Heat Questions

Part A: Theoretical Questions

1. Explain the difference between temperature and the quantity of heat.
2. What factors control the amount of thermal energy in an object?
3. Explain the principle of heat exchange.
4. How long will heat exchange take place between two objects?
5. Define melting point and boiling point.
6. Explain the difference between boiling and evaporation.
7. Which material would be better for making a calorimeter: tin, paraffin wax or graphite?

Part B: Heat Capacity and Specific Heat Capacity

1. Calculate the amount of energy released when 120 g of copper is cooled by 25 °C.
2. Calculate the amount of energy required to heat 0.225 g of lead by 8.75°C.
3. Calculate the amount of energy needed to heat 40.8 g of water by 12.5 °C.
4. Calculate the amount of energy released when 15.3 g of iron is cooled from 1250 °C to 875 °C.
5. Calculate the amount of energy required to heat 336 g of ice from -7.4 °C to -1.9 °C.
6. Calculate the mass of gold that will rise from 25.0 °C to 29.6 °C when 2130 J of energy is added.
7. Calculate the temperature change when 3.56 kg of zinc is heated with 865 J of energy.
8. Calculate the change in temperature when 88.8 g of paraffin wax has 475 J of energy added.
9. What is the final temperature when 2.33 kJ of energy is added to 35.0 g of tin at 50.0 °C?
10. What is the final temperature when 16.9 g of silver at 444 °C has 288 J of energy added?
11. What was the initial temperature if 0.654 kJ of energy causes 290. g of water to end up at 76.9 °C?
12. When 310. kJ of energy is added to 2134 g of helium at room temperature (25 °C), what will be the final temperature?

Substance	Phase	c_p $J \cdot g^{-1} \cdot K^{-1}$
Air (Sea level, dry, 0 °C)	gas	1.0035
Air (room conditions)	gas	1.012
Aluminum	solid	0.897
Ammonia	liquid	4.700
Animal tissue	mixed	3.5
Antimony	solid	0.207
Argon	gas	0.5203
Arsenic	solid	0.328
Beryllium	solid	1.82
Bismuth	solid	0.123
Cadmium	solid	0.231
Carbon dioxide	gas	0.839
Chromium	solid	0.449
Copper	solid	0.385
Diamond	solid	0.5091
Ethanol	liquid	2.44
Gasoline	liquid	2.22
Glass	solid	0.84
Gold	solid	0.129
Granite	solid	0.790
Graphite	solid	0.710
Helium	gas	5.1932
Hydrogen	gas	14.30
Iron	solid	0.450
Lead	solid	0.129
Lithium	solid	3.58
Magnesium	solid	1.02
Mercury	liquid	0.1395
Methane at 2 °C	gas	2.191
Methanol	liquid	2.597
Nitrogen	gas	1.040
Neon	gas	1.0301
Oxygen	gas	0.918
Paraffin wax	solid	2.5
Silica (fused)	solid	0.703
Silver	solid	0.233
Sodium	solid	1.230
Tin	solid	0.227
Tungsten	solid	0.134
Uranium	solid	0.116
Water vapour (at 100 °C)	gas	2.080
Water (at 25 °C)	liquid	4.1813
Water (ice) (at −10 °C)	solid	2.11
Zinc	solid	0.387

Part C: Calorimetry Questions

1. If a calorimeter with a heat capacity of 440 kJ/˚C has 24480 J of energy added, what is the change in temperature?

2. A calorimeter with a heat capacity of 128 kJ/˚C contains 75 g of water at 22.2 ˚C. If the temperature increases to 45.7 ˚C, then how much energy has been added?

3. If the temperature of 250 g of water in a calorimeter (C = 325 kJ/˚C) is decreased by 18.1 ˚C, what is the change in energy?

