National 5 Physics

Electricity and Energy

Problem Booklet

Contents

Specific Heat Capacity

1. What is the difference between heat and temperature?

2. What is meant by the following statement: “The specific heat capacity of water is 4180 J kg^{-1} $°C^{-1}$.”?

3. A 2.4 kg lump of brass is heated up by a Bunsen burner. When 9120 J of heat energy has been absorbed, the temperature of the brass increases by 10 °C. What is the specific heat capacity of the brass?

4. A pane of glass has a mass of 800 g. What is the temperature change of the glass if it is heated by 1000 J of heat energy?

5. A block of lead is heated from 24 °C to 28°C by a heat source that gives off 6144 J of heat energy. What is the mass of the lead block?

6. Copy and complete this table:

Heat Energy / J	Specific Heat Capacity / J kg^{-1} $°C^{-1}$	Mass / kg	Change in Temperature / °C
	2350	2.0	10
	902	5.0	25
36,900		4.5	2
6885		0.75	34
10,080	2100		12
105,600	480		40
2400	128	2.5	
27,690	2130	3.25	

7. In an experiment, a 2 kg block of copper is warmed with a 70 W electrical immersion heater. The temperature of the copper is measured every minute using a thermometer. The heat energy used is calculated by finding the power of the heater and using E = P t. The results are shown.

Heat Energy / J	Change In Temperature / °C
0	0
4,200	3.4
8,400	6.8
12,600	10.2
16,800	13.6
21,000	17.0

a) Using this data, draw a line graph and use the gradient of the straight line to find the specific heat capacity of copper.

b) Is this experimental value for the specific heat capacity of copper larger, smaller or the same as the actual value? Explain any difference.

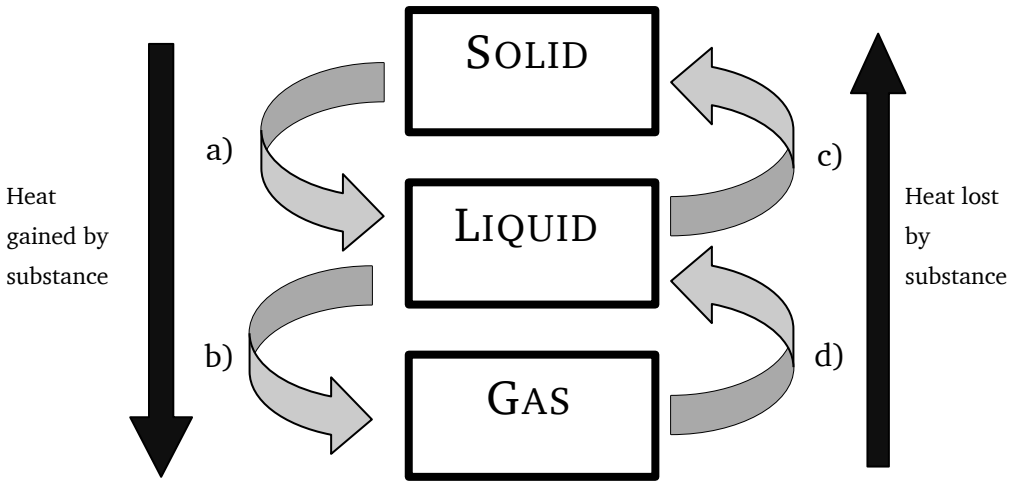
Latent Heat

1. What is the meaning of the following terms:

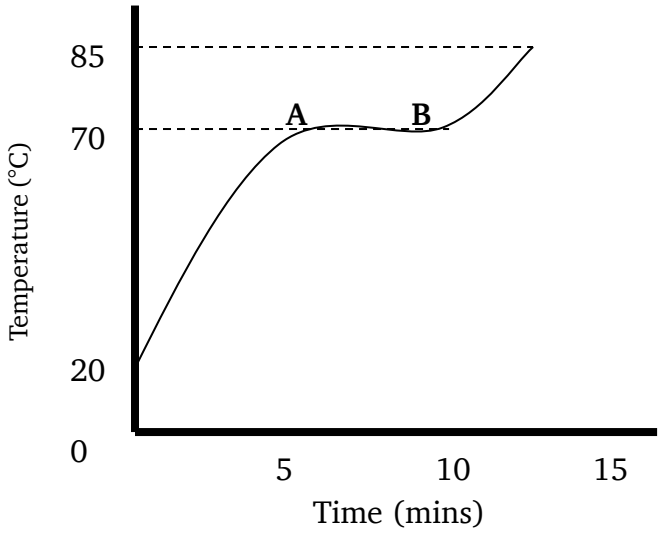
   a) Latent Heat of Vaporisation?

   b) Latent Heat of Fusion?

2. Complete this flow diagram to show the name given to each change of state.



3. Stearic acid is a solid at room temperature. 100 g of stearic acid is heated in a water bath until it reaches a temperature of 85 °C. A graph of how the temperature changes with time is shown.



