**Governor Stirling Senior High School**

**YEAR 11 PHYSICS**

**Task 4: Test 2- Heating and Cooling**

***Marking Key***

Section A consists of 15 questions, each worth one mark. Each question has only one correct answer. Circle the correct answer. Attempt all questions. Marks will not be deducted for incorrect answers.

1 What is the first law of thermodynamics?

A Matter can exist in four states: solid, liquid, gas and plasma.

B Matter can be neither created nor destroyed.

*C* Energy can be neither created nor destroyed.

D All matter is made up of small particles that are in constant motion.

2 How does the kinetic particle model define temperature?

A Temperature is the average rate of vibration of the particles.

B Temperature is the average speed of the particles.

C Temperature is the average velocity of the particles.

D Temperature is the average kinetic energy of the particles.

3 A (petrol) car sits at the bottom of a hill. A driver gets in and the car begins to accelerate up the hill. What is happening in terms of energy?

A As the petrol burns, heat energy is created.

B Chemical energy is converted into potential energy.

C Chemical energy is converted into kinetic energy.

D Chemical energy is converted into kinetic energy and potential energy.

4 A 100 g block of aluminium and a 100 g block of copper at room temperature are immersed in boiling water for 25 s. The specific heat capacity of aluminium is 900 J kg C–1 and of copper is 380 J kg C–1. Which will be at the highest temperature when they are both removed?

A The aluminium block

B The copper block

C Both will be at the same temperature.

D There is insufficient information to decide.

5 By which means is heat energy transferred?

A Convection

B Conduction

C Radiation

D All of the above

6 By which means is heat energy transferred through space?

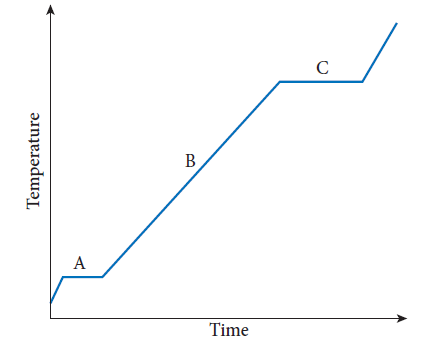
A Convection

B Conduction

C Radiation

D All of the above

A solid substance is heated at a constant rate. The graph below shows how its temperature changes over time. Use this graph to answer the next 3 questions.



7 What is the state of the substance at point A on the graph?

A Solid

B A mixture of solid and liquid

C Liquid

D Part liquid and part gas

8 What is the state of the substance at point B on the graph?

A Solid

B A mixture of solid and liquid

C Liquid

D Part liquid and part gas

9 What is the state of the substance at point C on the graph?

A A mixture of solid and liquid

B Liquid

C Part liquid and part gas

D Gas

10 Which of the following would make a material a good conductor of heat?

A Delocalised electrons

B The presence of ions (charged atoms)

C The lack of delocalised electrons

D Lots of air holes

11 Which of the following is not a form of electromagnetic radiation?

A X-rays

B Gamma rays

C Cosmic rays

D Radiant heat

12 Which of the following is true of a closed system?

A Energy can enter or leave, but the amount of matter remains constant.

B Matter can enter or leave, but the amount of energy remains constant.

C Both the total amount of matter and the total amount of energy remains constant.

D No work from an external source is done on the system.

13 Which of the following would be an isolated system?

A The inside of a refrigerator with the door closed

B The inside of a thermos flask with the lid on

C Any planet or moon

D The human body

14 Joe Cool is considering the eaves, or roof overhang, in his new house, in relation to solar radiation. What do you advise him to do?

A To maximise the benefits of the sunshine, don’t have any eaves.

B Have short eaves to keep out the summer sun but let in the winter sunshine.

C Have long eaves to insulate the house, particularly from the hot summer sun.

D Eaves don’t matter – spend money on insulation instead.

15 A bar heater is the most useful form of heating in a large open space because:

A Convection is increased near the heater so more energy flows off to the people.

B Conduction is increased so more heat gets to the people quicker.

C Conduction, radiation and convection all get to the people quicker.

D *Radiant energy goes directly to the people to heat them.*

Section B Short answer (30 marks)

Section B consists of four questions. Write your answers in the spaces provided.

1 400 mL of an unknown liquid is heated by adding 4800 J of heat energy. This causes its temperature to rise from 14°C to 38°C. What is the specific heat capacity of the unknown liquid?

(3 Marks)

Answer: Use ΔQ = mcΔT.

ΔQ = 4800 J, m = 0.4 kg and ΔT = 38°C – 14°C = 24°C (1 mark)

4800 J = 0.4 kg × c × 24°C

4800 J = 9.6c kg °C

c = 500 J kg–1 °C–1  (1 mark)

The specific heat capacity is 500 J kg–1 °C –1. (1 mark)

2 100 L of water at 10°C is added to a bath containing 500 L of water at 94°C. Find the final temperature of the bath, after it has reached thermal equilibrium, assuming no further heat is lost from the water. 1 L of water has a mass of 1 kg.