4. An iron calorimeter has a heat capacity of 68.85 kJ/˚C. What is its mass?

Part D: Phase Change Questions

1. Calculate the energy required to melt 2.34 kg of ice at 0˚C.

2. Calculate the amount of energy need to evaporate 355 g of alcohol at 78.3˚C.

3. How much energy is removed when 2309 g of ammonia at -75 ˚C is frozen.

4. Calculate the amount of energy needed to convert 15 g of lead at 300.˚C to a liquid.

5. Calculate the amount of energy needed to turn 65 g of ice at -14.6 ˚C to steam at 118.3 ˚C.

Substance	Latent Heat Fusion kJ/kg	Melting Point ˚C	Latent Heat Vaporization kJ/kg	Boiling Point ˚C
Alcohol, ethyl	108	−114	855	78.3
Ammonia	339	−75	1369	−33.34
Carbon dioxide	184	−78	574	−57
Helium			21	−268.93
Hydrogen	58	−259	455	−253
Lead	24.5	327.5	871	1750
Nitrogen	25.7	−210	200	−196
Oxygen	13.9	−219	213	−183
1,1,1,2-Tetrafluoroethane		−101	215.9	−26.6
Toluene		−93	351	110.6
Turpentine			293	
Water	333	0	2260 (at 100°C)	100
Iron	272	1538		2862

Part E: Heat Exchange Questions

1. What mass of iron at 296 ˚C would be needed to heat 3.00 kg of ammonia from 25.0 ˚ C to 38.5 ˚C?

2. A 72.0 g sample of water is cooled from 42.0 ˚C to 37.6 ˚C when a 24.1 g piece of metal that had been cooled to 7.4 ˚C is added. What was the metal?

3. A lump of iron at 25.0 ˚C is tossed into 32.1 kg of molten lead (c = 0.142 J/g°C) at 1625˚C and cools the lead to1438 ˚C. What is the mass of the iron?

4. Two gases are injected into an insulated container. The first gas, a 0.023 g sample of carbon dioxide cools from 133.2 ˚C to 97.7 ˚C, while the other 0.108 g sample heats up by 12.2 ˚C. What is the second gas?

5. Calculate the final temperature when a 3.88 g sample of tungsten at 1135˚C is combined with a 485 g sample of water at 18 ˚C.

6. Calculate the temperature of water created by mixing together 1.25 kg of water at 31.2 ˚C and 218 g of water at 99.0 ˚C.

7. A calorimeter with a heat capacity of 484 J/˚C contains 155 g of water at 18.5 ˚C. This heats up to 42.0 ˚C when a 46.14 g sample of tin is added. What was the initial temperature of the tin?

8. A 50.88 g sample of copper is dropped into a 185 g volume of water in a 12.5 g tin container at 22.2 ˚C which then heats up to 135.5 ˚C. What was the initial temperature of the copper? (Hint: bp = 100 ˚C)

Answers

Part B

1. Q = -1155 J
2. Q = 0.254 J
3. Q = 2.13 kJ
4. Q = -2.58 kJ
5. Q = 3.9 kJ
6. m = 3.6 kg
7. $\Delta T = 0.628$ °C
8. $\Delta T = 2.14$ °C
9. $T_2 = 343.27$ °C
10. $T_2 = 517$ °C
11. $T_1 = 76.4$ °C
12. $T_2 = 52.97$ °C

Part C

1. $\Delta T = 0.0556$ °C
2. Q = 3.02 MJ
3. Q = -5901 kJ
4. m = 15.3 kg

Part D

1. Q = 779 kJ
2. Q = 304 kJ
3. Q = -783 kJ
4. Q = 0.42 kJ
5. Q = 0.20 MJ

Part E

1. Q = 190350 J m = 1.64 kg
2. Q = 1324 J c = 1.819 J/g°C (beryllium)
3. m = 1.34 kg
4. Q = -0.685 J c = 0.52 J/g°C (argon)
5. $T_2 = 18.3$ °C
6. $T_2 = 41.29$ °C
7. $T_1 = 2580$ °C
8. $T_1 = 25\ 264$ °C (not very realistic)