Factsheet will help you.

The car drives slowly downhill (inclinometer and speedo indicate this). The brakes are being applied and the regenerative braking arrow is on. Energy produced by the car brakes recharges the battery. This is regenerative braking.

b. How does the graph help to explain your answer to part a, above?

There's a net energy gain. The battery charge has increased. The graph goes slightly upward during this interval. This is the only interval where the battery charge is not decreasing.

c. Draw an energy flow diagram to represent energy transformations when an electric vehicle brakes.



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16. Driving in a city often means frequent braking to slow down for traffic, give-way signs, pedestrians and cyclists. Can you think of a reason why electric cars have an advantage over combustion engine cars when driving in a city? Use the *Renewable energy vehicle* fact sheet, graph and learning object, to help you explain why this may be true.

    There's lots of starting and stopping in the city. This means the driver often brakes to slow down. In the learning object the regenerative braking arrow lights up at least eight times as the car slows down. The regenerative braking system of electric vehicles feeds most energy created by braking back into cars' batteries. Much less energy is lost as heat when braking compared with combustion engine cars. The graph shows one interval where energy is fed back into the car's battery. An advantage of an electric car is that regenerative braking extends the car's range.

17. The regenerative braking arrow lights up multiple times during the journey. However, there's only one time interval on the graph where we see an increase in battery charge (7:15 to 7:30). With reference to energy, can you explain why this might be?

    This shows there's only one interval when the amount energy generated by the brakes and put back into the battery is more than the amount of energy used to drive the car. For all other times during the drive when the regenerative braking arrow comes on, more energy is required to move the car than is supplied by regenerative braking.

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