Unit 3 Part 1 Review (Work, Energy, Power, Efficiency)
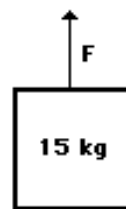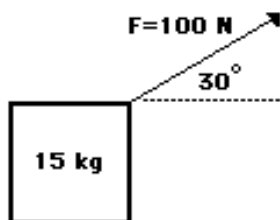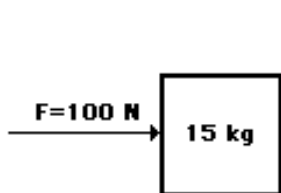
1) Apply the work equation to determine the amount of work done by the applied force in each of the situations described below.

a) A 100 N force is applied to move a 15.0 kg object a horizontal distance of 5.0 meters at constant speed. *[ans: 500 J]*

b) A 100. N force is applied at an angle of 30.0° to the horizontal to move a 15 kg object at a constant speed for a horizontal distance of 5.0 m. *[ans: 430 J]*

c) An upward force is applied to lift a 15 kg object to a height of 5.0 m at constant speed. *[ans: 740 J]*

2) A student with a mass of 56.0 kg runs up three flights of stairs in 12.0 seconds. The student has gone a vertical distance of 8.0 m. Determine the amount of work done by the student to elevate her body to this height. *[ans: 4400 J]*

3) Kaho carries a 20.5 kg suitcase up three flights of stairs (a height of 10.0 m) and then pushes it with a horizontal force of 50.0 N at a constant speed of 0.5 m/s for a horizontal distance of 35.0 m. How much work does Kaho do on his suitcase during this entire motion? *[ans: 3760 J]*

4) What is the meaning of positive work? Of negative work?

5) A 68 kg in-line skater starts from rest and accelerates up to a speed of 2.5 m/s in 15 m.
   a) Find her final total kinetic energy after the 15 m of travel. *[ans: 210 J]*
   b) After 15 m, she exerts a braking frictional force of 280 N. What is her stopping distance? *[ans: 0.76 m]*

6) A 2.0 g bullet initially moving with a velocity of 87 m/s [E] passes through a block of wood. On exiting the wood, the bullet's velocity was 12 m/s [E].
   a) How much work did the force of friction do on the bullet as it passed through the wood? *[ans: 7.4 J]*
   b) If the wood block was 4.0 cm thick, what was the average force that the wood exerted on the bullet? *[ans: 190 N [back]]*

7) Charlie, a 75 kg passenger in a van, is wearing a seat belt when the van moving at 15 m/s collides with a concrete wall. The front end of the van collapses 0.50 m in coming to rest.
   a) What was Charlie's kinetic energy before the crash? *[ans: 8400 J]*
   b) What average force did the seat belt exert on Charlie during the crash? *[ans: 17000 N [back]]*

8) A child on a sled (total mass of 47.5 kg) is at the top of a small hill, which has a height of 8.40 m. There is another, even smaller hill, a short distance beyond the first hill, which has a height of 3.87 m. Assuming that the snow is a frictionless surface, with what speed will the child read the top of the second hill if:
a) The child starts down the first hill from rest? *[ans: 9.42 m/s]*
b) The child starts down the first hill with a speed of 12 km/h? *[ans: 10.0 m/s]*
c) What if the child's mass was 37.5 kg instead, would your answers in part a and b change? Why?

9) A frictionless ramp is inclined at an angle of 35°. A 540 g rock starts down the ramp from the top, with a kinetic energy of 5.3 J. The rock reaches the bottom of the ramp with 21.5 J of kinetic energy. What is the length along the incline of the ramp? *[ans: 5.3 m]*

10) The first loop on a roller coaster has a radius of 15.4 m. This loop is at the bottom of the first hill. At the top of this loop, the roller coaster has a speed of 15.6 km/h. A roller coaster cart on the track has a mass of 653 kg. Assuming that the track was frictionless,
a) What was the roller coaster's speed at the bottom of the loop? *[ans: 25.0 m/s]*
b) Assuming that the roller coaster barely made it to the top of the first hill, before going down the other side, what was the height of the first hill? *[ans: 31.8 m]*

11) A 60 kg student does 60 push-ups in 40 seconds. With each push-up, the student must lift an average of 70% of the body mass a height of 40 cm off the floor. Assuming two significant digits, calculate the following:
a) the work the student does against the force of gravity for each push-up *[ans: 160 J]*
b) the total work done against the force of gravity in 40 seconds *[ans: 9900 J]*
c) the power achieved for this period *[ans: 250 W]*

12) A water pump rated at 2.0 kW can raise 55 kg of water per minute at a constant speed from a lake to the top of a storage tank. How high is the tank above the lake? Assume that all the energy from the pump goes into raising the height of the water. *[ans: 220 m]*

13) How many minutes would it take a hair dryer rated at 1.5×10^3 W to use 5.0 MJ of energy? (note that 1 MJ = 1×10^6 J) *[ans: 56 minutes]*

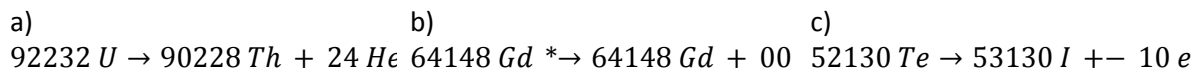14) A machine requires 580 J of energy to do 110 J of useful work. How efficient is the machine? *[ans: 19%]*

