SPH 3U

Name: ANSWER FALL 2018

SPH 3U UNIT # 3 TEST – ENERGY & SOCIETY

Knowledge & Understanding / 13 Application / 31 Communication / 10 Thinking & Inquiry / 12

Multiple Choice (5 Knowledge Marks)

For each question, choose the answer that is most correct.

1. An isotope:

   a. Has the same number of protons and neutrons as the element on the periodic table
   (b.) Has the same number of protons but a different number of neutrons as the element on the periodic table
   c. Has a different number of protons but the same number of neutrons as the element on the periodic table
   d. Does not exist in nature
   e. none of the above

2. Work is not done when:

   a. the total energy of the system remains constant
   b. the angle between the force and displacement is 90°
   c. the object does not move
   (d.) all of the above * the correct answer
   (e.) b and c only

3. When heat is transferred through a vacuum, it is called:

   a. conduction
   b. convection
   (c.) radiation
   d. all of the above
   e. none of the above

4. 1 kg of uranium provides as much energy as ___ kg of coal:

   a. 1×10^{-6}
   b. 1×10^{-3}
   c. 1×10^{3}
   (d.) 1×10^{6}
   e. None of the above

5. Gamma particles have an atomic mass of:

   (a.) 0
   b. 1
   c. 2
   d. 4
   e. none of the above

SPH 3U Name: _____

Matching (1 mark each, total 8 Knowledge Marks)

Match the description in Column A with the correct type of energy from Column B.

Column A

D 1. The energy stored in a rubber ball as it hits a wall.

E 2. Rubbing your hands together on a cold winter day causes this type of energy.

A 3. When you plug anything into an outlet, you are using this type of energy.

H 4. When you light a match, you are turning this type of energy into thermal and light energy.

G 5. A rubber ball held at a height of 6 m above a desk would possess this energy, while a rubber ball sitting on the desk would not.

F 6. Solar panels turn this type of energy into electrical energy.

C 7. Uranium-235 atoms release this type of energy when split open.

B 8. A hockey puck is shot at the net. As it travels quickly across the ice it possesses this type of energy.

Column B

a. Electrical
b. Kinetic
c. Nuclear
d. Elastic
e. Thermal
f. Light
g. Gravitational Potential
h. Chemical

Calculations (31 Application Marks)

1. Show the nuclear decay for the following elements (6 marks, 2 marks each)
   a. $^{115}_{49}In$ undergoing beta decay

$$^{115}_{49}In \longrightarrow {}^{0}_{-1}e + {}^{115}_{50}Sn$$

(1) (1)

   b. $^{238}_{92}U$ undergoing gamma decay

$$^{238}_{92}U + {}^{0}_{-1}e \longrightarrow {}^{238}_{91}Pa + {}^{0}_{0}\gamma$$

(1) (1)

   c. $^{84}_{36}Kr$ undergoing alpha decay

$$^{84}_{36}Kr \longrightarrow {}^{4}_{2}He + {}^{80}_{34}Se$$

(1) (1)

2. A squirrel, with a mass of 1.2 kg, does 3000 J of work when running straight up a tree trunk. How high up the tree did the squirrel run? (3 marks)

SPH 3U

Name: _____

$m = 1.2\ kg$
$W = 3000\ J$ } (1)
$h = ?$

$E_g = mgh$ (1)

$h = \frac{E_g}{mg}$

$h = \frac{3000\ J}{(1.2\ kg)(9.8\ N/kg)} = 255.1\ m = 260\ m$ (1)

(3)

3. The Kingda Ka at the Six Flags Great Adventure Park is the tallest rollercoaster in the world (for now), with a height of 139 m.

a) If the cars have a gravitational potential energy of 1798104 J, determine their mass. (3 marks)

$E_g = 1798104\ J$
$m = ?$
$h = 139\ m$ } (1)

$m = \frac{E_g}{gh}$ (1)

$m = \frac{1798104\ J}{(9.8\ N/kg)(139\ m)}$

$m = 1320\ kg$
$= 1300\ kg$ (1)

(3)

b) If it takes 3.0 minutes for the cars to get to the top, determine the power. (4 marks)

$t = 3.0\ min = 180\ s$ (1)
$W = 1798104\ J$ } (1)
$P = ?$

$P = \frac{W}{t}$ (1)

$P = \frac{1798104\ J}{180\ s}$

$P = 9989.47\ W$
$P = 10000\ W$ (1)

(4)