Describe and explain what happens to the stearic acid between points A & B.

4. How much heat energy is required to:

    a) Turn 400 g of ice in to 400 g of water?

    b) Turn 400 g of water in to 400 g of steam?

5. How much heat energy is given out by:

    a) 700 g of steam turning in to 700 g of water?

    b) 700g of water turning in to 700 g of ice?

6. What is the mass of alcohol if 1.008 MJ of energy is required to change all of the alcohol from a liquid to a gas?

7. A 50 g substance is a gas at room temperature. It is cooled to a very low temperature and it becomes 50g of liquid. If the substance releases 18,850 J of heat energy as it changes state:

    a) What is the specific latent heat of vaporisation of the substance?

    b) What is the name of the substance?

8. In a laboratory, 150 g of water is found to have a temperature of 20 °C. It is heated to a temperature of 100 °C and it is all converted in to steam. How much heat energy is required to do heat 150 g of water at 20 °C in to 150 g of steam at 100 °C?

Pressure

1. What is the meaning of the term ‘pressure’ in terms of force and area?

2. A 480 g tin of baked beans is a cylinder with a radius of 3.2 cm. It is placed on a kitchen counter. What is the pressure on the counter caused by the tin?

3. A car of mass 1250 kg is driven on to a bridge. The pressure on the surface of the bridge when all four tyres are on the ground is 39.0 kPa. What is the contact area of one tyre on the bridge?

4. A television has a length of 124 cm, a height of 93 cm and a depth of 7.0 cm. If it has a mass of 30 kg, what is the:

   a) Maximum pressure that the television can exert on a surface?

   b) Minimum pressure that the television can exert on a surface?

5. By measuring your weight and the area of your feet, calculate the pressure that you exert on the floor when:

   a) You are standing normally.

   b) You are standing on one foot.

6. Are you more likely to fall through an icy lake if you are on your tip toes or lying flat on your back with your arms and legs stretched out? Explain your answer.

7. Copy and complete this table:

Pressure / Pa	Force / N	Area / m^2
	120	1.6
	4000	0.5
1.1×10^5		2.0
9000		8.0×10^{-2}
12,000	7.2×10^5	
1.4×10^4	4.9×10^4	

Gas Laws

1. Explain, using the kinetic theory of particles, what happens to the particles in a liquid when it melts and becomes a gas.

2. Explain, using kinetic theory, how the air in a bicycle tyre creates pressure on the inside surface of the tyre.

3. Why does the Kelvin temperature scale start at –273 °C?

4. Convert these temperatures from degrees Celsius to Kelvin.

   a) 0°C

   b) 20°C

   c) –273°C

   d) 100°C

5. Explain, using the appropriate gas law, why it is important that car tyres are not filled up with so much air that the air pressure is above the car manufacturer's guidelines?

6. At a temperature of 20 °C, the pressure of a fixed mass of gas in a sealed container is found to be 104 kPa. The gas is heated to a uniform temperature of 90 °C using a heat bath. What is the pressure of the gas at a temperature of 90 °C?

7. The pressure of the air in a lorry tyre is found to be 2.58×10^5 Pa at the end of a journey. Once the tyre has cooled down, the temperature of the air inside the tyre is found to be 10 °C with the pressure decreasing to 2.41×10^5 Pa. What was the temperature of the air in the tyre at the end of the journey? Give your answer in degrees Celsius.

8. Explain, using the appropriate gas law, why a balloon will burst if you squeeze it.

9. A 5 cm^3 syringe is filled with air and the pressure of the air is found to be 1.01×10^5 Pa. The syringe plunger is then pushed until there is 3 cm^3 of air. What is the new air pressure?

10. A scuba diving air tank has a volume of 7.5 litres and is filled with air at a pressure of 1.21×10^7 Pa. What volume of air will be released by the tank at atmospheric pressure (1.01×10^5 Pa)?

11. The volume of a fixed mass of gas is 30.0 cm^3 at 30 °C. The temperature of the gas is increased to 60 °C without changing the pressure. What is the volume of the gas now?

12. A student makes this statement: "As the temperature of the gas has doubled, the volume of the gas will also double. Therefore, the volume of the gas at 60 °C will be 60.0 cm^3."

    a) Explain why this statement is incorrect.

    b) Calculate what the volume of the gas would actually be at 60 °C.

13. Air is trapped in a glass capillary tube by a bead of mercury. The volume of air is found to be 0.15 cm^3 at a temperature of 27 °C. Assuming that the pressure of the air remains constant, what is the volume of the air at a temperature of 87 °C?

14. A fixed mass of gas is trapped in to a syringe. The gas has a pressure of 1.63×10^5 Pa when it has a volume of 3.0 cm^3 and a temperature of 22 °C. The gas is then heated until it has a uniform temperature of 57 °C. What will be the pressure of the gas if the volume of the gas is increased to 5.0 cm^3?