

Unless stated otherwise, there is no air resistance and no friction.

1. Describe the following situations a) to h) in the language of physics. Use

«... is doing work on ... .. 's ... energy increases while ... 's energy decreases.»

*Example:* Lucy is lifting her backpack off the floor and putting it on the table.

«Lucy is doing work on her backpack. The backpack's gravitational potential energy increases while Lucy's energy decreases.»

- A crane is lifting a piano onto the sixth floor.
- While a truck brakes (wheels locked) the asphalt's and the tires' temperature increases.
- Margaret is compressing a spring.
- The spring in a toy pistol gun is accelerating the dart.
- Francis is winding up his grandfather's cuckoo clock by pulling its weights up.
- Amy's winding up her toy car's mainspring.
- The toy car's mainspring is accelerating the car.
- The toy car crashes into a wall thus the toy car and the wall are slightly warmed by the impact.



2. Miss Hilton ( $m = 58.0$  kg) is standing on the fifth floor ( $h = 15.0$  m) of a hotel.

- What form of energy does she possess?
- Calculate the amount of energy she possesses.

3. A coil spring ( $k = 5.0 \frac{\text{N}}{\text{cm}}$ ) has been stretched by 1.00 cm.

- What form of energy does it possess?
- Calculate the amount of energy it possesses.



4. An SBB intercity train with a mass of 453 t and length of 100.0 m is travelling at  $199 \frac{\text{km}}{\text{h}}$ .

- What form of energy does it possess?
- Calculate the amount of energy it possesses.

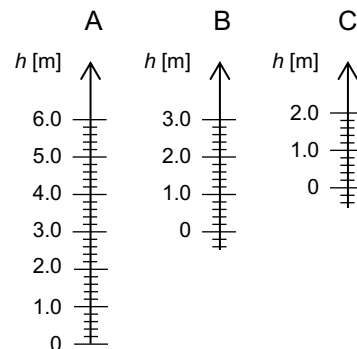
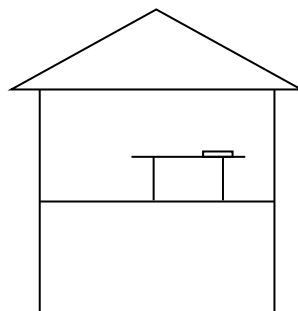
5. The Airbus A320 ( $m = 77.0$  t) is one of Edelweiss' fleet's airplanes which is used for short- and medium-haul routes. It carries up to 174 passengers and is travelling at 11'900 m above sea level at a speed of  $885 \frac{\text{km}}{\text{h}}$ .

What is its total amount of energy?

6. The gravitational potential energy of the chocolate depends on the chosen reference level.

What is the energy of the chocolate ( $m = 0.100$  kg) relative to

- (ground floor),
- (first floor) and
- (tabletop)?



7. A coil spring ( $k = 2.0 \frac{\text{N}}{\text{cm}}$ ) was compressed by 5.0 cm. A little bullet ( $m = 40.0 \text{ g}$ ) is placed on it, then the spring is released and the bullet is shot vertically upwards.
- What is the elastic potential energy of the compressed spring?
  - What height does the bullet reach?
  - What is the velocity of the bullet the moment it leaves the spring?
8. Trevor ( $m = 88.0 \text{ kg}$ ) is walking up the Üetliberg, starting at Triemli and ending at the lookout tower. The difference in altitude is 384 m. Before he starts out, he eats some chocolate. His favourite chocolate is the bittersweet kind which contains 2'180 kJ of energy per 100 g. How much chocolate (in g) is needed for the ascent?
9. A flower pot ( $m = 2.00 \text{ kg}$ ) falls out the window ( $h = 20.0 \text{ m}$ ).
- Determine its gravitational potential energy before the fall.
  - Determine its velocity shortly before it reaches the ground.
  - What would be the velocity of a flower pot which is twice as heavy?
10. A ball is thrown vertically upwards with an initial velocity of  $7.6 \frac{\text{m}}{\text{s}}$ . Calculate the height it reaches.
11. A rock ( $m = 5.00 \text{ kg}$ ) is thrown from a bridge ( $h = 23.0 \text{ m}$ ) with an initial velocity of  $10.0 \frac{\text{m}}{\text{s}}$ .
- What is its total energy right after it was tossed?
  - What is its gravitational potential energy at 4.00 m above the ground?
  - What is its kinetic energy at 4.00 m above the ground?
  - What is its velocity at 4.00 m above the ground?
  - At what height above the ground does its velocity amount to  $15.0 \frac{\text{m}}{\text{s}}$ ?
12. A rubber bouncing ball ( $m = 25 \text{ g}$ ) is thrown vertically down with a velocity of  $4.80 \frac{\text{m}}{\text{s}}$  from a height of 3.32 m. As it touches the ground, 25% of its mechanical energy is transformed into internal energy. How high does the ball bounce back?

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Solutions:

2. b) 8.53 kJ  
 3. b) 25 mJ  
 4. b) 0.692 GJ  
 5. 11.3 GJ  
 6. A) 4.1 J      B) 1.2 J C) 0  
 7. a) 0.25 J      b) 64 cm      c)  $3.5 \frac{\text{m}}{\text{s}}$   
 8. 15.2 g  
 9. a) 392 J      b)  $19.8 \frac{\text{m}}{\text{s}}$       c)  $19.8 \frac{\text{m}}{\text{s}}$   
 10. 2.9 m  
 11. a) 1.38 kJ      b) 196 J      c) 1.18 kJ      d)  $21.7 \frac{\text{m}}{\text{s}}$       e) 16.6 m  
 12. 3.4 m