4. When 2.1×10^4 J of heat is added to a substance with a specific heat capacity of 3.45×10^5 J/kg°C, its temperature increases from 1.5°C to 95°C. What is the mass of the substance? (3 marks)

$Q = 2.1 \times 10^4\ J$
$C = 3.45 \times 10^5\ J/kg°C$
$t_1 = 1.5°C$
$t_2 = 95°C$
$m = ?$ } (1)

$Q = mc(t_2 - t_1)$ (1)

$m = \frac{Q}{c(t_2 - t_1)}$

$m = \frac{2.1 \times 10^4\ J}{(3.45 \times 10^5\ J/kg°C)(95°C - 1.5°C)}$

$m = 0.00065101\ kg$
$m = 0.00065\ kg$
(1) $6.5 \times 10^{-4}\ kg$

(3)

5. A bull rider, with a mass of 75 kg, is thrown from a height of 2.2 m above the ground and is travelling at a speed of 21.5 m/s. Use the Law of Conservation of Energy to solve the following questions.

a. If the bull rider is thrown **straight up**, determine their maximum height. (8 marks)

13.

b. The bull rider lands on a barrel that has been knocked over, and has a height of 0.45 m. At what speed will the bull rider be travelling upon first contact with the barrel? (4 marks)

$m = 75\,kg$

	Throw	Max Height	Barrel
h	2.2 m ①	$\frac{E_g}{mg}$ 25.78 m = (26 m) ①	0.45 m
E_g	mgh 1617 J ①	$E_T - E_K$ 18951 J ①	mgh 330.75 J ①
v	21.5 m/s	0 m/s	$\sqrt{\frac{2E_K}{m}}$ 22.28 m/s (22 m/s) ①
E_K	$\frac{1}{2}mv^2$ 17334 J ①	$\frac{1}{2}mv^2$ 0 J ①	$E_T - E_g$ 18020 J ①
E_T	$E_K + E_g$ 18951 J ① →	18951 J ① →	18951 J ①

Define and Describe (10 Communication Marks)

1. List the steps needed for a nuclear power plant to create electricity. For each step, include the energy transformation that is occurring. (6 marks)

Name: _____

Uranium heats heavy water, which turns water to steam ①
(nuclear → thermal) ①

↓

Steam turns turbine ①
(thermal → kinetic) ①

↓

Turbine turns generator, creates electricity ①
(kinetic → electrical) ①

6

2. In one, well-written paragraph, state whether you are for or against nuclear power. Give reasons for your opinion. (4 marks)

Name: _____

(4)

4

SPH 3U

Name: _____

Short Answer (12 Thinking & Inquiry Marks)

1. Explain why an energy transformation that is more than 100% efficient would disprove the Law of Conservation of Energy. It might help to use equations to support your answer. (4 marks)

Law of Conservation of Energy states that energy cannot be created or destroyed, it only transfers forms.

$$\text{Efficiency} = \frac{\text{output}}{\text{input}} \times 100\%$$

For a reaction to be more than 100% efficient, output > input. This would mean energy was created during the transformation, which is not possible, according to the Law of Conservation of Energy.

SPH 3U

Name: _____

2. Prove that 1 kilowatt hour is equal to 3.6×10^6 J. (4 marks)

$P = 1\,kW$

$t = 1\,hour$

$W = Pt$

$W = (1\,kW)(1\,hour)$

$W = 1\,kWh$

but $P = 1\,kW = 1000\,W$

$t = 1\,hour = 3600\,s$

$W = Pt$

SPH 3U

Name: _____

3. You are given the following question:

An object is travelling 32 m/s at a height of 97 m above the surface of the Earth. Determine the speed of the object just before it hits the ground.

Prove that you do not need the mass of the object to solve this problem. (4 marks)

$E_{T\,before} = E_K + E_g$

$= \frac{1}{2}mv_1^2 + mgh_1$

$E_{T\,after} = E_K + E_g$

$= \frac{1}{2}mv_2^2 + mgh_2$

$E_{T\,before} = E_{T\,after}$

$\frac{1}{2}mv_1^2 + mgh_1 = \frac{1}{2}mv_2^2 + mgh_2$

Assuming m is constant, it can be cancelled out:

$\frac{1}{2}\cancel{m}v_1^2 + \cancel{m}gh_1 = \frac{1}{2}\cancel{m}v_2^2 + \cancel{m}gh_2$

$\therefore v_2 = \sqrt{2\left(\frac{1}{2}v_1^2 + gh_1 - gh_2\right)}$

$\therefore$ m is not needed to solve for v_2.