

## Concepts of Physics: Homework 7

Due: 21 October 2022

### 1 Converting thermal energy into work

A skier slides down a slope, producing 500 J of thermal energy. Is it possible to convert some of this back into useful kinetic or potential energy? Is it possible to convert all of this back into useful kinetic or potential energy? Explain your answers.

### 2 Gas engine efficiency

A gas engine operates in a cycle. During one cycle 2000 J of energy is supplied and there is 1500 J of waste energy. Determine the efficiency of the engine.

### 3 Gas engine input energy

A gas engine operates in a cycle, with efficiency 0.25. During one cycle it produces 1000 J of useful output energy. What input energy is required and what waste energy is produced during one cycle?

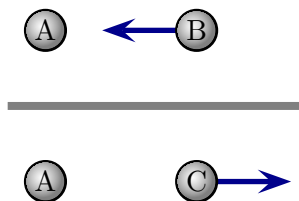
### 4 Skateboarder and energy

A skateboarder with mass 50 kg skates up and down a bowl-shaped surface. The skater eventually comes to a stop, having produced 5000 J of thermal energy.

- If all the thermal energy could be converted back into useful kinetic energy that would propel the skateboarder up the ramp, determine the maximum height that the skateboarder could reach.
- Explain whether it is possible to accomplish this without any outside intervention.

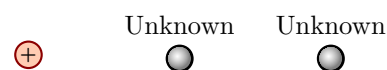
### 5 Pairs of charged balls

Various pairs of balls that may or may not be charged are placed near each other and the observed interactions are as illustrated. What interaction would occur if C were placed near to B? Explain your answer.



### 6 Combined electric forces

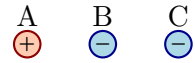
Three charged particles are held at fixed locations. The distances between adjacent charges are the same and the sizes of their charges are the same. The particle on the left is positively charged.



- Suppose there is no net force on the middle charge. What type of charge could the particle on the right have? Explain your answer.
- Suppose the net force on the middle charge points right. What type of charge could the particle on the right have? Explain your answer.

### 7 Electric forces and charge particle motion

Three charged particles are held at fixed locations. The distances between adjacent charges are the same and the sizes of their charges are the same. The charge in the middle (B) is initially held at rest and is then released. After it is released, which way will it begin to move? Explain your answer.



8 Hobson, *Physics, Concepts and Connections, 5ed*, Ch. 8 Conceptual Exercise 14, page 184.

### 9 Motion of an ion

An ion is an atom that has lost (or perhaps gained) one or more electrons. Consider:

- A potassium ion: a neutral potassium atom that has lost one electron.
- A calcium ion: a neutral calcium atom that has lost two electrons.



In separate experiments each is held at rest the same distance above a negatively charged sheet of metal and then released.

- Describe the motion of the charges after they have been released.
- At the moment of release, will the force on the calcium ion be the same as, larger than or smaller than the force on the potassium ion? Explain your answer.
- Suppose that each charge is observed when it has moved the same distance from or towards the plate. Will the speed of the calcium ion be the same as, larger than or smaller than the speed of the potassium ion? Explain your answer.
- The motion of calcium ions is not a hypothetical issue. Briefly describe some reasons why it is important for your life. You can look up this information.

### 10 Reading exercise: interference of waves

Read section 9.2 (pages 190-193). The following exercises are intended to give you an understanding of the concepts presented in the text.

- Sound consists of waves which are similar to the water waves illustrated in Fig. 9.12. Suppose that two speakers situated close to each produce sound waves that travel outwards

and that a listener moves his/hear ear around to the right of the speakers (corresponding to moving up and down along the right edge of Fig. 9.12). What would the listener observe (i.e. hear)?

- b) Do Concept Check 4 on page 191. After you have done it check the answer at the end of the text.
- c) Do Conceptual Exercise 9 on page 222.