(3 Marks)

Answer: If the final temperature is x°C, then:

Heat before = heat after (1 mark)

0.1 kg × c × 10°C + 0.5 kg × c × 94°C = 0.6 kg × c × x°C (1 mark)

48 kg °C = 0.6x kg °C

x = 80°C (1 mark)

Alternative solution, if final temperature is x(in °C): (1 mark)

Heat lost by the 100 L = Heat gained by the 500 L

0.1 J × c × (x – 10)°C = 0.5 J × c × (94 – x)°C (1 mark)

0.1x – 1 = 47 – 0.5x

0.6x kg °C = 48 kg °C

x = 80°C (1 mark)

*Answer*: 80°C

3 A 2 kg block of ice at 0°C is being heated at a steady rate of 240 J s–1. How long will it take to melt, given that the latent heat of fusion (melting) of ice is 334 kJ kg–1?

(3 Marks)

Answer: Heat required for melting = mL

= 2 kg × 334 kJ kg–1

= 668 kJ = 668 000 J (1 mark)

Rate of heat = 240 J s–1.

After t s, the melting ice will have received 240t J of heat energy. (1 mark)

The ice will have all melted when 240t J = 668 000 J t ≈ 2783 s.

Time to melt ice ≈ 2783 s ≈ 46 min 23 s. (1 mark)

4 How much energy is required to convert a 1 kg block of ice at –10°C to water at 30°C? The specific heat capacities of water and ice are 4200 J kg–1 K–1 and 2100 J kg–1 K–1 and the latent heat of fusion (melting) of ice is 334 kJ kg–1.

(3 Marks)

Answer:

Heat ice to 0°C: ΔQ = mcΔT

= 1 kg × 2100 J kg–1 °C × 10°C

= 21 000 J (1 mark)

Heat required for melting = mL

= 1 kg × 334 kJ kg–1

= 334 kJ

= 334 000 J (1 mark)

Heat water to 30°C: ΔQ = mcΔT

= 1 kg × 4200 J kg–1 °C–1 × 30°C

= 126 000 J

Total heat needed = 21 000 J + 334 000 J + 126 000 J

= 481 000 J or 481 kJ (1 mark)

5 This is a list of some different types of radiation:

radio waves, X-rays, visible light, infrared light, gamma rays, ultraviolet light

Re-order the list so it goes from:

a lowest energy to highest energy**.**

Answer: Radio waves, infrared light, visible light, ultraviolet light, X-rays, gamma rays (2 marks; give 1 mark if order partially correct)

b lowest wavelength to highest wavelength.

Answer: Gamma rays, X-rays, ultraviolet light, visible light, infrared light, radio waves (1 mark)

c lowest frequency to highest frequency.

Answer: Radio waves, infrared light, visible light, ultraviolet light, X-rays, gamma rays (1 mark)

6 Find the efficiency of an 800 W heater that emits 45 600 J of heat energy in a minute.

(2 Marks)

Answer:

Rate of heat production = 45 600 J ÷ 60 s

= 760 J s1

= 760 W (1 mark)

Efficiency = 

= 95% (1 mark)

7 Explain why a person standing in a breeze is more likely to feel cold if their clothes are wet rather than dry.

(2 Marks)

***If wet – evaporation occurs, this extracts Lv from the body, making it cooler.***

**(2 marks)**

8 House insulation bats have an "R" value. **R** is called the **thermal resistance** of the material. The higher the value of R, the better the insulation.

The amount of heat conducted through an insulator per square metre each second, **H**, and the temperature difference across it, **(Th - Tc)**, are related to the thermal resistance of the insulator by the following formula:

Th – Tc

R = -----------

H

where Th and Tc are the respective temperatures on the hot and cold sides of the insulator.

A ceiling insulator has an R value of 3.0

1. Calculate the amount of heat conducted through it per square metre each second when the temperature difference is 8.0 oC.

(2 Marks)

ΔT = 8.0 oC H = ΔT/R

R = 3.0 = 8/3

= 2.67 Jm-2s-1

(2)

9 At a certain time, insolation is 160 J m2 s1, of which 10% is reflected. Four solar hot water panels on the roof each measure 2.5 m × 1.5 m. The system contains 1000 L of water, of specific heat capacity 4200 J kg1 K1. The mass of 1 L of water is 1 kg.

a How much energy is received by the panels in an hour, assuming no heat loss other than the 10% reflection?

(3 Marks)

Answer:

Rate of reflection = 10% of 160 J m–2 s–1 = 16 J m2 s1

Rate of heat transfer to panels = 160 – 16 J m–2 s–1 = 144 J m2 s1 (1 mark)

Total area = 4 × 2.5 m × 1.5 m = 15 m2.

Total time = 3600 s (1 mark)

Amount of energy reaching this area = 144 J m–2 s–1 × 15 m2 × 3600 s

= 7776 kJ (1 mark)

b By how many degrees will the temperature of the water rise in the hour?

(2 Marks)

Answer:

ΔQ = mcΔT

7 776 000 = 1000 × 4200 × ΔT (1 mark)

ΔT ≈ 1.85°C or 1.85 K (1 mark)