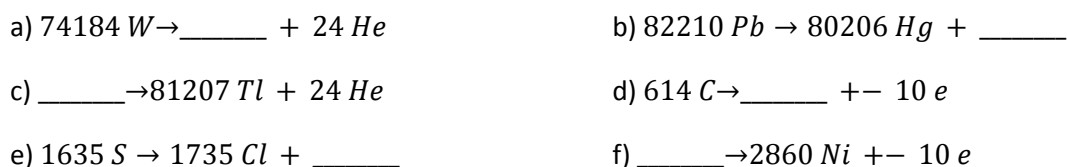# Unit 3 Part 2 Review (Thermal Energy and Nuclear Energy)

Thermal Energy

1) How much heat is absorbed by 1.00×10^2 g of ice at $-10.0\ ℃$ to become water at $20.0\ ℃$?
   [ans: 43800 J or 43.8 kJ]

2)
   [ans: 476000 J or 476 kJ]

3) How much heat is needed to change 2.00 kg of ice at $-50.0\ ℃$ into steam at $150.0\ ℃$?
   [ans: 6420000 J or 6420 kJ or 6.42 MJ]

4) An ice chest is filled with 4.50 kg of ice at $0.0\ ℃$. How much heat does it absorb as the ice completely melts? *[ans: 1500000 J or 1500 kJ or 1.5 MJ]*

5) A 40.0 g sample of chloroform is condensed from a vapour at $61.6\ ℃$ to a liquid at $61.6\ ℃$ by removing 9870 J of heat. What is the heat of vaporization of chloroform?
   [ans: 247000 J/kg or 247 kJ/kg]

6) If you add 25 g of ice at $0.0\ ℃$ to 366 g of water at $20.0\ ℃$, to what temperature will the water drop as the ice melts and as the resulting water warms? *[ans: 13.64℃ -> 14 ℃]*

7) To make iced tea, you start with 1.0 L of water initially at $90.0\ ℃$. What minimum amount of ice at $0.0\ ℃$ is needed to cool the tea to $0.0\ ℃$? *[ans: 1.13 kg -> 1.1 kg]*

8) How much heat needs to be added to 100.0 g of lead to just melt it if it starts at $20.0\ ℃$? Lead melts at $327.5\ ℃$ and has a specific heat capacity of 128 J/(kg℃). *[ans: 6440 J]*

9) How much heat needs to be added to 100.0 g of aluminium to just melt it if it starts at $20.0\ ℃$?
   [ans: 2.90×10^5 J or 290. kJ]

10) How far does a 1.00 g hailstone at $0.0\ ℃$ need to fall in order for it to melt completely?
   [ans: 34000 m]

11) How far would the 1.00 g raindrop in question 10) now need to fall to completely vaporize it? It starts at $0.0\ ℃$. *[ans: 270000 m]*

12) What are the three types of heat transfer. Explain each briefly.

Nuclear Energy

1) State whether each of the following decay reactions is alpha, beta, or gamma decay.

a) $$92232\ U \rightarrow 90228\ Th\ +\ 24\ He$$
b) $$64148\ Gd\ ^* \rightarrow 64148\ Gd\ +\ 00$$
c) $$52130\ Te \rightarrow 53130\ I\ +-\ 10\ e$$

2) Fill in the blank with the correct radioactive nucleus, decay particle or decayed nucleus in each of the following decay reactions.

a) $74184\ W \rightarrow$ _____ $+\ 24\ He$

b) $82210\ Pb \rightarrow 80206\ Hg\ +$ _____

c) _____ $\rightarrow 81207\ Tl\ +\ 24\ He$

d) $614\ C \rightarrow$ _____ $+-\ 10\ e$

e) $1635\ S \rightarrow 1735\ Cl\ +$ _____

f) _____ $\rightarrow 2860\ Ni\ +-\ 10\ e$

3) Write the balanced decay reaction formula when each of the following radioactive isotope decays in the manner stated.

a) $2045\ Ca$ (beta)

b) $94234\ Pu$ (alpha)

c) $84210\ Po$ (alpha)

d) $1124\ Na$ (beta)

4) What is the name of the product isotope formed when Radon-222 decays by alpha decay?
   [ans: Polonium-218]

5) What is the name of the product isotope formed when Thorium-234 decays by beta decay?
   [ans: Protactinium-234]

6) Does the identity of an atom change during radioactive decay? Why or why not?

7) List the 3 types of radiation (alpha, beta, gamma) in order from least penetrating to most penetrating.

8) Why would you expect alpha particles to be less able to penetrate materials than beta?

9) A 208 g sample of sodium-24 decays. How much of this radioactive isotope will remain after 3 half-lives? *[ans: 26 grams]*

10) Chromium-48 has a short half-life of 21.6 hours. How many half lives will occur in 2 days and 16.8 hours? *[ans: 3]*

11) Carbon-14 has a half-life of 5730 years. How much of a 144 g sample of carbon-14 will remain after 1.719×10^4 years? *[ans: 18.0 g]*

12) Potassium-42 has a half-life of 12.4 hours. How long will it take for 848 grams sample to decay to 26.5 grams? *[ans: 62.0 hours]*

Answers

1) a) alpha   b) gamma   c) beta   2) a) $72180\ Hf$ b) $24\ He$ c) $83211\ Bi$ d) $714\ N$ e) $-\ 10\ e$ f) $2760\ Co$